KANSAS STATE
UNIVERSITY

Structures Inspection Workbook

Certified Inspector Training Program

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Certified Inspector Training Workbook

Acknowledgement

Each of the sections of this manual were prepared by Construction Personnel of the Kansas Department of Transportation (KDOT) and contain information from the Standard Specifications for State Road and Bridge Construction, KDOT Construction Manual, KDOT Form Manual, KDOT CMS Manual, the Manual of Uniform Traffic Control Devices (MUTCD), and various other sources. This manual is not intended to replace any of the documents, but is intended as a training aid and reference for Certified Inspector Training. This manual should be used as a guide in preparation of documentation and other inspection activities only, for answers to project specific questions always refer to the latest edition of the documents mentioned, the contract, special provisions and plans for the project in question.

We wish to convey our appreciation to all contributors who assisted in the preparation of the manual.

BUREAU OF CONSTRUCTION AND MATERIALS EDITION 2019

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CIT Structures

Jake Pfannenstiel – Bridge Design Engineer
Andrew Spencer – Bridge Load Rating Engineer
Ron Hornick – District One, Area Two ET Specialist
Jimmy Parrish – District One, Area Three ET Specialist

Contact Information:

- Jake Pfannenstiel:
  785-296-5006
  Jake.Pfannenstiel@ks.gov
- Andrew Spencer:
  785-296-2718
  Andrew.Spencer@.ks.gov
- Ron Hornick:
  913-764-4525 ext. 203
  Ronald.Hornick@ks.gov
- Jimmy Parrish:
  913-942-3054
  James.Parrish@ks.gov

What this class is and is not

- This ***is*** an introductory class dealing with some of the important aspects of inspecting structures.
- It ***is*** a class to help clue you into where to find the information to do your job successfully.
- It ***is <u>not</u>*** going to tell you everything you need to know to be a good inspector. That takes time and experience.

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Keys to being successful in this class and in your jobs

- Relax and remember you can pass this class.
- Ask questions.
- Don't memorize the details/specs, they change too often. Learn how and where to find the details; Standard specifications, plans, special provisions, project specific special provisions.
- Be respectful to others.
- Enjoy yourself.

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CIT – Structures Standard Specifications

SS--1

- What are they?
- Who are they for?
  - KDOT
  - The Contractor
  - Local Projects
  - Outside entities (FHWA, DWR, AASHTO)

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1. *Project Special Provisions:*
   - Specifications pertaining to an individual Project;
2. *2015 Special Provisions:*
   - Revisions or Additions to the Standard Spec.;
3. *Plan Notes:*
   - Notes setting work limits and specifying Bid Items;
4. *2015 Standard Specifications:*
   - Overall standing parameters by which all works are constructed and paid for.

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- Division 150 – Equipment
- Division 200 – Earthwork
- Division 400 – Concrete
- Division 700 – Structures

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1. Project Special

-Example

(PS Label)

07-PS0425
Sheet 1 of 3
10-23 KA-1826-01

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2007 EDITION

OSTERBERG CELL LOAD TEST (DRILLED SHAFT)

1.0 DESCRIPTION

Conduct Osterberg Cell (O-Cell) load tests at the locations designated in the Contract Documents.

BID ITEM	UNIT
Osterberg Cell Load Test (Drilled Shaft)	Each

2.0 MATERIALS

Provide materials for the test drilled shaft according to **SECTION 703**.
Provide O-Cells with the minimum capacity (in each direction) designated in the Contract Documents. Provide O-Cells equipped with the necessary hydraulic lines, fittings, pressure sources, pressure gages, and telltale devices. Provide O-Cells from either:

LOADTEST, Inc. 2631-D NW 41st Street Gainesville, FL 32606 Telephone: (800) 368-1138 or (352) 378-3717 Fax: (352) 378-3934	or	LOADTEST, Inc. 5402 S Klee Mill Rd, Suite 4 Sykesville, MD 21784 Telephone: (800) 436-2355 or (410) 552-1979 Fax: (410) 552-1843

The Engineer will accept the O-Cell based on brand name, compliance with the specified requirements, and visual inspection for condition at the point of usage.

Provide a recognized brand of portland cement and water from a source approved by the Engineer for the grout. The Engineer will accept the portland cement and water based on visual inspection.

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2. Special

2015 SPECIAL PROVISION

List All Special Provisions Latest Version of Special Provisions Help

Special Provision Divisions:

100 - General Clauses and Convents	600 - Flexible Pavement
150 - Equipment	700 - Structures
200 - Earthwork	800 - Incidental Construction
300 - Stabilized Subgrade, Base and Shoulders	900 - Roadside Improvement, Planting, and Seeding
400 - Concrete	1000 - Materials
500 - Rigid Pavement	

Questions or Comments about Special Provisions may be sent to:

Construction - Lee Ann Legge Materials - Stacey Lowe

ALL LATEST 100 150 200 300 400 500 600 700 800 900 MATERIALS HELP

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2. Special

150- Equip. (currently none)

rev. 12/01/15

2015 SPECIAL PROVISION

ALL LATEST 100 150 200 300 400 500 600 700 800 900 MATERIALS HELP

SECTION 200

SPECIFICATION NUMBER	TITLE	SECTION
15-02001	REMOVAL OF EXISTING STRUCTURES	202

400- Concrete

rev. 6/17/15

2015 SPECIAL PROVISION

ALL LATEST 100 150 200 300 400 500 600 700 800 900 MATERIALS HELP

SECTION 400

SPECIFICATION NUMBER	TITLE	SECTION
15-04001	KANSAS CITY METRO MATERIALS	400

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2. Special

700- Structures

rev. 09/28/16

2015 SPECIAL PROVISION

ALL LATEST 100 150 200 300 400 500 600 700 800 900 MATERIALS HELP

SECTION 700

SPECIFICATION NUMBER	TITLE	SECTION
15-07001	BRIDGE PROJECT MARKER	700
15-07002	PRESTRESSED CONCRETE MEMBERS	715
15-07003	STRUCTURAL STEEL FABRICATION	705
15-07003-R1	STRUCTURAL STEEL FABRICATION	705
15-07003-R02	STRUCTURAL STEEL FABRICATION	705
15-07004	STRUCTURAL METALS FABRICATION	744
15-07004-R01	STRUCTURAL METALS FABRICATION	744
15-07005	QUALIFICATION OF FIELD WELDERS	713
15-07006	EXPANSION JOINTS	719
15-07007	DRILLED SHAFT (SPECIAL)	
15-07008	SIGN STRUCTURES AND BRIDGE MOUNTED SIGN ATTACHMENTS	722
15-07009	HIGH MAST LIGHT TOWERS	738

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3. Plan

GENERAL NOTES

EMBANKMENT: Complete the embankment at the abutments as shown on the Bridge Excavation sheet prior to driving the abutment piling or commencing with the abutment footing excavation.

BRIDGE EXCAVATION: All excavation shall be Class III. See the Bridge Excavation sheet for the limits of pay excavation.

BACKFILL COMPACTION: Compact backfill at the abutments and piers.

PILING: Drive all piling to penetrate or bear within the sand and gravel of the undifferentiated Pliocene and Pleistocene deposits. Bedrock will not be encountered at this site. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile DrivingFormula Load of:

Abutment No. 1   69.8 Tons
Pier No. 1 80.6 Tons
Pier No. 2 76.6 Tons
Pier No. 3 80.6 Tons
Abutment No. 2   69.8 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

PILING SPLICE LOCATION: Integral pile splice locations and weld testing criteria for, Abutments No. 1 & 2 will follow the "Standard Pile Details" Sheet (BR110).

TEST PILE SPECIAL: Drive the test pile special at the locations directed by the Engineer/Geologist or as on the Plans. Use (Pile Driver Analyzer) (PDA) equipment and methods compliant with KDOT Specifications. The test piling shall remain in place as permanent piling. Drive the test pile special piling to the resistance value of the Strength load divided by Phi shown on the plans.

CONCRETE: Superstructure concrete is bid as Concrete (Grade 4.0)(AE)(SA). Substructure concrete is bid as Concrete (Grade 4.0)(AE). If desired, the Contractor may use Concrete (Grade 4.0) in the footings and in the abutments below the construction joint. Bevel all exposed edges of all concrete with a ¾" triangular molding, except where noted on the plans. Construction joints are optional, but if used, place only at locations shown, or at locations approved by the Engineer.

REINFORCING STEEL: All reinforcing steel dimensions are to the centerline of bars unless otherwise noted. All reinforcing steel, except the spiral bars, shall conform to the requirements of ASTM A615, Grade 60. Spiral bars may meet the requirements of either ASTM A615 (Gr. 40 or 60) or A82, and are included in the bid item "Reinforcing Steel (Gr. 60)".

Where non-coated bars come in contact with epoxy coated bars, they need not be coated.

CONSTRUCTION LOADS: Limited traffic is permitted on the new sub-deck, one-course deck or any concrete overlay during the curing period, keep any exposed deck wet during the curing period. See KDOT Specifications Section 710 Tables 710-1 & 710-2 for additional information.

CONSTRUCTION JOINTS: The construction joints shown are optional with the Contractor. If used, place the construction joints only at locations shown or at locations approved by the Engineer.

SLOPE PROTECTION (Aggregate): Place Slope Protection (Aggregate) to the limits and thicknesses shown on the plans or as directed by the Engineer. Use Aggregate Stone for Ditch Lining as described in Section 1114.

DRIP LINE PROTECTION: Place a 10 foot wide mat of geotextile under the rock/rubble embankment on the berm and berm slopes and centered on the drip lines of the slab.

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4. Standard

http://www.ksdot.org/burconsmain/specprov/specifications.asp

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SPECIFICATIONS

Updated 6/23/2015

2007

2007 Edition - Standard Specifications for State Road and Bridge Construction
NOTE: The 2007 Standard Specifications can be ordered by using the Standard Specifications and Construction Manual Order Form

2007 Special Provisions
NOTE: Project Special Provisions are NOT posted individually online. They can be found in the Contract Bidding Proposal, either the electronic file or paper copy.

Guidelines for Development, Review and Approval of Specifications

Commentary on the 2007 Standard Specifications for State Road and Bridge Construction **Updated 7-26-07**

Accounting and Cross Reference of the 1990 Special Provisions with the 2007 Standard Specifications for State Road and Bridge Construction **Updated 7-26-07**

Contact Information

If you have any questions or comments, please contact:

Ordering:
Standard Specifications and Construction Manual Order Form

Lee Alvarado
Bureau of Construction & Materials, 7th Floor
700 SW Harrison St

2015 - Effective July 2015 Letting

2015 Edition - Standard Specifications for State Road and Bridge Construction
NOTE: The 2015 Standard Specifications can be ordered by using the Standard Specifications and Construction Manual Order Form

2015 Special Provisions
NOTE: Project Special Provisions are NOT posted individually online. They can be found in the Contract Bidding Proposal, either the electronic file or paper copy.

Accounting and Cross Reference of the 2007 Special Provisions with the 2015 Standard Specifications for State Road and Bridge Construction **Updated 6-23-15**

Checklists/Manuals

Construction Checklists

Construction Manual

Documentation Manual

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4. Standard Specification

Typical information provided in each Section:

- Description (for Bid Items & Units)
- Materials
- Construction Requirements
- Measurement & Payment

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4. Standard Specifications

150- Equipment

DIVISION 150 - **EQUIPMENT**

151	COMPACTION EQUIPMENT
152	HAULING AND WEIGHING EQUIPMENT
153	MIXING PLANT FOR STABILIZED BASE AND SHOULDERS
154	CONCRETE PAVEMENT AND CONCRETE STRUCTURE EQUIPMENT
155	ASPHALT SURFACING AND ASPHALT PAVEMENT RECYCLING EQUIPMENT 15-ER-1-R08 - ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015
156	ROADSIDE IMPROVEMENT EQUIPMENT
157	OTHER EQUIPMENT

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4. Standard Specifications

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204	EXCAVATION AND BACKFILL FOR STRUCTURES
205	EXCAVATION AND EMBANKMENT FOR HIGHWAYS
206	SELECT SOIL
207	OVERHAUL
208	LINEAR GRADING
209	SPECIAL FILL
210	SALVAGING, STOCKPILING AND PLACING TOPSOIL
211	GEOFOAM LIGHTWEIGHT EMBANKMENT FILL
212	GEOFOAM LIGHTWEIGHT EMBANKMENT FOR VOID FILL
213	PREFABRICATED VERTICAL DRAIN
214	MECHANICALLY STABILIZED EARTH FILL
215	GRANULAR DRAINAGE BLANKET

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4. Standard Specifications

400- Concrete

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403	ON GRADE CONCRETE
404	CONCRETE FOR PRESTRESSED CONCRETE MEMBERS
405	CURING ENVIRONMENT

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4. S.S.

700- Structures

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703	DRILLED SHAFTS
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708	FALSEWORK AND FORM CONSTRUCTION
709	STEEL PERMANENT DECK FORMS
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4. Standard Specification

Example- 703 Drilled Shafts: Description – *(Bid Items/Units)*

703 - DRILLED SHAFTS

SECTION 703

DRILLED SHAFTS

703.1 DESCRIPTION

Construct drilled shafts by the cased or uncased method depe
Document requirements.

BID ITEMS	UNITS
Drilled Shaft (*) (**)	Linear Foot
Permanent Casing (*) (Set Price)	Linear Foot
Sonic Test (Drilled Shaft) (Set Price)	Each
Core Hole (Investigative)	Linear Foot

*Size
**Cased (If Contract Documents specify the cased method.)

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4. 2015 Standard Specification

Example- 703 Drilled Shafts

- Materials

703.2 MATERIALS

a. Concrete. Unless otherwise shown in the Contract Documents, provide Grade 4.0 concrete that complies with **SECTIONS 401, 402 and 1102**. Provide a mix design with a target slump of 9 inches ± 1 inch. Do not withhold mix water at the plant and do not add water at the site.

b. Grout/Flowable Fill. For backfilling the cross-hole sonic testing pipes and core holes, provide cementitious grout (mixed according to the manufacturer's directions) that complies with **DIVISION 1700**.

Provide grout or flowable fill for backfilling the void space between the temporary and permanent casing with:

- 28 day strength of 1000 psi;
- mortar sand, FA-M (**SECTION 1102**) mixed with 2 bags of Type II portland cement per cubic yard; and
- water-to-cement ratio less than 1.

c. Granular Backfill Material. Provide granular backfill material for backfilling the void space between the temporary and permanent casing that is fine enough to fill the entire volume. The Engineer will accept the granular material based on a visual inspection.

d. Reinforcing Steel. Provide steel bars for concrete reinforcement that comply with **DIVISION 1600**.

e. Casing. Provide casing of sufficient thickness to carry the working stresses and loads imposed on the casing during construction. At a minimum, use 14-gage corrugated metal pipe (CMP) for the permanent casing.

If required, provide a permanent casing that is less than or equal to 1 inch out-of-round. The deviation of a chord from end to end shall be a maximum of 2 inches.

The Engineer will accept the casing based on compliance with the specified requirements, and visual inspection for condition.

f. Pipe for Sonic Testing. Provide pipe that complies with **DIVISION 1900**.

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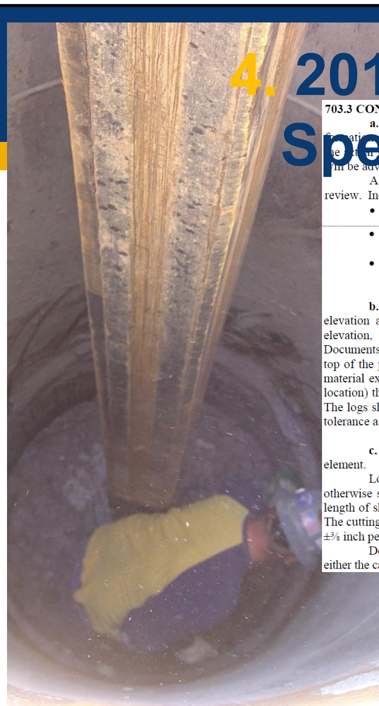
4. 2015 Standard Specification



703.3 CONSTRUCTION REQUIREMENTS

a. General. Drilled shaft lengths shown in the Contract Documents are an estimate from the top of formation elevations determined from borings. Actual formation elevations encountered at each shaft, may require the actual length of each drilled shaft be adjusted. If the Engineer changes the drilled shaft lengths, the Contractor will be advised (in writing) of the revised bottom of rock socket elevation.

A minimum of 28 days before constructing the drilled shafts, submit an installation plan to the Engineer for review. Include the following:

- Name and experience record of the drilled shaft superintendent in charge of drilled shaft operations;
- List of proposed equipment, such as cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core-sampling equipment, tremies or concrete pumps and casing; and
- Details of concrete placement, including proposed operational procedures for tremie and pumping methods and method of achieving a sealed tremie or pump.

b. Investigative Core Hole. Provide NX sized (2.125 inches) core samples organized in descending elevation and stored in standard core cardboard boxes. Perform this work, from the existing ground surface elevation, 15 working days in advance of the drilled shaft construction, at locations shown in the Contract Documents or ordered by the Engineer. Extract and maintain a core of the foundation material from 4 feet above the top of the plan tip elevation to 6 feet below the plan tip elevation shown in the Contract Documents. Discard all material extracted above 4 feet above the top of the plan tip elevation. Maintain, protect and label (elevation and location) these samples for review by the KDOT. While drilling, prepare a continuous standard drilling/coring log. The logs shall remain with the sample for review. Survey the location of the core hole with the same construction tolerance as **subsection 703.3c**.

c. Excavating the Drilled Shaft. Prior to constructing drilled shafts, complete the excavation for the entire element.

Locate the top of the shaft within 2 inches of the location shown in the Contract Documents. Unless otherwise shown in the Contract Documents, bore all shafts plumb to within a tolerance of 1 inch per 10 feet of length of shaft, not to exceed 6 inches over the full length of the shaft. The bottom of the shaft shall be nearly flat. The cutting edges of excavation equipment shall be normal to the vertical axis of the equipment within a tolerance of ±3/8 inch per foot of diameter.

Depending upon site conditions and requirements in the Contract Documents, construct the drilled shaft by either the cased or uncased method:

Example- 703 Drilled Shafts

- Const. Requirements

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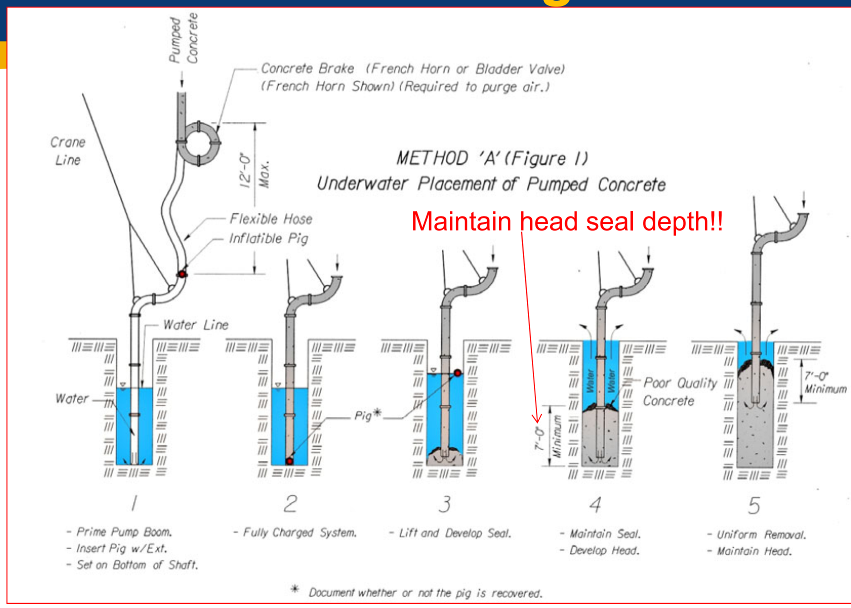
4. S. *Figures*



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4. Standard

Example- 704 Piling

Pile tip (bottom) is as bad or worse than the top condition.

Description –

(Bid Items/ Units)

704.1 DESCRIPTION

Drive the specified types of piles to the penetration and bearing values shown in the Contract Documents.

BID ITEMS	UNITS
Piles (*) (**)	Linear Foot
Test Piles (*) (**)	Linear Foot
Test Piles (Special) (*) (**)	Linear Foot
Cast Steel Pile Points	Each
Pre-Drilled Pile Holes	Linear Foot

*Type: Cast-In-Place Concrete, Prestressed Concrete, Steel or Steel Sheet, Corrugated Metal Sheet [+]
**Size
[+]Black or Galvanized

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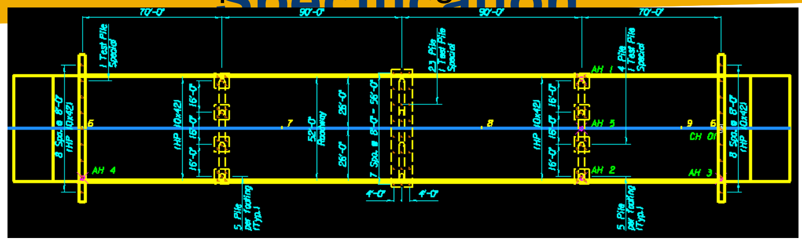
4. Standard Specification

Example- 704 Piling – Test Pile



704.4 *Construction Requirements*

b. Test Pile (Special). Pile Driving Analyzer (PDA). The Engineer will use the PDA to monitor the driving of the test piles (special). Provide the Engineer with the completed "Pile and Driving Equipment Data" sheet a minimum of 3 weeks before the scheduled date of driving piling. The Engineer will forward this information to the Chief Geologist.

In order to mobilize the PDA, notify the Engineer a minimum of 5 working days before driving the test piles (special). Prior to driving the test pile (special), the Engineer will require approximately 1½ hours to prepare the test piling (special) and install the dynamic measuring equipment. If with prior approval, the piles are to be welded prior to the Engineer attaching the testing equipment, provide the Engineer with safe and reasonable means of access to the pile for preparing the pile and attaching the instruments.

When a restrike is required by the Engineer, follow **subsection 704.4e.(3).** for restrike procedures.

To obtain the estimated ultimate loads, the Engineer will use the PDA to take dynamic measurements as the test pile (special) is driven to the required driving resistance. If non-axial driving is indicated by dynamic test equipment measurements, immediately realign the driving system. The Engineer will use the PDA results to provide the Contractor with a blow count for production driving.

4. Standard Specification

Example- 704 Piling

TABLE 704-1: PILE FORMULAS, (p. 700-19)

TABLE 704-1: PILE FORMULAS

Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2\ W\ H}{S + 1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S + 0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S + 0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S + 0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S + 0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S + 0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers

** For diesel hammers, the quantity X/W shall not be less than 1.

P = safe bearing power in pounds

W = weight in pounds, of striking part of hammer

H = height of fall in feet

E = energy of ram in foot-pounds per blow

S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers

X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

4. Standard

Example- 708 Falsework & Form Construction

-Description

-Bid Item

708.1 DESCRIPTION

Design and construct safe, adequate falsework to provide the necessary rigidity, support the loads imposed and produce the final structure to the lines and grades shown in the Contract Documents. Falsework is defined to be any temporary structure which supports structural members or form work.

BID ITEM	**UNITS**
Falsework Inspection	Lump Sum

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4. Standard

Example- 708 Falsework & Form Construction

- Materials

Any grinding needs to be parallel to direction of beams.

708.2 MATERIALS

Use sound falsework piling to withstand driving, is reasonably straight, and is of sufficient size to provide the strength to safely carry the actual loads imposed. Use sound timber in good condition and free from defects that might impair its strength.

All approved metal or wood forms shall present a smooth surface, be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including placement and vibration of the concrete.

Do not use aluminum forms in contact with concrete.

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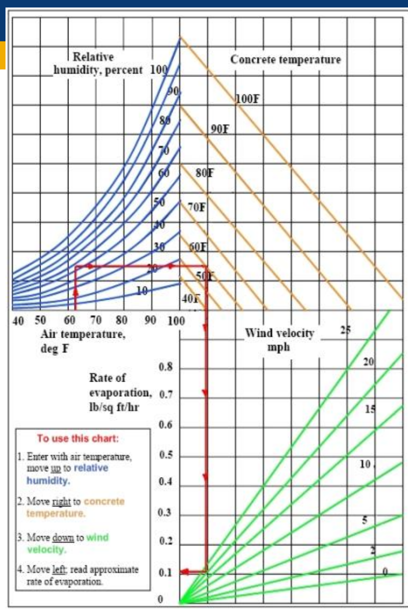
4. Standard
ication



Example- 710 Concrete Structure Construction

Fig. 710-1, Evaporation Rate Chart, p. 700-42

(Goal is to eliminate plastic shrinkage cracks.)

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4. Standard
ion

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS

Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay) Bridge Overlays	14 Wet Plus 7 Curing Membrane	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.

Example- 710 Concrete Structure Construction-

TABLE 710-1

p. 700-45

Minimum Cure Times

Kansas Department of Transportation

4. Standard Specification

Example- 710 Concrete Structure Construction

Load Limits on Decks, TABLE 710-2 p. 700-46

Construction loads on the new bridge subdeck, new one-course deck or any concrete overlay are subject to the limitations in **TABLE 710-2**. The use of supplemental cementitious materials will require additional time before specified loading is allowed.

TABLE 710-2: CONCRETE LOAD LIMITATIONS ON BRIDGE DECKS

Days after concrete is placed	Element	Allowable Loads
1*	Subdeck, one-course deck or concrete overlay	Foot traffic only.
3*	One-course deck or concrete overlay	Work to place reinforcing steel or forms for the bridge rail or barrier.
7*, Δ	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10 *, Δ (15)**, Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Light truck traffic (gross vehicle weight less than 5 tons).****
14 *, Δ (21)**, Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Legal Loads; Heavy stationary loads with the Engineer's approval.***Overlays on new decks.
28	Bridge decks	Overloads, only with the State Bridge Engineer's approval.***

*Maintain the specified wet cure at all times (**TABLE 710-1**).
** All haunched slab structures.
*** Submit the load information to the appropriate Engineer. Information that will be required is the weight of the material and the footprint of the load, or the axle (or truck) spacing and the width, the size of each tire (or track length and width) and their weight.
****An overlay may be placed using pumps or conveyors until legal loads are allowed on the bridge.
Δ Increase time period by 3 days when supplemental cementitious materials are used October 1 thru April 30.

Kansas Department of Transportation

All

- Read & Review all parts carefully
- When in doubt Ask and Investigate
- Do not abandon Common Sense

Thanks for Your Attention.

Kansas Department of Transportation

CIT Structures

Construction Manual

Construction Manual

FOREWORD

This manual has been published to provide construction personnel engaged in inspection activities with a convenient guide for the procedures and methods that are acceptable for the construction of state highway projects under the supervision of the Kansas Department of Transportation.

The procedures, methods and guidelines herein are meant as a guide only and may be modified and/or revised to better fit any given situation or circumstance.

The Construction Manual is not intended as a textbook of highway engineering, but rather as a reference book of guidelines. It is essential that the user have a thorough understanding of the specifications as well as this manual.

Many of the guidelines herein contained are general in character and are not to be construed as replacing, modifying, or superseding any of the provisions of the specifications, plans or contract.

In keeping with the idea that the Highway Construction Industry is an, ever-changing entity, requiring constant re-evaluation of policy and procedures, the format was devised to provide for addition, change, and elaboration of content without the necessity of republishing the entire manual. Each recipient of this manual is requested to suggest needed additions and changes. The suggestions should be submitted through the appropriate channels to the office of the Bureau Chief of Construction and Materials. If revisions are necessary, they will be published by the Headquarters Construction staff and transmitted to the recipients of manuals, whose responsibility it shall be to post these revisions.

Construction Manual

- Parts I – V
  - Part I General
  - Part II Contract Administration
  - Part III Surveying
  - Part IV Construction Inspection
  - Part V Materials and Testing

Kansas Department of Transportation

Construction Manual

- Part I General (definitions and outlines)
  - Part 1.03.13 Field Engineer
    - Supervises and directs the activities of all personnel involved in the construction
  - Part 1.03.14 Project Engineer and Engineering Technicians
    - Directly responsible to the Field Engineer
    - Supervises and inspects operations
    - Keeps documentation records and makes reports

Kansas Department of Transportation

Construction Manual

- Part I General (definitions and outlines)
  - Part 1.04.06 Contractor
    - Proper relations between the Contractor and KDOT personnel are of the utmost importance.
    - Adhere to the plan, specifications and contract requirements, as closely as possible.

Kansas Department of Transportation

Construction Manual

- Part I General (definitions and outlines)
  - Part 1.04.08 Federal Highway Administration
    - The role of the Federal Highway Administration (FHWA) in relation to federally financed highway construction is to review and require modifications, as necessary, to construction oversight and material acceptance procedures to the extent necessary to be able to provide assurance to Congress that the Contractor constructs these projects in close conformance with approved plans, specifications and change orders.

Kansas Department of Transportation

Construction Manual

- Part I General (definitions and outlines)
  - Part 1.05.01 Integrity
    - Absolute integrity on the part of all KDOT personnel is essential to maintain public confidence in KDOT.
  - Part 1.07.01 Safety
    - The Field Engineer and/or Project Coordinator are responsible for providing safety leadership at all time and safety enforcement, when necessary.
    - Safety is everybody's business.

Kansas Department of Transportation

Construction Manual

- Part II Contract Administration
  - Part 2.04.01 Quantity Changes
    - There are several items of work which are bid on a "planned quantity" basis, and unless either party questions the planned quantity , payment is made on the basis of the planned amount.

Kansas Department of Transportation

Construction Manual

- Part II Contract Administration
  - Part 2.07.02 Responsibility, Authority and Behavior of the Inspector
    - The Inspector is responsible for determining that the work is being constructed in accordance with the requirements of the Contract Documents. This does not give the Inspector the right to unnecessarily or willfully disrupt the operations of the Contractor.

Construction Manual

- Part II Contract Administration
  - Part 2.10.01 Measurement and Payment
    - The Standard Specifications prescribes, in general, how measurements of quantity shall be made.
    - Therefore before making any measurements on a project, the Field Engineer should study the Plans, Specifications and Special Provisions to determine first, what is to be measured, and second how it is to be measured.

Construction Manual

- Part II Contract Administration
  - **Part 2.11.03 Project Diary**
    - See the Construction Management System (CMS) User Manual for detailed information .
  - Part 2.11.04 Field Records
    - See the Construction Management System (CMS) User Manual for detailed information .

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Construction Manual

- Part III Surveying
  - Part 3.05.01 Benchmarks
    - Thoroughly check all benchmark elevations before any other level work is started.
  - Part 3.23 Surveys for Structures
  - Part 3.23.01 General
    - In staking out structures, set all lines and measurements absolutely correct.

Kansas Department of Transportation

Construction Manual

- Part III Surveying
  - Part 3.23.01 General
    - When possible, completely stake out the entire structure before structure construction begins.
    - Stake the line on the outside of all culverts and multiple-box bridges and offset the stakes a distance sufficient to clear the excavation.
    - Convey the system of staking each pier and abutment to all parties involved in the structure construction.

Kansas Department of Transportation

Construction Manual

- Part III Surveying
  - Part 3.23.05 Elevations
    - Set at least two benchmarks near each structure.
    - Prior to placing concrete, set molding and check elevation.
    - Also check for elevation after the concrete has been placed, and just before the finishing operation.

Kansas Department of Transportation

Construction Manual

- Part IV Construction Inspection
  - Part 4.05 Structures
  - Part 4.05.01 General
    - Review structure plans for possible errors in quantities and elevations.
  - Part 4.05.03 Inspection
    - The Inspector should check all the forms for line, elevation, plumbness, spacing, quality of lumber, bracing, strength, placement of reinforcing steel, etc. before any concrete is placed.

Kansas Department of Transportation

Construction Manual

- Part IV Construction Inspection
  - Part 4.05.04 Excavation
  - Part 4.05.05 Culvert Foundation
  - Part 4.05.06 Bearing Piles
    - After the Contractor completes the actual pile layout, it should be thoroughly checked by the inspector.
    - Before using any piling, it is the Inspector's responsibility to make certain that the material is tested and that the test reports are on file.

Kansas Department of Transportation

Construction Manual

- Part IV Construction Inspection
  - Part 4.05.06 Bearing Piles
    - a. Pile Lengths
    - b. Test Pile
    - c. Test Pile (Special)
    - d. Log of Continuous Pile Driving for Abutment and Pier Footings
    - e. Pile Driving Hammers
    - f. Driving Pile

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Construction Manual

- Part IV Construction Inspection
  - Part 4.05.07 Drilled Shafts

  - Part 4.05.08 Superstructure
    - a. Falsework Construction
    - b. Structural Steel Construction
    - c. Structure Construction
    - d. Form Removal

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Construction Manual

Computations of Quantities

Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest	Minimum Pay to Nearest
607	Asphalt Prime Coat	Emulsified Asphalt (*)	Ton		10 Gallons	.1 Ton	Ton
		Cutback Asphalt (*)	Ton		10 Gallons	.1 Ton	Ton
608	Asphalt Sealing	Cover Material (*)	CUYD	X	0.25 CU YD		CUYD
609	Single Asphalt Surface Treatment	Cutback Asphalt (*)	Ton		10 Gallons	.1 Ton	Ton
		Emulsified Asphalt (*)	Ton		10 Gallons	.1 Ton	Ton
610	Double Asphalt Surface Treatment	Asphalt Cement (*)	Ton		10 Gallons	.1 Ton	Ton
		Water (Flexible Pavement) (Set Price)	MGAL		0.1 MGAL		MGAL
		Manipulation (Asphalt Seal)	STA		0.1 STA		0.1 STA
		Manipulation (*.A.S.T.)	STA		0.1 STA		0.1 STA
611	Hot Mix Asphalt (HMA) - Commercial Grade	HMA - Commercial Grade (Class *)	Ton		20 LBS or 0.01 Ton^		Ton
		HMA - Commercial Grade (Class *) (Patching)	Ton		20 LBS or 0.01 Ton^		Ton
612	Milling	Milling	SQYD	X	0.1 FT	0.1 SQYD	SQYD
			Ton		20 LBS or 0.01 Ton^		Ton
613	Ultrathin Bonded Asphalt Surface	HMA Surface (Ultrathin Bonded) (*) (**)	Ton		20 LBS or 0.01 Ton^		Ton
614	Plant Mix Asphalt Construction	Aggregate for Asphalt Surface Course (*)	Ton		20 LBS or 0.01 Ton^		Ton
07-06001	(BM-Mixes)	Aggregate for Asphalt Base Course (*)	Ton		20 LBS or 0.01 Ton^		Ton
		Aggregate for Asphalt Surface Course (*) (Shoulders)	Ton		20 LBS or 0.01 Ton^		Ton
		Aggregate for Asphalt Base Course (*) (Shoulders)	Ton		20 LBS or 0.01 Ton^		Ton
		Asphalt Cement (**)	Ton		10 Gallons	.1 Ton	Ton
		Cutback Asphalt (**)	Ton		10 Gallons	.1 Ton	Ton
		Asphalt Core (Set Price)	Each		Each		Each
		Material for Asphalt Patching (Set Price) (***)	Ton		20 LBS or 0.01 Ton^		Ton
07-06002	Plant Mix Asphalt Construction - Commercial Grade (BM-Mixes)	Plant Mix Asphalt Mixture - Commercial Grade	Ton		20 LBS or 0.01 Ton^		Ton
		Plant Mix Asphalt Mixture - Commercial Grade (Patching)	Ton		20 LBS or 0.01 Ton^		Ton
07-06004	Asphalt Pavement - UGWC/KC/Kansas	Plant Mix Asphalt Mixture - Wyandotte County (*)	Ton		20 LBS or 0.01 Ton^		Ton
07-06010	HMA Base (Reflective Crack Interlayer (RCI))	HMA Base (RCI) (*)	Ton		20 LBS or 0.01 Ton^		Ton
		Quality Control Testing (HMA)	Ton		20 LBS or 0.01 Ton^		Ton
	DIVISION 700						
701	Temporary Shoring	Temporary Shoring	Lump Sum		Lump Sum		Lump Sum
702	Corrugated Metal Sheet Piling	* Corrugated Metal Sheet Piling	LNFT		0.1 LNFT		LNFT
703	Drilled Shafts	Drilled Shaft (*) (**)	LNFT		0.1 LNFT		LNFT
		Permanent Casing (*) (Set Price)	LNFT		0.1 LNFT		LNFT
		Sonic Test (Drilled Shaft) (Set Price)	Each		Each		Each
		Core Hole (Investigative)	LNFT		0.1 LNFT		LNFT

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Computations of Quantities

Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest	Minimum Pay to Nearest
704	Piling	Piles (*) (**)	LNFT		0.1 LNFT		0.1 LNFT
		Test Piles (*) (**)	LNFT		0.1 LNFT		0.1 LNFT
		Test Piles (Special) (*) (**)	LNFT		0.1 LNFT		0.1 LNFT
		Cast Steel Pile Points	Each		Each		Each
		Pre-Drilled Pile Holes	LNFT		0.1 LNFT		0.1 LNFT
706	Bearings and Pads for Structures	Elastomeric Bearing Pad (**)	Each		Each		Each
		Bearing (*) (**)	Each		Each		Each
707	Finger Plate and Modular Expansion Devise	Expansion Device (Finger Plate)	LNFT		0.1 LNFT		LNFT
		Expansion Device (Modular)	LNFT		0.1 LNFT		LNFT
708	Falsework and Form Construction	Falsework Inspection	Lump Sum		Lump Sum		Lump Sum
710	Concrete Structure Construction	Concrete (*) (**) (***)	CUYD	X	0.1 FT	0.1 CUYD	CUYD
711	Reinforcing Steel	Reinforcing Steel (*) (**)	LBS	X	0.1 FT	1 LB	10 LBS
		Reinforcing Steel (Repair) (*) (**) (Set Price)	LBS	X	0.1 FT	1 LB	10 LBS
712	Structural Steel Construction	Structural Steel (*) (**) (***)	LBS		LB		LB
		Structural Steel (Merchant Quality)	LBS		LB		LB
		Welded Stud Shear Connectors	Each		Each		Each
		Bridge Drainage System	Lump Sum		Lump Sum		Lump Sum
			LNFT		0.1 LNFT		LNFT
			Each		Each		Each
			LBS		LB		LB
714	Painting Structural Steel	Bridge Painting (*)	Lump Sum		Lump Sum		Lump Sum
		Environmental Protection	Lump Sum		Lump Sum		Lump Sum
		Power Wash	Lump Sum		Lump Sum		Lump Sum
715	Prestressed Concrete Members	Prestressed Concrete Beams (*) (**)	LNFT		0.1 LNFT		LNFT
		Prestressed Concrete Panels	SQFT	X	0.1 FT	0.1 SQFT	SQFT
716	Post - Tensioning (Haunched Slab Bridges)	Post - Tensioning for Slab Bridge	LBS	X	LB		LB
717	Silica Fume Overlay	Silica Fume Overlay (*) (**)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Material for Silica Fume Overlay (Set Price)	CUYD	X	0.1 FT	0.1 CUYD	CUYD
719	Expansion Joint (Strip Seal Assembly)Preformed Elastomeric (Neoprene & Compression & Other)	Expansion Joint (*)	LNFT		0.1 LNFT		LNFT
721	Handrail for Bridges & Other Uses	Bridge Handrail (*) (**)	LNFT		0.1 LNFT		LNFT
		Handrail (*) (**)	LNFT		0.1 LNFT		LNFT
722	Sign Structures & Bridge Mounted Sign Attachments	Bridge Mounted Sign Attachment (*)(**)	Each		Each		Each
		Butterfly Overhead Sign Structure(*)(**)	Each		Each		Each
		Cantilever Sign Structure(*)(**)	Each		Each		Each
		Overhead Sign Structure(*)(**)	Each		Each		Each
		Overhead Sign Structure (Mast Arm Type)(*)(**)	Each		Each		Each

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Construction Manual

Computations of Quantities

Section	Section Title	Pay Item	Unit	Comps	Minimum Measure to Nearest	Minimum Compute to Nearest	Minimum Pay to Nearest
722	Sign Structures & Bridge Mounted Sign Attachments (cont.)	Overhead Sign Structure (Single Tapered Tube)(*)(**)	Each		Each		Each
		Remove and Reset Sign Structure (***)	Each		Each		Each
		Reset Sign Structure (***)	Each		Each		Each
		Sign Structural Modification (***)	Each		Each		Each
723	Substructure Waterproofing Membrane	Substructure Waterproofing Membrane	SQYD	X	0.1 FT	0.1 SQYD	SQYD
724	Bridge Backwall Protection System	Bridge Backwall Protection System	SQYD	X	0.1 FT	0.1 SQYD	SQYD
725	Abutment Drainage Systems	Abutment Strip Drain	SQYD	X	0.1 FT	0.1 SQYD	SQYD
726	Concrete Masonry Coating	Concrete Masonry Coating	SQYD	X	0.1 FT	0.1 SQYD	SQYD
727	Repair (Structure)	Bridge Repair	Lump Sum		Lump Sum		Lump Sum
		Jacking of Existing Structure	Lump Sum		Lump Sum		Lump Sum
		Raise Expansion Device	Each		Each		Each
		Remove and Reset Expansion Device	Each		Each		Each
		Reset Existing Bearing	Each		Each		Each
728	Bridge Curb Repair	Bridge Curb Repair	LNFT		0.1 LNFT		LNFT
729	Multi-Layer Polymer Concrete Overlay	Multi-Layer Polymer Concrete Overlay	SQYD	X	0.1 FT	0.1 SQYD	SQYD
730	Epoxy Resin Crack Repair	Epoxy Resin Crack Repair	LNFT		0.1 LNFT		LNFT
731	Area Prepared for Patching (Existing Concrete Bridge Decks)	Area Prepared for Patching	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Area Prepared for Patching (Full Depth)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Area Prepared for Patching (Poured with Overlay)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
		Reinforcing Steel (Repair) (*) (**) (Set Price)	LBS	X	0.1 FT	1 LB	10 LBS
732	Machine Preparation (Existing Concrete Bridge Decks)	Machine Preparation (*)	SQYD	X	0.1 FT	0.1 SQYD	SQYD
733	Hydrodemolition	Hydrodemolition	SQYD	X	0.1 FT	0.1 SQYD	SQYD
734	Structural Plate Structures	(*) Structural Plate Pipe (**) (***)	LNFT		0.1 LNFT		LNFT
		(*) Structural Plate Pipe Arch (**) (***)	LNFT		0.1 LNFT		LNFT
		(*) Structural Plate Arch (**) (***)	LNFT		0.1 LNFT		LNFT
735	Precast Reinforced Concrete Box	Reinforced Concrete Box (*) (Precast)	LNFT		0.1 LNFT		LNFT
07-07001	Bridge Project Marker	Bridge Project Marker	Each		Each		Each
07-07003	Heat Straightening (In-Place) of Damaged Structural Steel	Heat Straightening Repair	LNFT		0.1 LNFT		LNFT
07-07012	Expansion Joint (Membrane Sealant)	Expansion Joint (Membrane Sealant *)	LNFT		0.1 LNFT		LNFT
07-07018	Rolled Beam Detour Bridge	Erect and Remove Rolled Beam Detour Bridge	Lump Sum		Lump Sum		Lump Sum
		Furnish Rolled Beam Detour Bridge	Lump Sum		Lump Sum		Lump Sum

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- Part V Materials
  - Section 5.1 General
  - Section 5.2 Quality Control/ Quality Assurance
  - Section 5.3 Mix Design Methods
  - Section 5.4 Laboratory and Sample Identification
  - Section 5.5 Required Sample Sizes
  - Section 5.6 Aggregates
  - Section 5.7 Inspection and Sampling of Materials
  - Section 5.8 Nuclear Gauge

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- Part V Materials
  - Section 5.9 Sampling and Test Methods Forward
    - 5.9.17 KT-17 Sampling Freshly Mixed Concrete
    - 5.9.18 KT-18 Air Content of Freshly Mixed Concrete by the [redacted]

Construction Manual

- Part V Materials
  - Section 5.10 Calculations
  - Appendicies
    - **Appendix A - Sampling and Testing Frequency Chart – Non-Quality Control/Quality Assurance**
      - Appendix A is found in the back of the Part V, along with appendix B,C and D

Construction Manual

SAMPLING AND TESTING FREQUENCY CHART
NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)							
GRANULAR BASE Sec. 307 and 1106 (Continued)							
Combined Aggregate (continued)	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACI			e	
Completed Work	Field Density Tests (0.1 lb/ft^3 [1 kg/m^3] or 0.1% of optimum density)	KT-13 or KT-41	ACI			a	1000 ft (300 m).
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACI			a	1000 ft (300 m).
DIVISION 400							
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION Sec. 401, 402, 703, 710 and 717	Slump (0.25 in [5 mm])	KT-21	ACC			h	As needed to control product, min. 1 set of tests every 50 yd^3 (50 m^3). Select initial sample from first 2 or 3 loads and then on a random basis or as conditions indicate.
	Temperature (1 °F [0.5 °C])	KT-17	ACC				
	Mass per cubic foot (0.1 lb/ft3 [1 kg/m3])	KT-20	ACC				
	Air Content (0.25%)	KT-18, KT-19, or KT-20	ACC				
	Moisture in Aggregate (0.1 g or 0.01% of mass)	KT-24	VER		Minimum of 1 in AM and 1 in PM during concrete mixing operations.		
	Density of Fresh Concrete (0.1 lb/ft^3 [1 kg/m^3])	KT-36	ACI			a b	1 per 150 yd^2 (150 m^2) for thin overlays and bridge deck wearing surfaces.

7/27 Appendix A 2016 Revised 2016

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Construction Manual

SAMPLING AND TESTING FREQUENCY CHART
NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 400 (continued)							
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION Sec. 401, 402, 703, 710 and 717 (continued)	Permeability (0.01%, KT-73 or 10 coulomb, AASHTO T 277 or nearest 0.1 kΩ-cm, KT-79)	KT-73 or AASHTO T 277 or KT-79	VER	l	1 per mix design per project.		Acceptance of contractor's mix design by KDOT.
	Cylinders (1 lbf [1 N], 0.1 in [1 mm], 1 psi [0.01 MPa])	KT-22 and KT-76	VER	k	Bridge Deck Only (all classes except thin overlay) Min. of 2 sets of 3 per pour or major mix design change and 1 set of 3 per 100 yds^3 (100 m^3).		
		KT-22 and KT-76	VER	k	Thin Overlays and Bridge Deck Surfacing Min. of 1 set of 3 per 150 yd^2 (150 m^2) per placement or major mix design change.		

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Construction Manual

SAMPLING AND TESTING FREQUENCY CHART
NON QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CMS	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 400 (continued)							
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION Sec. 401, 402, 703, 710 and 717 (continued)	Cylinders (1 lbf [1 N], 0.1 in [1 mm], 1 psi [0.01 MPa]) (continued)				Drilled Shafts 1 set of 3 per shaft minimum and 1 of 3 set per 100 yd^3 (100 m^3). Other Construction (all classes) Min. of 2 sets of 3 per pour or major mix design change and one set of 3 per 100 yd3 (100 m3). Waive the 2 sets of 3 minimum for pours of less than 20 yd3 (20 m3) that are non-critical elements. (This includes all structural concrete not classified as bridge deck wearing surface - i.e. culverts, wash checks, ditch lining, bridge substructure, hubguards, handrails, etc.)		

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CONSTRUCTION MANUAL

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Parts I - IV - Construction Manual (2014)

Part V - Materials (2010)

Part V - Materials (2012)

Part V - Materials (2014)

Part V - Materials (2015)

Part V - Materials (2016) (individual sections)

Part V - Materials (2016) (entire Part V)

*****PLEASE REMOVE ANY CURRENT VERSION AND REPLACE WITH UPDATED**** (7/22/16)**

Summary Changes of Part V 2016 (Maintained by the Bureau of Construction & Materials)

Source Documents for Pay Quantities

Computations of Quantities (Measure to - Pay to)

Checklists/Manuals

Construction Checklists

Documentation Manual

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CIT Structures

Documentation

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Documentation

- Definition
  - Source
    - Merriam-webster.com
      - The documents, records, etc. that are used to prove something or make something official
    - Dictionary.com
      - The use of documentary evidence

Kansas Department of Transportation

Documentation

Documentation

- What is to be documented?
  - Everything
    - Conversations; If you stated it or your heard it, document it. Relevant to the contract documents. **Facts only!** No thoughts, opinions or hearsay.
    - Measurements; Actual and that which are physically conducted or calculated.
    - Length, width, depth
    - Feet, square feet, square yards, cubic yards
    - Pounds, tons
    - Equipment and personnel

Documentation

- How is to be documented?
  - Documentation Manual
    - I. **Purpose:** A uniform method, greater efficiency
    - II. **Scope:** Manual demonstrates by example, minimum reporting requirements
    - III. **Definitions:**
      - A. Field Book: A permanently bound book used for the entry of information. A computer is not considered a field book.

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Documentation

- How is to be documented?
  - Documentation Manual
    - III. **Definitions:**
      - D. Source Document: Any permanent record inscribed showing the origin of the information itself and such data. i.e. A **Field Book**:

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Documentation

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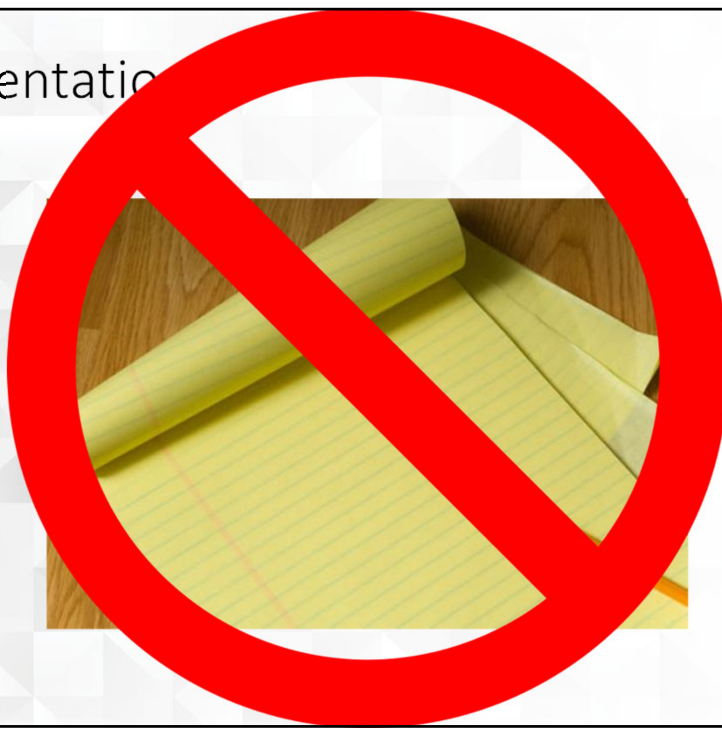
Department of Transportation

Documentatio



Kansas
Department of Transportation

Documentation

- How is to be documented?
  - Documentation Manual
    - IV. **Introduction to General Index:** The Index is broken down into separate divisions coinciding with the 2007 Standard Specification for State Road and Bridge Construction. Each division is further broken down into various example plates.

Kansas Department of Transportation

Documentation

- How is to be documented?
  - Documentation Manual
    - V. **Documentation of Field Records:** Documentation shall be made to substantiate payments. All field book entries should be made using 2H lead. Original entries, later determined to be error, shall not be erased. A line should be drawn through the incorrect details and the correct details should be entered directly above the stricken material. All corrections and reference notations should have the initials of the person making the corrections and notations.

Kansas Department of Transportation

Documentation

GENERAL INDEX

Kansas Department of Transportation

Documentation

- Diary
  - CMS Procedures Manual

The CMS Project Diary should contain a day to day record of all significant items relating to the project. A partial list of items to be noted in the diary is:

1. Working days or reason for not charging time.
2. Weather.
3. Orders given the Contractor, and to whom the order was given.
4. Important discussions with the Contractor or his/her representative.
5. Controlling items of work and equipment being used.
6. Official visitors and inspections.
7. Work or material rejected, and reasons.
8. Time of shutting down or resuming of work, and explanations.
9. Work done by Contractor's forces during the day.
10. General purpose of work.
11. Account of any time by Contractor's personnel and equipment on disputed items of work.
12. Length and cause of any delay.
13. Arrival and departure of major equipment.
14. Record of telephone calls.
15. Unusual conditions, if any, such as high water, bridge failures or slides.
16. Progress of staking and surveys made.

Kansas Department of Transportation

Documentation

- Section 700
  - Documentation Manual _ Drilled Shaft

RECORD OF DRILLED SHAFTS			Br. No 16.41		Abut. No 1	
		Measured	Plan	Measured	Vertical	Date
Shaft	Plan	Diameter	Depth	Depth	Alignment	Checked
No.	Diameter	Shaft	Shaft	Shaft	Check	Insp.
	THIS PLATE IS AN OPERATIONAL CHECK USED					
	TO VERIFY THE ACCEPTABILITY OF THE WORK					
	COMPLETED. THIS CHECK IS BACKUP DATA FOR					
	INFORMATION SHOWN ON THE "RECAPITULATION					
	OF DRILLED SHAFTS COMPLETED".					
	English = feet and inches					
	Metric =(meter and millimeters)					

Kansas Department of Transportation

Documentation

- Section 700
  - Documentation Manual _ Drilled Shaft

RECAP OF DRILLED SHAFTS COMPLETED											
	Shaft	Measured	Plan	Pay	Accum.		Date		Reference		
Location	No.	Length	Length	Length	Pay		Completed	Insp	Bk / Pg	Remarks	

Kansas Department of Transportation

Documentation

- Section 700
  - Documentation Manual _ Piling

RECORD OF TESTED MATERIALS RECEIVED AND USED

MATERIAL: STEEL PILES (Type)

								Accum			
	TEST REPORT DATA				Field Data			Quantity			
Date	CMS	Heat	Number	Quantity	Field	Number	Quantity	Received		Date	
Checked	ID	Number	of Pieces	(Lin. Ft.)	Ident.	of Pieces	(Lin. Ft.)	(Lin. Ft.)	INSP	Used	INSP

Kansas Department of Transportation

Documentation

- Section 700
  - Documentation Manual _ Piling

LOG OF TEST PILE DRIVING

LOCATION: PIER NO. 1 DATE 6/15/2002 TYPE OF HAMMER: DELMAG DIESEL (D-12)

BM 2 3.51 1252.67 1249.16 TYPE OF PILE: HP 12 x 53

PIER 1 HUB B 3.48 1249.16 WEIGHT OF HAMMER: 8250

COMPUTATION FORMULA USED: WEIGHT OF CAP: 1740

$$P = \frac{2 \times W \times H \times 0.80}{S + 0.1\,(X / W)}$$

PLAN LENGTH OF PILING: 87 LIN. FT.

WEIGHT OF PILE PER LIN. FT. 53 LBS

				Distance			Computed		
		Blows	Point of	of Tip	Drop	Average	Bearing		
Pile	Cutoff	Per	Pile	Below	of	Penetration	Power		
Number	Elevation	Foot	Elevatioin	Cutoff	Hammer	in Inches	in Tons	Remarks	Insp

Note: This plate is to be used in addition to the data normally recorded on the log of pile driving.

Kansas Department of Transportation

Documentation

- Section 700
  - Documentation Manual _ Piling

PILE DRIVING NOTES

		LC	LC
PIER NO. 1 DATE: 6-15-02	3'	BR	PIER
BM 2 3.51 1252.67 1249.16	3' 1 2	7 8	13 14
BM 2A 6.41 1246.19	3' 4 3	10 9	16 15
FORMULA USED P= 2 x W x H x .80 / S + 0.1 (X / W)	3' 5 6	11 12	17 18

Pile No.	Drop of Hammer	Avg. Pen. Last 20 Blows	Computed Bearing inTons	Top of Piling After Driving Rod	Top of Piling After Driving Elevation	Cut Off Elevation	Actual Length Cut off	Length Pile in Leads	Length Pile in Place	Length Ordered & Acc.	Pay Length Cut Off	Heat No.	Meas. Thick	Insp

TYPE OF PILE: HP 12 x 53

MINIMUM BEARING: 60 TON/PILE

HAMMER TYPE: DELMAG (D-12) DIESEL

Documentation

- Section 700
  - Documentation Manual _ Piling

RECAPITULATION OF PILE DRIVING QUANTITIES

Date	Pier or Abut Number	Length Ordered and Accepted	Accum Length Ordered & Acc.	Length of Pile in Place	Accum Length of Pile in Place	Length of Pile Cut off	Accum Length of Pile Cut off	Number of Pile Splices	Accum Number of Splices	Refer BK. NO.	Refer PG. NO.		Insp

Documentation

- Section 700
  - Documentation Manual _ Reinforcing Steel

Tested Material Received Used and on Hand Plan Quantity

Material: - Reinforcing Steel (Grade 420)

Date	Test Report Data			Field Data				Distribution of Materials.			
Checked	CMS ID	Ident.	Qnty	Ident.	Qnty	Insp.	Received	Date	Used	On Hand	Insp.

A field record of the tested material is necessary to eliminate the possibility of using untested materials or causing unnecessary delay due to performing a check of the office records. This plate supplies the field inspector with a complete record

If a field copy of the test reports are available, materials received can be checked on it. The distribution record is optional with the individual.

Documentation

- Section 700
  - Documentation Manual _ Reinforcing Steel

Reinforcing Steel Check

Date	Size			Spacing		Clearance		Remarks	Insp.
Checked	Bar	Plan	Actual	Plan	Actual	Plan	Actual		Insp.

Note: In order to be assured that the reinforcing steel in a structure is placed in conformance with the plans and specifications, an actual count of the bars and measurement checks of the spacing is required, however; in many cases it is not possible t

Documentation

- Section 700
  - Documentation Manual _ Reinforcing Steel

RECAP OF REINFORCING STEEL														
	Reinforcing Steel				Reinforcing Steel				Mesh Reinforcement					
		Accum	Refer.			Accum	Refer.			Accum	Refer.			
Date	Lbs.	Lbs.	Bk	Pg	Lbs.	Lbs.	Bk	Pg	Lbs.	Lbs.	Bk	Pg	Est. No.	Insp.
	THIS PLATE PROVIDES DOCUMENTATION OF THE ACCUMULATION OF THE INDIVIDUAL PAY ITEMS LISTED													
	FOR ESTIMATE PURPOSES. QUANTITIES SHOWN ARE BASED ON PLAN QUANTITIES AND ARE SUBJECT													
	TO REVISION BASED ON FINAL COMPLETED QUANTITIES.													

Kansas Department of Transportation

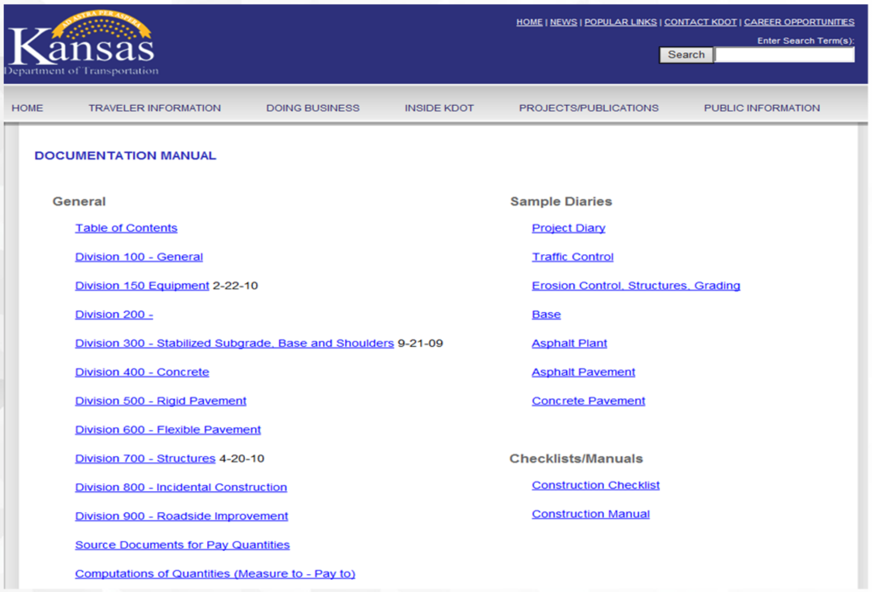
Documentation

- Section 700
  - Documentation Manual _ Concrete Testing

	CONCRETE TEST DATA -										
Date											
Time											
Station											
Theo.Wt. Per Cu. Ft.											
Wt Bucket, Conc & Glass											
Weight of Bucket and Glass											
Meas. Wt											
Corr Factor											
Corrected											
Weight /Cu.Ft.						This plate is an operational record of the tests performed during the placement of the concrete pavement.					
Weight Difference											
% Air											
Slump											

Kansas Department of Transportation

Documentation



Kansas
Department of Transportation

Documentation

- #1 Rule about documentation…

IF IT ISN'T DOCUMENTED, IT DIDN'T HAPPEN!

Kansas
Department of Transportation

Documentation

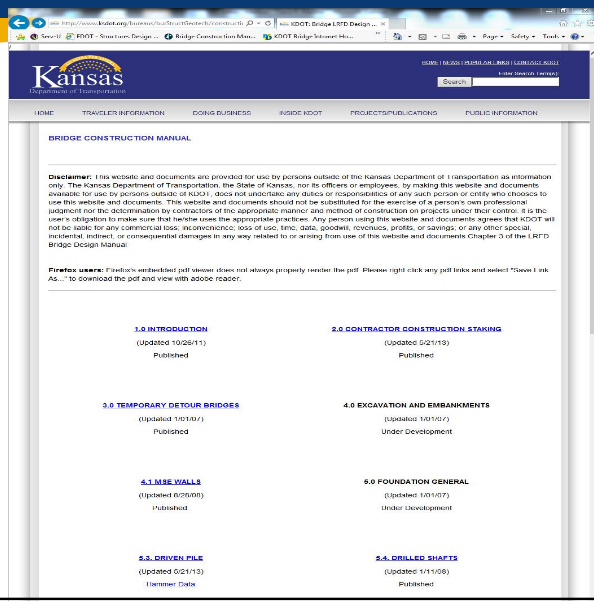
Kansas Department of Transportation

Bridge Construction Manual

Bridge Construction Manual

- Where do you find the Bridge Construction Manual?
- It is housed in the KDOT Bureau of Structures and Geotechnical Services home page under 'Fabricator Information'
- The direct link is: http://www.ksdot.org/bureaus/burStructGeotech/constructionmanual/bcm.asp

Bridge Construction Manual



Bridge Construction Manual

Kansas Department of Transportation — *Bridge Construction Manual*

5.0 DRILLED SHAFTS

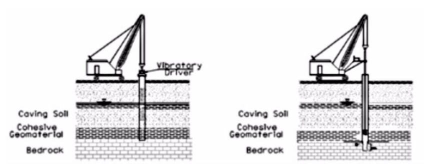
Table of Contents

Appendix

Bridge Construction Manual

Temporary Casing:

In sandy conditions it is typical to vibrate the temporary casing to full length and seat it into the bedrock then excavate the overburden material.



Permanent Casing:

As stated earlier, the plans may call for, or the site conditions may dictate, the use of a permanent

Kansas Department of Transportation

Bridge Construction Manual

- Offer commentary on KDOT specifications
- Highlight good practices
- Introduction for inspectors, and designers
  - Pile Driving worked examples
  - Drilled Shaft guidance
  - Traps to avoid/be aware of during construction
- No longer being updated
- Chapters with active hyperlinks are only chapters available
- Feel free to contact me for structure related questions or guidance

Kansas Department of Transportation

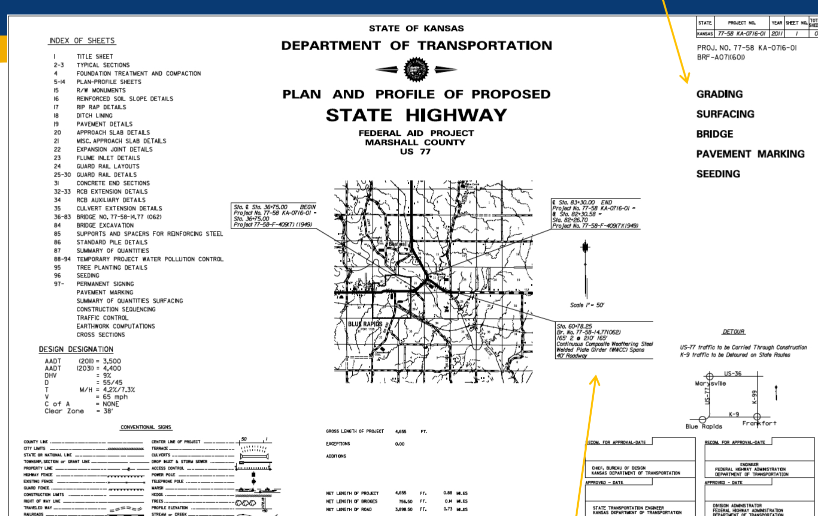
Project Plan Sheets

PL-1

Title Sheet

Project Index

Project Scope



Bridge Location Description & Structure Type

Kansas Department of Transportation

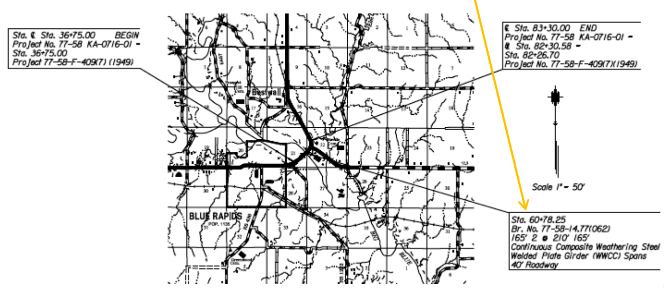
Title Sheet

INDEX OF SHEETS

1	TITLE SHEET
2-3	TYPICAL SECTIONS
4	FOUNDATION TREATMENT AND COMPACTION
5-14	PLAN-PROFILE SHEETS
15	R/W MONUMENTS
16	REINFORCED SOIL SLOPE DETAILS
17	RIP RAP DETAILS
18	DITCH LINING
19	PAVEMENT DETAILS
20	APPROACH SLAB DETAILS
21	MISC. APPROACH SLAB DETAILS
22	EXPANSION JOINT DETAILS
23	FLUME INLET DETAILS
24	GUARD RAIL LAYOUTS
25-30	GUARD RAIL DETAILS
31	CONCRETE END SECTIONS
32-33	RCB EXTENSION DETAILS
34	RCB AUXILIARY DETAILS
35	CULVERT EXTENSION DETAILS
36-83	BRIDGE NO. 77-58-14.77 (062)
84	BRIDGE EXCAVATION
85	SUPPORTS AND SPACERS FOR REINFORCING STEEL
86	STANDARD PILE DETAILS
87	SUMMARY OF QUANTITIES
88-94	TEMPORARY PROJECT WATER POLLUTION CONTROL
95	TREE PLANTING DETAILS
96	SEEDING
97-	PERMANENT SIGNING
	PAVEMENT MARKING
	SUMMARY OF QUANTITIES SURFACING
	CONSTRUCTION SEQUENCING
	TRAFFIC CONTROL
	EARTHWORK COMPUTATIONS
	CROSS SECTIONS

Bridge Sheets

Location Description:
Sta.
Br. No.
Span Lengths
Structure Type
Roadway Width

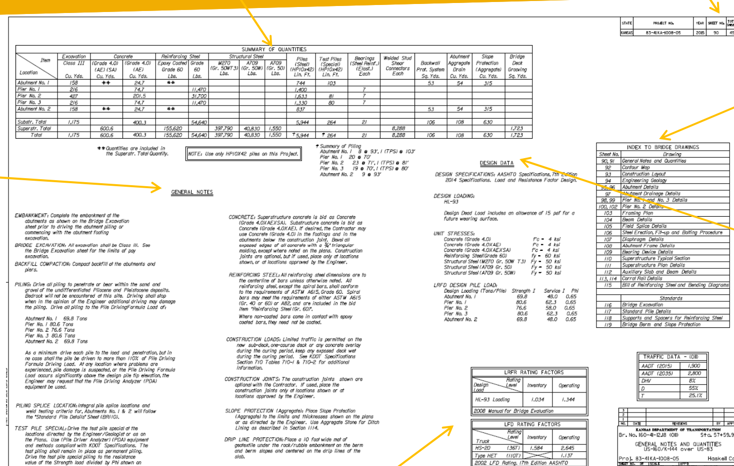


Kansas Department of Transportation

General Notes & Quantities

Summary of Quant.

Proj. & Sheet No.



Gen. Notes

Bridge Sheet Index

Design Code Data

Load Rating Data

Title Block

Kansas Department of Transportation

General Notes & Quantities

SUMMARY OF QUANTITIES

✳ Piles (Steel) (HP12x74) Lin. Ft.	Bridge Backwall Prot. System Sq. Yds.	Abutment Strip Drain Sq. Yds.	Bedding for Slope Protection Cu. Yds.	Slope Protection (Riprap Stone) (Light 24") Cu. Yds.
†				

Pile Type

✳ NOTE: Use only HP12x74 steel pile on this project.

† Summary of Piling:
Abutment No. 1 9 @ 68 ft.

Pile Lengths

Anticipated Bearing Layer

PILING: Drive all piling to bear upon the limestone of the Neva Member. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment #1: 154 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

LRFD DESIGN PILE LOAD:

Design Loading (Tons/Pile)	Strength	Service	Phi
Abutment #1	154	109	0.60

(Should be same # or somethings wrong)

General Notes & Quantities

EMBANKMENT: Complete the embankment at the abutments as shown on the Bridge Excavation sheet prior to driving the abutment piling or commencing with the abutment footing excavation.

BRIDGE EXCAVATION: Elevation 1092.90 shall designate the Excavation Boundary Plane of Class I and Class II Excavation; Class I above the plane, Class II below the plane. See the Bridge Excavation sheet for the limits of pay excavation.

BACKFILL COMPACTION: Compact backfill at the abutments.

PILING: Drive all piling to bear upon the limestone of the Neva Member. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load of:

Abutment #1: 154 Tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to more than 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

REMOVAL OF EXISTING STRUCTURES: Removal of existing structure is included in the bid item, "Removal of Existing Structures", Lump Sum. With the exception of the steel cover plates over the roadway and the bridge number plate, all materials removed from the existing structure shall become the property of the Contractor. Remove this material from the site. Steel cover plates and bridge number plate shall be retained by KDOT.

EXISTING STRUCTURE: Plans of the existing structure are on file and available for inspection by qualified bidders at the State Bridge Office, KDOT, Eisenhower State Office Building, 700 SW Harrison, Topeka, KS.

BROKEN CONCRETE: Waste the broken concrete from the existing bridge on sites provided by the Contractor and approved by the Engineer.

DEMOLITION PLANS: This is a Category A Demolition. Submit detailed Demolition Plans to the Field Engineer per KDOT Specifications. No Demolition work will begin without approved Demolition Plans. A Licensed Professional Engineer is not required.

SLOPE PROTECTION (Riprap Stone): Place Slope Protection (Riprap Stone) to the limits and thicknesses shown on the plans or as directed by the Engineer.

REINFORCING STEEL: All reinforcing steel dimensions are to the centerline of bars unless otherwise noted. All reinforcing steel, except the spiral bars, shall conform to the requirements of ASTM A615, Grade 60. Spiral bars may meet the requirements of either ASTM A615 (Gr. 40 or 60) or A82, and are included in the bid item "Reinforcing Steel (Gr. 60)".
Where non-coated bars come in contact with epoxy coated bars, they need not be coated.

CONCRETE: Superstructure concrete is bid as Concrete Grade 4.0(AE)(SA). Substructure concrete is bid as Concrete Grade 4.0(AE). If desired, the Contractor may use Concrete Grade 4.0 in the footings and in the abutments below the construction joint. Bevel all exposed edges of all concrete with a $\frac{3}{4}$" triangular molding, except where noted on the plans. Construction joints are optional, but if used, place only at locations shown, or at locations approved by the Engineer.

PLACING SEQUENCE: The Contractor will adhere to the placing direction/sequence shown on the plans. Changes will be accepted only if the Contractors Engineer adjusts the chamber diagram so that the fabricator can adjust the web chamber and headed stud anchor heights accordingly. This revised diagram will be approved by the design Engineer prior to deck forming. If profile grinding decreases the clearance to the top mat of reinforcement to less than $2\frac{1}{2}$" a polymer overlay will be placed at no cost to the State.

CONCRETE PLACING: Place and hand vibrate all concrete for Abutment #1 above the construction joint to the bottom of deck elevation just prior to the normal paving train operations. Do this work in a manner to avoid cold joints in either the slab or in Abutment #1.

CONSTRUCTION LOADS: Only foot traffic is permitted on the new sub-deck, one-course deck or any concrete overlay during the seven day curing period, keep any exposed deck wet during the 7-day curing period. See KDOT Specifications.

ABUTMENT STRIP DRAIN: See the General Notes on the "Abutment Strip Drain" sheet.

BRIDGE BACKWALL PROTECTION SYSTEM: See the General Notes on the "Abutment Strip Drain" sheet.

QUANTITIES: Items not listed separately in the Summary of Quantities are subsidiary to other items in the proposal.

TEMPERATURE: The design temperature for all dimensions is 60°F.

DIMENSIONS: All dimensions shown on the design plans are horizontal dimensions unless otherwise noted. Make necessary allowances for roadway grade and cross slope.

GOVERNMENT BENCH MARKS: Preserve any National Geodetic Survey bench marks that are located on the project. Notify Mr. Monroe Rivers, NGS State Geodetic Advisor, Bureau of Design, KDOT, at (785)296-6835, if any government bench marks are in danger of being destroyed due to construction. Notification shall be given 30 days prior to the start of construction. The National Geodetic Survey will send personnel to relocate the bench mark or issue instructions concerning its relocation.

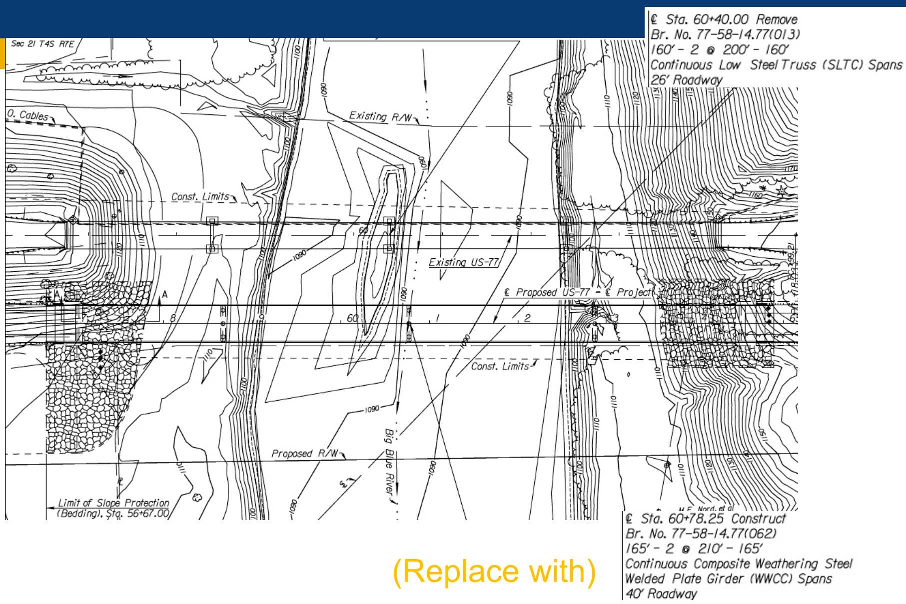
GAGING STATION: Provide the United States Geological Survey (U.S.G.S.) with the labor and equipment necessary to access, remove, attach, support or anchor any new or existing stream gaging hardware to the bridge. The labor and equipment required to perform this work will be considered subsidiary to the other bid items in the contract. Contact Jim Putnam at the U.S.G.S. to coordinate this work:

Jim Putnam
U.S. Geological Survey
4821 Quail Crest Place
Lawrence, KS 66049-3839
Phone # 785-832-3541

(Not always the same on each Project so take your time and read each carefully)

Contour Map

(Remove what)



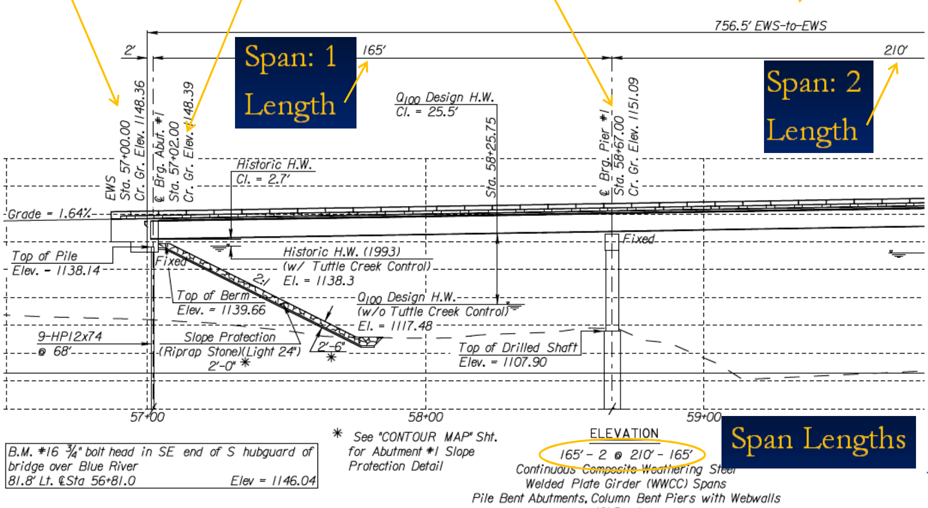
(Replace with)

Construction Layout

Station & Elevation Info:

E.W.S. Centerline of Bearing Centerline of Pier

Br. Length: End to End



Construction Layout

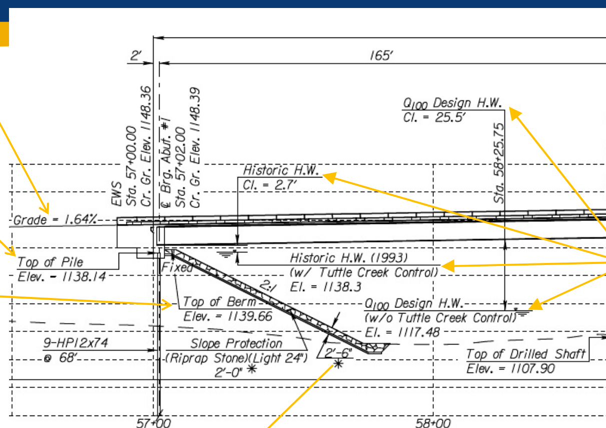
Profile Grade

Top of Pile

Berm Elev.

Hydraulics Info

Slope Protection Info

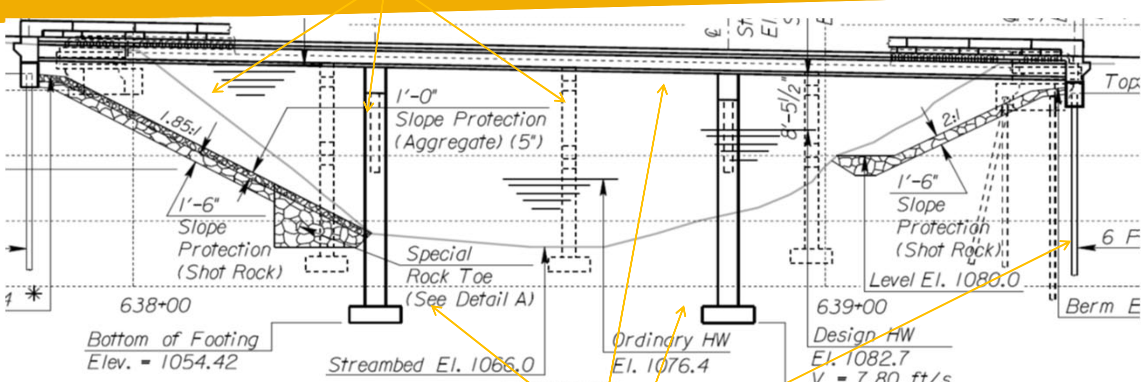


✳ See "CONTOUR MAP" Sht. for Abutment #1 Slope Protection Detail

Kansas Department of Transportation

Construction Layout

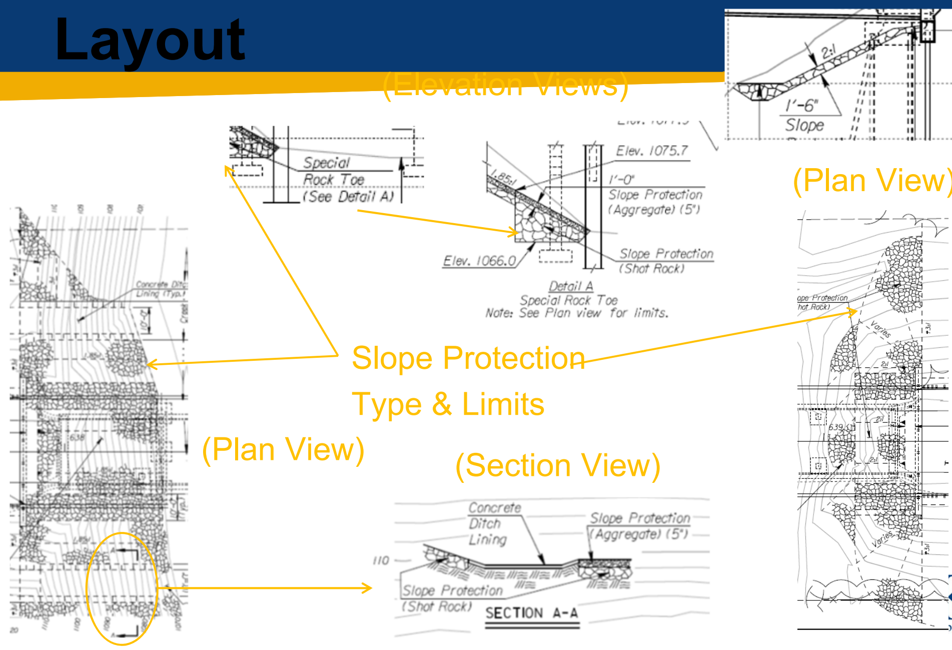
Existing Structure



Proposed Construction

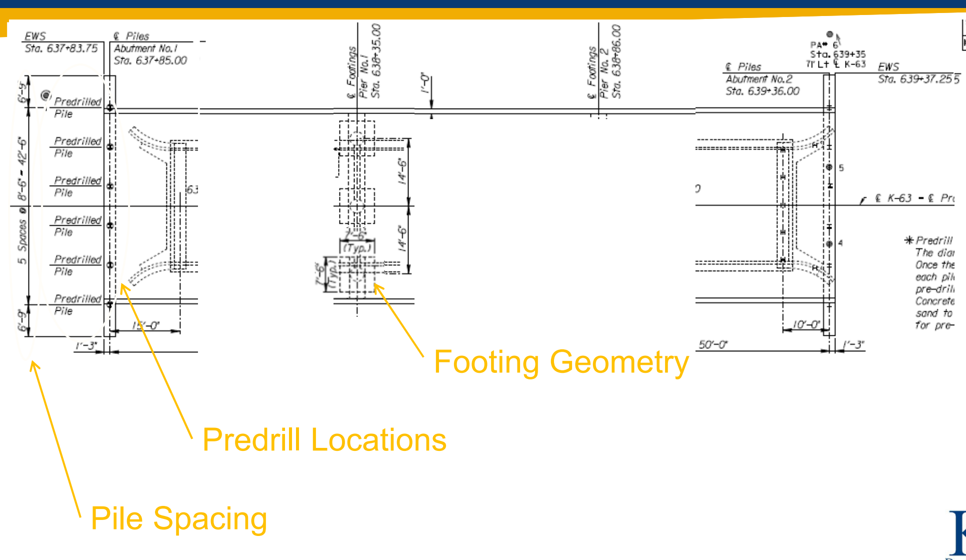
Kansas Department of Transportation

Construction Layout



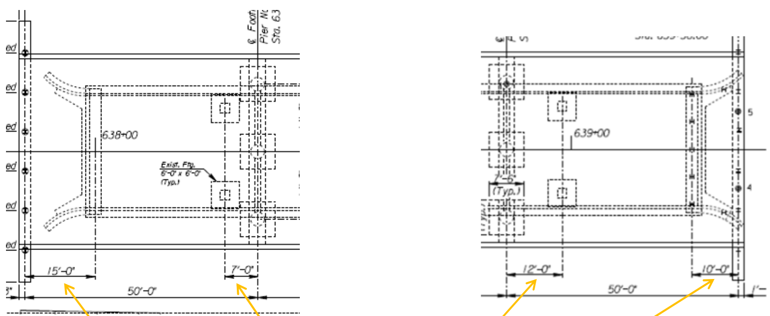
Kansas Department of Transportation

Engineering Geology



Kansas Department of Transportation

Engineering Geology

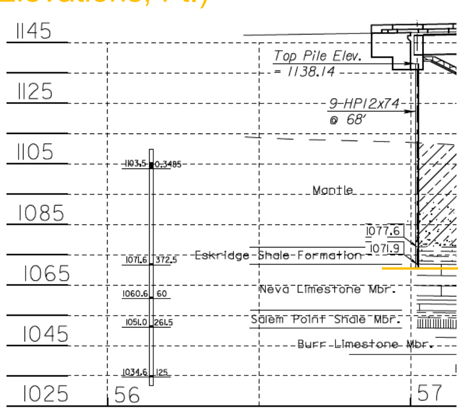


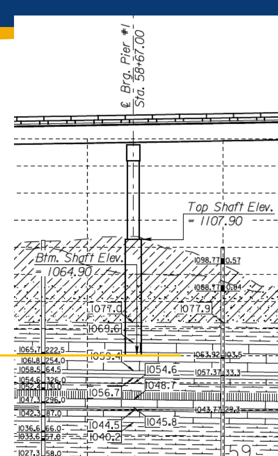
Clearance to Existing
Substructure Foundations

Kansas
Department of Transportation

Engineering Geology

(Subsurface
Elevations, Ft.)





From Gen. Notes: *PILING: Drive all piling to bear upon the limestone of the Neva Member. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Drive all piling to the Pile Driving Formula Load*

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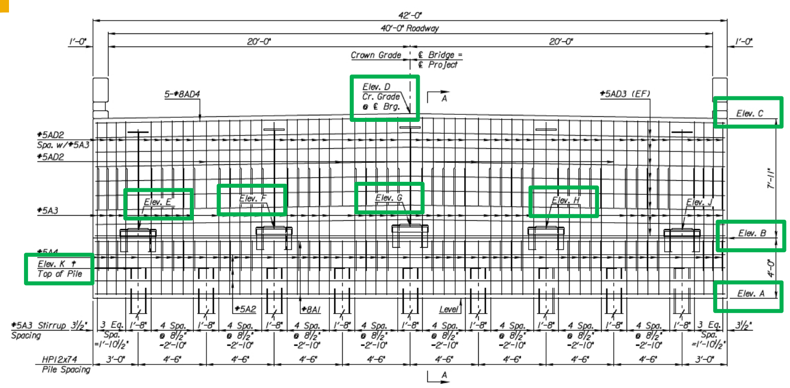
Department of Transportation

Abutment Details

(Project Alignment & Geometry)



Elevations

Kansas Department of Transportation

Abutment Strip Drain

ABUTMENT STRIP DRAIN: The Bridge Contractor shall excavate to the limits shown on the Bridge Excavation sheet, grade the bottom of the backfill area, place the strip drain, and place the perforated pipe, the outlet pipe, the CMP, and the backfill. Guide post and coarse aggregate are subsidiary to this bid item. Guide post and coarse aggregate are not required if the CMP empties onto riprap.

BRIDGE BACKWALL PROTECTION SYSTEM: Apply a Bridge Backwall Protective System to the approach side of the abutments and the wings in accordance with KDOT Specifications and the manufacturer's recommendations. Cover the abutments and wings to the limits shown on the details. Prior to backfilling, repair any damage done to the system at no charge to the state.

Place perforated pipe next to the strip drain. Use non-perforated pipe outside the limits of the strip drain. Enclose the perforated pipe with the extension of the filter fabric.

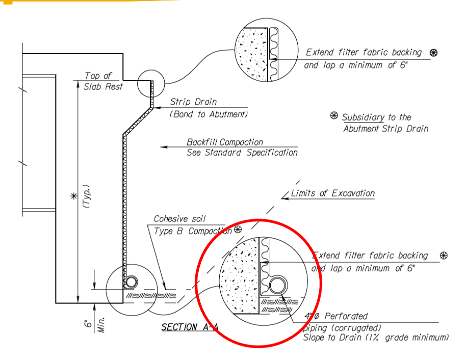
Compact the abutment backfill. See the KDOT Specifications.

Perforated pipe and non-perforated outlet pipe shall be corrugated polyethylene tubing conforming to the KDOT Specifications.

Fit the CMP end section with 1/4" galvanized mesh screen to prevent the entrance of rodents. Seal the joint between the outlet pipe and the end section with a joint sealer. Place coarse aggregate at the outlet end as shown.

Grade the bottom surface of the excavated area to drain. Backfill this area with a cohesive type soil. The soil should be a silty clay or clay under the Kansas Classification System with a minimum plasticity index of 13. Compact the material to Type B standards.

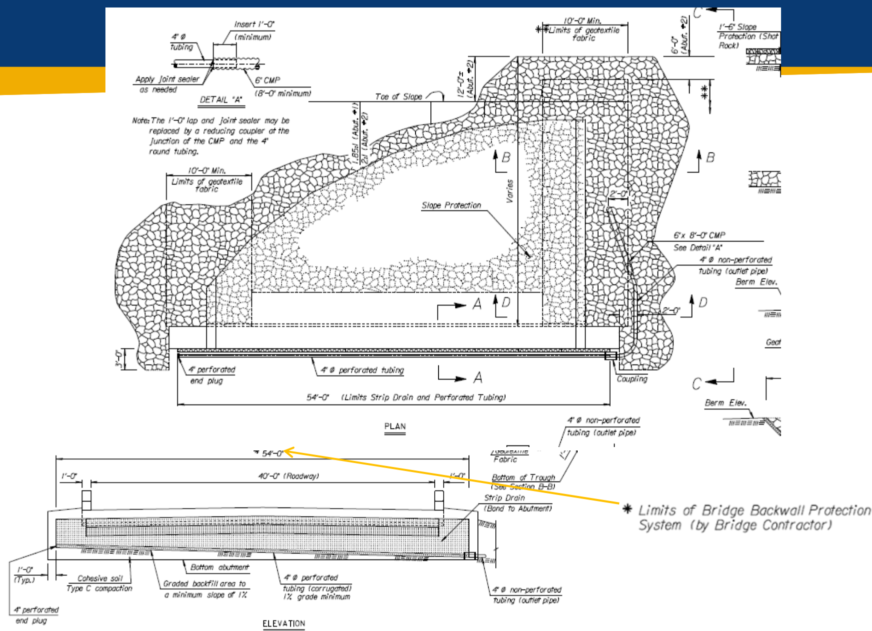
Place the outlet pipe on the downstream side of structures over streams and as shown or noted on other crossings (See the "Construction Layout" sheet).

