Kansas State University | Salina

Aggregate Field Testing Technician Workbook

Certified Inspector Training Program

Kansas Department of Transportation

Aggregate Field Tester Certification Workbook

Table of Contents

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AGGREGATE FIELD TESTER
CIT PROGRAM

Written Test: Open book – 60 multiple choice questions

Grading: Must score at least 60% on each section of the written exam with an overall score of 70% or better to pass. <u>Failure on any part of the written exam requires retaking the entire exam.</u>

Must pass all performance exam sections. Failure of three or less performance subtest requires retest on only the subtest(s) failed. Failure of four or more subtests of the performance exam requires retest on the entire performance exam.

Exam Results: Exams will be graded in two to three weeks. Exam results are emailed to the student. Exam results are not given over the phone.

Exam Re-takes: Students who need to re-take either the written and/or performance exam need to register to do so. The re-take registration form can be found on the CIT website at www.citksu.com.

To be certified: Students must successfully pass the written exam and the performance exam. The student will be mailed a certification card and letter.

Reasons for Certified Inspector Training (CIT) Training Program

Overview

The Kansas Department of Transportation (KDOT) has established this training program to educate, test and certify those individuals responsible for performing inspection and testing functions on KDOT construction projects. KDOT's Bureau of Construction and Materials has responsibility for the establishment and administration of the materials portion of the KDOT's Quality Control/Quality Assurance (QC/QA) Program. The Bureau develops standards and specifications for materials, establishes sampling procedures and frequencies, and test procedures used in the laboratory and the field in order to assure compliance with specifications. It performs materials testing to assist each of the six KDOT districts in administering quality assurance functions of the QC/QA Program. Such testing includes tests on materials purchased by contractors or the State for use in maintenance or construction activities. The Bureau also conducts tests on soils, concrete, bituminous mixtures and numerous other specialized materials, the results of which are used by others for a variety of reasons.

Quality control and quality assurance activities involve the routine sampling, testing and analysis of various materials to determine the quality of a given product and to attain a quality product. The goal of the Certified Inspection and Testing Training Program (CIT^2) is to provide persons engaged in the inspection and/or testing of KDOT construction projects specific training in, but not limited to, soils, aggregates, and concrete and/or asphalt disciplines.

Each student is required to demonstrate specific abilities as defined by the training modules described in the CIT^2 manual. The manual can be found online at: https://www.ksdot.org/Assets/wwwksdotorg/bureaus/burMatrRes/Documents/CIT_Manual_2019.pdf

Federal Funding

On projects involving federal funds, KDOT must certify to the Federal Highway Administration as to the quality of each type of material used on each project before the State is completely reimbursed by the federal government.

The certification and training requirements contained in this manual are intended to comply with the requirements of 23 CFR Part 637 which states, "After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the IA (Independent Assurance) program shall be executed by qualified sampling and testing personnel."

Reasons for Quality Control/Quality Assurance

Inspectors fulfill a very important job on any project—they safeguard the public interest in a number of ways.

The primary reason for materials inspection, sampling and testing requirements is to verify that all materials incorporated into the work will meet the requirements of the contract documents, including the plans, specifications, and special provisions.

Plans and specifications are prepared to require the use of certain specific materials known or expected to perform satisfactorily with minimum maintenance throughout the life of the facility or infrastructure project. Any material that deviates appreciably from the specifications requirements will not perform as expected and, in all probability, will shorten the useful life of the facility or add unexpected costs in maintenance. Because there are limited dollars available for transportation infrastructure, the useful life and long-term maintenance costs of every project are critical considerations.

Secondly, all contractors bidding or furnishing materials to a project should be treated equally. That is, the contract documents provide a fair and uniform basis for bidding because they define the requirements to be met--ideally with the least possible difference of interpretation. The contractor commits to furnish materials and complete work that will equal or exceed such requirements. For this reason it is essential that quality assurance be correctly understood and applied uniformly by engineers and inspectors from project-to-project so that all contractors and suppliers are treated alike.

Thirdly, the expenditure of public funds must be documented to substantiate whether taxpayers actually received the quantity and quality of materials specified in exchange for tax dollars spent. Whether or not to pay the costs invoiced by contractors is a decision which relies heavily upon inspection reports and test results. In a fundamental way, inspectors play a key role in serving the public--to justify the expenditure of public monies and the acceptance of any contractor's work. Through the work of knowledgeable, competent and skilled inspectors, KDOT can verify and confirm whether or not the contractor has fulfilled its obligations to build the project as intended.