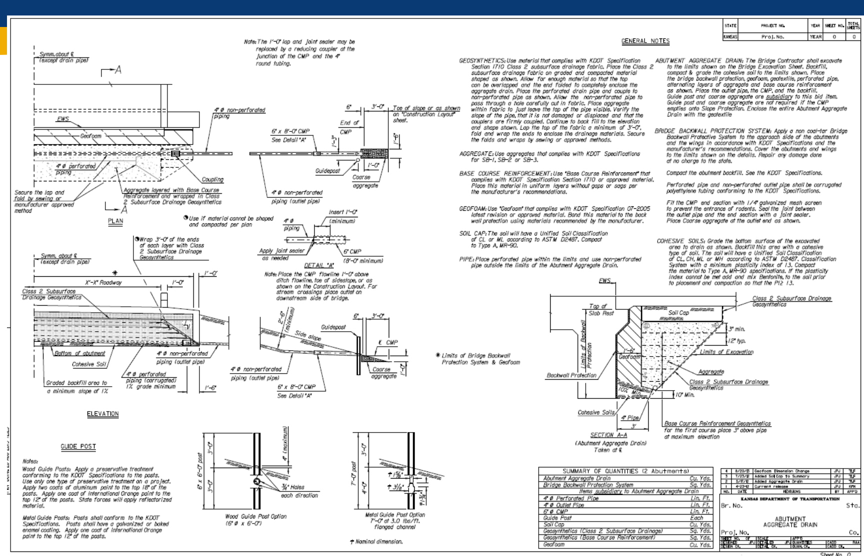


SUMMARY OF QUANTITIES (Abutment #1)	
Abutment Strip Drain	X Sq. Yds.
Bridge Backwall Protection System	X Sq. Yds.
Items Subsidiary to Strip Drain	
4" Ø Perforated Pipe	38 Lin. Ft.
4" Ø Outlet Pipe	26 Lin. Ft.
6" Ø CMP	8 Lin. Ft.
Items Subsidiary to Slope Protection (Shot Rock)	
Geotextile Fabric	X Sq. Yds.

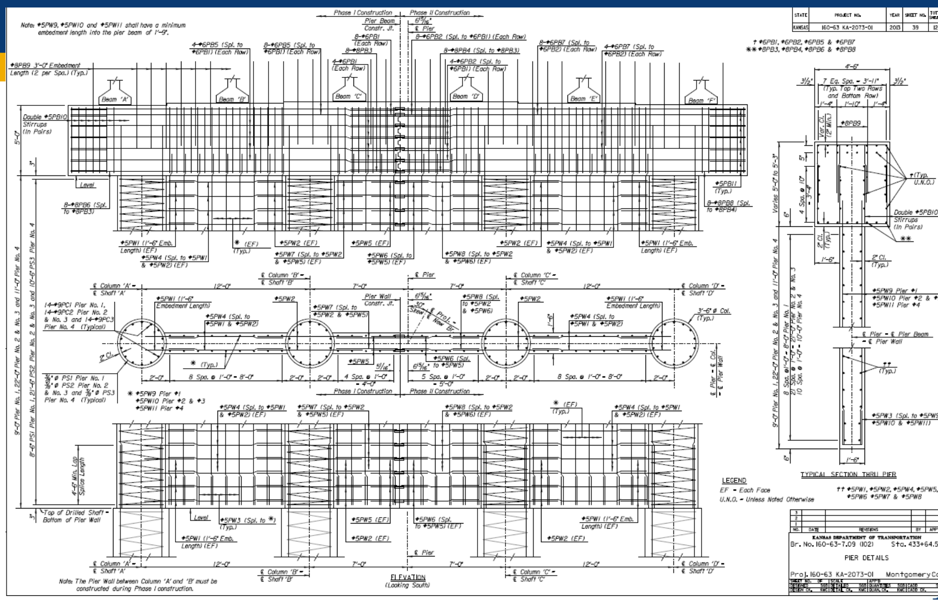
Kansas Department of Transportation

Abutment Strip Drain

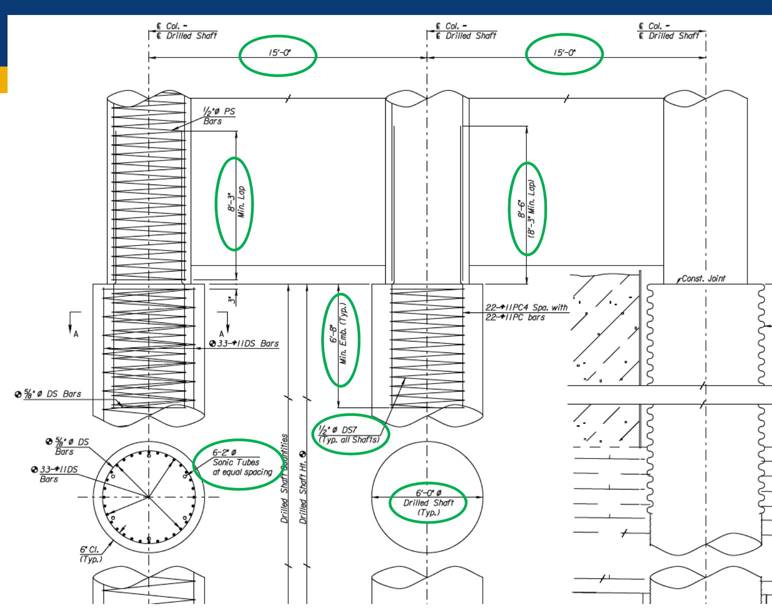




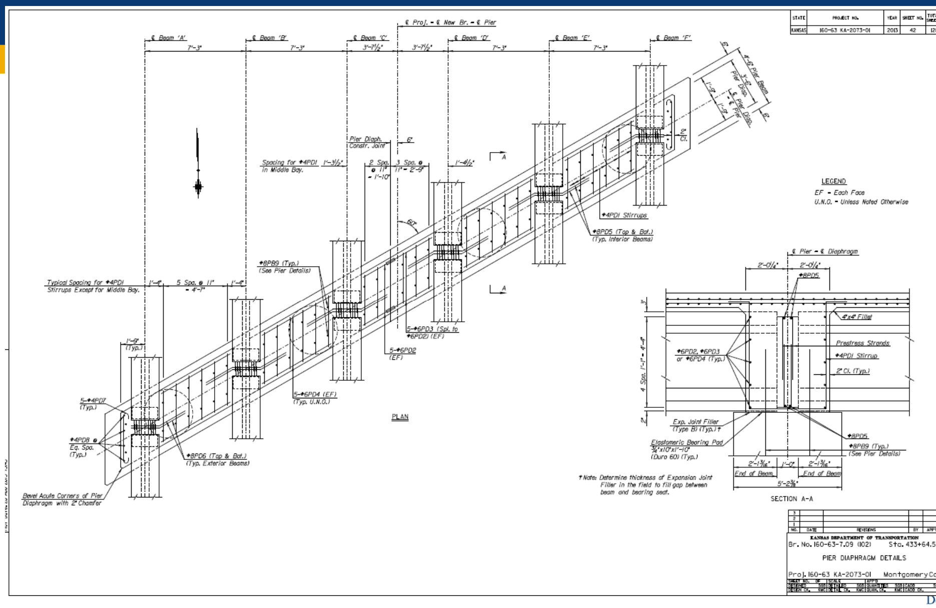
Pier Details



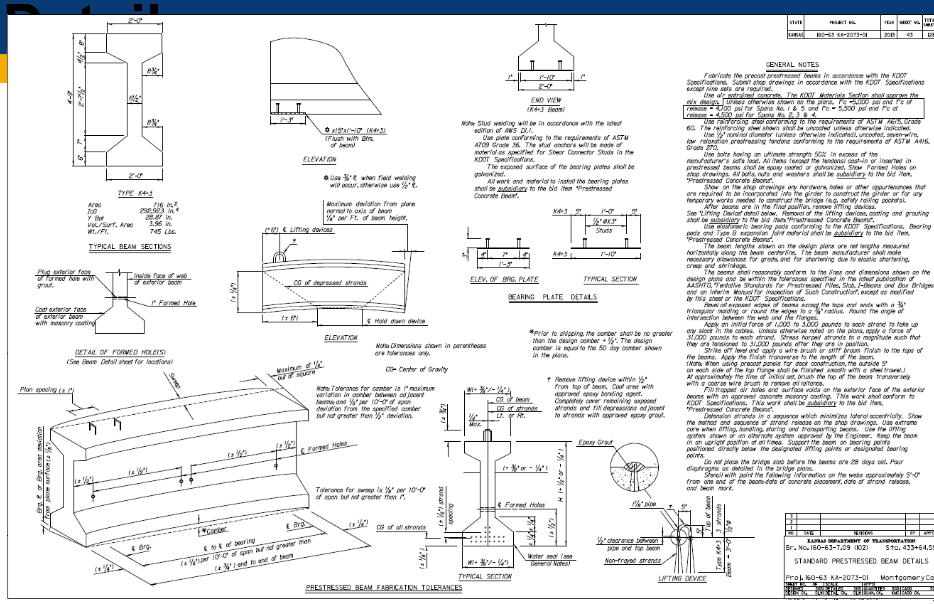
Drilled Shaft Details



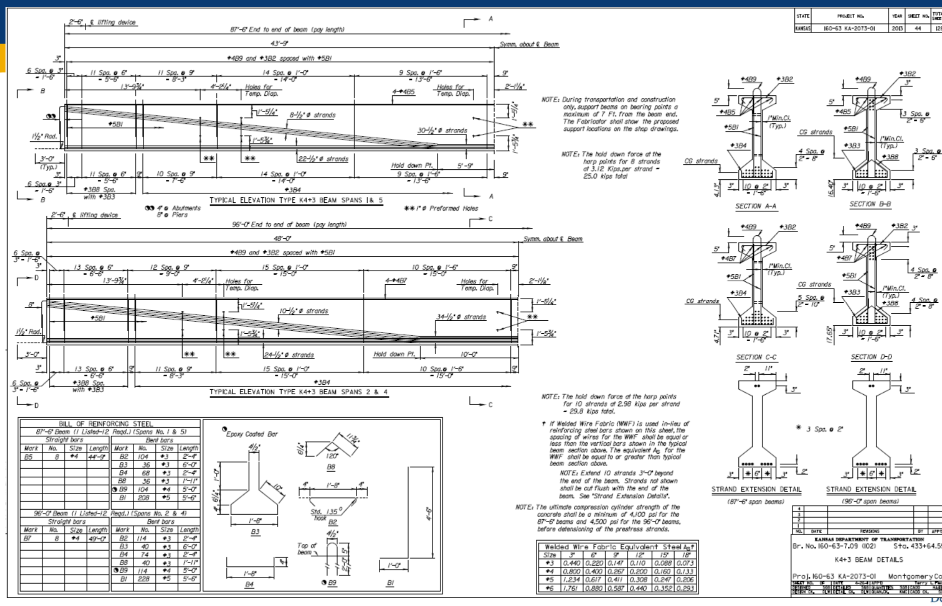
Pier Diaphragm



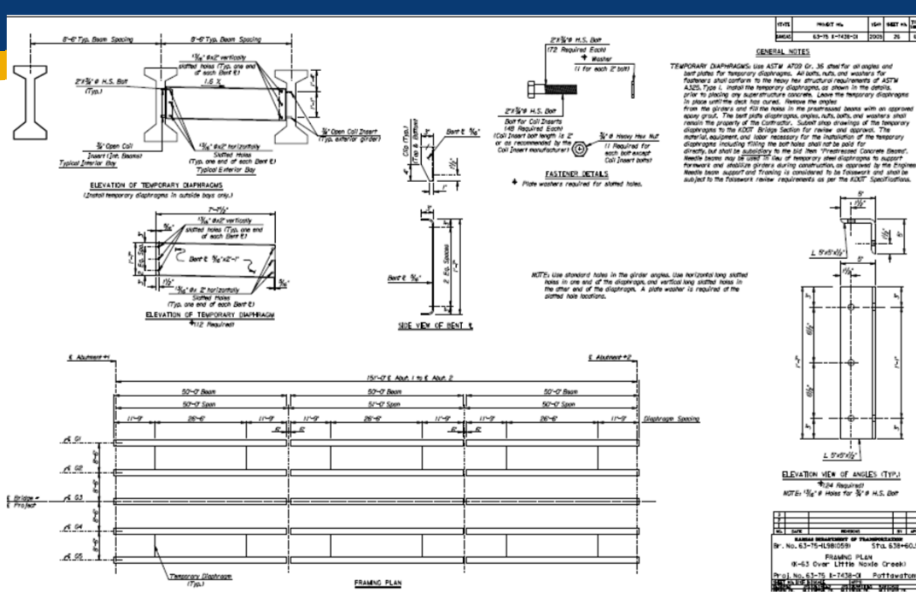
Standard Prestressed Beam Detail



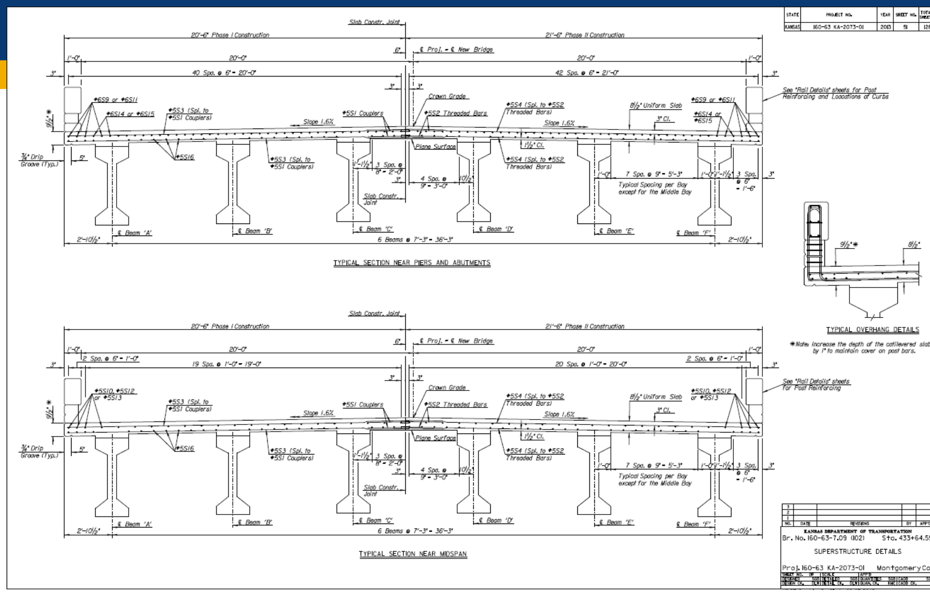
K4+3 Beam Details



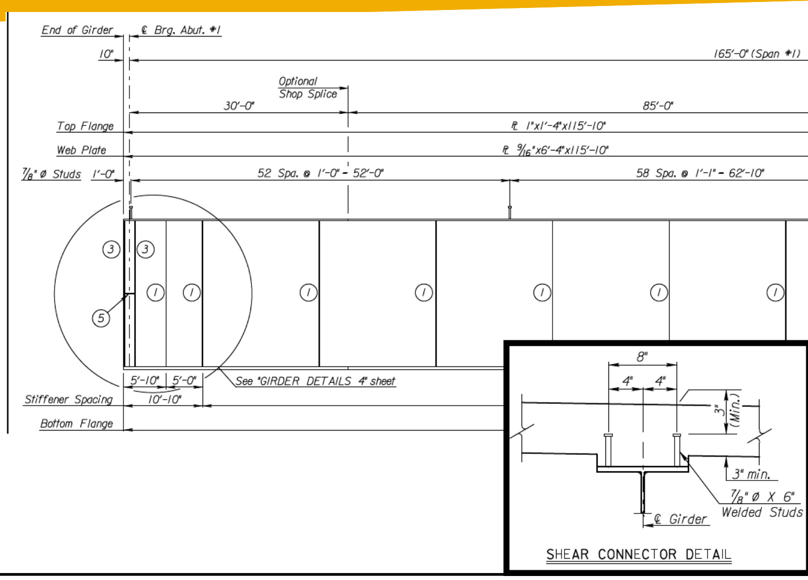
Temporary Framing Plan



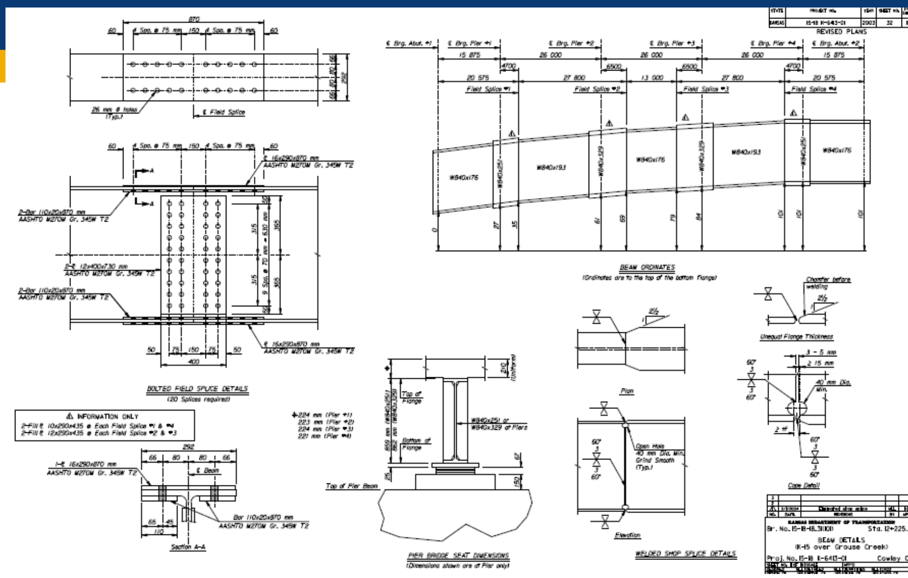
(Conc.) Typical Section



Headed Stud Anchor and Bearing Device Details

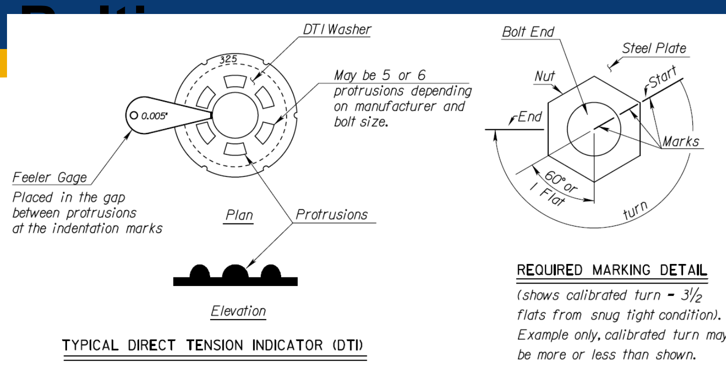


Steel Beam Details



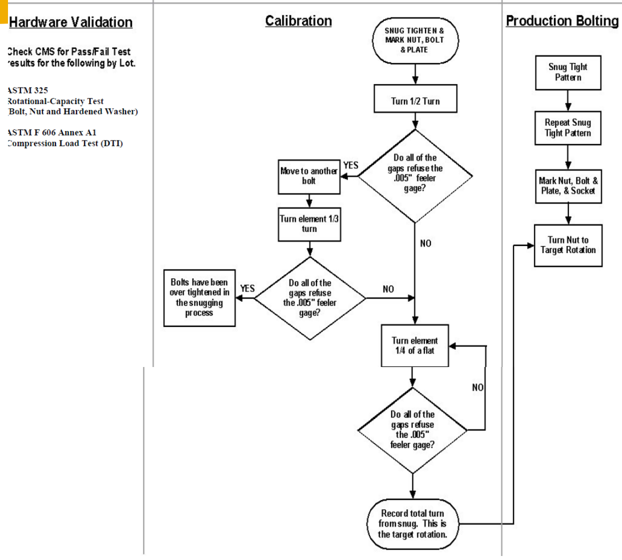
PL-27

Steel Erection, Fit-up and



712 – STRUCTURAL STEEL CONSTRUCTION

FIGURE 712-1
Bolting Operation Flow Chart
Calibration Procedure



712.3 CONST. REQ'M.

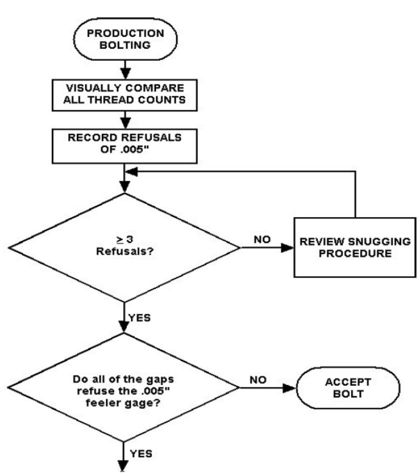
b. Bolted Field Connections, p. 700-55, 56, 57

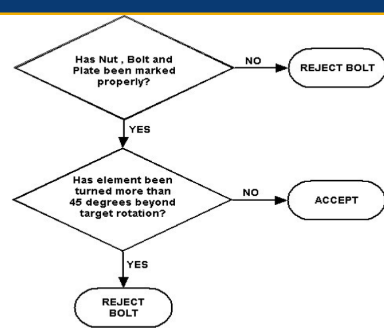
Kansas Department of Transportation

712.3 CONST. REQ'M., Fig. 712-2
b. Bolted Field Connections, p. 700-60

712 - STRUCTURAL STEEL CONSTRUCTION

FIGURE 712-2 – Direct Tension Indicator Verification





Bolt Size	DTI Spaces		Minimum Installation Refusals	
	A 325	A 490	A 325	A 490
5/8	4	5	2	3
3/4	5	6	3	3
7/8	5	6	3	3
1	6	7	3	4
1-1/8	6	7	3	4
1-1/4	7	8	4	4
1-3/8	7	8	4	4

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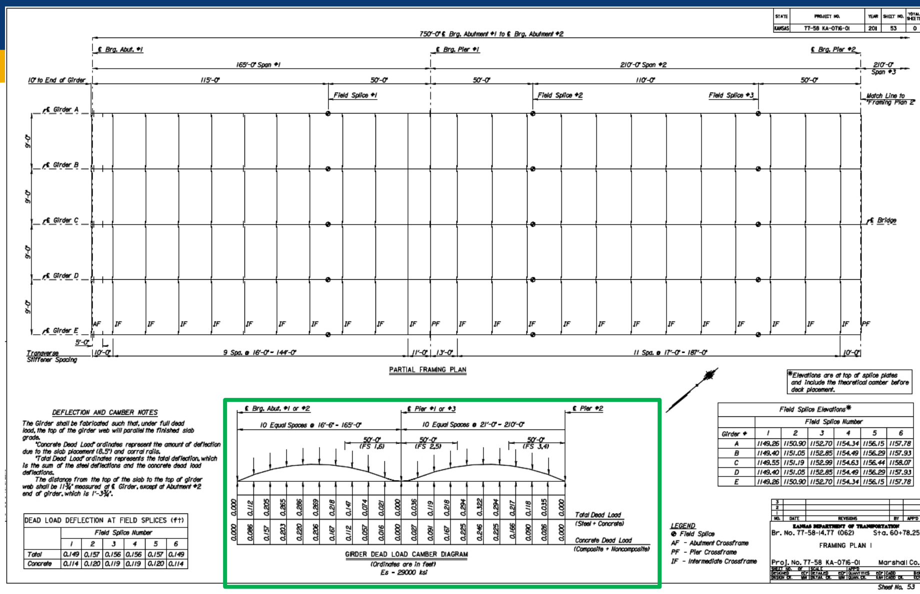
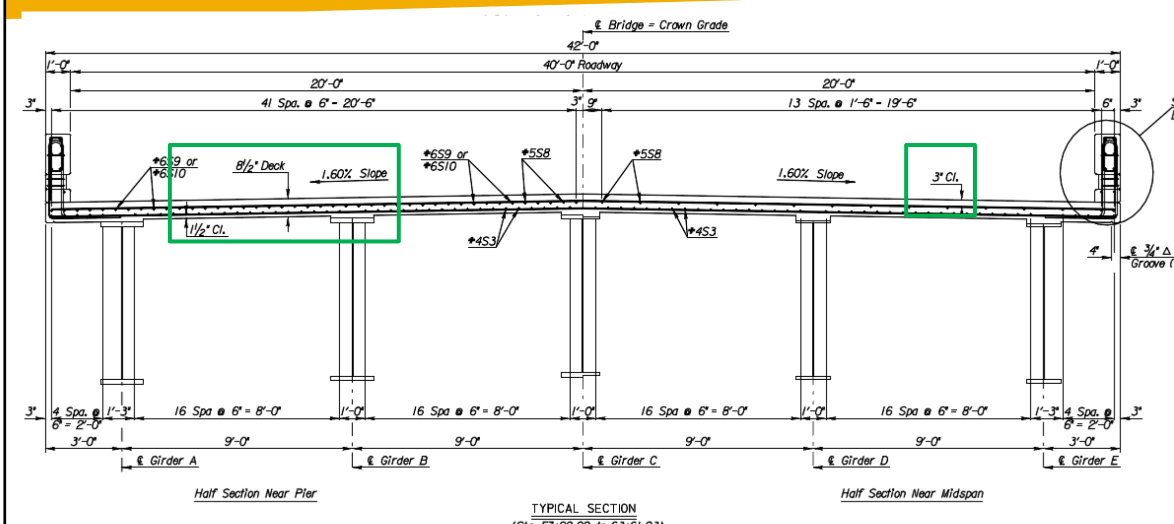
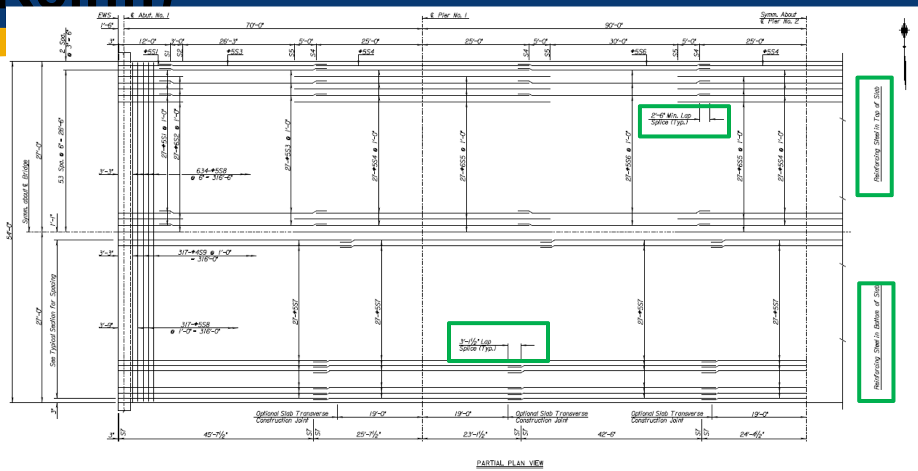
Framing Plan



(Steel) Typical Section



Superstructure Details (Deck Reinf.)



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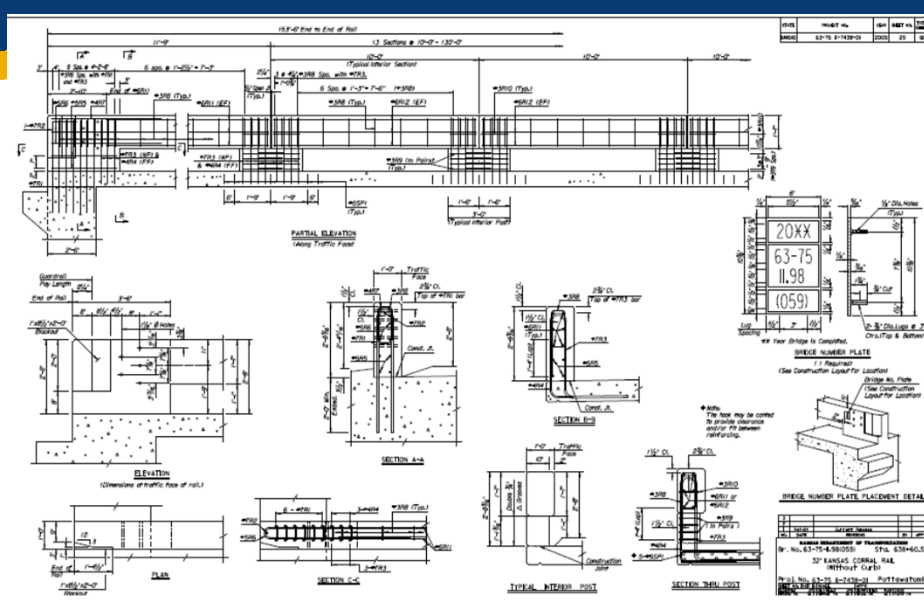
Kansas Corral Rail



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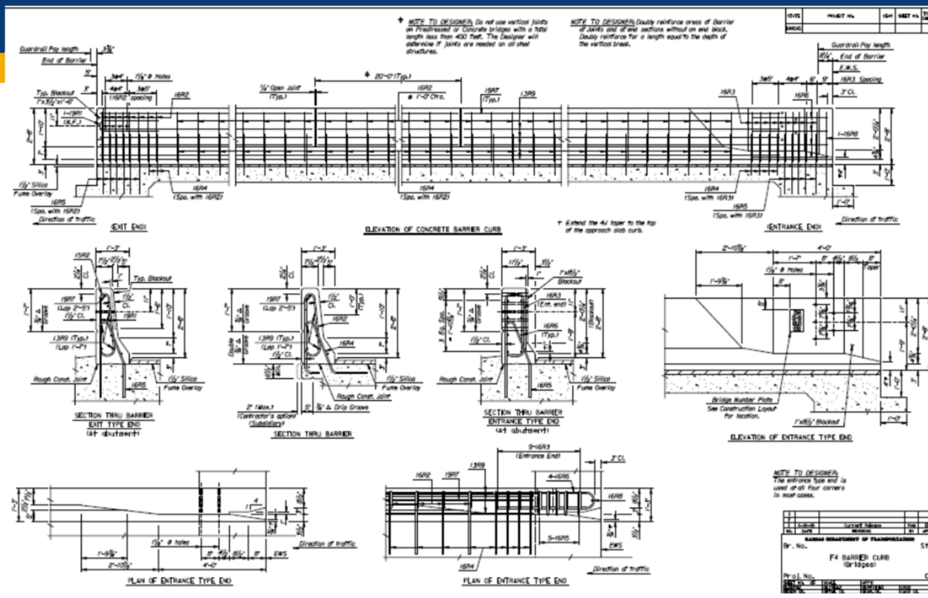
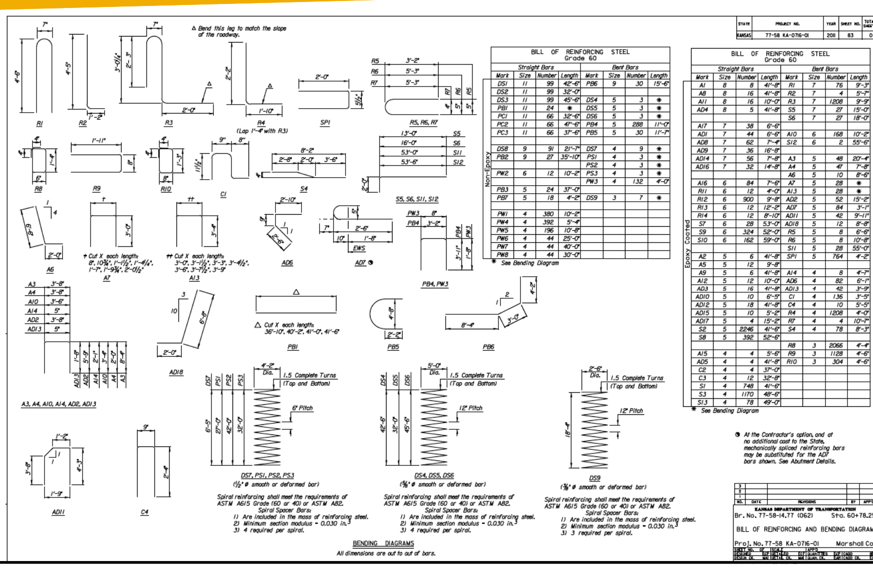
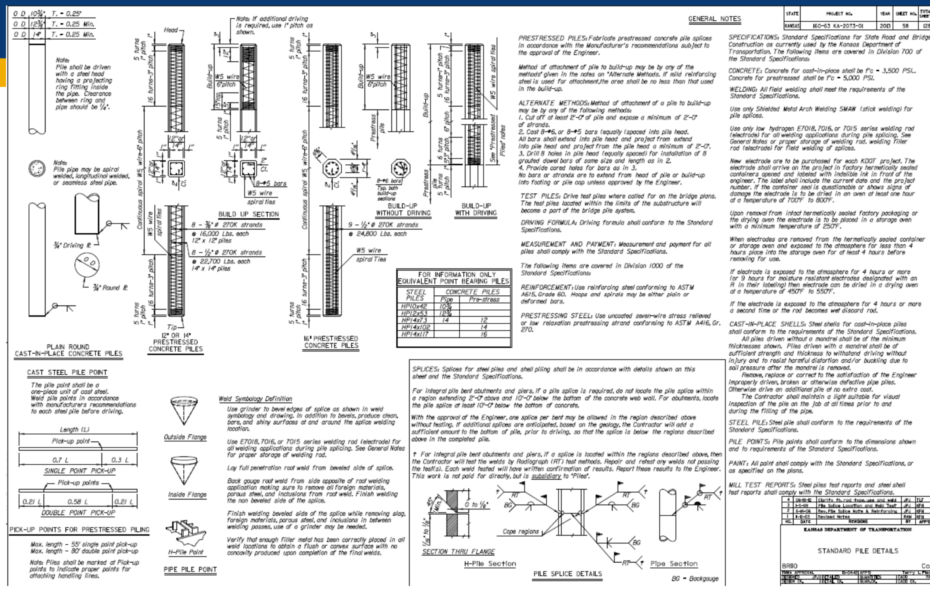
F4 Barrier Curb



Bill of Reinforcing Steel & Bending Diagrams



Standard Pile Details



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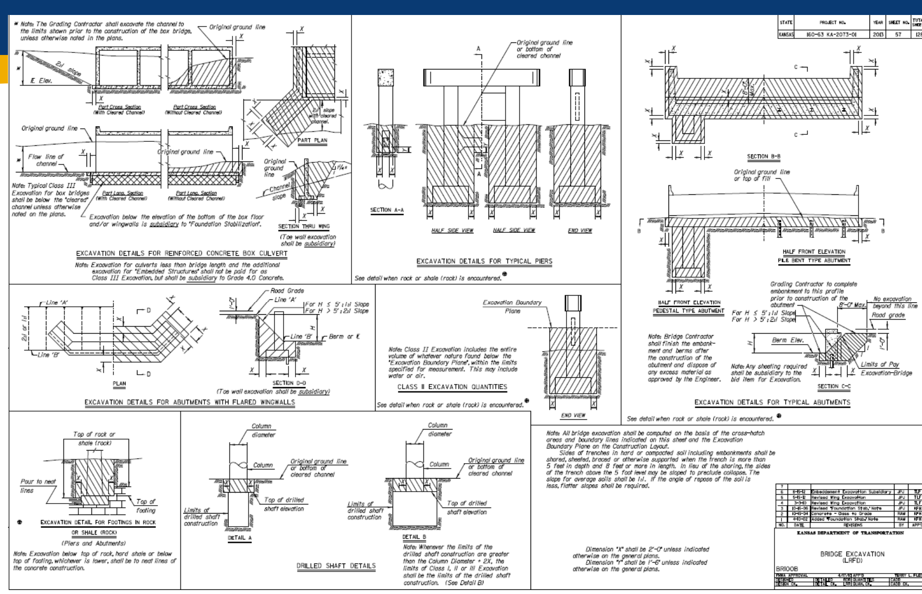
Bridge Excavation



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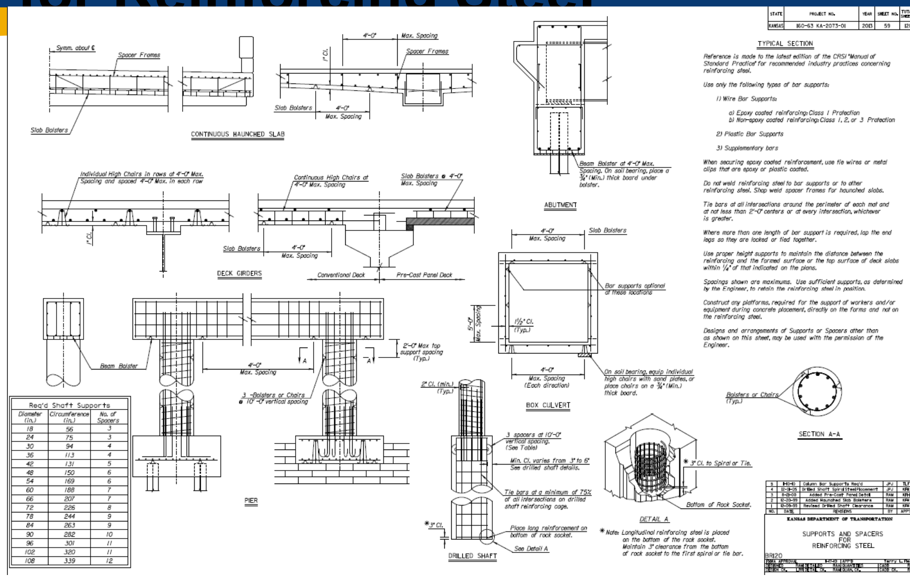
Supports and Spacers for Reinforcing Steel



Req'd Shaft Supports

Diameter (in.)	Circumference (in.)	No. of Spacers
18	56	3
24	75	3
30	94	4
36	113	4
42	131	5
48	150	6
54	169	6
60	188	7
66	207	7
72	226	8
78	244	9
84	263	9
90	282	10
96	301	11
102	320	11
108	339	12

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Final Thoughts:

Bridge Plans contain a lot of information – some of which is record keeping (hydraulics, scour, As-built changes, revisions, etc.) some of which is for initial construction.

Currently there are only 2 Bridge Squads left. Maintenance Plans are handled by a consultant sit-in, so if you ever have questions, or see something that doesn't quite add up, just email or call.

Thanks & Good Luck!!!

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Concrete & Reinforcing Steel

C&R-1

CONCRETE
STD SPEC Division 400

- Concrete for Pavement
  - not used in structures
- Concrete (Grade 5.0)
- Concrete (Grade 4.5)
- Concrete (Grade 4.0)
- Concrete (Grade 3.0 and Grade 3.5)
- Concrete (Grade 2.5)

C&R-2

CONCRETE
STD SPEC Division 400

- Concrete (Grade 5.0) - fc’ = 5000 psi
- Concrete (Grade 4.5) – fc’ = 4500 psi
- Concrete (Grade 4.0) – fc’ = 4000 psi
- Concrete (Grade 3.0) – fc’ = 3000 psi
- Concrete (Grade 2.5) – fc’ = 2500 psi

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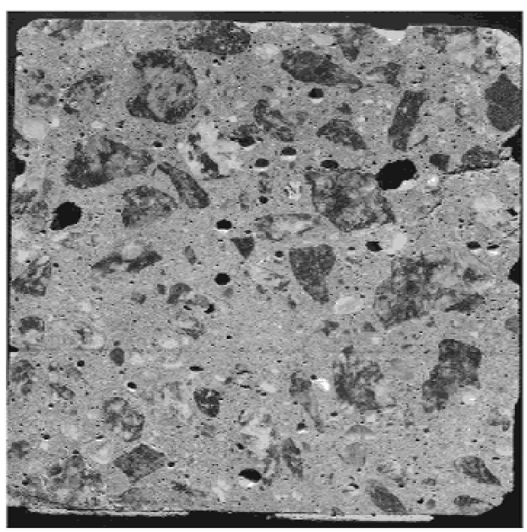
C&R-3

CONCRETE
STD SPEC Division 400

- Aggregate
- Cement
- Water
- Air



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C&R-4

CONCRETE

STD SPEC Division 400

- **(AE)**
  - Air-Entrained Concrete
- **(AE)(SW)**
  - Select Coarse Aggregate for Wear
- **(AE)(SA)**
  - Select Coarse Aggregate for wear and Absorption
- **(AE)(AI)**
  - Select Coarse Aggregate for wear and Acid Insolubility
- **(AE)(PB)**
  - Select Coarse Aggregate for use in Prestressed Beams

Division 1100 - Aggregates

C&R-5

Kansas Department of Transportation

Cement Types

- Table 401-1
  - What type in subdeck?
  - What type in corral rail?

TABLE 401-1: PORTLAND CEMENT & BLENDED HYDRAULIC CEMENT

Concrete for:	**Type of Cement Allowed**
On Grade Concrete	Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type II Portland Cement
All Concrete other than On Grade Concrete.	Type I Portland Cement Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type II Portland Cement
High Early Strength Concrete	Type III Portland Cement Type I, IP(x), IS(x), IT(Ax)(By), or II Cement may be used if strength and time requirements are met.

C&R-6

Kansas Department of Transportation

Water/Cement Ratios

- Table 401-A1: General Concrete

TABLE 401-A1: GENERAL CONCRETE		
Grade of Concrete	lb. of Cementitious per yd of Concrete, minimum	lb. of Water per lb. of Cementitious, maximum
Grade 7.0(**):MA Gradation	700	0.35
Grade 6.0(**):MA Gradation	650	0.35
Grade 5.0(**):MA Gradation	602	0.35
Grade 4.5(**):MA Gradation	602	0.40
Grade 4.0(**):MA Gradation	602	0.44
Grade 3.5 and 3.0(**):MA Gradation	564	0.46
Grade 2.5(**):MA Gradation	526	0.50

General Concrete (*) (**)
*Grade as specified in the Contract Documents
**Air Entrained meeting subsection 401.3a.

Air entrained concrete with a target air of 6.5 ± 1.5 percent.
Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard. Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

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C&R-7

Water/Cement Ratios

- Table 402-A1: Concrete for Structures

TABLE 402-A1: CONCRETE FOR STRUCTURES		
Grade of Concrete	lb. of Cementitious per yd of Concrete, minimum	lb. of Water per lb. of Cementitious, maximum
Grade 6.0(**)(***)(****): MA Gradation	700	0.35
Grade 5.0(**)(***)(****): MA Gradation	602	0.35
Grade 4.5(**)(***)(****): MA Gradation	602	0.40
Grade 4.0(**)(***)(****): MA Gradation	602	0.44
Grade 3.5 and 3.0(**): MA Gradation	564	0.46
Grade 2.5(**): MA Gradation	526	0.50

Structural Concrete (*) (**) (***)(****)
*Grade as specified in the Contract Documents
**Air Entrained meeting subsection 402.3e.
***Aggregate as specified in DIVISION 1100.
****MPC (Moderate Permeability Concrete)

C&R-8

Air entrained concrete with a target air of 6.5 ± 1.5 percent.
Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard. Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

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C&R-8

Structural Concrete Slump

- 402.3.f
  - Concrete will have a designated slump
  - Actual slump must fall within tolerance range
  - If specified SLUMP $\le$ 3”, tolerance $\pm$ ¾”
  - If specified SLUMP > 3”, tolerance $\pm$ 25%
  - Slump for Drilled Shafts:
    - Target Slump = 9”
    - Actual Slump ≥ 8”
  - Max designated slump for all other structural concrete = 5”

C&R-9

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Slump Tolerances

- **Example #1:**
  - **Specified Slump = 4”**
    What is the acceptable range?
  - **4” x 25% = 1” → Tolerance is $\pm$ 25%**
  - **4” – 1” = 3”**
  - **4” + 1” = 5”**
- **Acceptable range – 3” to 5”**

C&R-10

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Slump Tolerances

- **Example #2:**
  - **Specified Slump for a Bridge Deck = 2 ¼" What is the acceptable range?**
  - **2 ¼" $\leq$ 3" → Tolerance is $\pm$ ¾"**
  - **2 ¼" – ¾" = 1 ½"**
  - **2 ¼" + ¾" = 3"**
- **Acceptable range – 1 ½" to 3"**

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C&R-11

Slump Tolerances

- **Example #3:**
  - **Specified Slump for Structural Concrete = 3 ½" What is the acceptable range?**
  - **3 ½" > 3" → Tolerance is $\pm$ 25%**
  - **3 ½" x 25% = ⅞"**
  - **3 ½" + ⅞" = 4 ⅜"**
  - **3 ½" – ⅞" = 2 ⅝"**
- **Acceptable range – 2 ⅝" to 4 ⅜"**

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C&R-12

Slump Tolerances

- **Example #4:**
  - **Specified Slump for Structural Concrete = 3" What is the acceptable range?**
  - **3" ≤ 3" → Tolerance is ± ¾"**
  - **3" – ¾" = 2 ¼"**
  - **3" + ¾" = 3 ¾"**
- **Acceptable range – 2 ¼" to 3 ¾"**

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C&R-13

Placement Time

- 401.8.a – Mixing, Delivery and Placement Limitations
- Non-agitated Concrete – place within 30 minutes of adding the cement to the water
- Agitated Concrete – use Table 401-5

TABLE 401-5: AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME		
T = Ambient Air Temperature at Time of Batching (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
T < 75	1 ½	None
75 ≤ T	1	None
75 ≤ T < 90	1 ½	Set Retarder

- If concrete temp. ≥ 90°F, 45 min. placement time

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C&R-14

Placement Time

- **Concrete Temperature**
  - **90 degrees or greater** — **45 Minutes**
  - **< 90 degrees**
    - **Air Temperature**
      - **< 75 deg.** — **1.5 Hours**
      - **75 to 89 deg.** — **1.0 Hour (*)**
      - **> 90 deg** — **1.0 Hour**

C&R-15

(*) With the use of an approved Set Retarder, time may be increased to 1 ½ hours.

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Reinforcing Steel

- **4 Major Questions:**
  - **Is it Clean and Free of heavy rust?**
  - **Is it properly---**
    - **Tied**
    - **Spaced**
    - **Supported**
  - **Is there adequate clearance---**
    - **From the forms?**
    - **Between the mats?**
    - **From the Top of Concrete?**
  - **Is there a defined pattern?**

C&R-16

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C&R-17

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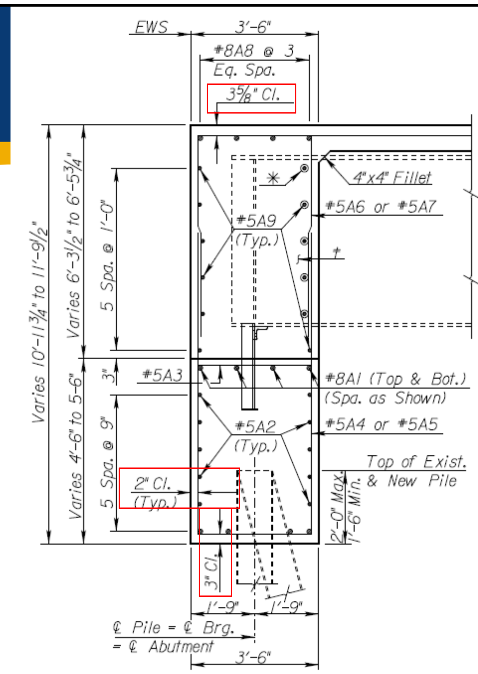
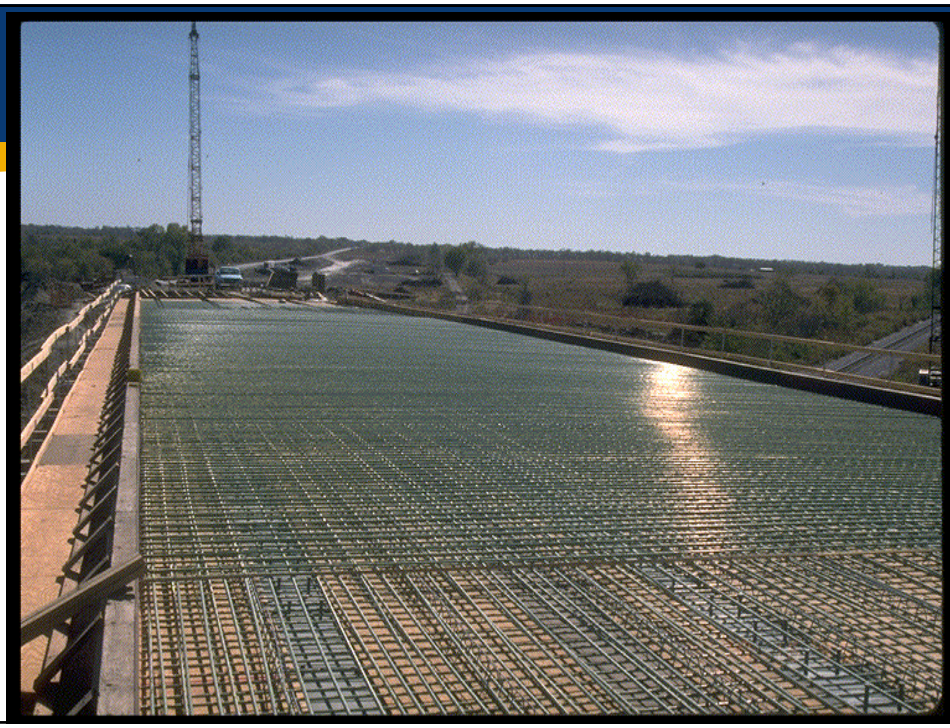
Department of Transportation

C&R-18

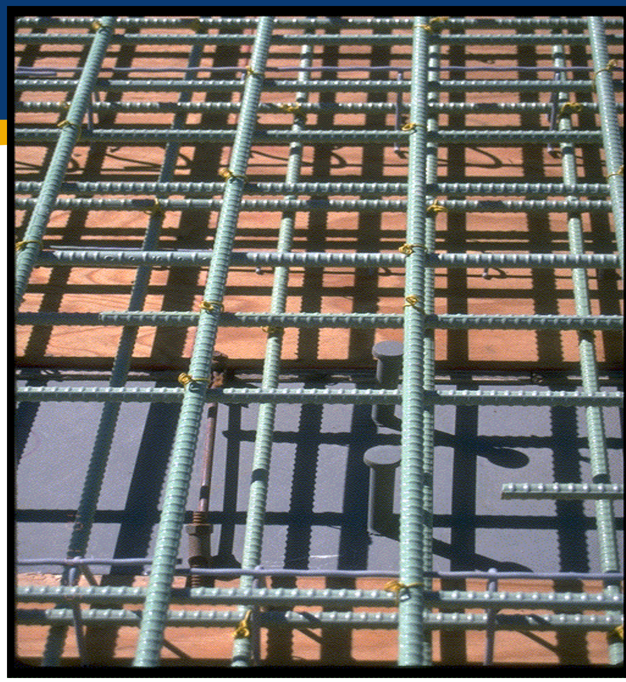


TYPICAL SECTION THRU ABUTMENT

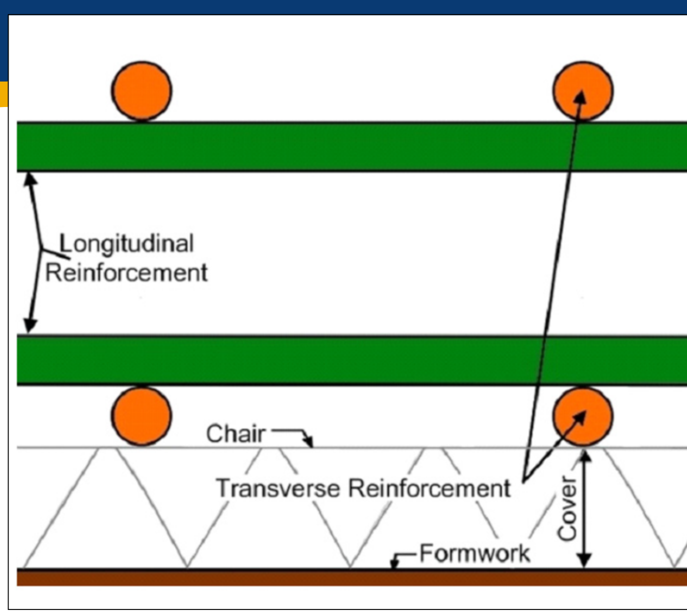
C&R-19



C&R-20

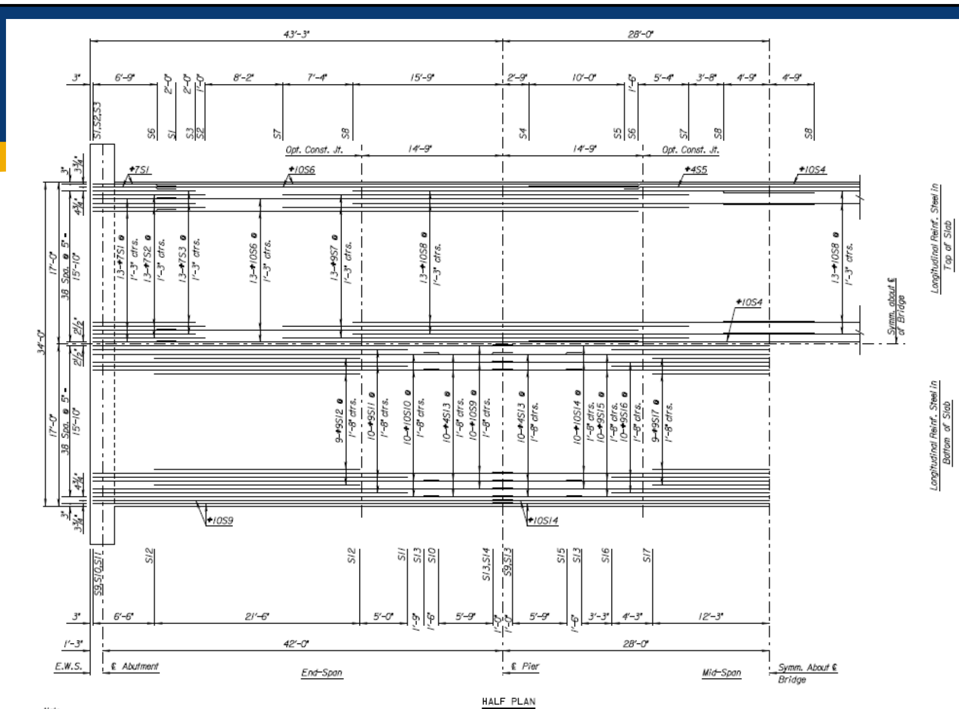


C&R-21



Longitudinal Reinforcement
Chair
Transverse Reinforcement
Cover
Formwork

C&R-22



43'-3"
28'-0"
Opt. Const. Jt.
14'-9"
Longitudinal Reinf. Steel in Top of Slab
Longitudinal Reinf. Steel in Bottom of Slab
Symm. about ℄ of Bridge
42'-0"
28'-0"
E.W.S.
℄ Abutment
End-Span
℄ Pier
Mid-Span
Symm. About ℄ Bridge
HALF PLAN

C&R-23

C&R-24

C&R-24

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C&R-25

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C&R-26

Reinforcing Steel

Construction Requirements:

- **Remove heavy mill scale or rust**
- **Check for proper bar spacing**
- **Verify the bars are tied adequately**
  - **Spacing of ties meet requirements**
- **Verify the pattern**
- **Check for adequate clearance**

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Reinforcing Steel

- Tie perimeter steel at all intersections
- Tie rest of steel intersections at 24 inches or less in all directions

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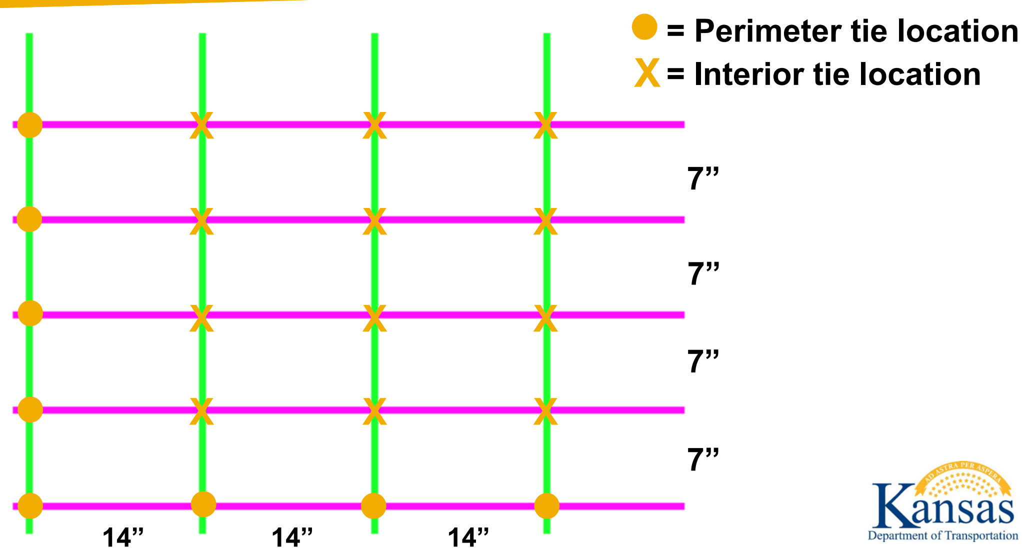
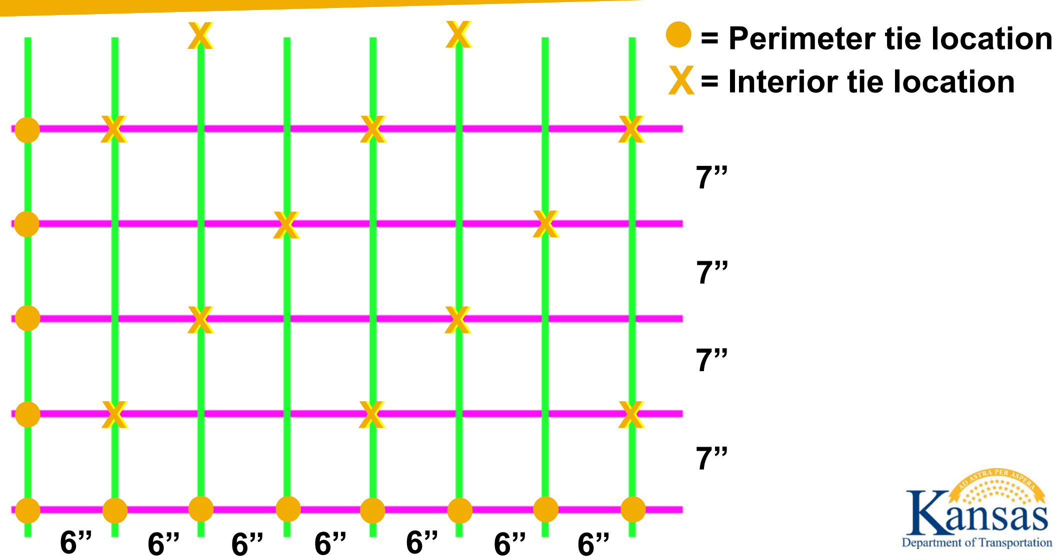
Reinforcing Steel



C&R-29

Reinforcing Steel



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Epoxy Coated Reinforcing Steel

Construction Requirements:

- **Use padded or non-metallic slings**
- **Patch ALL cracks or defects in coating**
  - **Especially at Ends and Bends**
- **Use plastic coated wire ties**
- **Protect from UV light**
  - **Req'd to be covered for long term storage**
- **Use plastic coated bar chairs**

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K.D.O.T. Steel Reinforcement

TABLE 711-1: BAR SIZE WEIGHTS

Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

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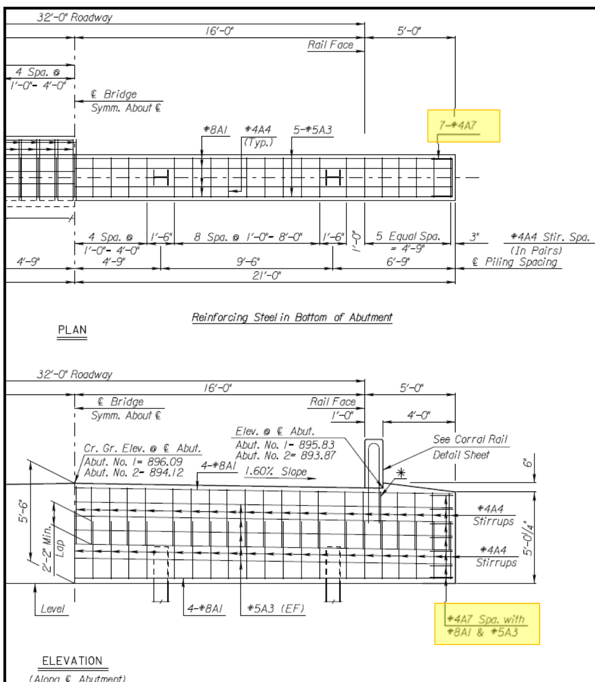
K.D.O.T. Steel Reinforcement

- **Measurement and Payment (Section 711.4)**
- **Table 711-1 for Weights**
- **Compute to the nearest 1.0 lb**
  - N = number of bars of specific mark (A3, PB2, etc.)
  - L = length of specified bar
  - W = weight of bar size in (lbs/ft) (Table 711-1)
- **Total Mark Weight = N** x **L** x **W**

C&R-33



Total A7 weight?

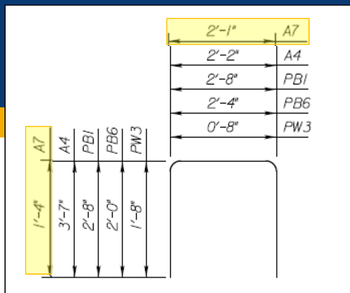
Count the Number of bars:

= 7 x 2 x 2

= 28

7 bars at <u>each wing</u> (x2) of <u>both abutments</u> (x2)

C&R-34



A4, A7, PB1, PB6, & PW3

Calculate the Length of One A7 bar:

= 1'-4"+1'-4"+2'-1"

= 4'-9" = 4.75 ft

BILL OF REINFORCING STEEL
Epoxy Coated - Grade 60

Superstructure / Abutment - Deck - Rail

Straight Bars				Bent Bars			
Mark	Size	Number	Length	Mark	Size	Number	Length
S4	#10	4	50'-6"	R1	#7	24	9'-3"
S6	#10	60	50'-6"	R2	#7	4	5'-7"
S8	#10	52	48'-6"	R3	#7	220	7'-9"
S9	#10	48	44'-0"	S1	#7	60	11'-3"
S10	#10	40	36'-3"	S2	#7	52	14'-3"
S14	#10	24	58'-0"	S3	#7	52	13'-3"
S7	#9	52	42'-8"	A2	#5	62	3'-11"
S11	#9	40	33'-0"	R5	#5	8	6'-6"
S12	#9	36	21'-6"	R6	#5	8	10'-8"
S15	#9	20	42'-6"				
S16	#9	20	33'-0"	A4	#4	164	9'-4"
S17	#9	18	24'-6"	A5	#4	62	6'-2"
				A7	#4	28	4'-9"
A1	#8	16	41'-8"	R4	#4	220	3'-2"
				R7	#4	4	10'-8"
R11	#6	24	8'-3"				
R12	#6	144	9'-8"	R8	#3	384	4'-4"
T1	#6	97	33'-8"	R9	#3	208	4'-6"
				R10	#3	52	4'-6"
A3	#5	20	41'-8"				
				T3-T18			⊗
A6	#4	2	32'-8"				
S5	#4	2	30'-6"				
S13	#4	80	9'-3"				
T2	#4	82	33'-8"				
SC1	#4	78	6'-6"				

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Find the Weight (lb/ft) of the Bar Size Being Calculated:

- Bar Size = #4
- Weight:

  0.668 lb/ft

TABLE 711-1: BAR SIZE WEIGHTS

Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

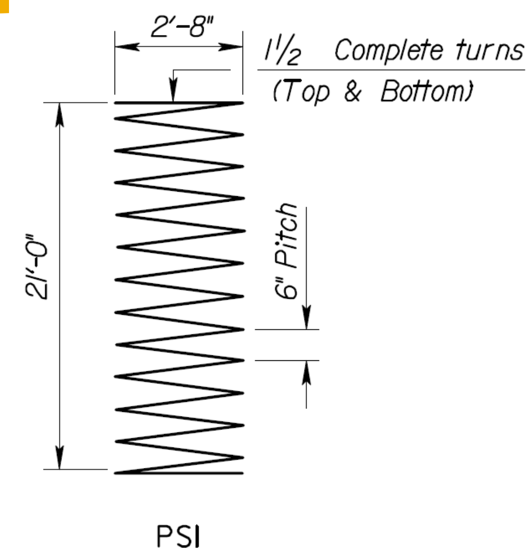
*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

Total A7 Mark Weight = 28 x 4.75 x 0.668 = 88.844 lb

Kansas Department of Transportation

C&R-36

Spiral Reinforcing Steel



C&R-37

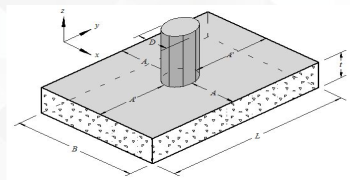
Spiral Reinforcing Steel

- **Typical 1.5 turns Top & Bottom**
- **Table 711-1 for Weights based on bar size**
- **[(1.5 + 1.5) + (Total Height/pitch)] * pi * dia. * Columns * W**
- **[(3.0) + (21 ft./0.5ft)] * 3.14 * 2'-8" * 3 Cols. * 0.376 lb/ft**
- **[3.0 + 42.0] * 3.14 * 2'-8" * 3 Cols * 0.376 lb/ft**
- **(45.0) * 9.42 * 0.376 lb/ft * 2'-8"**
- **159.386 lb/ft * 2'-8" =**
  159.386 lb/ft * 2.66 ft = 423.97 lb ≈ 424 lb

C&R-38

CIT Structures

Foundations



Foundations

- Types of Foundations
  - Spread Footings
    - Where scour is not a concern and rock with adequate bearing capacity is found near the surface.
  - Pile Footings
    - In many cases pile support footings will be recommended.
  - Drilled Shafts
    - When rock is not found near the surface.

Foundations

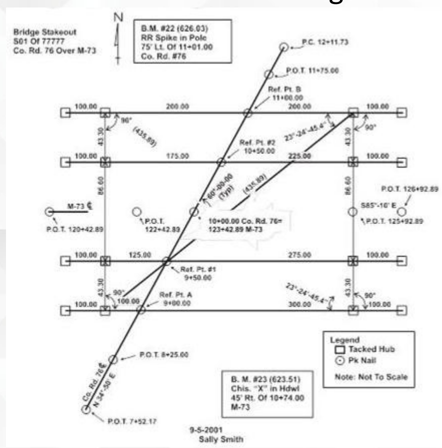
- Construction of Foundations
  - Staking
  - Specifications and Plan Details
  - Excavation
  - Placement of footing materials
  - Measurement and Payment

Foundations

- Staking
  - Section 802 - Contractor Construction Staking
    - Control Stakes: Do not perform vertical control using GPS.
    - 802.3 c (2) Bridge. Prior to construction, set project control points and Critical Bridge Element control points for the horizontal and vertical location
    - See Table 802-1 Critical Bridge Elements
    - Independent survey under different surveyor
    - 802.3 c (3) Documentation. Provide and maintain a current copy of all field survey notebooks at the project site at all times.

Foundations

- Staking
  - Section 802 - Contractor Construction Staking



Kansas
Department of Transportation

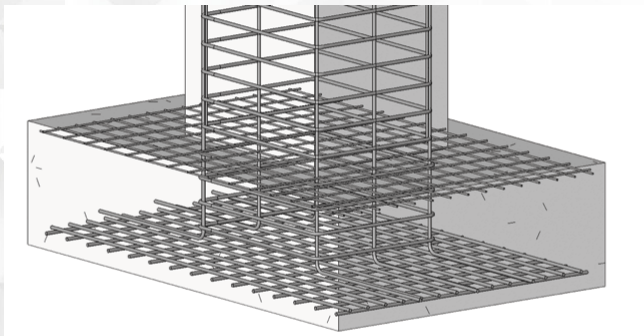
Foundations

- Staking
  - Section 802 - Contractor Construction Staking
    - Off-Set Stakes
    - Excavation will destroy the control point.
    - Be certain they are placing Off- Set stakes outside the excavation limits. Keep these stakes preserved.

Kansas
Department of Transportation

Foundations

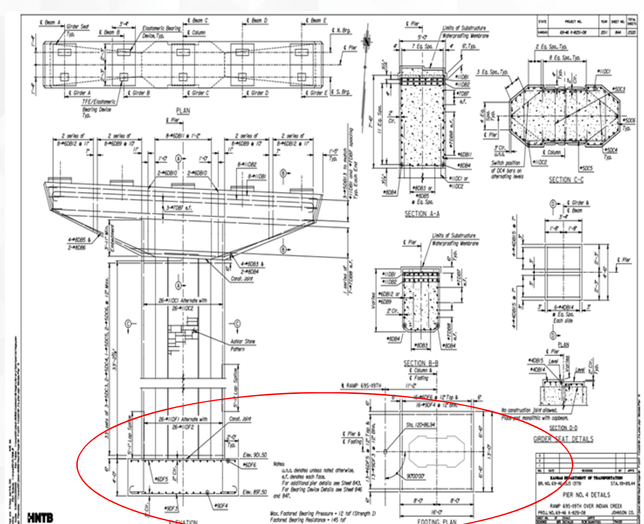
- SPREAD FOOTING



Kansas Department of Transportation

Foundations

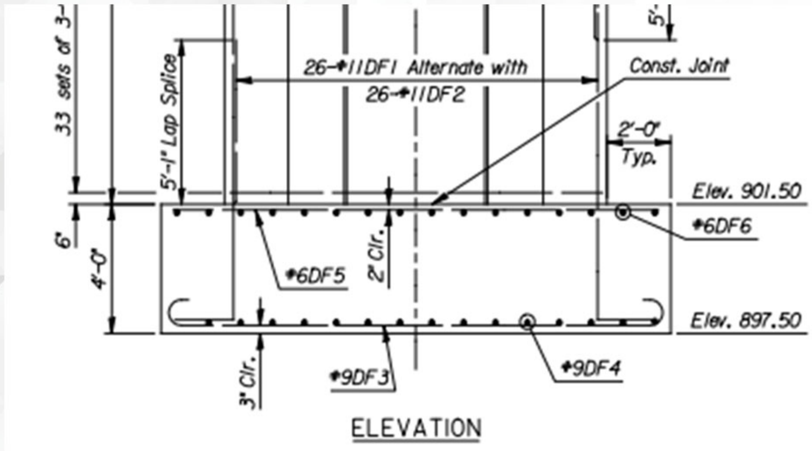
- Plan Details
  - Spread Footing



Kansas Department of Transportation

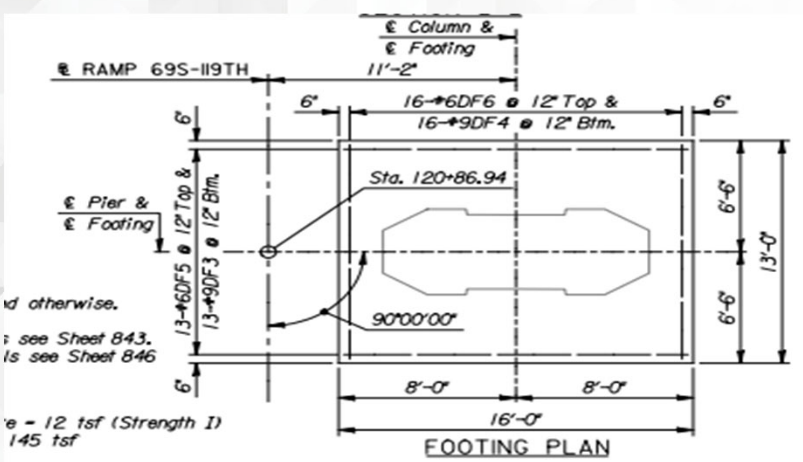
Foundations

• Plan Details – Spread Footing



Foundations

• Plan Details – Spread Footing



Foundations

- Excavation
  - Section 204 - Excavation and Backfill for Structures
    - Class I Excavation: is the entire volume of whatever nature, except water, found above the Excavation Boundary Plane, with in the limits specified.
    - Class II Excavation: is the entire volume of whatever nature, including water, found below the Excavation Boundary Plane, with in the limits specified.
    - Class III Excavation: Bridge excavation not classified as Class I or Class II. Class III Excavation is the entire volume of whatever nature encountered including water, within the limits specified.

Kansas Department of Transportation

Foundations

- Excavation
  - Spread Footing
    - Normally, the excavation should be carried to the elevation of the footing shown in the plans. A possible exception would be in the event that a satisfactory foundation in rock can be secured at a higher elevation. Contact the Bureau of Structures and Geotechnical Services.
    - Always compare the material encountered at the footing elevation with that shown on the plans and geology report.

Kansas Department of Transportation

Foundations

- Excavation
  - Footings
    - Equipment – Excavators and Jackhammers

Foundations

- Excavation
  - Spread Footing
    - If the Engineer determines it is necessary to lower a footing below the elevation shown in the Contract Documents, the additional excavation is paid as follows:

Kansas Department of Transportation

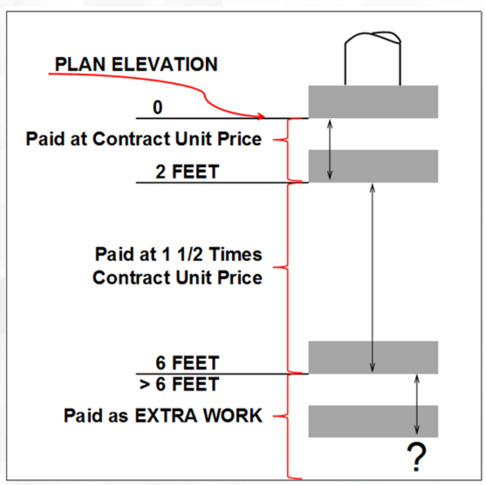
Foundations

- Excavation
  - Spread Footing
    - 204.4 c. Measurement and Payment
    - Additional excavation up to and including 2 feet below the contract elevation is paid at the contract unit price.
    - Additional excavation from more than 2 feet up to and including 6 feet below the contract elevation is paid at 1½ times the contract unit price.
    - Additional excavation more than 6 feet below the contract elevation is paid as Extra Work, SECTION 104.

Kansas Department of Transportation

Foundations

- Excavation
  - Spread Footing
    - 204.4 c. Measurement and Payment
    - Measure the quantity of CUYD's in each zone.
    - Change Order with new Prices



Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Spread Footing
    - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
    - Section 401 General Concrete, Section 402 Structural Concrete and Section 710 Concrete Structure Construction.

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Spread Footing
  - Placing Rebar and Concrete

Foundations

- Measurement and Payment
  - Spread Footing
    - Section 710 Concrete Structure Construction _ The Engineer will measure the various grades of concrete placed in the structure by the cubic yard. No deductions are made for reinforcing steel and pile heads extending into the concrete.
    - Section 711 Reinforcing Steel _ The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.

Kansas Department of Transportation

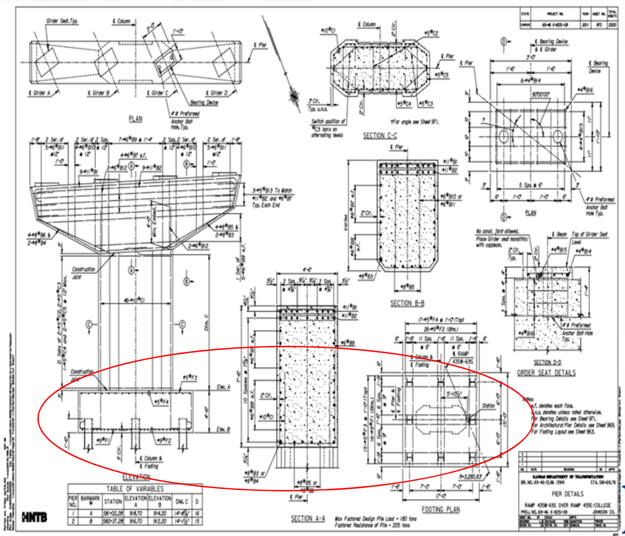
Foundations

- PILE FOOTING

Kansas Department of Transportation

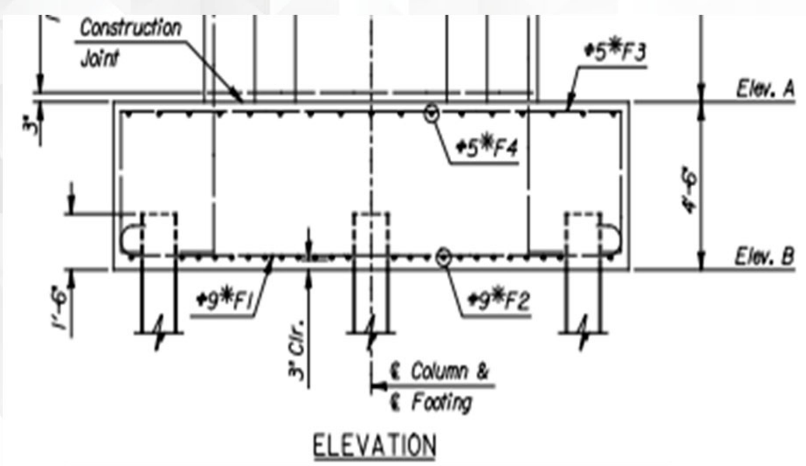
Foundations

- Plan Details
  - Pile Footing



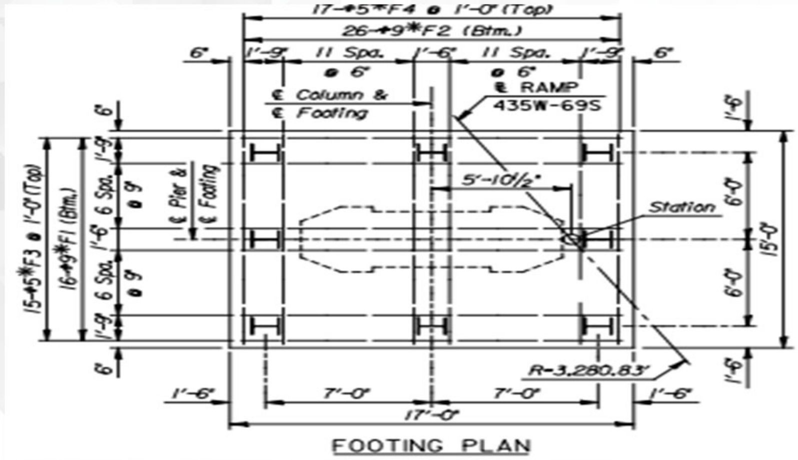
Foundations

- Plan Details – Pile Footing



Foundations

- Plan Details – Pile Footing



Kansas Department of Transportation

Foundations

- Excavation
  - Pile Footing
    - Complete the excavation before driving any piling. After driving piling remove loose and displaced material.
    - If necessary reshape and recompact the bottom of the excavation.
    - Piling placed in groups with concrete caps completing the foundation.

Kansas Department of Transportation

Foundations

- Excavation
  - Pile Footings
    - Pile Footing for Pier
    - Typically the Engineer shall not have any need to change elevation of the footing.

Kansas Department of Transportation

Foundations

- Excavation
  - Pile Footings
    - Pile Footing for Abutment

Foundations

- Placement of footing materials
  - Pile Footing
    - Section 704 Piling and Section 1609 Steel Piling and Pile Points.
    - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
    - Section 401 General Concrete, Section 402 Structural Concrete and Section 710 Concrete Structure Construction.

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Pile Footing
  - Certified Material

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Pile Footing
  - Allowable Pile Hammer

Foundations

- Placement of footing materials
  - Pile Footing
  - Placing Piling

Foundations

- Placement of footing materials
  - Pile Footing Concrete Cap
  - Placing Rebar and Concrete

Foundations

- Measurement and Payment
  - Pile Footing
    - Section 704 Piling _ The Engineer will measure the length of steel pile, steel sheet pile, cast-in-place concrete pile and prestressed concrete pile remaining in the structure, by the linear foot.
    - Section 710 Concrete Structure Construction _ The Engineer will measure the various grades of concrete placed in the structure by the cubic yard.
    - Section 711 Reinforcing Steel _ The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.

Kansas Department of Transportation

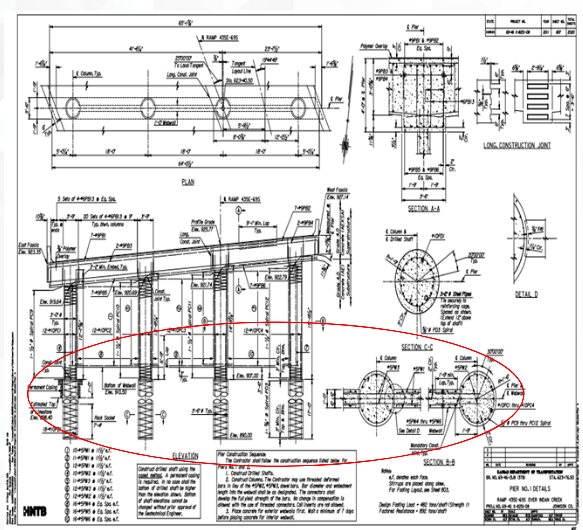
Foundations

• Drilled Shafts

Kansas Department of Transportation

Foundations

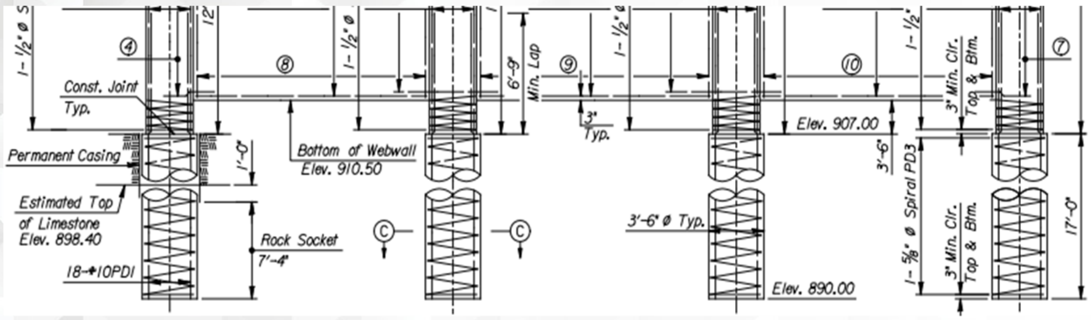
• Excavation
  • Drilled Shafts



Kansas Department of Transportation

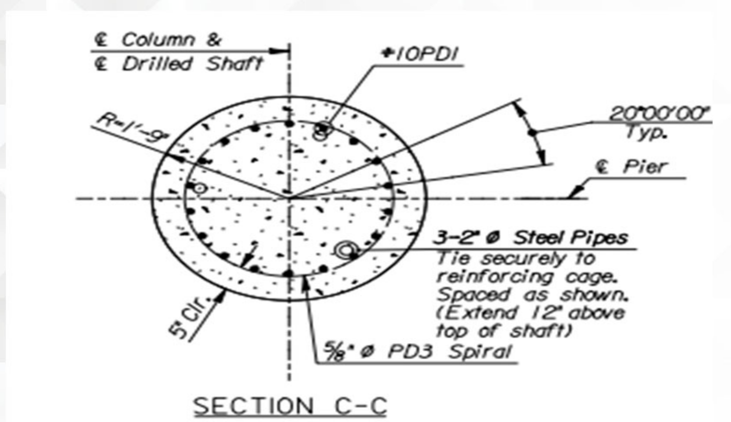
Foundations

- Excavation
    - Drilled Shafts



Foundations

- Excavation
    - Drilled Shafts



Foundations

- Excavation
  - Drilled Shafts
    - Specifications - Section 703 Drilled Shafts
    - Drilled shafts are considered where footing conditions require bearing to be carried to a rock formation an the following conditions exist:
    - The footing would have short piles
    - The water table is high
    - A spread footing foundation would be uneconomical
    - Concerns about pile driving i.e. overhead clearance

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Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Drilled shaft lengths shown in the Contract Documents are an estimate from the top of formation elevations determined from borings.
    - Actual formation elevations encountered at each shaft, may require the actual length of each drilled shaft be adjusted.
    - If the Engineer changes the drilled shaft lengths, the Contractor will be advised (in writing) of the revised bottom of rock socket elevation.

Kansas
Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Equipment – Excavators or Cranes with drill rig attachment
    - Auger Bits

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Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Equipment – Excavators or Cranes with drill rig attachment
    - Core Barrels

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Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Equipment – Excavators or Cranes with drill rig attachment
    - Clean Out Buckets

Kansas Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Oversized for Cased Method

Kansas Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Limestone excavated from the rock socket

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Department of Transportation

Foundations

- Excavation
  - Drilled Shafts
    - Identify if excavation is classified as a Dry Shaft or Wet Shaft
    - Read your Specifications, when you are done reading them, read them again and again.
    - Have a copy of the specifications and plans on site at all times.
    - Have any additional correspondence that may have came from Geology. i.e. investigative core hole results

Kansas
Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
    - Section 711 Reinforcing Steel and Section 1601 Steel Bars for Concrete Reinforcement.
    - Section 401 General Concrete, Section 402 Structural Concrete and Section 703 Drilled Shafts

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Rebar cage rigged from crane

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Rebar cage rigged from cranes

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Rebar cage

Kansas Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Spacers for clearance

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Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Sonic Tubes
  - Sonic Test all shafts placed by Wet pour method

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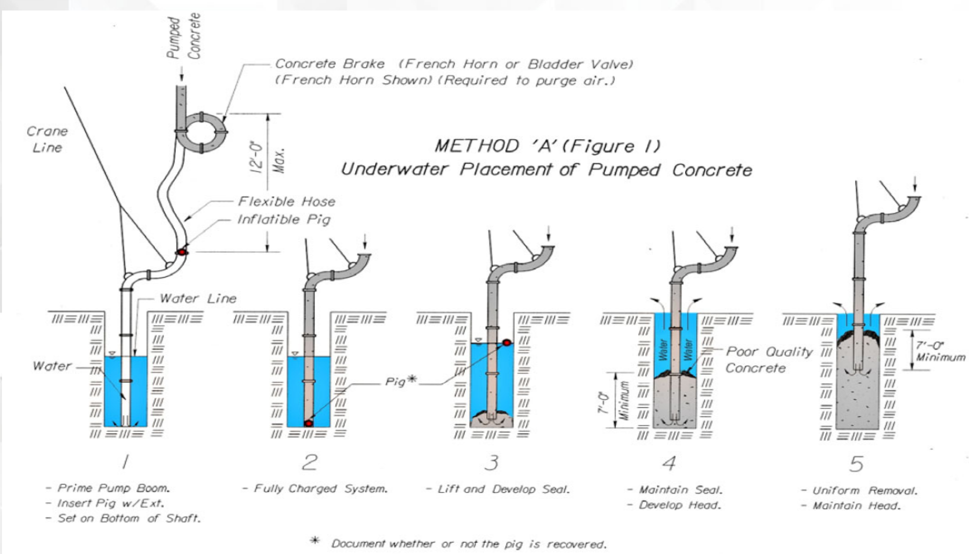
Department of Transportation

Foundations

- Placement of footing materials
  - Drilled Shafts
  - Concrete
  - Over pump Wet and Dry Pours – Provision 15-07015

Foundations



Foundations

- Measurement and Payment
  - Drilled Shaft
    - Section 703 Drilled Shafts _ The Engineer will measure drilled shafts by the linear foot measured from the bottom of the rock socket to the top of the completed drilled shaft.

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Foundations

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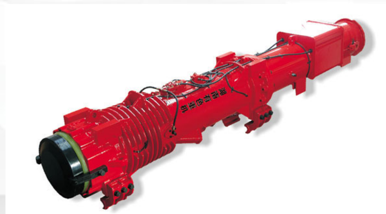
CIT Structures

Pile Driving



Kansas Department of Transportation

Pile Driving

Kansas Department of Transportation *Bridge Construction Manual*

5.3 DRIVEN PILE

5.3.1 General

Driven piles are used as the foundation for almost all abutments in Kansas bridges. Likewise they are used as the foundation for many piers in Kansas bridges. Proper pile driving inspection is critical to a successful bridge project.

Kansas Department of Transportation

Pile Driving

What is a driven pile?

There are two types of driven piles: sheet pile and foundation pile. Sheet piles are long, interlocking, rolled steel plates used in retaining structures, such as walls and cofferdams. Foundation piles are long slender columns designed to be driven into the ground. Foundation piles will be discussed here.

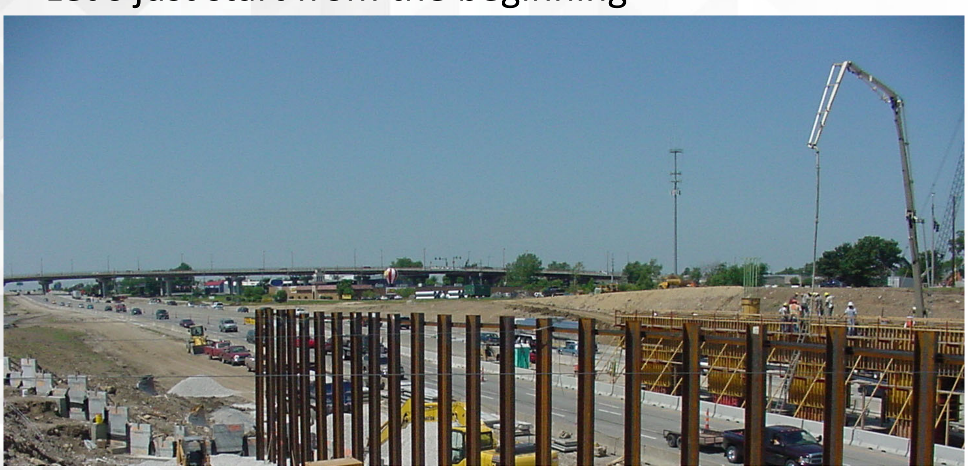
Foundation piles are simply columns, designed to transmit surface loads to low lying soil or bedrock. These loads are transmitted by friction between the pile and ground and by point bearing through the end of the pile. The actual amount of frictional resistance or end bearing is dependent on the particular site conditions.

Foundation piles are made of steel, concrete, or timber. Of these materials, steel H-pile and cast-in-place pipe pile are most commonly used in Kansas. The material and size of pile to be used on a particular project are designated in the plans on the General Notes and Summary of Quantities Sheet.

Kansas Department of Transportation

Pile Driving

- Pile Driving Inspection
  - Let's just start from the beginning



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Pile Driving

- What are H piles?

Kansas
Department of Transportation

Pile Driving

- First things first, right?

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Pile Driving

- SECTION 704 – PILING

BID ITEMS	UNITS
Piles (*) (**)	Linear Foot
Test Piles (*) (**)	Linear Foot
Test Piles (Special) (*) (**)	Linear Foot
Cast Steel Pile Points	Each
Pre-Drilled Pile Holes	Linear Foot

  - *Type: Cast-In-Place Concrete, Prestressed Concrete, Steel or Steel Sheet, Corrugated Metal Sheet +
  - **Size
  - +Black or Galvanized

Kansas Department of Transportation

Pile Driving

- SECTION 704 – PILING

  Table 704-1: Pile Formulas

TABLE 704-1: PILE FORMULAS

Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2\ W\ H}{S+1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S+0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

Kansas Department of Transportation

Pile Driving

- Plan Sheets – Summary Sheet

STATE	PROJECT NO.	YEAR	SHEET NO.	TOTAL SHEETS
KANSAS	69-46 K-8251-08	2011	957	2520

SUMMARY OF BRIDGE QUANTITIES

ITEM / LOCATION	CLASS III EXCAVATION	CONCRETE (GRADE 4.0) (AE)	CONCRETE (GRADE 4.0) (AE)(SA)	REINFORCING STEEL (GRADE 60)	REINFORCING STEEL (GRADE 60) (EPOXY COATED)	STRUCTURAL STEEL (A709) (GRADE 50W)	STRUCTURAL STEEL (M270) (GRADE 50WT3)	WELDED STUD SHEAR CONNECTOR
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Lbs.	Lbs.	Lbs.	Lbs.	Each
ABUTMENT NO. 1	100	18.6	**	-----	♦2,550	-----	-----	-----
PIER NO. 1	*110	97.6	-----	15,360	-----	-----	-----	-----
PIER NO. 2	*115	96.6	-----	15,160	-----	-----	-----	-----
ABUTMENT NO. 2	-----	16.4	**	-----	♦2,110	-----	-----	-----
SUBSTRUCTURE	325	229.2	-----	30,520	4,660	-----	-----	-----
SUPERSTRUCTURE	-----	-----	362.8	-----	83,180	117,999	134,282	2,778
TOTAL	325	229.2	362.8	30,520	87,840	117,999	134,282	2,778

ITEM / LOCATION	PILE (STEEL) (HP12x53)	PILE (STEEL) (HP14x89)	PRE-DRILLED PILE HOLE	MULTI-LAYER POLYMER CONCRETE OVERLAY	SLOPE PROTECTION (AGGREGATE)	BRIDGE DRAINAGE SYSTEM	ABUTMENT STRIP DRAIN	BRIDGE BACKWALL PROTECTION SYSTEM	BEARING (STEEL REINFORCED ELASTOMERIC)	CONCRETE MASONRY COATING
	Lin. Ft.	Lin. Ft.	Lin. Ft.	Sq. Yds.	Cu. Yds.	Lump Sum	Sq. Yds.	Sq. Yds.	Each	Sq. Yds.
ABUTMENT NO. 1	196	-----	-----	-----	264	-----	24	52	-----	-----
PIER NO. 1	-----	192	104	-----	-----	-----	-----	-----	4	921
PIER NO. 2	-----	184	64	-----	-----	-----	-----	-----	4	902
ABUTMENT NO. 2	172	-----	-----	-----	229	-----	28	47	-----	-----
SUBSTRUCTURE	368	376	168	-----	493	-----	52	99	8	1,823
SUPERSTRUCTURE	-----	-----	-----	914	-----	Lump Sum	-----	-----	-----	275
TOTAL	†368	††376	168	914	493	Lump Sum	52	99	8	2,098

*Excavation quantities for pier footings are calculated relative to existing ground.

**Quantities are included in the superstructure total quantity.

♦Reinforcing steel in the abutments placed above the construction joint is included in the superstructure total quantity.

†This includes 4 @ 49' and 4 @ 43'.

††This includes 8 @ 24' and 8 @ 23'.

LRFR RATING FACTORS

DESIGN LOAD / RATING LEVEL	INVENTORY	OPERATING
HL-93 Loading	1.05	1.37
2008 Manual for Bridge Evaluation		

LFD RATING FACTORS

TRUCK / RATING LEVEL	INVENTORY	OPERATING
HS-20 TRUCK (36T)	1.53	2.55
TYPE H.E.T. (110T)		1.12
2002 LFD Rating, 17th Edition AASHTO		

INDEX OF BRIDGE DRAWINGS

SHEET NO.	DRAWING TITLE
957	BRIDGE QUANTITIES & INDEX
958,959	GENERAL NOTES
960	CONTOUR MAP
961	CONSTRUCTION LAYOUT
962	ENGINEERING GEOLOGY
963	FOOTING LAYOUT
964-967	ABUTMENT DETAILS
968	ABUTMENT STRIP DRAIN
969	ARCHITECTURAL PIER DETAILS
970	PIER DETAILS
971	ELASTOMERIC BEARING DEVICE DETAILS
972	FRAMING PLAN
973,974	GIRDER DETAILS
975	CROSSFRAME DETAILS
976	ABUTMENT DIAPHRAGM DETAILS
977	MISCELLANEOUS STEEL DETAILS
978	SLAB PLAN
979	SLAB DETAILS

Pile Driving

- Plan Sheets – Quantity Sheet

SUMMARY OF BRIDGE QUANTITIES

ITEM / LOCATION	CLASS III EXCAVATION	CONCRETE (GRADE 4.0) (AE)	CONCRETE (GRADE 4.0) (AE)(SA)	REINFORCING STEEL (GRADE 60)	REINFORCING STEEL (GRADE 60) (EPOXY COATED)	STRUCTURAL STEEL (A709) (GRADE 50W)	STRUCTURAL STEEL (M270) (GRADE 50WT3)	WELDED STUD SHEAR CONNECTOR	PILE (STEEL) (HP12x53)	PILE (STEEL) (HP14x89)	PRE-DRILLED PILE HOLE	MULTI-LAYER POLYMER CONCRETE OVERLAY	SLOPE PROTECTION (AGGREGATE)	BRIDG DRAINA SYSTE
	Cu. Yds.	Cu. Yds.	Cu. Yds.	Lbs.	Lbs.	Lbs.	Lbs.	Each	Lin. Ft.	Lin. Ft.	Lin. Ft.	Sq. Yds.	Cu. Yds.	Lump S
ABUTMENT NO. 1	100	18.6	**	-----	♦2,550	-----	-----	-----	196	-----	-----	-----	264	-----
PIER NO. 1	*110	97.6	-----	15,360	-----	-----	-----	-----	-----	192	104	-----	-----	-----
PIER NO. 2	*115	96.6	-----	15,160	-----	-----	-----	-----	-----	184	64	-----	-----	-----
ABUTMENT NO. 2	-----	16.4	**	-----	♦2,110	-----	-----	-----	172	-----	-----	-----	229	-----
SUBSTRUCTURE	325	229.2	-----	30,520	4,660	-----	-----	-----	368	376	168	-----	493	-----
SUPERSTRUCTURE	-----	-----	362.8	-----	83,180	117,999	134,282	2,778	-----	-----	-----	914	-----	Lump S
TOTAL	325	229.2	362.8	30,520	87,840	117,999	134,282	2,778	†368	††376	168	914	493	Lump S

*Excavation quantities for pier footings are calculated relative to existing ground.

**Quantities are included in the superstructure total quantity.

†This includes 4 @ 49' and 4 @ 43'.

††This includes 8 @ 24' and 8 @ 23'.

Pile Driving

- Plan Sheets – Quantity Sheet

PILE (STEEL) (HP12x53)	PILE (STEEL) (HP14x89)	PRE-DRILLED PILE HOLE	MULTI-LAYER POLYMER CONCRETE OVERLAY	SLOPE PROTECTION (AGGREGATE)	BRIDC DRAINA SYSTI
Lin. Ft.	Lin. Ft.	Lin. Ft.	Sq. Yds.	Cu. Yds.	Lump
196	———	———	———	264	———
———	192	104	———	———	———
———	184	64	———	———	———
172	———	———	———	229	———
368	376	168	———	493	———
———	———	———	914	———	Lump
†368	††376	168	914	493	Lump

†This includes 4 @ 49' and 4 @ 43'.

††This includes 8 @ 24' and 8 @ 23'.

Kansas Department of Transportation

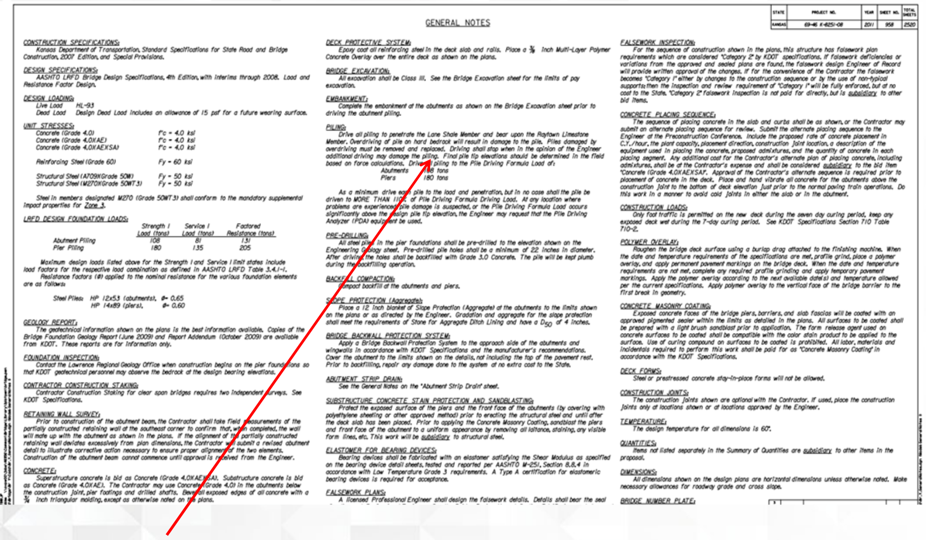
Pile Driving

- Plan Sheets – Pile Designation
  - HP 12 X 53
  - "H" - pile
  - 12" in width and depth
  - Weighs 53 lbs. per foot

Kansas Department of Transportation

Pile Driving

- Plan Sheets – Engineering Geology



Pile Driving

- Plan Sheets – General Notes

PILING:

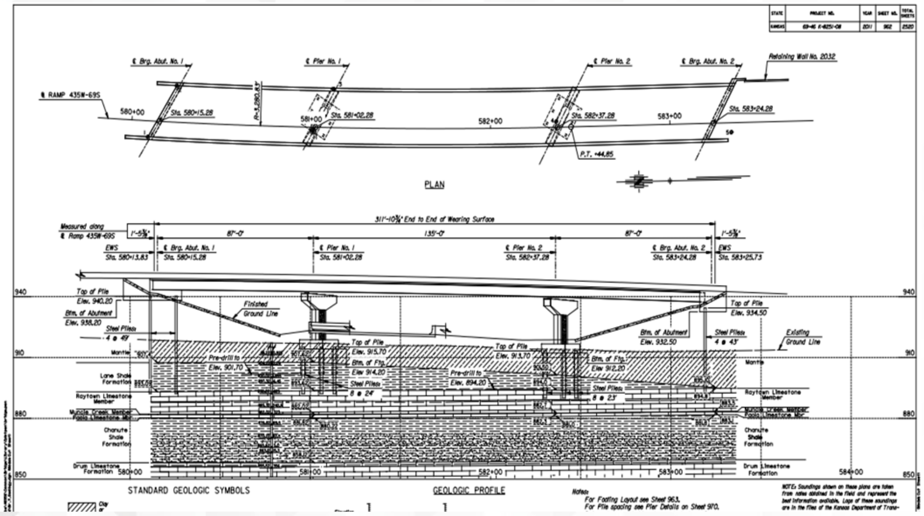
Drive all piling to penetrate the Lane Shale Member and bear upon the Raytown Limestone Member. Overdriving of pile on hard bedrock will result in damage to the pile. Piles damaged by overdriving must be removed and replaced. Driving shall stop when in the opinion of the Engineer additional driving may damage the piling. Final pile tip elevations should be determined in the field based on force calculations. Drive all piling to the Pile Driving Formula Load of:

Abutments	108 tons
Piers	180 tons

As a minimum drive each pile to the load and penetration, but in no case shall the pile be driven to MORE THAN 110% of Pile Driving Formula Driving Load. At any location where problems are experienced, pile damage is suspected, or the Pile Driving Formula Load occurs significantly above the design pile tip elevation, the Engineer may request that the Pile Driving Analyzer (PDA) equipment be used.

Pile Driving

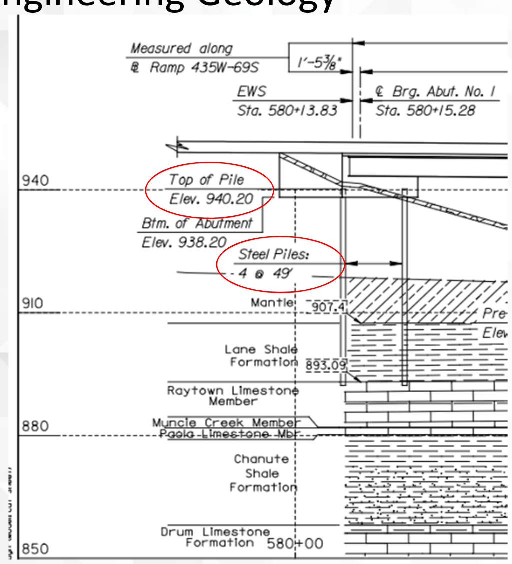
- Plan Sheets – Engineering Geology



Kansas Department of Transportation

Pile Driving

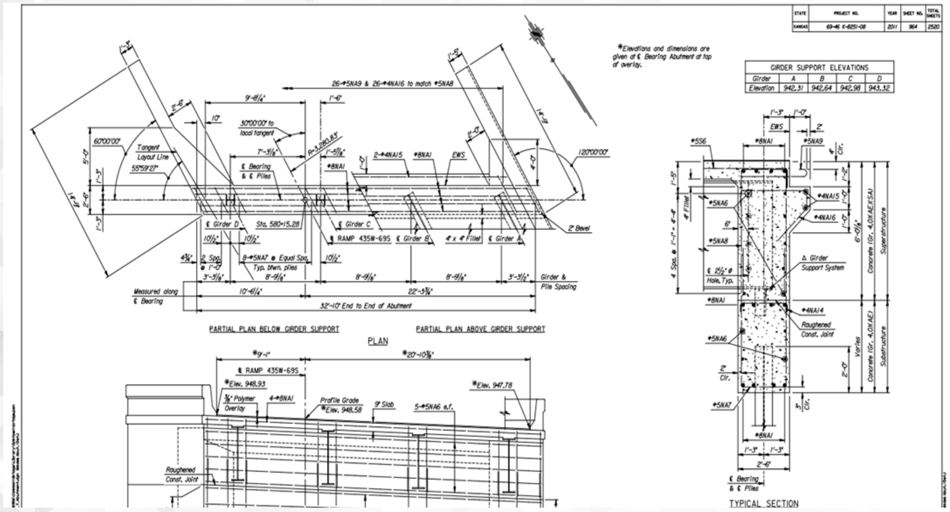
- Plan Sheets – Engineering Geology



Kansas Department of Transportation

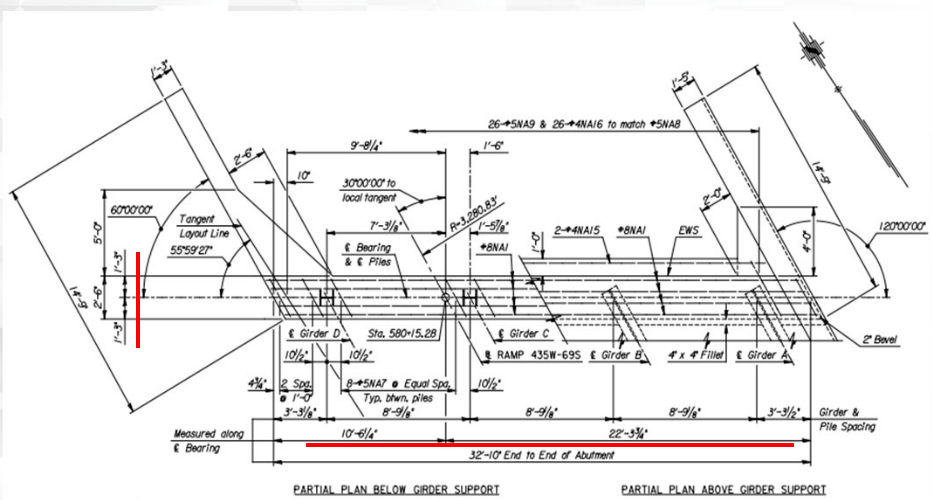
Pile Driving

- Plan Sheets – Abutment Details



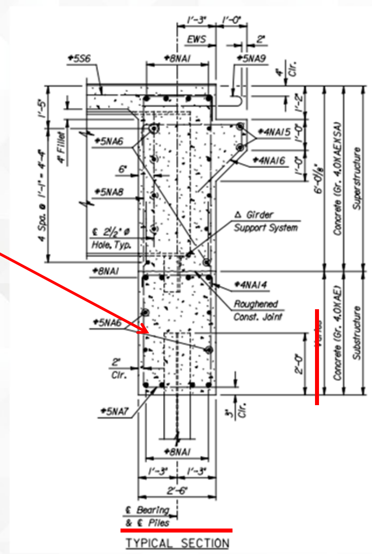
Pile Driving

- Plan Sheets – Abutment Details



Pile Driving

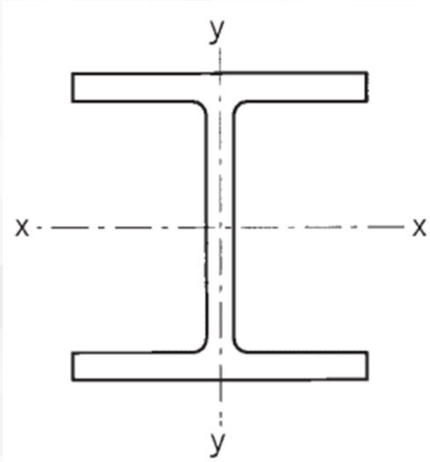
- Plan Sheets – Abutment Details



Kansas Department of Transportation

Pile Driving

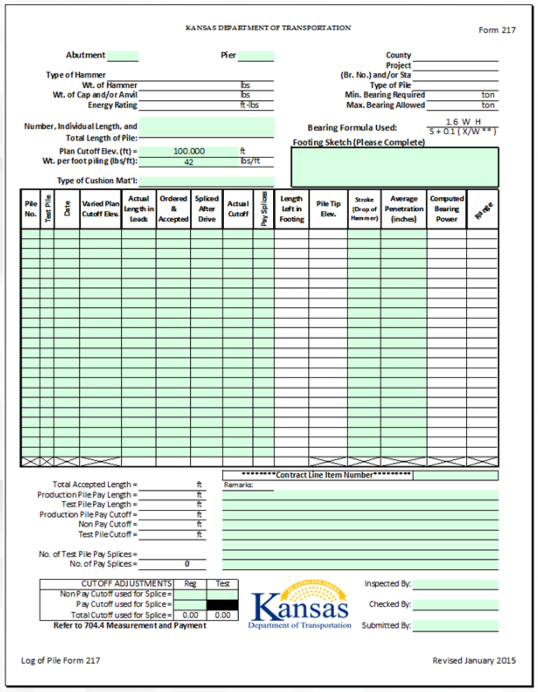
- Plan Sheets – Pile orientation
- Strong Axis - y
- Weak Axis - x



Kansas Department of Transportation

Pile Driving

- DOT Form - 217



Pile Driving

- From the Contractor – Hammer Specs
- Delmag

Delmag Product Specifications, models D6-32 through D30-32/33 (for models D36-32/33 through D200-42, see below)							
Models	D6-32	D8-22	D12-42	D16-32	D19-42	D25-32/33	D30-32/33
Maximum Batter							
standard/extended	1:3	1:2	1:5/1:1	1:5/1:1	1:5/1:1	1:5/1:1	1:5/1:1
Piston Weight							
(lbs)	1,322	1,762	2,820	3,528	4,015	5,513	6,615
Energy per Blow (adj)							
max (ft lbs)	13,500	20,100	33,990	40,200	43,225	66,380	75,452
min (ft lbs)	6,300	9,434	15,660	18,871	20,540	29,486	35,383
Bearing Capacity*							
(tons)	68	90	157	201	216	332	377
Blows per Minute							
min/max	38/52	36/52	35/52	36/52	35/52	35/52	36/52
Consumption							
Diesel fuel (gal/hr)	0.7	1	0.95	1.45	1.45	2.11	2.64
Lubrication oil (gal/hr)	0.16	0.26	0.26	0.26	0.26	0.26	0.26
Capacity							
Diesel fuel (gal)	5	5.28	6.34	20	20	17.7	17.7
Lubrication oil (gal)	1.3	1.58	1.72	5	5	5.02	5.02
Operating Weights (aprox.)							
Hammer only (lbs)	5,440	5,870	7,600	8,900	9,500	14,100	15,200
Hammer w/ typical drive cap (lbs)	6,640	7,070	8,800	10,100	10,700	16,100	17,200
Anvil (impact block)	370	370	620	753	753	1,360	1,360
Dimensions (in)							
Overall length	196	231	233	233	233	256	256
Hammer length	150	185	186	186	186	207	207
Hammer len. w/ ext.	--	--	--	219	219	246	246
Hammer depth-rear	14	14	14	14	14	19	19
Hammer depth-front	14	14	14	14	14	18	18
Guiding							
Standard (box leads)	8" x 21"	8" x 21"	8" x 21"	8" x 21"	8" x 21"	8" x 27"	8" x 27"
Optional	12"/14" spud	12"/14" spud	8" x 27"	8" x 27"	8" x 27"	8" x 32"	8" x 32"
			12"/14" spud	12"/14" spud	12"/14" spud	14" spud	14" spud

Pile Driving

- From the Contractor – Pile and Driving Equipment Data
- DOT Form – 217aa

Notice to Contractors

Pile and Driving Equipment Data

Test Pile/Test Pile (Special), Section 704, Division 700, 2007 Standard Specifications

Project No. ______ County ______

Contract No. ______ Structure Name/No. ______

Pile Contractor or Subcontractor ______

HAMMER COMPONENTS

RAM

ANVIL

Manufacturer ______ Model ______

Type ______ Serial No. ______

Rated Energy ______ (ft-lb) @ ______ (ft) Length of Stroke

Fuel Setting ______

Modifications ______

CAPBLOCK

Material ______

Thickness ______ (inches) Area ______ (in²)

Modulus of Elasticity (E) ______ (psi)

Coefficient of Restitution (e) ______

PILECAP

Helmet
Bonnet
Anvil Block
Drivehead

Weight ______ (lb)

CUSHION

Material ______ Area ______ (in²)

Modulus of Elasticity (E) ______ (psi)

Coefficient of Restitution (e) ______

Revision 10/2008 **DOT Form 217AA**

Kansas Department of Transportation

Pile Driving

- From the Contractor – Pile and Driving Equipment Data
- DOT Form – 217aa

Pile and Driving Equipment Data

Test Pile/Test Pile (Special), Section 704, Division 700, 2007 Standard Specifications

PILE

Pile Type ______

Length (in leads) ______ (ft)

Weight (per foot) ______ (lb)

Wall Thickness ______ (in) Taper ______

Cross Sectional Area ______ (in²)

Design Pile Capacity ______ (ton)

Description of Splice ______

Tip Treatment Description ______

NOTE: If a mandrel, or follower, is used to drive the pile, attach the manufacturer's detail sheets including the weight and dimensions.

Submitted by ______ Date ______

One Copy Each Sent To:

___ Bureau of Construction and Maintenance
___ Bureau of Design, State Bridge Office
___ Bureau of Materials and Research, Geology Section
___ Project Engineer

Revision 10/2008 **DOT Form 217AA**

Kansas Department of Transportation

Pile Driving

- From the Contractor – Mill Certification and BOL
- From Topeka - Certification

DATE 2/27/12

[redacted]

CUSTOMER NO. 3670

REQUEST ID 166562

NUCOR-YAMATO STEEL CO.
P.O. BOX 1228 • BLYTHEVILLE,AR 72316

CERTIFIED MILL
100% MELTED AND MANUF
All shapes produced by Nucor-
and rolled to a fully killed and fi
(Length May Not Be Traceabl

SHIP TO
SKYLINE STEEL
CAHABA PLACE, SUITE 200
4908 CAHABA RIVER ROAD
BIRMINGHAM, AL 35243

SPECIFICATIONS
ASTM A572/A572M GR50-
ASTM A709/A709M-11 (
ASTM A6/A6M-11

SOLD TO
SKYLINE STEEL GEORGIA OFFICE
3250 PEACHTREE INDUS BLVD
SUITE 107
DULUTH, GA 30096

ITEM #	ITEM DESCRIPTION	QTY	HEAT #	MECHANICAL PROPERTIES						CHEMICAL PROPERTIES							
				YIELD TO TENSILE RATIO	YIELD STRENGTH PSI / MPa	TENSILE STRENGTH PSI / MPa	ELONG % / %	CHARPY IMPACT TEMP °F / °C	CHARPY IMPACT IMPACT ENERGY FT-LBS / JOULES	C	Mn	P	S	Si	Cu	Ni	Cr
1	HP12 - 53.0 50' HP310x 79.0 15.240 M	3	379406 3	.71 .72	57000 56000 393 386	80000 78000 552 538	23 22 23 22			.16	.80	.012	.026	.19	.29	.13	.13

Pile Driving

- What have we done so far?
  - Read the specifications.
  - Familiarized ourselves with the plans.
  - Know quantity, lengths and bearing capacity.
  - Know orientation and placement within the foundation.
  - Began setting up final documentations.
  - Began setting up field notes for actual pile driving.

Pile Driving

- What have we done so far?
  - Know our Ordered and Accepted Lengths.
  - Know the Pile dimension and weight.
  - Know the Pile hammer to be used.
  - Know our Pile driving formula.

Pile Driving

- Ready to Drive Pile

LEADS

Pile Driving

- Ready to Drive Pile

HAMMER

Kansas Department of Transportation

Pile Driving

- Driving Pile
  - Check for correct Piling used
  - Check heat number
  - Pile Points if specified

Kansas Department of Transportation

Pile Driving

- Driving Pile
  - Determine placement
  - Check Axis
  - Check spacing

Kansas
Department of Transportation

Pile Driving

- Driving Pile
  - Check for Plumb
  - Set Pile

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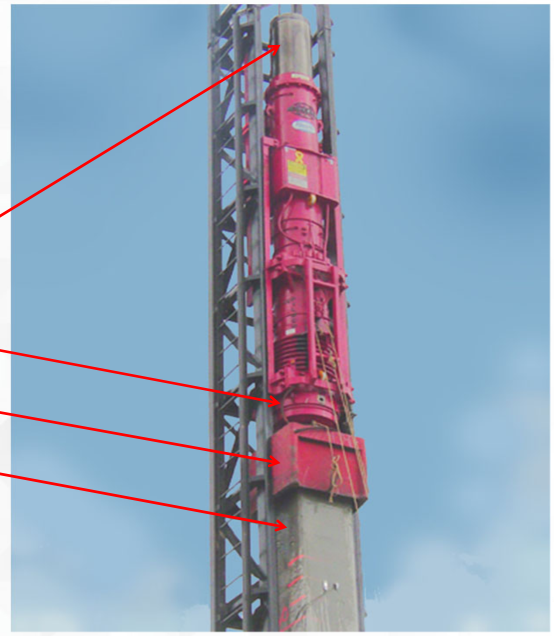
Department of Transportation

Pile Driving

- Driving Pile
  - Leads and Hammer
  - Ram (striking part)
  - Anvil
  - Cap
  - Pile

Once pile driving begins it is a very quick and fluid motion



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Pile Driving

- Driving Pile
  - Mark distance of penetration
  - Count blows

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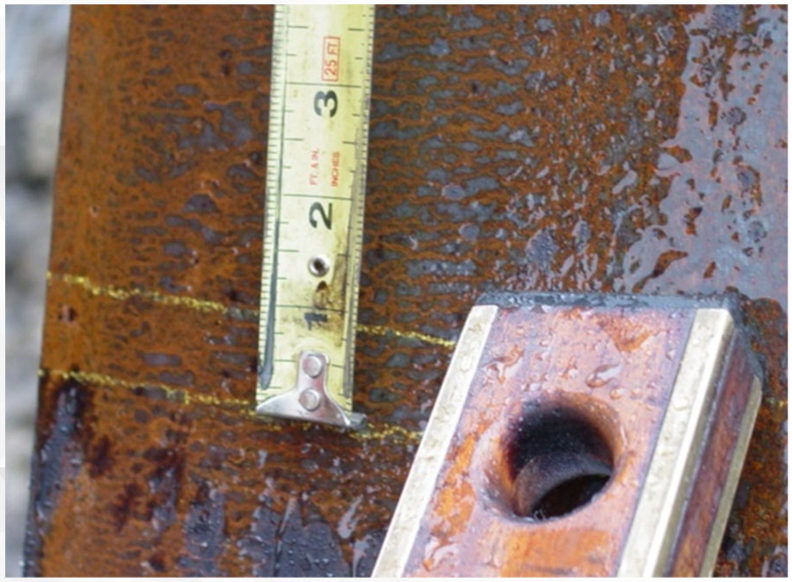
Pile Driving

- Driving Pile
  - Measure distance of penetration in 20 blows
  - Average



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Pile Driving

- Driving Pile
  - Check height of drop
  - Compensate for the distance through the hammer
  - Mark hammer and leads 1’ increments

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Department of Transportation

Pile Driving

- We know our Pile formula, right?

TABLE 704-1: PILE FORMULAS		
Hammer	**Pile Type**	**Formula**
Gravity	Timber	$P = \frac{2\ W\ H}{S+1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S+0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers
** For diesel hammers, the quantity X/W shall not be less than 1.
P = safe bearing power in pounds
W = weight in pounds, of striking part of hammer
H = height of fall in feet
E = energy of ram in foot-pounds per blow
S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers
X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

Kansas Department of Transportation

Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{1.6\quad W\quad H}{S+0.1\ (X/W^{**})}$$

Kansas Department of Transportation

Pile Driving

- P= safe bearing power in pounds
- W= weight in pound, of striking part of hammer
- H= height of fall in feet
- S= the average penetration in inches per blow for the last 20 blows for diesel hammers
- X= weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

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Pile Driving

- P= safe bearing power in pounds
- W= 4,190 lbs. (striking part of hammer)
- H= 10 feet (height of hammer drop)
- S= 0.15 (3 inches /20 blows)
- X= 4550 lbs. (2597 lbs. pile (49’x53) + 1953 lbs. cap and/or anvil)

Kansas Department of Transportation

Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{1.6 * 4190 * 10}{0.15+0.1(4550/4190**)}$$

Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(4550/4190**)}$$

Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(1.09**)}$$

** Diesel quantity x/w shall not be < 1

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Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.109}$$

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Pile Driving

- Delmag Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.259}$$

Pile Driving

- Delmag Diesel Hammer Pile Formula

P = 258,842 lbs.

Pile Driving

- Delmag Diesel Hammer Pile Formula

$$P = \frac{258{,}842 \text{ lbs.}}{2000}$$

P = 129 tons

Pile Driving

- Delmag Diesel Hammer Pile Formula

P = 129 tons

Plans called out 108 tons

Don't drive over 110%

Pile Driving

- Driving Pile
  - Over driven pile
  - OUCH…!

Pile Driving

- Diesel Hammer Pile Formula
  - Back figure and solve for " S " prior to driving the pile. Have these notes with you as the pile driving is being performed.
  - The actual driving of the pile goes rather quickly, you need to be prepared with instructions to the contractor and inform him that satisfactory bearing has been achieved.
  - If you feel there is a problem, contact Geology.

Pile Driving

- Solve for

- "S"

- Range

Diesel Hammer for 35 foot pile

(W) Mass in lb's, of striking part of hammer: 3000 | Mass in lb's of cap/anvil: 1480 | Length of Pile ft: 35 | Mass of Pile per Ft.: 42 | X/W: 1 | Minimum Bearing: 77.9 | Maximum Bearing: 85.7

Drop of the Hammer in Feet

Inches in last 20 blows	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
0.250	107	117	128	139	149	160	171	181	192	203	213	224	235	245	256
0.375	101	111	121	131	141	152	162	172	182	192	[illegible]	212	222	232	243
0.500	96	106	115	125	134	144	154	163	173	182	[illegible]	202	211	221	230
0.625	91	101	110	119	128	137	146	155	165	174	[illegible]	192	201	210	219
0.750	87	96	105	113	122	131	140	148	157	166	[illegible]	183	192	201	209
0.875	83	92	100	109	117	125	134	142	150	159	[illegible]	175	184	192	200
1.000	80	88	96	104	112	120	128	136	144	152	[illegible]	168	176	184	192
1.125	77	84	92	100	108	115	123	131	138	146	[illegible]	161	169	177	184
1.250	74	81	89	96	103	111	118	126	133	140	[illegible]	155	162	170	177
1.375	71	78	85	92	100	107	114	121	128	135	[illegible]	149	156	164	171
1.500	69	75	82	89	96	103	110	117	123	130	[illegible]	144	151	158	165
1.625	66	73	79	86	93	99	106	113	119	126	[illegible]	139	146	152	159
1.750	64	70	77	83	90	96	102	109	115	122	[illegible]	134	141	147	154
1.875	62	68	74	81	87	93	99	105	111	118	[illegible]	130	136	142	149
2.000	60	66	72	78	84	90	96	102	108	114	[illegible]	126	132	138	144
2.125	58	64	70	76	81	87	93	99	105	111	[illegible]	122	128	134	140
2.250	56	62	68	73	79	85	90	96	102	107	[illegible]	119	124	130	136
2.375	55	60	66	71	77	82	88	93	99	104	[illegible]	115	121	126	132
2.500	53	59	64	69	75	80	85	91	96	101	[illegible]	112	117	123	128
2.625	52	57	62	67	73	78	83	88	93	99	[illegible]	109	114	119	125
2.750	51	56	61	66	71	76	81	86	91	96	[illegible]	106	111	116	121
2.875	49	54	59	64	69	74	79	84	89	94	[illegible]	103	108	113	118
3.000	48	53	58	62	67	72	77	82	86	91	[illegible]	101	106	110	115
3.125	47	52	56	61	66	70	75	80	84	89	[illegible]	98	103	108	112
3.250	46	50	55	59	64	69	73	78	82	87	[illegible]	96	101	105	110
3.375	45	49	54	58	63	67	71	76	80	85	[illegible]	94	98	103	107
3.500	44	48	52	57	61	65	70	74	79	83	87	92	96	100	105
3.625	43	47	51	55	60	64	68	73	77	81	85	90	94	98	102
3.750	[illegible]	46	50	54	58	63	67	71	75	79	83	88	92	96	100
3.875	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82	86	90	94	98
4.000	[illegible]	44	48	52	56	60	64	68	72	76	80	84	88	92	96
4.125	39	43	47	51	55	59	63	67	71	74	78	82	86	90	94
4.250	38	42	46	50	54	58	61	65	69	73	77	81	84	88	92
4.375	38	41	45	49	53	56	60	64	68	72	75	79	83	87	90
4.500	37	41	44	48	52	55	59	63	66	70	74	78	81	85	89
4.625	36	40	43	47	51	54	58	62	65	69	72	76	80	83	87
4.750	36	39	43	46	50	53	57	60	64	68	71	75	78	82	85
4.875	35	38	42	45	49	52	56	59	63	66	70	73	77	80	84
5.000	34	38	41	45	48	51	55	58	62	65	69	72	75	79	82
5.125	34	37	40	44	47	51	54	57	61	64	67	71	74	77	81
5.250	33	36	40	43	46	50	53	56	60	63	66	70	73	76	79
5.375	33	36	39	42	46	49	52	55	59	62	65	68	72	75	78
5.500	32	35	38	42	45	48	51	54	58	61	64	67	70	74	77

Kansas Department of Transportation

Pile Driving

- 2nd example Delmag Diesel Hammer – 40' (shorter pile)
- P= safe bearing power in pounds
- W= 4,190 lbs. (striking part of hammer)
- H= 10 feet (height of hammer drop)
- S= 0.15 (3 inches /20 blows)
- X= 4073 lbs. (2120 lbs. pile (40'*53) + 1953 lbs. cap and/or anvil)

Kansas Department of Transportation

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{1.6 * 4190 * 10}{0.15+0.1(4073/4190**)}$$

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(4073/4190**)}$$

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(0.97^{**})}$$

** Diesel quantity x/w shall not be < 1

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.1(1.00)}$$

** Diesel quantity x/w shall not be < 1

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.15+0.100}$$

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{67040}{0.250}$$

Pile Driving

- Diesel Hammer Pile Formula

$$P = \frac{268{,}160 \text{ lbs.}}{2000}$$

$$P = 134 \text{ tons}$$

Pile Driving

- 704.4 c. Driving Piles

- Completed pile driving – ….
  - Check position of pile

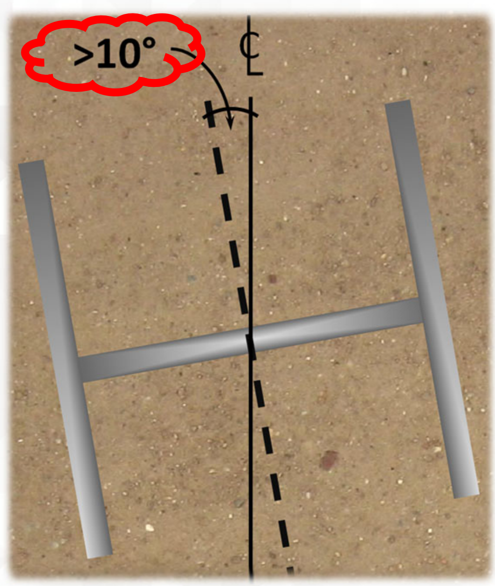
Pile Driving

- 704.4 c. Driving Piles
- Do not force misaligned piles into proper position.
- If the pile is 35 feet or less in length, the maximum allowable variation from the vertical or battered lines - ¼ inch per foot of length.
- If the pile is greater than 35 feet in length, the maximum allowable variation from the vertical or battered lines - ⅛ inch per foot of length.
- The maximum allowable variation on the head of the driven pile from the position - 2 inches for piles used in bents, and 6 inches for foundation piles.

Kansas Department of Transportation

Pile Driving

- 704.4 c. Driving Piles
- Drive all piles in the orientation shown on the Plans. If the axial orientation of the pile rotates or twists by more than 10°,



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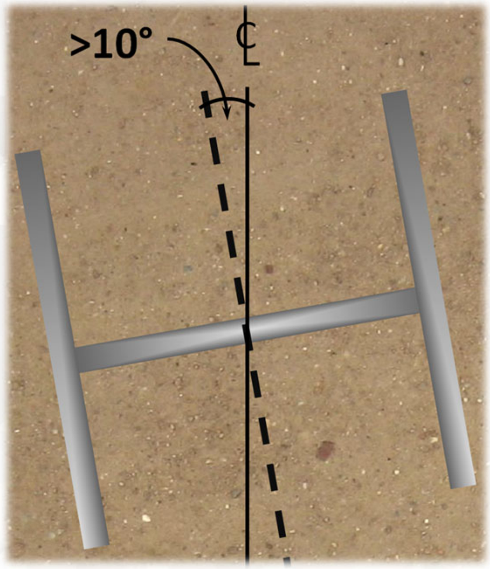
Pile Driving

- the Field Engineer will contact the Bureau of Structures and Geotechnical Services.



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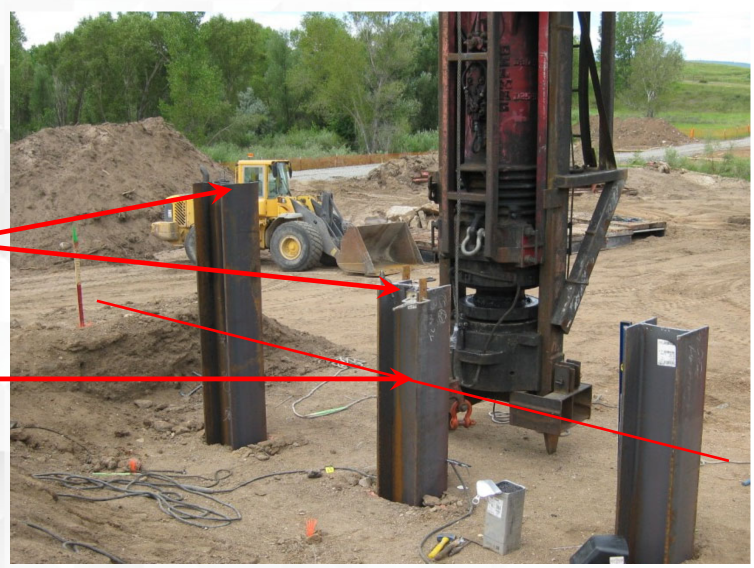
Pile Driving

- Pile elevation after driving to determine pay pile and cut-off
- Pile Cut-Off
- Pile remaining in structure



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Pile Driving

- 704.5 MEASUREMENT AND PAYMENT
  - The Engineer will measure the length of steel pile, steel sheet pile, cast-in-place concrete pile and prestressed concrete pile remaining in the structure, by the linear foot.
  - The Engineer will measure each cast steel pile point used.

Pile Driving

- 704.5 MEASUREMENT AND PAYMENT
  - If after driving the ordered and accepted length of pile, plan bearing is not achieved and additional pile is required, the Engineer will measure for payment each pile splice needed to lengthen the pile to achieve bearing.

Pile Driving

- 704.5 MEASUREMENT AND PAYMENT
  - The Engineer will measure pile cut-off by the linear foot for Pile (*) (**). Pile cut-off is the difference between the length of pile ordered and accepted and the actual length of pile remaining in the structure.
  - Payment for pile splices at 4 times the contract unit price of the type of pile spliced is full compensation for the specified work.

Pile Driving

- 704.5 MEASUREMENT AND PAYMENT

TABLE 704-2: PILE CUT-OFF PAYMENT

Pile Type	% of Contract Unit Price Paid
Cast-in-place (Shell)	60
Pre-stressed concrete	75
Steel	75
Steel Sheet	75

Pile Driving

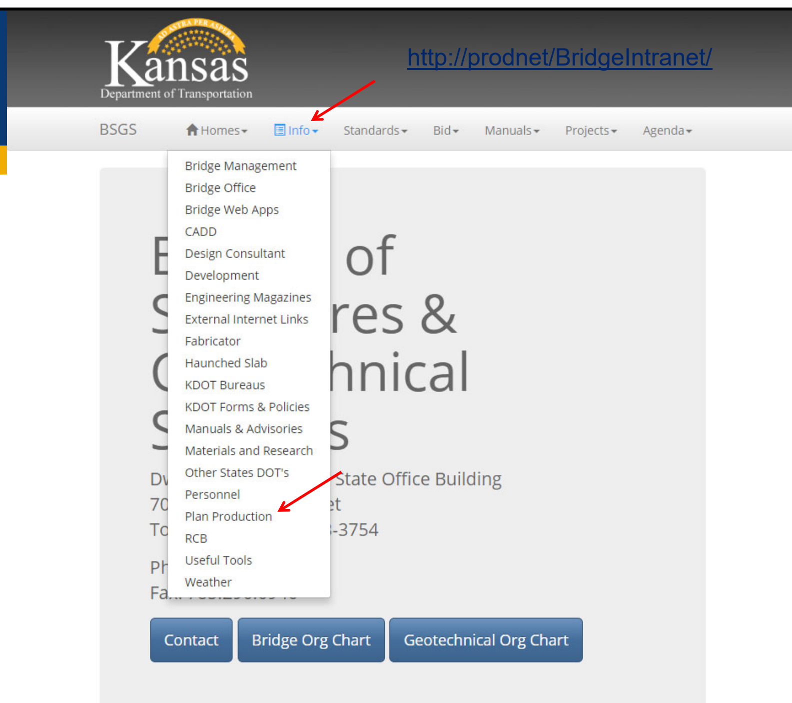
- 704.5 MEASUREMENT AND PAYMENT
  - Steel Pile _ Unit price $55.00 lnft
  - Table 704-2 _ 75% of unit price
  - $55.00 * 75% = $41.25
  - lnft cut-off determined by DOT Form 217 = 12.35'
  - Amount added to contract = $509.44

Pile Driving

708- Falsework & 710 -Form Construction

F&F-1

http://prodnet/BridgeIntranet/



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Plan Production

RCB

Useful Tools

Weather

Plan Production

- Bid Tabs
- Bridge Bid Items
- Consultant Shop Drawings
- Plan Review Summary Information (Revised 10-24-2012)
- Plans in U.S. Customary Units
- Posting Electronic Files for Letting
- Railroad Grade Separation Guidelines 2007
- Revised Plans Procedure
- Revised Plans Transmittal Memo Example
- Revised Shop Drawing
- Road Memo "Earthwork Computation Report and Alignment &Cross Section Report"
- Shop Drawing Distribution
- Shop Drawing Letter Email Distribution
- Stamping PDF Plans

BSGS Intranet

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Timeline for Submittals:

(Covered in S. Spec. 105.10 Plans & Working Drawings) ***(p. 100-43)***

Plan Review Summary Information

Plan Type	Information	# of Plan Copies	Lead Time Required	Specs to Review	Note Numbers to Review		P.E. Stamp Required	Plan Review	Recommend Approval
Shop Details	Consultant	*	Project Specific	101 106 705 707 709 716 719 721 722 735 1609	5200 6000 6010 6100 6110 6111 6115 6120 6130	6200 6210 6220 6410 6420 6600 6620 6625 7410	No	No	* *
	In House	*	Project Specific				No	Yes	* *
Shoring	Standard	*	3 weeks	701 702	30 35 300 1030		Yes	Yes	Yes
	Railroad		6 weeks						
Falsework	Category (1)	*	4 weeks	105 708 710	4100 4105 4115 4120	4130 4140 7800 7810	Yes	Yes	Yes
	Category (2)	*	4 weeks	105 708 710	4100 4106 4110 4120	4130 4140 7800 7820	Yes	District Policy	
Erection	Category A	(1)		105 708 710 SP07-07004	3000 3010 5210 6420 6520	6521 6522 6523 8700	No	No	No
	Category B	*	4 weeks				Yes	Yes	Yes
	Category C	*	4 weeks				Yes	Yes	Yes
Demolition	Category A	(1)		105 708 710 SP07-07014	3000 3010 5210 6420 6520	6521 8700 9001 9002 9003	No	No	No
	Category B	*	4 weeks				No	No	No
	Category C	*	4 weeks				Yes	Yes	Yes
Pour Sequence	Discuss Possible Changes at Precon Meeting	*	2 Weeks	105 708 SP07-0711	4140 4200 5100 5110 7000 7210 7215	7300 7301 7310 7311 7312 7320 7330 7400	No	Yes	Yes

Based on project complexity, the specifications and the notes listed in this document may only be the base of what is required.

* Electronic submittal conforming to 105.10 (b) of the Standard Sepcifications for State Road and Bridge Construction

* * General Compliance Stamp

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Plan Review Summary Information

Plan Type \ Information		# of Plan Copies	Lead Time Required	Specs to Review	Note Numbers to Review		P.E. Stamp Required	Plan Review	Recommend Approval
Falsework	Category (1)	*	4 weeks	105 708 710	4100 4105 4115 4120	4130 4140 7800 7810	Yes	Yes	Yes
	Category (2)	*	4 weeks	105 708 710	4100 4106 4110 4120	4130 4140 7800 7820	Yes	District Policy	

Based on project complexity, the specifications and the notes listed in this document may only be the base of what is required.

* Electronic submittal conforming to 105.10 (b) of the Standard Sepcifications for State Road and Bridge Construction

* * General Compliance Stamp

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Drawings:

105.10 PLANS AND WORKING DRAWINGS.

a. Plans. The Secretary [illegible] plans showing [illegible], roadway typical cross-sections, all structures, and a summary of contract pay items. Steel bridge plans show only general features. Keep one set of plans on the Project site.

b. Working Drawings. Submit an electronic copy of working drawings in Adobe PDF (Portable Document Format) file format, with a maximum internal page size of 17 inches by 11 inches. For each deliverable (falsework plans for a structure, shop drawings for structural elements which will be fabricated, etc.), submit the copy in one transmission, with the sheets consecutively numbered, and with no duplications of sheets.

c. Timely Submittal. Provide all working drawings to the Field Engineer or designated KDOT office at the time the Progress Schedule/Network Schedule identifies or at a date that allows the reviewing Engineers at least 15 business days to review the drawings. If the Contractor desires the drawings be reviewed in less than 15 business days, notify the Field Engineer or designated KDOT office that the time for review and approval is critical. While KDOT will attempt to accommodate the Contractor's time frame, KDOT makes no guarantee that KDOT will complete the review process in less than 15 business days.

d. Timely Review. Within 15 business days after the Contractor has provided initial or revised working drawings to the Field Engineer or designated KDOT office, the Field Engineer or designated KDOT office will review and either approve or reject the drawings. If rejected, correct and resubmit revised working drawings for the Engineer's approval. Allow the Field Engineer and other reviewing Engineers a reasonable time for subsequent review and approval. The Contractor assumes all risk of delay incurred for revisions and the Engineer's review of these revisions. If KDOT fails to accept or reject initial or revised drawings within 15 business days, the Contractor may seek compensation under **subsection 104.6** for additional time or acceleration costs.

e. Responsibility for Working Drawings. The Contractor has sole responsibility for the adequacy and accuracy of the working drawings. The Engineer's approval of the working drawings is for KDOT's benefit, not to ensure Contractor quality control. The Engineer's review and/or approval are not intended as an undertaking of the Contractor's duty to provide adequate and accurate working drawings.

(p. 100-

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Falsework vs. Formwork

Falsework:

- Temporary Construction used to support vertical loads during construction
- "Works" to hold the structure up

Formwork:

- Temporary Structure to mold concrete into desired shape until hardened
- "Forms" the concrete

(p. 700-35)

- Contractor is responsible for Falsework Design Plans by a licensed P.E.
- Field Engineer submits Falsework Plans to Bridge (or Local Projects if structure is on City or County System)
- Bridge/Local P. will review Falsework Drawings and remit to Field Engineer

(p.700-35)

708.3 CONSTRUCTION REQUIREMENTS

a. Falsework Design.

(1) General Falsework Design Requirements. Design falsework according to the KDOT Bridge Design Manual, Falsework Design, Analysis and Inspection.

Include the type, size, grade and finish of all lumber used. Provide adequate details of the proposed method of construction. The Engineer may request additional information.

In designing forms and centering, regard concrete as a liquid. In computing loads, assume a weight of 150 pounds per cubic foot for the vertical pressure, and a minimum of 85 pounds per cubic foot in computing horizontal pressure.

Do not place cast-in-place shear bolts, coil inserts or other devices used as falsework support in pier columns without the approval of the Engineer. Through bolts are permitted. Do not drill and grout bolts or other devices into the pier columns unless shown in the Contract Documents.

(2) Category 1 Structures. On the structures listed below, submit to the Engineer for review (See **SECTION 105**) by the State Bridge Office (SBO) (or Bureau of Local Projects) and, if applicable, the railroad company, 7 copies of detailed falsework plans designed and sealed by a Professional Engineer.

(Cat 1: Bridge or Local Projects)

- All structures over or under railroad tracks;
- All structures built over highways or streets carrying traffic;
- All structures requiring falsework that directly carries highway traffic loads during construction;
- Deck overhangs greater than beam depth or greater than 54 inches;
- Superstructure forming with "non-typical" support (i.e. needlebeams); and
- All structures that require falsework plans to be submitted to the SBO (or Bureau of Local Projects) as noted in the Contract Documents.

(3) Category 2 Structures. If not included in the Category 1 structures above, submit to the Engineer for review (See **SECTION 105**) by the Field Engineer, 3 copies of detailed falsework plans designed and sealed by a Professional Engineer on the Category 2 structures listed below.

(Cat 2: Field Engineer or District E.)

- All cast-in-place span structures supported on falsework;
- Concrete Box Structures with cell spans greater than 16 feet or cell heights greater than 14 feet;
- Decks with girder spacing equal to or greater than 14 feet; and
- Substructure forming with "non-typical" support.

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708.3 a. Design Requirements:(p.700-35)

- When computing loads, concrete is treated as a liquid.
- No cast-in-place shear bolts, coils, or other devices to support falsework in piers
- Through-bolts are permitted
- Do not drill and grout bolts or other devices unless stated in contract documents
- Know the difference between Category 1 and Category 2 Structures (pg. 700-35)

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Section 708.3 b. (p. 700-36)

b. Falsework Construction. Adhere to all falsework details.

Drive falsework piling to a satisfactory depth and bearing value to support all falsework that is not founded on rock, shale or thick deposits of other compact material in their natural beds. Do not use mudsills on earth, sand, gravel and similar materials, unless otherwise noted in the Contract Documents. Do not support falsework on any part of the structure, except the footings, without written approval from the Engineer. The number and spacing of falsework piling, the adequacy of sills, caps and stringers, and the amount of bracing in the falsework framing is subject to approval of the Engineer.

If the falsework piling or vertical members are of sufficient length to cap at the desired elevation for the horizontal members, cap them and construct frames to the proper elevation. If falsework piling are not of sufficient length, extend them using an approved pile splice. Do not use wedges at pile splices. Cut the ends of the piling or vertical members square for full bearing. If vertical splices are necessary, the abutting members shall be of the same approximate size, with the ends cut square for full bearing. Provide an adequate splice to maintain rigidity of the joint, including inserting a #9 reinforcing bar 18 inches into each end of the abutting members.

Upon completion, remove all forms and falsework according to **SECTION 710**. Pull or cut off falsework piling 12 inches below low water level, the natural ground or the bottom of a channel change. On grade separation structures, pull or cut off the falsework piling 12 inches below subgrade elevation of the roadbed that the piles are driven into. Pull or cut off all other falsework piling 12 inches below finished grade.

Unless the Contract Documents provide for permanent camber, construct the falsework to provide only sufficient camber to prevent final settlement below the finish grades shown in the Contract Documents. Use adequate hardwood wedges or screw jacks in all falsework construction, and place and adjust them to provide the proper form alignment. If required, provide a means for adjusting forms to offset any excessive settlement. When screw jacks are used, adequately brace and secure them to prevent tipping of the jacks in any direction.

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Construction (p. 700-36)

- **Pile splicing should be avoided**
  - **When approved, spliced pieces should be nearly the same diameter, ends squared, and the joint should be braced and banded. (See Bridge Construction Manual for Example)**
- **Provide some means for measuring Settlement during concrete placement**

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Bad

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Section 708.3 c. (p. 700-
Requirements:

c. Falsework Inspection Requirements. For Category 1 structures, the falsework designer of record shall make a Falsework Inspection of the as-built falsework for substantial compliance with the falsework plans prior to placing concrete in the structure.

Conduct an on-site review of the falsework. Items to be reviewed include but are not limited to:

- The condition of the materials used for piling, cross bracing, beams, plywood decking, shims and jacks.
- The size and spacing of all structural members regarding their compliance to the submitted falsework plan.
- The condition and compliance of all splices.

Provide written documentation to the Engineer stating the falsework as-built is acceptable and in compliance with the original sealed plans. If the falsework is not in compliance, make corrections to the falsework or submit a revised, sealed falsework design prior to the placement of any concrete. When modifications are made to the falsework, the designer of record shall make Falsework Inspections until written documentation is provided to the Engineer stating that the falsework is in compliance, at no additional cost to KDOT.

For Category 2 falsework plans, conduct a walk-though review of the falsework with the Field Engineer, prior to placing concrete in the structure. Variations and deficiencies from the plan will be noted in writing and supported with photos or sketches. Forward the documentation to the falsework designer. The designer must respond in writing that the deficiencies are minor and the falsework is in substantial compliance, or must propose a new falsework plan which addresses the deficiencies.

The Engineer will refuse approval to proceed with other phases of the work if the falsework is determined to be unsafe or inadequate to properly support the subjected loads.

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Falsework Inspection Requirements:
Section 708.3 c. (p. 700-36)

Category 1

- Check condition of all materials used in Falsework
- Check the size and spacing of all members are in compliance with Falsework Plans
- The condition and compliance of all splices
- Provide written documentation of Falsework as-built approval

Category 2

- Conduct a walk-through review with the Field Engineer before placing concrete

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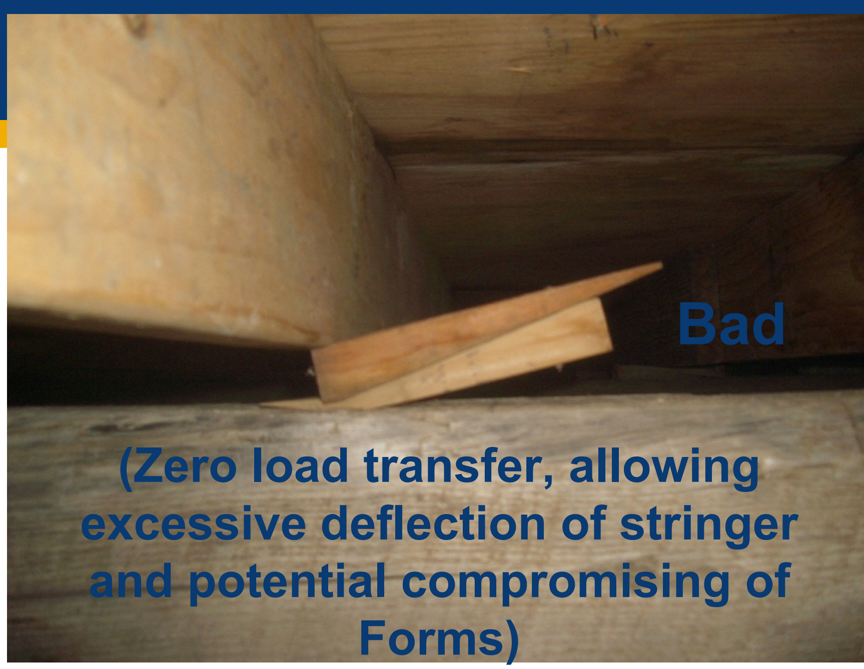

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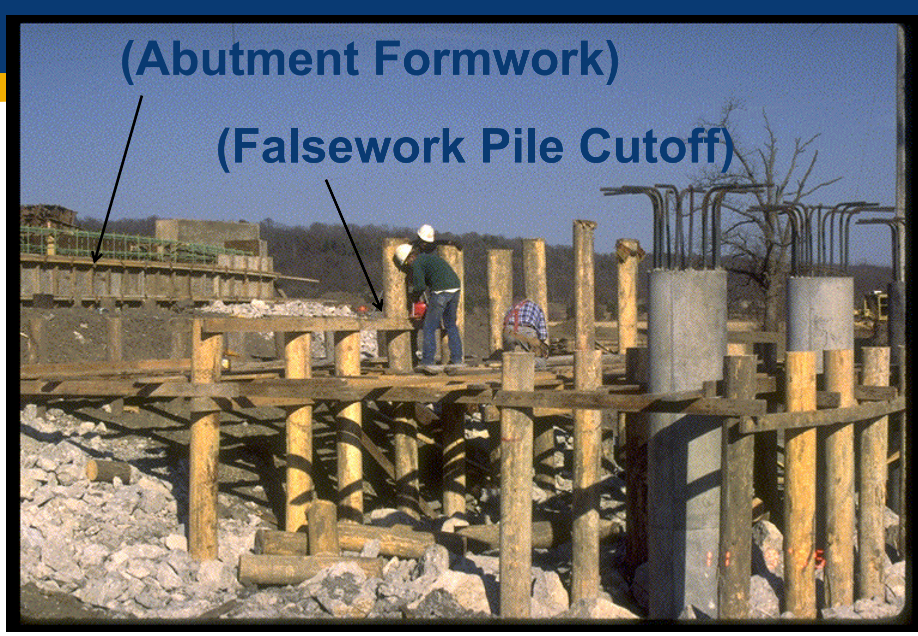
(Beginning Span: 1
Superstructure Formwork)
(Elevation View – Span: 1
& 2 Superstructure
Falsework)
11 16 '95


(Abutment Formwork)
(Falsework Pile Cutoff)

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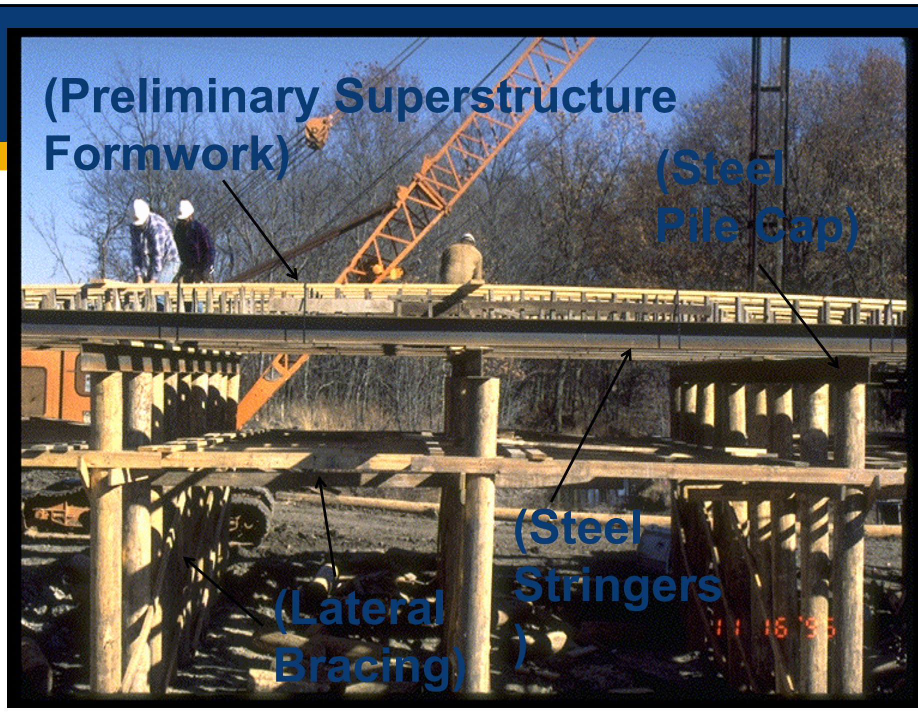

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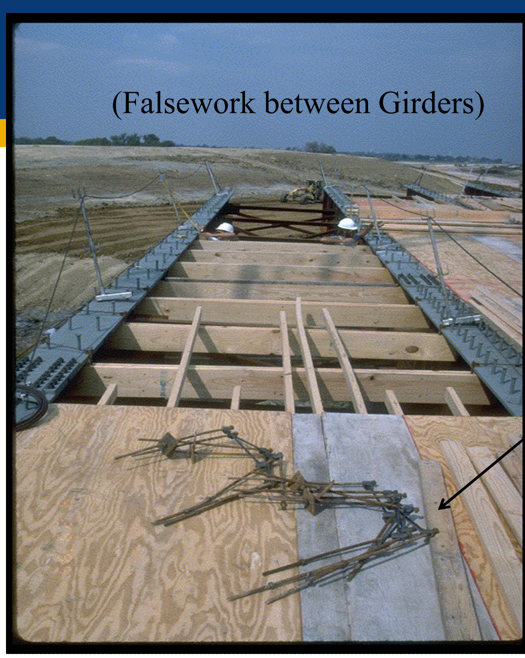
Deck Overhangs:

FALSEWORK Plans required if:

Overhang > Depth

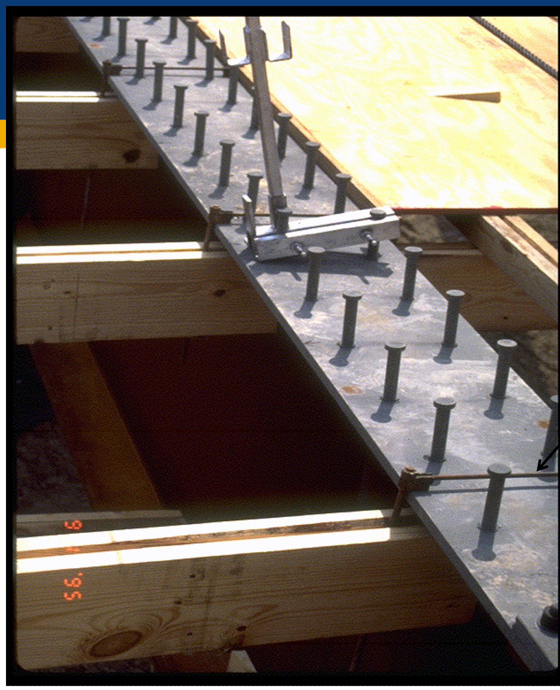
-or-

Overhang > 54 inches



(Falsework between Girders)

(Formwork Hangers)



(NEVER
Weld Hangers)

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(Submit to Local Projects for Review)

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708.3 d.
(p. 700-36)

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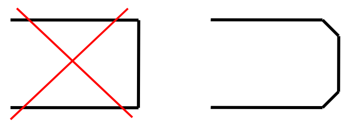
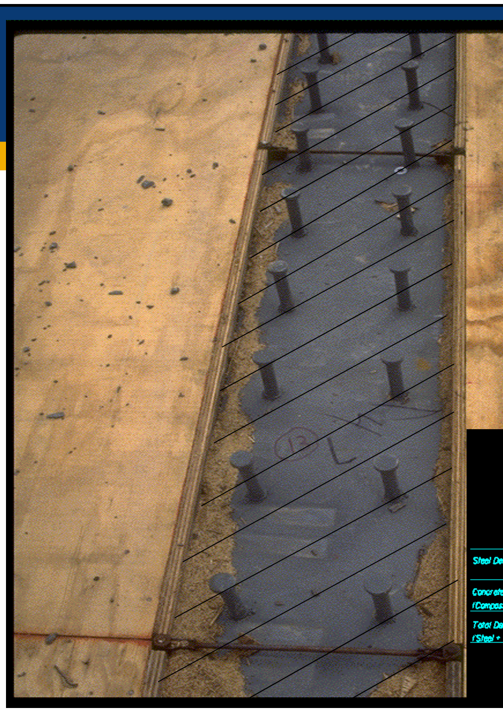
- Wood/plywood shall be sound & installed with grain running in the same direction
- Mortar-tight, with no warping or bulging
- No permanent aluminum deck forms
- Oil formed surfaces with clear, paraffin based oil
- Moisten wood forms with water before placement
- Bevel all exposed edges with ¾” triangular molding



What are Fillets and why are they used?

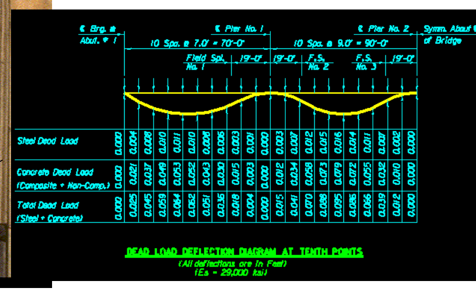


Fillets: Conc. placed over top flange to adjust for beam deflection due to Dead loads.

Should always be positive. (Typically 1" to 3".)

Will be smallest over Piers.

Typ. Deflection Diagram:



Steel Dead Load	0.000	0.004	0.008	0.010	0.011	0.010	0.008	0.006	0.003	0.001	0.000	0.003	0.007	0.012	0.015	0.016	0.014	0.011	0.007	0.002	0.000
Concrete Dead Load (Composite + Non-Comp.)	0.000	0.021	0.037	0.049	0.053	0.052	0.043	0.030	0.015	0.003	0.000	0.012	0.034	0.058	0.073	0.079	0.072	0.055	0.032	0.010	0.000
Total Dead Load (Steel + Concrete)	0.000	0.025	0.045	0.059	0.064	0.062	0.051	0.036	0.018	0.004	0.000	0.015	0.041	0.070	0.088	0.095	0.086	0.066	0.039	0.012	0.000

DEAD LOAD DEFLECTION DIAGRAM AT TENTH POINTS
(All deflections are in Feet)
(Es = 29,000 ksi)

710-Conc. Construction, p. 700-40

710-Conc. Construction

- **CURING:** **Figure 710-1** *(p. 700-42)*
- **CURE TIMES:** **Table 710-1** *(p. 700-45)*
- **LOAD LIMITS:** **Table 710-2** *(p. 700-46)*
- ***REMOVAL OF FORMS:*** **Table 710-3** *(p. 700-48)*

Removal of Forms: **Table 710-3** *(p. 700-48)*

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	**Span Length (feet)**						
	Less than 10	**10 or less**	**Greater than 10**	**10 to 20**	**20 + to 30**	**Greater than 20**	**Greater than 30**
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	**Time (Days)**
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

Δ - increase the time period 3 days when supplemental cementitious materials are used Oct 1 – April 30

*, **, *** or + - *refer to Note below Table*

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(Type) Structural Element:

(P.B. Formwork) on Single Col.:

(P.B. Falsework) on Multiple Col.'s

(Forms/Falsework) for Decks:

Box Culverts Roofs:

Box Culvert Walls & Wings:

(Col. Forms) on Pile Cap Footings:

(Col. Forms) on Spread Footings:

(Duplicate, ignore:)

(P.B. Forms), 1- Column:

(P.B. Forms), Multiple Columns:

(Col. Forms) Drilled Shafts:

Box Culverts Floors on Rock:

Box Culverts Floors on Soil:

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	**Span Length (feet)**						
	Less than 10	**10 or less**	**Greater than 10**	**10 to 20**	**20 + to 30**	**Greater than 20**	**Greater than 30**
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	**Time (Days)**
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
~~Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns~~	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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* Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 65% of the specified f'_c. To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.
** Do not set girders or beams on the pier beams until the falsework under the pier beams is removed.
*** Remove the formwork from subdecks or one-course decks within 6 weeks after the deck has been placed.
$^{+}$ Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 75% of the specified f'_c. To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.
$^{\Delta}$ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.

* - reduce by days if attain 65% f'c

** - Do Not set beams on pier beam until falsework under pier beam is struck

*** - remove formwork within 6 weeks of placement

\+ - reduce days if attain 75% of f'c

Δ - increase the time period 3 days when supplemental cementitious materials are used Oct 1 – April 30

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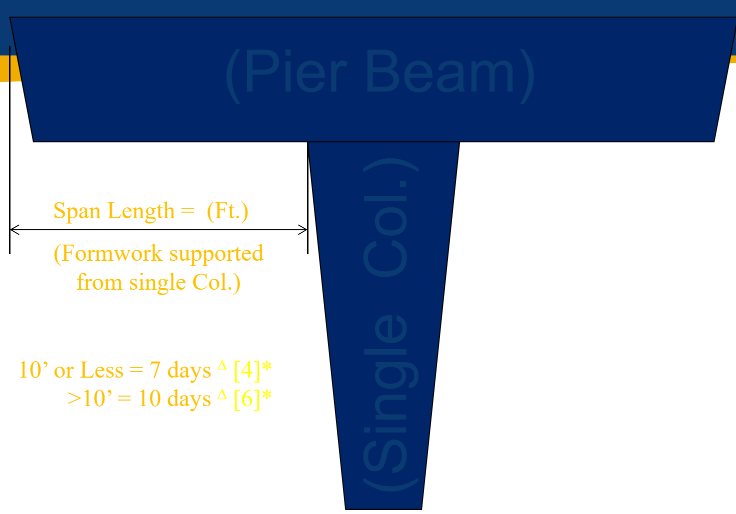

Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
* = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets 65% of f'c.

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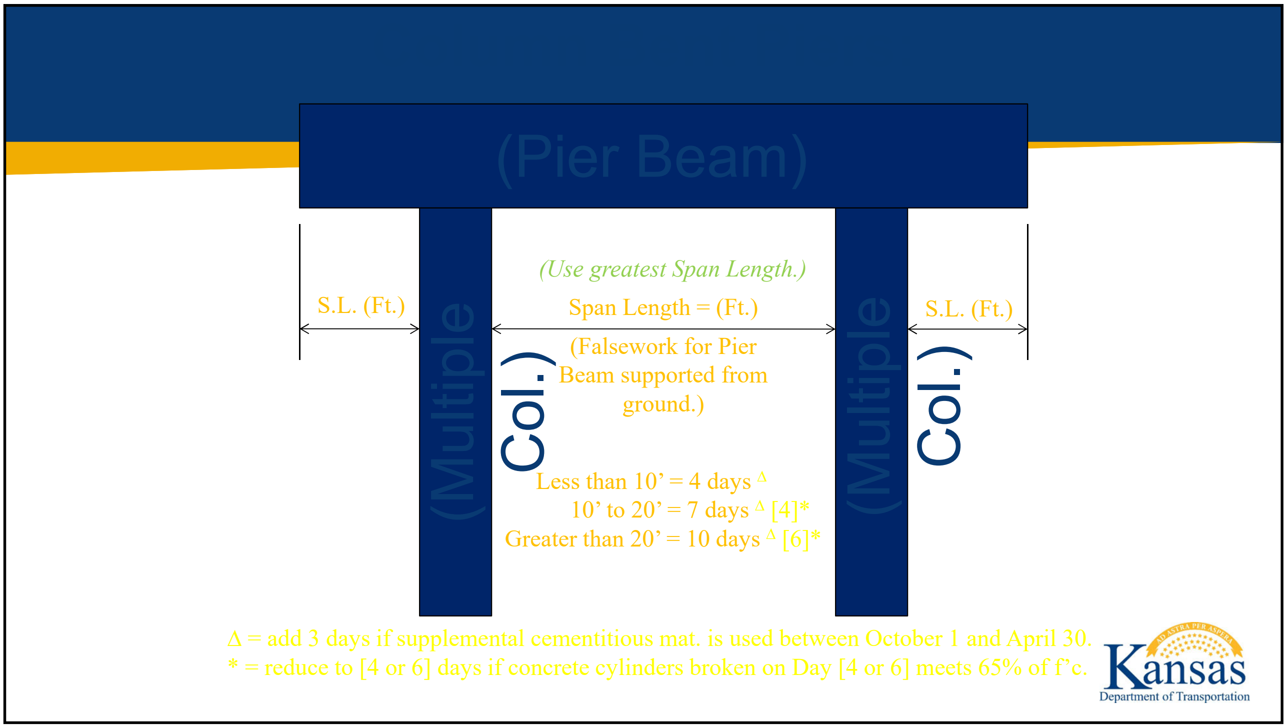
(Pier Beam)
(Multiple Col.)
(Multiple Col.)
(Use greatest Span Length.)
S.L. (Ft.)
Span Length = (Ft.)
S.L. (Ft.)
(Falsework for Pier Beam supported from ground.)
Less than 10’ = 4 days Δ
10’ to 20’ = 7 days Δ [4]*
Greater than 20’ = 10 days Δ [6]*
Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
* = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets 65% of f’c.
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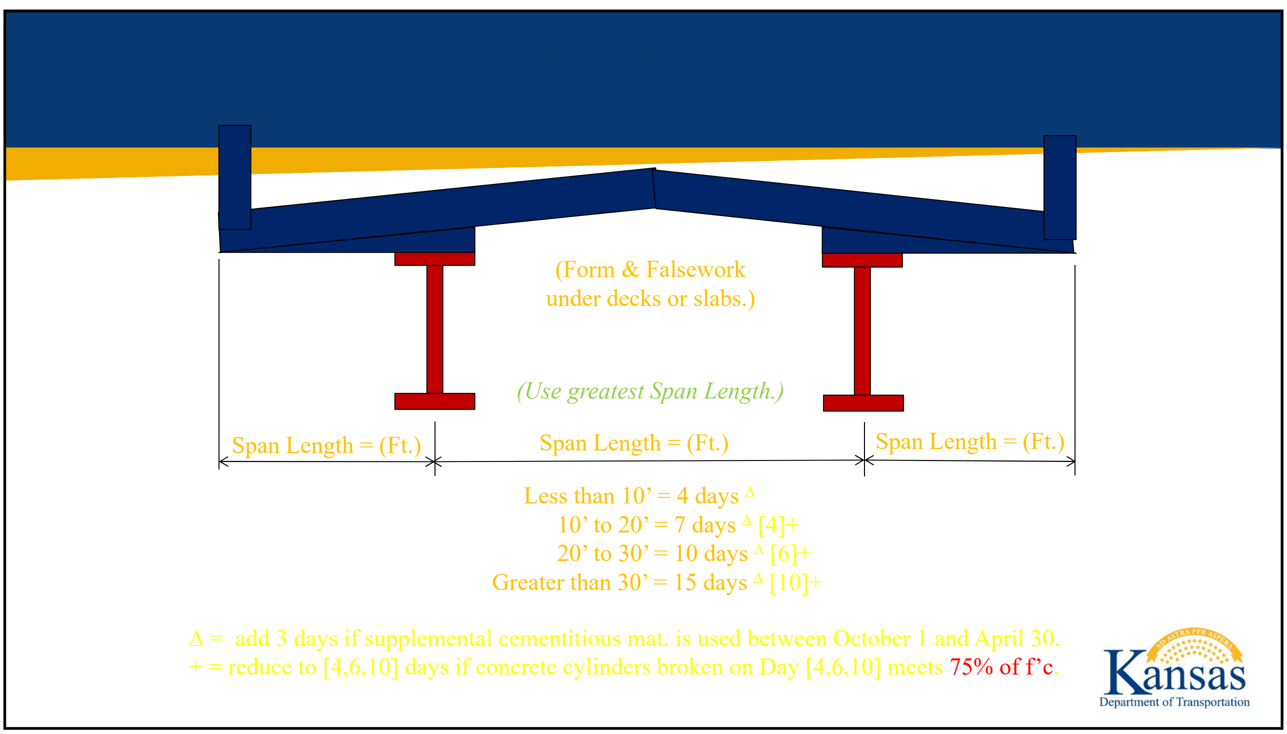
(Form & Falsework under decks or slabs.)
(Use greatest Span Length.)
Span Length = (Ft.)
Span Length = (Ft.)
Span Length = (Ft.)
Less than 10’ = 4 days Δ
10’ to 20’ = 7 days Δ [4]+
20’ to 30’ = 10 days Δ [6]+
Greater than 30’ = 15 days Δ [10]+
Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
+ = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f’c.
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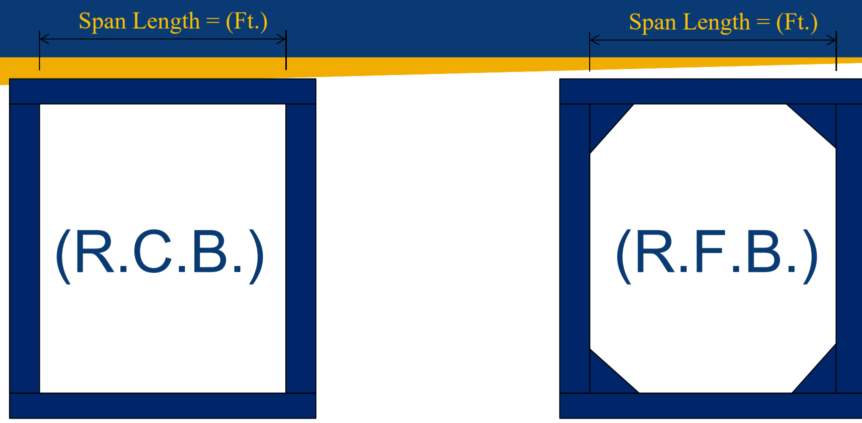

10' or Less = 7 days $^{\Delta}$ [4]+
10' to 20' = 7 days $^{\Delta}$ [4]+
Greater than 20' = 10 days $^{\Delta}$ [6]+

Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
+ = reduce to [4 or 6] days if concrete cylinders broken on Day [4 or 6] meets 75% of f'c.

Q1: Concrete columns for a 3-column bent pier were poured yesterday. How long from concrete placement can pier beam formwork erection start?

1. Structural Element?
   3-Column Bent

2. Type of Work?
   Pier Beam Formwork

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	 4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	 2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

1. Structural Element?
   3-Column Bent

2. Type of Work?
   Pier Beam Formwork

= 2 Days

Kansas
Department of Transportation

Q2: How long from initial (3 column) pour before placing concrete for the pier beam?

1. Structural Element?
   3-Column Bent

2. Type of Work?
   Pier Beam Concrete placement

Kansas
Department of Transportation

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} $\boxed{4^{\Delta}}$ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

1. Structural Element?

3-Column Bent

2. Type of Work?

Pier Beam Concrete

= 4 Days

Kansas Department of Transportation

Q3: The concrete deck for a steel girder bridge was placed on October 15th. The width of the deck is 60'. There are 6 girders spaced at 9'-0". No test specimens were made. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

Deck, girders spaced at 9 Ft.

2. Type of Work?

removal of Deck Forms

Kansas Department of Transportation

1. Structural Element?

Deck,

9 Ft. span

2. Type of Work?

Removal of Forms

= 4 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

Kansas
Department of Transportation

Q4: The concrete deck for a steel girder bridge was placed on October 15th. The width of the deck is 60'. There are 6 girders spaced at 9'-0". No test specimens were made. Supplemental cementitious materials were added. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

Deck, girders spaced at 9 Ft

with S.C.M.'s, Δ = add 3 Days

2. Type of Work?

removal of Deck Forms

Kansas
Department of Transportation

1. Structural Element?

Deck,

9 Ft. span

2. Type of Work?

Removal of Forms

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

4 Days

Δ = add 3 Days

Total = 7 Days

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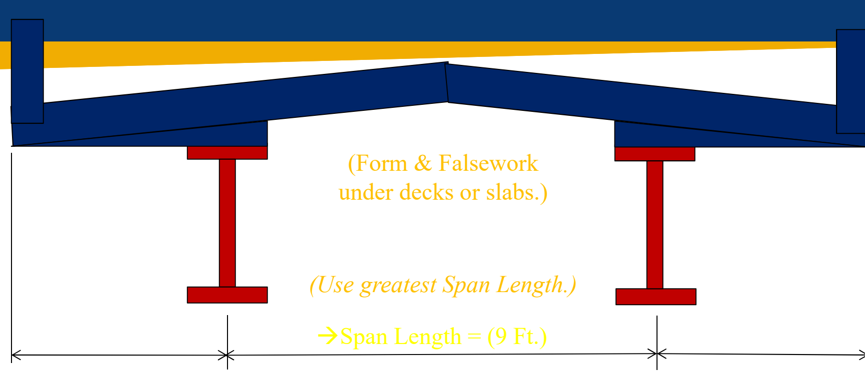

→Less than 10' = 4 days $^{\Delta}$

10' to 20' = 7 days $^{\Delta}$ [4]+

20' to 30' = 10 days $^{\Delta}$ [6]+

Greater than 30' = 15 days $^{\Delta}$ [10]+

4+3= 7 Days

→Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.

\+ = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f'c.

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Q5: The concrete deck for a prestressed concrete beam bridge was placed yesterday. The width of the deck is 60'. There are 5 girders spaced at 11'-0". No test specimens were made. How many days between the deck placement and when the deck forms can be removed?

1. Structural Element?

   Deck, girders spaced at 11 Ft.

2. Type of Work?

   removal of Deck Forms

Kansas Department of Transportation

1. Structural Element?

   Deck,

   11 Ft. span

2. Type of Work?

   Removal of Forms

= 7 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			$\boxed{7^{\Delta}\ [4]^{+}}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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Q6: How many days if grade 4.0 concrete (4000 psi) is specified, and test specimens broke at a strength of 3100 psi after 4 days?

1. Structural Element?
   Deck, girders spaced at 11 Ft.
   + Cylinders made, broke on Day 4
   Requirement for: + = *reduce days if attain 75% of* f'c
   0.75(4000) = 3000 psi Needed
   break of 3100 > 3000 req'd, OK.
   Remove forms on Day 4 after breaks.
2. Type of Work?
   removal of Deck Forms

Kansas Department of Transportation

1. Structural Element?
   Deck,
   11 Ft. span
2. Type of Work?
   Removal of Forms

= [4] *Days if + cylinders made broke above Req'd .?*

Yes. = Remove at 4 Days.

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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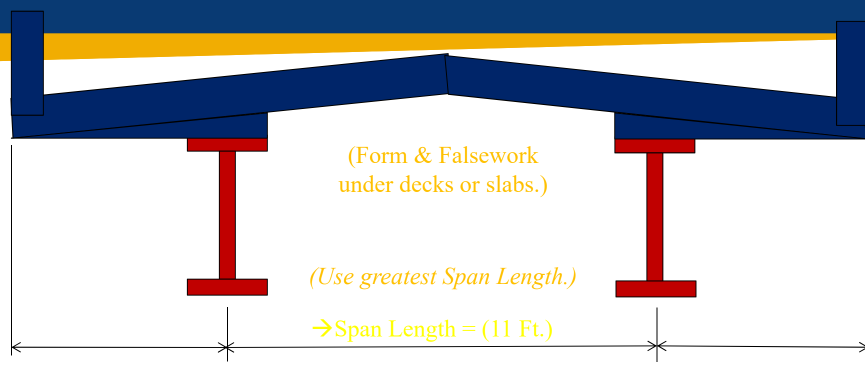

ess than 10’ = 4 days $^{\Delta}$
→ 10’ to 20’ = 7 days $^{\Delta}$ [4]+
20’ to 30’ = 10 days $^{\Delta}$ [6]+
Greater than 30’ = 15 days $^{\Delta}$ [10]+

[4]+ good break?
= 4 Days

Δ = add 3 days if supplemental cementitious mat. is used between October 1 and April 30.
→+ = reduce to [4,6,10] days if concrete cylinders broken on Day [4,6,10] meets 75% of f’c.

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End.

Thanks !!!

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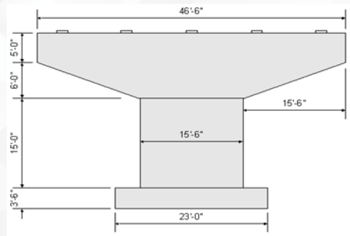
CIT Structures

Substructures



Substructures

- Superstructure
- Substructure

Substructures

- Types of Substructures
  - Abutments
    - Used at the ends of the bridge to retain the embankment and carry the vertical and horizontal loads from the superstructure to the substructure.
  - Pier
    - Element supporting the superstructure located between the bridge abutments.
  - Walls
    - MSE - Mechanically Stabilized Earth.

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Substructures

- Common types of Substructures
  - U-Type Abutment

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Substructures

- Common types of Substructures
  - Pedestal Abutment

Substructures

- Common types of Substructures
  - Column Bent Pier

Substructures

- Common types of Substructures
  - Wall Pier

Substructures

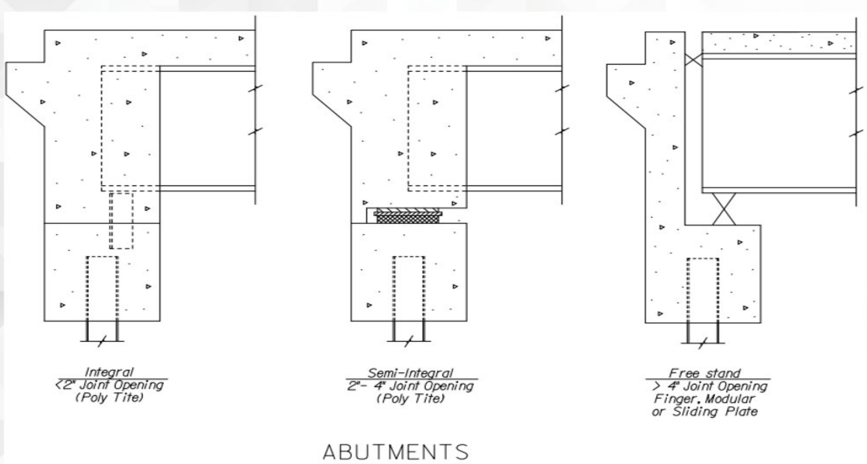
- Common types of Substructures
  - Column Bent with Web Wall Pier

Substructures

- Common types of Substructures
  - Cantilever Pier (Tee-Pier / Hammerhead)

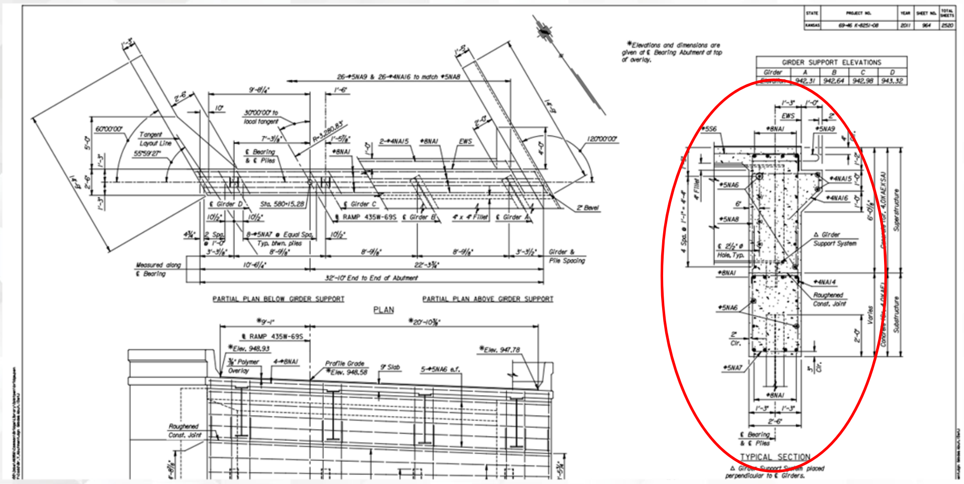
Substructures

- Types of Abutments
  - Abutments



Substructures

- Construction of Substructures
  - Abutments



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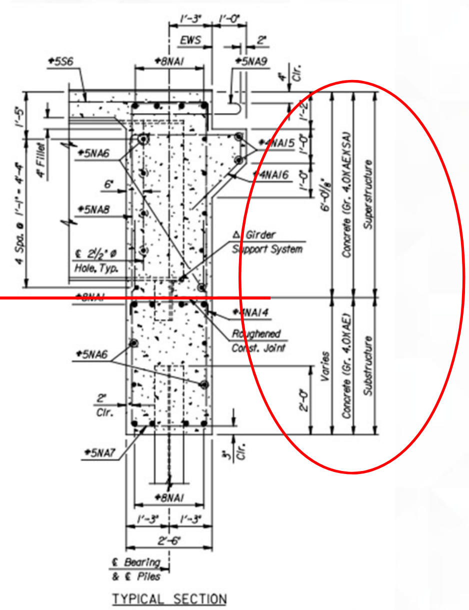
Substructures

- Construction of Substructures
  - Abutments
  - Superstructure
  - Substructure



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Substructures

- Construction of Substructures
  - Abutments
    - Soil foundation cut to grade, level clear of debris
    - Contractor may use a commercial grade concrete leveling pad. This also assists in placement of form work. Must be to grade, can not be considered part of structure.
    - Verify re-steel, bar size length, bends and spacing. Tied adequately.
    - Bar chairs in good condition. (epoxy bars = epoxy chairs)

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Substructures

- Construction of Substructures
  - Abutments
  - Check form measurements
  - Check Bar spacing
  - Verify beam seats and/or girder chairs.

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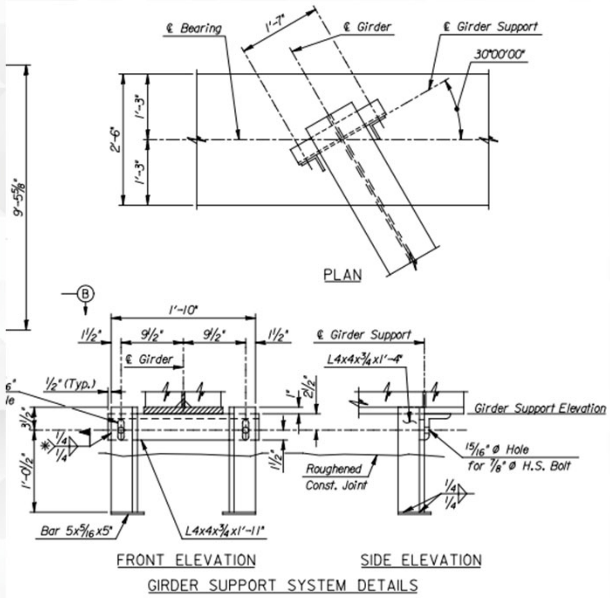
Substructures

- Construction of Substructures
  - Abutments
  - Girder Supports placed in the substructure concrete



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Substructures

- Construction of Substructures
  - Abutments

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Substructures

- Construction of Substructures
  - Abutments

Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-1

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	**Minimum Cure Time (days)**	**Curing Medium and Use**
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.