Finally, the specification requirements for materials are constantly evolving, based on new developments, past performance of material in the field, research and technological innovations. Accurate recordkeeping of materials and test results using consistent inspection practices provides a basis to compare results over time—an indispensable advantage for meaningful research. Data properly collected and recorded by inspectors can confirm whether or not changes in material specifications and testing requirements have, in fact, resulted in a better product, state-wide or in a particular location or application.

All inspectors should review the applicable clauses of the Standard Specifications at regular intervals to refresh their understanding of material and testing requirements.

Aggregate Field

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Course is Designed to

- Teach you to properly and consistently sample and test aggregates
- Teach you to perform the calculations associated with these tests
- Prepare you to pass the test

Workbook Introduction
5.2.2.1 – Rounding Off Numbers

1) 5.2.2.2 – Random Sampling &
   5.2.2.1 – Rounding Off Numbers

Workbook Introduction
Excerpts from Part V of the Construction Manual

3.1.1. When the digit next beyond the last place to be retained is less than 5, retain unchanged the digit in the last place retained.

Round to the Nearest 0.1:

73.2 ÷ 10 = 7.32 → 7.3

Round to the Nearest 0.01:

148.656 ÷ 16 = 9.291 → 9.29

Round to the Nearest Whole Number:

84.8 ÷ 2 = 42.4 → 42

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Workbook Introduction
Excerpts from Part V of the Construction Manual

3.1.2. When the digit next beyond the last place to be retained is greater than 5, increase by 1 the digit in the last place retained.

Round to the Nearest 0.1:

73.7 ÷ 10 = 7.37 → 7.4

Round to the Nearest 0.01:

148.736 ÷ 16 = 9.296 → 9.30

Round to the Nearest Whole Number:

85.8 ÷ 2 = 42.9 → 43

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Workbook Introduction
Excerpts from Part V of the Construction Manual

3.1.3. When the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, increase by 1 the digit in the last place retained if it is odd, leave the digit unchanged if it is even. Increase by 1 the digit in the last place retained, if there are digits beyond this 5.

Round to the Nearest 0.1:

73.5 ÷ 10 = 7.35 → 7.4

Round to the Nearest 0.01:

148.720 ÷ 16 = 9.295 → 9.30

Round to the Nearest Whole Number:

85.0 ÷ 2 = 42.5 → 42

Workbook Introduction
Excerpts from Part V of the Construction Manual

3.1.3. When the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, increase by 1 the digit in the last place retained if it is odd, leave the digit unchanged if it is even. Increase by 1 the digit in the last place retained, if there are digits beyond this 5.

Round to the Nearest 0.1:

82.513 ÷ 10 = 8.2513 → 8.3

Round to the Nearest 0.01:

16.8898 ÷ 16 = 1.05561 → 1.06

Round to the Nearest Whole Number:

91.12 ÷ 2 = 45.56 → 46

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Workbook Introduction
Excerpts from Part V of the Construction Manual

1) 5.2.2.2 – Random Sampling &
   5.2.2.1 – Rounding Off Numbers
2) KT-01 – Sampling and Splitting of Aggregates
3) KT-02 – Sieve Analysis of Aggregates
4) KT-03 – Material Passing #200 Sieve by the Wash Method
5) KT-11 – Moisture Tests
6) KT-50 – Uncompacted Void Content of Fine Aggregate
7) KT-80 – Uncompacted Void Content of Coarse Aggregate
8) 5.9 – Sampling and Test Methods Foreword

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Workbook Introduction
5.9 – Sampling and Test Methods Foreword

1. Safety
2. Scope

   Hierarchy for Test Methods

   1st - KDOT Construction Manual, Part V (KT Methods)
   2nd - AASHTO Standards
   3rd - ASTM Standards

   Information about Footnotes in the KT Methods

   Unless otherwise noted, the use of potable water is required.

   Constant Mass is Defined
3. Accuracy
4. SI Units

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Workbook Introduction
Excerpts from 2015 Specifications Book
And Part V of the Construction Manual

9) Section 1103 (15-11002-R01) – Aggregates for HMA
   Section 1104 – Aggregates for Aggregate Base Construction
   Section 1113 – Aggregates for Shoulder Construction
   Appendix A - Sampling and Testing Frequency Chart
   Appendix B – Sampling and Testing Frequency Chart (QC)
10) Performance Checklists
11) Agg Field Worksheets

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Workbook Introduction

That concludes the Workbook Introduction

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5.2.2.2 Random Sampling

1. **OBJECTIVE**

   Determine where or when a random sample should be taken using random numbers obtained from a random number table.