Substructures

- Construction of Substructures
  - Abutments –Removal of Forms / Backfill

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}

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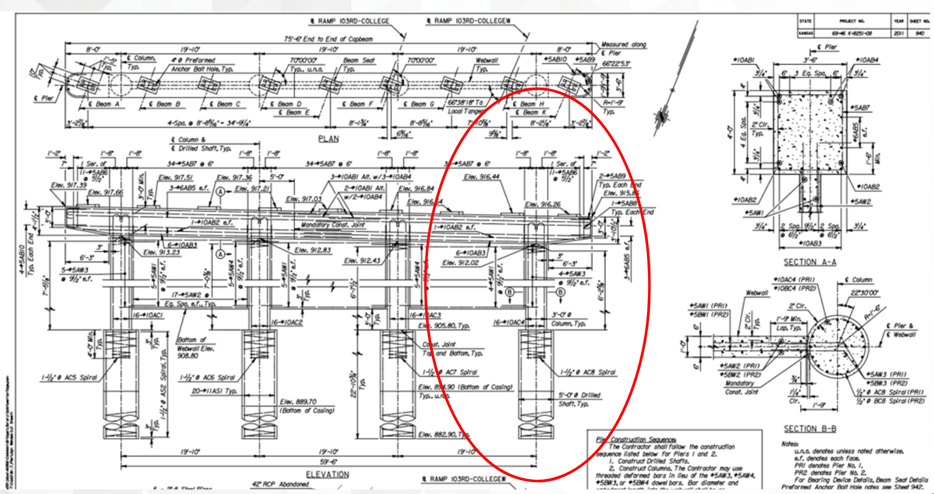
Substructures

- Construction of Substructures
  - Piers



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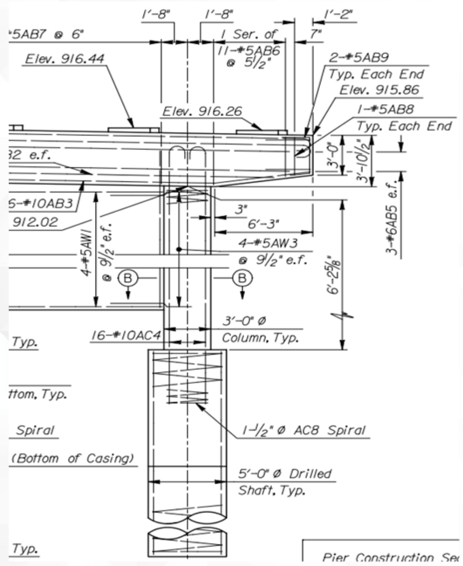
Substructures

- Construction of Substructures
  - Piers
  - Column is placed on Drilled Shaft
  - Section 710 – Table 710-3



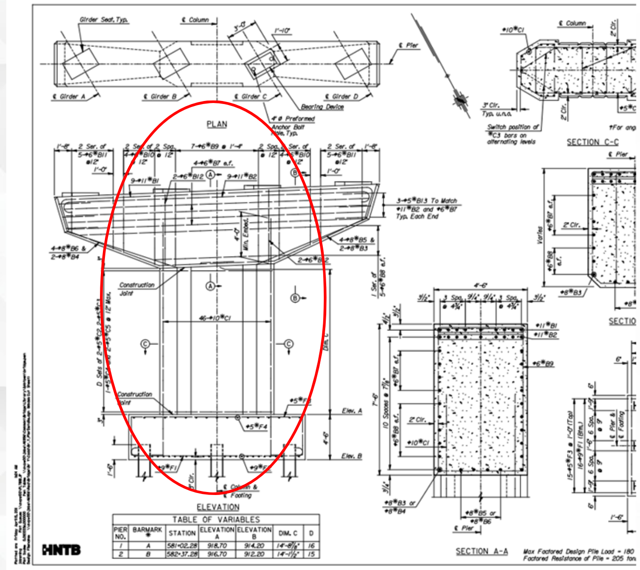
Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4 Δ [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4 Δ [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2 Δ
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4 Δ [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4 Δ [2]+ 7 Δ [4]+
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2 Δ 4 Δ [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2 Δ

Substructures

- Construction of Substructures
  - Piers
  - Column is place on Pile Footing
  - Section 710 – Table 710-3



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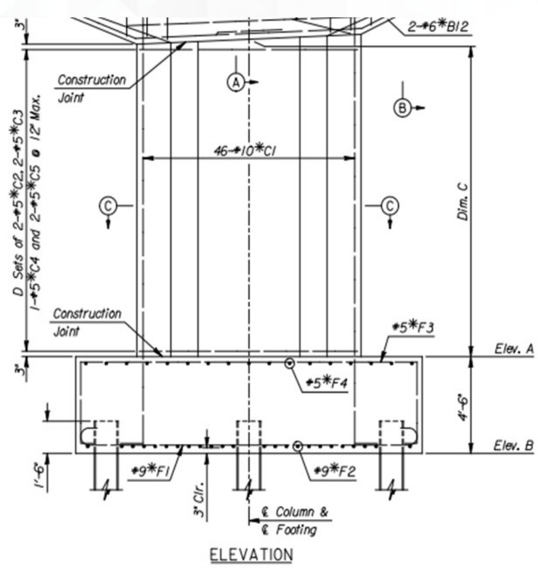
Substructures

- Construction of Substructures
  - Piers
  - Column is placed on Pile Footing and cylinders made / break at 70% design strength
  - Section 710 – Table 710-3



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Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for ~~cantilevered piers~~ - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}

Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3
  -

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

* Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 65% of the specified f'_c. To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.
** Do not set girders or beams on the pier beams until the falsework under the pier beams is removed.
*** Remove the formwork from subdecks or one-course decks within 6 weeks after the deck has been placed.
$^{+}$ Contractors may reduce the time required before form removal to the number of days shown in brackets, provided the concrete is shown to have attained a minimum strength of 75% of the specified f'_c. To accomplish this, prepare the necessary cylinders, obtain the services of an approved laboratory to break them at the appropriate time and provide a report to the Engineer. Field cure the cylinders alongside and under the same curing conditions, as the concrete they represent.
$^{\Delta}$ Increase the time period 3 days when supplemental cementitious materials are used October 1 thru April 30.

Substructures

- Construction of Substructures
  - Piers
  - Column Forms
  - Check diameter
  - Free of rust
  - Form release
  - Not out of round

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Substructures

- Construction of Substructures
  - Piers
  - Column Rebar
  - Check diameter
  - Bar size / spiral spacing
  - Not racked

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Substructures

- Construction of Substructures
  - Piers

Kansas Department of Transportation

Substructures

- Construction of Substructures
  - Pier Column
    - Verify re-steel, bar size, length, bends and spacing.
    - Tied adequately.
    - Verify lap lengths and embed lengths of rebar.
    - Check that forms are clean, and plumb.
    - Check that elevation of top of can is determined and cut dimension to top of concrete is recorded.
    - Determine if through bolts are being used.

Kansas Department of Transportation

Substructures

- Construction of Substructures
  - Pier Column
    - 708.3 CONSTRUCTION REQUIREMENTS
    - **a. Falsework Design.** Do not place cast-in-place shear bolts, coil inserts or other devices used as falsework support in pier columns without the approval of the Engineer. Through bolts are permitted. Do not drill and grout bolts or other devices into the pier columns unless shown in the Contract Documents.

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Substructures

- Construction of Substructures
  - Piers – Through Tubes/Bolts to Support Forms

Kansas Department of Transportation

Substructures

- Construction of Substructures
  - Piers
  - Bottom of Pier Cap Elevation / Top of Can Elevation

Substructures

- Construction of Substructures
  - Piers - Concrete Placement

Substructures

- Construction of Substructures
  - Piers - Concrete Placement

Substructures

- Construction of Substructures
  - **710.3 CONSTRUCTION REQUIREMENTS**
    - **b. Handling and Placing Concrete.**

Place concrete to avoid segregation of the materials and displacement of the reinforcement. Do not deposit concrete in large quantities at any point in the forms, and then run or work the concrete along the forms.

Deposit the concrete in the forms in horizontal layers. Perform the work rapidly and continuously between predetermined planes. Vibrate through each plane.

Fill each part of the form by depositing the concrete as near to the final position as possible. If the chutes for placement of concrete are on steep slopes, equip them with baffle boards or assemble in short lengths that reverse the direction of movement. Do not drop concrete in the forms a distance of more than 5 feet, unless confined by clean, smooth, closed chutes or pipes.

Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not disturb the forms, or place any strain on the ends of projecting reinforcement.

If placing concrete by pumping, place the concrete in the pipeline to avoid contamination or separation of the concrete, or loss of air by fitting the pump with a concrete brake (e.g. french horn or bladder valve) at the end of the pump boom. Obtain sample concrete for slump and air test requirements at the discharge end of the piping.

Do not use chutes, troughs or pipes made of aluminum.

Uniformly consolidate the concrete without voids.

Substructures

- Construction of Substructures
  - Piers
    - Formwork and working platform for Pier Beam

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Department of Transportation

Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}

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Substructures

- Construction of Substructures
  - Pier Caps and Formwork

Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Substructures

- Construction of Substructures
  - Piers
    - Formwork and working platform for Pier Beam

Substructures

- Construction of Substructures
  - Concrete Structure Construction Table 710-3

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

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Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Substructures

- Measurement and Payment
  - Substructures
    - Section 710 Concrete Structure Construction _ The Engineer will measure the various grades of concrete placed in the structure by the cubic yard. No deductions are made for reinforcing steel and pile heads extending into the concrete.
    - Section 711 Reinforcing Steel _ The Engineer will measure the reinforcing steel by the pound, based on the theoretical number of pounds shown in the Contract Documents or placed as ordered in writing by the Engineer.

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Substructures

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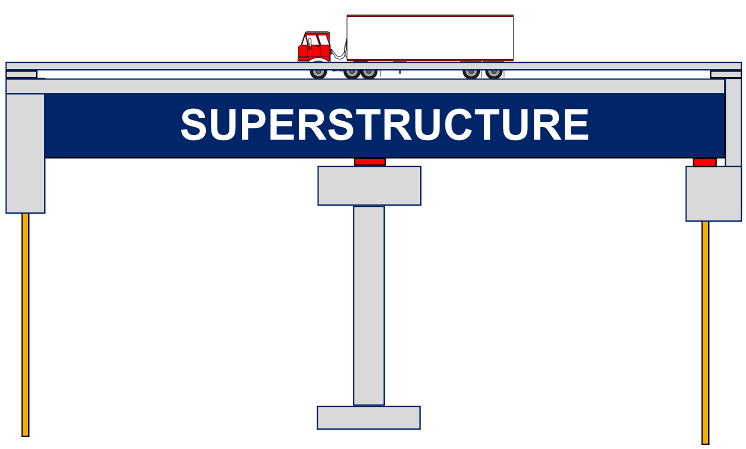
Superstructures

SUP-1

Superstructures



SUP-2

Definitions

- Superstructure
  - From Bearings Up
- Bridge Deck
  - From Top of Beams Up
  - From Bottom of Deck Up (Haunched Slabs)
  - May also be the Wearing Surface (single course)
- Bridge Wearing Surface Concrete, SFO, Asphalt, or any Overlay

SUP-3

Basic Types

- Slab
  - Uniform
  - Haunched
  - Post-tensioned
  - Voided
- Girder
  - Prestressed or Post-tensioned Concrete
  - Structural Steel (Bolted or Welded)
    - Rolled Beams
    - Plate Girders

SUP-4

Basic Types

- **Plan Orientation**
  - **Normal**

  - **Skewed**

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SUP-5

Kansas Department of Transportation

SUP-6

Haunched Slab

- **Maximum Span - 72’**
- **Falsework**
  - **A GREAT deal of Falsework**
- **Heavy Reinforcement**
- **Lengthy Curing Period**
- **Very Stout Bridge**

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SUP-7

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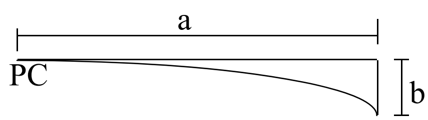
SUP-8

SUP-9

Parabolic Haunch Formula



- **Theory**
  - **The Vertical ordinate will vary with the square of the distance from the PC.**
  - **Any Ordinate =**

$$\frac{(\text{distance from PC})^2 * \ b}{a^2}$$

  - **Area = (a * b)/3**

SUP-10

SUP-11

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KANSAS DEPARTMENT OF TRANSPORTATION

COMPUTATION SHEET

Sheet 1 of __ Sheets

Project: 7-54 K 5039-01 Contract # 597146354 Br. No.: ______ County: ______

Type of Work: GRBRS Subject: Grade 30 Concrete (AE) Change in Plans No.: ______

DECK PLACEMENT

SLAB (UNIFORM)
40.750 X 10.400 X 0.400 = 169.52 Cu M

HAUNCH (TO FACE OF PIER)
4 X 1/3 X 7.550 X 10.400 X 0.215 = 22.51 Cu M

HAUNCH (ABOVE PIER)
2 X 10.400 X 0.900 X 0.215 = 4.02 Cu M

PIER CAP
4 X 5.050 X 0.900 X 0.5 X (0.385 + 0.302) = 6.24 Cu M

ABUTMENT
4 X 5.200 X 0.750 X 0.5 X (1.300 + 1.217) = 19.63 Cu M

WINGS
4 X 0.750 X 1.200 X 0.5 X (1.555 + 1.705) = 5.87 Cu M

PAVEMENT REST
2 X 10.100 X 0.300 X 0.5 X (0.300 + 0.600) = 2.73 Cu M

SUBTOTAL = 230.53 Cu M

CORRAL RAIL PLACEMENT

RAIL
2 X 40.750 X 0.300 X 0.485 = 11.86 Cu M

INTERMEDIATE POST
26 X 0.250 X 0.910 X 0.5 X (0.355 + 0.359) = 2.11 Cu M

END POST
4 X 0.300 X 1.070 X 0.5 X (0.330 + 0.335) = 0.43 Cu M

RAIL JOINTS
- 26 X 0.485 X 0.300 X 0.010 = -0.04 Cu M

END POST (BLOCKOUT)
- 4 X [(0.025 X 0.415 X 0.600 + (0.5 X 0.600 X 0.200 X 0.050)] = -0.04 Cu M

SUBTOTAL = 14.32 Cu M
GRAND TOTAL = 244.85 Cu M
OR = 244.8 Cu M

Computed By: J. Hoffman 02/07/99 Checked By: M. Jacobs 02/12/99
Approved By: ______ Date Approved: ______
Rev. 11-80 D.O.T. Form No. 213

SUP-12

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Prestressed Concrete Girder

- Spans from 60’ to 110’
- Component Construction
  - Rapid Assembly
- Special Deck Forming Considerations
  - Temporary Diaphragms
  - Camber Correction
  - Overhangs
  - Composite Designs

SUP-13

SUP-14

SUP-15

SUP-16

SUP-17

Kansas
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SUP-18

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Structural Steel Girder

- Generally Longer Spans > 110'
- Bolting and Welding Required
  - Experienced Labor and Inspection
- Special Deck Forming
- Very Flexible
- May Require Painting

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SUP-19

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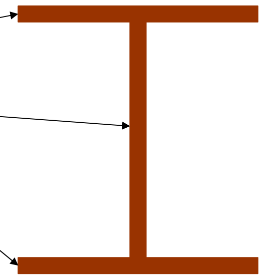
SUP-20

Structural Steel Girder

- **Basic Parts**
  - **Flanges**
  - **Webs**
  - **Stiffener**
    - **Bearing**
    - **Intermediate**
    - **Connection**
    - **Longitudinal**
    - **Girder Ends**
  - **Cross-Frames / Diaphragms**
  - **Bolts and Splices**
  - **Studs (field applied or shop applied)**



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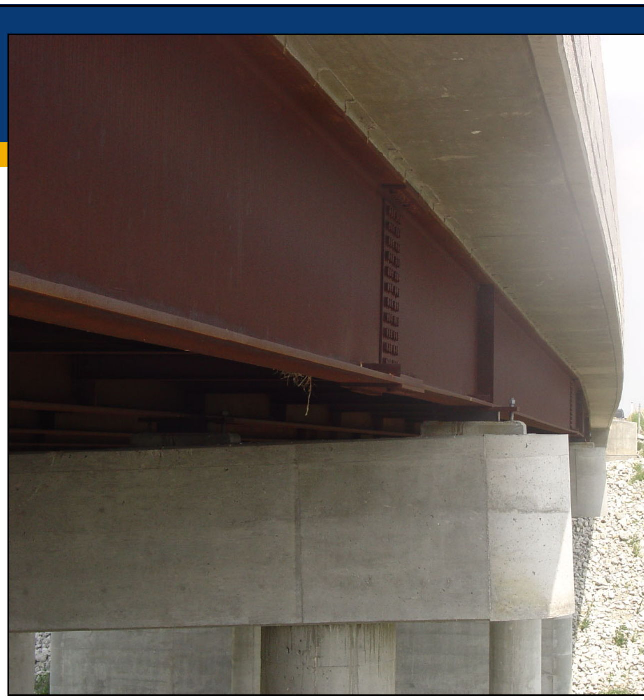
SUP-21



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SUP-22

SUP-23

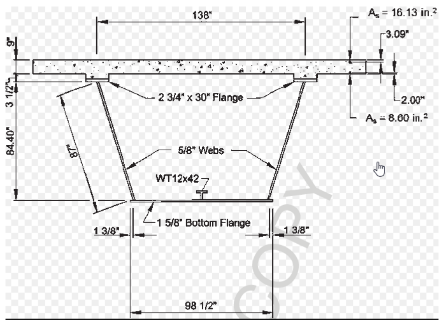
Steel Bridge Construction

- **Basic Beam/Girder Types**
  - **Rolled Beam**
    - **From the mill**
    - **I shaped**
    - **Mill chamber only (no vertical curve or dead load chamber)**
    - **Usually not horizontally curved**
  - **Plate Girder**
    - **Fabricated from plates in the shop**
    - **I shaped**
    - **Cambered for vertical dead load**
    - **Can be horizontally curved**

SUP-24

Steel Bridge Construction

- **Basic Beam/Girder Types (Continued)**
  - **Box Girder**
    - **Fabricated from plates in the shop**
    - **Box or Tub shaped (slope sides or vertical)**
    - **Usually used for ramps**



SUP-25

Steel Bridge Construction

- **Basic Materials**
  - **Weathering Steel (members, fasteners, washers and DTI's)**
    - **Top of top flange painted**
    - **2D away from joint painted, Encased +2 inches**
    - **Fascia and bottom on Plate girders with drainage over the side**
  - **Non Weather Steel (Painted)**
  - **Galvanized (Joints)**

SUP-26

Steel Bridge Construction

- Erection = Picking up the Pieces and holding them in the correct location (or blocking them). Follows a Plan. Uses Matchmarks and ID's to determine which piece goes where.
- Fit-Up = Properly aligning the pieces using specialized tools, equipment, and skills. Drift Pin and Erection Bolts are not in finished structure.
- Bolting = The calibration and execution of a proper tightening sequence to achieve the design clamping force.

- **These are three separate inspectable operations**

SUP-27

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Steel Bridge Construction

- Erection Bolt must be clearly identifiable as an erection bolt. They are the contractors property and are only for contractor's ease of erection. They are not production bolts.
- Production bolts will arrive to the job in sealed kegs, tubs, or buckets. They will have their producer's mark and grade stamped on the head. Once a production bolt has been fully tightened it may not be retightened and used as a production bolt it has become an erection bolt.

SUP-28

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Bridge Decks
&
Bridge Deck Overlays

Decks: 400 (Mud) & 700 (Structures)

Overlays: 731 (Area Prep. for Patching),
732 (Machine Prep.),
717 (Conc. OL),
729 (Poly OL)

BD-1

710.3 Construction Requirements

- Get **very** familiar with this specification!!!!
- Lots of information, won't be able to cover all of it
- Know **where** to look

BD-2

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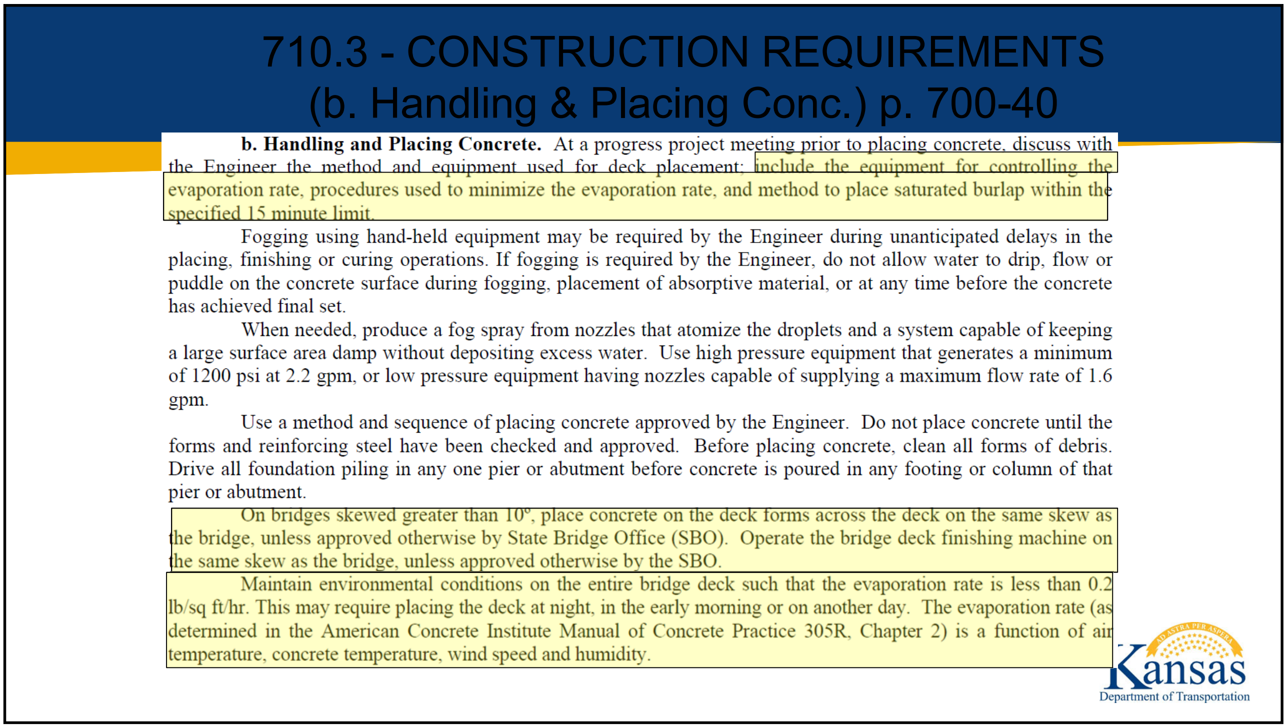

710.3 - CONSTRUCTION REQUIREMENTS
(b. Handling & Placing Conc.) p. 700-40
b. Handling and Placing Concrete. At a progress project meeting prior to placing concrete, discuss with the Engineer the method and equipment used for deck placement; include the equipment for controlling the evaporation rate, procedures used to minimize the evaporation rate, and method to place saturated burlap within the specified 15 minute limit.
Fogging using hand-held equipment may be required by the Engineer during unanticipated delays in the placing, finishing or curing operations. If fogging is required by the Engineer, do not allow water to drip, flow or puddle on the concrete surface during fogging, placement of absorptive material, or at any time before the concrete has achieved final set.
When needed, produce a fog spray from nozzles that atomize the droplets and a system capable of keeping a large surface area damp without depositing excess water. Use high pressure equipment that generates a minimum of 1200 psi at 2.2 gpm, or low pressure equipment having nozzles capable of supplying a maximum flow rate of 1.6 gpm.
Use a method and sequence of placing concrete approved by the Engineer. Do not place concrete until the forms and reinforcing steel have been checked and approved. Before placing concrete, clean all forms of debris. Drive all foundation piling in any one pier or abutment before concrete is poured in any footing or column of that pier or abutment.
On bridges skewed greater than 10°, place concrete on the deck forms across the deck on the same skew as the bridge, unless approved otherwise by State Bridge Office (SBO). Operate the bridge deck finishing machine on the same skew as the bridge, unless approved otherwise by the SBO.
Maintain environmental conditions on the entire bridge deck such that the evaporation rate is less than 0.2 lb/sq ft/hr. This may require placing the deck at night, in the early morning or on another day. The evaporation rate (as determined in the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2) is a function of air temperature, concrete temperature, wind speed and humidity.
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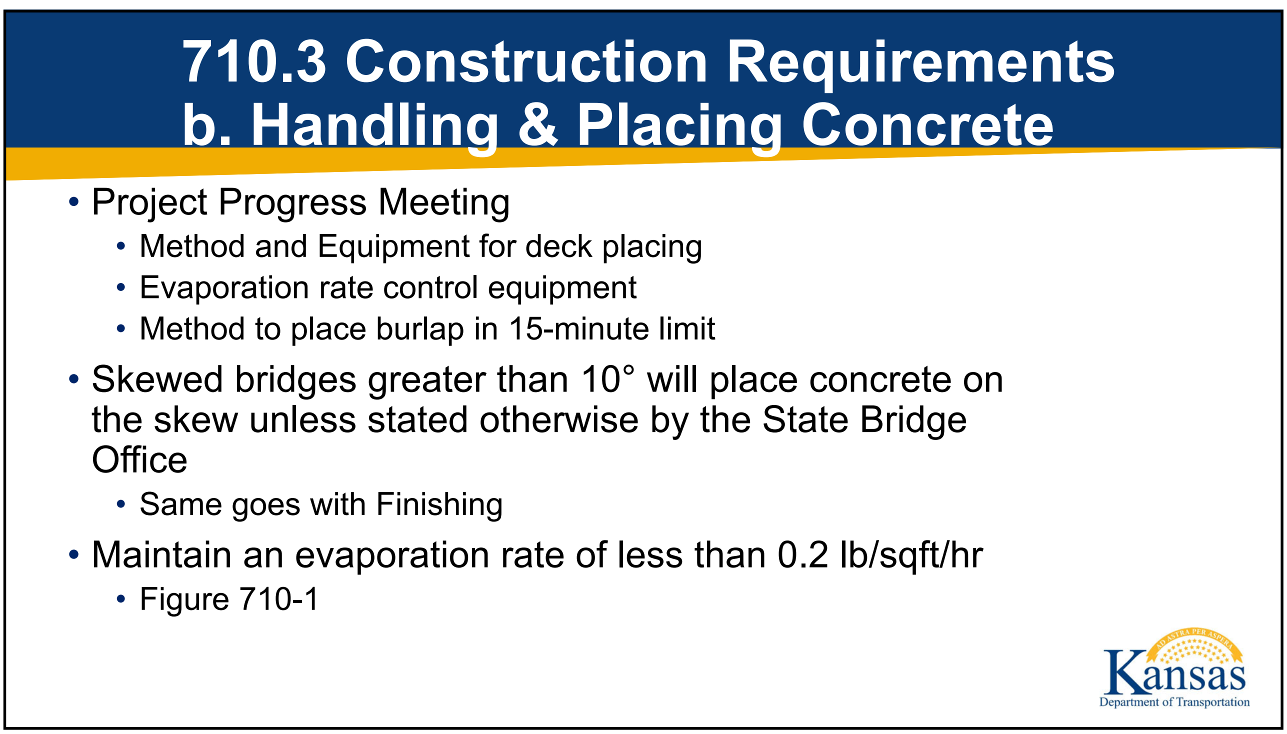

710.3 Construction Requirements
b. Handling & Placing Concrete
• Project Progress Meeting
• Method and Equipment for deck placing
• Evaporation rate control equipment
• Method to place burlap in 15-minute limit
• Skewed bridges greater than 10° will place concrete on the skew unless stated otherwise by the State Bridge Office
• Same goes with Finishing
• Maintain an evaporation rate of less than 0.2 lb/sqft/hr
• Figure 710-1
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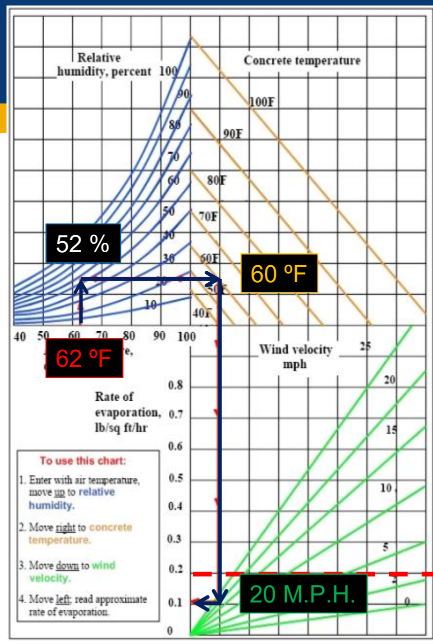
Evaporation Rate Chart, Fig. 710-1, p. 700-42



- 62° ambient temperature
- 52% relative humidity
- 60 concrete temperature
- 20 mph wind velocity

Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft^2/hr (1.0 kg/ m^2/hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate is less than 0.2 lb/ft^2/hr (1.0 kg/m^2/hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.

(Fog/ with Wind Breaks)

(No Fog)

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(Fog)

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710.3 - CONSTRUCTION REQUIREMENTS
(b. Handling & Placing Conc.) p. 700-40

Just prior to and at least once per hour during placement of the concrete, the Engineer will measure and record the air temperature, concrete temperature, wind speed and humidity on the bridge deck. The Engineer will take the air temperature, wind and humidity measurements approximately 12 inches above the surface of the deck. With this information, the Engineer will determine the evaporation rate by using KDOT software or by using **FIGURE 710-1** (Figure 2.1.5 from the American Concrete Institute Manual of Concrete Practice 305R, Chapter 2).

When the evaporation rate is equal to or above 0.2 $lb/ft^2/hr$, take actions (such as cooling the concrete, installing wind breaks, sun screens etc.) to create and maintain an evaporation rate less than 0.2 $lb/ft^2/hr$ on the entire bridge deck.

Place concrete to avoid segregation of the materials and displacement of the reinforcement. Do not deposit concrete in large quantities at any point in the forms, and then run or work the concrete along the forms.

Deposit the concrete in the forms in horizontal layers. Perform the work rapidly and continuously between predetermined planes. Vibrate through each plane.

Fill each part of the form by depositing the concrete as near to the final position as possible. If the chutes for placement of concrete are on steep slopes, equip them with baffle boards or assemble in short lengths that reverse the direction of movement. Do not drop concrete in the forms a distance of more than 5 feet, unless confined by clean, smooth, closed chutes or pipes.

Work the coarse aggregate back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, do not disturb the forms, or place any strain on the ends of projecting reinforcement.

If placing concrete by pumping, place the concrete in the pipeline to avoid contamination or separation of the concrete, or loss of air by fitting the pump with a concrete brake (e.g. french horn or bladder valve) at the end of the pump boom. Obtain sample concrete for slump and air test requirements at the discharge end of the piping.

Do not use chutes, troughs or pipes made of aluminum.

Uniformly consolidate the concrete without voids.

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Pump Truck circa 1990

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(Take mud samples from wherever the boom is during deck placement to get representative sample.)

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(b. Handling & Placing Conc.) p. 700-40

Accomplish consolidation of the concrete on all span bridges that require finishing machines by means of a mechanical device on which internal (spud or tube type) concrete vibrators of the same type and size are mounted (**subsection 154.2**). Observe special requirements for vibrators in contact with epoxy coated reinforcing steel as specified in **subsection 154.2**. Provide stand-by vibrators for emergency use to avoid delays in case of failure.

Operate the mechanical device so vibrator insertions are made on a maximum spacing of 12-inch centers over the entire deck surface. Provide a uniform time per insertion of all vibrators of 3 to 15 seconds, or until the course aggregate settles below the surface of the concrete, unless otherwise designated by the Engineer. Provide positive control of vibrators using a timed light, buzzer, automatic control. Smoothly extract the vibrators from the concrete at a rate to avoid leaving any large voids or holes in the consolidated concrete. Do not drag the vibrators horizontally through the concrete.

Use hand held vibrators (**subsection 154.2**) in inaccessible and confined areas such as along hubguards. When required, supplement vibrating by hand spading with suitable tools to provide required consolidation.

Reconsolidate any voids left by workers.

The method used for transporting concrete batches, materials or equipment over previously placed single pour (non-overlaid) floor slabs or floor units, or over units of structures of continuous design types is subject to approval by the Engineer.

Do not operate bridge deck finishing equipment on previously placed concrete spans until:

- A minimum of 72 hours on structures that are fully supported with falsework; (Haunched Slabs) and
- A minimum of 72 hours on structures with concrete girder spans with concrete decks; (Prestressed)
- A minimum of 96 hours on structures with steel girder spans with concrete decks. (Plate Girders or Rolled Beams)

The time delays begin after the day's pour has been completed.

Follow **TABLE 710-2** for load limitations after concrete placement. Prior to permitting approved traffic on the bridge deck, construct temporary bridge approaches and maintain them in a condition to prevent damage to the bridge ends.

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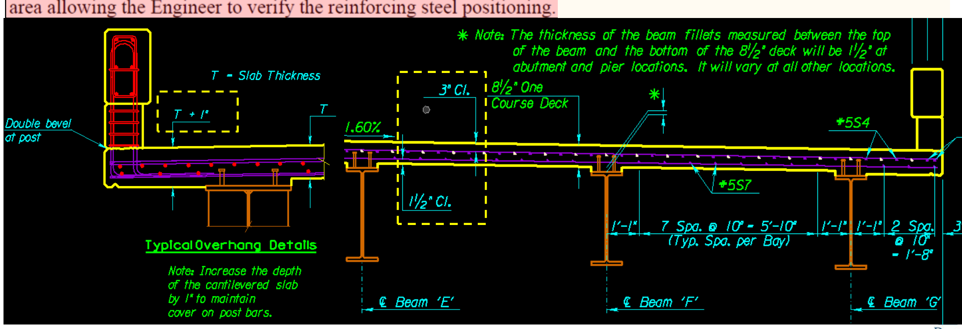
(Mud placement, Single Drum Screed, Gang Vibrators)
(CHECK/RECORD Cover & Fillet Depths at 10th

710.3 - CONSTRUCTION REQUIREMENTS (d. Finishing) p. 700-43 (location not in sequence)

(Calculate fillet depths at each of the 10^{th} points from survey for depth checks during pour. Dry run of screed machine. Verify clearance checks at each 10^{th} point. Record screed arm height.)

Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.



Longitudinal Reinforcing Splice

Bar Ties

Bar Chairs

Spacer Frames

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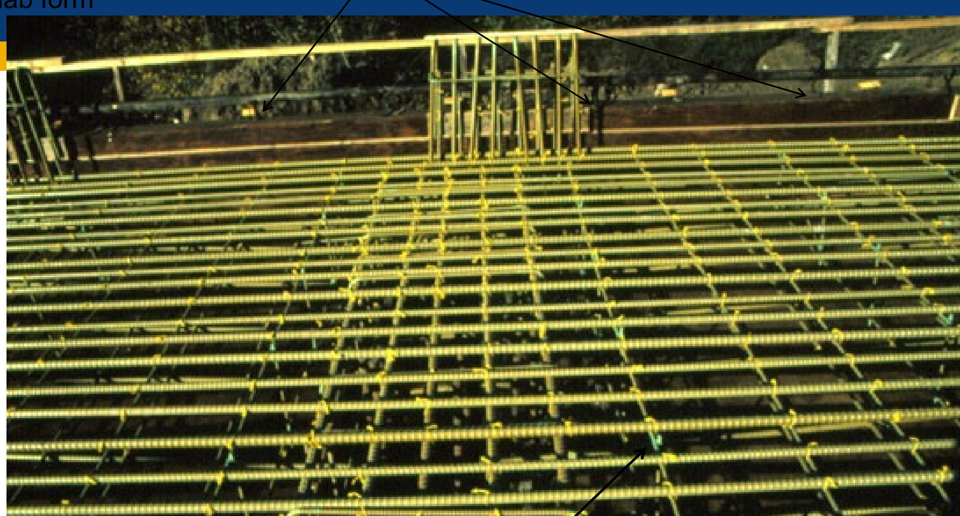
Ensure all screed rail jacks are positively secured to top of deck or slab form



Epoxy touch up paint

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710.3 - CONSTRUCTION REQUIREMENTS

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding ⅛ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see **subsection 710.3f.** for grooving requirements.

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Float Train c. '90 (Transverse Grooving now done by multi-blade diamond arbor, see Sub-Sec. f., p. 700-46)

Kansas Department of Transportation

710.3 - CONSTRUCTION REQUIREMENTS (e. Curing & Protection) p. 700-44

e. Curing and Protection.

(1) General. Cover concrete surfaces according to **TABLE 710-1**. Cure all pedestrian walkway surfaces in the same manner as the bridge deck. The determination of the time requirement for curing commences after all the concrete for the placement is in place and finished. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Maintain a damp surface until the wet burlap is placed. Fully saturate burlap before placing on concrete surface. Cover all concrete surfaces with saturated burlap within 15 minutes after finishing the concrete, do not mar concrete during placement of the wet burlap. Maintain the curing so that moisture is always present at the concrete surface.

Place and weight down the burlap so it will remain in intimate contact with the surface covered.

When an impermeable sheeting material is used, lap each unit 18 inches with the adjacent unit. Place and weight down the impermeable sheeting material so it will remain in intimate contact with the surface covered. When any burlap or impermeable sheeting material becomes perforated or torn, immediately repair it, or discard and replace it with acceptable material.

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS

Bridge decks (full-depth decks with no overlay) Bridge Overlays	14 Wet Plus 7 Curing Membrane	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.

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710.3 - CONSTRUCTION REQUIREMENTS (e. Curing & Protection) p. 700-44

(Type 2 liquid membrane)

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Sections:
731 (Area Prep. for Patching)
732 (Machine Prep.)
717 (Conc. OL)
729 (Poly OL)

731 – AREA PREP. FOR PATCHING (a. General p. 700-116

731.1 DESCRIPTION

Perform all work necessary to remove all asphalt material and unsound concrete from the existing bridge or the designated area to the depth specified in the Contract Documents, or as designated by the Engineer.

BID ITEMS	UNITS
Area Prepared for Patching	Square Yard
Area Prepared for Patching (Full Depth)	Square Yard
Area Prepared for Patching (Poured with Overlay)	Square Yard
Area Prepared for Patching (Set Price)	Square Yard
Area Prepared for Patching (Full Depth) (Set Price)	Square Yard

731.2 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete .... **SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade .... **SECTION 1102**
Concrete Curing/Precure Materials .... **DIVISION 1400**
Reinforcing Steel .... **DIVISION 1600**
Epoxy Resin Base Bonding Systems .... **DIVISION 1700**
Rapid Set Concrete Patching Materials* .... **SECTION 1716**
***When specified in the Contract Documents.**

On bridge decks that do not receive a concrete overlay, use coarse aggregate complying with **SECTION 1102**, except grading must adhere to **TABLE 731-1**.

TABLE 731-1: AGGREGATE GRADATION

Sieve Size	Percentage Retained
¾ "	0
½ "	0-10
⅜ "	15-50
#8	90-100

731 – AREA PREP. FOR PATCHING (a. General p. 700-116)

731.3 CONSTRUCTION REQUIREMENTS

a. General (All Decks). Remove asphalt material and unsound concrete as shown in the Contract Documents and as designated by the Engineer, to the depth required to reach sound concrete and rust free reinforcing steel. Dispose of removed material on sites approved by the Engineer.

Unless specifically noted in the Contract Documents, the Contractor may choose to remove unsound concrete by other means capable of removing the required concrete, without injury to the sound concrete and reinforcing steel.

Unless specifically noted in the Contract Documents, the Contractor may **not** choose to remove unsound concrete by hydrodemolition. When hydrodemolition is allowed, remove the required concrete, without injury to the sound concrete and reinforcing steel. When hydrodemolition is allowed and used as the method of removal, the Engineer will determine the areas of unsound concrete after hydrodemolition.

Do not use jack hammers or chipping hammers heavier than the nominal 15-pound class on any partial depth concrete removal. Jack hammers up to the nominal 30-pound class may be used in areas of full depth patching to within 6 inches of the edges of the designated areas. Do not use chipping hammers heavier than a nominal 15-pound class to remove the 6-inch edge. Operate jack hammers and chipping hammers at an angle to prevent damage to the sound concrete.

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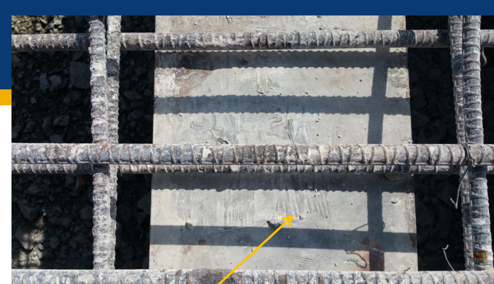

1. Locate and mark beams if working on a steel structure.
2. Work carefully to **NOT** gouge or damage Top Flange during removal.
3. If damaged, beams will be repaired at No Cost to the State.

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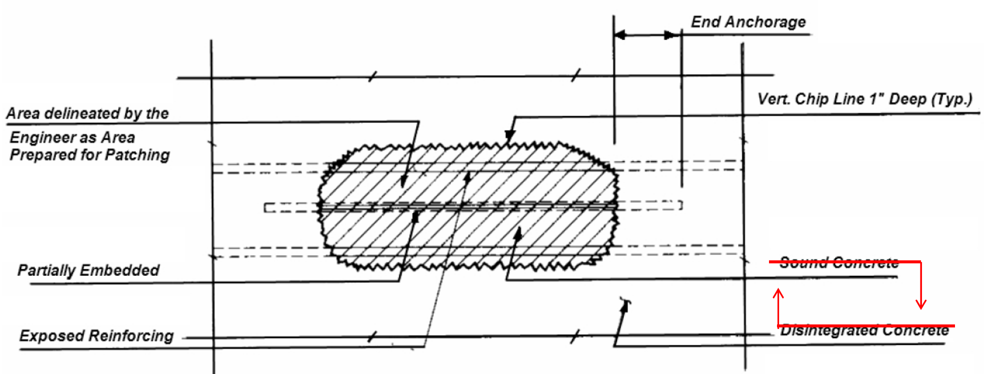
(1) Reinforcing. Remove all scale and heavy rust from steel bars. When concrete is removed by jack hammers, wet sandblasting is prohibited. If reinforcing is left exposed, and signs of rust appear, the Engineer may require that the cleaning be repeated. Do not cut, stretch or damage any exposed reinforcing steel. Do not break the bond between the reinforcing steel and concrete where bars are partially exposed yet remain anchored in sound concrete, near the ends or where more than half the bar is beneath the concrete removal line. See **FIGURE 731-1**.

FIGURE 731-1

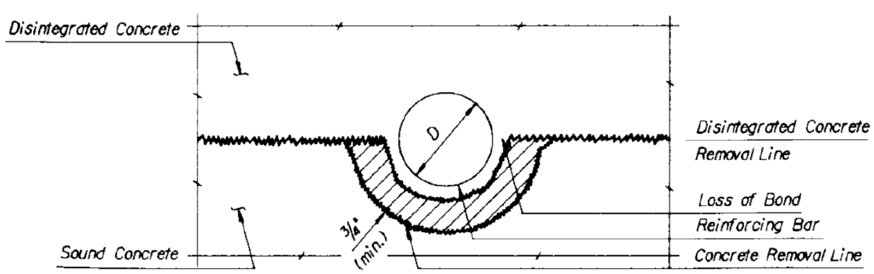


731 – AREA PREP. FOR PATCHING

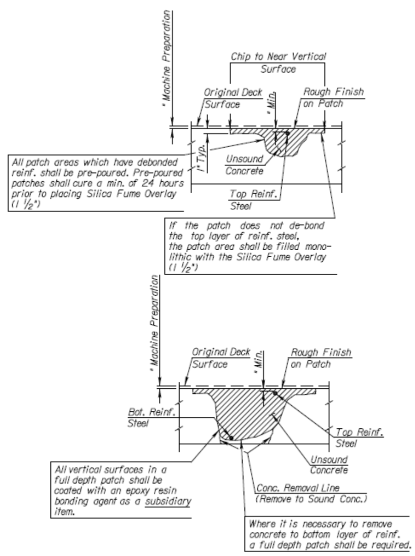
(2) Bonding of Reinforcing Steel.

(a) Top Layer of Transverse Reinforcing Bars. Where the bond between existing concrete and the top layer of transverse reinforcing steel has been destroyed (**FIGURE 731-2**), remove the concrete adjacent to the bar to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of ¾ inch. A bar may be considered bonded by the Engineer even if less than ½ the bar depth is embedded in concrete.

FIGURE 731-2



(b) All Reinforcing Bars Other Than the Top Layer of Transverse Bars. Where more than ½ the diameter of the steel is exposed (**FIGURE 731-3**), or where the bond between existing concrete and reinforcing steel has been destroyed (**FIGURE 731-2**), remove the concrete adjacent to the bars to a depth that shall permit concrete to bond to the entire periphery of the bar with a minimum clearance of ¾ inch.



DECK PATCHING DETAILS

MACHINE PREPARATION (   ): This item shall consist of preparing the deck for a SFO by removing concrete from the roadway surface of the bridge deck to a depth of   inches. See KDOT Specifications.

AREA PREPARED FOR PATCHING: This item shall consist of removing unsound concrete and bituminous patches from the bridge deck, cleaning reinforcing bars, filling the removed patched areas with concrete and preparing the entire area of the deck for SFO. Quantity shown is an estimate of the areas involved. The exact areas shall be determined by tapping, before, during and after chipping operation to ensure that all unsound concrete has been removed. See KDOT Specifications.

FULL DEPTH PATCHING: Forms shall be provided to enable placement of concrete in areas of full depth removal of bridge slab. The forms may be suspended from existing reinforcing bars by wire ties or a method approved by the Engineer may be used. See KDOT Specifications for method of measurement and basis of payment.

REINFORCING IN BRIDGE DECK: Care should be exercised to prevent cutting, stretching or damaging exposed reinforcing steel. Extreme care should be exercised to avoid breaking the bond between the reinforcing steel and concrete where bars are partially exposed yet remain anchored in sound concrete. Reinforcing steel damaged, cut or deteriorated shall be replaced as directed by the Engineer. See table for replacement bar size and minimum splice length required. Replacement of bars damaged by the Contractor shall be subsidiary to "Area Prepared for Patching".

SILICA FUME OVERLAY: This item shall consist of cleaning the concrete surface and placing the 1½ inch SFO. See KDOT Specifications.

SILICA FUME OVERLAY CONSTRUCTION JOINTS: All vertical construction joints in the overlay and the vertical joint between the overlay and the curbs shall be cleaned by sandblasting, and then painting the joints with an approved Concrete Masonry Coating 72 hours after placement of the Silica Fume Overlay.

REPAIR OF EPOXY COATED REINFORCING STEEL: Replace any epoxy coating that is removed from the reinforcing steel during the concrete removal process. Thoroughly clean damaged areas with a stiff wire brush to remove dirt and damaged coating. Apply an approved patching material in accordance with manufacturer's recommendations. Avoid dripping any patching material onto existing concrete that will have new concrete placed against it. See KDOT Specifications.

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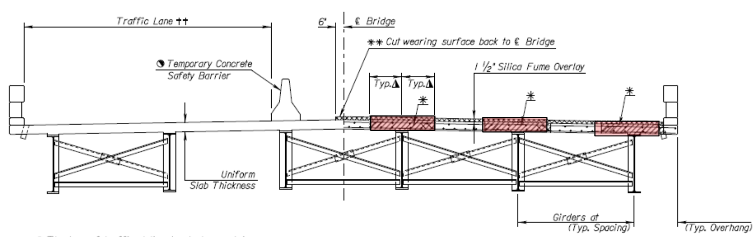
731-DECK PATCHING – GIRDER BRIDGE



The type of traffic delineator to be used is found in the traffic control sheets.

‡‡ See "Construction Staging" sheet for traffic lane and roadway widths.

Δ Girder Spacing /4 or as directed by the Engineer.

** Note: Cutting the wearing surface back to ℄ Bridge, concrete removal, all material, equipment, and labor necessary for this item shall be Subsidiary to other items.

* PATCHING SEQUENCE: When large areas of full depth patches are needed in this area, they shall be patched in segments. The segments of full depth patch shall be a maximum of 8'-0" in length parallel to the centerline of bridge with a minimum of 8'-0" between segments. After the patches in the initial segments have cured, the areas between the segments shall be patched. The segmental patching will not be required if adequate shoring is provided to support the deck and curbs.

SUMMARY OF QUANTITIES

ITEM	UNITS	QUANTITY		
† Machine Preparation ( )	Sq. Yds.			
† Area Prepared for Patching	Sq. Yds.			
Area Prepared for Patching (Full Depth)	Sq. Yds.			
Silica Fume Overlay (1 ½")	Sq. Yds.			
Reinforcing Steel (Repair) (Grade 60) (Epoxy Coated) (Set Price)	Lbs.			
† Material for Silica Fume Overlay (Set Price)	Cu. Yds.			
HMA-Commercial Grade (Class A)	Tons			

† See KDOT Specifications when hydroblasting is used for machine preparation.

◪ MINIMUM REBAR SPLICE LENGTHS

Existing Bar Size	Minimum Splice Lengths (inches)	
	Existing Gr. 40 ksi Bars	Existing Gr. 60 ksi Bars
#4	12"	16"
#5	13"	20"
#6	16"	24"
#7	20"	30"
#8	26"	39"
#9	33"	49"
#10	42"	62"
#11	51"	77"

Note: If splicing epoxy coated reinforcing steel, increase the above splice lengths by 20%.

◪ Lap lengths are based on a Class B splice. Use the minimum splice length corresponding to the grade of the existing reinforcing in the deck.

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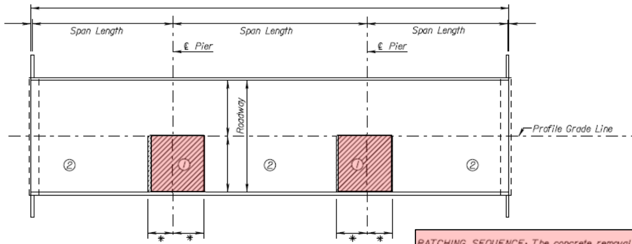
731-DECK PATCHING – SLAB BRIDGE



DECK PATCHING SEQUENCE
(Showing sequence for one lane only, other lane similar)

* Span Length /4 or as directed by the Engineer.

PATCHING SEQUENCE: The concrete removal shall be completed in stages, beginning with removal of deteriorated concrete in Area ①. If more than 15 longitudinal bars in Area ① are debonded for a distance of greater than 4 ft. along the bars, the concrete removal shall stop and the patch area filled with Concrete Grade 4.0 (AE). The patch shall cure a minimum of 3 days before concrete removal resumes in that area. Following the completion of work in Area ①, concrete removal may begin in Area ②. Concrete removal shall not begin in Area ② until the patching concrete in adjacent Area ① has cured a minimum of 3 days. The maximum size of any full depth patch shall be limited to 4 ft. x 8 ft. in any direction. Fully debonded bars in Area ① shall be limited to the same 4 ft. x 8 ft. maximum patch size. All patching and BDWS concrete shall cure according to the Specifications prior to allowing traffic on that lane.

SUMMARY OF QUANTITIES

ITEM	UNITS	QUANTITY		
† Machine Preparation ( )	Sq. Yds.			
† Area Prepared for Patching	Sq. Yds.			
Area Prepared for Patching (Full Depth)	Sq. Yds.			
Silica Fume Overlay (1 ½")	Sq. Yds.			
Reinforcing Steel (Repair) (Grade 60) (Epoxy Coated) (Set Price)	Lbs.			
† Material for Silica Fume Overlay (Set Price)	Cu. Yds.			
HMA-Commercial Grade (Class A)	Tons			

† See KDOT Specifications when hydroblasting is used for machine preparation.

◪ MINIMUM REBAR SPLICE LENGTHS

Existing Bar Size	Minimum Splice Lengths (inches)	
	Existing Gr. 40 ksi Bars	Existing Gr. 60 ksi Bars
#4	12"	16"
#5	13"	20"
#6	16"	24"
#7	20"	30"
#8	26"	39"
#9	33"	49"
#10	42"	62"
#11	51"	77"

Note: If splicing epoxy coated reinforcing steel, increase the above splice lengths by 20%.

◪ Lap lengths are based on a Class B splice. Use the minimum splice length corresponding to the grade of the existing reinforcing in the deck.

DECK PATCHING SEQUENCE (SLAB, BOX & T-GIRDER)

KANSAS DEPARTMENT OF TRANSPORTATION

Kansas Department of Transportation

732 – MACHINE PREP. (p. 700-121)

732.1 DESCRIPTION

Prepare the bridge deck surface for a concrete bridge deck overlay by removing the existing concrete and asphaltic material from bridge deck and approaches as shown in the Contract Documents.

BID ITEM	UNITS
Machine Preparation (*)	Square Yard
*Thickness	

732.2 MATERIALS - None specified.

732.3 CONSTRUCTION REQUIREMENTS

Remove concrete and asphaltic materials from the existing surface to the specified depth over the area of the deck by means of milling or cutting procedure capable of removing the specified material without injury to the sound concrete.

When specified, mill the approaches according to the Contract Documents.

732.4 MEASUREMENT AND PAYMENT

The Engineer will measure machine preparation by the square yard. Milling of approaches is subsidiary to the machine preparation bid item.

Payment for "Machine Preparation" at the contract unit price is full compensation for the specified work.

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717 – BRIDGE OVERLAYS
p. 700-91

717.1 DESCRIPTION

Construct the portland cement concrete overlay as shown on the Contract Documents.

When Bridge Deck Grooving is a bid item in the contract, perform the grooving as shown in the Contract Documents.

BID ITEMS	UNITS
Portland Cement Concrete Overlay (*)	Square Yard
Material for Portland Cement Concrete Overlay (Set Price)	Cubic Yard
Bridge Deck Grooving	Square Yard

* Thickness

717.2 MATERIALS

Provide materials that comply with the applicable requirements.

Grade 4.0 (AE) Concrete+ .... **SECTIONS 401 & 402**
Aggregate for Concrete Not On Grade.. **DIVISION 1102**
Precure/Finishing Aid Material++ .... **DIVISION 1400**
Concrete Curing Materials .... **DIVISION 1400**
Concrete Masonry Coating .... **DIVISION 1700**

+Use concrete that meets requirements for low permeability concrete (LPC) as specified in **DIVISION 400**.

++When silica fume is used as an SCM, the use of Precure/Finish Aid may be used according to the manufacturer's instructions.

For overlays use Supplemental Cementitious Materials at allowable substitution rates as listed in **TABLE 401-2**.

717.3 – BRIDGE OVERLAYS – Const. Req.
(b. Surface Prep.) p. 700-92

TABLE 717-1: PORTLAND CEMENT CONCRETE OVERLAY PRODUCTION REQUIREMENTS	
Total Placed Surface Area per Bridge (Square Yards)	**Minimum Cubic Yards per Hour**
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5

b. Preparation of Surface. Prior to placement of concrete, sand or shot blast the surface followed by an air blast to the bottom 3 inches of hubguard, and edges against which concrete is to be placed to remove all dirt, oil, pavement marking and other foreign material, as well as any unsound concrete, laitance and curing material from the surface. Wet sand blasting may be used only with approval of the Engineer. It is desired that the surface be roughened by the sand or shot blast to provide satisfactory bond with the surfacing concrete. Protect metal deck drains and areas of the curb or railing above the proposed surface from the sand or shot blast.

Check the finish machine clearance above the prepared surface before concrete is placed to obtain the thickness specified in the Contract Documents.

A minimum of 2 hours before the placing of the concrete overlay, use clean water to thoroughly wet any concrete surfaces to which the concrete is to bond against. Blow or broom away all free water immediately ahead of the placing operation. Bonding surfaces should be maintained in a damp condition with no free water.

717.3 – BRIDGE OVERLAYS
(c. Placing Concrete) p. 700-92

c. Placing Concrete. Place and fasten the screed rails in position to obtain finished concrete at the required profile. Place the supporting rails upon which the finishing machine travels outside the area to be concreted. A hold-down device shot into concrete is prohibited, unless the concrete is to be subsequently overlaid. Hold-down devices of other types leaving holes in exposed areas will be approved provided the holes remaining are grouted full. Methods for anchoring and supporting the rails and the concrete placing procedure require approval by the Engineer.

Locate longitudinal joints along lane lines, or as approved by the Engineer. Keep the joints clear of wheel paths as much as practical.

Placing of the overlay is prohibited when conditions on the bridge deck are such that the evaporation rate is estimated to equal or exceed 0.2 pounds per square foot per hour, or is predicted to exceed that rate during the course of the placement, unless corrective measures listed in **subsection 710.3b.** are taken to reduce the evaporation rate to below 0.2 pounds per square foot per hour.

Fogging may be necessary during placement of the overlay. Accomplish fogging according to **subsection 710.3b**.

The evaporation rate will be rechecked with the measures in place, using the procedures outlined above.

The elapsed time between depositing the concrete on the deck and final screeding may not exceed 15 minutes, unless otherwise authorized by the Engineer.

Manipulate and mechanically consolidate new concrete to a minimum of 98% of the consolidated unit weight and screed to final grade. In irregular areas or along the curb where the finishing screed does not reach, hand tamp with a 6-inch by 6-inch metal plate device to assist in consolidation and bonding of the concrete. When concrete for partial depth patches is placed with the overlay, apply additional vibration or hand tamping in the patch areas to assist in consolidation and bonding of the concrete.

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717.3 – BRIDGE OVERLAYS
(f. Weather Limitations) p. 700-93

f. Weather Limitations. See **SECTION 401**. Also, discontinue concreting operations when a descending air temperature in the shade and away from artificial heat falls below 45ºF except with written approval from the Engineer. Do not start or resume operations until an ascending air temperature reaches 40ºF, or if night time temperatures are expected to fall below 35ºF.

BD-32

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729 – MULTI-LAYER POLY OVERLAYS
p. 700-109

729.1 DESCRIPTION

Prepare the surface of the reinforced concrete bridge deck and construct a multi-layer polymer concrete overlay (overlay) as shown on the Contract Documents.

Provide an overall combination of labor and equipment with the capability of proportioning and mixing the polymer resin components and placing the primer and aggregate, in accordance with this specification and the manufacturer/supplier's recommendations.

BID ITEM	UNITS
Multi-Layer Polymer Concrete Overlay	Square Yard

729.2 MATERIALS

a. General.

(1) Proportion all polymer materials according to the manufacturer/supplier's recommendations.

(2) Provide the Engineer with a copy of the polymer materials manufacturer/supplier's mixing and application recommendations.

(3) If concrete bridge deck patching is specified, polymer concrete materials may be used for patching of the concrete bridge deck. See **SECTION 731**.

b. Epoxy. Provide a Type III epoxy resin as defined in **DIVISION 1700**.

c. Polyester. Provide a polyester resin as defined in **DIVISION 1700**.

d. Aggregate.

(1) Provide FA-C aggregate meeting **TABLE 1102-5** and **TABLE 1102-6**, or

(2) As provided by the polymer concrete overlay supplier in a prequalified system, **DIVISION 1700**.

Kansas Department of Transportation

729 – MULTI-LAYER POLY OVERLAYS
p. 700-109

729.3 CONSTRUCTION REQUIREMENTS

a. General. Wet cure concrete on new bridge decks for 14 days and allow the deck to dry for 21 days before applying the overlay.

Portland cement concrete patches require a minimum cure period of 28 days before application of the overlay.

At the preconstruction conference, discuss the patching material and the corresponding curing period. Submit changes, including a written statement from the polymer manufacturer/supplier recommending changes, to the Engineer for approval.

b. Equipment. Equipment is subject to approval of the Engineer and must comply with these requirements:

(1) Surface Preparation Equipment.

(a) Shot blasting equipment capable of producing a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch. Final acceptance is based on testing procedures as outlined in KT-70, Part V.

(b) Shot/Sand blast equipment capable of producing the required surface relief on the deck adjacent to bridge rails and barriers and areas not accessible with shot blast equipment.

(c) Empty shot blasters and dispose of waste material a minimum of 50 feet from the prepared bridge deck. On long structures empty shot blasters on the unprepared surface a minimum of 50 feet from prepared surface to prevent contamination of the deck by return of dust to the prepared surface.

(d) The Engineer must approve the use of scarifiers, scrablers or milling machines.

Kansas Department of Transportation

729 – MULTI-LAYER POLY OVERLAYS
p. 700-110

(e) Wet sand blasting is prohibited.

(2) Mechanical Application Equipment.

(a) Polymer mixing and distribution system capable of accurate and complete mixing of the polymer resin and hardening agent, verification of the mix ratio and uniform and accurate distribution of the polymer materials at the specified rate on 100% of the work area.

(b) A self-propelled aggregate spreader (if required) capable of uniform and accurate application of the dry aggregate over 100 % of the work area.

(c) An air compressor capable of producing a sufficient amount of oil free and moisture free compressed air to remove all dust and loose material.

(d) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

(3) Hand Application Equipment.

(a) Calibrated containers for accurate measurement of the polymer components.

(b) Paddle type mixer or other mixing device capable of accurate and complete mixing of the polymer resin and hardening agent.

(c) Notched squeegees and brooms capable of spreading the polymer material in accordance with this specification and the manufacturer/supplier's recommendations.

(d) Aggregate spreader capable of uniform and accurate application of the dry aggregate.

(e) Adequate additional hand tools to facilitate the placement of the polymer concrete overlay in accordance with this specification and the manufacturer/supplier's recommendations.

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729 – MULTI-LAYER POLY OVERLAYS
p. 700-110

c. Preparation of Surface.

(1) When specified, perform any required repairs under **SECTION 731** and cure repairs, before preparation of the surface, unless placed with the overlay.

(2) Protect metal deck drains and areas of the curb or railing above the proposed surface from the shot blast.

(3) Close deck drains so the overlay materials will not pass through the drains.

(4) Remove any remaining contamination of the prepared deck surface or surface of subsequent courses. Sand blast or bush hammer contaminated areas to produce an acceptable surface for placement of the overlay.

(5) As the final preparation for the placement of the overlay, make a complete cleanup by shot blasting and/or other approved means, followed by an air blast with dry, oil free air or vacuum. Brooming is not acceptable. Remove all pavement marking, loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation and curing materials from patches and other foreign material from the surface of the deck.

(6) Produce a surface relief equal to the International Concrete Repair Institute (ICRI) Surface Preparation Level 6 to 7 or ASTM E 965 Pavement Macrotexture Depth of 0.04 to 0.08 inch.

(7) Place the first coat of the overlay within 24 hours of preparing the deck surface. Prepared surfaces exposed for more than 24 hours must be lightly sand blasted prior to application of the overlay.

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729 – MULTI-LAYER POLY OVERLAYS, Continued…

d. Placing the Multi-Coat Poly
e. Face of Curbs, Barriers and Rail
f. Application Rates
g. Curing
h. Testing
i. Correction of Unbonded Areas
j. Weather Limitations

… Basically, if you get one of these Projects, read through it as best you can, then call Dan Wadley at Materials and he'll come out and help you.

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Thanks!!!

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CIT Structures

Curing

Curing

- Curing mediums
  - Wet Burlap
  - Liquid membrane-forming compounds
  - White polyethylene sheeting
  - Formwork

Curing

• 710.3 e. Curing and Protection

(1) General. Cover concrete surfaces according to **TABLE 710-1**. Cure all pedestrian walkway surfaces in the same manner as the bridge deck. The determination of the time requirement for curing commences after all the concrete for the placement is in place and finished. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Maintain a damp surface until the wet burlap is placed. Fully saturate burlap before placing on concrete surface. Cover all concrete surfaces with saturated burlap within 15 minutes after finishing the concrete, do not mar concrete during placement of the wet burlap. Maintain the curing so that moisture is always present at the concrete surface.

Place and weight down the burlap so it will remain in intimate contact with the surface covered.

When an impermeable sheeting material is used, lap each unit 18 inches with the adjacent unit. Place and weight down the impermeable sheeting material so it will remain in intimate contact with the surface covered. When any burlap or impermeable sheeting material becomes perforated or torn, immediately repair it, or discard and replace it with acceptable material.

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Curing

• 710.3 e. Curing and Protection

(2) Liquid Membrane Forming Compounds. Use spraying equipment capable of supplying a constant and uniform pressure to provide uniform distribution at the rates required. Agitate the liquid membrane forming compound continuously during application. The surface must be kept wet from the time it is finished until the liquid membrane forming compound is applied. Apply liquid membrane forming compound at a minimum rate per coat of 1 gallon per 200 square feet of concrete surface.

(3) Bridge Subdecks and Decks. Provide a work bridge to facilitate application of all curing materials. Maintain the curing so that moisture is always present at the concrete surface.

Maintain the wet burlap in a fully wet condition using misting hoses, self-propelled, machine-mounted fogging equipment with effective fogging area spanning the deck width, moving continuously across the entire burlap-covered surface, or other approved devices until the concrete has set sufficiently to allow foot traffic. At that time,

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Curing

- 710.3 e. Curing and Protection

(5) Cold Weather Curing. If concrete is placed in cold weather, comply with **SECTION 401**.

If concrete is placed and the ambient air temperature is expected to drop below 40ºF during the entire specified curing period, provide suitable measures such as straw, additional burlap or other suitable blanketing materials or housing and artificial heat to maintain the concrete temperature between 40 and 90ºF as measured on the surface of the concrete. Keep the surface of the concrete moist by the use of an approved moisture barrier such as wet burlap or polyethylene sheeting or both as defined in **TABLE 710-1**. Maintain the moisture barrier in intimate contact with the concrete during the entire specified curing period. After the completion of the required curing period, remove the curing and protection to prevent rapid cooling of the concrete.

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Curing

- Foundations and Substructures
  - In the Forms with Burlap and Poly
  - Footings
  - Abutments
  - Pier Columns and Caps

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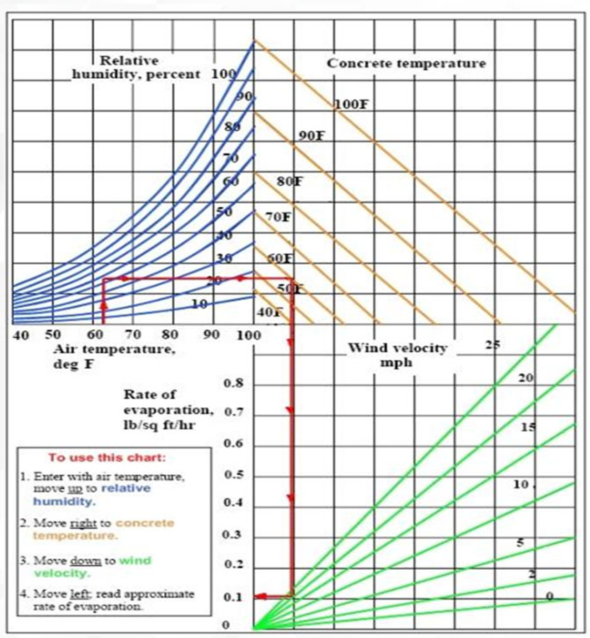
Curing

- Superstructure
  - Bridge Decks
  - Starts with Environmental Conditions
  - Evaporation Rate
  - < 0.2 lb/sq ft/hr
  - Fogging 1200 psi / 2.2 gpm or low rate 1.6gpm

Curing

- Superstructure
  - Bridge Decks
  - Figure 710-1
  - Equal to or above 0.2 lb/ft2/hr, take actions to create and maintain an evaporation rate less than 0.2 lb/ft2/hr



Curing

- Superstructure
- Figure 710-1

Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use the chart, follow the four steps outlined above. When the evaporation rate exceeds 0.2 lb/ft^2/hr (1.0 kg/ m^2/hr), measures shall be taken to prevent excessive moisture loss from the surface of unhardened concrete; when the rate is less than 0.2 lb/ft^2/hr (1.0 kg/m^2/hr) such measures may be needed. When excessive moisture loss is not prevented, plastic cracking is likely to occur.

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Curing

- Superstructure

- **Cover within 15 minutes**
- Fully Saturate burlap before placing on concrete surface

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Curing

- Superstructure

- Place and weight down burlap so it will remain in intimate contact with the surface covered

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Curing

- Superstructure

- Do not mar concrete during placement
- Maintain damp surface

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Curing

- Superstructure
- Maintain the wet burlap in a fully wet condition
- Place Soaker Hoses, supply running water continuously

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Curing

- Superstructure
- When impermeable sheeting is used, lap each unit 18”

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Department of Transportation

Curing

- Superstructure
- If the concrete temperature is above 90 degrees, do not use polyethylene sheeting in direct sunlight for the first 24 hours

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Curing

- 710.3 e. Curing
- Table 710-1
- Minimum Cure Times and Curing Mediums
- Note the specified type of liquid membrane

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS

Type of Work	Minimum Cure Time (days)	Curing Medium and Use
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay) Bridge Overlays	14 Wet Plus 7 Curing Membrane	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.
Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.

Kansas Department of Transportation

Curing

- Superstructures

TABLE 710-1: MINIMUM CURE TIMES AND CURING MEDIUMS		
Type of Work	**Minimum Cure Time (days)**	**Curing Medium and Use**
Bridge decks (full-depth decks with multi-layer polymer overlays) Bridge subdecks (decks with overlays)	14 Wet	Wet burlap covered with white polyethylene sheeting during the 14-day period.
Bridge decks (full-depth decks with no overlay) Bridge Overlays	14 Wet Plus 7 Curing Membrane	Wet burlap covered with white polyethylene sheeting during the 14-day period. After the wet cure period, apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat within 30 minutes of removing the sheeting and burlap. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period.

Curing

- Superstructures

Other unformed or exposed surfaces	7 Curing Membrane	Apply 2 coats of Type 2 white liquid membrane forming compound. Place the first coat immediately after completion of the concrete finish just as the surface water disappears. Spray the second coat immediately after and at right angles to the first application. Protect the curing membrane against marring for a minimum of 7 days. The Engineer may limit work during this 7-day period. Should the compound be subjected to continuous damage, the Engineer will require wet burlap, white polyethylene sheeting or other approved impermeable material to be applied at once for the remainder of the cure time.
Formed sides and ends of bridge wearing surfaces and bridge curbs Other formed surfaces	4 Formed	Formed surfaces will be considered completely cured upon the Engineer's permission to remove the forms, providing the forms have been in place for a minimum of 4 days. If forms are removed before the end of the 4-day cure period, cure the surface with an application of Type 1-D liquid membrane forming compound.

Kansas Department of Transportation

Curing

- Superstructures
- Load Limits during cure period Table 710-2

TABLE 710-2: CONCRETE LOAD LIMITATIONS ON BRIDGE DECKS		
Days after concrete is placed	**Element**	**Allowable Loads**
1*	Subdeck, one-course deck or concrete overlay	Foot traffic only.
3*	One-course deck or concrete overlay	Work to place reinforcing steel or forms for the bridge rail or barrier.
7*, Δ	Concrete overlays	Legal Loads; Heavy stationary loads with the Engineer's approval.***
10 *, Δ (15)**, Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Light truck traffic (gross vehicle weight less than 5 tons).****
14 *, Δ (21)**, Δ	Subdeck, one-course deck or post-tensioned haunched slab bridges	Legal Loads; Heavy stationary loads with the Engineer's approval.***Overlays on new decks.
28	Bridge decks	Overloads, only with the State Bridge Engineer's approval.***

Kansas Department of Transportation

Curing

- Superstructures
- Load Limitations during cure period
- Table 710-2
- 3 days placing reinforcing steel and form work
- Maintain wet cure

Kansas Department of Transportation

Curing

- Superstructures
- Load Limitations during cure period
- Table 710-2
- 14 days Legal Loads
- Maintain wet cure

Kansas Department of Transportation

Curing

Kansas Department of Transportation

Concrete & Reinforcing Steel Test Review

C&R Rev-1

Concrete & Reinforcing Steel Review

Placement Time:

1. If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? No set retarding admixture is added.

C&R Rev-2

Concrete & Reinforcing Steel Review

Placement Time:

- 401.8.a
- Non-agitated Concrete – place within 30 minutes of adding the cement to the water
- Agitated Concrete – use Table 401-5

TABLE 401-5: AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME		
T = Ambient Air Temperature at Time of Batching (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
$T < 75$	1 ½	None
$75 \leq T$	1	None
$75 \leq T < 90$	1 ½	Set Retarder

- If concrete temp. ≥ 90°F, 45 min. placement time

C&R Rev-3

Kansas
Department of Transportation

Concrete & Reinforcing Steel Review

Placement Time:

1. If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? <u>No set retarding admixture is added</u>.

1 hour (401.8.a --- Table 401-5. page 400-9)

C&R Rev-4

Kansas
Department of Transportation

Concrete & Reinforcing Steel Review

Placement Time:

2. If ambient air temp. is 76° F and the agitated concrete temperature at the time of placement is 80° F, what is the maximum time allowed for placement of the concrete after water is added to the mix? A set retarding admixture is added.

1.5 hours (401.8.a --- Table 401-5. page 400-9)

C&R Rev-5

Concrete & Reinforcing Steel Review

Placement Time:

3. What is the maximum time allowed for placement of agitated concrete if the ambient air temp. is 99° F and the concrete temp. at the time of placement is 90° F? No set retarding admixture is added.

45 minutes (401.8.a --- paragraph below Table 401-5. page 400-9)

C&R Rev-6

Concrete & Reinforcing Steel Review

Water/Cement Ratio:

4. What is the maximum ratio of water to cement for Grade 3.5 concrete?

C&R Rev-7

Kansas Department of Transportation

Concrete & Reinforcing Steel Review

Water/Cement Ratio:

See Slide "C&R – 7"

- **Table 401-A1: General**

TABLE 401-A1: GENERAL CONCRETE

Grade of Concrete	lb. of Cementitious per yd of Concrete, minimum	lb. of Water per lb. of Cementitious, maximum
Grade 7.0(**):MA Gradation	700	0.35
Grade 6.0(**):MA Gradation	650	0.35
Grade 5.0(**):MA Gradation	602	0.35
Grade 4.5(**):MA Gradation	602	0.40
Grade 4.0(**):MA Gradation	602	0.44
Grade 3.5 and 3.0(**):MA Gradation	564	0.46
Grade 2.5(**):MA Gradation	526	0.50

General Concrete (*) (**)
*Grade as specified in the Contract Documents
**Air Entrained meeting subsection 401.3a.

Air entrained concrete with a target air of 6.5 ± 1.5 percent.
Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard. Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

C&R Rev-8

Kansas Department of Transportation

Concrete & Reinforcing Steel Review

Water/Cement Ratio:

See Slide “C&R – 8”

- **Table 402-A1: Concrete for Structures**

TABLE 402-A1: CONCRETE FOR STRUCTURES		
Grade of Concrete	**lb. of Cementitious per yd of Concrete, minimum**	**lb. of Water per lb. of Cementitious, maximum**
Grade 6.0(**)(***)(****): MA Gradation	700	0.35
Grade 5.0(**)(***)(****): MA Gradation	602	0.35
Grade 4.5(**)(***)(****): MA Gradation	602	0.40
Grade 4.0(**)(***)(****): MA Gradation	602	0.44
Grade 3.5 and 3.0(**): MA Gradation	564	0.46
Grade 2.5(**): MA Gradation	526	0.50

Structural Concrete (*) (**) (***)(****)
*Grade as specified in the Contract Documents
Air Entrained meeting **subsection 402.3e.
***Aggregate as specified in **DIVISION 1100**.
****MPC (Moderate Permeability Concrete)

Air entrained concrete with a target air of 6.5 ± 1.5 percent.
Maximum water to cementitious ratio of 0.50 and a minimum cementitious content of 480 lbs per cubic yard. Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

Kansas Department of Transportation

C&R Rev-9

Concrete & Reinforcing Steel Review

Water/Cement Ratio:

4. What is the maximum ratio of water to cement for Grade 3.5 concrete?

0.46 (401 Appendix A --- Table 401-A1. page 400-11)

Kansas Department of Transportation

C&R Rev-10

Concrete & Reinforcing Steel Review

Concrete Slump:

5. The designated slump for a concrete is 3”.
   What is the acceptable slump range?

C&R Rev-11

Concrete & Reinforcing Steel Review

Concrete Slump:

- 402.3.f
  - Concrete will have a designated slump
  - Actual slump must fall within tolerance range
  - If specified SLUMP $\leq$ 3”, tolerance $\pm$ ¾”
  - If specified SLUMP > 3”, tolerance $\pm$ 25%
  - Slump for Drilled Shafts:
    - Target Slump = 9”
    - Actual Slump ≥ 8”
  - Max designated slump for all other structural concrete = 5”

See Slide “C&R – 9”

C&R Rev-12

Concrete & Reinforcing Steel Review

Concrete Slump:

5. The designated slump for a concrete is 3”. What is the acceptable slump range?

  - Designated Slump = 3” ($\leq$ 3”, tolerance $\underline{+}$ ¾”)
  - 3” ± ¾”
  - 3” – ¾” = 2 ¼”
  - 3” + ¾” = 3 ¾”

- **Acceptable range is 2 ¼” to 3 ¾”**

C&R Rev-13

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

6. In an abutment beam, there are 40 - #6A5 bars. #6A5 bars are 30’-0” long. What is the total weight of the A5 bars?

C&R Rev-14

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

- First, count the number of bars
  - Given in the problem, **40 bars**
- Second, find the length of one bar
  - Given in the problem, **30.0 ft**
- Third, find the weight (lb/ft) for the size of bar
  - **Table 711-1: Bar Size Weights**

TABLE 711-1: BAR SIZE WEIGHTS

Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

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C&R Rev-15

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

6. In an abutment beam, there are 40 - #6A5 bars. #6A5 bars are 30'-0" long. What is the total weight of the A5 bars?

1.502 lb/ft x 30 ft x 40 bars = 1802.4 ≈ 1802 lb

(711.4 --- Table 711-1. page 700-53)

Kansas Department of Transportation

C&R Rev-16

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

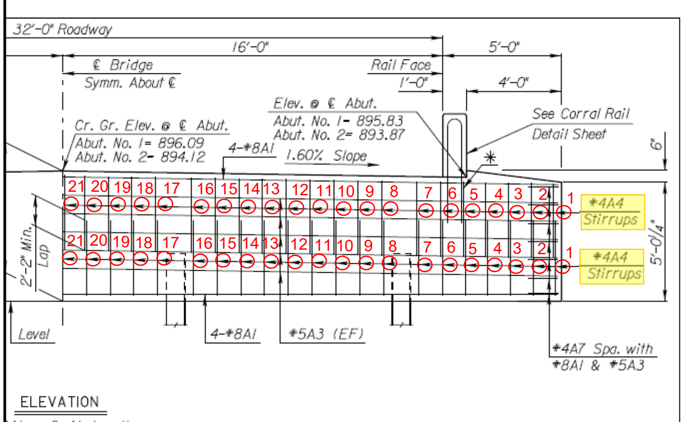
7. Given the example haunched slab project sheets, what is the total weight of the #4A4 stirrups?

- First, count the number of bars

C&R Rev-17

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):



Count Number of A4 bars:

(Option #1: count the number of arrows)

Bar 21 is located at the centerline of the abutment. Be sure not to count it twice! There is only one Bar 21 located at centerline where as Bars 1 - 20 are located on both sides of the centerline of abutment and should be counted twice.

Bars 1 - 20 Bar 21

(20 bars)*(2 sides) + 1 = 41 bars

Two sets of Stirrups (bottom is already counted)

Top is a duplicate of bottom

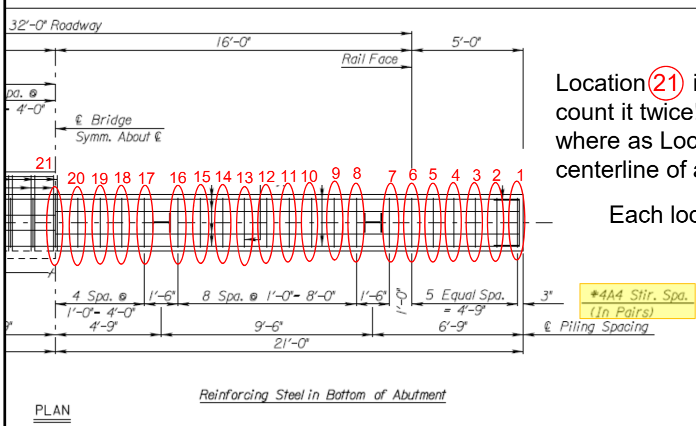
= 41+41 = 82 bars per abutment

= 82 bars per abutment X two abutments = 164 total #4A4 Stirrups

C&R Rev-18

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):



Count Number of A4 bars:

(Option #2: count the number of locations by the spacing)

Location 21 is AT the centerline of the abutment. Be sure not to count it twice! Location 21 is only at the centerline of the abutment, where as Locations 1 - 20 are located on both sides of the centerline of abutment and should be counted twice.

Each location has ***Two*** stirrups. Spacings are ***in pairs***.

Locations 1 - 20   Locations 21

[(20 Locations)*(2 Bars)*(2 sides)] + (2 bars) = 82 bars per Abutment

= 82 bars per abutment X two abutments = 164 total #4A4 Stirrups

C&R Rev-19

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

7. Given the example haunched slab project sheets, what is the total weight of the #4A4 stirrups?

- ~~First, count the number of bars~~
- Second, determine length of bar mark

C&R Rev-20

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

Length:

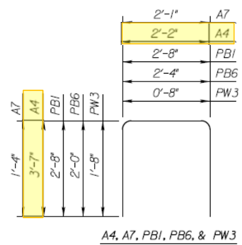
= 3'-7"+3'-7"+2'-2"

= (3+3+2)'-(7+7+2)"

= 8'- $^{16}/_{12}$"

= 8' + 1.333'

= **9.333 ft.**



BILL OF REINFORCING STEEL Epoxy Coated - Grade 60								
	Straight Bars				Bent Bars			
	Mark	Size	Number	Length	Mark	Size	Number	Length
	S4	#10	4	50'-6"	R1	#7	24	9'-3"
	S6	#10	60	50'-6"	R2	#7	4	5'-7"
	S8	#10	52	48'-6"	R3	#7	220	7'-9"
	S9	#10	48	44'-0"	S1	#7	60	11'-3"
	S10	#10	40	36'-3"	S2	#7	52	14'-3"
	S14	#10	24	58'-0"	S3	#7	52	13'-3"
	S7	#9	52	42'-8"	A2	#5	62	3'-11"
	S11	#9	40	33'-0"	R5	#5	8	6'-6"
	S12	#9	36	21'-6"	R6	#5	8	10'-8"
k - Rail	S15	#9	20	42'-6"				
	S16	#9	20	33'-0"	A4	#4	164	9'-4"
	S17	#9	18	24'-6"	A5	#4	62	6'-2"

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

7. Given the example haunched slab project sheets, what is the total weight of the #4A4 stirrups?

- ~~First, count the number of bars~~
- ~~Second, determine length of bar mark~~
- Third, determine weight (lb/ft) of bar size

Concrete & Reinforcing Steel Review

Bid Item Quantity (Reinforcing Steel):

The designated bar size is #4

Weight:

0.668 lb/ft

TABLE 711-1: BAR SIZE WEIGHTS		
Bar Size (US Customary)	Bar Size (SI)	Weight (Pounds / Lin.Ft.)
#3 or 3/8"	9 or 10*	0.376
#4	12 or 13	0.668
#5	15 or 16	1.043
#6	19 or 20	1.502
#7	22	2.044
#8	25	2.670
#9	29 or 30	3.400
#10	32	4.303
#11	35 or 36	5.313
#14	43 or 45	7.650
#18	55 or 57	13.600

*Consult with KDOT's Bureau of Design, State Bridge Office, to determine the correct conversion of the 10mm bars.

Total Mark Weight = 164 x 9.333 x 0.668 = 1022 lb

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C&R Rev-23

Falsework & Form Construction Review

F&F-1

Q1: Concrete columns for a single column bent pier were poured yesterday. How long from concrete placement can pier beam formwork erection start?

Single Column Bent

Pier Beam Formwork

Kansas Department of Transportation

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} 2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

Single Column Bent

Pier Beam Form work

= 4 Days

Deck, girders spaced at 7.25 Ft.

removal of Deck Forms

1. Structural Element?

Deck,
7.25 Ft. span

Removal of Forms

= 4 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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Deck, girders spaced at 7.25 Ft
with S.C.M.'s

removal of Deck Forms

Kansas Department of Transportation

1. Structural Element?

Deck,

7.25 Ft. span

Removal of Forms

4 Days

Δ = add 3 Days

Total = 7 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	$\boxed{4^{\Delta}}$			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

Kansas
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Wing Walls

removal of Wing Wall Forms

Kansas
Department of Transportation

1. Structural El

Wing Walls

Removal of Forms

= 4 Days

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)							
Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} $[4]^{+}$	10^{Δ} $[6]^{+}$		15^{Δ} $[10]^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} $[4]^{+}$		7^{Δ} $[4]^{+}$		10^{Δ} $[6]^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} $[2]^{+}$ 7^{Δ} $[4]^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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Q6: Same structure as Q5. How many days if grade 4.0 concrete (4000 psi) is specified, and test specimens broke at a strength of 2800 psi after 3 days?

Deck, girders spaced at 11 Ft.
+ Cylinders made, broke on Day 4
Requirement for: +
0.65(4000) = 2600 psi Needed
break of 2800 > 2600 req'd, OK.
Remove forms on Day 3 after breaks.

removal of Wing Wall Forms

Kansas
Department of Transportation

1. Structural El... ?

Wing Walls

Removal of Forms

= [3] Days

*if * cylinders made broke above Req'd .?*

Yes. = Remove at 3 Days.

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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Department of Transportation

1. Structural Element?

Deck,

11 Ft. span

Removal of Forms

TABLE 710-3: MINIMUM STRENGTH GAIN TIME BEFORE REMOVAL OF FORMS & FALSEWORK (DAYS)

Type of Work	Span Length (feet)						
	Less than 10	10 or less	Greater than 10	10 to 20	20 + to 30	Greater than 20	Greater than 30
Cantilevered Piers - Formwork (supporting the pier beam) supported on column		7^{Δ} [4]*	10^{Δ} [6]*				
Column Bent Piers - Falsework supporting pier beam**	4^{Δ}			7^{Δ} [4]*		10^{Δ} [6]*	
Forms and Falsework under slabs, beams, girders, arches and brackets***	4^{Δ}			7^{Δ} [4]$^{+}$	10^{Δ} [6]$^{+}$		15^{Δ} [10]$^{+}$
RCB and RFB top slabs not re-shored		7^{Δ} [4]$^{+}$		7^{Δ} [4]$^{+}$		10^{Δ} [6]$^{+}$	

Type of Work	Time (Days)
Walls, Wing Walls and vertical sides of RCB and RFB structures Do not backfill according to **SECTION 204**, until 3 days after forms are removed.	4^{Δ} [3]*
Footing Supported on Piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Spread Footing founded in rock – minimum before erecting forms and reinforcing steel for columns	2^{Δ}
Footing supported on piles - minimum cure before erecting forms and reinforcing steel for columns	4^{Δ} [2]*
Columns for cantilevered piers - 1. minimum before supporting forms and reinforcing steel for the pier beam on the column. 2. minimum before placing concrete for the pier beam	4^{Δ} [2]$^{+}$ 7^{Δ} [4]$^{+}$
Columns for bent piers - 1. minimum before erecting formwork and reinforcing steel for the pier beam 2. minimum before placing concrete for the pier beam	2^{Δ} 4^{Δ} [2]*
Drilled shafts - minimum before erecting forms and reinforcing steel for the columns	2^{Δ}
Floors for RCB and RFB structures on rock or a seal course - minimum before erecting forms and reinforcing steel	2^{Δ}
Floors for RCB and RFB structures on soil or foundation stabilization - minimum before erecting forms and reinforcing steel	4^{Δ} [2]*
Do not remove forms or falsework from post tensioned elements until all applied post tensioning forces are transferred.	NA

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700 STRUCTURES

Say there was a question about the **(finished) smoothness of a bridge deck:** where would one look?

710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
d. Finishing

700-43

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding ⅛ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see **subsection 710.3f.** for grooving requirements.

Kansas Department of Transportation

710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
d. Finishing

700-43

d. Finishing. Finish all top surfaces, such as the top of retaining walls, curbs, abutments and rails, with a wooden float by tamping and floating, flushing the mortar to the surface and provide a uniform surface, free from pits or porous places. Trowel the surface producing a smooth surface, and brush lightly with a damp brush to remove the glazed surface.

Strike off bridge decks with a self-propelled finishing machine, which may be manually operated by winches to reach a temporary bulkhead when approved by the Engineer. The screed on the finish machine must be self-oscillating, and operate or finish from a position either on the skew or transverse to the bridge roadway centerline.

On decks skewed greater than 10°, operate the finishing machine on the same skew as the bridge, unless approved otherwise by the SBO. Before placing concrete, position the finisher throughout the proposed placement area allowing the Engineer to verify the reinforcing steel positioning.

Irregular sections may be finished by other methods approved by the Engineer. Reinforced concrete box bridges that will be under fill may be struck off by other approved methods.

Float and straightedge the wearing surface so the finished surface is at the cross-section shown in the Contract Documents. Do not add water to the surface of concrete, unless approved by the Engineer, and when approved apply as a fog spray.

Secure a smooth riding bridge deck, correcting surface variations exceeding ⅛ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.

Straightedge decks that are to receive an overlay, leaving them with an acceptable float or machine pan finish.

For decks not receiving an overlay, and without the bid item Bridge Deck Grooving, finish the deck with the rough burlap drag.

For decks not receiving an overlay, and with the bid item Bridge Deck Grooving, see **subsection 710.3f.** for grooving requirements.

Kansas Department of Transportation

Say there was a question about the form removal for ornamental (structural) rubbed finish work: where would one look?

710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
g. Removal of Forms and Falsework

700-47

g. Removal of Forms and Falsework. Do not remove forms and falsework without the Engineer's approval. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **TABLE 710-1**.

If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**. Remove forms on handrails, ornamental work and other vertical surfaces that require a rubbed finish as soon as the concrete has hardened sufficiently that it shall not be damaged.

Under normal conditions, the Engineer will allow removal of forms and falsework according to **TABLE 710-3**. The determination of the time requirement for the removal of forms commences after all the concrete for the placement is in place and finished. If high early strength concrete is used, the specified time limits may be decreased as determined by the Engineer, and agreed upon before placing the concrete.

Kansas
Department of Transportation

710 CONCRETE STRUCTURE CONSTRUCTION
710.3 CONSTRUCTION REQUIREMENTS
g. Removal of Forms and Falsework

700-47

g. Removal of Forms and Falsework. Do not remove forms and falsework without the Engineer's approval. During cold weather, the specified time limits may be increased at the discretion of the Engineer, based upon the amount of protection and curing afforded the concrete.

Do not remove forms and falsework until the minimum amount of time required for strength gain has elapsed regardless if the concrete is fully cured per **TABLE 710-1**.

If forms are removed before expiration of the cure period, maintain the cure as provided in **DIVISION 700**. Remove forms on handrails, ornamental work and other vertical surfaces that require a rubbed finish as soon as the concrete has hardened sufficiently that it shall not be damaged.

Under normal conditions, the Engineer will allow removal of forms and falsework according to **TABLE 710-3**. The determination of the time requirement for the removal of forms commences after all the concrete for the placement is in place and finished. If high early strength concrete is used, the specified time limits may be decreased as determined by the Engineer, and agreed upon before placing the concrete.

Kansas Department of Transportation

Say there was a question about minimum production rate for a concrete bridge overlay: where would one look?

Kansas Department of Transportation

717.3 CONSTRUCTION REQUIREMENTS

a. Equipment. Use a finishing machine consisting of a mechanical strike-off capable of providing a uniform thickness of concrete slightly above finish grade in front of an oscillating screed or screeds. The finishing machine will be inspected and approved by the Engineer before work is started on each project.

Use a minimum of 1 oscillating screed capable of consolidating the concrete by vibration to 100% of the vibrated unit weight with the following features:

- Install identical vibrators so a minimum of 1 vibrator is provided for each 5 feet of screed length;
- Bottom face a minimum of 5 inches wide with a turned up or rounded leading edge;
- Effective weight a minimum of 75 pounds for each square foot bottom face area;
- Positive control of vertical position, the angle of tilt and the shape of the crown;
- Design together with appurtenant equipment to obtain positive machine screeding of the plastic concrete as close as practical to the face of the existing curb line;
- Length sufficient to uniformly strike-off and consolidate the width of the lane to be paved;
- Forward and reverse motion under positive control;
- Supporting rails which are fully adjustable (not shimmed) to obtain the correct profile, unless otherwise approved by the Engineer. Provide supports which are sufficiently rigid and do not deflect under the weight of the machine. Anchor the supporting rails to provide horizontal and vertical stability; and
- Equip to travel on the completed lane when placing concrete in a lane abutting a previously completed lane.

Manufacturer's specifications or certification may be used as verification of the oscillating screed requirements.

A drum roller equipped to perform all functions outlined for the oscillating screed above, may be used for finishing the overlay concrete in lieu of an oscillating screed. Equip the drum roller to vibrate by either a factory or

Kansas Department of Transportation

717 - BRIDGE OVERLAYS

field adaptation. The drum roller must be able to compact the concrete to a minimum of 100% of the consolidated unit weight.

Provide an overall combination of labor and equipment with the capability for proportioning, mixing, placing and finishing new concrete at the following minimum rates shown in **TABLE 717-1**.

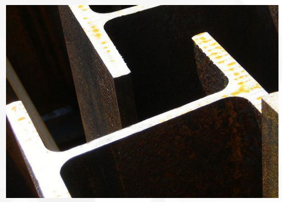
TABLE 717-1: PORTLAND CEMENT CONCRETE OVERLAY PRODUCTION REQUIREMENTS

Total Placed Surface Area per Bridge (Square Yards)	Minimum Cubic Yards per Hour
0-328	1.0
329-492	1.5
493-656	2.0
Over 656	2.5

Kansas Department of Transportation

CIT Structures

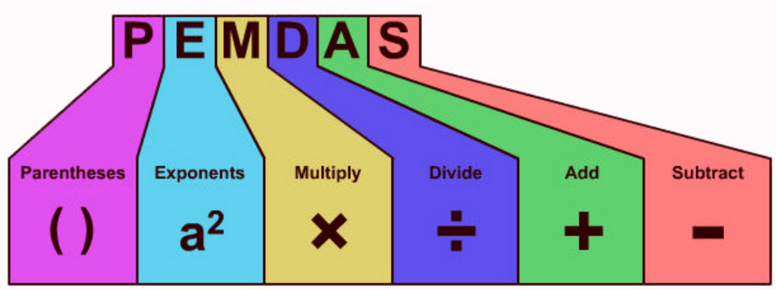
Pile Driving Review



Mathematics Order of Operations

- Be sure to remember the rules of math while calculating pile bearing

- PEMDAS



- Parentheses
- Exponents
- Multiplication
- Division
- Addition
- Subtraction

Pile Driving Review

- P= safe bearing power in pounds
- W= weight in pound, of striking part of hammer
- H= height of fall in feet
- S= the average penetration in inches per blow
- X= weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

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Pile Driving Review

- Pile Designation
  - HP 12 X 53
  - "H" - pile
  - 12" in width and depth
  - Weighs 53 lbs. per foot

Kansas Department of Transportation

Pile Driving Review

- Drive distance

- S = Average penetration in inches per blow
- 5 blows for gravity hammer
- 20 blows for air/steam & diesel

Pile Driving Review

- Diesel Hammer

Pile Driving Review

TABLE 704-1: PILE FORMULAS

Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2\ W\ H}{S+1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S+0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers

** For diesel hammers, the quantity X/W shall not be less than 1.

P = safe bearing power in pounds

W = weight in pounds, of striking part of hammer

H = height of fall in feet

E = energy of ram in foot-pounds per blow

S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers

X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

Kansas Department of Transportation

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{1.6 \quad W \quad H}{S + 0.1\,(X/W^{**})}$$

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Pile Driving Review

- Pile Driving Review
  - Pile is a 10 x 42 and 26 feet long
  - Delmag Diesel D19-42 Hammer and the striking part of the hammer weighs 4,190 lbs
  - Cap and Anvil weigh 1,200 lbs
  - Height of fall 10 feet
  - 2.0” total in 20 blows for an average penetration 0.10 inches

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{1.6 * 4190 * 10}{0.10+0.1(2292/4190**)}$$

(10 = FALL)

(S = 2.0/20)

(X= 1200+(42 X 26))

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10+0.1(\cancel{0.55**})}$$

** Diesel quantity x/w shall not be < 1

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10+0.1(1.00**)}$$

** Diesel quantity x/w shall not be < 1

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.10+0.10}$$

Pile Driving Review

- Delmag Diesel Hammer Pile Formula

$$P = \frac{67040}{0.20}$$

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Pile Driving Review

- Delmag Diesel Hammer Pile Formula

P = 335200 lbs / 2000

P = 168 tons

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Pile Driving Review

- Air/Steam Hammer
- Single Action

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Pile Driving Review

TABLE 704-1: PILE FORMULAS

Hammer	Pile Type	Formula
Gravity	Timber	$P = \frac{2WH}{S+1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3WH}{S+0.35}\left(\frac{W}{W+X}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2WH}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6WH}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers
** For diesel hammers, the quantity X/W shall not be less than 1.
P = safe bearing power in pounds
W = weight in pounds, of striking part of hammer
H = height of fall in feet
E = energy of ram in foot-pounds per blow
S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers
X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

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Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{2 \quad W \quad H}{S+0.1}$$

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Pile Driving Review

- Pile Driving Review
  - Pile is a 14 x 89 and 20 feet long
  - Conmaco E65 Air/Steam Hammer and the striking part of the hammer weighs 6,500 lbs
  - (For Air/Steam Hammer the weight of Pile, Cap and Anvil are not used in the calculations)
  - Height of fall 5 feet
  - 1.0" total in 20 blows for an average penetration 0.05 inches

Kansas Department of Transportation

Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{2 \quad 6500 \quad 5}{0.05 + 0.1}$$

(5 = fall)

(S = 1.0/20)

Kansas Department of Transportation

Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{65000}{0.05 + 0.1}$$

Pile Driving Review

- Conmaco Air/Steam Hammer

$$P = \frac{65000}{0.15}$$

Pile Driving Review

- Conmaco Air/Steam Hammer

P = 433333 lbs / 2000

P = 217 tons

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Pile Driving Review

- Gravity Hammer
- Steel H-Pile

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Pile Driving Review

TABLE 704-1: PILE FORMULAS		
Hammer	**Pile Type**	**Formula**
Gravity	Timber	$P = \frac{2\ W\ H}{S+1.0}$
Gravity	Steel Steel Shell Steel Sheet	$P = \frac{3\ W\ H}{S+0.35}\left(\frac{W}{(W+X)}\right)$
Air/Steam (Single Acting)	All Types	$P = \frac{2\ W\ H}{S+0.1}$
Air/Steam (Double Acting)	All Types	$P = \frac{2\ E}{S+0.1}$
Delmag and McKierman-Terry*	All Types	$P = \frac{1.6\ W\ H}{S+0.1\left(\frac{X^{**}}{W}\right)}$
Link-Belt*	All Types	$P = \frac{1.6\ E}{S+0.1\left(\frac{X^{**}}{W}\right)}$

*diesel hammers
** For diesel hammers, the quantity X/W shall not be less than 1.
P = safe bearing power in pounds
W = weight in pounds, of striking part of hammer
H = height of fall in feet
E = energy of ram in foot-pounds per blow
S = the average penetration in inches per blow for the last 5 blows for gravity hammers and the last 20 blows for air/steam or diesel hammers
X = weight in pounds of the pile plus the weight of any cap and/or anvil used on the pile during driving

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Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3\ W\ H}{S+(0.35)}\left(\frac{W}{(W+X)}\right)$$

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Pile Driving Review

- Pile Driving Review
  - Pile is a 12 x 53 and 15 feet long
  - Gravity Hammer and the striking part of the hammer weighs 4,050 lbs
  - Cap and Anvil weighs 900 lbs

  - Height of fall 8 feet
  - 1.0” total in 5 blows for an average penetration 0.2 inches

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Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3\ \ 4050\ \ 8}{0.2+(0.35)} \left(\frac{4050}{(4050+1695)} \right)$$

(8 = FALL)

(S = 1.0/5)

(X = 900 + (15 X 53))

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Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{3\ \ 4050\ \ 8}{0.55}\left(\frac{4050}{5745}\right)$$

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Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = \frac{97200}{0.55}\left(\frac{4050}{5745}\right)$$

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Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = 176727 \left(0.705 \right)$$

Pile Driving Review

- Gravity Hammer w/ Steel H Pile

$$P = 124593 \text{ lbs} / 2000$$

$$P = 62 \text{ tons}$$

Pile Driving Review

Kansas
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REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b. (1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or

will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b. (1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

(2) Each payroll submitted shall be accompanied by a “Statement of Compliance,” signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;
(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

REQUIRED CONTRACT PROVISION

SPECIFIC EQUAL EMPLOYMENT OPPORTUNITY CONTRACTUAL REQUIREMENT

1. General:

Equal employment opportunity requirements to NOT discriminate and to take affirmative action to assure equal employment opportunity shall apply to all Contractors, subcontractors and suppliers who have a contract, subcontract or purchase order that equals or exceeds $10,000.

A. Federal Aid Projects
The specific affirmative action requirements for these contracts are imposed pursuant to 41 CFR Part 60-1, 60-250, 60-741, 23 CFR Parts 633 and 230, FHWA Form 1273 and the Americans With Disabilities Act of 1990.

B. State Funded Projects
The specific affirmative action requirement for these contracts are imposed pursuant to the Kansas Act Against Discrimination, K.S.A. 44-1001 et seq. as amended and the rules and regulations promulgated thereunder.

The Contractor agrees: (a) to comply with the Kansas Act Against Discrimination (K.S.A. 44-1001 et seq.); the Kansas Age Discrimination in Employment Act (K.S.A. 44-1111 et seq.) and the applicable provisions of the Americans With Disabilities Act (42 U.S.C. 12101 et seq.)(ADA) and to not discriminate against any person because of race religion, color, sex, disability, national origin or ancestry, or age in the admission or access to, or treatment or employment in, its programs or activities; (b) to include in all solicitations or advertisements for employees, the phrase "equal opportunity employer"; (c) to comply with the reporting requirements set out at K.S.A. 44-1031 and K.S.A. 44-1116; (d) to include those provisions in every subcontract or purchase order so that they are bind upon such subcontractor or vendor; (e) that a failure to comply with the reporting requirements set forth herein or if the Contractor is found guilty of any violation of such acts by the Kansas Human Rights Commission, such violation shall constitute a breach of contract and the contract may be cancelled, terminated or suspended, in whole or in part, by the Kansas Department of Transportation (KDOT) or the Kansas Department of Administration; (f) if it is determined that the Contractor has violated applicable provisions of ADA, such violation shall constitute a breach of contract and the contract may be cancelled, terminated or suspended, in whole or in part, by the KDOT or the Kansas Department of Administration. The provisions of this paragraph, with the exception of those relating to the ADA, are not applicable to a Contractor who employs fewer than four employees during the term of such contract or whose contracts with KDOT cumulatively total $5,000 or less during the fiscal year.

2. Equal Employment Opportunity (EEO) Policy:

A. The Contractor will accept as a minimum operating policy the following statement:
"It is the policy of this company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, age, sex, color, disability, national origin, or veteran status. Such action shall include: employment, upgrade, demotion, transfer, recruitment, recruitment advertising, layoff, termination, wages, benefits, and selection for training including preapprenticeship, apprenticeship and on the job training."
All other EEO requirements will need to be incorporated by each Contractor into their policy.

B. Annually the Contractor will send to the KDOT Office of Civil Rights (OCR) one copy of the company's EEO policy signed and dated by the company's Policy Officer. The EEO Policy must be approved by the KDOT before the award of a contract, subcontract or purchase order over $10,000. Contractors are encouraged to submit their policies for approval before bidding projects so as not to delay contract or subcontract award. Firms with more than 50 employees must also submit an Affirmative Action (AA) plan.

C. To comply with requirements of TEA 21, all Contractors and subcontractors must annually provide information on the firm's age, gross receipts, and work type. This information will be due on the same date as the EEO policy, and is required before a Contractor can perform work.

3. Contents of EEO Policy/AA Plan:

A. The minimum operating statement listed in 2.A and additions designated by the company to comply with all relevant laws.

B. The designation of the EEO Officer responsible and capable of effectively administering and promoting an active EEO program and the designation of the full authority to do so.

C. The company's recruitment policy with specific actions to be taken for the coming year, relevant to the current work force.

D. Certification that the Contractor does not maintain or permit any segregation of its facilities and that no employee will be denied access to any facility based on sex or disability.

E. The company's training and promotion policy to upgrade the skills of minorities and women.

F. The Company's personnel actions in regard to job site inspection, wages, benefits, transfers, demotions, layoffs, terminations, promotions, new hires and upgrades, and the company's complaint procedure.

4. Dissemination of EEO Policy /AA Plan:

A. All members of the Contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the Contractor's EEO policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To confirm that the above agreement will be met, the following actions will be taken and documented as a minimum:

(1) Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the Contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.

(2) All new supervisory or personnel employees will be given a thorough indoctrination by the EEO Officer or other knowledgeable company official, covering all major aspects of the Contractor's equal employment opportunity obligations within thirty days following reporting for duty with the Contractor.

(3) All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer or appropriate company official in the Contractor's procedures for locating and hiring minority group employees.

B. In order to make the Contractor's EEO policy known to all employees, prospective employees and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., the Contractor will take the following actions:

(1) Notices and posters setting forth the Contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

(2) The Contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by meetings, employee handbooks, and other appropriate means. Meetings should be conducted periodically and documented to confirm new employees are included.

5. Unions:

If the Contractor relies in whole or in part upon unions as a source of employees, the Contractor will use best efforts to obtain the cooperation of such unions to increase opportunities for minorities and women within the unions, and to effect referrals by such unions of minority and female employees. Actions by the Contractor either directly or through a Contractor's association acting as agent will include the procedures set forth below:

A. The Contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

B. The Contractor will use best efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, age, sex, disability, national origin, or veteran status.

C. The Contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the Contractor, the Contractor shall so certify to the KDOT and shall set forth what efforts have been made to obtain such information.

D. In the event the union is unable to provide the Contractor with a reasonable flow of minority and female referrals within the time limit set forth in the collective bargaining agreement, the Contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, age, sex, disability, national origin, or veteran status; making full efforts to obtain qualified and/or qualifiable minority group members and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees). In the event the union referral practice prevents the Contractor from meeting the obligations pursuant to Executive Order 11246, as amended, for federal or federal-aid construction projects, and these special provisions, such Contractor shall immediately notify the KDOT.

6. Subcontracting:

The Contractor, when seeking to subcontract a portion of the work on this project, is required to take affirmative action to consider DBEs as potential subcontractors. In the event assistance is needed to locate or obtain a list of potential DBEs, the KDOT's Plans and Proposals Section and the OCR may be contacted.

"Disadvantaged Business Enterprises" are businesses which have been certified as disadvantaged by the OCR and are listed in the current DBE directory which is also available at www.ksdot.org.

The Contractor will certify on DOT Form 260 that all EEO provisions applicable to this contract are included in all subcontracts.

The Contractor will exert concerted efforts to train and develop DBEs by providing direct assistance in such areas as preparing quotations, understanding highway construction plans and standard specifications applicable to the portion(s) of the work to be subcontracted, and familiarizing DBEs with business practices and other actions which will facilitate their development into viable highway construction Contractors.

By making systematic written and verbal contact with DBEs likely to have an interest in highway construction work, the Contractor will make every effort to solicit DBE subcontractor quotes. Additionally, the Contractor will not restrict DBEs in the furnishing of subcontractor quotes to any other bidder/Contractor who may be preparing bid proposals for submission on this Contract.

In order to afford DBEs an opportunity to participate as subcontractors on portions of the work to be subcontracted, it is required that itemized quantities and particular incidentals to such work be furnished to DBEs in order to solicit quotes for prospective subcontractors. Bid solicitation should be directed only to those Contractors whose specialties and skills encompass those bid quantities for which bids are being solicited.

The Contractor will affirmatively solicit the interest, capabilities, and prices of DBEs and document results of such solicitation in detail. The Contractor fully understands that requests for Approval of Subcontractor (DOT Form 259) submitted to the KDOT for approval may be denied if such affirmative action cannot be demonstrated when requested. When requested to establish evidence of affirmative action being taken, the prime Contractor shall provide:

A. Copies of letters and requests for bids sent to potential DBEs and of certified mail receipts.

B. Copies of letters and bid quotes received from DBEs. Copy of the letter and bid quote received from the subcontractor for whom the Request for Approval is submitted, if the subcontractor is not a DBE.

7. Required Notices and Posters:

A. Required on State Funded and Federal-Aid Projects:
1. Unemployment Insurance Notice K-CNS 405
2. Workers Compensation Law K-WC 40
3. Kansas Equal Opportunity
4. Child Labor K-ESLR 100

B. Required on Federal-Aid Projects Only:
1. Contractor's EEO Policy and Contact Number for EEO Officer
2. Wage Rate Information FHWA 1495 and 1495A
3. Wage and Hour Posters WH 1321 and WH 1088
4. Fraud Notice FHWA 1022
5. Equal Opportunity Poster
6. Job Safety and Health Poster OSHA 3165 and 3167
7. Contract Wage Rates
8. Family Medical Leave Act WH 1420
9. Polygraph WH 1462
10. Government Contracts WH 1313

8. Noncompliance with EEO/AA Requirements:

A. KDOT will not award a contract, approve a subcontract or sign a purchase order until the required EEO/AA policy has been submitted to and approved by the KDOT Civil Rights Administrator in the OCR.

B. If discrimination, harassment or a hostile work environment exists on any project, the KDOT will take every action needed to confirm the problem is corrected in a timely manner. KDOT will also monitor the project to determine if retaliation is taken against any employee who files a complaint.

C. Contract Compliance reviews are conducted by OCR on selected federal aid contracts. A Contractor can expect to be reviewed once every three years or more often if any deficiencies had been previously found. During a Compliance Review all areas listed previously in items 2-7 will be verified for compliance. *The compliance review is the Contractor's ONLY opportunity to provide documentation of ALL efforts undertaken to meet or exceed all EE0/AA requirements of the contract. It is IMPORTANT that all relevant documentation be provided at this time. During any subsequent appeal process new documentation not previously submitted to the OCR will NOT be considered in the appeal.* A deficiency occurs when the Contractor fails to comply with a requirement and/or fails to document every good faith effort to comply. A Voluntary Corrective Action Plan (VCAP) is required to correct certain deficiencies that do not directly affect a protected group or result in discrimination. A follow up review is conducted to confirm that the VCAP was enacted and determine if it is effective.

D. When a Contractor's action or inaction adversely affects a protected group member (discrimination) or when a Contractor has failed to provide written documentation of every good faith effort to provide equal opportunity and to take affirmative action, these procedures will follow:

(1) For the first documented occurrence of such a deficiency the OCR will discuss the deficiency with the Contractor's representative during the compliance meeting or at an exit conference held shortly after the compliance meeting. Within 15 days a written notice of a show cause hearing is sent to the Contractor. The show cause hearing is an informal hearing providing the Contractor's opportunity to submit a Corrective Action Plan (CAP) for the immediate correction of the noted deficiency and to eliminate any future reoccurrence. The hearing is chaired by the Chief of the Bureau of Construction and Maintenance

and attended by a staff of OCR and an FHWA representative. KDOT (the Chief of the Bureau of Construction and Maintenance and the Civil Rights Administrator) must approve and the FHWA representative must concur that the CAP will achieve compliance before it is accepted.

(2) For the second documented occurrence of the same deficiency within 3 years the OCR will discuss the deficiency with the Contractor's representative during the compliance meeting or at an exit conference held shortly after the compliance meeting. Within 15 days the KDOT Compliance Review Committee consisting of the Chief of the Bureau of Construction and Maintenance, the Director of Operations and the District Engineer will review the Contractor's documentations and the findings of the OCR and either concur or disagree with those findings. Upon concurrence by the Compliance Review Committee a notification of monetary assessment will be sent to the Contractor with a copy to KDOT's Prequalification Committee and the field office, and the assessment will begin on the date of the letter. As noted above, *the Contractor's opportunity to document every good faith effort is during the compliance review.* The applicable monetary assessments are listed in Table 1. The assessment will be collected for a minimum of five days or so long as the Contractor remains in non compliance.

(3) For the third documented occurrence of the same deficiency within 3 years of the second deficiency the OCR will discuss the deficiency with the Contractor's representative during the compliance meeting or at an exit conference held shortly after the compliance meeting. Within 15 days the KDOT Compliance Review Committee consisting of the Chief of the Bureau of Construction and Maintenance, the Director of Operations and the District Engineer will review the Contractor's documentations and the findings of the staff of OCR and either concur or disagree with those findings. Upon concurrence the Compliance Review Committee sets a debarment period of up to six months and notification is sent to the Contractor, KDOT's Prequalification Committee and other interested agencies. During the debarment period the Contractor will not be eligible to request KDOT plans, submit a bid as prime or subcontractor or otherwise acquire new work on KDOT projects. Any work currently in progress can be completed.

(4) For the fourth documented occurrence of the same deficiency within 3 years of the third deficiency the OCR will discuss the deficiency with the Contractor's representative during the compliance meeting or at an exit conference held shortly after the compliance meeting. Within 15 days the KDOT Compliance Review Committee consisting of the Chief of the Bureau of Construction and Maintenance, the Director of Operations and the District Engineer will review the Contractor's documentations and the findings of the OCR and either concur or disagree with those findings. Upon concurrence the Compliance Review Committee sets a debarment period of one year and notification is sent to the Contractor, KDOT's Prequalification Committee and other interested agencies. During the debarment period the Contractor will not be eligible to request KDOT plans, submit a bid as prime or subcontractor or otherwise acquire new work on KDOT projects. Any work currently in progress can be completed.

(5) The Contractor may request an appeal to the KDOT Compliance Appeal Board (CAB) within five days of the receipt of the notice of assessment or debarment (2, 3 or 4 above). The request is made to the Deputy Secretary for Engineering & State Transportation Engineer (Deputy Secretary) who chairs the CAB. The two other members include one member named by the Deputy Secretary and one member named by the Contractor within 5 days of the appeal request. A date and time will be set by the Deputy Secretary for hearing the appeal and will notify the Contractor, FHWA, KDOT's Civil Rights Administrator and the CAB members. The CAB reviews the documents previously submitted by the Contractor and the previous decision of the Compliance Review Committee. The Contractor presents verbal or written statements to the CAB as to why they disagree with the finding of noncompliance. *The CAB cannot consider any new documentation at this time because its purpose is to concur or disagree with the findings previously made.* The Deputy Secretary will advise the Secretary of' Transportation of the decision of the CAB and the final administrative decision will be issued by the Secretary and made known to all concerned parties. During the appeal process the Contractor is not relieved from taking corrective action to eliminate noted deficiencies and the sanction imposed remains in place pending the decision.

TABLE 1 SCHEDULE OF DAILY MONETARY ASSESSMENTS		
Original Contract Amount Range		**Amount of Assessment to be Deducted for Each Day of Non-Compliance**
$0.00	$100,000.00	$200.00
$100,000.01	$500,000.00	$400.00
$500,000.01	$1,000,000.00	$800.00
$1,000,000.01	$2,500,000.00	$1,000.00
$2,500,000.01	$5,000,000.00	$1,500.00
$5,000,000.01	$10,000,000.00	$2,000.00
$10,000,000.01	$25,000,000.00	$2,500.00
Over $25,000,000.01		$3,000.00

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ERRATA SHEET FOR STANDARD SPECIFICATION BOOK FOR STATE ROAD AND BRIDGE CONSTRUCTION, EDITION 2015

SECTION 101
DEFINITIONS AND TERMS

Page 100-4, subsection 101.3. Add the following:

ELECTRONIC DESIGN FILES - One or more of the following files that KDOT furnishes to the Contractor in electronic form:

- Base file (plan view of entire project length);
- Cross Section Stack files (vertical layout of cross sections);
- Existing Ground Survey (existing ground contours in three-dimensions);
- Cross Section Sheet Files (final cross section sheets)
- Vertical Alignment description files
- Existing & Proposed Horizontal Alignment description files
- Cross Section Report files
- Superelevation description files
- Existing and Proposed Three-Dimensional Surfaces
- Three-Dimensional Line String File

These files are not considered Contract Documents or Exploratory Work Documents.

Page 100-6, subsection 101.3, delete the definition for MEDIAN, and replace with the following:
Median - The area between the inside edges of pavement of two parallel roadways (including the inside shoulders).

Page 100-6, subsection 101.3. Delete the definition for PART V, and replace with the following:
Part V (2018 version) of the KDOT Construction Manual which primarily refers to materials and tests for materials used in the project. Part V (2018 version) is a Contract Document.

SECTION 105
CONTROL OF WORK

Page 100-42, subsection 105.9, add the following:

e. Timely Submittal. Provide subcontractor approval forms to the Field Engineer at least 5 business days prior to subcontractor starting work. If the Contractor desires the subcontractor approval forms to be reviewed in less than 5 business days, notify the Field Engineer that the time for review and approval is critical. While KDOT will attempt to accommodate the Contractor's time frame, KDOT makes no guarantee that KDOT will complete the review process in less than 5 business days.

f. Timely Review. Within 5 business days after the Contractor has provided subcontractor approval forms to the Field Engineer, the Field Engineer will review and either approve or reject the subcontractor approval forms. If rejected, correct and resubmit revised subcontractor approval forms for the Engineer's approval. Allow the Field Engineer a reasonable time (or "at least 5 business days") for subsequent review and approval. The Contractor assumes all risk of delay incurred for revisions and the Engineer's review of these revisions.

SECTION 152
HAULING AND WEIGHING EQUIPMENT

Page 150-4, subsection 152.2, second paragraph:

- The weighing devices shall be accurate to within 0.50% throughout the range of use.

SECTION 154
CONCRETE PAVEMENT AND CONCRETE STRUCTURE EQUIPMENT

Page 150-9, delete subsection 154.3 Subgrade Trimmers.

SECTION 155
ASPHALT SURFACING AND ASPHALT RECYCLING EQUIPMENT

Page 150-14, delete subsection 155.6b.(2)(b) and replace with the following:

(b) Reclaimed Asphalt Pavement (RAP) Material Conveyor. If the plant is used for recycling, a dual weighing system is required to control delivery of virgin aggregate and RAP material to the drum. Equip the system with interlocking mechanisms that shall accurately deliver virgin aggregates and RAP material in proper proportions. Belt scales for the RAP material shall comply with **subsection 155.6b.(2)**.

SECTION 157
OTHER EQUIPMENT

Page 150-19, add the following:
157.4 SUBGRADE TRIMMERS

Use a standard manufacture rotary drum subgrade trimmer that is automatically controlled (from a reference system) in regard to both line and grade.

SECTION 205
EXCAVATION AND EMBANKMENT FOR HIGHWAYS

Page 200-18, subsection 205.4j., delete the tenth paragraph on the page (Where a grass median…) and replace with the following:

Where grass is to be planted, do not place any rock excavation material or shale in the top 18 inches of the area. Construct the top 18 inches with earthen material suitable for growth of vegetation.

SECTION 214
MECHANICALLY STABILIZED EARTH FILL

Page 200-29, subsection 214.2e. replace "ASTM A82" with " ASTM A1064" throughout entire subsection.

SECTION 501
PORTLAND CEMENT CONCRETE PAVEMENT

Page 500-4, subsection 501.3, delete third line and replace with the following:

Reinforcing Steel ....**DIV 1600/SEC 711**

SECTION 502
PORTLAND CEMENT CONCRETE PAVEMENT

Page 500-23, subsection 502.3, delete third line and replace with the following:
Reinforcing Steel ....**DIV 1600/SEC 711**

SECTION 601
ASPHALT APPLICATION TEMPERATURES

Page 600-1, subsection 601.1, delete TABLE 601-1 and replace with the following:

TABLE 601-1: ASPHALT APPLICATION TEMPERATURES				
TYPE AND GRADE	**TEMPERATURE RANGE (ºF)**			
	Spraying		**Plant Mixing**	
	Min.	**Max.**	**Min.**	**Max.**
Asphalt Binder	275	340	*	*
Cutback Asphalt, MC 30	88	125	88	125
Cutback Asphalt, MC & RC 70 &250	125	200	125	200
Cutback Asphalt, MC & RC 800 & 3000	150	250	150	250
Asphalt Rejuvenating Agent, ARA	70	150	70	150
Emulsified Asphalt, CRS-1H, RS-1H, SS-1HP, CMS-1, MS-1, HFMS-1, RS-1HP, CRS-1HP	100	180	100	180
Emulsified Asphalt, SS-1H, CSS-1H	None	150	None	150
Emulsified Asphalt, CSS-1HM, CSS-Special	None	120	None	120
EBL	120	180	NA	NA

* Use the Producer's recommended mixing temperature range.

SECTION 605
SURFACE RECYCLED ASPHALT CONSTRUCTION

Page 600-43, delete subsection 605.3e.(2) and replace with the following:
(2) Operation Number 2. Use an asphalt paver equipped with automatic grade control to spread and finish the amount specified of the new asphalt surface material. **SECTIONS 601** and **602** apply. If a HMA overlay is included in the contract, place the HMA and surface recycle concurrently without remixing or blending the two.

SECTION 608
CHIP SEALS

Page 600-50, subsection 608.3e., delete the first paragraph and replace with the following:
Immediately following the application of the asphalt material, spread cover material with a self-propelled aggregate spreader in quantities designated in the Contract Documents. Operate the aggregate spreader and haul trucks delivering material to the spreader at a speed less than or equal to 5 miles per hour. The tires of the trucks or aggregate spreaders shall not come in contact with the fresh asphalt material at any time.

Page 600-50, subsection 608.3f., delete TABLE 608-1 and replace with the following:

TABLE 608-1: RATES OF APPLICATION FOR CHIP SEAL				
Type	**Composition**	**Aggregate Cu. Yd./Mile 24 foot width***	**Asphalt Material Gal/Sq. Yd. Residue***	**Asphalt Type****
CM-A	Sand-Gravel	105	0.20	CRS-1H/CRS-1HP
CM-B	Sand-Gravel	135	0.23	CRS-1H/CRS-1HP
CM-D	Crushed Sandstone	145	0.27	CRS-1H/CRS-1HP or RS-1H/RS-1HP
CM-K	Limestone	140	0.24	RS-1H/RS-1HP
CM-L-1	Lightweight	85	0.17	CRS-1H/CRS-1HP
CM-L-2	Lightweight	115	0.26	CRS-1H/CRS-1HP
CM-L-3	Lightweight	150	0.30	CRS-1H/CRS-1HP

*Rates shown are estimated and will be adjusted to comply with actual field conditions.
** The required asphalt type will be listed in the contract. Asphalt type may be changed with approval of the DME.

SECTION 615
SAW AND SEAL JOINTS (HMA OVERLAY)

Page 600-92, subsection 615.3b., delete the third paragraph and replace with the following:
Configure the joints according to **FIGURE 615-1 or 615-2** within 1 inch horizontally above the existing joint.

SECTION 704
PILING

Page 700-20, subsection 704.4e.(1), delete the 6th bullet and replace with the following:

- Restrike for 20 blows or until the pile penetrates an additional 4 inches, whichever comes first. Record the penetration for every 5 blows. In the event the pile movement is less than ½ inch during the restrike, the restrike may be terminated after 10 blows.

Page 700-20, subsection 704.4e.(2), delete the last bullet and replace with the following:

- The Test Pile is then immediately restruck with the warmed-up hammer for 20 blows or until the pile penetrates an additional 4 inches, whichever comes first. Record the penetration for every 5 blows. In the event the pile movement is less than ½ inch during the restrike, the restrike may be terminated after 10 blows.

SECTION 714
PAINTING STRUCTURAL STEEL

Page 700-68, subsection 714.3e., delete the second paragraph and replace with the following:
Unless noted otherwise in the Contract Documents, use a waterborne acrylic, brown finish coat color equivalent to Federal Standard No. 595a, Color No. 20045.

SECTION 717
BRIDGE OVERLAYS

Page 700-93, subsection 717.3g., third paragraph, second sentence, delete "7-day" and replace with "required".

SECTION 729
MULTI-LAYER POLYMER CONCRETE OVERLAY

Page 700-109, delete subsection 729.3a. and replace with the following:

a. General. Wet cure concrete on new bridge decks for 14 days and allow the deck to dry for 14 days before applying the overlay.

Portland cement concrete patches require a minimum cure period of 14 days before application of the overlay.

SECTION 731
AREA PREPARED FOR PATCHING
(EXISTING CONCRETE BRIDGE DECKS)

Page 700-119, delete subsection 731.3d. and replace with the following:

d. Bridge Decks That Receive a Multi-Layer, Single-Layer or Slurry Polymer Concrete Overlay.

(1) Polymer concrete materials may be used for patching of the concrete bridge deck.

For shallow patches, 3 inches maximum depth, polymer concrete overlay resin and FA-C aggregate, **TABLE 1102-6,** may be used.

For deep patches, greater than 3 inches polymer concrete overlay resin with an approved MA-3 or MA-4 aggregate, **TABLE 1102-3,** may be used.

The slurry polymer concrete system may be used for shallow patching and where a bar is considered bonded by the Engineer, even if less than ½ the bar depth is embedded in concrete (**subsection 731.3a.(2)(a)**).

Mix and cure all patching according to manufacturer/supplier's recommendations.

(2) A Rapid Set Concrete Patching Material, compatible with the overlay may be used for patching the concrete bridge deck.

(3) Strike off patches to a level approximately ¼ inch below the top of the original concrete deck.

SECTION 735
PRECAST REINFORCED CONCRETE BOX

Page 700-125, subsection 735.1, in the DESIGN subsection delete "For fill height less than or equal to 3 feet…" and associated 4 bullets.

SECTION 736
PRECAST CULVERTS

Page 700-130, subsection 736.2f., replace "SCA-5" with "UD-2".

SECTION 808
REMOVAL OF EXISTING PAVEMENT MARKINGS

Page 800-32, delete subsection 808.3a. and replace with the following:

a. Removal of Existing Stripes and Symbols. Completely remove the existing pavement markings and symbols without damaging the asphalt or concrete pavement surface or longitudinal and transverse joints. Waterblasting will be allowed for removal of markings on asphalt and concrete surfaces on a performance basis.

As the work progresses, remove all material deposited on the pavement as a result of the removal operations. Continuously remove all residue and dust, especially in areas near the traveling public.

When replacement of the removed existing markings is a part of the Contract Documents, follow the manufacturer's requirements for the new pavement markings as to the method of removal of the existing markings, or surface preparation requirements.

SECTION 810
INERTIAL BARRIER SYSTEM

Page 800-35, delete subsection 810.1 and replace with the following:
810.1 DESCRIPTION

Install and relocate inertial barrier systems (IBS) as shown in the Contract Documents. Stockpile the replacement modules at the project site.

BID ITEMS	UNITS
Inertial Barrier System (*)	Each
Replacement Modules (IBS)	Each
*Type TL-2 or TL-3	

Page 800-35, subsection 810.4, delete last paragraph and replace with the following:

Payment for "Inertial Barrier System" and "Replacement Modules (IBS)" at the contract unit prices is full compensation for the specified work.

SECTION 811
IMPACT ATTENUATOR

Page 800-36, subsection 811.1, delete the bid items and replace with the following:

BID ITEMS	UNITS
Impact Attenuator (*)	Each
*Type (TL-2, TL-3 or Severe Duty)	
Impact Attenuator (Temporary) (**)	Each
Replacement Modules (Impact Attenuator)	Each
**Type (TL-2 or TL-3)	

Page 800-37, subsection 811.4, delete the last paragraph and replace with the following:

Payment for "Impact Attenuator (Temporary)" and "Replacement Modules (Impact Attenuator)" at the contract unit price is full compensation for the specified work.

SECTION 813
RUMBLE STRIPS (MILLED)

Page 800-43, subsection 813.1, delete bid item Rumble Strips (Milled) (*) (Edgeline).

Page 800-43, delete subsection 813.3d.

Page 800-43. subsection 813.4, delete third paragraph.

Page 800-43, subsection 813.4, fifth paragraph, delete "Rumble Strips (Milled) (*) (Edgeline)".

SECTION 814
ELECTRIC LIGHTING SYSTEM AND TRAFFIC SIGNALS

Page 800-44, subsection 814.1, add the following Bid Item:

BID ITEMS	UNITS
Flashing Beacon System	Lump Sum

Page 800-47, subsection 814.3 add the following:

q. Flashing Beacon System. Install flashing beacon systems as shown in the Contract Documents.

Page 800-47, add the following to subsection 814.4:

The Engineer will measure flashing beacon system by the lump sum.

The Payment for "Flashing Beacon System" at the contract unit price is full compensation for the specified.

SECTION 816
ADJUSTMENT OF INLETS, MANHOLES AND OTHER EXISTING STRUCTURES

Page 800-50, subsection 816.1, add the following Bid Items:

BID ITEMS	**UNITS**
Adjustment of Existing Structure	Each
Adjustment of Junction Box	Each
Adjustment of Fire Hydrant	Each

Page 800-50, subsection 816.4, delete the third paragraph and replace with the following:

The Engineer will measure the adjustment of existing structures as shown in the Contract Documents. The Engineer will measure each adjustment of junction box and fire hydrant.

Page 800-50, subsection 816.4, delete the last sentence and replace with the following:

Payment for "Adjustment of Catch Basins", "Adjustment of Curb Inlets", "Adjustment of Manholes", "Structural Steel", "Cast Steel", "Cast Iron" "Adjustment of Meter Box (*)", "Adjustment of Valve Box (*)", "Adjustment of Existing Structures", "Adjustment of Junction Box" and "Adjustment of Fire Hydrant" at the contract unit prices and "Adjustment of Manholes" at the contract set price is full compensation for the specified work.

SECTION 824
CONCRETE SIDEWALKS, STEPS AND RAMPS

Page 800-67, subsection 824.2, delete third material listing and replace with the following:

Masonry Bricks Compliant with PROWAG ....**SECTION 1301**

Page 800-68, subsection 824.3e.(1), change all refences from "Paving Brick(s)" to "Masonry Brick(s)".

SECTION 827
GUARDRAIL AND GUIDEPOSTS

Page 800-76, subsection 827.4, delete the fifth paragraph and replace with the following:

The Engineer will measure temporary guardrail by the linear foot.

SECTION 828
FENCING

Page 800-80, delete subsection 828.3p. and replace with the following:

p. Erection of Single Wire Cable Fence. Construct single wire cable fence as shown in the Contract Documents. Set all required posts as shown in the Contract Documents by driving or drilling and backfilling. Use metal posts.

Page 800-80, delete the second paragraph and replace with the following:

The Engineer will measure single wire cable fence by the linear foot. Line posts are subsidiary to single wire cable fence.

SECTION 850
SEPARATION GEOTEXTILE

Page 800-116, subsection 850.2, delete the first sentence and replace with the following:

Provide a woven or non-woven geotextile that complies with **SECTION 1710** and is contained on PQL-48 as a Class 1 geotextile.

SECTION 855
SOLID INTERLOCKING PAVING UNITS (PAVING BRICKS)

Page 800-129, subsection 855.2, change reference to "DIVISION 300" to "SECTION 1304".

SECTION 1106
AGGREGATES FOR GRANULAR BASE

Page 1100-19, subsection 1106.2c.(1). In TABLE 1106-1 for the No. 8 sieve, change “70” to “80”.

SECTION 1108
AGGREGATES FOR COVER MATERIAL

Page 1100-25, subsection 1108.2c.(2). In TABLE 1108-1 for Minimum Gradation Factor, change “4.00” to “3.90”.

SECTION 1113
AGGREGATES FOR SHOULDER CONSTRUCTION

Page 1100-34, subsection 1113.2b., delete the third bullet, and Note 4.

SECTION 1203
EMULSIFIED ASPHALT

Page 1200-7, delete TABLE 1203-1 and replace with the following:

TABLE 1203-1: SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALT	RS-1H/ RS-1HP		SS-1H		MS-1		SS-1HP	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity, Saybolt Furol								
At 77°F, sec.	-----	-----	10	100	-----	-----	10	75
At 122°F, sec.	75	300	-----	-----	100	400	-----	-----
Residue by Distillation, (% by Mass).................	65	-----	57	-----	65	-----	57	-----
Oil Distillate, (% by Volume). .	-----	-----	-----	-----	-----	8	-----	-----
Storage Stability, %[1]	-----	1	-----	1	-----	1	-----	-----
Demulsibility:								
35 ml of 0.02 N $CaCl_2$, %. .	60	-----	-----	-----	-----	-----	-----	-----
50 ml of 0.1 N $CaCl_2$, %. . .	-----	-----	-----	-----	75	-----	-----	-----
Sieve Test, % Retained.	-----	0.50	-----	0.50	-----	0.50	-----	0.1
Tests on Distillation Residue:								
Penetration, 77°F, 100g, 5 sec.	75	150	75	125	300	-----	75	150
Solubility, %.	97.5[3]	-----	97.5	-----	97.5	-----	-----	-----
Ductility, 77°F, mm.	800	-----	800	-----	-----	-----	-----	-----
Ductility, 39.2°F, mm	-----	-----	-----	-----	-----	-----	100	350
Elastic Recovery @ 50°F, 20 cm elongation, %	60[2]	-----	-----	-----	-----	-----	25	-----

[1] If the Contractor's storage tanks are equipped with a mechanical propeller type agitation device, and the entire contents of the tank are thoroughly mixed before each day's use, the requirement for satisfactory compliance with the storage stability test will be waived.
[2] RS-1HP only
[3] RS-1H only

Page 1200-8, delete TABLE 1203-2 and replace with the following:

TABLE 1203-2: SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALT	CRS-1H/ CRS-1HP		CSS-1H/ CSS-1HM		CMS-1		CSS-Special	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity, Saybolt-Furol:								
At 77°F, sec.	-----	-----	10	60	-----	-----	----	----
At 122°F, sec.	75	300	-----	-----	100	400	----	----
Residue by Distillation, (% by Mass)…………………	65	-----	57	-----	65	-----	64.0[1]	66.0[1]
Oil Distillate, (% by Volume).	-----	3	-----	-----	-----	8	----	0.5
Storage Stability, %.	-----	1	-----	1	-----	1	----	----
Sieve Test, % Retained.	-----	0.50	-----	0.50	-----	0.50	----	0.1
Tests on Distillation Residue:								
Penetration, 77ºF, 100g, 5 sec	75	150	50	100	300	-----	-25%[2]	+25%[2]
Solubility, %.	97.5[4]	-----	97.5	-----	97.5	-----	----	----
Ductility, 77°F, mm. . . .	800	-----	800	-----	-----	-----	----	----
Viscosity, Saybolt-Furol, 180°F, sec..	-----	-----	-----	-----	300	700	----	----
Elastic Recovery @50°F, 20 cm elongation, %	60[3]	----	----	----	----	----	----	----

[1] Use modified AASHTO T 59 procedure – distillation temperature of 350°F with a 20-minute hold.
[2]Penetration will be determined by the producer and submitted to the Chief Chemist at the time of prequalification.
[3] CRS-1HP only
[4]CRS-1H/CSS-1H only

SECTION 1206
POLYMER MODIFIED ASPHALT CEMENT FOR CHIP SEALS

Page 1200-12, delete this entire section.

SECTION 1207
WARM MIX ASPHALT ADDITIVES

Page 1200-13, delete subsection 1207.5b. and replace with the following:
b. WMA additives.
(1) Prequalification as specified in **subsection 1207.4**.
(2) Field observation of WMA production.

SECTION 1405
BURLAP

Page 1400-6, delete subsection 1405.5 and replace with the following:
1405.5 BASIS OF ACCEPTANCE
a. New burlap will be accepted on the basis of a visual inspection for compliance with AASHTO M 182.

b. Used burlap will be accepted on the basis of a visual inspection for compliance with AASHTO M 182 and **subsection 1405.2b** above.

SECTION 1502
COLD APPLIED CHEMICALLY CURED JOINT SEALANT

Page 1500-3, delete subsection 1502.4c. and replace with the following:

c. Prequalified List. The Bureau of Construction and Materials will include products complying with **subsection 1502.2** on a prequalified list. Failure of any field installation in less than the anticipated life will be cause for removal of the product from prequalified status. Products removed from prequalified status will be considered for re-qualification if the manufacturer can provide evidence that the cause of failure has been positively identified, and necessary formulation changes and quality control measures have been implemented to eliminate that cause. Even if there is no formulation change, re-prequalify every 3 years by submitting test data that is no more than 3 years old. Complete prequalification under **subsection 1502.4**. is required for products removed from the prequalified list.

SECTION 1504
PREFORMED ELASTOMERIC COMPRESSION JOINT SEALS FOR CONCRETE

Page 1500-5, subsection 1504.b.(1), delete "AASHTO M 220" and replace with "ASTM D2628".

SECTION 1509
MEMBRANE SEALANT

Page 1500-15, subsection 1509.2a., delete the first paragraph and replace with the following:

a. Foam Sealant. Provide a foam sealant consisting of an open-cell high density polyurethane foam impregnated with either a polymer modified bitumen or a neoprene rubber suspended in chlorinated hydrocarbons. Precompress the foam sealant prior to packaging. Use a precompressed dimension as recommended by the sealant manufacturer to provide a water tight seal throughout a joint movement range of ±25% (minimum) from the specified joint opening dimension. Provide a foam sealant that is slowly self-expanding to permit workers ample time to install the foam before the foam exceeds the joint opening width. Supply the foam in pieces 5 feet in length or longer. Miter the ends of each piece for ease of joining to the adjacent pieces.

SECTION 1601
STEEL BARS FOR CONCRETE REINFORCEMENT

Page 1600-1, delete subsection 1601.4 and replace with the following:

1601.4 PREQUALIFICATION

a. General. Follow the instructions on the AASHTO National Transportation Product Evaluation Program's (NTPEP) website to participate in the audit program for reinforcing steel mill.

Forward an official copy of the latest NTPEP audit report, including split sample test results, and the plant's quality control plan to the Bureau Chief of Construction and Materials for evaluation. Producing mills that have successfully met the requirements of the audit (including test results that comply with **subsections 1601.2b.** and **1601.5c.**) and are listed on the NTPEP website as compliant will be prequalified.

In order to maintain prequalified status, send a copy of the annual NTPEP certificate of compliance, the "Record of Specimens Tested" sheet from the audit, and the "Variation Report" as soon as it is received. Producing mills that have prequalified using the NTPEP program and are subsequently removed from "compliant" status as shown on the NTPEP website will be removed from prequalified status.

Producing mills that fail to provide the annual documents described above or fail to adhere to the requirements of **subsection 1601.6b.** may be removed from prequalified status.

b. Comparison Testing. The NTPEP's 3rd party yield, tensile, and elongation test results will be compared to the parallel plant data from each heat for variations and differences. These variations and differences may not exceed the values shown in **TABLE 1601-1**, based on the 3rd party values as the reference where applicable.

SECTION 1602
EPOXY COATED STEEL FOR CONCRETE REINFORCEMENT

Page 1600-5, add the following subsection 1602.2a.(3):

(3) See **SECTION 711** for construction requirements and additional storage and handling requirements.

SECTION 1617
WELDED STUD SHEAR CONNECTORS

Page 1600-28, delete subsection 1617.2b., and replace with the following:

b. Material Specifications. The flux requirements for studs applied by the SW process are governed by AWS D1.5. Use steel for the studs that complies with ASTM A108, Grade Designation 1010 through 1020 (AISI/SAE), and AWS D1.5. The testing of the cold finished steel or the full diameter finished studs (stud manufacturer's option)~~,~~ must comply with the physical property requirements of AWS D1.5, Table 7.1, Type B.

SECTION 1619
STEEL PIPE

Page 1600-31, subsection 1619.5a. (1). Delete the 2nd sentence.

SECTION 1622
STEEL POSTS FOR DELINEATOR MARKERS

Page 1600-37, subsection 1622.1. Delete the first sentence and replace with the following:

This specification governs steel posts intended for the support of delineator markers and Type 2 object markers.

SECTION 1623
STEEL PERMANENT DECK FORMS

Page 1600-38, delete subsection 1623.2b. and replace with the following:

b. Material Specifications. Use forms made from zinc-coated sheet steel that complies with ASTM A653, structural steel (SS) Grades 33, 37, 40, 50 Class 1 and 55, or high strength low alloy steel (HSLAS) Grades 40 through 80. Provide a zinc-coating (total both sides) that conforms to Coating Designation G210. Although this specification allows for a range of acceptable materials, the specific steel designation, grade, and class (when applicable) will be shown in the Contract Documents. Certain HSLAS require specific welding procedures. If welding of these steels is required, consult the steel producer.

SECTION 1705
EPOXY-RESIN-BASE BONDING SYSTEMS FOR CONCRETE

Page 1700-9, delete subsection 1705.1c.(6) and replace with the following:

(6) Class F – For use above 75°F. The highest allowable temperature is defined by the manufacturer of the product.

SECTION 1717
PRECAST PANEL BEDDING MATERIALS

Page 1700-26, subsection 1717.4, last paragraph, change subsection reference from "1716.2" to "1717.2".

SECTION 1801
INORGANIC ZINC PRIMER FOR STRUCTURAL STEEL

Page 1800-1, delete subsection 1801.3b. and replace with the following:

b. Cyclic Corrosion/UV Exposure .... ASTM D5894
(1) Scribe Corrosion .... ASTM D1654
(2) Unscribed Area .... ASTM D1654

Page 1800-2, delete subsection 1801.4b. and replace with the following:

b. Testing by KDOT may be waived if testing has been performed on the identical product by another state within the past 12 months. Results must satisfy the requirements contained within this specification. Forward a copy of the test report to the Engineer of Tests for evaluation, along with evidence that the product referenced in the test report is identical to that submitted for prequalification.

SECTION 1802
ORGANIC ZINE PRIMER FOR STRUCTURAL STEEL

Page 1800-3, delete subsection 1802.3b. and replace with the following:

b. Cyclic Corrosion/UV Exposure. .... ASTM D5894
(1) Scribe Corrosion .... ASTM D1654
(2) Unscribed Area .... ASTM D1654

Page 1800-4, delete subsection 1802.4b. and replace with the following:

b. Testing by KDOT may be waived if testing has been performed on the identical product by another state within the past 12 months. Results must satisfy the requirements contained within this specification. Forward a copy of the test report to the Engineer of Tests for evaluation, along with evidence that the product referenced in the test report is identical to that submitted for prequalification.

SECTION 1806
WATER-BORNE ACRYLIC FINISH COAT

Page 1800-8, delete subsection 1806.3b. and replace with the following:

b. Cyclic Corrosion /UV Exposure .... ASTM D5894
(1) Scribe Corrosion .... ASTM D1654.
(2) Unscribed Area .... ASTM D1654.

Page 1800-8, delete subsection 1806.4b. and replace with the following:

b. Testing by KDOT may be waived if testing has been performed on the identical product by another state within the past 12 months. Results must satisfy the requirements contained within this specification. Forward a copy of the test report to the Engineer of Tests for evaluation, along with evidence that the product referenced in the test report is identical to that submitted for prequalification.

SECTION 1903
CAST IRON AND DUCTILE IRON PIPE

Page 1900-7, delete subsection 1903.2b. and replace with the following:

b. Material Specifications. Provide components of open systems complying with ASTM A48 when produced from gray cast iron or ASTM A536 when produced from ductile cast iron. Accessory items may also be produced from ferritic malleable cast iron in compliance with ASTM A47. Provide pipe, fittings, and accessory items for sanitary, storm drain, waste, and vent piping applications complying with ASTM A74. The mechanical property requirements of ASTM A74 determine the class or grade of cast iron required.

SECTION 2110
MULCH

Page 2100-16, add the following to the end of subsection 2100.2e.:

Other products not meeting the requirements of this subsection may be approved provided it meets the following criteria:

(1) Contain non-toxic tackifiers that, upon drying, become insoluble and non-dispersible to eliminate direct raindrop impact on sol according to ASTM D7101 and EPA 2021.0-1.

(2) Contain no germination or growth inhibiting factors and do not form a water-resistant crust that can inhibit plant growth.

(3) Contain a minimum 90% organic material (ASTM D2974).

(4) Have a rainfall event (R-factor) greater than 140 (ASTM D6459).

(5) Have a cover factor no greater than 0.03 (ASTM D6459).

(6) Have a minimum Vegetation Establishment of 400% (ASTM D7322).

(7) Have a minimum Water Holding Capacity of 600% (ASTM D7367).

SECTION 2114
TEMPORARY SEDIMENT BARRIERS

Page 2100-12, delete subsection 2114.2f. and replace with the following:

f. Filter Sock. Provide burlap or synthetic mesh bags or tubes, coarse aggregate, wood chips, compost or other permeable filler material to slow and filter stormwater runoff. Mesh bags or tubes shall have openings between 1/8” and 3/8” in size. Use only coarse aggregate filler for curb inlet protection unless approved by the Area Engineer. Compost filler shall comply with **TABLE 2114-1**.

TABLE 2114-1: COMPOST FOR FILTER SOCK REQUIREMENTS

Parameter	Range
pH	5.0-8.5
Moisture Content	<60%
Organic Matter Content	>25% of dry weight
Particle Size	99% < 2” 30%-50% < 3/8”

SECTION 2203
ROLL-UP SIGNS

Page 2200-5, subsection 2203.4. Delete the third paragraph and replace with the following:

Testing and evaluation by KDOT may be waived if complete testing has been performed on the <u>identical</u> product by AASHTO National Transportation Product Evaluation Program (NTPEP) within ten years of the KDOT submittal date. Forward an official copy of the test report along with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

SECTION 2209
HIGH DURABILITY PAVEMENT MARKING MATERIAL

Page 2200-12, delete subsection 2209.2d. and replace with the following:
d. Adhesion. 22 N, minimum.

SECTION 2210
TEMPORARY PAVEMENT MARKING TAPE

Page 2200-14, subsection 2210.1. First paragraph, delete the second sentence and replace with the following:
This includes both Type I and Type II materials for use on both portland cement concrete and asphalt surfaces.

INDEXING / FORMATTING (Non-Content) CORRECTIONS

INDEX

Page I-1, Biodegradable Log, change page number from "900-27" to "900-7".

Page I-5, Landscape Retaining Wall, change page number from "800-104" to "800-125".

Page I-6, delete Liner Pipe from the Index. Handle by a project special provision.

Page I-6, delete Mobilization (Emergency Erosion Control) (Set Price) from the Index. No longer applicable to 2015 specifications.

Page I-7, Precast Arch Culvert and Precast Rigid Frame Culvert, change page number from "800-57" to "700-129".

Page I-8, Rubblized Concrete, change page number from "800-1001" to "800-101".

Page I-8, delete Shot-crete. No longer a bid item, replaced with Concrete Surface Repair.

Page I-12, BRIDGE CURB REPAIR, change page number from "700-103" to "700-108".

Page I-16, EROSION PIPE, change page number from "800-43" to "800-51".

Page I-22, POLYMER MODIFIED ASPHALT CEMENT FOR CHIP SEALS (Materials), change page number from "700-143" to "1200-12".

Page I-27, UNKNOWN HAZARDOUS MATERIALS, change page number from "100-59" to "100-63".

DIVISION 200
EARTHWORK

Page i, delete Table of Contents title "Stabilized Subgrade, Base and Shoulders" and replace with "Earthwork".

Page i, add "200-" before page numbers.

DIVISION 300
STABILIZED SUBGRADE, BASE AND SHOULDERS

Page i, add "300-" before page numbers.

SECTION 502
PORTLAND CEMENT CONCRETE PAVEMENT (NON-QC/QA)

Page 500-30, subsection 502.3g.(10), change all references with subsection 502.4 to subsection 502.3.

DIVISION 600
FLEXIBLE PAVEMENT

Page i, add "600-" before page numbers.

DIVISION 700
STRUCTURES

Page i, add "700-" before page numbers.

SECTION 737
FIELD ERECTION

Pages 700-132 TO 700-135, delete header "737 – CONTROLLED DEMOLITION" and replace with "737-FIELD ERECTION".

SECTION 850
SEPARATION GEOTEXTILE

Pages 800-116, delete header "850 – GEOMEMBRANE" and replace with "850 – SEPARATION GEOTEXTILE".

07-29-19 (C&M) (LAL)
Sep-19 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
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FUEL ADJUSTMENT

1.0 DESCRIPTION

This is the method of price adjustment for fuel (regardless of the type of fuel) used on various items of work involved in the construction of the Project.

This specification applies when 10-10-00-Required Contract Provision Price Adjustment for Fuel, latest revision, is a part of the contract, and the Contractor accepts that provision.

2.0 METHOD OF PRICE ADJUSTMENT FOR FUEL

a. Items of Work Included. The items of work subject to price adjustment for fuel are those selected by the Contractor on 10-10-00, latest revision. The Fuel Use Factors for those items are shown in **TABLE 1**, next sheet.

b. Price Adjustment.

- The Engineer will make fuel adjustment payments (or deductions) for the applicable work completed, except no payments are made for work that is completed after the expiration of the working days or calendar completion date. Deductions for fuel adjustment are made regardless of whether or not the working days or calendar completion date has expired.
- The Contractor will begin work on the Project as soon as possible (check with the District Engineer before the letting to obtain the anticipated starting date) and pursue the work in an expeditious manner. Do not move off the Project without the written permission of the Engineer. If the Contractor moves off the Project without the written permission of the Engineer, the Engineer will discontinue the payments for fuel price adjustment for the remainder of the contract. Deductions for fuel adjustment are made regardless of whether or not the payments for fuel price adjustments are discontinued.
- The Engineer will establish a Monthly Fuel Index (MFI) on the first day (excluding Saturdays, Sundays, and holidays) of each month. The Engineer will base the MFI on the Rack Average given for NO2-ULS Fuel, St. Louis, reported by AXXIS Petroleum, Inc., Axxis Price Service. The MFI for the month the contract is let becomes the Starting Fuel Index (SFI) for the duration of the contract. Information regarding the computation of the MFI is available from the Bureau of Construction and Materials, Topeka, Kansas.
- The difference (plus <u>or</u> minus) between the SFI and MFI (to the nearest $0.01 per gallon) is the Monthly Fuel Index Adjustment Factor (MFIAF). The MFIAF established on the first day (excluding Saturdays, Sundays, and holidays) of each month is applied to applicable work completed during that month.
- The Fuel Use Factor (FUF) for the various items of work is in **TABLE 1**, next sheet.
- The fuel adjustment payment (or deduction) is computed each pay period in this way:

  Fuel Adjustment (in dollars) = FUF x MFIAF x Units of Work on the Pay Estimate

- The Engineer will make adjustment payments (or deductions) for the applicable work completed, using the bid item "Fuel Adjustment".

TABLE 1: FUEL USE FACTOR ITEMS OF WORK		
ITEM OF WORK	**FUEL USE FACTOR PER UNIT (U.S. Customary units and metric)**	
Common Excavation	0.25 gals. per cubic yard	0.33 gal. per cubic meter
Common Excavation (Contractor-Furnished)	0.25 gals. per cubic yard	0.33 gal. per cubic meter
Rock Excavation	0.33 gals. per cubic yard	0.43 gal. per cubic meter
Rock Excavation (Non-Durable Shale)	0.33 gals. per cubic yard	0.43 gal. per cubic meter
Unclassified Excavation	0.29 gals. per cubic yard	0.38 gal. per cubic meter
Embankment	0.30 gals. per cubic yard	0.39 gal. per cubic meter
Embankment (Contractor-Furnished)	0.30 gals. per cubic yard	0.39 gal. per cubic meter
Concrete Placement: 3 inches*	0.30 gals. per square yard	0.36 gal. per square meter
Concrete Placement: 3 ½ inches*	0.33 gals. per square yard	0.39 gal. per square meter
Concrete Placement: 4 inches*	0.36 gals. per square yard	0.43 gal. per square meter
Concrete Placement: 4 ½ inches*	0.39 gals. per square yard	0.46 gal. per square meter
Concrete Placement: 5 inches*	0.42 gals. per square yard	0.50 gal. per square meter
Concrete Placement: 5 ½ inches*	0.45 gals. per square yard	0.53 gal. per square meter
Concrete Placement: 6 inches*	0.48 gals. per square yard	0.57 gal. per square meter
Bonded Concrete Pavement (3 inches)*	0.30 gals. per square yard	0.36 gal. per square meter
Bonded Concrete Pavement (3 ½ inches)*	0.33 gals. per square yard	0.39 gal. per square meter
Bonded Concrete Pavement (4 inches)*	0.36 gals. per square yard	0.43 gal. per square meter
Bonded Concrete Pavement (4 ½ inches)*	0.39 gals. per square yard	0.46 gal. per square meter
Bonded Concrete Pavement (5 inches)*	0.42 gals. per square yard	0.50 gal. per square meter
Bonded Concrete Pavement (5 ½ inches)*	0.45 gals. per square yard	0.53 gal. per square meter
Bonded Concrete Pavement (6 inches)*	0.48 gals. per square yard	0.57 gal. per square meter
Concrete Pavement: 6 inches	0.48 gals. per square yard	0.58 gal. per square meter
Concrete Pavement: 6 ½ inches	0.51 gals. per square yard	0.61 gal. per square meter
Concrete Pavement: 7 inches	0.54 gals. per square yard	0.65 gal. per square meter
Concrete Pavement: 7 ½ inches	0.57 gals. per square yard	0.69 gal. per square meter
Concrete Pavement: 8 inches	0.60 gals. per square yard	0.72 gal. per square meter
Concrete Pavement: 8 ½ inches	0.63 gals. per square yard	0.76 gal. per square meter
Concrete Pavement: 9 inches	0.66 gals. per square yard	0.79 gal. per square meter
Concrete Pavement: 9 ½ inches	0.69 gals. per square yard	0.82 gal. per square meter
Concrete Pavement: 10 inches	0.72 gals. per square yard	0.86 gal. per square meter
Concrete Pavement: 10 ½ inches	0.75 gals. per square yard	0.89 gal. per square meter
Concrete Pavement: 11 inches	0.78 gals. per square yard	0.93 gal. per square meter
Concrete Pavement: 11 ½ inches	0.81 gals. per square yard	0.96 gal. per square meter
Concrete Pavement: 12 inches	0.83 gals. per square yard	0.99 gal. per square meter
Concrete Pavement: 12 ½ inches	0.86 gals. per square yard	1.02 gal per square meter
Concrete Pavement: 13 inches	0.89 gals. per square yard	1.06 gal. per square meter
Concrete Pavement: 13 ½ inches	0.92 gals. per square yard	1.10 gal. per square meter
Concrete Pavement: 14 inches	0.95 gals. per square yard	1.14 gal. per square meter
Concrete Pavement: 14 ½ inches	0.98 gals. per square yard	1.17 gal. per square meter
Cold Recycled Asphalt Material	10.20 gals. per station	334.65 gals. per kilometer
Surface Recycled Asphalt Construction**	2.40 gals. per ton	2.65 gals. per megagram
HMA – Construction***	2.40 gals. per ton	2.65 gals. per megagram
HMA - (Commercial Grade)	2.40 gals. per ton	2.65 gals. per megagram

*For Bonded Concrete Pavement. When both items are in contract, only pay on Concrete Placement bid item.
** Calculate theoretical tons (mg) of asphalt.
*** **NOTE**: If Asphalt Treated Base or Asphalt Treated Base-Commercial Grade (Class A) are bid as alternates on the project, the price adjustment does not apply to those bid items.

KANSAS DEPARTMENT OF TRANSPORTATION
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SECTION 108

PROSECUTION AND PROGRESS

Page 100-68, delete subsections 108.5 c.(2) and (3) and replace with the following:

(2) Every Saturday on which the Contractor or a subcontractor chooses to work and is able to work on the CIOW (regardless of whether the Contractor or subcontractors perform work on the CIOW). Exceptions: Do not charge a working day or cleanup working day if the only work performed is for temporary erosion and sediment control maintenance or corrective actions from SWPPP Inspection. Do not charge a working day or cleanup day if the only work performed does not require inspection by the Engineer.

(3) Every Sunday or legal holiday on which the District Engineer allows the Contractor or a subcontractor to perform work requiring inspection (regardless of the type of work or the time spent working). Exceptions: Do not charge a working day or cleanup working day if the only work performed is for temporary erosion and sediment control maintenance or corrective actions from SWPPP Inspection. Do not charge a working day or cleanup day if the only work performed does not require inspection by the Engineer.

Page 100-68, subsection delete subsection 108.5d.(3) and replace with the following:

(3) Piling Delivery. The Engineer will not charge working days on days the Contractor or subcontractor awaits the arrival of permanent piling if:

- the contract requires test piles;
- the bridge Contractor or subcontractor ordered the permanent piling immediately after driving the test piles; and
- piling installation is the CIOW.

Page 100-70, subsection 108.8c.(2), change "10 business days" to "5 business days".

Page 100-72, subsection 108.8d., delete TABLE 108-1, and replace with the following:

TABLE 108-1: TABLE OF LIQUIDATED DAMAGES			
Original Contract Amount Range		Amounts of Liquidated Damages to be Deducted for Each Day Over Contract Time, Project Open Time or Cleanup Time Condition at End of Working Days, Calendar Days, Calendar Completion Date, Cleanup Time	
		Project Not Complete after Contract Time Expires under 108.4a.(1) or Project Not Open to Unrestricted Traffic after Project Open Time Expires under 108.4a.(2)*	Project Open to Unrestricted Traffic, but not Completed after Cleanup Time Expires under 108.4a.(2)
		(A)	(B)
$0.00	$500,000.00	$900.00	$450.00
$500,000.01	$1,000,000.00	$1,200.00	$600.00
$1,000,000.01	$2,500,000.00	$1,400.00	$700.00
$2,500,000.01	$5,000,000.00	$1,600.00	$800.00
$5,000,000.01	$10,000,000.00	$2,000.00	$1,000.00
$10,000,000.01	$25,000,000.00	$4,000.00	$2,000.00
Over $25,000,000.00		$4,000.00	$2,000.00

*Or Not Available to the Next Contractor, when applicable.

07-13-18 C&M (SKE)
Nov-18 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 202 and replace with the following:

SECTION 202

REMOVAL OF EXISTING STRUCTURES

202.1 DESCRIPTION

Remove and dispose of the existing structures as specified in the Contract Documents. Existing structures include the structures identified in the Contract Documents for removal, and man-made structures not specifically identified in the Contract Documents that are in conflict with the new construction and would normally be encountered upon a careful examination of the work site. Excluded are utilities and structures for which other provisions are made for removal.

Protect any structures designated to remain.

Remove, clean and store any materials designated for salvage.

Remove, clean, store and reconstruct any existing structures as designated in the Contract Documents.

Inspect all building structures that are scheduled for removal, and determine if asbestos is present.

BID ITEMS	UNITS
Removal of Existing Structures	Lump Sum
Removal and Reconstruction of Existing Structures	Lump Sum

202.2 MATERIALS

a. Backfill Material. Backfill cavities created by removing existing structures, using granular material or loose friable soil from the project. Use material that is free of excess moisture, frozen lumps, roots, sod, rocks greater than 4 inches in diameter or other deleterious material. The Engineer will accept the backfill material based on visual inspection.

b. Materials to Reconstruct Existing Structures. Provide the specified materials that comply with the materials' divisions (**SECTIONS 1000 – 2500**).

If the existing structure is damaged during the removal operations, replace any damaged materials with new materials matching the originals.

202.3 CONSTRUCTION REQUIREMENTS

a. Removal of Existing Structures. Raze, remove and dispose of all existing man-made structures and debris not designated to remain.

If the substructure of an existing structure lies wholly or partly within the limits of a new structure, remove the existing substructure to accommodate the new structure. Remove the existing substructure to the natural stream bottom, or 12 inches below the natural ground surface or new finished lines, whichever is lower.

Unless the area is excavated during the new construction, backfill to the level of the surrounding ground and compact all cavities left by the structure removals. If the backfill area is within the limits of the new construction, compact the backfill to the type of compaction and within the moisture range designated in the Contract Documents.

Provide temporary erosion and pollution control according to **DIVISION 900**.

b. Removal and Reconstruction of Existing Structures. Before removing the existing structures designated for relocation, take sufficient measurements and color photographs of the existing structures so the reconstruction duplicates the original. Provide the Engineer with copies of the measurements and photographs.

Submit for the Engineer's approval, a written plan for the relocation and reconstruction of the existing structures, before beginning any relocation and reconstruction work. Reconstruct the structure according to the details in the Contract Document.

c. Existing Bridge Deck. Designate one Prime Contractor employee as the Removal Supervisor. The Removal Supervisor, or their designee, must be on location any time work is performed on removal of the existing structure.

Before performing any work to remove the deck, schedule a pre-work meeting with the Engineer. Include the Removal Supervisor and key personnel who will be working on the removal item. Discuss a detailed procedure of how removal will be accomplished and how damage to the structure will be avoided.

Remove the deck or any portion of the deck without damaging the girders.

Clearly mark the location of the existing girder top flanges on top of the existing deck concrete. Mark the entire length of all girders before sawing or removing any concrete. Limit concrete sawing to a maximum depth of 3 inches directly above any girder and within 3 inches of either edge of a girder top flange. Do not use drop-type pavement breakers. Do not use a hoe ram directly above any girder or within 1.0 foot of either edge of a girder top flange. Use a jackhammer no heavier than 15 pounds to remove concrete above and within 1.0 foot of either side of a girder top flange.

Also, see **SECTION 702 - CONTROLLED DEMOLITION**.

Damage includes, but is not limited to saw cuts, dents, cracks, distortion or any other damage found by the Engineer. This also includes spalling of prestressed concrete beams that would require repair.

If the girder is damaged:

- The Engineer, in coordination with the State Bridge Office (SBO), will determine if the damages require repair. The Engineer will determine what repairs are required for minor nicks, dents, cuts and spalls not affecting the structure capacity.
- If any damage requires additional engineering, hire an independent engineer, licensed in Kansas to develop repair plans, provide structural analysis and stress calculations (including fatigue calculations), and submit sealed calculations to the SBO for review and approval.
- The Contractor's independent engineer shall evaluate the capacity of any damaged members, and submit sealed calculations showing any capacity loss of damaged members.
- Submit a copy of the repair plan, per **SECTION 105**, sealed by a licensed Professional Engineer, to the SBO for approval.
- After repairs have been completed, the Contractor's independent engineer shall evaluate the capacity of any repaired members, and submit sealed calculations showing any capacity loss of repaired members.
- The ideal situation is to repair any damage so there is no structure capacity loss. Structure capacity loss would be a reduction of the controlling load rating capacity for the structure. If there is minor capacity loss, and KDOT deems this loss acceptable, KDOT will assess a Contract Deduct. See **subsection 203.4**. In this case, the Contractor has the option to either accept the deduction or repair to eliminate any capacity loss.

The Contractor is responsible for all repairs to the damaged girders as authorized by the Engineer, plus any materials, equipment, labor, delays and traffic from the damage or repair. If damage is severe, additional engineering and inspection fees incurred by KDOT may also be deducted.

d. Salvaged Materials. The salvaged material will remain the property of the State, County or City, as applicable. If not shown in the Contract Documents, the Engineer will designate the storage areas.

Remove the material in sections or pieces that can be transported and stored. Dismantle steel and wood bridges designated in the Contract Documents. Match mark the salvaged steel members, unless the Engineer waives this requirement.

Unless shown otherwise in the Contract Documents, salvage and clean all existing pipe determined usable by the Engineer.

If during the removal and transport to the storage area, the Contractor damages material designated as salvage, the Engineer will deduct 60% of the current quoted price for replacement material delivered to the project from payments due the Contractor.

e. Asbestos Removal.

(1) Building Structures. Inspect all building structures that are scheduled for removal, and determine if asbestos is present by sampling and testing. The Contract Documents may identify that asbestos is present in building structures.

(2) Bridge Structures. The Contract Documents will identify when asbestos is present in the bridge structure.

(3) When asbestos is determined to be present in building structures or identified in the Contract Document to be present in building structures or bridge structures, remove and dispose of asbestos, while complying with all Federal and State regulations, laws, rules and ordinances pertaining to asbestos removal and waste disposal. File all appropriate notification forms and any required permits with Federal and State authorities, and pay all related fees. Provide the Engineer copies of all notification forms, correspondence, test results, recommendations and other information to document compliance with these requirements.

202.4 MEASUREMENT AND PAYMENT

a. Measurement. The Engineer will measure the removal of existing structures and removal and reconstruction of existing structures by the lump sum. The initial inspection of building structures to determine if asbestos is present is subsidiary to these bid items.

(1) Building Structures. If the Contract Documents identify asbestos in the removal of building structures, asbestos removal is subsidiary to "Removal of Existing Structures". If asbestos removal is not shown in the Contract Documents, but is required after the initial inspection indicates the presence of materials containing asbestos, the asbestos removal will be paid for as Extra Work, **SECTION 104**.

(2) Bridge Structures. When the Contract Documents identify asbestos in the removal of bridge structures, asbestos removal is subsidiary to "Removal of Existing Structures". If asbestos removal is not shown in the Contract Documents, but asbestos is identified during the removal of existing structure, the asbestos removal will be paid for as Extra Work, **SECTION 104**.

b. Payment. Payment for "Removal of Existing Structures" and "Removal and Reconstruction of Existing Structures" at the contract unit price is full compensation for the specified work.

When existing bridge deck damage is severe, KDOT inspection and engineering fees will be assessed under the bid item "Contract Deduct".

If after repairs are made, there is a reduced capacity for the structure, KDOT will assess an additional "Contract Deduct". The Contract Deduct will be calculated by multiplying the percent loss of capacity (calculated after repair) times the total contract price of all bridge bid items (reinforcing steel, structural steel, concrete, expansion joints, etc.) for the structure.

10-23-15 BSGS (JPJ)
Jan-16 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 306 and replace with the following:

SECTION 306

CEMENT TREATED BASE

Exception: If the PCCP in the contract is not specified as QC/QA, (Bid item Quality Control Testing (CTB) is not included as a bid item) subsections 306.2 (entire subsection), 306.4d. and 306.4g. of this SECTION are not applicable to the contract.

306.1 DESCRIPTION

Design a cement treated base (CTB) mixture meeting the requirements of the Contract Documents. Construct 1 or more courses of the CTB on a prepared roadway as shown in the Contract Documents.

BID ITEMS	**UNITS**
Cement Treated Base	Square Yard
Quality Control Testing (CTB)	Square Yard

306.2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

a. General. Provide qualified personnel and sufficient equipment complying with the requirements listed in Part V to conduct quality control testing that complies with Appendix B, Sampling and Testing Frequency Chart for Cement Treated Base Construction Items for Quality Control/Quality Assurance Projects.

Allow the Engineer access to the Contractor's laboratory to observe testing procedures, calculations, test documentation and plotting of test results.

Calibrate and correlate the testing equipment with prescribed procedures, and conduct tests in compliance with specified testing procedures as listed in Part V.

Maintain a Quality Manual in the field laboratory showing the calibrations performed on all test equipment and when the next calibration is due for that equipment. As a minimum, follow the calibration/verification interval established in Table 1: Cement Treated Base Materials Test Equipment in Section 5.2.7.8-Cement Treated Base: Contractor's Quality Control Plan (CTB), Part V. See also, Part V Section 5.2.7.8.1-Example of a Laboratory Quality Manual for CTB.

b. Quality Control Plan (QCP). At the pre-construction conference, submit to the Engineer for approval by the DME, a QCP as outlined in Section 5.2.7-Contractor's Quality Control Plan, Part V. Follow 5.2.7.8-Cement Treated Base: Contractor's Quality Control Plan in Part V as a general guideline. Keep a printed copy of the approved QCP in the Contractor's laboratory and make available to the Engineer when requested.

The Contractor's laboratory and equipment will be inspected and approved as outlined in Part V, Section 5.2.7-Contractor's Quality Control Plan.

Provide an organizational chart showing the specified lines of authority relating to both mix design and quality control operations during production. Include a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection. Identify the company official acting as liaison with KDOT, and the Certified Technician who will direct inspection and testing. Post the chart in the test facility.

Provide a quality control organization or private testing firm having personnel certified according to the Policy and Procedures Manual for The Certified Inspection and Testing (CIT) Training Program. The testing for this type of construction will require personnel certified in ACI Concrete Field Testing Technician (CF), Aggregate Field Tester (AGF), Soils Field Tester (SOF) and Nuclear Moisture Density Gauge Tester (NUC) classifications. Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing.

Provide a minimum of 1 employee on the project certified in the QC/QA Concrete/Cement Treated Base Specs (QCS) classification.

Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing. At the beginning of the project, provide the Engineer with the list of certified technicians and alternates, phone numbers and tests/inspection they will be performing. As personnel changes and certifications may expire, continue to provide the Engineer with an accurate list.

Submit the mix design for the CTB. If an existing mix design is used, provide the mix design number. Include all the elements of the mix design specified in the Contract Documents.

Submit the proposed methods and procedures to control the elements identified as necessary for the quality of the CTB. These elements include, but are not limited to: producing the aggregate, managing the aggregate stockpiles, proportioning the individual materials for the mixture, mixing and transporting the mixture, placing and consolidating the mixture, and finishing and curing the mixture.

c. Required Duties of Certified Technicians. Be available on the project site whenever cement treated base is being produced and being placed on the project site. Perform and utilize quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix designs.

Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing, consolidating, finishing and curing to assure it is operating properly and that placement, consolidation, finishing and curing comply with the mix design and other contract requirements.

d. Contractor's Testing Facilities. Describe the testing facility and its accreditation in the QCP.

Locate the testing facility either at the plant site or at the project. Obtain approval of the testing facilities and location from the DME before the commencement of mixture production.

Provide suitable space for the required testing equipment. Also, equip the testing facility with these items for the exclusive use of the testing facility's quality control personnel and the Engineer:

- A telephone with a private line;
- A copying machine; and
- Broadband internet connection (for 1 computer). If the Engineer determines that broadband internet service is not available, provide a fax machine, at no additional cost.

e. Documentation. Include in the QCP procedures, charts and forms to be used to provide the required documentation.

Record and document all test results and calculations. Record all original documentation in a bound field book or other KDOT approved bound record and turn over to KDOT at the end of the project.

At all times, have complete records of all inspections and tests readily available on site for the Engineer. All records documenting the Contractor's quality control inspections and tests become the property of KDOT upon completion of the work.

Indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the corrective action taken in the records. Examples of quality control forms and charts are available in Part V, or Contractors may design their own. Documentation procedures are subject to approval by the Engineer before the start of the work and to compliance checks during the progress of the work.

Maintain control charts on an ongoing basis. Plot data according to **SECTION 106**.

Record all test results and calculations on electronic data sheets. Record specific test results on a Daily Quality Control Summary Sheet to facilitate the computation of moving test averages. Base the moving averages on 4 consecutive test results. Include a description of quality control actions taken (adjustment of aggregate or additive proportions in the mix, moisture adjustments, etc.) in the Daily Quality Control Summary Sheet.

Provide forms on a computer-acceptable medium, where required. Document batch tickets and gradation data according to KDOT requirements.

Complete testing and charting within 1 working day after sampling.

Keep all quality control charts current. Email or fax the data to the Field Engineer and DME, weekly. Show both individual test results and moving average values. As a minimum on approved control charts, plot the single test values and the 4-test moving average values for gradation of combined aggregates, in-place CTB moisture and dry density, and compressive strength (requires a separate graph for PWL, but no moving average plot).

Complete the charting within 1 working day after the sampling or testing, respective to each type of test.

Make all test results and control charts available to the Engineer at the project site. The Engineer will periodically make compliance checks on the documentation during the progress of the work.

Submit (email or fax) copies of all failing test results (based on a moving average of 4 tests, if appropriate) and a summary sheet to the Field Engineer on a daily basis.

File all reports, records, charts and diaries developed during the progress of construction activities. Upon completion of the contract, all documentation becomes the property of KDOT.

f. Testing Requirements. In the QCP, identify test methods, procedures and equipment proposed for use. Use standard KDOT test methods and properly calibrated measuring and testing equipment as outlined in Part V. Detail any alternative sampling method, procedure or inspection equipment proposed to be used. Such alternatives are subject to review and approval by the DME.

Take all samples for tests and perform in-place tests at random locations selected according to the Contractor's QC Plan and at the rates specified in the Sampling and Testing Frequency Chart for Cement Treated Base for Quality Control/Quality Assurance Projects in Appendix B, Part V. Retain the latest 10 gradation samples for use by the Engineer.

Retain the second half of the latest 10 gradation samples for use by the Engineer.

g. Mix Design. Design a mixture of aggregate and portland cement or fly ash, or both. If fly ash is used in the mixture, address the set time and strength gain as a function of the ambient temperature. Design the mixture according to the following requirements:

(1) The compressive strength shall be between 650 and 1600 psi. Any test correlating to the maximum value or higher requires scoring or sawing joints in the base that fall within the failing test section (from previous to next passing test sections). Determine compressive strength at 7 days, according to Part V.

(2) Submit a single point gradation for the combined aggregates along with a plus/minus tolerance for each sieve to the Engineer. The plus/minus tolerances shall be used by the Contractor to perform quality control checks and by the Engineer to perform aggregate gradation verification testing. Perform tests on the combined materials.

(3) Submit the mix batch weights in an acceptable manner to the DME. Address the initial set times (specified in AASHTO T 154) and placement times (with regards to the set times) in the proposed mix design.

(4) Submit laboratory compressive strength test results on a minimum of 1 set of 3 plugs, produced from the proposed mix design and utilizing the actual materials proposed for use on the contract.

(5) Submit the test results 2 weeks prior to the anticipated date for using the design on the contract. The Engineer will review the design within 5 working days of receipt. The Engineer may perform any testing necessary to verify the adequacy of the Contractor's design. If the Engineer calls for verification tests, supply the Engineer with the necessary materials to enable the Engineer to test the mix properties within 5 working days of notification.

(6) Submit any proposed changes to the approved mix design to the DME for approval before implementing the proposed changes.

h. Corrective Action. In the QCP, identify procedures for notifying the Engineer when corrective measures must be implemented, and for halting production.

Notify the Engineer when the moving average test result trend line for any property approaches the specification limits. Cease operations when 2 consecutive moving average points fall outside the specification limits, or 2 consecutive single compressive strength tests exceed the specification limits. Ceasing operations is the Contractor's responsibility. Quality control tests for this determination include aggregate gradation, compliance with the mix design band and in-place density of CTB.

Failure to cease operations for the conditions cited above will subject all subsequent material to rejection, or acceptance at a reduced price, as determined by the Engineer.

The Engineer may examine materials represented by individual test results, which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor or KDOT test results. The information from additional testing (including testing of in-place pavement) may be used to define unacceptable work according to **SECTION 105**. The Engineer will apply appropriate price reductions or initiate corrective action.

If a dispute exists between the Engineer and Contractor about the validity of any test results, the KDOT District Materials Laboratory or MRC will perform referee testing. If one of the disputed KDOT test results was generated at the MRC, then an independent laboratory agreeable to both parties will be selected. The AASHTO Accreditation Program shall have approved the selected laboratory for the appropriate test procedure. If referee testing indicates that KDOT test results are correct, the Contractor is responsible for the cost of additional testing, including referee testing performed at the MRC. If the referee testing indicates that the Contractor test results are correct, KDOT is responsible for the cost of additional testing.

i. Non-Conforming Materials. In the QCP, specifically address how non-conforming materials will be controlled and identified.

Establish and maintain an effective and positive system for controlling non-conforming material, including procedures for its identification, isolation and disposition. Reclaim or rework non-conforming materials according to procedures acceptable to the Engineer.

Identify all non-conforming materials and products to prevent use, shipment and intermingling with conforming materials and products. Provide holding areas, mutually agreeable to the Engineer and Contractor.

The Engineer will determine if reclaiming or reworking of non-conforming materials is allowed.

306.3 MATERIALS

Provide materials that comply with the applicable requirements.

Concrete Admixtures & Curing Material .... **DIVISION 1400**
Portland Cement and Fly Ash .... **DIVISION 2000**
Water for CTB .... **DIVISION 2400**
Aggregates for CTB .... **DIVISION 1100**

306.4 CONSTRUCTION REQUIREMENTS

a. Preparation and Maintenance of the Subgrade. Before placing any CTB material on any section, complete the ditches and drains along that section to effectively drain the highway. Use automatic grade control equipment to trim the surface of the subgrade to the line, grade and cross-section as shown in the Contract Documents. Maintain the subgrade to the as-constructed condition under other contract bid items, repairing any encountered defects to the specifications of the previous bid items. Maintain the subgrade surface to readily drain at all times. Protect the subgrade from damage when handling materials, tools and equipment. Do not store or stockpile materials on the subgrade. Do not place material or lay CTB on a frozen or muddy subgrade.

Lightly spray the subgrade with water to obtain a thoroughly moistened condition before the CTB is placed. Do not puddle water on the grade.

Do not place CTB on frozen subgrade. Do not deposit any material until the subgrade or base has been checked and approved by the Engineer.

b. Mixing the Materials. Do not place CTB on the project until the Engineer has reviewed and approved the submitted mix design.

Plant mix the aggregate, cementing agent and water according to the approved mix design.

Control the charge in a batch mixer, or the rate of feed to a continuous mixer (pugmill), to allow complete mixing of all the materials. Mix the materials to produce a homogeneous mixture. Do not use frozen aggregate.

Take all compressive strength samples at the plant site. Compact the samples prior to the CTB reaching its initial set.

c. Spreading and Compacting the CTB. The maximum compacted thickness of a single lift is 6 inches. If the thickness is greater than 6 inches, spread and compact the subgrade in multiple lifts of equal thickness with a maximum lift thickness of 6 inches. If the base is spread in multiple lifts, offset the longitudinal joints by at least 6 inches.

If multiple lifts are placed, keep the surface of each lift moist until the succeeding lift is spread. Cover the exposed lower lift with the final lift the same day the lower lift is placed.

Compact each lift of CTB to a minimum of 95% of the standard density.

Compact the CTB within 2 hours from the time the water and cementing agent is added to the aggregate, or before the mixture reaches the initial set, whichever is the shorter timeframe.

d. Compaction Determination. Determine dry density and moisture content according to Part V.

If the mix is stiff (can be slip-formed), determine the standard density by averaging the 3 most recent field molded densities using plant mixed base material. Compact one standard mold (using plant mixed material with the proper moisture content) for each day's operation as specified in KT-37.

If the mix is fluid (requires forming), determine the Standard Dry Density by averaging the 3 most recent consolidated unit weight test results (KT-20). It will be necessary to convert the unit weight (wet density) into a standard dry density which also requires the percent of moisture (KT-11 (4)) to be known. Use Equation 1 to determine the standard dry density.

Equation 1: $$\text{Standard Dry Density} = \frac{\text{Wet Density}}{(1 + [\%\text{Moisture} / 100])}$$

Determine the density of the CTB within 1 day of the compaction operations. The Engineer may verify the Contractor's density test results by conducting density tests at random. If the comparison is not favorable, the DME will investigate to determine the cause and may suspend production until corrective action is taken.

e. Trimming and Finishing the CTB. Use equipment defined in **SECTION 154** to trim and recompact the CTB within 2½ hours of the time the water and cementing agent is added to the aggregate.

Trim and compact the CTB to the grades, lines and typical cross sections shown in the Contract Documents. Dress the edge slopes and joints between sections.

Use automatic grade control equipment to trim the surface of the CTB to line grade and cross section.

Keep the surface of the CTB moist during all finishing operations.

Perform the finishing and compacting operations to produce a smooth, dense surface, free of surface compaction planes, cracks, ridges or loose material.

If required, lightly scarify the surface of the CTB to loosen any imprints left by the trimming and compacting equipment. Recompact the surface of the CTB.

At the end of each day's operations, construct a straight transverse construction joint by cutting back into the completed work to form a vertical face. Place a protective covering of earth on the newly constructed CTB a distance back of the joint for turning of equipment used on the following day's work.

Upon satisfactory performance, the Engineer may approve the use of equipment that combines the placing, compacting and finishing operations.

f. Protection and Curing. Keep the surface of the CTB moist until the curing material is applied. Apply the curing material immediately after completing the trimming and finishing. Protect the CTB against the loss of moisture for a curing period of 7 days (unless the Contractor's mix design test results justify a different curing period). Protect the CTB against freezing during the curing period.

Apply a wax-based liquid membrane-forming compound for the curing material. The minimum application rate for wax-based liquid membrane-forming compound is 0.12 gallons per square yard. Use an enclosed spray system that minimizes wind influence and obtains the proper application rate. Keep all traffic and construction equipment off the CTB. The only exception is the equipment used to apply the curing material. Cover the surface and edges of the CTB with a complete, uniform coverage. Use a hand sprayer in inaccessible areas.

If the wax-based liquid membrane-forming compound will be in place for more than 30 days, reapply a single coat at the single application rate within 7 days of placing the pavement.

At locations where it is necessary to carry traffic across the CTB, place a layer (8 inches or greater, compacted depth) of stable earth (sand-clay) over the CTB.

The Contractor may place portland cement concrete pavement (PCCP) on the CTB after a minimum of 24 hours, provided all traffic and construction equipment is kept off the CTB.

The Contractor assumes the risk of 7-day compressive strength requirements when PCCP is placed early.

To promote cracking through the full depth of the base, score or cut the finished CTB surface to coincide with the pavement joint locations, in a parallel manner and within 1 foot:

- if the 7-day compressive strength exceeds 1600 psi.
- if the Contractor opts to place the PCCP over the CTB before the 7-day compressive strength is determined. The Engineer may waive this requirement when the Contractor's control charts for CTB shows a history that the 7-day compressive strength is below 1600 psi.

g. Compressive Strength Determination. Using random numbers, select and obtain sampled material at the plant. Make and cure compression test specimens to represent each sublot. Make and cure compression test specimens, and determine the 7-day compressive strength of the CTB according to Part V. Sulfur cap compression test specimens in accordance with AASHTO T 231. When additional test specimens are taken for early determination of the compressive strength, the specimens are for information only. Perform the 7-day compressive strength testing. Maintain records of all sampling and testing. The Engineer will witness all compressive strength tests and initial the Contractor's documentation.

A percent within limits (***PWL***) analysis shall be made on a lot-by-lot basis and shall be based on Contractor quality control test results on all quality control samples representing the lot of the completed CTB. The ***PWL*** result shall be determined as specified under Computation of Pay Factor. Compute the pay adjustment as shown in Equation 2. It shall be based on the compressive strength values within each lot and the lower specification limits (***LSL***).

KDOT will use a spreadsheet program to calculate pay adjustments for compressive strength and to compare the Contractor's QC and KDOT's verification test results. If the comparison fails, KDOT's value will be used to calculate the pay adjustment for that lot. The lot comparison is based on KDOT's verification result falling within the Contractor's mean, plus or minus 2 times the Contractor's sample standard deviation. When the Contractor's sample standard deviation is less than 260 psi, then 260 psi shall be used for the sample standard deviation during lot comparison with KDOT's value. When there are 3 or more tests in a lot and when the lot comparison between Contractor and KDOT tests pass, the Contractor's actual standard deviation will be used to calculate the compressive strength pay factor. When requested, KDOT will provide a copy of this program to the Contractor. It is the Contractor's responsibility to obtain the software required to run this program.

Values computed using equations referenced in this specification may vary slightly from the spreadsheet values due to the rounding of numbers. In such cases, the numbers computed by the spreadsheet shall take precedence.

A typical lot is defined as a normal day's placement. At the beginning of the project, estimate the quantity to be placed during a normal day and submit to the Engineer for approval. Once approved, break the quantity into 4 equal parts (each part represents a sublot). Determine a random location for sampling within each sublot. When the total quantity for the day deviates from expectations, adjust the number of sublots based on **TABLE 306-1**.

TABLE 306-1: SUBLOT BREAKDOWN OF A NORMAL DAY'S PRODUCTION	
Number of Sublots	**% of Daily Quantity**
4	75-115
3	50-74
2	25-49
1	1-24

Adjust the quantity of the last sublot to accommodate any minor changes in production, and adjust the random location for sampling based on the size of the sublot. When there is only 1 test in a lot, the pay factor will be automatically calculated by the KDOT spreadsheet using a sample standard deviation of 260 psi and n of 3. When there are 2 tests in a lot, the pay factor will be calculated by the KDOT spreadsheet using a spreadsheet calculated standard deviation and n of 3. When there are 3 or 4 tests, the lot stands on its own. Regardless of the number of Contractor tests in a lot, the lot comparison between Contractor and KDOT tests will apply. When the quantity exceeds 115% of the normal daily quantity, increase the number of sublots and restrict the 4th sublot to a maximum of 100% of the established normal daily quantity. Each sublot added may have a maximum of 25% of the normal daily quantity.

Compute the sample standard deviation as shown in Section 5.2.1-Statistics, Part V.

Calculate the Compressive Strength Quality Indices ($\boldsymbol{Q_L}$) for each lot as shown in Section 5.2.1-Statistics, Part V. Use the following definitions, and round to the nearest hundredth.

Where: $\overline{X}$ is the average measured compressive strength of all QC samples representing a lot, rounded to 1.0 psi.
LSL is the lower specification limit for compressive strength, defined as 650 psi.
S is the sample standard deviation of the compressive strength of all QC samples representing a lot, rounded to 0.1 psi.

Determination of the percent within limits (***PWL***) values. Use the computed ***Q*** value to determine the compressive strength percent within limits value ($\boldsymbol{PWL_C}$) by locating the $\boldsymbol{Q_L}$ values in the left column of the ***PWL*** Table in Section 5.2.1-Statistics, Part V. Select the appropriate $\boldsymbol{PWL_C}$ by moving across the selected $\boldsymbol{Q_L}$ to the column representing the number of samples in the lot.

When the computed $\boldsymbol{Q_L}$ is a negative value ($\overline{X}$ lies below the ***LSL***), the Engineer will determine if the material in the lot may remain in place. If the material is left in place, and there were no individual plugs found to be less than 600 psi, then 50.00 is assigned as the ***PWL*** value. For results exceeding these limits and permitted to remain in place, use the calculated ***PWL*** value.

When the computed Q_L is greater than the largest Q_L value shown in the table, a value of 100.00 is assigned as the ***PWL*** value for the designated PWL_C.

Computation of Cement Treated Base Compressive Strength Pay Adjustment. Compute the pay factor for compressive strength using Equation 2 and round to nearest thousandth (0.001). Multiply the pay factor times the square yards, times $5.00 per square yard to determine the pay adjustment.

Equation 2:

$$P = \frac{(PWL_C \text{ x } 0.15)}{100} - 0.135$$

Cement Treated Base Compressive Strength Pay Factor (Failing Comparison Test). When the comparison between Contractor and KDOT tests fails, use KDOT test results to calculate the compressive strength pay factor for the lot. Follow the procedures as stated above to determine the pay factor or disposition of the lot. Use the following values to determine Q_L: $\overline{X}$ of KDOT's test result for the lot, ***S*** of 260 psi, ***LSL*** of 650 psi. When selecting the PWL_C value from the ***PWL*** in TABLE 2, use ***n*** of 4.

h. Weather Limitations. Do not place material if the CTB will be exposed to ambient air temperatures below 32ºF during the first 7 days of cure. (See **subsections 306.4b., c.** and **f.**). Remove and replace all CTB that is permitted to freeze within the first 24 hours, whether frozen on the surface or full depth. When materials are exposed to freezing ambient air temperatures after the first 24 hours but before the 7 day cure period is complete, demonstrate that the 7 day design strength has been achieved. Failure to demonstrate the 7 day design strength has been achieved shall require removal and replacement at Contractor's expense.

As directed by the Engineer and at the Contractor's expense, repair or replace cured materials exposed to ambient air temperatures below freezing or repeated freeze/thaw cycles that result in loosening or fluffing of the surface.

A lift of pavement placed prior to exposure to freezing ambient air temperatures constitutes curing of the CTB.

Do not place material on frozen subgrade. Mixing and placing may proceed when the ambient air temperature is 40ºF and rising, and discontinue when the ambient air temperatures reaches 45ºF and falling.

306.5 MEASUREMENT AND PAYMENT

The Engineer will measure the CTB and quality control testing of CTB by the square yard. Material placed beyond the neat lines indicated in the Contract Documents is not measured for payment unless authorized by the Engineer.

Payment for "Cement Treated Base" and "Quality Control Testing (CTB)" at the contract unit prices is full compensation for the specified work.

No adjustment of the contract unit price for "Quality Control Testing (CTB)" is made for overruns or underruns in the contract quantity.

If the PCCP in the contract is specified as QC/QA, (Quality Control Testing (CTB) is included as a bid item), compressive strength pay adjustments will apply under the bid item "Cement Treated Base Compressive Strength Pay Adjustment" and will be shown as an added item to the contract.

11-09-18 C&M (RAB)
May-19 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2015 EDITION

Delete SECTION 403 and replace with the following:

SECTION 403

ON GRADE CONCRETE

403.1 DESCRIPTION

Provide the grades of concrete specified in the Contract Documents.

This specification is specific to On Grade Concrete. See **SECTION 401** for general concrete requirements.

403.2 MATERIALS

Provide materials that comply with the applicable requirements.

General Concrete.	**SECTION 401**
Aggregate	**DIVISION 1100**
Admixtures and Plasticizers	**DIVISION 1400**
Grade 2 Calcium Chloride	**DIVISION 1700**
Admixtures and Plasticizers	**DIVISION 1400**
Cement, Fly Ash, Silica Fume, Slag Cement and Blended Supplemental Cementitious	**DIVISION 2000**
Water	**DIVISION 2400**

403.3 CONCRETE MIX DESIGN

a. General. Design the concrete mixes for on grade concrete as specified in the Contract Documents.

b. Concrete Mix Design. Use procedures outlined in **SECTION 401**.

c. Portland Cement and Blended Hydraulic Cement and Supplemental Cementitious Materials. Unless specified otherwise in the Contract Documents, select the type of portland cement, blended hydraulic cement and supplemental cementitious materials as specified in **SECTION 401**.

d. On Grade Concrete Specific Requirements. Use Optimized, Air-Entrained Concrete. Provide the Engineer written notification of mix design selection prior to the pre-construction conference.

(1) Design air-entrained concrete for pavement meeting **TABLE 403-1**.

(2) Design air-entrained concrete for shoulders meeting **TABLE 403-2**.

(3) Design air-entrained concrete for other uses with a maximum water to cementitious ratio of 0.45 and a minimum cementitious content of 480 lbs per cubic yard.

(4) For projects that are not QC/QA paving projects, verify the mix design in the field by performing compressive strength tests on cylinders made from samples taken from concrete produced at the project site before or during the first day that concrete pavement is placed on the project. If the compressive strength tests indicate noncompliance with minimum design values, suspend paving operations and submit a new mix design for approval.

(5) Control air content for PCCP by **subsection 403.4**.

(6) The amount of cementitious material listed in **TABLES 403-1** and **403-2** is the designated minimum for concrete pavement and shoulders respectively. It may be necessary to add additional cementitious material or otherwise adjust the mix proportions as permitted by the specifications to provide a mix design that complies with the compressive strength and permeability requirements.

(7) Maximum limit of lb. of water per lb. of cementitious material includes free water in aggregates, but excludes water of absorption of the aggregates.

(8) Concrete permeability requirements according to **TABLES 403-1** and **403-2**.

(9) Permeability requirements do not apply for concrete patching material used in **SECTION 833** when existing pavement to be patched is more than 10 years old.

(10) ASTM C1567 may be required if supplementary cementitious materials (SCMs) other than silica fume are utilized. See **subsection 401.3j.** for requirements.

TABLE 403-1: AIR-ENTRAINED CONCRETE FOR PAVEMENT						
lb. of Cementitious per yd^3 of Concrete, minimum	**lb. of Water per lb. of Cementitious, maximum**	**Percent of Air by Volume**	**28-Day Comp Strength, psi minimum**	**Volume of Permeable Voids, maximum**	**Surface Resistivity, minimum**	**Rapid Chloride Permeability, maximum**
517	0.45	See **subsection 403.3e.**	4000	12.5%	9.0 kΩ-cm	3000 Coulombs

TABLE 403-2: AIR-ENTRAINED CONCRETE FOR SHOULDERS					
lb. of Cementitious per yd^3 of Concrete, minimum	**lb. of Water per lb. of Cementitious, maximum**	**Percent of Air by Volume**	**Volume of Permeable Voids, maximum**	**Surface Resistivity, minimum**	**Rapid Chloride Permeability, maximum**
480	0.45	See **subsection 403.3e.**	12.5%	9.0 kΩ-cm	3000 Coulombs

(11) Concrete for shoulders using the same aggregates, gradations, and water to cementitious ratio as the mainline pavement concrete on the same project will be approved without testing for Volume of Permeable Voids, Surface Resistivity or Rapid Chloride Permeability.

e. Design Air Content. Provide a minimum air content that complies with these 2 criteria:

- a minimum volume of 5.0% or the volume determined using Equation C, whichever is greater, as measured behind the paver, and
- a maximum AVA spacing factor of 0.0100 inch behind the paver.

For a typical PCCP, design the mix at the minimum air content plus 0.5%.

The target air content is the air content that meets both criteria above.

If the AVA spacing factor exceeds 0.0100 inch, use Equation C to determine the target air content required to produce an acceptable spacing factor.

Equation C: Min. % air content at 0.0100 inch = % air measured + (measured AVA spacing factor – 0.0100)/0.0010.

Mixes with Laboratory or Field Prequalification AVA spacing factors greater than 0.0100 inch will not be approved.

When AVA spacing factors exceed 0.0100 inch take immediate steps to reduce the spacing factor. The Field Engineer will conduct an investigation using the following steps. If any one of the steps 1 through 9 corrects the problem, the Field Engineer will stop the investigation. The steps may be completed in combination and/or out of order. For example some may want to conduct steps 5 or 6 before some of the other steps.

1. If the failing sample came from behind the paver, the Engineer will take the following steps. Obtain an AVA sample from a unit weight bucket of concrete obtained from grade in front of the paver. Also, measure the total air content in the concrete on the grade in front of the paver. Obtain AVA and total air samples from behind

the paver. Determine the loss of air and spacing factor due to the paving operation. Adjust for air loss due to paving.

2. Verify calibration of the AVA.
3. Change the location of the AVA during testing.
4. Call in the Research Unit or another AVA machine for comparison testing.
5. Check the mix design for compliance with **SECTION 401**.
6. Check all of the gradations.
7. Check the total air content vs. target air content.
8. Check for Contractor compliance with admixture supplier's recommendations on dosage rates and order of introduction of the chemicals into the mix.
9. Check for material compatibility by using different admixtures or sources of admixtures.

Refer to the "11 Strategies to Improve the Air-Void Spacing Factor" in **APPENDIX A**.

If the problem is not corrected, the Field Engineer will take the following steps:

Obtain 2 cores from any area with an AVA spacing factor >0.0125 inches and send to Materials Research Center for hardened air evaluation.

- If the AVA spacing factor > 0.0125 inches and the average hardened air spacing factor is > 0.0080 inches, then suspend paving and submit new mix design.
- If the AVA spacing factor > 0.0125 inches and the average hardened air spacing factor < 0.0080 inches, then accept PCCP.

Take immediate steps to increase the air content whenever the air content behind the paver falls below 5.0%. Suspend paving operations when 2 consecutive air contents behind the paver fall below 5.0%. Suspend paving operation and remove and replace the represented concrete when air content behind the paver falls below 4.0%.

Air Void Spacing Factor does not apply to concrete used in **SECTION 833** when existing pavement to be patched is more than 10 years old.

The maximum air content is 10%. Take immediate steps to reduce the air content whenever the air content exceeds 8%.

f. Slump.

(1) Maximum design slump for slip form On Grade Concrete is 2 ½ inches. Do not designate a slump in excess of 5 inches for all other On Grade Concrete.

(2) For all other On Grade Concrete placement, designate a slump that is required for satisfactory placement of the concrete application. Reject concrete with a slump that limits the workability or placement of the concrete.

(3) If the designated slump is 3 inches or less, the tolerance is ±3/4 inch, or limited by the maximum allowable slump for the individual type of construction.

(4) If the designated slump is greater than 3 inches the tolerance is ±25% of the designated slump.

403.4 AIR-ENTRAINED ON GRADE CONCRETE

a. Air Content for PCCP. Provide an air content that complies with **subsection 401.3e**.

Using fresh concrete, the Engineer will determine the air void spacing factor using the AVA according to the manufacturer's requirements. Prequalify mixtures by either the laboratory option or the field option. Contact the Engineer to arrange testing by the AVA. Additional AVA testing will be required if the concrete plant is changed during the course of the project.

b. Laboratory Prequalification. Prepare a trial mix using a drum-type mixer according to AASHTO T 126 using all of the materials in the proportions, except the air entraining agent, contemplated for use in the field. Laboratory mixes require more air entraining agent than is needed in the field.

The Engineer will perform the following: Consolidate a sample in the unit weight bucket by vibration according to KT-20. Obtain 3 samples from the unit weight bucket for testing by the AVA. Valid results must have a minimum of 2 spacing factor readings within a range of 0.0025 inch. Test the third sample if the first 2 do not meet these criteria. Determine the air content of the trial mix by KT-19 (Volumetric Method) or KT-18 (Pressure

Method) calibrated to yield the same result. Calculate a target percent air content at a maximum air void spacing factor of 0.01 inch using the equation in **subsection 403.3e.**, when applicable.

c. Field Prequalification. Produce a trial batch at a minimum air temperature of 60ºF using the batch plant and project materials.

The Engineer will perform the following: Test for air content by the procedure specified under laboratory prequalification. Correlate this air content to the average of at least 2 valid AVA test results. Valid AVA results have a maximum range of 0.0025 inch.

When necessary, calculate a target percent air content at a maximum AVA spacing factor of 0.0100 inch, using the Equation C in **subsection 403.3e**.

d. Field Verification. Coordinate with the Engineer so production samples may be obtained behind the paver to establish the target air content on the first paving day. Produce concrete using the same materials and proportions that were used in the prequalification mixture. Adjustments may be approved in the dosage of air entraining agent. AVA samples will be taken both in the path of a vibrator and the gap between vibrators.

Perform the test for air content at the delivery site of the concrete KT-19 (Roll-a-meter) or KT-18 (pressure meter), calibrated to yield the same result.

e. Control of the Air Content During Paving Operations. Maintain an air content behind the paver as determined by KT-19 or KT-18, which meets **subsection 403.3e**. Maintain all production parameters established during field verification. The dosage of air-entraining agent may be varied to control the air content. With AVA testing, 5% adjustments will be permitted to the aggregate proportions, as well as any adjustment to the water reducer in accordance with **subsection 401.3k**. Comply with all specifications regarding production of fresh concrete.

Determine the air loss due to paving operations at a minimum of two randomly-determined sublots per day. Determine the difference between the air content from concrete sampled before the paver, and concrete sampled behind the paver. QC/QA samples may be obtained in front of the paver and then corrected subtracting the difference determined during that ½ days production. Loss of air due to paving operations may adversely affect the spacing factor.

Failure to maintain the minimum required air content will result in suspension of operation. Take immediate steps to increase the air content above the minimum values stated in **subsection 403.3e**.

Other similar designs using higher cementitious contents (this may adversely affect permeability) and the same admixture types and dosage (with the same or lower water-cementitious ratio) may be used in limited areas such as crossovers, etc. Unauthorized changes in any aspect of production are cause for rejection of the pavement.

Random checks of the air void spacing factor of the concrete in the path and gap of the vibrators will be conducted by the Engineer to verify a maximum AVA spacing factor of 0.0100 inch at the measured air content.

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APPENDIX A – NON-MANDATORY INFORMATION

STRATEGIES TO IMPROVE THE AIR VOID SPACING FACTOR

Better air-void characteristics are obtained by a more thorough mixing of the sand and the air-entraining agent. Below are listed some strategies to help the mixing process.

1. Increase the mixing time of the plant or mixing revolutions of the truck.
2. Use a higher dosage of water reducer, up to 390 ml per 100 kg (6 oz. per 100 lbs) of cement. Use a non-retarding water reducer above 195 ml per 100 kg (3 oz. per 100 lbs) if needed.
3. Reduce the Paste Content (less water or less cement).
4. Use a higher proportion of rock.
5. Use a third, mid-sized aggregate.
6. Use coarser graded sand, or a finer sand if the current one is extremely coarse.
7. Maintain a higher air content (use more air-entraining agent).
8. Use coarser cement.
9. Change types or brands of the water reducer or the air entraining agent, or both.
10. Cool the mix ingredients; i.e., use chilled water.
11. Use a different plant, or modify the plant configuration. Introduce aggregates together on the belt feed (multiple weigh hoppers), use live bottoms aggregate bins, use dual drums, etc.

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2015 EDITION

Delete SECTION 401 and replace with the following:

SECTION 401

GENERAL CONCRETE

401.1 DESCRIPTION

Provide the grades of concrete specified in the Contract Documents.
See **SECTION 402** for specific requirements for Structural Concrete.
See **SECTION 403** for specific requirements for On Grade Concrete.
See **SECTION 404** for specific requirements for Prestressed Concrete.

401.2 MATERIALS

Provide materials that comply with the applicable requirements.

Aggregate .... **DIVISION 1100**
Admixtures and Plasticizers .... **DIVISION 1400**
Grade 2 Calcium Chloride.. **DIVISION 1700**
Cement, Fly Ash, Silica Fume, Slag Cement and Blended Supplemental
Cementitious.. **DIVISION 2000**
Water ………………………………………………………………….......................…..**DIVISION 2400**

401.3 CONCRETE MIX DESIGN

a. General. Design the concrete mixes specified in the Contract Documents.

Do not place any concrete on the project until the Engineer approves the concrete mix designs. Once the Engineer approves the concrete mix design, do not make changes without the Engineer's approval.

Take full responsibility for the actual proportions of the concrete mix, even if the Engineer assists in the design of the concrete mix.

Provide aggregate gradations that comply with **DIVISION 1100** and Contract Documents.

Admixture dosage rate requirements for mix design approval and field production are provided in **subsection 401.3k**.

If desired, contact the DME for available information to help determine approximate proportions to produce concrete having the required characteristics on the project.

Submit all concrete mix designs to the Engineer for review and approval. Submit completed volumetric mix designs on KDOT Form No. 694 and all required attachments at least 60 days prior to placement of concrete on the project. The Engineer will provide an initial review of the design within 5 business days following submittal.

Include the following information:

(1) Test data from KT-73 tested at 28 days, KT-79 tested at 28 days or AASHTO T-277 tested at 56 days. Provide test results on a minimum of 1 set of 3 cylinders for each mix, tested at the highest water to cementitious material ratio that meets **subsection 401.3h**. Submit accelerated cure procedures for the Engineer's approval.

(2) Test data from ASTM C 1567 for blended cements meeting **subsection 401.3j.** for all concrete utilizing all actual materials proposed for use on the project at designated percentages.

(3) Single point grading for the combined aggregates along with a plus/minus tolerance for each sieve. Use plus/minus tolerances to perform quality control checks and by the Engineer to perform aggregate grading verification testing. The tests may be performed on the combined materials or on individual aggregates, and then theoretically combined to determine compliance.

(4) Laboratory 28-day compressive strength test results on a minimum of 1 set of 3 cylinders produced from the mix design with the highest water to cementitious ratio for the project, utilizing all actual materials

proposed for use on the project at designated percentages. The average compressive strength shall exceed the strength requirements for the Grade specified in the Contract Documents as determined by **subsection 401.3b**. Perform compressive strength tests according to KT-76.

(5) Historical mix production data for the plant producing concrete for the project to substantiate the standard deviation selected for use in **subsection 401.3b.**, if applicable.

(6) Necessary materials to enable the Engineer to test the mix properties, if applicable.

(7) Batching sequence. Consider the location of the concrete plant in relation to the job site, and identify when and at what location the water reducer or plasticizer is added to the concrete mixture.

Submit complete mix design data including proportions and sources of all mix ingredients, and the results of strength and permeability tests representing the mixes proposed for use. The data may come from previous KDOT project records or a laboratory regularly inspected by Cement and Concrete Reference Laboratory (CCRL). Data from other sources will only be accepted if testing was conducted or witnessed by personnel certified in Hardened Concrete Properties (HCP) according to the Policy and Procedures Manual for The Certified Inspection and Testing (CIT) Training Program.

After initial review, the Engineer will perform any testing necessary to verify the design. This may include a 3-cubic yard test batch at the producing plant. Do not make changes to the Approved Concrete Mix Design without the Engineer's approval. Limited adjustments may be made to admixture dosages and aggregate proportions in accordance with **subsection 401.3i.** and **subsection 403.4e**. These adjustments must be recorded and submitted to the Engineer.

Mix designs will remain approved when verification testing for strength and permeability conducted within the last 12 months indicate continued compliance with the specifications and percentages of constituents including aggregate and cementitious materials and product, type and supplier of admixtures remain the same. Test results on the same mix from other sources are acceptable.

Improvements in concrete strength, workability, durability and permeability are possible if the combined aggregate grading is optimized. Procedures found in ACI 302.1 or other mix design techniques, approved by the Engineer, are acceptable in optimizing the mix design.

Delay the commencement of tests for temperature, slump, and air content and molding of field cylinders from 4 to 4½ minutes after the sample has been taken from a continuous mixer. If a batch type mixer is used, take the tests at the point of placement and begin testing immediately.

b. Required Compressive Strength for Concrete Mix Design. The required compressive strength for mix design approval shall be based on previous data from similar mix designs or according to **subsection 401.1b.(2)**.

(1) Concrete Mix Design Based on Previous Data. Provide concrete mix designs based on previous 28-day compressive strength test data from similar concrete mixtures. Similar mixtures are within 1000 psi of the specified 28-day compressive strength, and are produced with the same type and sources of cementitious materials, admixtures and aggregates.

Consider sand sources the same, provided they are not more than 25 miles apart on the same river and no tributaries enter the river between the 2 points. Consider crushed locations similar if they are mined in one continuous operation, and there is no significant change in geology. Mixes that have changes of more than 10% in proportions of cementitious materials, aggregates or water content are not considered similar.

Air entrained mixes are not considered similar to non-air entrained mixes.

Mixes tested with admixtures are not the same as mixes tested without those admixtures.

Test data should represent at least 30 separate batches of the mix. One set of data is the average of at least 2 cylinders from the batch. The data shall represent a minimum of 45 days of production within the past 12 months.

Do not include data over 1 year old. When fewer than 30 data sets are available, the standard deviation of the data must be corrected to compensate for the fewer data points.

Provide a 4000 psi concrete with a $f'cr$ greater than or equal to 5200 psi. Otherwise provide a concrete mix design that will permit no more than 5% of the 28-day compressive strength tests to fall below the specified 28-day compressive strength ($f'c$) based on equation A, and no more than 1% of the 28-day compressive strength tests to fall below the specified 28-day compressive strength ($f'c$) by more than 500 psi based on equation B.

Equation A: $f'cr = f'c + 1.62*k*s$

Equation B: $f'cr = (f'c\text{-}500) + 2.24*k*s$

Where: $f'cr$ = average 28-day compressive strength required to meet the above criteria.
$f'c$ = specified 28-day compressive strength
s = standard deviation of test data
k = constant based on number of data points
n = number of data points
$k = 1.3 - n / 100$, where $15 < n < 30$
$k = 1$, where $n > 30$

Provide a concrete mix design that has an average compressive strength that is equal to the larger of Equation A or Equation B. Submit all supporting test data with the mix design.

(2) All Other Concrete Mix Designs. For concrete mixes that have fewer than 15 data points, or if no statistical data is available, use Equations A and B to calculate $f'cr$ using the following values.

s = 20% of the specified 28-day compressive strength ($f'c$)
$k = 1$

c. Portland Cement and Blended Hydraulic Cement. Unless specified otherwise in the Contract Documents, select the type of portland cement or blended hydraulic cement according to **TABLE 401-1**.

TABLE 401-1: PORTLAND CEMENT & BLENDED HYDRAULIC CEMENT

Concrete for:	Type of Cement Allowed
On Grade Concrete	Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type IL(x) Portland-Limestone Cement Type II Portland Cement
All Concrete other than On Grade Concrete.	Type I Portland Cement Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type IL(x) Portland Limestone Cement Type II Portland Cement
High Early Strength Concrete	Type III Portland Cement Type I, IP(x), IS(x), IT(Ax)(By), Type IL(x) or II Cement may be used if strength and time requirements are met.

d. Blended Cement Concrete. When approved by the Engineer, the concrete mix design may include SCMs such as fly ash, slag cement, silica fume or blended SCM from an approved source as a partial replacement for portland cement or blended hydraulic cement except where controlled in **SECTIONS 402, 403** or **404**. Obtain the Engineer's approval before substituting SCMs for Type III cement. Changes in SCM or cement will require a new mix design approval.

(1) Cements meeting **SECTION 2001** are not field blended cements.

(2) Cements with SCMs added at the concrete mixing plant are field blended cements.

(3) Supplementary materials can be combined with cement to create field blended cements. Do not exceed allowable substitution rates noted in **TABLE 401-2**. Substitute 1 pound of SCM for 1 pound of cement.

(4) SCMs in prequalified cements are to be included in the total combined substitution rate.

TABLE 401-2: ALLOWABLE SUBSTITUTION RATE FOR SUPPLEMENTARY CEMENTITIOUS MATERIAL.	
Material	**Substitution Rate***
Slag Cement	40% Maximum
Fly Ash	25% Maximum
Blended SCM	25% Maximum
Limestone	10% Maximum
Silica Fume	5% Max
Total Combined	50%

* Total Substitution Rate includes material in preblended cements and blended SCMs.

(5) When used, add silica fume with other cementitious materials during batching procedures. If the silica fume cannot be added to the cementitious materials, add the loose silica fume to the bottom of the stationary drum that is wet, but has no standing water, before adding the dry materials. The Engineer may approve shreddable bags on a performance basis, only when a central batch mixing process is used. If so, add the bags to half of the mixing water and mix before adding cementitious materials, aggregate and remainder of water.

Mix silica fume modified concrete for a minimum of 100 mixing revolutions.

e. Strength. Design concrete to meet **TABLE 401-3**.

TABLE 401-3: CONCRETE STRENGTH REQUIREMENTS	
Specified 28 Day Compressive Strengths, minimum, psi *f'c*	
Grade of Concrete:	**Non Air Entrained/Air Entrained Concrete**
Grade 7.0	7,000
Grade 6.0	6,000
Grade 5.0	5,000
Grade 4.5	4,500
Grade 4.0	4,000
Grade 3.5	3,500
Grade 3.0	3,000
Grade 2.5	2,500

f. High Early Strength Concrete (HESC). Design the high early strength concrete mix to comply with strength and time requirements specified in the Contract Documents.

Unless otherwise specified, design high early strength concrete for pavement at a minimum of 1 of the Contractor's standard deviations above 2400 psi (cylinders) at 24 hours. If no statistics are available, design a HESC with a compressive strength greater or equal to 2880 psi.

Submit complete mix design data including proportions and sources of all mix ingredients, and the results of time and strength tests representing the mixes proposed for use. The strength and time data may come from previous KDOT project records or from an independent laboratory, and shall equal or exceed the strength and time requirements listed in the Contract Documents.

g. Slump. Designate a slump for each concrete mix design that is required for satisfactory placement of the concrete application not to exceed 5 inches except where controlled by maximum allowable slumps stated in **SECTIONS 402, 403** and **404**. Reject concrete with a slump that limits the workability or placement of the concrete.

h. Permeability. Supply concrete meeting the permeability requirements specified in **SECTION 402** for structural concrete and **SECTION 403** for on grade concrete. Permeability testing from KT-73 tested at 28 days, KT-79 tested at 28 days **or** AASHTO T-277 tested at 56 days is required for all bridge overlays, Moderate Permeability Concrete, and any project with over 250 cubic yards of concrete (this includes structural concrete, on grade concrete etc.). The field verification test procedure must be the same test procedure as the mix design approval test.

There are no permeability requirements for concrete for prestressed concrete members as specified in **SECTION 404**.

i. Air Content. Determine air content by KT-18 (Pressure Method) or KT-19 (Volumetric Method). With the exception of concrete for pavement as shown in **SECTION 403**, use the middle of the specified air content range of 6.5 ± 1.5% for the design of air entrained concrete. Maximum air content is 10%. Take immediate steps to reduce the air content whenever the air content exceeds 8%.

j. Alkali Silica Reactivity. If the concrete mix design includes supplemental cementitious materials (SCMs), provide mortar expansion test results from ASTM C 1567 as part of mix design approval unless meeting the minimum requirements shown in **TABLE 401-4**. Use the project's mix design concrete materials at their designated percentages. Provide a mix with a maximum expansion of 0.10% at 16 days after casting. Provide ASTM C 1567 results on an annual basis.

<table>
<tr><th colspan="5">TABLE 401-4: MINIMUM SCM CONTENT REQUIRED TO WAIVE ASTM C 1567 TESTING</th></tr>
<tr><th rowspan="2">Type of Coarse Aggregate Sweetener#

See TABLE 1102-2 or TABLE 1116-1</th><th colspan="4">Proportion Required by Percent Weight of Total Cementitious Material</th></tr>
<tr><th>Slag Cement</th><th>Class C Fly Ash</th><th>Class F Fly Ash</th><th>Silica Fume</th></tr>
<tr><td>Crushed Sandstone</td><td colspan="2" rowspan="3">ASTM C 1567 Testing Required</td><td>25%</td><td>Any*</td></tr>
<tr><td>Crushed Limestone or Dolomite</td><td>25%</td><td>Any*</td></tr>
<tr><td>Siliceous Aggregate Meeting subsection 1102.2a.(2) or 1116.2a.(2)</td><td>25%</td><td>Any*</td></tr>
<tr><td>Any combination of Limestone (or Dolomite or Sandstone) and Siliceous Aggregate meeting subsection 1102.2a.(2) or 1116.2a.(2) or any TMA</td><td>Any*</td><td>≥15%</td><td>Any*</td><td>Any*</td></tr>
</table>

*Subject to the maximum allowable percentages in **TABLE 401-2**.

ASTM C 1567 Testing can be waived for ternary mix designs with approval of the KDOT Bureau of Research.

k. Admixtures for Acceleration, Air-Entraining, Plasticizing, Set Retardation and Water Reduction. Verify that the admixtures used are compatible and will work as intended without detrimental effects. Use the dosages recommended by the admixture manufacturers. Incorporate and mix the admixtures into concrete mixtures according to the manufacturer's recommendations. Determine the quantity of each admixture for the concrete mix design.

(1) Accelerating Admixture. When specified in the Contract Documents, or in situations that involve contact with reinforcing steel and require early strength development to expedite opening to traffic, a non-chloride accelerator may be approved. The Engineer may approve the use of a Type C or E accelerating admixture. A Grade 2 calcium chloride accelerator may be used when patching an existing pavement more than 10 years old.

Add the calcium chloride by solution (the solution is considered part of the mixing water).

- For a minimum cure of 4 hours at 60°F or above, use 2% (by dry weight of cement) calcium chloride.
- For a minimum cure of 6 hours at 60°F or above, use 1% (by dry weight of cement) calcium chloride.

(2) Air-Entraining Admixture. When specified, use an air-entraining admixture in the concrete mixture. If another admixture is added to an air-entrained concrete mixture, determine if it is necessary to adjust the air-entraining admixture dosage to maintain the specified air content.

(3) Water-Reducers and Set-Retarders. A water-reducing admixture for improving workability may be required. If unfavorable weather or other conditions adversely affect the placing and finishing properties of the concrete mix, the Engineer may allow the use of water-reducers and set-retarders. Verify that the admixtures will work as intended without detrimental effects. If the Engineer approves the use of water-reducers and set-retarders, their continued use depends on their performance.

(4) Plasticizer Admixture. A plasticizer is defined as an admixture that produces flowing concrete, without further addition of water, and/or retards the setting of concrete. Flowing concrete is defined as having a slump equal to or greater than 7 ½ inches while maintaining a cohesive nature.

Manufacturers of plasticizers may recommend mixing revolutions beyond the limits specified in **subsection 401.8**. If necessary, address the additional mixing revolutions in the concrete mix design. The Engineer may allow up to 60 additional revolutions when plasticizers are designated in the mix design.

Before the concrete mixture with a slump equal to or greater than 7 ½ inches is used on the project, conduct tests on at least 1 full trial batch of the concrete mix design in the presence of the Engineer to determine the adequacy of the dosage and the batching sequence of the plasticizer to obtain the desired properties. Determine the air content of the trial batch both before and after the addition of the plasticizer. Monitor the slump, air content, temperature and workability at regular intervals of the time period from when the plasticizer is added until the estimated time of completed placement. At the discretion of the Engineer, if all the properties of the trial batch remain within the specified limits, the trial batch may be used in the project.

Do not add water after plasticizer is added to the concrete mixture.

(5) Field Adjustment to Admixtures. Limited adjustments to the dosage rate of accelerators, set-retarders, water reducers, and air-entraining admixtures are permitted to compensate for environmental changes during placement without a new concrete mix design or trial batch. Test the concrete for temperature, air content, and slump whenever changes are made to the dosage rates to ensure continued compliance with the specifications. The allowable adjustments are based on the dose used in the Approved Concrete Mix Design and according to the following:

- Do not exceed the accelerator dosage used in the Approved Concrete Mix Design. The accelerator dosage may be reduced or eliminated as needed. Redosing accelerators is not permitted.
- The water reducer dosage used in the Approved Concrete Mix Design sets the minimum permitted dose for use in the field. The water reducer dose may be increased from that shown in the Approved Concrete Mix Design provided that the slump does not to exceed the maximum designated slump. Slump reduction may be obtained by withholding a portion of the mix water as specified in **subsection 401.8a**.
- Redosing of water reducers and air-entraining admixtures is permitted to control slump or air content in the field, when approved by the Engineer, time and temperature limits are not exceeded, and at least 30 mixing revolutions remain before redosing. Redose according to manufacturer's recommendations.
- Set retarders may be added as needed during production. Do not include set retarders in the Concrete submitted for Mix Design Approval. Redosing retarders is not permitted. Paperwork for submitted mix designs (Form 694) with no (zero) water reducer and/or set retarder in the original Concrete submitted for Mix Design Approval must show the manufacturer of the admixtures that may be included in the Project Concrete.

401.4 REQUIREMENTS FOR COMBINED MATERIALS

a. Measurements for Proportioning Materials.

(1) Cement. Measure cement as packed by the manufacturer. A sack of cement is considered as 0.04 cubic yards weighing 94 pounds net. Measure bulk cement by weight. In either case, the measurement must be accurate to within 0.5% throughout the range of use.

(2) Supplemental Cementitious Materials. Supplemental cementitious materials proportioning and batching equipment is subject to the same controls as required for cement. Provide positive cut off with no leakage from the cut off valve. Cementitious materials may be weighed accumulatively with the cement or separately. If weighed accumulatively, weigh the cement first.

(3) Water. Measure the mixing water by weight or by volume accurate to within 1% throughout the range of use.

(4) Aggregates. Measure the aggregates by weight, accurate to within 0.5% throughout the range of use.

(5) Admixtures. Measure liquid admixtures by weight or volume, accurate to within 3% of the quantity required. If liquid admixtures are used in small quantities in proportion to the cement as in the case of air-entraining agents, use readily adjustable mechanical dispensing equipment capable of being set to deliver the required quantity and to cut off the flow automatically when this quantity is discharged.

b. Testing of Aggregates.

(1) Production of On Grade Concrete Aggregate (OGCA). If OGCA is required, notify the Engineer in writing at least 2 weeks in advance of producing the aggregate. Include the source of the aggregate and the date

production will begin. Failure to notify the Engineer, as required, may result in rejection of the aggregate for use as OGCA. Maintain separate stockpiles for OGCA at the quarry and at the batch site and identify them accordingly.

(2) Testing Aggregates at the Batch Site. Provide the Engineer with reasonable facilities at the batch site for obtaining samples of the aggregates. Provide adequate and safe laboratory facilities at the batch site allowing the Engineer to test the aggregates for compliance with the specified requirements.

KDOT will sample and test aggregates from each source to determine their compliance with specifications. Do not batch the concrete mixture until the Engineer has determined that the aggregates comply with the specifications. KDOT will conduct sampling at the batching site, and test samples according to the Sampling and Testing Frequency Chart in Part V. For QC/QA contracts, establish testing intervals within the specified minimum frequency.

After initial testing is complete, and the Engineer has determined that the aggregate process control is satisfactory, use the aggregates concurrently with sampling and testing as long as tests verify compliance with specifications. When batching, sample the aggregates as near the point of batching as feasible. Sample from the stream as the storage bins or weigh hoppers are loaded. If samples cannot be taken from the stream, take them from approved stockpiles, or use a template and sample from the conveyor belt. If test results indicate an aggregate does not comply with specifications, cease concrete production using that aggregate. Unless a tested and approved stockpile for that aggregate is available at the batch plant, do not use any additional aggregate from that source and specified grading until subsequent testing of that aggregate indicate compliance with specifications. When tests are completed and the Engineer is satisfied that process control is satisfactory, production of concrete using aggregates tested concurrently with production may resume.

c. Handling of Materials.

(1) Approved stockpiles are permitted only at the batch plant and only for small concrete placements or for maintaining concrete production. Mark the approved stockpile with an "Approved Materials" sign. Provide a suitable stockpile area at the batch plant so that aggregates are stored without detrimental segregation or contamination. At the plant, limit stockpiles of tested and approved coarse, fine and intermediate aggregate to 250 tons each, unless approved for more by the Engineer. If mixed aggregate is used, limit the approved stockpile to 500 tons, the size of each being proportional to the amount of each aggregate to be used in the mix.

Load aggregates into the mixer such that no material foreign to the concrete or material capable of changing the desired proportions is included.

(2) Segregation. Do not use segregated aggregates. Previously segregated materials may be thoroughly re-mixed and used when representative samples taken anywhere in the stockpile indicated a uniform gradation exists.

(3) Cement and Supplemental Cementitious. Protect cement and supplemental cementitious materials in storage or stockpiled on the site from any damage by climatic conditions which would change the characteristics or usability of the material.

(4) Moisture. Provide aggregate with a moisture content of ±0.5% from the average of that day. If the moisture content in the aggregate varies by more than the above tolerance, take whatever corrective measures are necessary to bring the moisture to a constant and uniform consistency before placing concrete. This may be accomplished by handling or manipulating the stockpiles to reduce the moisture content, or by adding moisture to the stockpiles in a manner producing uniform moisture content through all portions of the stockpile.

Handheld moisture-determining devices are permitted. For plants equipped with an approved accurate moisture-determining device capable of continuously determining the free moisture in the aggregates, and provisions made for batch to batch correction of the amount of water and the weight of aggregates added, the requirements relative to manipulating the stockpiles for moisture control will be waived. Approval and accuracy of the moisture-determining device is based on daily comparisons with KT-24 or ASTM C 566 and at the discretion of the Engineer. Any procedure used will not relieve the producer of the responsibility for delivering concrete of uniform slump within the limits specified.

(5) Separation of Materials in Tested and Approved Stockpiles. Only use KDOT Approved Materials. Provide separate means for storing materials approved by KDOT. If the producer elects to use KDOT Approved Materials for non-KDOT work, during the progress of a project requiring KDOT Approved Materials, inform the Engineer and agree to pay all costs for additional material testing.

Clean all conveyors, bins and hoppers of any unapproved materials before beginning the manufacture of concrete for KDOT work.

401.5 MORTAR AND GROUT

a. General. Follow the proportioning requirements in **subsections 401.5b.** and **c.** for mortar and grout unless otherwise specified in the Contract Documents, including altering the proportions when a minimum strength is specified.

b. Mortar. Mortar is defined as a mixture of cementitious materials, FA-M aggregate and water, which may contain admixtures, and is typically used to minimize erosion between large stones or to bond masonry units.

Proportion mortar for laying stone for stone rip-rap, slope protection, stone ditch lining or pavement patching at 1 part of portland cement and 3 parts of FA-M aggregate by volume with sufficient water to make a workable and plastic mix.

Proportion mortar for laying brick, concrete blocks or stone masonry at ½ part masonry cement, ½ part portland cement and 3 parts FA-M aggregate, either commercially produced masonry sand or FA-M, by volume with sufficient water to make a workable and plastic mix.

Do not use air-entraining agents in mortar for masonry work.

The Engineer may visually accept the sand used for mortar. The Engineer may visually accept any recognized brand of portland cement or masonry cement that is free of lumps.

c. Grout. Grout is defined as a mixture of cementitious materials with or without aggregate or admixtures to which sufficient water is added to produce a pouring or pumping consistency without segregation of the constituent materials and meeting the applicable specifications.

401.6 COMMERCIAL GRADE CONCRETE

If the Contract Documents allow the use of commercial grade concrete for designated items, then use a commercial grade mixture from a ready mix plant approved by the Engineer.

The Engineer must approve the commercial grade concrete mixture. Approval of the commercial grade mixture is based on these conditions:

- All materials are those normally used for the production and sale of concrete in the vicinity of the project.
- The mixture produced is that normally used for the production and sale of concrete in the vicinity of the project.
- The mixture produced contains a minimum cementitious content of 6 sacks (564 lbs) of cementitious material per cubic yard of concrete.
- The water-cementitious ratio is as designated by the Engineer. The maximum water-cementitious ratio permitted may not exceed 0.50 pounds of water per pound of cementitious material including free water in the aggregate.
- Type I, II, III, IP, IS or IT cement may be used unless otherwise designated. Fly ash, slag cement and blended supplemental materials may be substituted for the required minimum cement content as specified in **subsection 401.3**. No additives other than air entraining agent will be allowed. The Contractor will not be required to furnish the results of strength tests when submitting mix design data to the Engineer.
- In lieu of the above, approved mix designs (including optimized) for all other grades of concrete, Grade 3.0 or above, are allowable for use as commercial grade concrete, at no additional cost to KDOT.

Exercise good engineering judgment in determining what equipment is used in proportioning, mixing, transporting, placing, consolidating and finishing the concrete.

Construct the items with the best current industry practices and techniques.

Before unloading at the site, provide a delivery ticket for each load of concrete containing the following information:

- Name and location of the plant.
- Time of batching concrete.
- Mix proportions of concrete (or a mix designation approved by the Engineer).
- Number of cubic yards of concrete batched.

Cure the various items placed, as shown in **DIVISION 700**.

The Engineer may test commercial grade concrete by molding sets of 3 cylinders. This is for informational purposes only. No slump or unit weight tests are required.

401.7 CERTIFIED CONCRETE

If KDOT inspection forces are not available on a temporary basis, the Engineer may authorize the use of concrete from approved concrete plants. Approval for this operation is based on certification of the plant and plant personnel, according to KDOT standards. KDOT's approval may be withdrawn any time that certification procedures are not followed. Contact the DME for additional information.

The Engineer will not authorize the use of certified concrete for major structures such as bridges, RCB box bridges, RCB culverts, permanent main line and ramp pavement or other structurally, critical items.

Each load of certified concrete must be accompanied by a ticket listing mix proportions, time of batching and setting on revolution counter, total mixing revolutions and must be signed by certified plant personnel.

401.8 MIXING, DELIVERY AND PLACEMENT LIMITATIONS

a. Concrete Batching, Mixing and Delivery. Batch and mix the concrete in a central mix plant, in a truck mixer or in a drum mixer at the work site. Provide plant capacity and delivery capacity sufficient to maintain continuous delivery at the rate required. The delivery rate of concrete during concreting operations must provide for the proper handling, placing and finishing of the concrete.

Seek the Engineer's approval of the concrete plant/batch site before any concrete is produced for the project. The Engineer will inspect the equipment, the method of storing and handling of materials, the production procedures and the transportation and rate of delivery of concrete from the plant to the point of use. The Engineer will grant approval of the concrete plant/batch site based on compliance with the specified requirements. The Engineer may, at any time, rescind permission to use concrete from a previously approved concrete plant/batch site upon failure to comply with the specified requirements.

Clean the mixing drum before it is charged with the concrete mixture. Charge the batch into the mixing drum such that a portion of the water is in the drum before the aggregates and cementitious material. Uniformly flow materials into the drum throughout the batching operation. All mixing water must be in the drum by the end of the first 15 seconds of the mixing cycle. Keep the throat of the drum free of accumulations restricting the flow of materials into the drum.

Do not exceed the rated capacity (cubic yards shown on the manufacturer's plate on the mixer) of the mixer when batching the concrete. The Engineer may allow an overload of up to 10% above the rated capacity for central mix plants and drum mixers at the work site, provided the concrete test data for strength, segregation and uniform consistency are satisfactory, and no concrete is spilled during the mixing cycle.

Operate the mixing drum at the speed specified by the mixer's manufacturer (shown on the manufacturer's plate on the mixer).

Mixing time is measured from the time all materials, except water, are in the drum. If it is necessary to increase the mixing time to obtain the specified percent of air in air-entrained concrete, the Engineer will determine the mixing time.

If the concrete is mixed in a central mix plant or a drum mixer at the work site, mix the batch between 1 to 5 minutes at mixing speed. Do not exceed the maximum total 60 mixing revolutions. Mixing time begins after all materials, except water, are in the drum, and ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. Mix time may be reduced for plants utilizing high performance mixing drums provided thoroughly mixed and uniform concrete is being produced with the proposed mix time. Performance of the plant must conform to Table A1.1 of ASTM C 94, Standard Specification for Ready Mixed Concrete. Five of the 6 tests listed in Table A1.1 must be within the limits of the specification to indicate that uniform concrete is being produced.

If the concrete is mixed in a truck mixer, mix the batch between 70 and 100 revolutions of the drum or blades at mixing speed. After the mixing is completed, set the truck mixer drum at agitating speed. Unless the mixing unit is equipped with an accurate device indicating and controlling the number of revolutions at mixing speed, perform the mixing at the batch plant and operate the mixing unit at agitating speed while travelling from the plant to the work site. Do not exceed 300 total revolutions (mixing and agitating). An additional 60 mixing revolutions may be allowed by the Engineer when plasticizers are designated in the mix design.

If a truck mixer or truck agitator is used to transport concrete that was completely mixed in a stationary central mixer, agitate the concrete while transporting at the agitating speed specified by the manufacturer of the equipment (shown on the manufacturer's plate on the equipment). Do not exceed 200 total revolutions (additional re-mixing and agitating).

Provide a batch slip including batch weights of every constituent of the concrete and time for each batch of concrete delivered at the work site, issued at the batching plant that bears the time of charging of the mixer drum with cementitious materials and aggregates. Include quantities, type, product name and manufacturer of all admixtures on the batch ticket.

On paving projects and other high volume work, the Engineer will evaluate the haul time, and whether tickets will be collected for every load. Thereafter, random checks of the loads will be made. Maintain all batch tickets when not collected.

When non-agitating equipment is used for transportation of concrete, place within 30 minutes of adding the cement to the water. Provide approved covers for protection against the weather when required by the Engineer.

When agitating equipment is used for transportation of the concrete, place concrete within the time and temperature conditions shown in **TABLE 401-5**.

TABLE 401-5: AMBIENT AIR TEMPERATURE AND AGITATED CONCRETE PLACEMENT TIME

T = Ambient Air Temperature at Time of Batching (°F)	Time limit agitated concrete must be placed within, after the addition of cement to water (hours)	Admixtures
T < 75	1 ½	All Cases
75 ≤ T < 90	1	None
75 ≤ T < 90	1 ½	Set Retarder
T_c = Concrete Temperature at time of placement (°F)	**Time limit agitated concrete must be placed within, after the addition of cement to water (hours)**	**Admixtures**
$90 \leq T_c^*$	¾	All Cases
Other conditions contributing to quick stiffening of concrete	¾	All Cases

Do not use concrete that has developed its initial set. Regardless of the speed of delivery and placement, the Engineer will suspend the concreting operations until corrective measures are taken, if there is evidence that the concrete cannot be adequately consolidated.

Weather conditions and the use of admixtures can affect the set times for the concrete. Do not use the time limits and total revolutions as the sole criterion for rejection of concrete. Exceed the time limits and total revolutions only after demonstrating that the properties of the concrete can be improved. Evaluation of the consistency and workability should be taken into consideration. Reject concrete that cannot be adequately consolidated.

Adding water to concrete after the initial mixing is prohibited, with this exception:

If the concrete is delivered to the work site in a truck mixer, the Engineer will allow water (up to 2 gallons per cubic yard) be withheld from the mixture at the batch site, and if needed, added at the work site to adjust the slump to the specified requirements. Determine the need for additional water as soon as the load arrives at the construction site. Use a calibrated water-measuring device to add the water, and add the water to the entire load. Do not add more water than was withheld at the batch site. After the additional water is added, turn the drum or blades an additional 20 to 30 revolutions at mixing speed. The Engineer will supervise the adding of water to the load, and will allow this procedure only once per load. Conduct all testing for acceptance and produce any required cylinders after all water or admixtures have been added.

Do not add water at the work site if the slump is within the designated slump tolerance, even if water was withheld.

Do not add water at the work site if the percent air is above 8%, regardless of the slump, even if water was withheld.

Do not withhold and add water if plasticizer is added to the concrete mixture at the batch site.

If at any time during the placement of concrete it is determined that redosing with water is adversely affecting the properties of the concrete, the concrete will be rejected and the Engineer will suspend the practice.

b. Placement Limitations.

(1) Placing Concrete at Night. Do not mix, place or finish concrete without sufficient natural light, unless an adequate, artificial lighting system approved by the Engineer is provided.

(2) Placing Concrete in Cold Weather. Unless authorized by the Engineer, discontinue mixing and concreting operations when the descending ambient air temperature reaches 40°F. Do not begin concreting operations until an ascending ambient air temperature reaches 35°F and is expected to exceed 40ºF.

If the Engineer permits placing concrete during cold weather, aggregates may be heated by either steam or dry heat system before placing them in the mixer. Use an apparatus that heats the mass uniformly and is so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. Do not heat aggregates directly by gas or oil flame or on sheet metal over fire. Aggregates that are heated in bins, by steam-coil or water-coil heating, or by other methods not detrimental to the aggregates may be used. The use of live steam on or through binned aggregates is prohibited. Unless otherwise authorized, maintain the temperature of the mixed concrete between 50 to 90°F at the time of placing. Do not, under any circumstances, continue concrete operations if the ambient air temperature is less than 20°F.

If the ambient air temperature is 35°F or less at the time the concrete is placed, the Engineer may require that the water and the aggregates be heated to between 70 and 150°F.

Do not place concrete on frozen subgrade or use frozen aggregates in the concrete.

Make adjustments for potential longer set time and slower strength gain for concrete with SCMs. Adjust minimum time requirements as stated in **SECTION 710** for concrete used in structures. For concrete paving, be aware of the effect that the use of SCMs (except silica fume) may have on the statistics and moving averages.

401.9 INSPECTION AND TESTING

Unless otherwise designated in the Contract Documents or by the Engineer, obtain samples of fresh concrete for the determination of slump, weight per cubic yard and percent of air from the final point of placement.

The Engineer will cast, store and test strength and permeability test specimens in sets of 3.

KDOT will conduct the sampling and test the samples according to **DIVISION 2500** and the Sampling and Testing Frequency Chart in Part V. For QC/QA contracts, establish testing intervals within the specified minimum frequency.

The Engineer will reject concrete that does not comply with specified requirements.

The Engineer will permit occasional deviations below the specified cementitious content, if it is due to the air content of the concrete exceeding the designated air content, but only up to the maximum tolerance in the air content.

Continuous operation below the specified cementitious content for any reason is prohibited.

As the work progresses, the Engineer reserves the right to require the Contractor to change the proportions if conditions warrant such changes to produce a satisfactory mix. Any such changes may be made within the limits of the specifications at no additional compensation to the Contractor.

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APPENDIX A – NON-MANDATORY INFORMATION

SUGGESTED GUIDELINES FOR MEETING KDOT'S PERMEABILITY SPECIFICATIONS

General:

Water and chlorides permeate through the mortar and paste of the concrete mixes. They do not readily permeate through the larger aggregates. Permeability can be improved by decreasing the mortar and paste of the concrete mix and increasing the coarse aggregate portions.

The use of optimized mix designs, blended cements, and/or supplementary cementitious materials (SCMs) can reduce the permeability of concrete. **SECTIONS 1102 and 1116**, Aggregates for Concrete describes optimized aggregate gradations for concrete mixes. Additional testing for alkali silica reaction (ASR) is required when SCMs are used in concrete as per **SECTION 401**. The amount of SCMs required to pass the ASR testing may be different than the amount required to comply with the permeability specifications. SCMs may also lower the necessary water cement (w/c) ratio and may slow set times and strength gain.

Optimizing the coarse aggregate gradations can decrease permeability. This includes mixes with more than 60% retained on the # 8 sieve and gradations with fineness modulus above 4.75. A fineness modulus of over 5.0 can yield even better results. Use the largest practical nominal maximum size aggregate allowed.

In general, keeping the w/c ratio below 0.43 may help meet the permeability specifications, as may lower cementitious content mixes when using Type I/II cements. These two properties control the paste in the mix. Concrete mixes with less than 25% paste (as displayed on KDOT Form 694) are more likely to pass the permeability specifications. Acceptable concrete can be mixed with paste contents of 23% or lower. Water cement ratios below 0.39 often do not provide enough water for all constituents to properly react, especially when admixtures are used, and may be counterproductive. High early strength concrete mixes using Type III cement and higher cementitious contents have also been able to pass the Standard Permeability requirements because of their low w/c ratios.

In general, the use of water reducers is helpful in reducing the paste content. Material compatibilities, following the admixture suppliers' recommendations for dosage rates, and the order of introduction of the chemicals into the mix are paramount to meeting KDOT specifications. Contractors should work with their admixture suppliers to find an admixture that works well with their combination of materials.

Changes made to an approved mix design will change the permeability, especially additional water, or redosing water that was withheld from the mix at a concrete plant. It is also recommended that concrete producers verify their mixes with a minimum of 3 cubic yards after doing their laboratory mix designs.

Standard Permeability Concrete (SPC) Requirements:

Volume of Permeable Voids 12.0% max, or
Surface Resistivity 9.0 kΩ-cm min, or
RCPT 3000 Coulombs max.

The SPC requirements may be met without the use of optimized mix designs, blended cements or SCMs. With certain aggregates, 25% slag cement will be required to pass the ASR testing. With other aggregates, a minimum of 40% slag cement by weight of total cementitious materials is usually needed. Some fly ashes require a minimum of 25% of the total cementitious material to pass the ASR test. Class C fly ash will react differently than Class F fly ash.

Some people believe that lower absorption aggregates have a better chance of meeting the permeability specification, but higher absorption aggregates have been used in concrete mixes utilizing these guidelines and have met the SPC specifications. KDOT has found that the properties of the concrete are often more important than the absorption of the aggregate when meeting this specification.

Moderate Permeability Concrete (MPC) Requirements:

Volume of Permeable Voids 11.0% max, or
Surface Resistivity 13.0 kΩ-cm min, or
RCPT 2000 Coulombs max.

Concrete mixes for MPC will require aggregates with a minimum Soundness of 0.95, a maximum LA Wear of 40, and a minimum Acid Insoluble Residue of 85%. These aggregates, by nature, are harder aggregates with very low absorption. MPC may rely more heavily on optimized gradations, blended cements or SCMs in order to meet the specification. Consideration could be given to ternary blends of cementitious materials, using more than one

SCM, or combining a blended cement with an additional SCM. Combinations of 25% to 30% slag cement with as little as 10% to 25% Class C fly ash have been very effective in keeping permeabilities below the level required for MPC. Incorporation of 20% Class F Fly Ash will often satisfy the requirements of the MPC specification.

Low Permeability Concrete (LPC) Requirements:

Volume of Permeable Voids 9.5% max, or
Surface Resistivity 27.0 kΩ-cm min, or
RCPT 1000 Coulombs max.

LPC will also use harder aggregates with very low absorption. These mixes must be optimized with the MA-6 gradation. Mix designs with 5% silica fume and 95% Type I/II cement often meet the LPC requirements. These mixes have traditionally been known as silica fume concrete. Ternary mix designs are useful in meeting these requirements. Consider using 3% to 5% silica fume with 25% to 30% slag cement, or 25% to 30% slag cements with 10% to 25% Class C fly ash. Class F fly ash alone may also be effective in reducing the permeability to these levels.

Contact KDOT's Bureau of Research or the District Office for additional guidance in meeting the Permeability Specifications.

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HMA BOND STRENGTH

Page 600-2, subsection 602.1. Add the following bid item:

BID ITEMS	**UNITS**
Emulsified Asphalt	Square Yard

Page 600-31, delete subsection 602.11c. and replace with the following:

c. Emulsified Asphalt. The Engineer will measure emulsified asphalt used for tack to the unit of measure specified in the Contract Documents. Payment for "Emulsified Asphalt" at the contract unit price is full compensation for the specified work.

The minimum asphalt residue required is 0.03 gallons/square yard.

Page 600-32, add the following new subsection:

602.12 BOND STRENGTH OF HOT MIX ASPHALT TACK COAT

a. General. The Engineer will determine the bond strength of the HMA tack coat according to KT-78 Method for Determining the Tensile Adhesive Strength of Asphalt Pavement Tack Coat. Take random samples from each lift placed, at a frequency determined by the Engineer and at locations selected by the Engineer. The recommended testing frequency is shown in **TABLE 602-19**.

TABLE 602-19: RECOMMENDED BOND TEST FREQUENCY

Tensile Stress (psi)	Bond Condition	Recommended Test Frequency
≥ 70	good	1 test per week
35 - 69	fair	2 tests per week
< 35	poor	test each day

For each test the Engineer will generate one random longitudinal location to obtain the bond strength samples. At the longitudinal test location, obtain two samples according to KT-78. At the random longitudinal location, the Engineer will generate two random transverse locations for each half of the paved lane. The outside lane sample will be obtained at a random location between 6 to 11 feet from the centerline of the roadway. The inside lane sample will be obtained at a random location between 1 to 6 feet from the centerline of the roadway. With the Engineer present, obtain the samples within 24 hours of the material being placed. Present the cores to the Engineer who will immediately transport the cores to the KDOT Field lab.

Dry the core holes, tack the sides and bottom, fill them with a HMA mixture (approved for the project) and properly compact it by the end of the next working day.

The Engineer will evaluate the samples using KT-78, within 48 ± 2 hour after the HMA was placed. The tensile stress for the test will be determined by using the lowest tensile stress of the two samples. When the evaluation of the test falls on a non-working day, then the test will be performed on the next working day. The Engineer will provide a copy of the results to the Contractor by the end of the working day on which the test is performed.

If the tensile stress of a test is less than 35 psi, suspend plant production and paving. Follow the Best Management Processes to verify proper placement of tack material.

APPENDIX A

Kansas Department of Transportation
Best Management Practices: Checklist for Emulsion Bonding Liquid (EBL) for use through a Spray-Paver

Emulsion Bonding Liquid (EBL) is a polymerized emulsion used primarily undiluted at rates dependent on the existing pavements macro-texture to meet the requirements of this specification.

PREPARATION:

- Understand condition (previous use) of delivery tankers and steps taken to minimize risk of contamination to the asphalt emulsion. Cross contamination of cationic EBL and anionic EBL emulsions can cause issues during paving operations including the ability of the nozzles to spray a proper fan pattern and clogging of the nozzles.
- Remove accumulated dust and dirt from the road surface by mechanical brooming.
- At the beginning of each day of paving the spray-paver should demonstrate the ability to spray a proper emulsion fan pattern by setting the EBL quantity to the day's target rate with the screed extended to the lane's paving width. The length of pavement sprayed should be sufficient to determine if all nozzles are working and the pattern is uniform.

STORAGE/HANDLING:

- Prevent contamination by water, oils or other liquids.
- Prevent contamination by other incompatible emulsions. Check with emulsion supplier if there is a question.
- Protect the EBL from freezing and boiling temperatures that break the emulsion and cause separation into asphalt and water. EBL should not be stored on-site (tanker is exposed to the weather) for long periods during cold weather conditions. A good practice is to use material within 24 hours of delivery.
- Protect from localized overheating caused by high temperature heating coils and surface heating pads. Where steam, hot oil or direct fire must be used, controls must keep coil surfaces below 185° F.
- Use bottom loading wherever possible or employ full-length drop hose to eliminate foaming. Foaming may cause a volume gauge error and may be detrimental to the stability of the emulsion.
- Allow surface crust that may form on emulsion in storage to float without disturbance. Return lines should have outlets near the tank bottom and circulating material should not free-fall or disturb the surface crust.
- High shear can break an emulsion. Enlarge clearances on new gear pumps by milling if necessary.
- Prevent unnecessary circulation that can cause drop in emulsion viscosity and stability.
- Do not agitate emulsion with forced air as it may cause the emulsion to break.

TRANSFER VEHICLE:

- The Transfer Vehicle can heat the asphalt emulsion to the specified temperature range so that it is fluid enough to spray from the nozzles. The process for increasing the temperature of the EBL should be completed gradually so as not to prematurely break the emulsion.
- For EBL, the specified application temperature is 120°F to 180°F. Excessive heat and/or pumping can cause the emulsion to break thereby causing the nozzles to clog or spray an unsatisfactory pattern.

APPLICATION:

- At the beginning of each day of paving and after prolonged delays the spray-paver should demonstrate the ability to spray a proper emulsion fan pattern (at full width). A prolonged delay may be defined as a 10 minute or longer cessation of HMA placement to the existing paving surface. If a prolonged delay is encountered a header should be built and the existing surface prepped for the continuation of paving operations.
- The initial acceleration of the paver to operating speed can be achieved by manual or automatic control. If automatic is selected the paver operator should ensure that the speed differential is not so great as to leave a screed plate indention in the newly applied material. If manual control is selected care should be taken to ensure that the proper rate and consistency of emulsion is achieved.

- Allowing the EBL to spray slightly wider than the lane's width (~3 inches on the shoulder side) can be a guide for monitoring emulsion application.
- The joint side of the first paving pass should have the EBL extending beyond the HMA.
- The emulsion being sprayed under the paver should always look consistent. If it isn't refer to *Appendix 1 – Trouble shooting*.
- For bonded dense graded projects, the nozzle size is usually smaller than those used in UBAS. Typically, the nozzle size and spray-paver type should be recorded and notice be given if the nozzles are changed during the project.
- For application consistency, the EBL quantities can be measured and calculated each time the spray-paver is refilled from the transfer vehicle.
- Paver speed and HMA material supply is critical to proper spray patterns. A speed too slow can cause irregular spray patterns.
- The proper EBL application will meet the Bond Strength Requirements in **TABLE 602-19**, this specification.
  - An open or rough textured surface may require more EBL than a surface that is tight or one that is flushed with asphalt.
    - Open or rough texture may be milled surfaces, UBAS ,chip seals, and some concrete pavements
    - Tight Texture may be new HMA surfaces, fog seals, hot in-place recycled surface

- The EBL's performance may be reduced if it is allowed to break prior to the placement and compaction of the HMA overlay. If paving operations have stopped momentarily and the EBL has broken prior to the application of HMA then a reduced rate of EBL may be applied over the already broken material prior to the continuation of regular paving operations. One example of this is at the startup of operations when the spray-paver demonstrates the nozzles ability to apply a uniform coverage.

SPECIAL CONSIDERATIONS:

- If the spray nozzles are not delivering a uniform coverage the paver's speed may not be sufficient to supply the necessary spray bar pressure to apply the EBL. For other solutions refer to *Appendix 1 – Trouble Shooting.*

ASPHALT EMULSION SUPPLIER:

- Asphalt particle size has an effect on the nozzles ability to spray a proper fan pattern. If the emulsion is delivered to the project and the particle size is too large the nozzles may clog even through the emulsion is at the higher end of the specified temperature range.

APPENDIX 1 – Trouble Shooting

At no time should the nozzles deliver an inconsistent fan pattern. "Foggy" areas that are momentary may not be severely detrimental as long as corrective action is taken to correct the fan pattern and the issue resolved in a short time. When areas of pavement are not receiving any emulsion and streaks are appearing on the surface paving operations should stop and corrective action taken.

Things to consider when determining inconsistent spray patterns;

1. Are the proper size nozzles installed and being used? Some spray-pavers have the capacity to use several nozzle sizes at a time. If they are large nozzles the fan pattern will not cover the pavement without increasing the EBL gallon per square yard quantity.
2. Is the paver traveling too slow? If the HMA material supply (truck count or plant speed) to the paver is not adequate the paver may travel slower to compensate for the supply issue. If this is the case paving operations should stop until a sufficient amount of trucks are available for proper operations.
3. Is the proper amount of EBL being delivered to the road's surface?
4. What is the temperature of the EBL? Increasing the temperature in a uniform and controlled manner may lower its viscosity and provide a better spray pattern.
5. Height of the spray bar can affect the width of the fan pattern. If all of the nozzles are spraying consistently but gaps of emulsion exist on the pavement the spray bar height may need to be increased.
6. If after refilling the paver with EBL the fan pattern becomes inconsistent switching between spray nozzles may clear the nozzles. Typically, spray-pavers have 2 or more sets of nozzles that are ready for operation.

APPENDIX B

Kansas Department of Transportation
Best Management Practices: Checklist for Tack

PREPARATION:

- Consult with the emulsion supplier with respect to a particular asphalt-aggregate combination as there are few absolute rules that will work the same under all circumstances.
- Understand condition (previous use) of delivery tankers and steps taken to minimize risk of contamination to the asphalt emulsion.
- Remove accumulated dust and dirt by mechanical brooming or by flushing with air and/or water.

STORAGE/HANDLING:

- Prevent contamination by water, oils or other liquids.
- Prevent contamination by other incompatible emulsions.
- Protect from freezing and boiling temperatures that break the emulsion and cause separation into asphalt and water.
- If water is added by contractor, then water is to be clean, potable water, free from detectable solids or incompatible soluble salts. Test for dilution incompatibility, whenever in doubt, by diluting the emulsion in the severest conditions anticipated (e.g., high dilution, cold water, hard water, high shear pumps). No instability or coagulation should appear.
- Protect from local overheating caused by high temperature heating coils and surface heating pads. Use of hot water is recommended for heating emulsion. Where steam, hot oil or direct fire must be used, controls must keep coil surfaces below 85° C (185° F).
- Use bottom loading wherever possible or employ full-length drop hose to eliminate foaming. Foaming may cause a volume gauge error.
- Allow surface crust that may form on emulsion in storage to float without disturbance. Vertical tanks can help maintain constant and minimal surface area. Return lines into tanks should have outlets near the tank bottom and circulation should not free-fall or disturb surface crust.
- Reduce high shear that can break emulsions by enlarging clearances on new gear pumps by milling if necessary.
- Prevent unnecessary circulation that can cause drop in emulsion viscosity and emulsion instability.
- Do not agitate emulsion with forced air as it may cause the emulsion to break.

DISTRIBUTOR:

- Review appropriate maintenance practices of distributor with driver.
- Apply tack by a pressure distributor.
- All nozzles on the distributor are open and functioning.
- Nozzles are turned at the same angle to the spray bar; approximately 30º, depending on the manufacturer of the distributor.
- Proper height above the pavement surface provides a double or triple lap of the liquid asphalt material.
- Distributor heats the asphalt emulsion to the proper temperature so that it is fluid enough to be sprayed from the nozzles; not coming out in strings.

APPLICATION:

- Proper asphalt emulsion is used; material adheres to the existing surface.
- Correct amount of tack coat is sprayed on the surface, so some of the existing surface will still be visible through the tack coat—not all of the existing pavement surface will be covered with the tack coat. Use of a diluted asphalt emulsion tack coat (slow-setting asphalt emulsion diluted 1:1 with water) will result in complete coverage of an extremely thin residual asphalt film.
- The proper tack coat application will leave ***residual asphalt cement content*** of approximately 0.03 to 0.06 gal/yd2 on the roadway.

- o An open-textured surface requires more tack coat than a surface that is tight or one that is “fat” or flushed.
- o More tack coat material may be needed on a milled surface because of the increased surface area. In this case, the application rate could be as great as 0.08 gal/yd2 of residual asphalt cement.
- The emulsion must break (change color from brown to black) and the water must evaporate from the emulsion before the new mix can be placed over the tack coat material.
- If the overlay is to be constructed under traffic, the tack coat is normally placed only a short distance in front of the paver; within the lane closure and far enough ahead for the tack to cure properly before the mix is laid on top of it.

SPECIAL CONSIDERATIONS:

- Do not dilute rapid setting (RS) emulsions with water. RS emulsions require dilution with specific chemical emulsifier solutions to produce stable dilutions.

ASPHALT EMULSION SUPPLIER:

Variables that may be causing issues are, but not limited to, the following:

- Ionic charge on the asphalt emulsion
- Type and concentration of the emulsifying agent
- Addition of chemical modifiers
- Asphalt particle size in the emulsion
- Hardness and quantity of the base asphalt cement
- Chemical properties of the base asphalt cement
- Manufacturing variables

NOTE: Most of the list is derived from the Hot-mix Asphalt Paving Handbook (AASHTO/FAA/FHWA/NAPA/US Corp), A Basic Emulsion Manual (Asphalt Institute) and Performance Guidelines, Section 11(AEMA)

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SECTION 606

MICROSURFACING

606.1 DESCRIPTION

Spread a mixture of modified emulsified asphalt, mineral aggregate, water and additives on a prepared surface as specified in the Contract Documents.

BID ITEMS	UNITS
Aggregate for Microsurfacing	Ton
Emulsified Asphalt (*) (Modified)	Ton
Mineral Filler	Ton

*Designated Type and Grade

606.2 MATERIALS

Provide materials that comply with the applicable requirements.

Emulsified Asphalt .... **DIVISION 1200**
Aggregate for Microsurfacing .... **DIVISION 1100, this specification**
Water .... **DIVISION 2400**

Conduct aggregate acceptance tests at the point of usage.

Use a Cationic Type CSS-1HM emulsified asphalt complying with **SECTION 1203**.

For mineral filler, use any recognized brand of non-air-entrained portland cement that is free of lumps and acceptable to the Engineer.

Provide a Type "C" certification for any proposed additives.

The Engineer and the Contractor will test materials according to the Contract Documents and Appendix B-Sampling and Testing Frequency Chart-Quality Control/Quality Assurance Specifications.

606.3 CONSTRUCTION REQUIREMENTS

a. Mix Design.

(1) Job Mix Formula. Develop and submit the job mix formula and certified test results meeting the criteria in **TABLE 606-1** for the Engineer's approval. Include aggregate type and gradation, percentage of modified emulsion, water and cement by weight of dry aggregate in the mix.

TABLE 606-1: MICROSURFACING MIX DESIGN REQUIREMENTS

Property	Test	Requirements
Wear Loss (Wet Track Test)	ASTM D3910 (1 hr soak) (6 day soak)	 50 g/ft^2, maximum 75 g/ft^2, maximum
Wet Cohesion	ASTM D3910 @ 30 minutes @ 60 minutes	 10 in-lbs, minimum 17 in-lbs, minimum
Wet Stripping	ISSA TB-114	90%, minimum
Mix Time @ 77^{o}F	ISSA TB-113	Controllable to 120 seconds, minimum

(2) Proportioning. Use the proportions in **TABLE 606-2** unless otherwise shown in the Contract Documents. Do not begin microsurfacing until the Engineer approves the mix design, materials, and construction.

TABLE 606-2: MICROSURFACING MIX PROPORTIONING

Material	Units	Value
Mineral Aggregate	lbs/SY dry weight	15, minimum
Modified Emulsion	Percent residue by weight	8.0, minimum
Mineral Filler	Percent by weight of dry aggregate	0.5 to 2.0 *
Additive	Percent by weight of dry aggregate	As required

* Unless otherwise approved by the Engineer.

(3) Aggregate and Asphalt. Screen the aggregate for lumps, and weigh it before delivery to the lay down machine. Weigh the emulsified asphalt. The Engineer will approve the screens and scales.

Provide individual volume or weight controls for proportioning each item to be added to the mix. Calibrate and mark each material control device. Locate the devices to be accessible for ready calibration, and place so the Engineer can determine the amount of each material used at any time.

Mineral filler may be added at the loading facility, provided the Engineer approves accurate proportioning and metering devices, and there is no detrimental effect on the final product.

b. Surface Preparation. Immediately before applying the microsurfacing, thoroughly clean the surface of the roadway of all foreign material and pre-wet as required.

c. Ruts. When shown in the Contract Documents, fill ruts, utility cuts and depressions in the existing surface before placing the final surface. Cover ruts and irregularities of less than ½ inch in depth with a full width scratch coat. Accomplish the scratch coat by using a rigid rear seal in the spreading equipment.

Independently fill ruts greater than ½ inch in depth using a rut filling spreader box 5 to 6 feet in width. Crown ruts filled with a rut filling spreader box to compensate for compaction.

Ruts in excess of 1 ½ inches require multiple passes with the spreader box to restore the original cross section. When multiple passes are required, carry traffic overnight on each rut-filling pass before a subsequent filling pass is made.

d. Mixing and Spreading. Mix and spread the microsurfacing materials with a self-propelled machine capable of accurately delivering and proportioning all of the required components. Operate the machine continuously while loading, eliminating construction joints. Do not use lumping, balling or unmixed aggregate.

Place longitudinal joints on lane lines. Do not overlap or leave gaps in longitudinal joints. Construct a finished microsurface with a uniform texture and free of scratches, tears and other surface irregularities. Repair the surface if any of these conditions exist:

- more than 1 surface irregularity that is ¼ inch or wider and 10 feet or longer in any 100 foot section of the microsurface;
- more than 3 surface irregularities that are ½ inch or wider and more than 6 inches long in any 100 foot section of the microsurface; or
- any surface irregularity that is 1 inch or wider and more than 4 inches long.

Construct finished, uniform, longitudinal and transverse joints in the microsurface. Repair the joints if any of these conditions exist:

- build-up of microsurface material at the joints;
- uncovered areas at the joints;
- longitudinal joints with more than ½ inch vertical space between the surface and a 4 foot straightedge placed perpendicular to the joint; or
- transverse joints with more than ¼ inch vertical space between the surface and a 4 foot straightedge placed perpendicular to the joint.

Construct the edges of the microsurface to follow the centerline, lane lines, shoulder lines and curb lines. Repair edges that vary more than ± 3 inches from a 100 foot straight line (or a 100 foot arch on a curved section).

Use methods approved by the Engineer to correct deficiencies in the microsurface. Construct a dense, repaired surface with a uniform texture.

e. Curing. Provide adequate means to protect the microsurface from damage by traffic until the mixture has cured sufficiently. Allow the surface of microsurfacing to cure so as to not adhere to or be picked up by the tires of vehicles. Allow traffic to use the microsurfacing when cured.

Cure the material used for filling wheel ruts a minimum of 24 hours before the full width coverage is applied.

f. Maintenance of Traffic. Maintain traffic according to **DIVISION 800** and the following:

- Station 1 flagger immediately ahead of the application of the microsurfacing material and 1 flagger immediately behind the section being cured.
- Display suitable speed limit signs and "fresh oil" signs. Move the signs forward with the flaggers as the work progresses.
- Suspend application of the microsurface early enough each day to permit traffic to safely travel over the completed work before sunset.
- Repair any traffic damage to the microsurface at Contractor expense.

g. Seasonal and Weather Limitations. Construct the microsurfacing between May 1 and October 15. Do not place microsurfacing when the ambient air temperature is less than 50ºF, or the weather is foggy or raining, or the air temperature is forecasted to go below 32ºF within 24 hours following the placement.

h. Observation Period. If the microsurfacing is constructed in accordance with the seasonal limitations in subsection **606.3g.**, the Engineer, along with the Contractor, will inspect the microsurfacing 30 days after work is completed on the microsurfacing. If the seasonal limitations in **subsection 606.3g.** are modified, the Engineer, along with the Contractor, will inspect the microsurfacing between May 1 and April 1 the following year. Repair areas where there is no microsurface left in place (bare areas) as directed by the Engineer:

- In 5% the wheel paths; and
- Individual areas ≥ 10 square yards; and
- Where the total square yards of bare areas is greater than 5% of the total square yards of the microsurfacing.

g. Pavement Smoothness. Microsurfacing is excluded from profilograph testing, and <u>not</u> eligible for pay adjustments.

606.4 MEASUREMENT AND PAYMENT

The Engineer will measure aggregate for microsurfacing, emulsified asphalt (modified) and mineral filler by the ton. No deduction will be made for moisture in the aggregate. When sacked portland cement is used, 1 sack equals 94 pounds.

Water used for pre-wetting the pavement surface and mix water is subsidiary to other bid items and will not be measured for separate payment.

Material used to correct surface deficiencies in the microsurfacing will not be measured for payment.

Payment for "Aggregate for Microsurfacing", "Emulsified Asphalt (Modified)" and "Mineral Filler" at the contract unit prices is full compensation for the specified work.

SECTION 1109

AGGREGATE FOR MICROSURFACING

1109.1 DESCRIPTION

This specification covers aggregates for use in microsurfacing operations.

1109.2 REQUIREMENTS

a. Composition. Provide aggregate for microsurfacing that is crushed gravel, crushed calcite cemented sandstone, or chat which is a material obtained from the mining of lead and zinc ores.

Produce crushed gravel by mechanical crushing of siliceous gravel and not containing more than 15% non-siliceous material.

b. Quality.

- Soundness, minimum (KTMR-21) 0.90
- Wear, maximum (AASHTO T 96) 40%

c. Product Control.

Provide material that complies with **TABLE 1109-1**:

TABLE 1109-1: GRADING REQUIREMENTS							
Percent Retained - Square Mesh Sieves							
½”	**3/8”**	**No. 4**	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 200**
0	0-1	6-14	30-55	50-75	65-85	75-90	85-95

Additional Requirements for Crushed Gravel.

- Percent Crushed Particles (KT-31) (minimum) 98%*
- Uncompacted Void Content of Fine Aggregates (KT-50) (minimum) 46%
- Sand Equivalent (KT-55) (minimum) 65%

*Provide 98% of the crushed gravel with 2 or more fractured faces.

Deleterious Substances. Provide materials that are free from weeds, sticks, grass, roots and other undesirable foreign matter.

d. Stockpiling. Stockpile and handle aggregates in such a manner to prevent detrimental degradation and segregation, the incorporation of appreciable amounts of foreign material, and the intermingling of stockpiled materials.

1109.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

1109.4 PREQUALIFICATION

Prequalify aggregate sources according to **subsection 1101.4**.

1109.5 BASIS OF ACCEPTANCE

Aggregates covered by this subsection are accepted based on the procedures described in **subsection 1101.5.**

01-06-15 C&M (BTH)
Feb-16 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 603 and replace with the following:

SECTION 603

ASPHALT PAVEMENT SMOOTHNESS

603.1 DESCRIPTION

Determine the smoothness of the pavement surface and correct the deficiencies as specified in the Contract Documents.

For the purposes of this specification, define new construction to mean construction where pavement did not exist before, and where existing pavement is removed down to the base or subgrade.

All other conditions should be considered rehabilitation construction.

When projects contain both new and rehabilitation construction, follow appropriate guidelines for each type.

BID ITEM	UNITS
Asphalt Pavement Smoothness	Lump Sum

603.2 MATERIALS - None specified.

603.3 CONSTRUCTION REQUIREMENTS

a. Profilograph Testing. Determine the pavement smoothness by profiling the pavement surface of through traffic lanes and ramps. Excluded from profilograph testing, and not eligible for pay adjustments, on all projects are:

- bridge decks
- acceleration and deceleration lanes of at-grade intersections
- turning lanes
- shoulders
- pavement on horizontal curves with centerline radius of curvature of less than 1000 feet, and pavement within the superelevation transition of such curves
- individual sections of pavement less than 50 feet in length
- the first (or last) 15 feet of a pavement section where the Contractor is not responsible for the adjoining surface
- side roads less than 250 feet in length
- county secondary projects
- existing roadways that are surfaced with a plan thickness of less than 4 inches of hot mix asphalt (HMA)
- chip seals
- microsurfacing
- ultrathin bonded asphalt surface (UBAS)

Profile and correct, if necessary, the following categories of asphalt surfacing. These are not eligible for pay adjustments:

- existing roadways that are milled, then surfaced with a plan thickness of less than 4 inches of hot mix asphalt (HMA).
- existing roadways that are surfaced with a plan thickness of less than 4 inches of HMA that is placed in 2 or more lifts.

- existing roadways that are cold in-place recycled (CIR) with a plan depth of 2 inches or more, then surfaced with a plan thickness of less than 4 inches of HMA.
- existing roadways that are hot-in-place recycled (HIR) with a plan depth of 1 ½ inches or more, then surfaced with a plan thickness of less than 4 inches of HMA.

In addition to the asphalt surfacing above, profile and correct, if necessary, the following categories of asphalt base, prior to placement of the surface course. These are not eligible for pay adjustments:

- CIR pavement with a plan thickness of 2 inches or more.
- HIR pavement with a plan thickness of 1 ½ inches or more.
- HMA Base with a plan thickness of less than 4 inches when the surface course is UBAS. Profile and correct HMA base prior to placing UBAS.

b. Equipment. Use a California type profilograph, prequalified by the Bureau of Construction and Materials, to determine the pavement profile. If approved by the Bureau of Construction and Materials, other types of profilographs that produce results compatible to the California type profilograph may be used. If the profilograph has a mechanical recorder, provide a ProScan electronic scanner with motorized paper transport to reduce the trace. Use the motorized paper transport when scanning the profilograph traces. The Bureau of Construction and Materials can provide the information necessary for the Contractor to obtain a ProScan electronic scanner. If approved by the Bureau of Construction and Materials, other types of automated trace reduction equipment may be used. If the profilograph has a computerized recorder, the trace produced is evaluated without further reduction.

c. Profilograph Operation. Provide an operator for the profilograph certified according to KT-46, Part V.

Determine the pavement profiles for each lane according to the procedures for 1 lane shown in Kansas Test Method KT-46. Additional profiles may be taken only to define the limits of an out-of-tolerance surface variation. The Engineer may use a 10-foot straightedge (or other means) to detect irregularities outside the required trace paths. The Engineer may also use the straightedge to delineate the areas that require corrective action.

Determine a profile index (in./mi.) for each pavement section of finished pavement. A pavement section is a continuous area of pavement surface 0.1 mile long by 1 lane wide (12 feet nominal). A partial pavement section resulting from an interruption (such as a bridge) of the continuous pavement surface is subject to the same testing and evaluation as a whole section.

Profile the pavement after final rolling, and within 72 hours of completing the asphalt paving on the project. At the Engineer's discretion, the Contractor will profile the pavement after final rolling, and within 24 hours of placement of the pavement.

If the Contractor elects to test intermediate lifts with the profilograph, make the profilograms available to the Engineer to review for evaluating the paving methods and equipment.

On surfaces excluded from profilograph testing, the Engineer will determine the pavement smoothness using a 10-foot straightedge. The Engineer will select the locations to be tested. The variation of the surface from the testing edge of the straightedge shall not exceed ⅛ inch between any 2 contacts, longitudinal or transverse.

Correct all irregularities exceeding the specified tolerance using equipment and methods approved by the Engineer. After the irregularities are corrected, the Engineer will retest the area to verify compliance with the specified tolerance.

d. Profilograph Evaluation and Corrective Actions. Evaluate the profilograph results according to KT-46. Provide the Engineer with the profilograms and their evaluation the first working day after profiling the roadway.

Determine and evaluate the profile index (in./mi.) for each trace and the average profile index (in./mi.) for each section to identify where corrective action is needed.

Determine the daily average profile index (in./mi.) for each day's paving operation. A day's paving operation is the pavement placed in a day (a minimum of 1 pavement section).

- If less than 1 pavement section is placed in a day, the day's production is grouped with the next day's production.
- If the production of the last day of project paving is less than 1 pavement section, it is grouped with the previous day's production.
- The Contractor has the option of profiling the final portion of a day's production (not to exceed 5 sections) the first working day that paving is continued in the same lane. If the Contractor opts to

profilograph the final portion of a day's paving the next working day that paving is continued in the same lane, those results (the final portion of the previous day's paving) are grouped with the day's paving as the lane is continued.

(1) For new construction bid items in **SECTION 602,** take the required corrective actions according to **TABLE 603-1**.

TABLE 603-1: ASPHALT PAVEMENT SURFACE TOLERANCES, NEW CONSTRUCTION SECTION 602 BID ITEMS

Pavement Surface Tolerances (in./mi.)		**Required Corrective Action**
Through Lanes Speed Limit Greater than 45 mph	**Acceleration Lanes*** **Deceleration Lanes*** **Ramps*** **Through Lanes Speed Limit 45 mph or Less**	
Profile Index per Section of 30 or less for an individual trace	Profile Index per Section of 40 or less for an individual trace	Correct all bumps and dips**.
Profile Index per Section greater than 30 for an individual trace		Correct the Profile Index of each individual trace to 30 or less per section**.
	Profile Index per Section greater than 40 for an individual trace.	Correct the Profile Index of each individual trace to 40 or less per section**.
Daily Average Profile Index greater than 40	Daily Average Profile Index greater than 65	Suspend the paving operations until corrective actions are taken to improve the paving operations.

*Acceleration/deceleration lanes include the taper. Acceleration lanes that become through lanes are limited to 500 feet from the nose of the ramp. Ramps are from the nose to the intersection of the adjoining road.
**Correct all areas within each section having high or low points (bumps or dips) with deviations in excess of 0.3 inches in a length of 25 feet or less regardless of the profile index value.

(2) For all other rehabilitation construction bid items in **DIVISION 600**, take the required corrective actions according to **TABLE 603-2**.

TABLE 603-2: ASPHALT PAVEMENT SURFACE TOLERANCES, REHABILITATION DIVISION 600 BID ITEMS (EXCEPT SECTION 602, NEW CONSTRUCTION)		
Pavement Surface Tolerances (in./mi.)		**Required Corrective Action**
Through Lanes	**Acceleration Lanes*** **Deceleration Lanes*** **Ramps*** **≥ 1 ½" Surface Recycled Asphalt/Hot In-place Recycled Asphalt Pavement** **≥ 2" Cold Recycle Asphalt Construction**	
Profile Index per Section of 30 or less for an individual trace	Profile Index per Section of 40 or less for an individual trace	Correct all bumps and dips**.
Profile Index per Section greater than 30 for an individual trace		Correct the Profile Index of each individual trace to 30 or less per section**.
	Profile Index per Section greater than 40 for an individual trace.	Correct the Profile Index of each individual trace to 40 or less per section**.
Profile Index per Section greater than 40 for an individual trace	Profile Index per Section greater than 50 for an individual trace.	Suspend the paving operations until corrective actions are taken to improve the paving operations.

*Acceleration/deceleration lanes include the taper. Acceleration lanes that become through lanes are limited to 500 feet from the nose of the ramp. Ramps are from the nose to the intersection of the adjoining road.

**Correct all areas within each section having high or low points (bumps or dips) with deviations in excess of 0.4 inches in a length of 25 feet or less regardless of the profile index value.

e. Corrections. Make the required corrections for pavement smoothness before making the pavement thickness determinations. Use these methods for corrections:

- diamond grinding when the layer is the final riding surface
- when the layer will be covered with a chip seal or microsurfacing
  - micro-milling or fine-lace milling (minimum of 60 teeth per foot) may be done in a continuous 100-foot segment provided there is at least 400 feet of the surface adjacent to the segment that is not milled or diamond ground
  - diamond grind when more than 100 feet within a 400-foot segment requires correction. The Engineer may permit micro-milling if in the opinion of the Engineer the resulting surface is not detrimental to the functionality of the chip seal or the microsurfacing
- milling if the layer will be covered by UBAS or a layer of HMA.
- remove and replace the entire pavement thickness
- remove the surface by milling, and replace the specified surface course
- overlay (not patch) with the specified surface course
- other methods that are approved by the Engineer

Apply the corrective measure to the full-lane width of the pavement. The corrected areas shall have uniform texture and appearance. The beginning and ending of the corrected areas shall be squared normal to centerline of the paved surface.

When grinding is performed, use vacuum equipment or other continuous methods to remove grinding slurry and residue. Remove from the project and properly dispose of the material. Do not allow the grinding slurry to flow across lanes being used by traffic, onto shoulder slopes, into streams, lakes, ponds or other bodies of water, or gutters or other drainage facilities. Do not place grinding slurry on foreslopes.

f. New Construction Bid Items in SECTION 602, and Eligible for Pay Adjustments. After the profilograph traces have been evaluated, make corrections according to **TABLE 603-3.**

TABLE 603-3: GRINDING REQUIREMENTS	
Condition	**Action***
Greater than 25% (132 feet) of the 0.1 mi. section requires correction	Continuously grind the entire 0.1 mi. section.**
Greater than 25% (1320 feet) of 1.0 mi. segment require correction	Continuously grind the entire 1.0 mi. segment, when the areas requiring correction are dispersed throughout the 1.0 mi. segment. If the areas requiring correction are isolated to 1/3 or ½ mi. within the 1.0 mi. segment, then only grind that 1/3 or ½ mi.

* Continuously grinding requires a minimum of 98% of the pavement be ground.
**If the skip length between areas to be ground (either within a 0.1 mi. section or between 0.1 mi. sections) is less than either grind length, combine the grinds so the area between is also ground. This additional ground area (area between) will apply to the computation of the 25% of the 0.1 mi. section.

If the Contractor elects or is required by **TABLE 603-3** to continuously grind the entire project, the following apply:

- the areas excluded in **subsection 603.3a.** are not required to be ground;
- at intersections constructed with multiple transitions for drainage (especially in urban areas), if smoothness meets **SECTION 603**, the intersection is not required to be ground; and
- when transitioning from a ground area to an unground area, feather the grinding a uniform distance throughout the project.

Grind and texture the entire surface of the pavement in the longitudinal direction. Provide positive lateral drainage by maintaining a constant cross slope between grinding passes in each lane.

Maintain a uniform transverse slope that matches the existing cross slope to the extent possible with no depressions or humps greater than 1/4 inch in 12 feet when tested with a string line or straightedge. Do not exceed by more than 1/16 inch the vertical alignment between adjacent passes of the cutting head. Begin and end grinding lines normal to the direction of vehicle travel. Grind the surface so corrugations are parallel to the pavement edge with ridges 1/16 inch, ±1/32 inch higher than the valleys of the corrugations.

g. Profilograms. After pavement sections are corrected, re-profile the pavement surface to verify compliance with the specified pavement smoothness. Provide the Engineer with the profilograms and their evaluation within 2 working days after correcting the pavement surface.

The Engineer may perform profilograph testing on the pavement surface for monitoring and comparison purposes. If the Engineer determines that the Contractor's certified test results are inaccurate, the Engineer may choose to test the entire project length. The Engineer will charge the Contractor for such testing at the rate of $500 per mile per profile track, with a minimum charge of $1000. Providing inaccurate test results may result in de-certification of the Contractor's certified operator.

603.4 MEASUREMENT AND PAYMENT

a. General. The Engineer will base the pay adjustment for pavement smoothness on the initial average profile index of the pavement section before any corrective work is performed. If the Contractor elects to remove and replace a pavement section, the Engineer will base the pay adjustment for pavement smoothness on the initial average profile index of the pavement section after the replacement.

For reconstruction projects, if the Contractor elects or is required by **TABLE 603-3** to continuously grind the entire project, pay adjustments will be based on the average profile index determined after all grinding is performed.

b. New Construction, Bid Items in SECTION 602, Eligible for Pay Adjustments. The Engineer will apply the contract price adjustment according to **TABLE 603-4**. Payments for "Asphalt Pavement Smoothness" are an added item to the contract.

TABLE 603-4: ASPHALT PAVEMENT SMOOTHNESS PAY ADJUSTMENT NEW CONSTRUCTION	
Average Profile Index (in./mi. per lane per 0.1 mi. section)	**Contract Price Adjustment (per 0.1 mi. section per lane)**
6.0 or less	+$1000.00
6.0 to 10.0	+$835.00
10.1 to 15.0	+$625.00
15.1 to 18.0	+$310.00
18.1 to 30.0	0.00
30.1 to 40.0	0.00*
40.1 or more	-$615.00*

*Correct to 30.0 in./mi. (40.0 in./mi. as noted in **TABLE 603-1**).

The pay adjustments in **TABLE 603-4** are for 12" thick hot mix asphalt and 8" thick portland cement concrete pavements. Pay adjustments for pavements of different thicknesses will be reduced or increased proportionally, based on the typical section for the extent. (i.e. pay adjustment for a 9" hot mix asphalt pavement is equal to the adjustment from the **TABLE 603-4** multiplied by 0.75).

c. Rehabilitation Construction, for all Other Bid Items in DIVISION 600 and Eligible for Pay Adjustments, Take the Required Corrective Actions According to TABLE 603-5. The Engineer will apply the contract price adjustment according to **TABLE 603-5**. Payments for "Asphalt Pavement Smoothness" are an added item to the contract.

TABLE 603-5 ASPHALT PAVEMENT SMOOTHNESS PAY ADJUSTMENT REHABILITATION CONSTRUCTION	
Average Profile Index (in./mi. per lane per 0.1 mi. section)	**Contract Price Adjustment (per 0.1 mi. section per lane)**
7.0 or less	+$152.00
7.1 to 10.0	+$76.00
10.1 to 30.0	0.00
30.1 to 40.0	0.00*
40.1 or more	-$203.00*

*Correct to 30.0 in./mi. (40.0 in./mi. as noted in **TABLE 603-2**).

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Jul-16 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 602, and replace with the following:

SECTION 602

HOT MIX ASPHALT (HMA) CONSTRUCTION
(Quality Control/Quality Assurance (QC/QA))

602.1 DESCRIPTION

Mix and place 1 or more courses of plant produced HMA mixture on a prepared surface as shown in the Contract Documents. Demonstrate quality control by providing the quality control testing.

BID ITEMS	UNITS
HMA Base (*)(**)(***)	Ton
HMA Surface (*)(**)(***)	Ton
HMA Overlay (*)(**)(***)	Ton
HMA Pavement (#) (##)	Square Yard
HMA Pavement (#) Shoulder	Square Yard
Emulsified Asphalt (****)	Ton
Asphalt Core (Set Price)	Each
Material for HMA Patching (Set Price)	Ton
Quality Control Testing (HMA)	Ton

*Mix Designation
**Grade of Asphalt Binder
***Shoulder
****Type and Grade of Emulsified Asphalt
Thickness
##Type of surface course HMA mixture

602.2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

a. General. Provide qualified personnel and sufficient equipment complying with the requirements listed in Part V to conduct quality control testing that complies with Appendix B, Sampling and Testing Frequency Chart for Asphalt Construction Items for Quality Control/Quality Assurance Projects.

Allow the Engineer access to the Contractor's laboratory to observe testing procedures, calculations, test documentation and plotting of test results.

Calibrate and correlate the testing equipment with prescribed procedures, and conduct tests in compliance with specified testing procedures as listed in Part V.

Maintain a Quality Manual in the field laboratory showing the calibrations performed on all test equipment and when the next calibration is due for that equipment. As a minimum, follow the calibration/verification interval established in Table 2: HMA Materials Test Equipment in Section 5.2.7.1-HMA: Contractor's Quality Control Plan, Part V. See also, Section 5.2.7.3-Example of a Laboratory Quality Manual for HMA, Part V.

Store and retain the most recent 2 lots per mix designation of quality control samples for KDOT. KDOT will retain the most recent 2 lots per mix designation gyratory compacted air voids (Va) verification samples and the remaining material not previously used for testing (back half of sample). Do not retain more than the previous 3 lots per mix designation of quality control or verification samples. When the hot mix plant shuts down for the winter, discard the samples after 7 days.

b. Quality Control Plan (QCP). At the pre-construction conference, submit to the Engineer for approval, a QCP as outlined in Section 5.2.7-Contractor's Quality Control Plan, Part V. Follow 5.2.7.1-HMA: Contractor's Quality Control Plan in Part V as a general guideline. The Contractor's laboratory and equipment will be inspected and approved as outlined in Section 5.2.7-Contractor's Quality Control Plan, Part V.

Include a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection. On the Contractor's organizational chart, show the specified lines of authority relating both to mix design and quality control operations during production. Post the organizational chart in the Contractor's test facility.

Provide a quality control organization or private testing firm having personnel certified according to the Policy and Procedures Manual for The Certified Inspection and Testing (CIT) Training Program. The testing for this type of construction will require personnel certified in Aggregate Field Tester (AGF), Aggregate Lab Technician (AGL), Superpave Field (SF), Profilograph (PO) and Nuclear Moisture Density Gauge Tester (NUC) classifications. Provide a minimum of 1 employee on the project certified in the QC/QA Asphalt Specs (QCA) classification.

Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing. At the beginning of the project, provide the Engineer with the list of certified technicians and alternates, phone numbers and tests/inspection they will be performing. Include certification expiration dates for all certified technicians. As personnel changes and certifications may expire, continue to provide the Engineer with an accurate list.

Provide an organizational chart showing the specified lines of authority relating to both mix design and quality control operations during production. Identify the company official acting as liaison with KDOT, and the Certified Technician who will direct inspection and testing. Post the chart in the test facility.
Brioche

c. Required Duties of Certified Inspectors. Be available on the project site whenever HMA is being produced and being placed on the project site. Perform and utilize quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix designs.

Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing and compacting to assure it is operating properly and that placement and compaction comply with the contract requirements.

d. Contractor's Testing Facilities. Describe the testing facility and its accreditation in the QCP.

Locate the testing facility either at the plant site or at the project. Obtain approval of the testing facilities and location from the DME before the commencement of mixture production.

Provide suitable space for the required testing equipment. Also, equip the testing facility with these items for the exclusive use of the testing facility's quality control personnel and the Engineer:

A telephone with a private line for the exclusive use of the testing facility's quality control personnel; and

A copying machine for use by the Contractor's personnel and the Engineer.

Broadband internet connection (for 1 computer). If the Engineer determines that broadband internet service is not available, provide a fax machine, at no additional cost.

An air conditioner capable of maintaining a temperature below 77°F in the main part of the Field Office and Laboratory.

Locate the KDOT field laboratory near the Contractor's testing facility and have it fully functional 2 working days before placement of the pre-production mix.

e. Documentation. Include in the QCP procedures, charts and forms to be used to provide the required documentation.

Record all original documentation in a bound field book or other KDOT approved bound record and turn over to KDOT at the end of the project.

At all times, have complete records of all inspections and tests available on site for the Engineer. All records documenting the Contractor's quality control inspections and tests become the property of KDOT upon completion of the work.

Indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the corrective action taken in the records. Examples of quality control forms and charts are available in Part V, or Contractors may design their own. Documentation procedures are subject to approval by the Engineer before the start of the work and to compliance checks during the progress of the work.

Maintain control charts on an ongoing basis.

Provide the following test data to the KDOT Project Representative:

- Copies of all test results and control charts on a weekly basis, representing the prior week's production;
- Copies of the quality control summary sheet on a daily basis. Include, as a minimum, mix gradation, binder content, theoretical maximum specific gravity (G_{mm}), air voids (V_a) at N_{des}, percent G_{mm} at N_{ini}

and N_{max}, voids in mineral aggregate (VMA), voids filled with asphalt (VFA) and dust to effective binder content (D/B) ratio; and

- Copies of all failing test results (based on a moving average of 4 tests, when appropriate). Include all applicable sieves, VMA, VFA, density at N_{ini} and N_{max}, and D/B ratio.

f. Testing Requirements. In the QCP, identify test methods, procedures and equipment proposed for use. Use standard KDOT test methods and properly calibrated measuring and testing equipment as outlined in Part V. Detail any alternative sampling method, procedure or inspection equipment proposed to be used. Such alternatives are subject to review and approval by the DME.

Take all samples for tests and perform in-place tests at random locations, selected according to the Contractor's QCP and at the rates specified in the Sampling and Testing Frequency Chart for Hot Mix Asphalt for Quality Control/Quality Assurance Projects in Appendix B, Part V.

g. Pre-Production Testing Requirements.

(1) The Engineer will observe the Contractor obtaining and splitting the pre-production test section sample into 3 representative portions. Each sample set shall consist of enough material for 2 gyratory specimens, theoretical G_{mm} and ignition burnoff.

(2) Mold 2 gyratory specimens from the 1st sample set immediately, while still hot. Additional heating may be required to raise the temperature of the sample to compaction temperature. Determine G_{mm}, perform ignition burnoff and complete calculations.

(3) Provide the KDOT Field Representative with the 2nd sample set. The KDOT Field Representative will mold 2 gyratory specimens, determine G_{mm}, perform ignition burnoff and complete calculations.

(4) Retain or provide the 3rd sample set to the KDOT District Materials Representative.

(5) The results of the testing will be compared. If Contractor and KDOT field laboratory test results do not compare favorably, the District Materials Laboratory will test their ⅓ of the sample. This sample will be transported to the District Materials Laboratory, after it has cooled to ambient air temperature. KDOT personnel will reheat the sample to compaction temperature, mold 2 gyratory specimens, determine G_{mm}, perform ignition burnoff and complete calculations. If the 3rd sample set is collected, transported while hot to the District Materials Laboratory and compacted in less than 2 hours, then, at the DME's discretion, the requirement to cool the sample may be waived.

If results are not acceptable to either party, repeat the above steps in **subsections 602.2g.(1)** through **(5)** for the Contractor's Field Laboratory, KDOT's Field Laboratory, and District Materials Laboratory until the issues may be resolved satisfactorily by all parties.

h. Lot 1 Testing Requirements.

(1) Sequence of Sampling. KDOT field personnel will determine the random truckload for the Contractor for sublots A, B, C and D, and the KDOT verification test.

The verification sample will be sampled and tested by KDOT field personnel. The verification sample shall be randomly taken within the lot and shall not be the same truckload as selected for the Contractor's sublot A, B, C or D.

KDOT field personnel will:

- provide the random spots to sample from behind the paving operations before compaction (KT-25);
- not supply the Contractor the identity of the truckload to be sampled ahead of time;
- notify the Contractor's laboratory of which truck to sample after the aggregate has left the cold feeds, and before the truck is finished loading; and
- determine whether the split sample will be taken from sublot A or B and notify the Contractor.

(2) Split Samples. The Contractor shall:

- obtain a sample large enough to split 3 ways for testing;
- retain and test ⅓ of the sample;
- supply ⅓ of the sample to the KDOT field laboratory for testing; and
- supply ⅓ of the sample to the KDOT District Materials Laboratory for testing.

(3) Results. At a minimum, compare G_{mm} and V_a results. The acceptable differences are 0.019 and 0.5%, respectively. If the results exceed these differences, take an additional split sample in Lot 1 from sublot C or D, as time permits.

If test results do not compare favorably, KDOT and the Contractor will investigate the differences in test results together and take appropriate action. The Contractor's test results will be used for quality control. KDOT Field Laboratory test results and District Materials Laboratory test results will be reported as "information only" samples.

i. Testing Requirements for Lots 2 and Greater.

(1) Take all samples for tests at random locations as designated in the approved QCP at the rates specified in Appendix B, Part V.

Provide the Engineer with the random locations before going to the roadway to determine density or sample the HMA. The Engineer reserves the right to generate the random locations. If the Engineer generates the random locations, the Contractor will be notified before going to the roadway to sample the HMA or determine density.

(2) Conduct the tests for mixture properties, aggregate gradation and binder content on representative portions of the HMA, quartered from the larger sample of HMA. Take a random sample weighing a minimum of 55 pounds from behind the paver and transport it to the test facility, using a method to retain heat to facilitate sample quartering procedures.

(3) Record and document all test results and calculations on data sheets provided by KDOT. Record specific test results on a daily summary sheet provided by KDOT to facilitate the computation of moving test averages. Base moving averages on 4 consecutive test results. Calculations are to be based on the precision displayed on the data sheets. Use "precision displayed" when calculating within Excel. Appendix B, Part V shows the accuracy to "record to" for the tests listed. Include a description of quality control actions taken (adjustment of cold feed percentages, changes in Job Mix Formulas (JMF), etc.) in the Daily Quality Control Summary Sheet. In addition, post and keep current quality control charts, showing both individual test results and moving average values. As a minimum, plot the single test values and the 4 test moving average values, as applicable, on KDOT approved control charts for the mix characteristics shown in **TABLE 602-12**.

(4) If the Contractor and Engineer agree, the procedures shown for sampling, testing and evaluation of Lot 1 in **subsection 602.2h.** may be used for any other Lot produced on the project.

j. Corrective Action. In the QCP, identify procedures for notifying the Engineer when corrective measures must be implemented, and for halting production.

k. Non-Conforming Materials. In the QCP, specifically address how non-conforming materials will be controlled and identified. Establish and maintain an effective and positive system for controlling non-complying material, including procedures for its identification, isolation and disposition. Reclaim or rework non-complying materials according to procedures acceptable to the Engineer. This could include removal and replacement of in-place pavement.

Positively identify all non-conforming materials and products to prevent use, shipment and intermingling with complying materials and products. Provide holding areas, mutually agreeable to the Engineer and Contractor.

602.3 MATERIALS

a. Asphalt Binder. Provide Asphalt Binder that complies with **DIVISION 1200**. Post a legible copy of the latest bill of lading for the Asphalt Binder on or near the gyratory compactor. Use the mixing and compaction temperatures shown on the bill of lading; however, the maximum mixing or compaction temperature is 340ºF, unless otherwise approved by the Field Materials Engineer. Notify the Engineer if the mixing or compaction temperature changes.

Exception: The mixing temperature may be increased no more than 10°F above the maximum mixing temperature shown on the bill of lading provided all the following are met:

- The air temperature is below 70°F.
- The plant has not produced mix earlier in the day.
- Do not exceed a mix temperature of 350°F.
- No truck has returned for its second load of the day.

Once a previously loaded truck returns for its next load, reduce the temperature to not higher than the maximum mix temperature shown on the bill of lading, not to exceed 340°F.

b. Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS). Provide RAP and RAS that comply with **SECTION 1103**.

c. Aggregates. Provide aggregates that comply with **SECTION 1103**.

d. Combined Aggregates. Provide combined aggregates for the mixes required in the Contract Documents as shown in **TABLE 602-1**.

Mixes may use any combination of aggregate and mineral filler supplements complying with the applicable requirements in **TABLES 1103-1** and **1103-2**.

Provide materials with less than 0.5% moisture in the final mixture.

The maximum quantity of crushed steel slag used in the mix is 50% of the total aggregate weight.

For all mixes used on the traveled way, the maximum quantity of natural sand is 35%.

Natural sand shall be called SSG-1, SSG-2, etc. in the mix design.

Additional requirements for SM-9.5T and SR-9.5T:

- Traveled way mixes shall include a minimum of 40% primary aggregate based on total aggregate weight;
- A minimum of 50% of the plus No. 4 mesh sieve material in the mixture shall be from the primary aggregate;
- A minimum of 45% of the plus No. 8 mesh sieve material in the mixture shall be from the primary aggregate; and
- Primary aggregates are designated as CS-1 (excluding limestone), CS-2 (excluding limestone), CG, CH-1 and CSSL as described in **subsection 1103.2a.(1)**. Primary aggregate requirements do not apply to the mixture used on the shoulder.

e. Contractor Trial Mix Design. A minimum of 10 working days before the start of HMA production, submit in writing to the DME for review and approval, a proposed JMF for each combination of aggregates. For each JMF submitted, include test data to demonstrate that mixtures complying with each proposed JMF shall have properties specified in **TABLE 602-1** for the designated mix type at the Recommended Percent Asphalt (P_{br}). Submit the proposed JMF on forms provided by KDOT. Submit the worksheets used in the design process to include at a minimum the mix properties listed in **TABLE 602-2**. Contact the DME to determine if additional information should be submitted. Provide sufficient material as identified in **TABLE 602-3**. Contact the DME to determine if additional material is needed for additional design checks such as the modified Lottman test (KT-56).

When more than 25% of the mix is comprised of siliceous virgin aggregates and/or RAP, add anti-strip to the mix. The minimum amount of anti-strip required in the mix is 0.01% for every percent of natural sand and RAP in the mix. Thus, if 25% natural sand and 10% RAP is in a mix, then 0.35% anti-strip by weight of virgin asphalt binder is required in the mix.

If during production, the Tensile Strength Ratio (TSR) values (both KDOT and Contractor) exceed 85%, then the Contractor and the DME, working together, may decide on a lower amount of anti-strip.

Submit for the Engineer's review and approval, the test data listed in **TABLE 602-4** for each blend and the proposed JMF. In addition, for mixes containing RAP or RAS, submit for the Engineer's review and approval, the test data listed in **TABLE 602-5** for each blend and the proposed JMF. Submit a mix design for each blend and the proposed JMF as outlined in **TABLE 602-6**.

For each aggregate used in the mix design, determine the specific gravity using KT-6. This may be accomplished while the project is being constructed or anytime during the 12 months preceding the start of construction on a project. If construction has not yet begun, notify the DME 5 working days prior to obtaining the material for the specific gravity test so that companion samples may be obtained at the same time. If construction has already begun on the project, then determine the specific gravity values of the individual aggregates before 10,000 tons of HMA is produced. Provide the test results to the DME within 14 days of sampling the material. If the producer of the aggregate has been required to submit material to KDOT for a new Official Quality test, since the time the Contractor ran the specific gravity tests, then perform KT-6 on the aggregate currently produced. Do not use the specific gravity values obtained from these tests in the mix design calculations for current projects, unless mutually agreeable to both parties. Use the information, as soon as it becomes available, as part of the process to verify and update the "Monthly Hot Mix Aggregate Specific Gravity Values" posted on KDOT's Internet site.

TABLE 602-1: COMBINED AGGREGATE REQUIREMENTS											
Nom. Max. Size Mix Designation	Percent Retained – Square Mesh Sieves									Min. VMA (%)	D/B Ratio
	$1^{1}/_{2}$"	1"	$^{3}/_{4}$"	$^{1}/_{2}$"	$^{3}/_{8}$"	No. 4	No. 8	No. 16	No. 200		
SM-4.75A				0	0-5	0-10		40-70	88.0-94.0	16.0	0.9 – 2.0
SR-4.75A			0	0-2	0-5	0-10		40-70	88.0-94.0	16.0	0.9 – 2.0
SM-9.5A				0	0-10	10 min.	33-53		90.0-98.0	15.0	0.6 – 1.2
SR-9.5A			0	0-2	0-10	10 min.	33-53		90.0-98.0	15.0	0.6 – 1.2
SM-9.5B				0	0-10	10 min.	53-68		90.0-98.0	15.0	0.8 – 1.6
SR-9.5B			0	0-2	0-10	10 min.	53-68		90.0-98.0	15.0	0.8 – 1.6
SM-9.5T				0	0-10	10 min.	53-68		90.0-98.0	15.0	0.8 – 1.6
SR-9.5T			0	0-2	0-10	10 min.	53-68		90.0-98.0	15.0	0.8 – 1.6
SM-12.5A			0	0-10	10 min.		42-61		90.0-98.0	14.0	0.6 – 1.2
SR-12.5A		0	0-2	0-10	10 min.		42-61		90.0-98.0	14.0	0.6 – 1.2
SM-12.5B			0	0-10	10 min.		61-72		90.0-98.0	14.0	0.8 – 1.6
SR-12.5B		0	0-2	0-10	10 min.		61-72		90.0-98.0	14.0	0.8 – 1.6
SM-19A		0	0-10	10 min.			51-65		92.0-98.0	13.0	0.6 – 1.2
SR-19A	0	0-2	0-10	10 min.			51-65		92.0-98.0	13.0	0.6 – 1.2
SM-19B		0	0-10	10 min.			65-77		92.0-98.0	13.0	0.8 – 1.6
SR-19B	0	0-2	0-10	10 min.			65-77		92.0-98.0	13.0	0.8 – 1.6

1. The requirements for Coarse Aggregate Angularity (CAA); Fine Aggregate Angularity (FAA); Sand Equivalent (SE); percent RAP; binder grade; Gyratory compaction revolutions N_{ini}, N_{des}, $N_{max,}$ N_{ini} level of compaction and VFA shall be as shown in the Contract Special Provisions for each mix designation.
2. The flat and elongated particles in the combined coarse aggregate shall not exceed 10% for the total sample.
3. The maximum percent moisture in the final mixture shall not exceed 0.5 for any mix designation.
4. The target air voids (V_a) for any mix designation shall be 4.0% at N_{des} gyrations.
5. The minimum tensile strength ratio (%TSR) shall be 80% for any mix designation.
6. The level of compaction of the mix when compacted to N_{ini} gyrations shall be less than the percent of the G_{mm} shown in the Contract Special Provision, and when compacted to N_{max} gyrations shall be a maximum of 98.0% of the G_{mm}.

TABLE 602-2: MIX PROPERTIES			
Property	Abbreviation	Test Method	Additional Information
Air Voids	V_a	KT-15 & KT-58	Calculated from G_{mm} and G_{mb}. Run at the P_{br}.
Recommended Percent Asphalt	P_{br}		Produce a mix with a V_a of 3.5% to 4.5%.
Theoretical Maximum Specific Gravity	G_{mm}	KT-39	Rice Test.
Percent Tensile Strength Ratio	%TSR	KT-56	Run test at P_{br} or at 0.3% to 0.5% less than P_{br}
Sand Equivalent	SE	KT-55	
Bulk Specific Gravity of HMA	G_{mb}	KT-15	Compacted Mix Property.
Percent G_{mm} at N_{ini} and N_{des} and N_{max}	$\%G_{mm}$ @ N_{ini} $\%G_{mm}$ @ N_{des} $\%G_{mm}$ @ N_{max}	KT-15	Use G_{mm} value from KT-39. Calculated from Gyratory Compaction height data, G_{mm}, and G_{mb}.
Voids in Mineral Aggregate	VMA	KT-15 & KT-6	Calculated from G_{mb}, G_{sb}, P_b.
Voids Filled with Asphalt	VFA		Calculated from VMA and V_a @ N_{des}.
Coarse Aggregate Angularity	CAA	KT-31	
Fine Aggregate Angularity	FAA	KT-50	

Formulas for calculations are in the Superpave Volumetric Mixture Design and Analysis Handbook.

TABLE 602-3: MATERIAL SUBMITTALS			
Submittal	**Quantity**	**Description**	**Additional Information**
Aggregate for KT-15	3 Samples	Sized for 6 inch Plugs	Comply with Job Mix Gradation.
Aggregate for KT-39	2 Samples	Sized for G_{mm} Testing	Comply with Job Mix Gradation.
Binder for KT-15	As Needed	Sized for 3 Plugs at P_{br}	
Binder for KT-39	As Needed	Sized for 2 G_{mm} Tests	
Each Aggregate for KT-6	As Needed	Specific Gravity Test	
Uncompacted HMA Sample	35 lbs	Cool sample to room temperature	If transported hot and compacted within 2 hours, then requirement to cool sample may be waived by the DME.
Gyratory Plugs at N_{max}	2 Plugs	Compacted at P_{br}	Compacted to N_{max}.

TABLE 602-4: TEST DATA SUBMITTALS	
Submittal	**Information**
Asphalt Binder	Source, Grade, Specific Gravity, Mixing and Compaction Temperature from the Producer of the asphalt binder.
Each Aggregate	Source and Producer, including Legal Description.
Gradation of Each Aggregate	Percentage Retained to nearest 1% (except nearest 0.1% for No. 200 sieve) Derive RAP gradation after residual binder is removed. Derive RAS gradation after residual binder is removed or from the Shingle Aggregate Gradation table in **SECTION 1103**.
Material Proportioning	Proportion of each material is shown in percentage of aggregate.
Composite Gradation	Based on Gradation of Each Aggregate and Material Proportioning.
Composite Gradation Plot	Plotted on KDOT Form 712 (0.45 power graph paper).
Asphalt Binder Added	Percentage to nearest 0.01% based on total weight of the mixture.
Aggregate	Percentage of flat and elongated particles in the coarse aggregate, CAA and FAA.
%TSR	Percent Tensile Strength Ratio of the Mixture (Modified Lottman Test).
Sand Equivalent	SE for the combined virgin aggregates.

TABLE 602-5: RAP AND RAS TEST DATA SUBMITTALS	
Submittal	**Information**
RAP and RAS	Source and location where RAP will be obtained. Source and location where RAS will be obtained.
RAP Aggregate	Bulk Specific Gravity (G_{sb}). Use the G_{sb} provided on the Contract Special Provision. If no value is provided, the Effective Specific Gravity (G_{se}) shall be calculated as shown in subsection 5.10.4, Part V and used as the G_{sb}.
RAS Aggregate	Bulk Specific Gravity (G_{sb}). The Effective Specific Gravity (G_{se}) shall be calculated as shown in subsection 5.10.4, Part V and used as the G_{sb}.
Asphalt Binder Content of RAP Asphalt Binder Content of RAS	Determined from ignition oven analysis using KT-57.
RAP G_{mm} RAS G_{mm}	Determined by KT-39.
Asphalt Binder Specific Gravity	Specific Gravity of the asphalt binder in the RAP and RAS (G_b) shall be set equal to 1.035.
Corrected Asphalt Binder Content of the total recycled mixture	Determined from ignition oven analysis using KT-57.

TABLE 602-6: MIX DESIGN TEST DATA SUBMITTALS	
Submittal	**Information**
Minimum of 2 Mix Designs	As a minimum, 1 mix design at the P_{br} and 1 mix design at 0.3% to 0.5% below the P_{br}
G_{mm}	Determined at each binder content.
Individual and Bulk Specific Gravity Tests	Provide results for a minimum of 2 specimens at each binder content.
Percent Air Voids	Provide % V_a in the mixture for each binder content when compacted to N_{ini}, N_{des} and N_{max} gyratory revolutions along with copies of the Gyratory graphs.
Percent VMA	Provide %VMA at each binder content. (Note: The Contractor is cautioned that plant produced material generally yields a mixture with less VMA than predicted by the design. In such case, the design VMA should be increased above the specified minimum accordingly.)
D/B Ratio	Calculate to the nearest 0.1% at each binder content.

f. Additives. Provide Warm Mix Asphalt (WMA) additives or processes that comply with **SECTION 1203**. The Contractor is permitted to use WMA, unless otherwise shown in the Contract Documents.

For mixes containing Warm Mix Asphalt (WMA) additives, submit for the Engineer's review and approval, the additive or process used, the recommended rate of application, and the temperature ranges for mixing and compaction.

Mixing temperature range is provided by the Asphalt Binder Supplier. When using WMA, the mixing temperature may be reduced no more than 30°F for WMA water foaming processes, and no more than 70°F for WMA chemical and organic additives. The minimum mixing temperature for WMA is 220°F.

602.4 CONSTRUCTION REQUIREMENTS

a. Plant Operation. Adjust all plant operations to operate continuously.

(1) Preparation of the Asphalt Binder. Heat the asphalt binder to within a range as specified in **SECTION 601**. When heating the asphalt binder to the specified temperature, avoid local overheating. At all times, provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. Asphalt binder received from the refinery at temperatures less than 375°F may be used as received, if the requirements regarding the reheating of asphalt binder in **SECTION 601** are met.

(a) Commingling of Asphalt Binders. Do not add or commingle asphalt binders from 2 or more sources into a storage tank. If this occurs, the contents of the storage tank are considered contaminated. Do not use the contents of the storage tank on the project, except as follows: It is permissible, at the Contractor's option, to thoroughly mix the contents of the tank and request sampling of the mixture. Submit the sample to the MRC for testing. Do not use the asphalt binder until approved, and when needed, a new mix design evaluation is completed.

(b) Asphalt Binder Sources. Before changing asphalt binder sources on a project, obtain approval from the DME. A new JMF may be required.

(c) Anti-Strip Additives. If liquid anti-strip additives are added at the Contractor's plant, install a "totalizer" to monitor the quantity of anti-strip additive being added. The Engineer may approve alternative methods for including anti-strip additives in a batch plant. If added at the plant, the anti-strip will be added in line with the asphalt binder as it is being transferred from the transit unit to the asphalt binder storage tank. Provide a method for the Engineer to monitor the percent of additive being added.

If hydrated lime is added, mix it in an approved pug mill to coat the combined aggregates. Moisten the combined virgin aggregate to a minimum of 3% above the saturated surface dry condition prior to, or during the addition of the hydrated lime.

(d) WMA Additives. If WMA additives are added at the Contractor's plant, install a "totalizer" to monitor the quantity of WMA additive being added. The Engineer may approve alternative methods for including chemical and organic WMA additives in a batch plant. If added at the plant, chemical and organic WMA additives will be added in line with the asphalt binder as it is being transferred from the transit unit to the asphalt binder storage tank. Provide a method for the Engineer to monitor the percent of additive being added.

(2) Preparation of Mineral Aggregate. When the mineral aggregate is composed of 2 or more ingredients, combine as shown in the approved JMF.

(a) Temperature Requirements. Dry the aggregate for the mixture and heat to a temperature to obtain an asphalt-aggregate mixture temperature immediately after mixing within the 75 to 150 second Saybolt viscosity range of the asphalt binder used. Obtain the temperature for this viscosity range from the MRC or the Asphalt Binder Producer. No mixing or compaction temperatures are to exceed 340ºF without approval from the Field Materials Engineer. The minimum temperature may be revised by the DME provided it is demonstrated that satisfactory results may be obtained at a lower temperature. In such event, deliver the HMA to the paver at a temperature sufficient to allow the material to be satisfactorily placed and compacted to the specified density and surface tolerance requirements.

(3) Preparation of HMA. Introduce asphalt binder into the prepared aggregate in the proportionate amount determined by the P_{br} in the JMF.

(a) Basis of Rejection. HMA will be rejected if the aggregate, as it is discharged from the drum or the pugmill, contains sufficient moisture to cause foaming of the mixture, or if the temperature of the aggregate is such that the asphalt-aggregate mixture temperature is outside the range specified in **SECTION 601**.

(b) Mixing Time. Operate drum mixers at a rate to provide uniform aggregate coating in a continuous operation. For batch and continuous type plants, the minimum wet mixing time is 40 seconds. In all cases, mix a sufficient time to produce a uniform mixture in which all the aggregate particles are thoroughly coated. On batch plants, begin the timing at the start of the asphalt binder introduction into the pugmill, and end upon the opening of the discharge gate. For continuous flow plants, mixing time in seconds shall equal:

[pugmill dead capacity in pounds] divided by [pugmill output in pounds per second].

(c) Manufacturer's Specifications. Operate all drying, pumping and mixing equipment within the limits specified by the manufacturer, unless it can be demonstrated to the satisfaction of the Engineer that such limits may be exceeded without detriment to the HMA.

(d) Batcher Operation. Coordinate HMA batchers (Gob Hoppers) with the plant production rate at all times so the hopper is more than ¾ full before the gates open, and the gates close before material can drop through the gob hopper directly into the surge bin, weigh hopper or truck.

(e) Wasted Material. Wasted material is not measured for pay.

If after an interruption of production, the drum-mixer contains cold, uncoated or otherwise unsuitable material, waste material through a diversion chute. In a continuous or batch plant drier, waste unsuitable material through the pugmill.

At the end of a production run, waste any segregated material in the cone of the storage bin.

(4) End of Day Quantities. At the end of each day of production provide the Engineer with a document signed by the Plant Foreman or the Project Manager listing the dry weight of each aggregate, mineral filler, RAP, and WMA chemical or organic additive; the tons of asphalt binder, the tons of anti-strip agent used for the project during the day, and the tons of water used in the WMA foaming process. The dry weight is the tons of the material less the water content.

b. Road Surface Preparation.

(1) Preparation of Earth Subgrade. Do not place any surfacing material on any section, until the ditches and drains along that section are constructed to effectively drain the highway, and the base or subgrade is trimmed to the line, grade and typical cross-section as shown in the Contract Documents.

Do not deposit any material until the subgrade or base has been checked and approved by the Engineer.

Maintain the subgrade as prepared until it is covered with the base course. Repair any defects which may develop, at the Contractor's expense, to the satisfaction of the Engineer.

Protect the subgrade from damage when handling materials, tools and equipment. Do not store or stockpile materials on the subgrade. Do not place material or lay pavement on a frozen or muddy subgrade, or when it is raining or snowing.

Lightly spray the subgrade or base with water to obtain a thoroughly moistened condition when the HMA is deposited on it. Lightly scarify, where necessary. Do not puddle water on the grade. Disturb the originally compacted crust or top portion of the subgrade as little as possible.

(2) Preparation of an Existing Asphalt Pavement. Clean the surface to remove all foreign material and broom to remove dust. Excavate areas shown in the Contract Documents to be patched to a depth directed by the Engineer. Fill with HMA and compact.

(3) Preparation of an Existing Concrete or Brick Pavement. Clean all foreign material and broom to remove dust. Clean and fill cracks and joints, and construct surface leveling as shown in the Contract Documents.

(4) Tack Coat. Prior to placing the HMA, apply a tack coat to the existing surface, as shown in the Contract Documents. When warranted by weather conditions, the Engineer may authorize a change in the asphalt for tack coat. When such changes are made, the price per ton of material being used will be the unit price bid for the material designated in the contract plus or minus the difference in the invoice price per ton of the 2 materials at the refinery as determined at the time of application.

c. Weighing Operations. See **SECTION 109** for details regarding weighing operations.

d. Hauling Operations. Schedule operations to minimize hauling over a surface course.

Deliver HMA to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance.

e. Paving Operations. Except when placing SM-4.75A, SM-9.5A or SR-9.5A asphalt mixtures, remix the material transferred from the hauling unit, prior to placement. Use equipment such as a mobile conveyor, material transfer device, shuttle buggy material transfer vehicle, material transfer paver or paver with remixer conveyor system. After starting the project with the equipment listed above, and after producing HMA pavement density within the limits specified in **TABLE 602-7**, the Engineer will consider other types of equipment or modifications to pavers that will produce less segregation. The use of equipment as noted above shall not relieve the Contractor of the responsibility to comply with **TABLE 602-7**. The Engineer will check the pavement for longitudinal streaks and other irregularities. Make every effort to prevent or correct any irregularities in the pavement, such as changing pavers or using different and additional equipment.

Do not raise (dump) the wings of the paver receiving hopper at any time during the paving operation. The Engineer may waive this requirement if it is determined that raising (dumping) the wings will not produce detrimental segregation. If segregation or irregularities in the pavement surface or density are noted, review the plant, hauling and paving operations and take corrective action. The recommendations made in KDOT's "Segregation Check Points" should reduce the segregation and irregularities to an acceptable level. Copies of KDOT's "Segregation Check Points" may be obtained from the KDOT District Office or Field Engineer.

Spread the HMA and finish to the specified crown and grade using an automatically controlled HMA paver. Operate the paver at a speed to provide a uniform rate of placement without undue interruption. At all times, keep the paver hopper sufficiently full to prevent non-uniform flow of the HMA to the augers and screed.

If the automatic grade control devices break down, the Engineer may allow the paver to operate to the close of the working day, provided the surface is satisfactory. Do not operate the paver without working automatic control devices upon another lift that was laid without automatic controls.

(1) Surface Quality. Spread the HMA without tearing the surface. Strike a finish that is smooth, free of segregation, true to cross section, uniform in density and texture and free from surface irregularities. If the pavement does not comply with all of these requirements, plant production and paving will be suspended until the deficiency is corrected.

The Engineer will check segregation and uniformity of density using methods outlined in Section 5.8.3 - Segregation Check Using the Nuclear Density Gauge, Part V. For shoulders with a plan width of less than or equal to 3 feet, and placed at the same time as the traveled way, do not take nuclear density readings on the shoulder nor within 1 foot of the shoulder unless the pavement section is uniform across the entire roadway. The acceptable criteria for density uniformity are in **TABLE 602-7**.

TABLE 602-7: SEGREGATION AND UNIFORMITY OF DENSITY CHECK

Mix Designation	Maximum Density Range (highest minus lowest)	Maximum Density Drop (average minus lowest)
All	4.4 lbs./cu. ft.	2.2 lbs./cu. ft.

Whenever the results from 2 consecutive density profiles fail to comply with both of the requirements listed in **TABLE 602-7**, plant production and paving will be suspended. Follow the procedures listed in the Profile Evaluation

Subsection of Section 5.8.3-Segregation Check Using the Nuclear Density Gauge, Part V until production may be resumed.

Joint density testing and the associated requirements listed below do not apply for HMA lift thicknesses less than or equal to 1 inch.

Evaluate the longitudinal joint density using methods outlined in Section 5.8.4-Joint Density Evaluation Using the Nuclear Density Gauge, Part V. Although it is the Contractor's responsibility to perform the joint density evaluation, the Engineer may make as many independent joint density verifications as deemed necessary at the random sample locations. The Engineer's results will be used for acceptance for joint density, whenever available. The acceptable criteria for joint density are in **TABLE 602-8**.

TABLE 602-8: JOINT DENSITY REQUIREMENTS	
Nuclear Gauge Readings	**Requirement**
Interior Density minus Joint Density	≤ 3.0 lbs./cu. ft.
OR	
Joint Density	≥ 90.00% of G_{mm}

If the results of 2 consecutive density profiles fail to comply with **TABLE 602-8**, the plant production and paving operations will be suspended. Follow the procedures listed in the Joint Evaluation Subsection of Section 5.8.4-Joint Density Evaluation Using the Nuclear Density Gauge, Part V, until production may be resumed.

(2) Leveling Courses. In general, spread leveling course mixtures by the method to produce the best results under prevailing conditions to secure a smooth base of uniform grade and cross section. The leveling course may be spread with a properly equipped paver or motor grader.

(3) Lift Thickness. Except for leveling courses or when shown otherwise in the Contract Documents, **TABLE 602-9** applies. The Engineer may adjust lift thickness to utilize the most efficient method of acquiring specified density and surface quality. The minimum lift thickness for any HMA mixture is 3 times the nominal maximum aggregate size, unless otherwise designated in the Contract Documents or approved by the Engineer.

TABLE 602-9: NOMINAL COMPACTED THICKNESS	
Lift	**Maximum Nominal Compacted Thickness**
Surface	2 inches
Base	4 inches

(4) Grade Control. Achieve grade control by use of 1 or more of the following grade reference devices. Approval of any of these devices will be based upon satisfactory performance.

(a) Traveling Stringline. Attach a traveling stringline or ski type attachment, a minimum length of 30 feet, to the paver and operate parallel with its line of travel.

(b) Reference Shoe. Attach a short reference shoe or joint matching device to the paver for control in matching surface grades along longitudinal joints.

(c) Erect Stringline. Use an erected stringline consisting of a tightly stretched wire or string offset from and parallel to the pavement edge on 1 or both sides. Erect the stringline parallel to the established pavement surface grade and support at intervals as necessary to maintain the established grade and alignment.

(d) Stringless Paving. Control line, grade and pavement cross-section as shown in the Contract Documents. Use electronic guidance systems that meet the requirements and tolerances listed in **SECTION 802**. Horizontal control is guided by GPS. Vertical control is guided by Total Stations. GPS will not be allowed for Vertical control.

When paving on a fresh subgrade that has not been trimmed by an automatically controlled machine, use an erected stringline or stringless paving to establish grade. Use either of these options on the first or second lift. When directed by the Engineer, use an erected stringline or stringless paving to match grade control points such as bridges.

(5) Compaction of Mixtures. Uniformly compact the HMA as soon after spreading and strike-off as possible without shoving or tearing. Use self-propelled rollers operated at speeds slow enough to avoid displacement of the HMA. Equipment and rolling procedures which result in excessive crushing of the aggregate are prohibited. Use a sufficient number and weight of rollers to compact the HMA to the required density, using a minimum of 2 rollers. If the hot mix plant is operating at over 275 tons per hour, use a minimum of 3 rollers. See

subsections 602.4e.(6) for exceptions to the minimum number of rollers. Perform final rolling with a steel roller unless otherwise specified. On the final pass, operate finishing, vibratory rollers in the static mode.

Coordinate the frequency, amplitude and forward speed of the vibratory roller to achieve satisfactory compaction without objectionable undulations. For HMA lifts with a compacted thickness less than 1¼ inch, operate vibratory rollers in the static mode.

Keep rollers in operation as necessary so all parts of the pavement receive substantially equal compaction at the proper time. The Engineer will suspend HMA delivery to the project at any time proper compaction is not being performed.

Remove, replace with suitable material and finish according to these specifications any mixture that becomes loose, broken, mixed with foreign material or which does not comply in all respects with the specifications.

(6) Density Requirements.

(a) For mixes with a specified thickness greater than or equal to 1 ½ inches:

For lots 1 and 2, control density as shown in **subsection 602.4e.(6)(b)**. Before beginning production, the Contractor has the option to accept the pay adjustment for density on both Lots 1 and 2, or only Lot 2. If the Contractor chooses to accept the pay adjustments for density on both Lots 1 and 2, or only Lot 2, control the density as shown in **subsections 602.4e.(6)(a)(i-ii)**. If the Contractor chooses to accept pay adjustment for density on Lot 1, the pay adjustment can not be rejected on Lot 2.

(i) HMA Overlay. For lots 3 and greater, the lot density requirements and appropriate density pay adjustment factors are shown in **subsection 602.9b.** as the percent of the G_{mm} value based on the average of the density tests. The standard lot size is 10 density tests. Smaller lot sizes may result as outlined in **TABLE 602-10**. Normally, the G_{mm} value used to calculate the density percentage is the average value of all G_{mm} tests conducted the same day the lot was placed and compacted. If less than 3 G_{mm} values were obtained that day, use the moving average value (last 4 tests prior to the end of the day). When starting a mix and less than 4 G_{mm} values have been determined, use the average value of those available at the end of each day.

(ii) HMA Surface, HMA Base and HMA Pavement. For lots 3 and greater, the lower specification limit (LSL) value for density is given in **subsection 602.9c.** along with the appropriate density pay adjustment factor equations. The LSL value is given as a percentage of G_{mm}. Lot density is determined using the measured density values for all sublots in a lot. The standard lot size is 10 density tests. Smaller lot sizes may result as outlined in **TABLE 602-10**. Normally, the G_{mm} value used to calculate the density percentage is the average value of all G_{mm} tests conducted the same day the lot was placed and compacted. If less than 3 G_{mm} values were obtained that day, use the moving average value (last 4 tests prior to the end of the day). When starting a mix and less than 4 G_{mm} values have been determined, use the average value of those available at the end of each day.

(b) For mixes with a specified thickness less than 1½ inches:

These mixes will not have a density pay adjustment. Control density using an approved rolling procedure with random nuclear gauge density determinations. Include a method for controlling density in the QCP.

Designate a "Compaction Foreman". This person shall control compaction procedures, review nuclear gauge results as they are obtained, adjust compaction procedures as needed to optimize compaction and report any changes in the compaction process and results of nuclear gauge testing to the Engineer. The compaction foreman may also be the nuclear gauge operator. The nuclear gauge operator shall continuously monitor compaction procedures. As a minimum, take 10 random nuclear gauge density determinations per day and report results to the Engineer. Throughout the day, nuclear gauge results shall be available for review by the Engineer. The compaction foreman shall document at a minimum of once every 2 hours that the approved rolling sequence is being followed. Documentation includes roller passes, the mat temperature at each pass, amplitude setting of rollers and roller speed. Provide the documentation to the Engineer.

Determine and periodically update an approved rolling procedure and periodically, as outlined in this section. As a minimum, evaluate the initial rolling procedure using 3 rollers. If the hot mix plant is operating at over 275 tons per hour, use a minimum of 4 rollers in the initial evaluation. Operate vibratory rollers according to **SECTION 151**. Evaluate HMA paver screed operation with the nuclear gauge at various vibration settings. For screed evaluation, take the nuclear gauge readings directly behind the screed and before rolling. The Compaction Foreman and Engineer will evaluate the densities obtained with the various roller combinations and screed settings to determine the initial approved rolling procedure.

Together, the Compaction Foreman and Engineer will determine when new rolling procedures are required. HMA production may be stopped by the Compaction Foreman or Engineer whenever rolling is not being performed according to the approved rolling procedure.

(c) For all lots, achieve the maximum density before the temperature of the HMA falls below 175°F. When using WMA, achieve the maximum density before the temperature of the WMA falls below 165°F. Do not crush the aggregate. When the mat temperature falls below 175°F or 165°F for WMA, roller marks may be removed from the mat with a self-propelled static steel roller or an oscillating roller operating in either the static mode or in the oscillating mode.

TABLE 602-10: DAILY PRODUCTION VS NUMBER OF SUBLOTS AND TEST REQUIREMENTS

Daily Production (tons)	Number of Sublots	No. of Cores or Nuclear Density Tests**	No. of Verification Cores or Nuclear Density Tests**
0-599	3*	6*	3*
600-999	4*	8*	4*
1000 or more	5	10	5

*Minimum number for mixes with a specified thickness of 1½ inches or greater: The Contractor may choose to obtain the number required for 1000 or more tons. If the Contractor chooses to test 5 sublots (10 tests), KDOT will obtain 5 verification tests.

**For mixes with a specified thickness less than 1½ inch: Verification testing may be performed, but is not required. Additional testing may be performed by the Contractor. A minimum of 10 tests are required.

(7) Contact Surfaces. Coat contact surfaces of curbing, gutters, manholes and similar structures with a thin uniform coating of asphalt material. Place the HMA uniformly high near the contact surfaces so that after compaction it shall be approximately ¼ inch above the edge of such structures.

(8) Adjustment of Manholes (Set Price). When required, this work will be performed and paid for under **SECTION 816**.

(9) Construction Joints.

(a) Transverse Construction Joints. Use a method of making transverse construction joints to provide a thorough and continuous bond, provide an acceptable surface texture and meet density requirements. Do not vary the surface elevation more than 3/16 inch in 10 feet, when tested longitudinally across the joint. When required, repair the joints or paving operations will be suspended.

(b) Longitudinal Joints. Construct well bonded and sealed longitudinal joints to obtain maximum compaction at the joint. If deemed necessary by the Engineer to properly seal the joint, apply a light coat of asphalt emulsion or asphalt binder to the exposed edge before the joint is made.

Before placing the fresh HMA against a cut joint or against old pavement, spray or paint the contact surface with a thin uniform coat of asphalt emulsion or asphalt binder. Where a finishing machine is used, make the longitudinal joint by depositing a sufficient amount of HMA to form a smooth and tight joint.

Offset the longitudinal joint in successive courses by 6 to 12 inches. Comply with traffic lane edges for the width of the surface of top course placement.

(10) Shoulder Surfacing and Widening. When the placement width of shoulders or uniform width widenings is less than can be accomplished with a regular paver, spread each course with a mechanical spreading device.

(11) Rumble Strips. When designated, construct rumble strips according to the Contract Documents.

f. Maintenance of Traffic. Maintain traffic according to **DIVISION 800** and the following:

Maintain one-way traffic, and restrict traffic speeds to 20 miles per hour in the vicinity of workers, unless otherwise designated. Use pilot cars to lead traffic through the area of paving and rolling operations, and if directed, through a curing area. The use of flaggers is allowed through patching operations, unless the patching area or distance between flaggers exceeds ½ mile, in which case the use of a pilot car shall be required. On overlay projects with 2 lanes or more in each direction for traffic use, the Engineer may waive the pilot car requirements.

Station one flagger ahead of the application of the tack coat and one flagger ahead of the area being protected from traffic. Take adequate protection for traffic on side roads approaching the tack area.

g. Treatment of Adjacent Areas. Pave sideroads, entrances and turnouts for mailboxes as shown in the Contract Documents. Overlay all widening areas designated in the Contract Documents or ordered by the Engineer.

h. Pavement Smoothness. Evaluate pavement smoothness according to **SECTION 603** and the following:

TABLE 602-11: MAXIMUM VARIATION OF THE SURFACE	
Length (feet)	**Maximum Variation of the Surface (inches)**
10	3/16
25	5/16

Correct all humps or depressions exceeding the specified tolerance by removing the defective work and overlaying with new material, or by other means approved by the Engineer. All necessary corrections are at the Contractor's expense.

602.5 PROCESS CONTROL

a. General. Establish gradation limits and proportions for each individual aggregate, mineral filler and RAP and RAS, when applicable. Specify the limits and proportions such that the material produced complies with the applicable requirements of the designated mix type. The Contractor is responsible for all process control operations including testing. At no time will KDOT's representative issue instructions to the Contractor or producer as to setting of dials, gauges, scales and meters. KDOT will collect and test verification samples and assurance samples and inspect the Contractor's quality control operations.

b. JMF Adjustments. Produce a mixture of uniform composition closely complying with approved design JMF to obtain the specified properties when compacted. If, during production, results from quality control tests demonstrate a need to make adjustments to the mix design, then make adjustments to the design JMF single point gradation and binder content to achieve the specified properties. The JMF adjustments shall produce a mix that complies with **TABLE 602-1** for the specified mix designation. When necessary, adjust on a sublot basis. Report the new JMF to KDOT's field representative and the DME before making such changes, and submit a new mix design for review and approval if required by the DME.

c. Specification Working Ranges. Establish acceptable limits for field test results by applying the tolerances shown in **TABLE 602-12** to the JMF or adjusted JMF for binder content. Establish acceptable limits for the other listed mix characteristics by applying the tolerances shown in **TABLE 602-12** to the requirements of **TABLE 602-1**.

TABLE 602-12: SPECIFICATION WORKING RANGES (QC/QA)				
Mix Characteristic	**Tolerance from JMF**			
	Single Test Value	**Plot**	**4 Point Moving Average Value**	**Plot**
Binder Content	±0.6%	*	±0.3%	*
Mix Characteristic	**Tolerance for Specification Limits**			
	Single Test Value	**Plot**	**4 Point Moving Average Value**	**Plot**
Gradation (applicable sieves in **TABLE 602-1**)	N/A	*	zero tolerance	*
Air Voids @ N_{des} gyrations	±2.0%	*	N/A	
Voids in Mineral Aggregate (VMA)	1.0% below min.	*	zero tolerance	*
Voids Filled with Asphalt (VFA)	N/A		zero tolerance	*
Course Aggregate Angularity (CAA)	zero tolerance		N/A	
Sand Equivalent (SE)	zero tolerance		N/A	
Fine Aggregate Uncompacted Voids (FAA)	zero tolerance		N/A	
%Tensile Strength Ratio (%TSR)	zero tolerance	*	N/A	
Density @ N_{ini} and N_{max}	N/A		zero tolerance	
Dust to Effective Binder (D/B) Ratio	zero tolerance	*	zero tolerance	*

* Plot data according to **subsection 106.4**.
For gradations, as a minimum, plot the No. 4, 8, 30 and 200 sieves.
Plot G_{mm} to third decimal point.
Indicate Job Mix Formula (JMF) and specification working range limits for single test results on the control charts using a green ink dotted line.
Indicate the specification working range limits for the 4-point moving average results with a green ink solid line.

d. Mixes with Reclaimed Asphalt Pavement (RAP). The intent of this section is to prevent more RAP going into a mix than is allowed in the Contract Documents. Totalizers are used to determine the %RAP in mix; however, this does not preclude the Engineer from using other methods for determining the %RAP in a mix.

Provide the Engineer with the totalizer readings at the end of each day of production. These shall include the final daily readings for the RAP, virgin aggregates and asphalt binder.

The %RAP will be checked a minimum of twice a day by the Engineer. Take the readings a minimum of 2 hours apart and a maximum of 6 hours apart. Do not take the readings within the first hour of start-up as adjustments to the plant are most frequent within this time frame.

Calculate RAP percentages using the plant totalizers for the virgin aggregates (AGG_v), and the RAP as follows:

Equation A: $$\%RAP = \frac{RAP * 100}{RAP + AGGv}$$

%RAP is the percent RAP in the total aggregates (Virgin and RAP) rounded to the nearest tenth.
RAP is the difference between the current and last reading of the RAP totalizer in tons.
AGG_v is the difference between the current and last reading of the Virgin Aggregate totalizer in tons.

%RAP is considered out of compliance when any of the following occurs:

- Any single test exceeds the maximum percentage allowed by specs by 3%.
- The 4-point moving average exceeds the maximum percentage allowed by specifications.

Actions to be taken if the %RAP is out of compliance:

- If any single test exceeds 3% of the maximum allowed %RAP stop production, perform the “0 check run” on the belts in the presence of the Engineer, and make adjustments to correct the discrepancy.
- If the 4-point moving average exceeds the maximum allowed %RAP three consecutive times, stop production, perform the “0 check run” on the belts in the presence of the Engineer, and make adjustments to correct the discrepancy.

- If the 4-point moving average exceeds the maximum allowed %RAP by more than 1% then the Contractor will be assessed the following penalty.

Equation B: $$\text{Contract Deduct} = \frac{BP * Q * (\%RAP_4 - \%RAP_{max})}{100}$$

Contract Deduct is the Dollar amount to be subtracted from the contract.
BP is the Bid Price of the mix.
Q is the Quantity, in tons, of material represented by the 4-point moving average. This value shall be based on the weigh tickets taken from the time of the 1st test of the 4-point moving average through the time of 4th test.
$\%RAP_4$ is the 4-point moving average of %RAP.
$\%RAP_{max}$ is the Maximum %RAP from the Project Special Provision.

Contract Deducts for RAP will be an item added to the contract.

Any time production is stopped due to non-compliant %RAP, restart the 4-point moving average provided the belt had the "0 check run" performed in the presence of the Engineer, and adjustments were made to the mix proportioning to correct previous discrepancies. The initial start-up at the beginning of each work day does not constitute a stop in production due to non-compliant %RAP.

If at any time the Contractor chooses to stop production in order to correct discrepancies in the mix proportioning concerning the %RAP, the most recent data (not to exceed 4 points) will be averaged. If the average exceeds the maximum allowed %RAP by more than 1% then a Contract Deduct will be assessed as calculated above with the following substitutions:

In the case where less than 4-points are available for the 4-point moving average, the most recent test is substituted for the 4th test, and the $\%RAP_4$ may be a single test, a 2-point moving average or a 3-point moving average.

602.6 COMPACTION TESTING

a. General. Make the density determination of the compacted mixture using test results on random samples selected by the Contractor or Engineer (see **subsection 602.2i.(1)**) from each lift placed. Select sites according to the approved QCP. Take the nuclear density tests or core samples before placement of the next lift and before opening to construction or public traffic, and no later than the next working day following the date of placement.

Exception to coring after any traffic on the overlay. Do not use this procedure more than twice on any one project or tied projects, unless approved by the Engineer. The Contractor may request re-evaluation by coring. (Testing and coring shall be subsidiary items.) When coring is requested, follow these procedures for the lot under re-evaluation.

(1) Immediately prior to coring, determine nuclear gauge densities in the presence of the Engineer in the locations previously tested. The average nuclear gauge density after traffic will be determined. A Contractor density correction factor will be calculated as follows: the average nuclear gauge density after traffic minus the average nuclear gauge density before traffic. If the calculated Contractor density correction factor is a negative value, the Contractor's density correction factor will be set equal to zero (normally the density correction factor will be a positive number).

(2) Immediately before coring, nuclear gauge densities will be determined by the Engineer in the presence of the Contractor in the locations previously tested. The average nuclear density after traffic will be determined. A KDOT density correction factor will be calculated as follows, the average nuclear gauge density after traffic minus the average nuclear gauge density before traffic. If the calculated KDOT density correction factor is a negative number, KDOT's density correction factor will be set equal to zero.

(3) Determine the Traffic Density Correction Factor. It will be the larger of the Contractor's density correction factor or KDOT's density correction factor determined in **subsections 602.6a.(1)** and **(2)**.

(4) With the Engineer present, obtain 1 core from each of the Contractor and KDOT nuclear gauge locations. Mark each core as they are taken. Take the cores to KDOT's field laboratory for drying and evaluation. Together, the Contractor and Engineer will determine the density of each core. Determine the corrected core density for each Contractor and KDOT core as follows: the core density minus the Traffic Density Correction Factor.

(5) Using the corrected Contractor core densities and the corrected KDOT core densities, the Engineer will re-evaluate this lot using the procedures outlined in **subsection 602.9**. Based on this re-evaluation, the Engineer will inform the Contractor of the lots disposition and density pay adjustment factor.

For shoulders with a plan width of less than or equal to 3 feet and placed at the same time as the traveled way, the density pay adjustment factors for the traveled way applies. Acceptance of or pay adjustment for density on all shoulders with a plan width greater than 3 feet and any shoulder not placed at the same time as the traveled way shall be according to **subsection 602.9**.

A lot consists of a day's production for each lift placed and contains the number of density locations as outlined in **TABLE 602-10**. Base lot acceptance on 2 test results from each sublot unless the Engineer's results (1 test per sublot) are used. V_a lots and density lots are normally of different sizes.

If the lane being placed is to be opened to traffic that day, the Engineer and the Contractor may predetermine the sublot size based on anticipated production. If actual production does not meet anticipated production, the sublot size will be adjusted. The number of tests shall be as outlined in **TABLE 602-10**.

The minimum number of density tests is as listed in **TABLE 602-10**. The Contractor has the option to take additional tests to provide 10 test results to determine payment. The density pay adjustment factors are computed using formulas in **subsection 602.9**. The density pay adjustment factors do not apply to sideroads, entrances, crossovers and other incidental surfacing.

b. Nuclear Density Tests (For mixes with a specified thickness of 1½ inches or greater.). Take 2 nuclear density tests at random within each sublot. The Engineer will take 1 random nuclear density verification test per sublot. Perform nuclear density testing to be used in the determination of the traveled way pay adjustment factors and control of shoulder density. Do not take nuclear gauge readings within 1 foot of a longitudinal joint or edge, nor within 20 feet of a transverse joint. For shoulders with a plan width of less than or equal to 3 feet, and placed at the same time as the traveled way, do not take nuclear density readings on the shoulder nor within 1 foot of the shoulder unless the pavement section is uniform across the entire roadway. Mark the outline of the nuclear gauge on the pavement at each location tested with a method of marking that shall last a minimum of 24 hours. Take the nuclear density test at the random location. Do not move the gauge from this location to maximize or minimize the density results. If the Contractor doubts the accuracy of any of the nuclear density test results, the pavement may be cored at the nuclear gauge test locations. If coring is chosen to determine the density for pay adjustment purposes, then all nuclear density test results representing the lot shall be voided and cores taken as prescribed in **subsection 602.6c**.

Take verification nuclear density tests, 1 per sublot, at random locations selected by the Engineer. Payment factors will be based on the Contractor's nuclear density test results, provided those results are validated by KDOT's nuclear density tests.

The Engineer will determine a calibration factor for the Contractor's nuclear density device at the same time as a calibration factor is determined for KDOT's device. The Contractor will be afforded the opportunity to observe the calibration procedure whether it is performed at the district laboratory or on the project site. The Engineer should provide calibration factors by the end of the working day following the date of collecting the cores. In cases where this is not possible, the Contractor and the Engineer may agree in advance to accept a zero pay adjustment for the concerned lots.

The Engineer and Contractor will compare nuclear density test results before any traffic is allowed on the roadway. If the Contractor or KDOT density values are suspect, the Engineer may approve re-testing the locations in question. When re-testing is approved, substitute the new nuclear density values for the values in question. Before traffic is allowed on the roadway, the Contractor needs to determine if cores will be taken.

c. Cores (For mixes with a specified thickness of 1½ inches or greater.) Take 2 cores at random locations within each sublot. It may be necessary to chill the compacted mixture before coring so that the samples may be removed intact without distortion. Cut the samples using a 4-inch coring device, unless a 6-inch coring device is approved by the Engineer. Mark all samples with the lot number, sublot number and core number.

Transport the cores to the laboratory as soon as possible to prevent damage due to improper handling or exposure to heat. Cut all cores including the Engineer's verification cores. The Contractor will be paid only for cores cut to calibrate the nuclear gauge, when requested by the Engineer. Use KT-15 Procedure III to determine core density.

Do not take cores within 1 foot of a longitudinal joint or edge, nor within 20 feet of a transverse joint. For shoulders with a plan width of less than or equal to 3 feet, and placed at the same time as the traveled way, do not take cores on the shoulder nor within 1 foot of the shoulder unless the pavement section is uniform across the entire roadway.

Take 1 verification core per sublot (at locations selected by the Engineer) for testing at KDOT's laboratory. Density pay adjustment factors and control of shoulder density are based on the core results, provided those results are validated by the verification cores sent to KDOT's laboratory.

Dry the core holes, tack the sides and bottom, fill with the same type of material and properly compact it by the next working day.

602.7 WEATHER LIMITATIONS

Do not place HMA on any wet or frozen surface or when weather conditions otherwise prevent the proper handling and finishing of the mixture.

Only place HMA when either the minimum ambient air temperature or the road surface temperature shown in **TABLE 602-13** is met.

TABLE 602-13: MINIMUM HMA PLACEMENT TEMPERATURES							
Paving Course	**Thickness (inches)**	**Air Temperature (ºF)**			**Surface Temperature (ºF)**		
		HMA	**WMA Foam**	**WMA Chem**	**HMA**	**WMA Foam**	**WMA Chem**
Surface	All	50	45	40	55	50	45
Subsurface	<1.5	50	45	40	55	50	45
Subsurface	≥1.5 and < 3	40	35	30	45	40	35
Subsurface	≥ 3	30	30	30	35	32	32

602.8 MIXTURE ACCEPTANCE

a. General. Test each mix designation at each plant for compliance with **TABLE 602-1**. Acceptance will be made on a lot by lot basis contingent upon satisfactory test results. Obtain test samples of the mix designation from the roadway behind the paving operation before compaction. The sampling device and procedures used to obtain the samples must be approved by the Engineer. Use KT-25 for obtaining HMA from the roadway and splitting of the sample. The Contractor's quality control tests will be used for acceptance provided those results are verified by KDOT.

A load or loads of mixture which, in the opinion of the Engineer, are unacceptable for reasons such as being segregated, aggregate being improperly coated, foaming aggregate or being outside the mixing temperature range may be rejected. Verification samples will be taken by the Engineer at randomly selected locations from behind the paver. Fill all sample locations before compaction.

The V_a test values will also be used to determine V_a pay adjustments according to **subsection 602.9d**. V_a pay adjustments apply to the HMA placed on the traveled way and shoulders (including ramps and acceleration and deceleration lanes).

b. Lot Definition for Mix Production Sampling and Testing. A lot is defined as an isolated quantity of a specified material produced from a single source or operation. Each lot shall normally be represented by 4 contiguous test results. A lot may be represented by test results on samples taken from 1 or more day's production.

c. Lot Investigation. The Engineer may examine materials represented by individual test results which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor or KDOT test results. The information from additional testing (including testing of in-place HMA) may be used to define unacceptable work according to **SECTION 105**. The Engineer may apply appropriate price reductions or initiate corrective action.

For any test, if a dispute exists between the Engineer and Contractor about the validity of the other's test results, the KDOT District Materials Laboratory or the MRC will perform referee testing, except for nuclear density dispute resolution and V_a dispute resolution. If the disputed KDOT test results were generated at the District Laboratory, the MRC will perform the referee tests. If the disputed KDOT test result was generated at the MRC, an independent laboratory agreeable to both parties will be selected. The Laboratory shall be accredited by the AASHTO Accreditation Program in the appropriate testing category.

If referee testing indicates that KDOT test results are correct, the Contractor pays for the additional testing, including referee testing performed at the MRC. This will be paid using the bid item Contract Deduct which will be an item added to the contract.

If the referee testing indicates that Contractor test results are correct, KDOT pays for the additional testing. Pay the independent lab for the testing and submit the paid invoice to KDOT. The Engineer will reimburse the Contractor (based on the invoice price) as Extra Work, **SECTION 104**.

(1) For nuclear density dispute resolution (the statistical comparison fails and the Contractor questions KDOT's results), the following procedure applies:

- Discard pay factors previously established with the nuclear gauge, and use the core results to establish the pay factors.
- With the Engineer present, take 1 core from each of the locations previously tested with the Contractor's nuclear gauge and KDOT's nuclear gauge (normally 15 cores). Mark all cores with the lot number, sublot number and core number.
- Take the cores to the field laboratory and dry to a constant weight before testing. The Contractor and the Engineer, working together, will determine the core densities (KT-15, Procedure III).
- A statistical comparison will be made between Contractor and KDOT core results. If the t-test passes, KDOT will pay for all cores. The Contractor's test results will be used to calculate the density pay factors. If the t-test fails, KDOT will not pay for the cores. KDOT test results will be used to calculate the density pay factors.

(2) For V_a dispute resolution (the statistical comparison fails and the Contractor questions KDOT results), the following procedure applies for the lots in question:

- Determine which lots to dispute. Only dispute the lot produced immediately prior to the lot currently under production and being tested. Notify the Engineer, prior to the completion of all Contractor V_a testing for this lot. (When production is completed for any mix, the last lot may be challenged the day production is completed). When the hot mix plant shuts down for the winter, the Contractor has a maximum of 7 calendar days to dispute the last lot produced prior to winter shut down.
- Discard V_a and V_a pay adjustment factors previously determined within the lots being questioned.
- All saved gyratory compacted V_a quality control and verification samples and back half of samples within the lots in question will be taken by KDOT to the District Materials Laboratory. All back half of samples shall be a minimum of 35 pounds. Failing to obtain enough material removes the right to dispute resolution. Copies of all paperwork, including work sheets, associated with previous V_a calculations for the disputed lots will also be taken to the District Materials Laboratory.

The following retesting will be completed by KDOT:

- Check the samples to be sure they are dry before retesting. Reweigh the original gyratory compacted V_a quality control and verification samples. Determine the G_{mb} at N_{des} revolutions for all saved gyratory plugs. Compare retest results with original test results. Use this information to isolate potential testing errors, but continue with the remainder of the retesting steps.
- Determine the G_{mm} using the back half of all samples within each lot being questioned. Normally, there will be 5 back halves (4 Contractor's and 1 KDOT) to test within each lot.
- Compact the back halves to N_{max} revolutions and determine the G_{mb} at N_{des} revolutions.
- Use G_{mm} determined above and the G_{mb} determined from the recompacted samples to calculate V_a at N_{des} revolutions for the lots in question.
- Using the retest V_a results, a statistical comparison will be made. If the t-test passes, the Contractor's retest results will be used to calculate the pay factor and KDOT will pay for all retesting. Use the procedures shown in **subsection 602.9d**. If the t-test fails, KDOT's retest results will be used to calculate the pay factor, and the Contractor will pay for all retesting.

d. Resampling of Lots. Take no samples for retest for pay adjustment purposes except as noted in **subsections 602.6b.** and **602.8c**.

e. Multiple Projects. If multiple projects are supplied from 1 or more plants using the same mix, carry over the lots at each hot mix plant from project to project.

f. Lot Size. A standard size mix production lot (density test lots are defined in **subsection 602.6a.(5)**) consists of 4 equal sublots of 750 tons each of HMA (lot size is 3,000 tons).

It is anticipated that lot size shall be as specified. However, with the Engineer's approval, the Contractor may re-define lot size for reasons such as, but not limited to, change in contract quantities or interruption of the work. Take 1 sample during production of each sublot and utilize it to determine disposition of the lot in which it occurs.

g. Increased Lot Size. After 8 consecutive sublots have been produced within the tolerance shown for all mix characteristics listed in **TABLE 602-12** and without a V_a penalty, the sublot size may be increased to 1,000 tons (lot size of 4,000 tons), provided the normal production rate of the plant is greater than 250 tons per hour. Provide immediate notification of lot size changes to the Engineer any time a change is made.

After 8 additional consecutive sublots have been produced at the 1,000 ton sublot size, the sublot size may again be increased to 1,250 tons per sublot (lot size of 5,000 tons), provided all 8 consecutive 1,000 ton sublots have been produced within the tolerances shown for all mix characteristics listed in **TABLE 602-12**, without a V_a penalty, production rates for the previous 2 days have been greater than 3,750 tons per day, and a minimum of 2 of the last 3 segregation profile checks comply with **TABLE 602-14**.

TABLE 602-14: SEGREGATION PROFILE CHECKS FOR INCREASED SUBLOT SIZE		
Mix Designation	**Maximum Density Range (highest minus lowest)**	**Maximum Density Drop (average minus lowest)**
All	3.1 lbs./cu. ft.	1.9 lbs./cu. ft.

If subsequent test results fall outside the tolerances shown for any mix characteristic listed in **TABLE 602-12** or a V_a penalty is incurred, decrease the sublot size to 750 tons. If the production rates fall below 3,750 tons per day for 2 consecutive days or a minimum of 2 of the last 3 segregation profile checks fail the above requirements, then reduce the 1,250 ton sublots size to 1,000 ton per sublot provided the **TABLE 602-12** criteria is met and no V_a penalty is incurred.

When the increased lot size criteria are again met for 4 consecutive sublots, the sublot may be increased as the limits given above.

h. Decreased Lot Size for Small Quantities. This is to be used when a small quantity (less than 3,000 tons) of a particular mix will be used. Use the plan quantity for the lot size. Reduce the sublot size below 750 tons by dividing the lot into 3 or 4 equal sublots. Before beginning production, provide the Engineer with the number and size of the sublots.

i. Pre-Production Mix. Test and evaluate a pre-production mix, limited to a maximum of 200 tons from each plant and type of mix before production of that mix. Evaluate the pre-production mix at initial start-up and after suspension of production resulting from failing test results. Do not adjust V_a payment for pre-production mixes. Provide a pre-production mix that complies with the gradation, D/B ratio, binder content, VMA, level of compaction for N_{ini}, N_{des}, N_{max} and laboratory V_a requirements prior to starting or resuming production. For binder content, V_a at N_{des} and VMA, use the "Single Test Value" listed in **TABLE 602-12** for comparison. For the other tests listed, use the values listed in **TABLE 602-1** for each mix. Except for initial start-up, normal delivery of material to the project before completion of certain test results on pre-production mixes may be authorized by the DME.

Place the material produced for the pre-production mix in locations approved by the DME. On projects where HMA is paid by the ton, consider placing the pre-production mix in non-critical areas such as side roads, entrances, shoulders or deep in the base. The Engineer will pay for material as the material produced, not in the location placed. However to prevent potential cost overruns, do not run an excessive number of "higher cost" pre-production mixes (as determined by the Engineer) on shoulders or entrances.

On projects in which the HMA is paid by the square yard, place pre-production mixes where required by the Contract Documents. A higher quality pre-production mix may be placed at no additional expense to KDOT. If HMA materials which are designated to be placed in the top 4 inches of the pavement structure are placed deeper than 4 inches as a pre-production mix, do not count the material toward the requirement to place the material in the top 4 inches of the pavement section.

At the direction of the Engineer, remove the pre-production mix if it is both out of specification and the material shortens the pavement life or changes the intended function. The Engineer will pay for the replacement of one pre-production mix at 100% of the contract unit price for each mix in the contract (not each mix design). If the HMA is paid by the square yard, then the removed material will be paid for at a rate of $40 per ton. The Engineer will create a change order (**SECTION 104**) adding the item of work with a unit price of $40/ton. The payment will be full compensation to the Contractor for the placement and removal of that pre-production mix. KDOT will not be financially responsible for any subsequent failed pre-production mixes (that require removal) for that mix. The removed material is the property of the Contractor.

The Engineer will not pay for pre-production mixes that are required to be replaced due to poor workmanship or equipment failure. The Engineer will make the final decision to remove a failed pre-production mix with input from the Contractor.

j. Suspension of Mix Production. Suspend production of the mix until appropriate corrections have been made, if 2 consecutive test results for any single mix characteristic fail to fall within the limits established by the tolerances shown in the single test value column of **TABLE 602-12**. Additionally, suspend production of the mix until appropriate corrections have been made, if any 4-point moving average value for any single mix characteristic fails to fall within the limits established by the tolerances shown in the 4-point moving average value column of **TABLE 602-12**. Production remains suspended pending the satisfactory results of a pre-production mix, unless waived by the DME.

The Engineer may stop production of HMA at any time the mix or process is determined to be unsatisfactory. Make the necessary corrections before production will be allowed to resume. Failure to stop production of HMA subjects all subsequent material to rejection by the Engineer, or acceptance at a reduced price, as determined by the Engineer.

602.9 BASIS OF ACCEPTANCE

a. General. Acceptance of the mixture will be contingent upon test results from both the Contractor and KDOT. The Engineer will routinely compare the variances (F-test) and the means (t-test) of the verification test results with the quality control test results for V_a, G_{mm} and density using a spreadsheet provided by KDOT. If KDOT verification test results do not show favorable comparison with the Contractor's quality control test results, then KDOT test results will be used for material acceptance, material rejection and the determination of any pay adjustment on the V_a and roadway density. Disputed test results will be handled according to **subsection 602.8c**.

KDOT will use a spreadsheet program to calculate pay adjustments for density and V_a, and to compare Contractor QC and KDOT QA test results (including G_{mm}). KDOT will provide a copy of this program to the Contractor, when requested. Microsoft Excel software is required to run this program; it is the Contractor's responsibility to obtain the correct software. Values computed using equations referenced in this specification may vary slightly from the spreadsheet values due to rounding of numbers. In such cases, the numbers computed by the spreadsheet will govern.

The comparison of quality control and verification tests will be completed using the t-tests to compare their population means and the F-test to compare their variances. The F & t tests, along with the Excel Spreadsheet used to compare the Contractor's QC results and KDOT's QA results, are described in Section 5.2.6 – Comparison of Quality Control and Verification Tests, Part V. (Examples of Air Voids F & t tests, along with Density F & t tests are shown in this section.) Additional information on the program may be obtained from the Bureau of Construction and Materials.

b. Asphalt Density Pay Adjustment for "HMA Overlay" Bid Items. Mixes with specified thickness of less than 1½ inches are not subject to the asphalt density pay adjustments.

For mixes with specified thickness of 1½ inches or greater: Asphalt density pay adjustment for compaction of the completed pavement shall be by lot, based on the percentage of G_{mm} obtained. Compute the asphalt density pay adjustment (incentive or disincentive) by multiplying the density pay adjustment factor (P_D) times the number of tons included in the lot times $40 per ton. (Air voids lots and density lots are normally of different sizes.) This adjustment will be paid for under the bid item Asphalt Density Pay Adjustment.

Density pay factors will be determined from **TABLE 602-15**. (For **TABLE 602-15**, average the percent of G_{mm} values to 0.01% and calculate the density pay adjustment factors rounded to the thousandths).

<table>
<tr><th colspan="4">TABLE 602-15: DENSITY PAY FACTORS FOR SPECIFIED THICKNESS[4]</th></tr>
<tr><th>Specified Thickness →</th><th>≥ 2"</th><th colspan="2">≥ 1½"</th></tr>
<tr><th></th><th>All</th><th>Continuous Action[5]</th><th>No Continuous Action[6]</th></tr>
<tr><th>% of G_{mm}
Average of 10 Density Tests[1]</th><th colspan="2">Pay Factor[2]</th><th>Pay Factor[2]</th></tr>
<tr><td>93.00% or greater</td><td colspan="2">1.040</td><td>1.040</td></tr>
<tr><td>92.00 to 92.99%</td><td colspan="2">A1</td><td>A1</td></tr>
<tr><td>91.00 to 91.99%</td><td colspan="2">1.000</td><td>1.000</td></tr>
<tr><td>90.00 to 90.99%</td><td colspan="2">A2</td><td>1.000</td></tr>
<tr><td>89.00 to 89.99%</td><td colspan="2">0.840 or Remove[3]</td><td>A3</td></tr>
<tr><td>less than 89.00%</td><td colspan="2">0.840 or Remove[3]</td><td>0.840 or Remove[3]</td></tr>
</table>

[1]For low daily production rates less than 1000 tons, or when the Engineer's verification tests are to be used for asphalt density pay determination, the lot sample size is as determined in **TABLE 602-10**.

[2]Shoulders: For shoulders with a plan width greater than 3 feet and any shoulder not placed at the same time as the traveled way, compact the HMA in the lot to a minimum of 90.00% (if specified thickness is ≥2") or 89.00% (if the specified thickness is from 1½" to 1⅞") of the G_{mm}. Otherwise, the Engineer will determine whether the HMA in the lot may remain in place or be removed. Any such material left in place shall have a density pay factor of 0.950 or less.

[3]Low Density: The Engineer will determine if the traveled way, shoulders with a plan width of 3 feet or less and placed with the traveled way, ramps, acceleration and deceleration lanes may remain in place or be removed. The Engineer will notify the Contractor before 11:00 AM of the next working day if the area is to be removed. Any such material left in place shall have a density pay factor of 0.840.

[4]Specified thickness is the total thickness shown in the Contract Documents for the mix being placed.

[5]Use for ≥1½" when another continuous action, such as milling, surface recycling, cold recycling or overlay is completed ahead of this overlay.

[6]Use for ≥1½" when another continuous action is not completed before the overlay.

Calculations for Density Pay Factors A1, A2 and A3:

A1 = [100 + 4 (% of lot G_{mm} - 92.00)] ÷ 100
A2 = [84 + 16 (% of lot G_{mm} - 90.00)] ÷ 100
A3 = [84 + 16 (% of lot G_{mm} - 89.00)] ÷ 100

Density Pay Adjustment Factor Calculation:

Density Pay Adjustment Factor (P_D)* = Density Pay Factor - 1.000
*P_D rounded to the nearest thousandth

c. Asphalt Density Pay Adjustment for "HMA Surface", "HMA Base" and "HMA Pavement" Bid Items. Asphalt Density Pay Adjustment for compaction of the completed pavement shall be by lot, based on the percentage of G_{mm} obtained. This adjustment will be paid for under the bid item Asphalt Density Pay Adjustment. Compute the Asphalt Density Pay Adjustment (positive or negative) by multiplying the Density Pay Adjustment factor ($\boldsymbol{P_D}$) times the number of tons included in the lot times $40 per ton. The Asphalt Density Pay Adjustment will be added or subtracted on the pay estimate. For shoulders with a plan width of less than or equal to 3 feet, and placed at the same time as the traveled way, the $\boldsymbol{P_D}$ for the traveled way will apply. The $\boldsymbol{P_D}$ does not apply to sideroads, entrances, crossovers and other incidental surfacing. Use KDOT test results for the lot to determine the $\boldsymbol{P_D}$ when the statistical comparison between the quality control and the verification tests fail (see **subsection 602.9a.**).

Lot Size: A lot shall normally be comprised of the results of 10 tests performed on a day's placement of a given mix placed in a given lift. Lot size is defined in **subsection 602.6**. (Air void lots and density lots are normally of different sizes).

Shoulders: For all shoulders with a plan width greater than 3 feet and any shoulder not placed at the same time as the traveled way, the lower specification limit (LSL) is 90.00%. When the lower percent within limits ($\boldsymbol{PWL_{LD}}$) is 50.00% or more for the lot, $\boldsymbol{P_D}$ is zero. When the $\boldsymbol{PWL_{LD}}$ is less than 50.00% for the lot, the Engineer will determine whether the HMA in the lot may remain in place or be removed. Any such material left in place will have a $\boldsymbol{P_D}$ of -0.050, unless the Engineer establishes lower values for $\boldsymbol{P_D}$ (-0.100, -0.200, -0.300, etc.) as a condition of leaving the material in place.

Determination of $\boldsymbol{P_D}$ and $\boldsymbol{PWL_{LD}}$: Calculate the lower density quality index ($\boldsymbol{Q_{LD}}$) for each lot using Equation 1 and round to hundredths. Locate the $\boldsymbol{Q_{LD}}$ value in the left column of the Percent Within Limits (PWL) Table in Section 5.2.1 - Statistics, Part V. Select the appropriate $\boldsymbol{PWL_{LD}}$ value by moving across the selected quality index row to the column representing the number of samples in the lot.

If $\boldsymbol{Q_{LD}}$ is greater than the largest quality index value shown in the table, use 100.00 as the value for $\boldsymbol{PWL_{LD}}$.

If $\boldsymbol{PWL_{LD}}$ is less than 50.00% for the lot, the Engineer will determine if the material in the lot may remain in place. If the material is left in place, the value of $\boldsymbol{P_D}$ for the lot will be equal to -0.160, unless the Engineer establishes lower values for $\boldsymbol{P_D}$ (-0.200, -0.300, etc.) as a condition of leaving the material in place. Otherwise, calculate $\boldsymbol{P_D}$ using Equation 2 and round to thousandths.

Equation 1: $$\boldsymbol{Q_{LD}} = \frac{\overline{X} - LSL}{S}$$

$\overline{X}$ is the average measured percent of G_{mm} of all samples within a lot rounded to hundredths.

LSL is the lower specification limit for density and is defined as 91.00% of G_{mm} for traveled way plan thickness 2 inches and less and 92.00% of G_{mm} for traveled way plan thickness greater than 2 inches.

S is the standard deviation of the measured density of all samples within a lot and is calculated using equation (4) in Section 5.17.09, Part V, rounded to hundredths.

Equation 2: $$\boldsymbol{P_D} = (\boldsymbol{PWL_{LD}} * 0.004) - 0.360$$

d. Asphalt Air Void Pay Adjustment. Asphalt Air Void (V_a) Pay Adjustment will be made on a lot basis and based on measured V_a from samples of plant produced material. This adjustment will be paid for under the bid item Asphalt Air Void Pay Adjustment. The V_a pay adjustment factor ($\boldsymbol{P_V}$) (positive or negative) will be determined and used to compute the V_a Pay Adjustment by multiplying $\boldsymbol{P_V}$ times the number of tons included in the lot times $40 per ton. The V_a Pay Adjustment will be added or subtracted on the pay estimate. When the statistical comparison between the quality control and the verification tests pass, use the procedures in **subsection 602.9d.(1)** to compute $\boldsymbol{P_V}$. When the statistical comparison fails, calculate $\boldsymbol{P_V}$ using procedures in **subsection 602.9d.(2)**.

Lot Size: A lot shall normally be comprised of the results of 4 contiguous individual V_a tests performed on gyratory compacted samples of a given mix design. Lot size is defined in **subsections 602.8f.**, **602.8g.** and **602.8h**. When there are 1 or 2 tests remaining, such as at the end of a project or season, combine them with the previous 4 tests to create a 5 or 6 test lot, respectively. When there are 3 tests remaining, combine the 3 tests into a lot. (Air voids lots and density lots are normally of different sizes).

(1) Air Voids Pay Adjustment Factor (Passing t-test). Calculate the upper and lower V_a quality indices ($\boldsymbol{Q_{UV}}$ and $\boldsymbol{Q_{LV}}$) for each lot using Equations 3 and 4, respectively and round to hundredths. Locate the $\boldsymbol{Q_{UV}}$ value in the left column of the Percent Within Limits (PWL) Table in Section 5.2.1 – Statistics, Part V. Select the appropriate upper percent within limit value ($\boldsymbol{PWL_{UV}}$) by moving across the selected quality index row to the column representing the number of samples (N) in the lot. Repeat the process using the $\boldsymbol{Q_{LV}}$ value and select the appropriate value for the lower percent within limits ($\boldsymbol{PWL_{LV}}$). If the $\boldsymbol{Q_{UV}}$ or $\boldsymbol{Q_{LV}}$ value is greater than the largest quality index value shown in the table, then a value of 100.00 is assigned as the value for $\boldsymbol{PWL_{UV}}$ or $\boldsymbol{PWL_{LV}}$, respectively. If both $\boldsymbol{Q_{UV}}$ and $\boldsymbol{Q_{LV}}$ exceed the values shown in the table, a value of 100.00 is assigned as the value for both $\boldsymbol{PWL_{UV}}$ and $\boldsymbol{PWL_{LV}}$. If either $\boldsymbol{Q_{UV}}$ or $\boldsymbol{Q_{LV}}$ is a negative value or $\boldsymbol{PWL_{UV}} + \boldsymbol{PWL_{LV}}$ is less than 150.00, the Engineer will determine if the material in the lot may remain in place. If the Engineer determines that the material may remain in place then the maximum value of $\boldsymbol{P_V}$ for the lot will be equal to –0.120. The Engineer may establish lower values for $\boldsymbol{P_V}$ (-0.200, -0.300, etc.) in such instances. Otherwise, calculate $\boldsymbol{P_V}$ using Equation 5 and round to thousandths.

Equation 3: $$\boldsymbol{Q_{UV}} = \frac{USL - \overline{X}}{S}$$

Equation 4: $$\boldsymbol{Q_{LV}} = \frac{\overline{X} - LSL}{S}$$

$\overline{X}$ is the average measured V_a of all samples within a lot rounded to hundredths.

USL is the upper specification limit for V_a and is defined as 5.00%.

LSL is the lower specification limit for V_a and is defined as 3.00%.

S is the standard deviation of the measured V_a for all samples within a lot and is calculated using equation (4) in Section 5.2.1 - Statistics, Part V, rounded to hundredths.

Equation 5: $$P_V = ((PWL_{UV} + PWL_{LV} - 100.00)(0.003)) - 0.270$$

PWL_{UV} is the upper percent within limits value for V_a.
PWL_{LV} is the lower percent within limits value for V_a.

(2) Air Voids Pay Adjustment (Failing t-Test). If the t-test fails, KDOT's test result will be used to calculate the P_V for the lot. Follow the procedures given in **subsection 602.9d.(1)** to determine the P_V or disposition of the lot. Use the values from **TABLE 602-16** to calculate Q_{UV}, Q_{LV}, PWL_{UV} and PWL_{LV} in Equations 3, 4 and 5 in **subsection 602.9d.(1)**.

TABLE 602-16: Statistical Values for Air Voids Pay Adjustment for Failing t-Test

Term	Definition	Value
$\overline{X}$	Average or Mean	KDOT's test result for the lot
S	Standard Deviation	0.50
USL	Upper Specification Limit	5.50%
LSL	Lower Specification Limit	2.50%
N	Sample Size	3

602.10 DETERMINATION OF THICKNESS, THICKNESS PAY ADJUSTMENT AND AREA PAY ADJUSTMENTS FOR "HMA PAVEMENT" AND "HMA PAVEMENT SHOULDER" BID ITEMS

a. General. Construct the pavement to the dimensions shown in the Contract Documents. Inform the Engineer when a section is ready for coring and measurement of width and length. Complete all paving of the shoulder and driving lanes within this section, unless otherwise approved by the Engineer.

A driving lane is defined as mainline lanes, acceleration lanes (including tapers), deceleration lanes (including tapers), auxiliary lanes, ramp lanes or combination thereof.

When shoulders, medians and widenings are placed monolithically with the adjacent driving lane, and there is not a separate bid item for shoulders, then the shoulders are considered as part of the driving lane, and are subjected to the same unit price adjustment as the driving lane.

b. Measurements. The Engineer will divide the projects into lots. A lot is comprised of 5 sublots with the same plan thickness. A sublot is defined as a single driving lane or a single shoulder, with an accumulative length of 1000 feet. If the last lot has 1 or 2 sublots (such as at the end of a project or season), combine them with the previous lot to create a lot with 6 or 7 sublots, respectively. Consider as a single lot if there are 3 or 4 sublots in the final lot.

The Engineer will generate 1 random location for coring within each sublot. Do not take a core within 1 foot of a longitudinal joint or edge. Obtain the cores with the Engineer present.

Take a 4-inch diameter core from the selected sites. Mark each core with its lot and sublot number, and transport to the KDOT field lab.

For information only, the Engineer will determine the thickness of each HMA mixture and the total HMA base for each core.

The Engineer will determine the total core thickness for pay by taking 3 caliper measurements at approximately 120° apart and record each to the nearest 0.1 inch. The average of the 3 caliper measurements rounded to the nearest 0.1 inch shall represent the average measured thickness. The Engineer will use the total pavement thickness measurements to determine thickness pay adjustment factors.

The Engineer will provide a copy of the results to the Contractor before the end of the following working day.

Prior to coring, the Contractor may request that areas trimmed without automatically controlled equipment be handled separately. (This would require the Contractor to designate the area as a lot before knowing the actual core thickness.) When requested and approved by the Engineer, each area will be considered a lot. Divide the area into 5 sublots and obtain 1 core from each sublot.

For Percent Within Limits (PWL) thickness analysis, if any sublot thickness exceeds the design thickness by more than 1.0 inch, the Excel spreadsheet will automatically consider that sublot thickness to be 1.0 inch more than the design thickness. The spreadsheet will recalculate a new lot mean and sample standard deviation based on the adjusted value.

Dry the core holes, tack the sides and bottom, fill them with a HMA mixture (approved for the project) and properly compact it by the end of the next working day.

c. Deficient Measurements for Driving Lanes. When any full depth core for driving lanes is deficient by 1.0 inch or greater from the specified thickness, take exploratory cores at intervals a minimum of 50 feet in each direction (parallel to the centerline) from the deficient core.

Continue to take exploratory cores in each direction until a core is taken that is deficient a maximum of 0.5 inch. Exploratory cores are used only to determine the length of pavement in a lot that is to be overlaid, as approved by the Engineer.

The minimum overlay length (with surface mix) shall be equal to the distance between the cores that are deficient by a maximum of 0.5 inch, and the width to be paved shall be full width of the roadway (driving lanes and shoulders) when this occurs.

The minimum overlay thickness is 3 times the nominal maximum aggregate size.

Complete the overlay to the satisfaction of the Engineer. Mill butt joints on the ends of the overlay area. The Engineer will not pay for any milling costs.

The exploratory cores are not used to determine thickness pay adjustment factors. Randomly select another core (outside the overlay area) to represent the sublot.

d. Deficient Measurements for Shoulders. When any full depth core taken from the shoulders is deficient by greater than 1.5 inches, take exploratory cores at intervals a minimum of 50 feet in each direction (parallel to the centerline) from the deficient core.

Continue to take exploratory cores in each direction until a core is only deficient a maximum of 0.8 inches.

Exploratory cores are used only to determine the length of pavement in a lot that is to be removed and replaced, or accepted at a reduced price (in addition to any disincentive assessed on that lot), as approved by the Engineer.

The minimum repair length is equal to the distance between the cores that are deficient a maximum of 0.8 inches, and the full width of the shoulder.

Mill butt joints on the ends of the overlay area. The Engineer will not pay for any milling costs. Unless approved by the Engineer, replacing includes complete removal of all HMA within the area defined by the results of the exploratory cores. Rework, stabilize (if required) and regrade the subgrade. When required, reconstruct the base and replace all HMA mixes shown in the Contract Documents. Obtain 1 random core within this sublot and use its core length to determine the thickness pay adjustment factor.

e. Asphalt Pavement Area Pay Adjustment. Determine the areas for pay and pay adjustment as shown in **TABLE 602-18**. The KDOT spreadsheet program will calculate these areas. This adjustment will be paid for under the bid item Asphalt Pavement Area Pay Adjustment.

Irregularly shaped areas may have to be calculated outside the program and the area entered into the program. Compute pay per lot for areas placed and not placed (deducted) as shown in Equations 10, 11, 12 and 13.

Equation 10: Pay for Driving Lane = $(\sum PDLA)(BP)$
Equation 11: Pay Deduct for Driving Lanes = $2(\sum PDLDA)(BP)$
Equation 12: Pay for Shoulder = $(\sum PSA)(BP)$
Equation 13: Pay Deduct for Shoulder = $2(\sum PSDA)(BP)$

$\sum PDLA$ = Pay Driving Lane Area per Lot, Square Yard
$\sum PDLDA$ = Pay Driving Lane Deduct Area per Lot, Square Yard
$\sum PSA$ = Pay Shoulder Area per Lot, Square Yard
$\sum PSDA$ = Pay Shoulder Deduct Area per Lot, Square Yard
BP = Bid Price for either the driving lanes or the shoulder, as applicable

TABLE 602-17: HMA AREA ABBREVIATIONS			
Abbreviation		**Definition**	**Units**
PDLA	=	Pay Driving Lane Area per Sublot	Sq Yd
PDLDA	=	Pay Driving Lane Deduct Area per Sublot,	Sq Yd
PSA	=	Pay Shoulder Area per Sublot	Sq Yd
PSDA	=	Pay Shoulder Deduct Area per Sublot	Sq Yd
MDLW	=	Measured Driving Lane Width	Ft
MSW	=	Measured Shoulder Width	Ft
MTLW	=	Measured Total Lane Width (includes shoulder, if any)	Ft
PDLW	=	Plan Driving Lane Width	Ft
PSW	=	Plan Shoulder Width	Ft
PTLW	=	Plan Total Lane Width (includes shoulder, if any)	Ft
EDLW	=	Excess Driving Lane Width	Ft
SL	=	Sublot Length	Ft

TABLE 602-18: HMA AREA SUBLOT CALCULATIONS[1]				
Condition	**PDLA[2]**	**PDLDA[2]**	**PSA[2]**	**PSDA[2]**
	(Sq Yd)	**(Sq Yd)**	**(Sq Yd)**	**(Sq Yd)**
Projects with a Separate Bid Item for Shoulder				
Narrow Driving Lane				
MSW is less than PSW	(SL)(MDLW)	(SL)(PDLW–MDLW)	(SL)(MSW)	(SL)(PSW–MSW)
MSW is greater than PSW	(SL)(MDLW)	(SL)(PDLW–MDLW)	(SL)(MSW[3])	0
Wide Driving Lane				
MSW + EDLW is less than PSW	(SL)(PDLW)	0	(SL)(MSW+EDLW)	(SL)(PSW–MSW-EDLW)
MSW + EDLW is greater than PSW	(SL)(PDLW)	0	(SL)(MSW+EDLW[4])	0
Projects without a Separate Bid Item for Shoulder[5]				
Narrow Driving Lane and Shoulder	(SL)(MTLW)	(SL)(PTLW–MTLW)	N/A	N/A
Wide Driving Lane and Shoulder	(SL)(MTLW[6])	0	N/A	N/A

[1]Deductions will be made for unplaced areas.
[2]Calculate the areas to the nearest 0.01 square yards. Measure the lengths and widths to the nearest 0.01 feet. Divide the result of all equations in this table by 9 so that the resulting units are square yards.
[3]MSW shall be between PSW and PSW + 0.25 feet. Any excess width over 0.25 feet will not be included in PSW.
[4]MSW+ EDLW shall be between PSW and PSW + 0.25 feet. Any excess width over 0.25 feet will not be included in PSW.
[5]Shoulder is normally 0.00 feet to 3.00 feet wide and placed at the same time as the driving lane. PTLW = PDLW + PSW
[6]MSTLW shall be between PTLW and PTLW + 0.25 feet. Any excess width over 0.25 feet will not be included for pay.

f. Asphalt Pavement Thickness Pay Adjustment. Compute the Asphalt Thickness Pay Adjustment for the driving lanes (TPA_{DL}) and shoulders (TPA_{SH}) using Equation 6 or 7, respectively. Compute the Asphalt Thickness Pay Adjustment factor (P_T) as shown in Equation 9. Determine area calculations for the driving lanes and shoulders as shown in **TABLE 602-18**. **TABLE 602-17** provides the definition for the abbreviations used in **TABLE 602-18**. Enter the measured values into the spreadsheet program to determine PDLA and PSA.

This adjustment will be paid for under the bid item Asphalt Pavement Thickness Adjustment.

Equation 6: $TPA_{DL} = P_T\ (\sum PDLA)(\$1.90)(\text{Plan Thickness})$
Equation 7: $TPA_{SH} = P_T\ (\sum PSA)(\$1.70)(\text{Plan Thickness})$

TPA_{DL} = Thickness Pay Adjustment per Lot for Driving Lane
TPA_{SH} = Thickness Pay Adjustment per Lot for Shoulder
$\sum PDLA$ = Pay Driving Lane Area per Lot, Square Yard

$\sum$PSA = Pay Shoulder Area per Lot, Square Yard
Plan Thickness = HMA Thickness shown on Plans, Inches

KDOT will use a spreadsheet program to calculate thickness pay adjustments. KDOT will provide a copy of this program to the Contractor, when requested. It is the Contractor's responsibility to obtain the Microsoft Excel software required to run this program. Values computed using equations referenced in this specification may vary slightly from the spreadsheet values due to rounding of numbers. In such cases the numbers computed by the spreadsheet take precedence.

Thickness Quality Index ($\boldsymbol{Q_T}$) Computation. In each lot, calculate $\boldsymbol{Q_T}$ for the total pavement thickness using Equation 8 and round to hundredths.

Equation 8:

$$\boldsymbol{Q_T} = \frac{\overline{X} - LSL}{S}$$

$\overline{X}$ = Average total core length of all samples representing a lot, rounded to the nearest 0.1 inch. (Adjust core length before averaging, as shown in **subsection 602.10b.**)
LSL = Lower specification limit for thickness. For driving lanes use 0.5 inch less than the total plan driving lane thickness shown on the typical section. For shoulders, use 0.8 inch less than the total plan shoulder thickness shown on the typical section.
S = Sample standard deviation of the measured core lengths of all samples representing a lot and is calculated using equation (4) in Section 5.2.1 – Statistics, Part V, rounded to hundredths.

Use the computed $\boldsymbol{Q_T}$ to determine the thickness Percent Within Limits value ($\boldsymbol{PWL_T}$) by locating the $\boldsymbol{Q_T}$ in the left column of the Percent Within Limits (PWL) Table in Section 5.2.1 - Statistics, Part V. Select the appropriate $\boldsymbol{PWL_T}$ by moving across the selected $\boldsymbol{Q_T}$ row to the column representing the number of samples in the lot.

If the computed $\boldsymbol{Q_T}$ is a negative value, then the lot and all adjacent areas (full width of roadway) shall be overlaid as determined by the Engineer. After the lot has been overlaid, randomly select another core for each sublot, and calculate a new pay factor. For lots that have been entirely overlaid, the maximum pay factor is zero.

If the computed $\boldsymbol{Q_T}$ is greater than the largest $\boldsymbol{Q_T}$ shown in the PWL Table, a value of 100.00 is assigned as the $\boldsymbol{PWL_T}$ for thickness.

For each lot and all lanes and shoulders, compute the thickness pay factor ($\boldsymbol{P_T}$) for the total pavement thickness using Equation 9 and round to nearest thousandth. No bonus will be paid for shoulders, thus use $\boldsymbol{P_T}$ = 0.000 whenever $\boldsymbol{P_T}$ calculates greater than 0.000 for shoulders.

Equation 9:

$$\boldsymbol{P}_T = \left(\frac{(\boldsymbol{PWL}_T) * 0.3}{100}\right) - 0.270$$

g. Minimum Quantity of HMA for Square Yard Projects with "HMA Pavement" and HMA Pavement Shoulder" Bid Items. For the total project, supply a minimum of 93% of G_{mm} required by the surface course of driving lanes and shoulders and the top base course of driving lanes and shoulder. Calculate the minimum quantity of those 2 mixes, individually as follows:

Equation 14:

$$\text{Minimum Quantity (Tons)} = \frac{0.93\,(A)\,(T)\,(G_{mm})}{42.7}$$

A = Area in square yards for each of the mixes.
T = Plan thickness in inches of surface course and the top base course of driving lanes and shoulders.
G_{mm} = Theoretical maximum specific gravity equals the average G_{mm} value used in the first 5 lots or the average G_{mm} for ½ of the project (whichever is less) for the 4 mixes listed in "T" in Equation 14. Determine the average G_{mm} from the Excel worksheet titled "Density F & T Test Worksheet".

If this minimum quantity of surface course or base course is not placed, a deduction of $40 per ton will apply to the quantity not placed for each mix. This will be paid using the bid item Contract Deduct which will be an item added to the contract.

602.11 MEASUREMENT AND PAYMENT

a. "HMA Base", "HMA Surface" and "HMA Overlay" Bid Items. The Engineer will measure HMA Base, HMA Surface and HMA Overlay by the ton of material at the time of delivery to the road. Batch weights will not be allowed as a method of measurement unless all the following conditions are met:

- the plant is equipped with an automatic printer system approved by the Engineer;
- the automatic printer system prints the weights of material delivered; and
- the automatic printer system is used in conjunction with an automatic batching and mixing control system approved by the Engineer.

Provide a weigh ticket for each load. Due to possible variations in the specific gravity or weight per cubic foot of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variances.

Payment for "HMA Base (*)(**)(***)", "HMA Surface (*)(**)(***)" and "HMA Overlay (*)(**)(***)" at the contract unit prices is full compensation for the specified work. Any pay adjustments will both be applied and the payment adjusted accordingly.

Sideroads, entrances and mailbox turnouts that are not shown in the Contract Documents that are to be surfaced shall be paid for at 1½ times the unit price for "HMA Surface (*)(**)(***)" or "HMA Base(*)(**)(***)".

b. "HMA Pavement" and "HMA Shoulder" Bid Items. The Engineer will measure HMA Pavement and HMA Pavement Shoulder by the square yard of the measured in-place material. All lifts, except the surface course, will be measured by the Contractor and verified by the Engineer. The Engineer will measure the surface course.

Measure each shoulder width, each driving lane width and sublot length separately. Measure the lengths (to the nearest 0.01 feet) a minimum of once per sublot. The location of the width measurements will be the same location as the mainline cores which were established using random numbers. Before the end of the next working day, type and submit to the Engineer, the Contractor's individual measurements and the sum of the 2 driving lanes. Likewise, when the surface course is completed the Engineer will provide a typed copy of the surface course measurements to the Contractor before the end of the next working day.

If the driving lane and shoulder (measured from centerline) is less than 0.25 feet (per side) deficient, a deduction will be assessed. If the roadway is greater than 0.25 feet (per side) deficient, correction will be required. The correction will be proposed by the Contractor and must be approved by the Engineer. After satisfactory correction by the Contractor, the deduction for the narrow roadway will be eliminated for the areas corrected.

The Engineer will measure the sublot length and width (to the nearest 0.01 feet). Measure the width from the construction joint to the top of the slope of HMA pavement. Calculate the pay area for each lot to the nearest square yard. Unless the Engineer authorizes in writing to increase the area of HMA pavement, the Engineer will use dimensions shown in the Contract Documents and as measured in the field to calculate the final pay quantity. If the Engineer authorizes in writing to increase the area of HMA pavement or shoulder, the additional area will be measured and paid for as "HMA Pavement (#) (##)" or "HMA Pavement (#) Shoulder", respectively. The length will be measured horizontally along the centerline of each roadway or ramp.

Payment for "HMA Pavement (#) (##)" and "HMA Pavement (#) Shoulder" at the contract unit prices is full compensation for the specified work.

The Asphalt Pavement Thickness Adjustment and Asphalt Pavement Area Pay Adjustment will be entered on the Contractor's Payment Vouchers (intermediates and final) after each lot of the surface course (driving lanes and shoulders) has been completed.

The Contractor will receive no additional compensation for overlaying or for removing and replacing areas of deficient thickness. Exploratory cores and cores taken to determine pavement thickness will not be measured for payment. The Engineer will apply a Contract Deduct for surface course (driving lanes and shoulders) and top base course (driving lanes and shoulders) mix not placed on the project as determined using Equation 14. The Contract Deduct will be computed by the spreadsheet and be an item added to the contract.

If the project has a large amount of grinding required for pavement smoothness, the Engineer may require the Contractor to cut cores after the grinding is complete. These cores will be used in the spreadsheet in place of the cores originally cut.

c. Emulsified Asphalt. The Engineer will measure emulsified asphalt used for tack by the ton. Payment for "Emulsified Asphalt" at the contract unit price is full compensation for the specified work.

d. Asphalt Core (Set Price). The Engineer will measure each asphalt core required by the Engineer to calibrate the nuclear density gauges (typically 3 cores for each calibration). No payment will be made for cores deemed unsuitable for calibrating the nuclear density gauges. No payment will be made for cores taken at the Contractor's option to determine density.

If during nuclear density dispute resolution, the Contractor's test results are used for payment, each core taken will be measured for payment at 1 ½ times the Asphalt Core (Set Price). If KDOT's test results are used for payment, then no payment for cores will be made for nuclear density dispute resolution.

Payment for "Asphalt Core (Set Price)" at the contract set unit price is full compensation for the specified work.

e. Material for HMA Patching (Set Price). When the Contractor is required to remove any existing base course, subgrade or surface course (unless damaged by the Contractor) and provisions are not made in the Contract Documents, the Engineer will measure the material used for repair and patching (either HMA-Commercial Grade or a specified mix on the project) separately, by the ton at the time of delivery to the road. The Engineer will not measure the quantity of material used in the repair of damage due to the Contractor's negligence. The Engineer will measure HMA materials by the ton. For mixes containing Reclaimed HMA Pavement (RAP) or Recycled Asphalt Shingles (RAS), compute the HMA material contained in the RAP and RAS using the binder content determined from ignition oven testing. Maintain this information for materials tracking purposes. No separate payment for HMA material in RAP and RAS will be made. Combined gradation results will be used for acceptance in accordance with **TABLE 602-1**.

Payment for "Material for HMA Patching (Set Price)" at the contract set unit price includes all excavation, compaction of subgrade or subbase if required, disposal of waste material and all material (including emulsified asphalt for tack), all labor, equipment, tools, supplies, incidentals and mobilization necessary to complete the work. Pay adjustments will not be applied to this material.

f. Quality Control Testing (HMA). The Engineer will measure Quality Control Testing (HMA) performed by the Contractor on a per ton basis of HMA Surface, HMA Base, HMA Overlay and HMA Pavement placed on the project. No adjustment in the bid price will be made for overruns or underruns in the contract quantity. The bid price will constitute payment for all necessary mix design testing, field process control testing, the testing laboratory and all necessary test equipment.

The Engineer will not measure for payment Quality Control Testing (HMA) for the bid item Material for HMA Patching (Set Price).

Payment for "Quality Control Testing (HMA)" at the contract unit price is full compensation for the specified work.

06-21-16 C&M (BTH)
Oct-16 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 613 and replace with the following:

SECTION 613

ULTRATHIN BONDED ASPHALT SURFACE

613.1 DESCRIPTION

Construct the ultrathin bonded asphalt surface (UBAS) as designated in the Contract Documents.

BID ITEMS	UNITS
HMA Surface (Ultrathin Bonded) (*) (**)	Ton
Emulsified Asphalt (Emulsion Bonding Liquid)	Ton
Quality Control Testing (HMA)	Ton

* Type of mix gradation
** Grade of Asphalt Binder

613.2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

a. General. Provide qualified personnel and sufficient equipment complying with the requirements listed in Part V to conduct quality control testing that complies with Appendix B - Sampling and Testing Frequency Chart for Asphalt Construction Items for Quality Control/Quality Assurance Projects.

Allow the Engineer access to the Contractor's laboratory to observe testing procedures, calculations, test documentation and plotting of test results.

Calibrate and correlate the testing equipment with prescribed procedures, and conduct tests in compliance with specified testing procedures as listed in Section 5.2.7- Contractor's Quality Control Plan, Part V.

Store and retain the most recent 2 lots per mix designation of quality control samples for KDOT. KDOT will retain the most recent 2 lots per mix designation gyratory compacted samples and the remaining material not previously used for testing (back half of sample). Do not retain more than the previous 3 lots per mix designation of quality control or verification samples. When the hot mix plant shuts down for the winter, discard the samples after 7 days.

Maintain control charts on an ongoing basis.

At the completion of the project, all documentation becomes the property of KDOT.

Provide the following test data to the KDOT Project Representative:

- Copies of all test results and control charts on a weekly basis, representing the prior week's production;
- Copies of the quality control summary sheet on a daily basis. Include, as a minimum, mix gradation, binder content, theoretical maximum specific gravity (G_{mm}) and film thickness; and
- Copies of all failing test results (based on a moving average of 3 tests, when appropriate).

b. Quality Control Plan (QCP). At the pre-construction conference, submit to the Engineer for approval, a QCP as outlined in Section 5.2.7 – Contractor's Quality Control Plan, Part V. Follow Appendix A of the Contractor's Quality Control Plan in Part V as a general guideline. The Contractor's laboratory and equipment will be inspected and approved as outlined in Section 5.2.7 - Contractor's Quality Control Plan, Part V.

Include a listing of the names and phone numbers of individuals and alternates responsible for quality control administration and inspection. On the Contractor's organizational chart, show the specified lines of authority relating both to mix design and quality control operations during production. Post the organizational chart in the Contractor's test facility.

Provide a quality control organization or private testing firm having personnel certified according to the Policy and Procedure Manual for the Certified Inspection and Testing (CIT) Training Program. The testing for this type of construction will require personnel certified in Aggregate Field Tester (AGF), Aggregate Lab Technician, Profilograph (PO), and Superpave Field (SF) classifications.

Only persons certified in the appropriate classifications covering the specific tests required shall perform such testing. At the beginning of the project, provide the Engineer with the list of certified technicians and alternates, phone numbers and tests/inspection they will be performing. Include certification expiration dates for all certified technicians. As personnel changes and certifications may expire, continue to provide the Engineer with an accurate list.

Provide an organizational chart showing the specified lines of authority relating to both mix design and quality control operations during production. Identify the company official acting as liaison with KDOT, and the Certified Technician who will direct inspection and testing. Post the chart in the test facility.

c. Required Duties of Certified Inspectors. Be available on the project site whenever UBAS is being produced and being placed on the project site. Perform and utilize quality control tests and other quality control practices to assure that delivered materials and proportioning meet the requirements of the mix designs.

Periodically inspect all equipment utilized in transporting, proportioning, mixing, placing, and compacting to assure it is operating properly and that placement and compaction comply with the contract requirements.

d. Contractor's Testing Facilities. Describe the testing facility and its accreditation in the QCP.

Locate the testing facility either at the plant site or at the project. Obtain approval of the testing facilities and location from the DME before the commencement of mixture production.

Provide suitable space for the required testing equipment. Also, equip the testing facility with these items for the exclusive use of the testing facility's quality control personnel and the Engineer:

A telephone with a private line for the exclusive use of the testing facility's quality control personnel; and

A copying machine for use by the Contractor's personnel and the Engineer.

Provide Broadband internet connection (for 1 computer). If the Engineer determines that broadband internet service is not available, provide a fax machine, at no additional cost.

An air conditioner capable of maintaining a temperature below 77°F in the main part of the Field Office and Laboratory.

Locate the KDOT field laboratory near the Contractor's testing facility and have it fully functional 2 working days before placement of the pre-production mix.

e. Documentation. Include in the QCP procedures, charts and forms to be used to provide the required documentation.

Record all original documentation in a bound field book or other KDOT approved bound record and turn over to KDOT at the end of the project.

At all times, have complete records of all inspections and tests available on site for the Engineer. All records documenting the Contractor's quality control inspections and tests become the property of KDOT upon completion of the work.

Indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected, and the corrective action taken in the records. Examples of quality control forms and charts are available in Part V, or Contractors may design their own. Documentation procedures are subject to approval by the Engineer before the start of the work and to compliance checks during the progress of the work.

Maintain control charts on an ongoing basis.

Provide the following test data to the KDOT Project Representative:

- Copies of all test results and control charts on a weekly basis, representing the prior week's production;
- Copies of the quality control summary sheet on a daily basis. Include, as a minimum, mix gradation, binder content, theoretical maximum specific gravity (G_{mm}) and film thickness; and
- Copies of all failing test results (based on a moving average of 3 tests, when appropriate). Include all applicable sieves, binder content and film thickness.

f. Testing Requirements. In the QCP, identify test methods, procedures and equipment proposed for use. Use standard KDOT test methods and properly calibrated measuring and testing equipment as outlined in Part V. Detail any alternative sampling method, procedure or inspection equipment proposed to be used. Such alternatives are subject to review and approval by the DME.

Take all samples for tests and perform in-place tests at random locations, selected according to the Contractor's QCP and at the rates specified in the Sampling and Testing Frequency Chart for UBAS for Quality Control/Quality Assurance Projects in Appendix B, Part V.

g. Pre-Production Testing Requirements.

(1) The Engineer will observe the Contractor obtaining and splitting the pre-production test section samples into 3 representative portions. Each sample set shall consist of enough material for G_{mm} and ignition burnoff testing.

(2) Determine G_{mm}, perform ignition burnoff, evaluate the mix gradation and complete calculations.

(3) Provide the KDOT Field Representative with the 2nd sample set. The KDOT Field Representative will determine G_{mm}, perform ignition burnoff, evaluate the mix gradation and complete calculations.

(4) Retain or provide the 3rd sample set to the KDOT Field or District Materials Representative.

(5) The results of the testing will be compared. If Contractor and KDOT field laboratory test results do not compare favorably, the District Materials Laboratory will test their ⅓ of the sample. KDOT personnel will determine G_{mm}, perform ignition burnoff, evaluate the mix gradation and complete calculations.

If results are not acceptable to either party, repeat the above steps in **subsections 613.2g.(1)** through **(5)** for the Contractor's Field Laboratory, KDOT's Field Laboratory, and KDOT's District Laboratory until the issues may be resolved satisfactorily by all parties.

h. Lot 1 Testing Requirements.

(1) Sequence of Sampling. KDOT field personnel will determine the random truckload for the Contractor for sublots A, B, C and D, and the KDOT verification test.

The verification sample will be sampled and tested by KDOT field personnel. The verification sample shall be randomly taken within the lot and shall not be from the same truckload as selected for the Contractor's sublot samples A, B, C or D.

Obtain sampling using KT-25 procedure C.1 Plant Discharge or C.2 Truck Bed.

KDOT field personnel will:

- not supply the Contractor the identity of the truckload to be sampled ahead of time;
- notify the Contractor's laboratory of which truck to sample after the aggregate has left the cold feeds, and before the truck is finished loading; and
- determine whether the split sample will be taken from sublot A or B and notify the Contractor.

(2) Split Samples. The Contractor shall:

- obtain a sample large enough to split 3 ways for testing;
- retain and test ⅓ of the sample;
- supply ⅓ of the sample to the KDOT field laboratory for testing; and
- supply ⅓ of the sample for the KDOT District Materials Laboratory for testing.

(3) Results. At a minimum, compare G_{mm}, binder content, and film thickness results. The acceptable difference for the G_{mm} results is 0.019. If the results exceed this difference, take an additional split sample in Lot 1 from sublot C or D, as time permits.

If test results do not compare favorably, KDOT and the Contractor will investigate the differences in test results together and take appropriate action. The Contractor's test results will be used for quality control. KDOT Field Laboratory test results and District Materials Laboratory test results will be reported as "information only" samples.

i. Testing Requirements for Lots 2 and Greater.

(1) Take all samples for tests randomly as designated in the approved QCP at the rates specified in Appendix B - Sampling and Testing Frequency Chart, Part V.

Provide the Engineer with the random locations before obtaining the sample. The Engineer reserves the right to generate the random locations. If the Engineer generates the random locations, the Contractor will be notified of which truck to sample after the aggregate has left the cold feeds, and before the truck is finished loading.

(2) Conduct the tests for mixture properties, aggregate gradation and binder content on representative portions of the HMA, quartered from the larger sample of HMA. Take a random sample weighing a minimum of 55 pounds using a method to retain heat to facilitate sample quartering procedures.

(3) Record and document all test results and calculations on data sheets provided by KDOT. Record specific test results on a daily summary sheet provided by KDOT to facilitate the computation of moving test

averages. Base moving averages on 3 consecutive test results. Calculations are to be based on the precision displayed on the data sheets. Use "precision displayed" when calculating within Excel. Appendix B - Sampling and Testing Frequency Chart, Part V shows the accuracy to "record to" for the tests listed. Include a description of quality control actions taken (adjustment of cold feed percentages, changes in Job Mix Formulas (JMF), etc.) in the Daily Quality Control Summary Sheet. In addition, post and keep current quality control charts, showing both individual test results and moving average values. As a minimum, plot the single test values on KDOT approved control charts for the mix characteristics shown in **TABLE 613-5**.

(4) If the Contractor and Engineer agree, the procedures shown for sampling, testing and evaluation of Lot 1 in **subsection 613.2h.** may be used for any other Lot produced on the project.

j. Corrective Action. In the QCP, identify procedures for notifying the Engineer when corrective measures must be implemented, and for halting production.

k. Non-Conforming Materials. In the QCP, specifically address how non-conforming materials will be controlled and identified. Establish and maintain an effective and positive system for controlling non-complying material, including procedures for its identification, isolation and disposition. Reclaim or rework non-complying materials according to procedures acceptable to the Engineer. This could include removal and replacement of in-place pavement.

Positively identify all non-conforming materials and products to prevent use, shipment and intermingling with complying materials and products. Provide holding areas, mutually agreeable to the Engineer and Contractor.

613.3 MATERIALS

a. Asphalt Binder. Provide Asphalt Binder that complies with **DIVISION 1200**. Post a legible copy of the latest bill of lading for the Asphalt Binder in the Contractor's Field Lab. Use the mixing and compaction temperatures shown on the bill of lading; however, the maximum mixing or compaction temperature is 340ºF, unless otherwise approved by the Field Materials Engineer. Notify the Engineer if the mixing or compaction temperature changes.

Provide Emulsion Bonding Liquid (EBL) that complies with **DIVISION 1200**.

b. Reclaimed Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS). Do not use RAP or RAS in the UBAS.

c. Aggregates. Provide aggregates that comply with **SECTION 1103**.

d. Combined Aggregates. Provide combined aggregates for the mixes required in the Contract Documents as shown in **TABLE 613-1**.

Mixes may use any combination (except as noted below) of aggregate and mineral filler supplements complying with the applicable requirements in **TABLES 1103-1** and **1103-2**. When coarse aggregates are blended from 1 or more sources, or if more than 1 type, each source or type shall meet the coarse aggregate properties (CAA, LA Abrasion, and micro-deval) in **TABLE 1103-3**.

The minimum Uncompacted Void Content of the Fine Aggregate "U" Value, of the combined aggregate is 45%.

The minimum sand equivalency (SE) of the combined aggregates is 45%.

Provide materials with less than 0.5% moisture in the final mixture.

The maximum quantity of crushed steel slag used in the mix is 50% of the total aggregate weight.

No natural sand will be used in the UBAS.

Traveled way mixes shall include:

- a minimum of 40% primary aggregate based on total aggregate weight;
- a minimum of 50% of the plus No. 4 mesh sieve material in the mixture shall be from the primary aggregate;
- a minimum of 45% of the plus No. 8 mesh sieve material in the mixture shall be from the primary aggregate; and

- Primary aggregates are designated as CS-1 (excluding limestone), CS-2 (excluding limestone), CG, CH-1 and CSSL as described in **subsection 1103.2a.(1)**. Primary aggregate requirements do not apply to the mixture on the shoulder.

e. Contractor Trial Mix Design. A minimum of 10 working days before the start of UBAS production, submit in writing to the DME for review and approval, a proposed JMF for each combination of aggregates. For each JMF submitted, include test data to demonstrate that mixtures complying with each proposed JMF shall have properties specified in **TABLE 613-1** for the designated mix type at the Recommended Percent Asphalt (P_{br}). Submit the proposed JMF on forms provided by KDOT. Submit the worksheets used in the design process to include at a minimum the individual coarse aggregate properties listed in **TABLE 1103-3**, the fine aggregate properties listed in **TABLE 1103-4**, and the mix properties listed in **TABLE 613-2**. Contact the DME to determine if additional material is needed for additional design checks.

For each aggregate used in the mix design, determine the specific gravity using KT-6. This may be accomplished while the project is being constructed or anytime during the 12 months preceding the start of construction on a project. If construction has not yet begun, notify the DME 5 working days prior to obtaining the material for the specific gravity test so that companion samples may be obtained at the same time. If construction has already begun on the project, then determine the specific gravity values of the individual aggregates before 10,000 tons of HMA is produced. Provide the test results to the DME within 14 days of sampling the material. If the producer of the aggregate has been required to submit material to KDOT for a new Official Quality test report since the time the Contractor ran the specific gravity tests, then perform KT-6 on the aggregate currently produced. Do not use the specific gravity values obtained from these tests in the mix design calculations for current projects unless mutually agreeable to both parties. Use the information, as soon as it becomes available, as part of the process to verify and update the "Monthly Hot Mix Aggregate Specific Gravity Values" posted on KDOT's Internet site.

TABLE 613-1: COMBINE AGGREGATE REQUIREMENTS FOR ULTRATHIN BONDED ASPHALT SURFACE*

Mix Designation / Nom Thickness	Percent Retained – Square Mesh Sieves										Asphalt Content (%)
	¾"	½"	⅜"	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200	
Type A - ⅝"		0	0-7	45-60	68-78	75-85	82-90	87-92	90-94	94.0-96.0	5.0 to 6.2
Type B - ⅝"	0	0-7	0-25	62-75	73-83	77-85	82-90	87-92	90-94	94.0-96.0	4.8 to 6.2
Type C - ⅝"	0	0-25	20-50	62-75	73-83	77-85	82-90	87-92	90-94	94.0-96.0	4.6 to 6.2

*For flat and elongated particles in the combined coarse aggregate, use the ratio of 3:1 in lieu of 5:1 shown in KT-59. Do not exceed 25% for the total sample.

TABLE 613-2: MIX PROPERTIES

Property	Test Method	Limits
Total Amine Value of Antistrip Agent, (mg/g of KOH, min) [a]	ASTM D2074	500
Design Film Thickness (μm, min.)	KDOT Construction Manual	9.0 [b]
Drain Down (% max.)	KT-63	0.10
Gyratory Compacted Revolutions, Ndes	KT-58	100 [c]
Emulsion Bonding Liquid (EBL),(gal/sy)	Equation 1	(0.20 ± 0.07) [d]

a – The asphalt binder used in the mix will contain a minimum of 0.25% of an amine based antistripping agent by weight of the asphalt binder.
b – Calculate using the film thickness equation in Section 5.10.4-Calcs for Marshall Mix Design of Bituminous Mixtures, Part V.
c – Compact gyratory specimen to 100 gyrations. Calculate the percent air voids using KT-15, Procedure IV.
d – Calculate the target EBL Shot Rate (S_{ebl} (gal.sy)), using Equation 1; however, the value must be within the limits in this table.

Equation 1: $$S_{ebl} = 3.93 * P_s * \frac{(V_a + MF)}{100}$$

The particle size (P_s), and the mix factor (MF) are based on the mix designation as shown in the **TABLE 613-3**.

TABLE 613-3: VARIABLES IN EBL SHOT RATE EQUATION		
Mix Designation	**Particle Size (Ps)**	**Mix Factor (MF)**
Type A	0.250	3.2
Type B	0.375	3.2
Type C	0.500	3.2

Consider adjusting the EBL spray rate based on the condition of the existing surface as listed in the **TABLE 613-4**. Consult the supplier of the EBL to obtain the recommended adjustment to the spray rate.

TABLE 613-4: EBL ADJUSTMENT CONSIDERATIONS		
Existing Pavement Type	**Condition**	**Adjustment Rate (gal/sy)**
PCCP	Smooth	0.00
	Textured	+0.02 to +0.04
HMA	Flushed	-0.02 to -0.04
	New	0.00
	Matte and OGFC	+0.02
	Dry	+0.03
	Milled	+0.02 to +0.04
Surface Recycle & Cold Recycle	Flushed	-0.02 to -0.04
	Black	+0.02
	Dry	+0.03
Chip Seal	Flushed	-0.02 to -0.04
	Black	+0.02
	Dry	+0.03

613.4 CONSTRUCTION REQUIREMENTS

a. Plant Operation. Adjust all plant operations to operate continuously.

(1) Preparation of the Asphalt Binder. Heat the asphalt binder to within a range as specified in **SECTION 601**. When heating the asphalt binder to the specified temperature, avoid local overheating. At all times, provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. Asphalt binder received from the refinery at temperatures less than 375°F may be used as received, if the requirements regarding the reheating of asphalt binder in **SECTION 601** are met.

(a) Commingling of Asphalt Binders. Do not add or commingle asphalt binders from 2 or more sources into a storage tank. If this occurs, the contents of the storage tank are considered contaminated. Do not use the contents of the storage tank on the project, except as follows: It is permissible, at the Contractor's option, to thoroughly mix the contents of the tank and request sampling of the mixture. Submit the sample to the MRC for testing. Do not use the asphalt binder until approved, and when needed, a new mix design evaluation is completed.

(b) Asphalt Binder Sources. Before changing asphalt binder sources on a project, obtain approval from the DME. A new JMF may be required.

(c) Anti-Strip Additives. If liquid anti-strip additives are added at the Contractor's plant, install a "totalizer" to monitor the quantity of anti-strip additive being added. The Engineer may approve alternative methods for including anti-strip additives in a batch plant. If added at the plant, the anti-strip will be added in line with the asphalt binder as it is being transferred from the transit unit to the asphalt binder storage tank. Provide a method for the Engineer to monitor the percent of additive being added.

(2) Preparation of Mineral Aggregate. When the mineral aggregate is composed of 2 or more ingredients, combine as shown in the approved JMF.

Temperature Requirements. Dry the aggregate for the mixture and heat to a temperature to obtain an asphalt-aggregate mixture temperature immediately after mixing within the 75 to 150 second Saybolt viscosity range of the asphalt binder used. Obtain the temperature for this viscosity range from the MRC or the Asphalt Binder Producer. No mixing or compaction temperatures are to exceed 340ºF without approval from the Field Materials Engineer. The minimum temperature may be revised by the DME provided it is demonstrated that satisfactory results may be obtained at a lower temperature. In such event, deliver the HMA to the paver at a temperature sufficient to allow the material to be satisfactorily placed and compacted to the specified density and surface tolerance requirements.

(3) Preparation of HMA. Introduce asphalt binder into the prepared aggregate in the proportionate amount determined by the P_{br} in the JMF.

(a) Basis of Rejection. HMA will be rejected if the aggregate, as it is discharged from the drum or the pugmill, contains sufficient moisture to cause foaming of the mixture, or if the temperature of the aggregate is such that the asphalt-aggregate mixture temperature is outside the range specified in **SECTION 601**.

(b) Mixing Time. Operate drum mixers at a rate to provide uniform aggregate coating in a continuous operation. For batch and continuous type plants, the minimum wet mixing time is 40 seconds. In all cases, mix a sufficient time to produce a uniform mixture in which all the aggregate particles are thoroughly coated. On batch plants, begin the timing at the start of the asphalt binder introduction into the pugmill, and end upon the opening of the discharge gate. For continuous flow plants, mixing time in seconds shall equal:

[pugmill dead capacity in pounds] divided by [pugmill output in pounds per second].

(c) Manufacturer's Specifications. Operate all drying, pumping and mixing equipment within the limits specified by the manufacturer, unless it can be demonstrated to the satisfaction of the Engineer that such limits may be exceeded without detriment to the HMA.

(d) Batcher Operation. Coordinate HMA batchers (Gob Hoppers) with the plant production rate at all times so the hopper is more than ¾ full before the gates open, and the gates close before material can drop through the gob hopper directly into the surge bin, weigh hopper or truck.

(e) Wasted Material. Wasted material is not measured for pay.

If after an interruption of production, the drum-mixer contains cold, uncoated or otherwise unsuitable material, waste material through a diversion chute. In a continuous or batch plant drier, waste unsuitable material through the pugmill.

At the end of a production run, waste any segregated material in the cone of the storage bin.

(4) End of Day Quantities. At the end of each day of production, provide the Engineer with a document signed by the Plant Foreman or the Project Manager listing the dry weight of each aggregate and mineral filler; the tons of asphalt binder, and the tons of anti-strip agent used for the project during the day. The dry weight is the tons of the material less the water content.

b. Road Surface Preparation.

(1) Preparation of an Existing Asphalt Pavement. Clean the surface to remove all foreign material and broom to remove dust. Excavate areas shown in the Contract Documents to be patched to a depth directed by the Engineer. Fill with HMA and compact.

(2) Preparation of an Existing Concrete or Brick Pavement. Clean all foreign material and broom to remove dust. Clean and fill cracks and joints, and construct surface leveling as shown in the Contract Documents.

c. Weighing Operations. See **subsection 109.1** for details regarding weighing operations.

d. Hauling Operations. Schedule operations to minimize hauling over a surface course.

Deliver HMA to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance.

e. Paving Operations.

(1) Equipment Use a transfer device between the haul units and the paver to assist in maintaining continuous placement. Use equipment such as a shuttle buggy, material transfer vehicle or mobile conveyor. (The material will not be deposited on the roadway and a pick-up device used to transfer the material to the paver.)

Use a self-priming paver, designed and built for applying the UBAS and approved by the Engineer.

Use a paver with the following requirements:

- with a receiving hopper, feed conveyor, asphalt emulsion storage tank, a system for measuring the EBL volume applied, a spray bar, and a heated, variable width, vibratory screed;

- capable of spraying the EBL, applying the hot mix surface course and leveling the surface of the mat in one pass;
- capable of placing the hot mix surface course within 5 seconds after the application of the EBL;
- capable of paving at a controlled speed from 30-100 feet/minute;
- equipped so no wheel or other part of the paving machine is in contact with the EBL before the hot mix surface course is applied; and
- equip the screed with the ability to crown the pavement at the center and have vertically adjusted extensions to accommodate the desired pavement profile.

The Engineer will check the pavement for longitudinal streaks and other irregularities. Make every effort to prevent or correct any irregularities in the pavement, such as changing pavers or using different and additional equipment.

Do not raise (dump) the wings of the paver receiving hopper at any time during the paving operation.

(2) Application: Spray the EBL by a metered mechanical pressure spray bar at the temperature specified in **TABLE 601-1**, or as recommended by the EBL supplier. Use a sprayer that accurately and continuously monitors the rate of spray and provides a uniform application across the entire width to be overlaid. The Engineer may make adjustments to the spray rate based upon the existing pavement surface conditions and the recommendations of the EBL supplier.

Apply the UBAS at a temperature of 290-330ºF and spread over the EBL immediately after the application of the EBL. Place the UBAS over the full width of the EBL with a heated vibratory screed. Adjust the screed and its extensions to eliminate variances in surface texture caused by density segregation. Operate the paver as continuous as possible to reduce the possibility of screed indentations in the finished mat.

The target application rate of the UBAS will be stated in the Contract Documents. Use a field application rate as necessary to minimize fracturing of the top size aggregate by the screed. The Engineer will determine the acceptable extent of fracturing at the edge of the paving for tapering purposes.

The finished asphalt surface shall be free of oversized material. The Engineer will determine the extent of the oversized material in the UBAS. Take immediate corrective action to eliminate the source. If the source of the oversized material is determined to be a stockpile or a process of plant operations, cease production until corrective actions are complete.

Spread the UBAS without tearing the surface. Strike a finish that is smooth, free of segregation, true to cross section, uniform in density and texture and free from surface irregularities. If the pavement does not comply with all of these requirements, plant production and paving will be suspended until the deficiency is corrected.

(3) Compaction: Roll the UBAS with a minimum of 1 pass and a maximum of 3 passes with 2-axle tandem steel rollers having a minimum weight of 10 tons, before the material temperature has fallen below 195ºF. The Engineer will determine the number of passes necessary based on appearance of the rolled material. Do not allow the roller or rollers to remain stationary on the freshly placed UBAS. Perform rolling immediately following the placement of the UBAS with approved asphalt rollers. Supply adequate roller units so the rolling will be accomplished promptly following the placement of the material. A release agent (added to the water system) may be required to prevent adhesion of the fresh mix to the roller drum and wheels. Normally, perform rolling in the static mode. Do not excessively roll the driving lanes, to the extent of aggregate degradation. The Engineer will determine the acceptable extent of fracturing at the edge of the pavement from the rolling operation. Do not open the new pavement to traffic or allow any roller to sit idle on the pavement until the rolling operation is complete and the material has cooled below 160°F.

Damaged Areas: Replace any defective areas, as determined by the Engineer, at no additional cost to KDOT.

(4) Construction Joints.

- Transverse Construction Joints. Use a method of making transverse construction joints which provide a thorough and continuous bond and provide an acceptable surface texture. Do not vary the surface elevation more than 3/16 inch in 10 feet, when tested longitudinally across the joint. When required, repair the joints or paving operations will be suspended.
- Longitudinal Joints. Construct well bonded and sealed longitudinal joints to obtain maximum compaction at the joint.

(5) Adjustment of Manholes (Set Price). When required, this work will be performed and paid for under **SECTION 816**.

f. Maintenance of Traffic. Maintain traffic according to **DIVISION 800** and the following:

Maintain one-way traffic, and restrict traffic speeds to 20 miles per hour in the vicinity of workers, unless otherwise designated. Use pilot cars to lead traffic through the area of paving and rolling operations, and if directed, through a curing area. The use of flaggers is allowed through patching operations, unless the patching area or distance between flaggers exceeds ½ mile, in which case the use of a pilot car shall be required. On overlay projects with 2 lanes or more in each direction for traffic use, the Engineer may waive the pilot car requirements.

Station one flagger ahead of the application of the tack coat and one flagger ahead of the area being protected from traffic. Take adequate protection for traffic on side roads approaching the tack area.

g. Treatment of Adjacent Areas. Pave sideroads, entrances and turnouts for mailboxes as shown in the Contract Documents. Overlay all widening areas designated in the Contract Documents or ordered by the Engineer.

h. Pavement Smoothness. UBAS is excluded from profilograph testing, and not eligible for pay adjustments.

613.5 PROCESS CONTROL

a. General. Establish gradation limits and proportions for each individual aggregate and mineral filler. Specify the limits and proportions such that the material produced complies with the applicable requirements of the designated mix type. The Contractor is responsible for all process control operations including testing. At no time will KDOT's representative issue instructions to the Contractor or producer as to setting of dials, gauges, scales and meters. KDOT will collect and test verification samples and assurance samples and inspect the Contractor's quality control operations.

b. JMF Adjustments. Produce a mixture of uniform composition closely complying with approved design JMF to obtain the specified properties when compacted. If, during production, results from quality control tests demonstrate a need to make adjustments to the mix design, then make adjustments to the design JMF single point gradation and binder content to achieve the specified properties. The JMF adjustments shall produce a mix that complies with **TABLE 613-1** for the specified mix designation. When necessary, adjust on a sublot basis. Report the new JMF to KDOT's field representative and the DME before making such changes, and submit a new mix design for review and approval if required by the DME.

c. Specification Working Ranges. Establish acceptable limits for field test results by applying the tolerances shown in **TABLE 613-5** to the JMF or adjusted JMF for binder content. Establish acceptable limits for the other listed mix characteristics by applying the tolerances shown in **TABLE 613-5** to the requirements of **TABLE 613-1**.

TABLE 613-5: SPECIFICATION WORKING RANGES (QC/QA)

Mix Characteristic	Tolerance from JMF and Specification Limits		
	Single Test Value	Plot	3 Point Moving Average Value
Binder Content (Maximum deviation from JMF)	±0.3%	*	±0.3%
Film Thickness	n/a	*	zero tolerance
Gradation**	n/a	*	zero tolerance
Course Aggregate Angularity (CAA)	zero tolerance		n/a
Fine Aggregate Uncompacted Voids (FAA)	zero tolerance		n/a
Sand Equivalent	zero tolerance		n/a

*Values to plot. In addition, plot the Gmm values. For gradations, as a minimum, plot the No. 4, 8, 30 and 200 sieves.

The maximum deviation for UBAS from the JMF for the sieves with a ± tolerance shall be as listed in **TABLE 613-6. Only the No. 16, 30, 50 and 100 sieves may exceed the limits listed in **TABLE 613-1** provided the minimum retained percentage shown in **TABLE 613-6** is met.

TABLE 613-6: SPECIFICATION WORKING RANGES FROM THE JMF										
Mix Designation	**Percent Retained – Square Mesh Sieves**									
	¾"	**½"**	**⅜"**	**No. 4**	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200**
Type A				±5	68 - 78	75 min	82 min.	87 min.	90 min.	94.0 – 96.0
Type B			±5	±4	73 - 83	77 min.	82 min	87 min.	90 min.	94.0 – 96.0
Type C		±5	±5	±4	73 - 83	77 min.	82 min	87 min.	90 min.	94.0 – 96.0

d. EBL Shot Rate Specification. Periodically determine the application rate of the EBL. The Engineer will verify the application rate. Acceptable tolerance of the application rate is the target rate ±0.02 gal/sq yd. Check for proper coverage at least twice per day by applying the EBL to the road surface for a minimum distance of 20 feet. When the Engineer verifies the coverage meets specification, back up the paver and shoot not more than 1/4 of the EBL shot rate over the previously tacked segment.

613.6 WEATHER LIMITATIONS

Do not place UBAS on any wet or frozen surface or when weather conditions otherwise prevent the proper handling and finishing of the mixture.

Only place UBAS when either the minimum ambient air temperature is 50°F or the minimum road surface temperature is 55°F.

613.7 MIXTURE ACCEPTANCE

a. General. Test the UBAS at each plant for compliance with **TABLE 613-1**. Acceptance will be made on a lot by lot basis contingent upon satisfactory test results. Obtain quality control and verification samples of the UBAS using KT-25 sampling procedure C.1 Plant Discharge or C.2 Truck Bed.

A load or loads of mixture which, in the opinion of the Engineer, are unacceptable for reasons such as being segregated, aggregate being improperly coated, foaming aggregate or being outside the mixing temperature range may be rejected.

b. Lot Definition for Mix Production Sampling and Testing. A lot is defined as an isolated quantity of a specified material produced from a single source or operation. Each lot shall normally be represented by 4 contiguous test results. A lot may be represented by test results on samples taken from 1 or more day's production.

c. Lot Investigation. The Engineer may examine materials represented by individual test results which lie beyond the Contractor's normal quality control testing variation. The investigation may be based on either Contractor or KDOT test results. The information from additional testing (including testing of in-place HMA) may be used to define unacceptable work according to **SECTION 105**. The Engineer may apply appropriate price reductions or initiate corrective action.

For any test, if a dispute exists between the Engineer and Contractor about the validity of the other's test results, the KDOT District Materials Laboratory or the MRC will perform referee testing. If the disputed KDOT test results were generated at the District Laboratory, the MRC will perform the referee tests. If the disputed KDOT test result was generated at the MRC, an independent laboratory agreeable to both parties will be selected. The Laboratory shall be accredited by the AASHTO Accreditation Program in the appropriate testing category.

If referee testing indicates that KDOT test results are correct, the Contractor pays for the additional testing, including referee testing performed at the MRC. This will be paid using the bid item Contract Deduct which will be an item added to the contract.

If the referee testing indicates that Contractor test results are correct, KDOT pays for the additional testing. Pay the independent lab for the testing and submit the paid invoice to KDOT. The Engineer will reimburse the Contractor (based on the invoice price) as Extra Work, **SECTION 104**.

d. Multiple Projects. If multiple projects are supplied from 1 or more plants using the same mix, carry over the lots at each hot mix plant from project to project.

e. Lot Size. A standard size mix production lot consists of 4 equal sublots of 400 tons each of asphalt mixture (lot size 1,600 tons). If the last sublot contains less than 200 tons, combine it with the previous sublot.

It is anticipated that lot size shall be as specified. However, with the Engineer's approval, the Contractor may re-define lot size for reasons such as, but not limited to, change in contract quantities or interruption of the work. Take 1 sample during production of each sublot and utilize it to determine disposition of the lot in which it occurs.

f. Increased Lot Size. After 8 consecutive sublots have been produced with the tolerances shown for all mix characteristics listed in **TABLES 613-5** and **613-6**, the sublot size may be increased by the Contractor to 500 tons each of asphalt mixture (lot size 2,000 tons), provided normal production rate of the plant is over 200 tons per hour. Immediately notify the Engineer of lot size change. If subsequent test results fall outside the tolerances shown for any mix characteristics listed in **TABLES 613-5** and **613-6**, the sublot size will be decreased to 400 tons. When the increased lot size criteria are again met, the sublot size maybe increased to 500 tons.

g. Pre-Production Mix. Test and evaluate a pre-production mix, limited to a maximum of 200 tons from each plant before production of that mix. Evaluate the pre-production mix at initial start-up and after suspension of production resulting from failing test results. Limit pre-production quantities to 100 tons following a suspension of production. Provide a pre-production mix that complies with the "Single Test Value" in **TABLES 613-5** and **613-6**. Except for initial start-up, normal delivery of material to the project before completion of certain test results on pre-production mixes may be authorized by the DME.

At the direction of the Engineer, remove the pre-production mix if it is both out of specification and the material shortens the pavement life or changes the intended function. The Engineer will pay for the replacement of one pre-production mix at 100% of the contract unit price. The payment will be full compensation to the Contractor for the placement and removal of that pre-production mix. KDOT will not be financially responsible for any subsequent failed pre-production mixes (that require removal) for that mix. The removed material is the property of the Contractor.

The Engineer will not pay for pre-production mixes that are required to be replaced due to poor workmanship or equipment failure. The Engineer will make the final decision to remove a failed pre-production mix with input from the Contractor.

h. Suspension of Mix Production. Suspend production of the mix until appropriate corrections have been made, if 2 consecutive test results for any single mix characteristic fail to fall within the limits established by the tolerances shown in the single test value column of **TABLE 613-5**. Additionally, suspend production of the mix until appropriate corrections have been made, if any 3-point moving average value for any single mix characteristic fails to fall within the limits established by the tolerances shown in the 3-point moving average value column of **TABLE 613-5**. Production remains suspended pending the satisfactory results of a pre-production mix, unless waived by the DME.

When the mix fails to meet the criteria listed in **TABLE 613-5**, identify the cause and document, in detail, what corrective action was taken. The JMF may only be adjusted, when requested by the Contractor, and when approved by the Engineer. For significant changes in the JMF, as determined by the Engineer, a new mix design may be required by the Engineer before the JMF is approved.

The Engineer may stop production of HMA at any time the mix or process is determined to be unsatisfactory. Make the necessary corrections before production will be allowed to resume. Failure to stop production of HMA subjects all subsequent material to rejection by the Engineer or acceptance at a reduced price, as determined by the Engineer.

613.8 MEASUREMENT AND PAYMENT

a. Ultrathin Bonded Asphalt Surface. The Engineer will measure UBAS by the ton of material at the time of delivery to the road. Batch weights will not be allowed as a method of measurement, unless all the following conditions are met:

- the plant is equipped with an automatic printer system approved by the Engineer;
- the automatic printer system prints the weights of material delivered; and
- the automatic printer system is used in conjunction with an automatic batching and mixing control system approved by the Engineer.

Provide a weigh ticket for each load. Due to possible variations in the specific gravity or weight per cubic foot of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variances.

Payment for "HMA Surface (Ultrathin Bonded)" at the contract unit prices is full compensation for the specified work.

Sideroads, entrances and mailbox turnouts that are not shown in the Contract Documents that are to be surfaced shall be paid for at 1½ times the unit price for "HMA Surface (Ultrathin Bonded)".

b. Emulsified Asphalt. The Engineer will measure emulsified asphalt used for tack by the ton. Payment for "Emulsified Asphalt (Emulsion Bonding Liquid)" at the contract unit price is full compensation for the specified work.

c. Quality Control Testing (HMA). The Engineer will measure Quality Control Testing (HMA) performed by the Contractor on a per ton basis of UBAS placed on the project. No adjustment in the bid price will be made for overruns or underruns in the contract quantity. The bid price will constitute payment for all necessary mix design testing, field process control testing, the testing laboratory and all necessary test equipment.

Payment for "Quality Control Testing (HMA)" at the contract unit price is full compensation for the specified work.

06-21-16 C&M (BTH)
Oct-16 Letting

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, EDITION 2015

Delete SECTION 802 and replace with the following:

SECTION 802

CONTRACTOR CONSTRUCTION STAKING

802.1 DESCRIPTION

Provide land surveying and construction surveying services and set right-of-way survey monuments according to the Contract Documents, KDOT's Construction Manual-Part III and consistent with standard surveying practices.

For the purposes of this specification, work being performed by the Professional Surveyor shall conform to the Kansas Statutes and Kansas State Board of Technical Profession's Regulations.

Work may be performed by the Professional Surveyor's authorized agents and employees as allowed by the Kansas Statutes and Kansas State Board of Technical Profession's Regulations.

BID ITEMS	UNITS
Contractor Construction Staking	Lump Sum
Right-of-Way Survey Monument	Each
Benchmark Monument (Concrete Cylinder)	Each
Monument Box	Each
Sign (Environmental Mitigation)	Each

802.2 MATERIALS

a. General. Provide the necessary materials to complete the specified surveying services. Provide materials and equipment that comply with the current requirements of the Kansas Statutes, Kansas State Board of Technical Profession's Regulations and the Contract Documents.

b. Benchmark Discs. Provide standard manufacture 2-inch diameter, domed, brass or bronze survey monuments to be set in concrete.

Refer to **subsection 802.3c.(7)** for individual stamping requirements.

c. Concrete. Use commercial grade concrete that complies with **SECTIONS 401** and **402**.

Volumetric proportioning and hand mixing of concrete is permitted for concrete footings where small quantities are required.

d. Miscellaneous Materials. Provide the following miscellaneous materials:

- Commercially available steel posts that comply with the physical requirements for steel delineator posts, **DIVISION 1600**;
- 3-inch x 8-inch x 16-gage metal sign blanks;
- Commercially available galvanized 2-inch x 5/16-inch bolts, with 2 flat washers, 1 lock washer and 1 nut per bolt;
- Commercially available ⅝-inch x 30-inch reinforcing steel bars (non-coated); and
- Other miscellaneous materials for R/W Survey Monuments detailed in the Contract Documents.

e. Monument Box. Provide a monument box of the brand and type shown in the Contract Documents.

f. Acceptance of Materials. The Engineer will accept materials for the specified surveying services, right-of-way survey monuments, miscellaneous materials and monument boxes based on compliance with dimensional and other specified requirements and visual inspection for condition.

g. Environmental Mitigation Area Signs. Other miscellaneous materials for the Environmental Mitigation area signs, detailed in the Contract Documents.

- Aluminum sign blanks, **DIVISION 1600**;
- Galvanized U-Posts, 2 lb./ft, **SECTION 1622**;
- Commercially available galvanized 2-inch x 5/16-inch bolts, with 2 flat washers, 1 lock washer and 1 nut per bolt; and
- Other miscellaneous materials for Environmental Mitigation Area Signs detailed in the Contract Documents.

802.3 CONSTRUCTION REQUIREMENTS

a. General.

(1) With the Engineer's approval, the Contractor's surveying operations may begin after the contract is signed, but prior to issuing the Notice to Proceed.

(2) Surveying Personnel. Before performing any surveying operations on the project, inform the Engineer of the Contractor's personnel responsible for land surveying, construction surveying and staking. Provide a Professional Surveyor, trained and experienced in construction staking and licensed by the Kansas State Board of Technical Professions according to Kansas Statutes to perform the required land surveys, the setting of all section corners, right-of-way survey monuments and reference point monuments set on the right-of-way lines.

(3) Provide surveying equipment that complies with the following tolerances:

- <u>Slope Staking</u>: Horizontal and Vertical tolerance of ± 0.10 feet (per KDOT Construction Manual - Cross Sections 3.06.02). Use a GPS system, a Total Station, or a Level & Transit.
- <u>Finish Staking</u>: (grade hubs, blue tops, string lines, etc.) and Structures: Horizontal tolerance = ± 0.05 feet; Vertical tolerance = ± 0.01 feet (per KDOT Construction Manual, subsection 3.09 - Finishing Stakes, Part III). For Horizontal, use a GPS system or a Total Station. For Vertical, use a Level or Total Stations. Do not use GPS for Vertical.
- <u>Critical Bridge Member Staking</u>: Horizontal tolerance = ± 0.02 feet; Vertical tolerance = ± 0.01 feet (Vertical as per Construction Manual, subsection 3.09 - Finishing Stakes, Part III). For Horizontal, use a GPS system or a Total Station. For Vertical, use a Level. See **subsection 802.3c.(2)** for Critical Bridge Member Staking.
- <u>Right of Way Survey Monuments</u>: For relative precision of all R/W Survey Monuments, comply with the precision expressed in the <u>Kansas Minimum Standards for Boundary Surveys</u> from the project coordinate data. Use a GPS system or Total Station.
- <u>Project Control Points</u>: The relative precision of any project control point ± 0.05 feet from the project coordinate data. Use a GPS system or Total Station.
- <u>Field Notes</u>: For all land surveying and construction staking, record 2 measurements for verification in the field notes for all PLSS corners and all project control points.
- <u>GPS equipment</u>: Take 2 GPS measurements at a minimum interval of 2 hours with the base station at 1 or 2 project control points. Include in the field survey notebooks a copy of the site calibration. The site calibration includes an area extending a minimum of 200 feet beyond the beginning and ending of the project and the construction limits furthest offset to the left and right of the project centerline. Take a minimum of 4 calibration points or as directed by the Engineer. Use the sum of the average residual of the site calibration and the delta of the point being staked.
- <u>Total Stations</u>: To verify the tolerances, record total station measurements from 2 project control points (set-up or backsight) to the point being established. Use the average of the 2 resulting coordinate values for the point being staked for the specified tolerances.
- <u>Levels</u>: Record in the field notes a turn through each project benchmark as they are encountered during staking activities (per KDOT Construction Manual, subsection - 3.23.05 – Elevations, Part III).
- <u>Control Stakes</u>: Do not perform vertical control using GPS.

(4) Before proceeding with the field surveys, provide the Engineer with a written report of any errors or apparent discrepancies found in previous surveys or the Contract Documents. The Engineer will provide the corrections or necessary interpretations.

Correct any deficient engineering layout or construction work that is the result of inaccuracies in the Contractor's surveys or staking operations, or the failure to report inaccuracies found in the work previously done by KDOT, at no additional cost to KDOT.

(5) The Engineer will perform final checks, measurements and surveys involving the determination of any pay quantities. The Engineer may check the accuracy and control of the Contractor's construction staking at any time throughout the duration of the project.

b. Land Surveying.

(1) Before any construction activity starts in the immediate area of an endangered Public Land Survey System (PLSS) corner, recover all endangered section corners and accessories of the PLSS on the project. Endangered PLSS corners are those as defined by Kansas Statutes and/or shown in the Contract Documents as lying within the range from the project centerline to distance 100 feet outside the construction limits, throughout the length of the project. Establish a minimum of 4 reference ties for each endangered PLSS corner. Each reference tie shall be a direct measurement to a precise (hard defined) point. Specify slope or horizontal measurement.

Complete a Land Survey Reference Report marked as a "Notice of Endangerment Activity" for each endangered PLSS corner. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statutes. Provide the Engineer with copies of the completed reports.

(2) Before any construction activity starts in the immediate area, clearly establish the right-of-way as shown in the Contract Documents. If the R/W Survey Monuments are set initially, determine each monument's position with the project coordinates, project stationing and offset.

(3) Before acceptance of the project, recover and verify, or reset all of the PLSS corners previously reported as endangered PLSS corners. Verify the top of all PLSS corners monuments are ¼ to ½ inch below the finish grade on concrete pavement and 4 to 6 inches below the finish grade on asphalt pavement. Establish a minimum of 4 reference ties for each of the PLSS corners. Each reference tie shall be a direct measurement to a precise (hard defined) point. Specify slope or horizontal measurement.

Complete a Land Survey Reference Report marked as a Notice of Completion of Endangerment Activity and Report of Restoration for each restored PLSS corner previously reported as endangered. File the reports with the appropriate governmental custodian responsible for maintaining those records, as required by Kansas Statutes. Provide the Engineer with copies of the completed reports. The Engineer will submit this report to the corresponding District surveyor.

(4) Before acceptance of the project, set supplemental/additional offset control points for each corner of the PLSS on the project that is located in the pavement.

Install one offset control point within public right-of-way along a PLSS line radiating from the corner if said line was determined by the preliminary survey of the project and the offset control point can be placed in an unpaved location, or install 2 offset control points in 2 adjacent quadrants at optimal unpaved locations

The offset control points shall be a brass or bronze capped rebar (minimum of 30 inches long and ⅝ inch in diameter). Stamp the cap with the Project Number and the stamping "PLSS - O/S".

The preferred locations are:

- An even foot from the PLSS corner;
- Bury control point 4 – 6 inches deep;
- At top of back slope in cut sections;
- Approximately 12 feet off shoulders in fill sections;
- At optimal location to fit conditions.
- Do not place within 7 feet to right-of-way, to avoid utilities.

Include the offset control points on the as-built plans as an additional reference tie to the PLSS corner. Include the project coordinates and station/offset tied to project stationing.

(5) Before the acceptance of the project, set all of the R/W Survey Monuments shown in the Contract Documents. If the R/W Survey Monuments were set initially, visually inspect each R/W Survey Monument to determine if it was either disturbed or destroyed. Reset all of the R/W Survey Monuments that are determined as disturbed or destroyed, at no cost to KDOT. Determine each reset monument's position with both the project coordinates and the project station/offset. Provide the Engineer with a written report of all right-of-way survey monuments set. The Engineer will submit this report to the corresponding District surveyor.

c. Construction Surveying and Staking.

(1) General.

- Check alignment and reference or re-reference all necessary control points.
- Establish or re-establish project centerline.
- Run a level circuit to check or re-establish plan benchmarks; set other benchmarks as needed.
- Take original cross-sections that are not incorporated in the plans.
- Stake or re-stake right-of-way where needed (to be done by a Professional Surveyor).
- Perform all construction layout and reference staking necessary for the proper control and satisfactory completion of all structures, grading, paving, drainage and all other appurtenances required for the completion of the work.
- Construction of ditches and other planned excavation and embankment designated in the Contract Documents may be performed by Global Positioning System (GPS) controlled grading equipment, according to the Contract Documents and this specification. GPS controlled grading equipment does not eliminate the need for finish staking or blue top staking according to the Contract Documents. Once a week, provide the Engineer with documentation (on a preapproved form) verifying machine calibration to monitor, verify, adjust and compensate for the wearing surface of the cutting edge of the machine being utilized.

(a) GPS Equipment. Use GPS controlled grading equipment capable of meeting the end results specified in the Contract Documents. The Engineer may require alternative (non-GPS) verification of shot locations. This could be by witnessing the Contractor take shots with GPS Rover, etc.

(b) Electronic Design Files/GPS Model. When available, KDOT will provide Electronic Design Files for the project. Convert the files provided by KDOT into the format required by the Contractor's system and equipment. Conform to the typical sections. Notify KDOT Design and the Field Office administering the contract, in writing, of any errors, omissions, ambiguities, or perceived inadequacies found in the Electronic Design Files provided by KDOT.

Make no claim on the contract under **SECTION 104**, for additional money, additional time or both because the KDOT produced plans differ from drawings generated from the Electronic Design Files, even if the Contractor did not manipulate the Electronic Design Files before generating the GPS Model. Accept sole responsibility for the adequacy and accuracy of all Contractor-generated, subcontractor-generated, or supplier-generated documents or GPS Models used on the project. Assume the risk of errors and omissions resulting from software conversions, Electronic Design File manipulation or other Electronic Design File creation used by the Contractor, subcontractors, suppliers or any combination thereof.

The GPS Model the Contractor generates from the Electronic Design Files may differ from the Contract Documents. The Contractor assumes the risk of such discrepancies.

KDOT printed plans controls over the related Electronic Design File(s) which controls over the Contractor's GPS Model.

(c) GPS 3D Model. Before beginning any GPS controlled machine grading, provide the KDOT Field Office and KDOT Design with an electronic copy of the GPS 3D Model created for that use. In addition to the GPS machine control, provide centerline stakes, slope stakes and grade stakes from the beginning thru the end of the project, at 500-foot intervals on straight runs, and at 250-foot intervals on curves, transitions, intersections, interchanges and break points. The Engineer may require closer staking intervals for other locations, such as transition areas. GPS controlled machine grading does not eliminate the need for finish staking or blue top staking.

The Engineer may review the Contractor's GPS machine control grading results, surveying calculations, records, field procedures and actual staking at any time. If the Engineer determines the work is not meeting the required horizontal and vertical tolerances, see Unacceptable Work, **SECTION 105**.

Contractor delays or errors due to operating the GPS machine control system will not result in any adjustment under **SECTION 104**, for additional money, additional time or both.

(2) Bridge. Prior to construction, set project control points and Critical Bridge Element control points for the horizontal and vertical location of the Critical Bridge Element features by a Professional Surveyor. Critical Bridge Elements include, but are not limited to the features listed in **TABLE 802-1**.

Prior to construction, provide an independent survey performed by a different Professional Surveyor to check the accuracy of the original survey of project control points and locations of the Critical Bridge Elements features.

Report any differences or discrepancies to the Project Engineer.

Resolve any differences or discrepancies, prior to construction of the Critical Bridge Elements.

After the Critical Bridge Elements have been constructed, provide a survey by a Professional Surveyor to verify the locations and elevations of the Critical Bridge Elements.

All surveys shall be within the tolerances for that bridge element allowed in the Contract Documents. Report any discrepancies in excess of the tolerances to the Project Engineer.

TABLE 802-1: CRITICAL BRIDGE ELEMENTS

Critical Element	Critical Component(s)
Spread Footing	Location & Elevation of CL
Pile Cap Footing	Location & Elevation of CL
Drilled Shaft	Location & Elevation of Center
Drilled Shaft Cap	Location & Elevation of CL
Column	Location & Elevation of Center
Pile Bent with Web Wall	Location & Elevation of CL
Abutment Beam/Bearing Seat	Location & Elevation of CL
Pier Beam/Bearing Seat	Location & Elevation of CL
Bearing Devices	Location & Elevation of CL, Temp. Offset
Bearing Stiffener	Location & Elevation of CL, Temperature Offset
Girder/Beam	Location of CL
Anchor Bolts/Preformed Holes	Location of CL
Expansion Device	Gap (Corrected for Temp) and Alignment
Fillets (Tenth Points)	Elevation
Surface of Forms (Slab Bridge Tenth Points)	Elevation
Post-tensioning Duct	Location & Elevation
Bolted Field Splice	Elevation

(3) Documentation. Provide and maintain a current copy of all field survey notebooks at the project site at all times. Produce the original field survey notebooks for inspection upon request by the Engineer. Include a detailed list of any abbreviations, codes, formatting or other nomenclature contained in the notebooks to facilitate clarity of the notes. Provide either one or a combination of both of the following types of notes, as directed by the Engineer:

- Provide standard, bound field notebooks where the handwritten field notes are indexed and kept in a clear, orderly and neat manner consistent with standard surveying practices and according to KDOT's procedures.
- Provide a legible ASCII file for electronic field notes where the "theoretical (calculated) point" can be checked against the "established point" set in the field. This method allows for a check of the inverse distance and direction for error tolerance. This procedure should be utilized for points with elevations. Before any construction staking begins, the procedures for all electronic field notes must be approved by the Engineer.

(4) Offset Horizontal Control (HC) Points. On projects 1 mile or longer, a Professional Surveyor shall set offset HC points. For projects up to 4 miles long, set 4 evenly spaced offset HC points. For projects over 4 miles, add an offset HC point for each additional mile or part thereof.

The preferred locations are:

- As directed by the Engineer;
- On hill tops;
- At top of back slope in cut sections;
- Approximately 12 feet off shoulders in fill sections;
- At optimal location to fit conditions.
- Do not place within 7 feet to right-of-way, to avoid utilities.

The offset HC points shall be a brass or bronze capped rebar (minimum of 30 inches long and ⅝ inch in diameter) placed in a concrete footing (6-inch diameter, minimum 4-foot depth into the ground) cast in place. Recess the cap approximately ¼ inch below the concrete. Stamp the cap with the Project Number and an ID of sequential numbers starting with one and running with project stationing [i.e.: KA-1234 HC1].

Provide the Engineer with a written report of all project offset HC points, listing the offset HC point number, project coordinates, and station/offset, and its physical location. The Engineer will submit this report to the corresponding District surveyor.

(5) Monuments. Upon completion of the surfacing, a Professional Surveyor shall recover and verify or reset all of the field survey monuments (such as P.I.'s, P.O.T.'s, P.C.'s, P.T.'s, P.O.S.T.'s,) on the project centerlines or baselines, as shown in the Contract Documents. Verify that the top of the field survey monuments are set a maximum of ½ inch below the finish grade on concrete pavement, or a maximum of 6 inches below the finish grade on asphalt pavement. Verify the accuracy of the locations of all field survey monuments versus those of the project centerlines or baselines shown in the Contract Documents. Establish a minimum of 4 reference ties for each of the field survey monuments on the project centerlines or baselines.

(6) Reports. Provide a written report to the Engineer indicating the descriptions of all field survey monuments and their 4 reference ties, regardless if the information in the Contract Documents was revised or not. Include in the report "station calls" for each of the field survey monuments (such as P.I.'s, P.O.T.'s, P.C.'s, P.T.'s, P.O.S.T.'s) on the project centerlines or baselines shown in the Contract Documents. The Engineer will submit this report to the corresponding District surveyor.

(7) Benchmarks. Recover and verify all of the project benchmarks shown in the Contract Documents. Establish permanent replacement benchmarks for all project benchmarks that were destroyed during the construction using one of these methods:

- A benchmark disc "set in place" on new concrete structure.
- A benchmark disc "drilled and grouted" on existing concrete structure.
- A benchmark disc set in the top of a concrete footing (6-inch diameter x 4-foot depth into the ground, minimum) cast in place.
- As directed by the Engineer.

Stamp the benchmark caps with the "Project Number" and the permanent replacement benchmark number as a letter designation following the benchmark it is replacing (i.e.: destroyed BM #21 is replaced by BM #21A). Without exception verify that the maximum spacing between benchmarks is a maximum of 30 feet in vertical difference, 500 feet in horizontal distance in urban areas or 1500 feet in horizontal distance in rural areas.

Provide the Engineer with a written report of all post project benchmarks, listing the benchmark number, elevation, project stationing and offset, and a complete description of the monument type and its physical location. Include in the report, all of the remaining benchmarks shown in the Contract Documents, the permanent replacement benchmarks and the remaining additional "construction benchmarks" used for the staking of the project. Do not include in the report any "temporary benchmarks" used for the construction staking of the project that are classified as "temporary" or "degradable" in nature. The Engineer will submit this report to the corresponding District surveyor.

d. Right-of-Way Survey Monuments. A Professional Surveyor shall set all right-of-way survey monuments on and along the KDOT right-of-way lines at these locations:

- All P.I. locations along normal/tangent sections.
- All P.C. and P.T. locations along curved sections.
- At an offset where a physical obstruction impedes the exact location.

Set all Reference Point monuments on and along KDOT right-of-way at these locations:

- At inter-visible points a maximum of 1320 feet apart where the right-of-way is straight, or on a continuous horizontal curve of constant radius.
- At the crest of a sharp hill or the shoulders of a large/rounded hill.
- At the treeline/brushline/cropline on both sides of a creek or river.
- As directed by the Engineer.

Set all right-of-way survey monuments according to the Contract Documents.

Fasten the R/W sign to the witness post in this sequence: bolt, flat washer, sign, post, flat washer, lock washer and nut.

When conditions warrant, the Engineer may adjust the specified depth. The depth shall be 15 inches in cultivated areas, 4 inches in pasture areas, drilled and grouted in rock, or a depth directed by the Engineer. When it is impossible to set a right-of-way survey monument at the exact point because of an obstruction, set the right-of-way survey monument along the right-of-way line, or the extended right-of-way line, on both sides of the obstruction. Use

1-foot increments for the offset distance from the exact point to the set monument. Field stamp the aluminum cap "O/S" either below or to the right of the "R/W" stamping.

e. Concrete Footings. When required, construct footings of commercial grade concrete according to the Contract Documents.

Extend the top of the footing slightly above the ground line and steel trowel to a smooth finish with a slope to drain away from the post.

f. Monument Box. When required, install the monument box and survey marker by a Professional Surveyor as shown in the Contract Documents.

If the monument box is installed in concrete pavement, use the same mix as used in the pavement.

g. As-Built Construction Plans and Survey Notebooks. Upon completion of the project, provide the Engineer with a set of electronic as-built construction plans in a pdf file format with the following information:

- As-built survey information shall be red in color on the plans;
- The monument descriptions and the 4 reference ties for all restored PLSS corners;
- The monument descriptions and the 4 reference ties for all field survey monuments on the project centerline or baseline;
- The monument descriptions and the 4 reference ties for all Offset Horizontal Control (HC) Points on the project; include the project coordinates and station/offset tied to project stationing.
- The project stationing and offset of the final position of every right-of-way survey monument and project alignment reference point that was set;
- The permanent replacement benchmarks and remaining construction benchmarks with benchmark number, project station/offset, elevation, and description;
- Stamped on the Signature and Seal sheet by a Professional Surveyor.

Deliver the original field survey notebooks and as-built construction plans to the Engineer upon completion of the project. See **TABLE 802-2**.

h. Sign (Environmental Mitigation). Install environmental mitigation area signs (including posts) as shown in the Contract Documents.

802.4 MEASUREMENT AND PAYMENT

The Engineer will measure each right-of-way survey monument, benchmark monument (concrete cylinder), monument box and environmental mitigation area signs (including posts) as a unit. Contractor construction staking will be measured by the lump sum.

The Engineer will make partial payments according to **TABLE 802-2**. The Engineer may adjust the **TABLE 802-2**, based on Contractor's progress and project complexity.

TABLE 802-2: CONSTRUCTION STAKING PAYMENT SCHEDULE*	
Percent of Original Contract Amount Completed	**Percent of Bid Item Paid**
Work Started	25%
5%	40%
25%	60%
50%	80%
70%	95%
All field books, As-Built construction plans (**subsection 802.3g.**) and records have been submitted to the Engineer.	100%

*Until all appropriate information is received, and the bid item is 100% paid, the work is considered incomplete and subject to **SECTION 108**.

The Percent of Original Contract Amount Completed = the amount earned by the Contractor divided by the total dollar value of the original contract (all bid items).

Payment for "Contractor Construction Staking", "Right-of-Way Survey Monument", "Benchmark Monument (Concrete Cylinder)", "Monument Box" and "Sign (Environmental Mitigation)" at the contract unit prices is full compensation for the specified work.

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KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2015 EDITION

SECTION 1116

AGGREGATES FOR ON GRADE CONCRETE

1116.1 DESCRIPTION

This specification is for coarse aggregates, intermediate aggregates, fine aggregates, mixed aggregates (coarse, intermediate and fine material) and miscellaneous aggregates for use in construction of concrete placed on grade.

For Intermediate Aggregates and Mixed Aggregates, consider any aggregate with 30% or more retained on the No. 8 sieve to be Coarse Aggregate.

1116.2 REQUIREMENTS

a. Quality of Individual Aggregates.

(1) Provide aggregate for concrete that complies with the following requirements. Crushed aggregates with less than 20% material retained on the 3/8" sieve must be produced from a source complying with these requirements prior to crushing. Fine Aggregates for Concrete have additional Quality Requirements stated in s**ubsection 1116.2e.(2).**

Soundness by Freeze/Thaw (min.) (KTMR-21)* 0.90
Wear Grading B (max.)(AASHTO T 96)** 50%
Additional Requirements:***
Modified Soundness by Freeze/Thaw (min.) (KTMR-21) 0.90
Relative Dynamic Modulus of Elasticity, minimum (KTMR-22 @ 660 F/T cycles) ... 95
Expansion, maximum (KTMR-22 @ 660 F/T cycles) 0.025%
* Soundness (KTMR-21) requirements do not apply to aggregates having less than 10% material retained on the No. 4 sieve.
** Wear (AASHTO T 96) requirements do not apply to aggregates having less than 10% retained on the No. 8 sieve.
***The additional requirements do not apply for uncrushed sand-gravel aggregates having less than 5% material retained on the ½" sieve.

(2) All predominately siliceous aggregate must comply with the Wetting & Drying Test requirements, or be used with a Coarse Aggregate Sweetener, or will require Supplemental Cementitious Materials (SCM) to prevent Alkali Silica Reactions (ASR). Refer to TABLE 401-4 to determine the need for ASTM C 1567 Testing. When required, provide the results of mortar expansion tests of ASTM C 1567 using the project's mix design concrete materials at their designated percentages. Provide a mix with a maximum expansion of 0.10% at 16 days after casting. Provide the results to the Engineer at least 15 days before placement of concrete on the project.

Wetting & Drying Test of Siliceous Aggregate for Concrete (KTMR-23)
Concrete Modulus of Rupture:
- At 60 days, minimum .... 550 psi
- At 365 days, minimum .... 550 psi

Expansion:
- At 180 days, maximum 0.050%
- At 365 days, maximum 0.070%

Aggregates produced from the following general areas are exempt from the Wetting and Drying Test:
- Blue River Drainage Area.
- The Arkansas River from Sterling, west to the Colorado state line.

- The Neosho River from Emporia to the Oklahoma state line.

(3) Coarse Aggregate Sweetener. Types and proportions of aggregate sweeteners to be used with Mixed Aggregates are listed in **TABLE 1116-1**.

TABLE 1116-1: COARSE AGGREGATE SWEETENER	
Type of Coarse Aggregate Sweetener	**Proportion Required by Percent Weight**
Crushed Sandstone*	40 (minimum)
Crushed Limestone or Dolomite*	40 (minimum)
Siliceous Aggregates meeting **subsection 1116.2a.(2)**	40 (minimum)
Siliceous Aggregates not meeting **subsection 1116.2a.(2)** **	30 (maximum)

*Waive the minimum portion of Coarse Aggregate Sweetener for all intermediate and fine aggregates that comply with the wetting and drying requirements for Siliceous Aggregates. In this case, combine the intermediate, fine and coarse aggregate sweetener in proportions required to comply with **subsection 1116.2a.(2)**

**To be used only with intermediate and fine aggregates that comply with the wetting and drying requirements of Siliceous Aggregates unless a Supplemental Cementitious Material is utilized.

(4) Deleterious Substances. Maximum allowed deleterious substances by weight are:

- Clay lumps and friable particles (KT-7) 1.0%
- Coal (AASHTO T 113)... 0.5%
- Shale or Shale-like material (KT-8)... 0.5%
- Sticks (wet) (KT-35) 0.1%
- Sum of all deleterious 1.5%

b. Mixed Aggregates

(1) Composition. Provide coarse, intermediate, and fine aggregates in a combination necessary to meet **subsection 1116.2b.(2).** Use a proven optimization method such as ACI 302.1 or other method approved by the Engineer. Aggregates may be from a single source or combination of sources.

(2) Product Control.

(a) Gradations such as those shown in **TABLE 1116-2** have proven satisfactory in reducing water demand while providing good workability. Adjust mixture proportions whenever individual aggregate grading varies during the course of the work. Use the gradations shown in **TABLE 1116-2**, or other gradation approved by the Engineer.

Optimization is not required for concrete for patching pavements more than 10 years old, or Commercial Grade Concrete. The Engineer may waive the optimization requirements if the concrete meets all the requirements of **DIVISION 400** and/or **DIVISION 500**.

Follow these guidelines:
1. Do not permit the percent retained on two adjacent sieve sizes to fall below 4%;
2. Do not allow the percent retained on three adjacent sieve sizes to fall below 8%; and
3. When the percent retained on each of two adjacent sieve sizes is less than 8%, the total percent retained on either of these sieves and the adjacent outside sieve should be at least 13%.
(for example, if both the No. 4 and No. 8 sieves have 6% retained on each, then:
1) the total retained on the 3/8 in. and No. 4 sieves should be at least 13%, and
2) the total retained on the No. 8 and No. 16 sieves should be at least 13%.)

TABLE 1116-2: ALLOWABLE GRADING FOR MIXED AGGREGATES FOR CONCRETE													
Type	**Usage**	**Percent Retained - Square Mesh Sieves**											
		1 ½"	**1"**	**¾"**	**½"**	**⅜"**	**No. 4**	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200**
MA-3	Optimized All Concrete		0	2-12	Note[1]	Note[1]	Note[1]	Note[1]	Note[2]	Note[2]	Note[2]	95-100[4]	98-100[5]
MA-4	Optimized All Concrete[3]	0	2-12	Note[1]	Note[1]	Note[1]	Note[1]	Note[1]	Note[2]	Note[2]	Note[2]	95-100[4]	98-100[5]
MA-5	Optimized All Concrete		0	2-12	8 min	22-34		55-65		75 min		95-100	98-100
MA-7	Contractor Design KDOT Approved	Proposed Grading that does not correspond to other limits in this table but meet the requirements for concrete in **DIVISION 400 and/or DIVISION 500**.											98-100

[1] Retain a maximum of 22% and a minimum of 6% of the material on each individual sieve.
[2] Retain a maximum of 15% and a minimum of 6% of the material on each individual sieve.
[3] Maximum top size of Limestone is ¾".
[4] Retain a maximum of 7% on the No. 100 sieve
[5] Retain a maximum of 2% on the No. 200 sieve

(b) Optimization Requirements for all Gradations, except MA-7.

- Actual Workability must be within ± 5 of Target Workability.

Where: W_A = Actual Workability
W_T = Target Workability
CF = Coarseness Factor

1. Determine the Grading according to KT-2
2. Calculate the Coarseness Factor (CF) to the nearest whole number.

$$CF = \frac{+3/8\text{” Material \% Retained}}{+\#8\text{ Material \% Retained}} \text{x}100$$

3. Calculate the Actual Workability (W_A) to the nearest whole number as the percent material passing the #8 sieve.

$$W_A = 100 - \%\text{ retained on \#8 sieve}$$

4. Calculate the Target Workability (W_T) to the nearest whole number where For 517 lbs cement per cubic yard of concrete

$$W_T = 46.14 - (CF/6)$$

For each additional 1 lb of cement per cubic yard, subtract 2.5/94 from the Target Workability.

Maintain an Actual Workability within ± 5 of the Target Workability for combined aggregates.

(c) Deleterious Substances. **Subsection 1116.2a.(4),** as applicable.
(d) Uniformity of Supply. Designate or determine the fineness modulus (grading factor) for each aggregate according to the procedure listed in Section 5.10.5-Fineness Modulus of Aggregates (Gradation Factor) of Part V before delivery, or from the first 10 samples tested and accepted. Provide aggregate that is within ±0.20 of the average fineness modulus.

Provide a single point grading for the combined aggregates along with a plus/minus tolerance for each sieve. Use plus/minus tolerances to perform quality control checks and by the Engineer to perform aggregate grading verification testing. The tests may be performed on the combined materials or on individual aggregates, and then theoretically combined to determine compliance.

(3) Handling of All Aggregates.

(a) Segregation. Before acceptance testing, remix all aggregate segregated by transit or stockpiling.

(b) Stockpiling.

- Maintain separation between aggregates from different sources, with different gradings or with a significantly different specific gravity.
- Transport aggregate in a manner that promotes uniform grading.
- Do not use aggregates that have become mixed with earth or foreign material.
- Stockpile or bin all washed aggregate produced or handled by hydraulic methods for 12 hours (minimum) before batching. Rail shipment exceeding 12 hours is acceptable for binning provided the car bodies permit free drainage.
- Provide additional stockpiling or binning in cases of high or non-uniform moisture.
- Stockpile accepted aggregates in layers 3 to 5 feet thick. Berm each layer so that aggregate do not "cone" down into lower layers.

c. Coarse Aggregates for Concrete.

(1) Composition. Provide coarse aggregate that is crushed gravel or crushed stone meeting the quality requirements of **subsection 1116.2a**. Consider limestone, calcite cemented sandstone, rhyolite, quartzite, basalt and granite as crushed stone.

Mixtures utilizing siliceous aggregate not meeting **subsection 1116.2a.(2)** may require supplemental cementitious materials to prevent Alkali Silica Reactions. Provide the results of mortar expansion tests of ASTM C 1567 using the project's mix design concrete materials at their designated percentages. Provide a mix with a maximum expansion of 0.10% at 16 days after casting. Provide the results to the Engineer at least 15 days before placement of concrete on the project.

(2) Product Control. Use gradations such as those in **TABLE 1116-3** which have been shown to work in Optimized Mixed Aggregates, or some other gradation approved by the Engineer that will provide a combined aggregate gradation meeting **subsection 1116.2b.**

(3) Deleterious Substances. **Subsection 1116.2a.(4),** as applicable.

TABLE 1116-3: GRADING REQUIREMENTS FOR COARSE AGGREGATES									
Type	**Composition**	**Percent Retained - Square Mesh Sieves**							
		1 ½″	**1″**	**¾″**	**½″**	**3/8″**	**No. 4**	**No. 8**	**No. 30**
CPA-1	Crushed Gravel or Crushed Stone	0	0-10	14-35	-	50-75	-	95-100	-
CPA-3	Crushed Gravel or Crushed Stone	-	-	0	0-35	30-70	75-100	95-100	-
CPA-4	Crushed Gravel or Crushed Stone	-	0	0-20	-	-	-	95-100	-

d. Intermediate Aggregate for Concrete.

(1) Composition. Provide intermediate aggregate for mixed aggregates (IMA) that is crushed stone, natural occurring sand, or manufactured sand meeting the quality requirements of **subsection 1116.2a.**

(2) Product Control. Provide IMA grading when necessary to provide a combined aggregate gradation meeting **subsection 1116.2b.**

(3) Deleterious Substances. **Subsection 1116.2a.(4),** as applicable.

(4) Organic Impurities (AASHTO T21). The color of the supernatant liquid is equal to or lighter than the referenced standard solution.

e. Fine Aggregates for Concrete.

(1) Composition.

(a) Type FA-A. Provide either singly or in combination natural occurring sand resulting from the disintegration of siliceous or calcareous rock, or manufactured sand produced by crushing predominately siliceous materials meeting the quality requirements of **subsection 1116.2a.** and **subsection 1116.2e.(2)**.

(2) Additional Quality Requirements.

(a) Mortar strength and Organic Impurities. If the DME determines it is necessary, because of unknown characteristics of new sources or changes in existing sources, provide fine aggregates that comply with the following:

- Mortar Strength (KTMR-26). Compressive strength when combined with Type III (high early strength) cement:
  - At age 24 hours, minimum 100%*
  - At age 72 hours, minimum 100%*

  *Compared to strengths of specimens of the same proportions, consistency, cement and standard 20-30 Ottawa sand.
- Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.

(3) Product Control.

(a) Size Requirements. Provide FA-A that comply with **TABLE 1116-4** or some other gradation approved by the Engineer that will provide a combined aggregate gradation meeting **subsection 1116.2b**.

TABLE 1116-4: GRADING REQUIREMENTS FOR FINE AGGREGATES FOR CONCRETE								
Type	**Percent Retained-Square Mesh Sieves**							
	⅜"	**No. 4**	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200**
FA-A	0	0-10	0-27	15-55	40-77	70-93	90-100	98-100

(b) Deleterious Substances.

- Type FA-A: Maximum allowed deleterious substances by weight are:
  - Coal (AASHTO T113)...0.5%
  - Sticks (wet) (KT-35)..0.1%
  - Sum of all deleterious 0.5%

f. Miscellaneous Aggregates for Concrete.

(1) Aggregates for Mortar Sand, Type FA-M.

(a) Composition. Provide aggregates for mortar sand, Type FA-M that is natural occurring sand.

(b) Quality.

- Mortar strength and Organic Impurities. If the DME determines it is necessary, because of unknown characteristics of new sources or changes in existing sources, provide aggregates for mortar sand, Type FA-M that comply with the following:
  - Mortar Strength (KTMR-26). Compressive strength when combined with Type III (high early strength) cement:
    - At age 24 hours, minimum 100%*
    - At age 72 hours, minimum 100%*

    * Compared to strengths of specimens of the same proportions, consistency, cement and standard 20-30 Ottawa sand.
  - Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.

(c) Product Control.

- Size Requirements. Provide aggregates for mortar sand, Type FA-M that comply with **TABLE 1116-5**.

TABLE 1116-5: GRADING REQUIREMENTS FOR MORTAR SAND								
Type	**Percent Retained - Square Mesh Sieves**							
	No. 4	**No. 8**	**No. 16**	**No. 30**	**No. 50**	**No. 100**	**No. 200**	**Gradation Factor**
FA-M	0	0-2	0-30	20-50	50-75	90-100	98-100	1.70-2.50

- Deleterious Substances. **Subsection 1116.2a.(4),** as applicable.

(2) Lightweight Aggregates.

(a) Composition. Provide a lightweight aggregate consisting of expanded shale, clay or slate produced from a uniform deposit of raw material.

(b) Quality.

- Soundness, minimum (KTMR-21) 0.90
- Loss on Ignition 5%

(c) Product Control.

- Size Requirements. Use gradations such as those in **TABLES 1116-3** and **1116-4** which have been shown to work in Optimized Mixed Aggregates, or some other gradation approved by the Engineer that will provide a combined aggregate gradation meeting **subsection 1116.2b**.
- Deleterious Substances. **Subsection 1116.2b.(2)(c)** as applicable.
- Organic Impurities (AASHTO T 21). The color of the supernatant liquid is equal to or lighter than the reference standard solution.
- Unit Weight (dry, loose weight) (max.) 1890 lbs/cu yd

(d) Concrete Making Properties. Drying shrinkage of concrete specimens prepared with lightweight aggregate proportioned as shown in the Contract Documents cannot exceed 0.07%.

(e) Uniformity of Supply. Designate or determine the fineness modulus (grading factor) according to procedure listed in Part V, Section 5.10.5-Fineness Modulus of Aggregates (Gradation Factor) before delivery, or from the first 10 samples tested and accepted. Provide aggregate that is within ±0.20 of the average fineness modulus.

(f) Proportioning Materials. Submit mix designs for concrete using modified lightweight aggregate to Construction and Materials for approval prior to use.

(g) Stockpiling. Stockpile accepted aggregates in layers 3 to 5 feet thick. Berm each layer so that aggregate do not "cone" down into lower layer.

1116.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

1116.4 PREQUALIFICATION

Aggregates for concrete must be prequalified according to **subsection 1101.4**.

1116.5 BASIS OF ACCEPTANCE

The Engineer will accept aggregates for concrete based on the prequalification required by this specification and **subsection 1101.5**.

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