5.2.2.2 Random Sampling

1. **SCOPE**

- Secure random samples from a lot using random numbers
  - Obtained from Tables
  - Obtained by other Methods
- Additional Testing is Permitted and Expected
  - Failing or Suspect Materials or Construction is encountered
  - Additional testing should occur immediately if
    - Failing test results occur
    - Materials or Work appear to be substandard

5.2.2.2 Random Sampling

2. DEFINITIONS

2.1. Lot

2.1.1. Sublot

2.1.2. Random

2.1.3. Sample

2.1.4. Random Number

2.1.5. Seed Number

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5.2.2.2 Random Sampling

2. DEFINITIONS

2.1. Lot

- Isolated or Defined Quantity
- Material from Single Source
  - Isolated or Defined Quantity
  - Specified Amounts of HMA
  - Stockpile of Aggregates
- Construction from Same Process
  - Measured Amount
  - LF of Roadway Constructed in Day

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5.2.2.2 Random Sampling

2.1. Lot Examples

- CTB (Compressive Strength)
  - Normal Day's Placement
  - 4 Sublots (Typical)
- PCCP (Thickness and Compressive Strength)
  - Single Day's Placement
  - 5 Sublots (Typical)
- HMA (Density)
  - Single Day's Placement
  - 5 Sublots (Typical)
- HMA (Air Voids)
  - 3000 to 4000 tons (Typical)
  - 4 Sublots (Typical)

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5.2.2.2 Random Sampling

2. DEFINITIONS (cont)

2.1.1. Sublot

- Used to Sample when sampling the entire Lot is not convenient
- Equal Portions of a Lot
- Sum of Sublots constitute the entire Lot

2.1.2. Random

- Without aim or pattern
- Depends on chance alone
- Not haphazard

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5.2.2.2 Random Sampling

2. DEFINITIONS (cont)

2.1.3. Sample

- Small part of Lot or Sublot
- Represents the whole
- May be made up of one or more increments or test portions

2.1.4. Random number

- Selected by chance
- Generated
  - Electronically from calculator or spreadsheet
  - Selected from a random number table (Table 1)

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5.2.2.2 Random Sampling

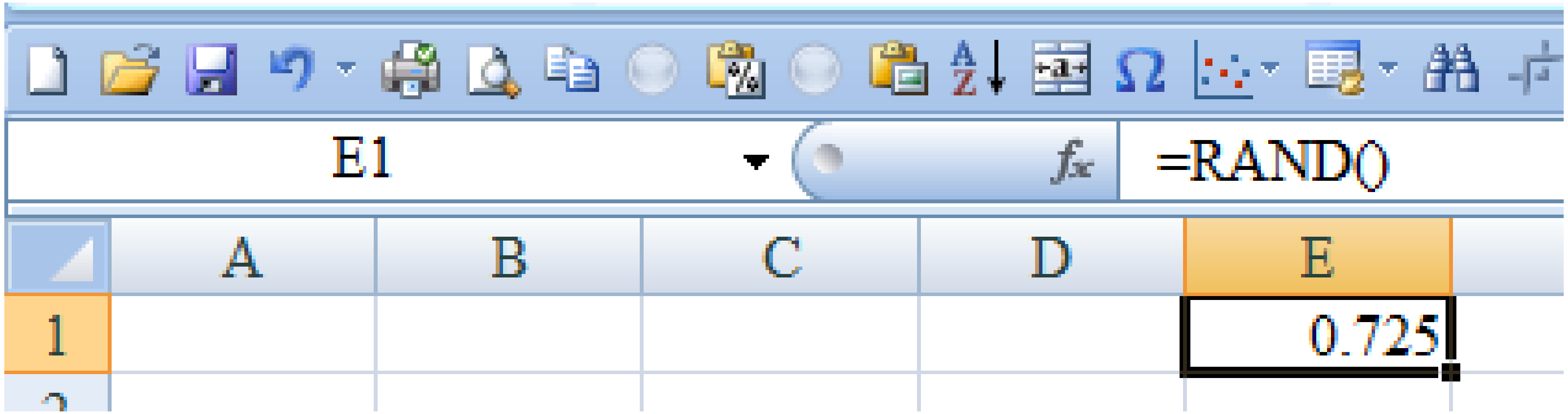
2. DEFINITIONS (cont)

2.1.5. Seed Number

- Starting point to select random number
- Generated from
  - Odometer
  - Calculator
  - Spreadsheet
  - Pointing at random number table

5.2.2.2 Random Sampling

4.2.1.2



If my seed number is 0.725, what is my column and row for my random number?

Column = 7 Row = 25

What's my random number?

5.2.2.2 Random Sampling

Column = 7
Row = 25

Random No.
0.097

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948

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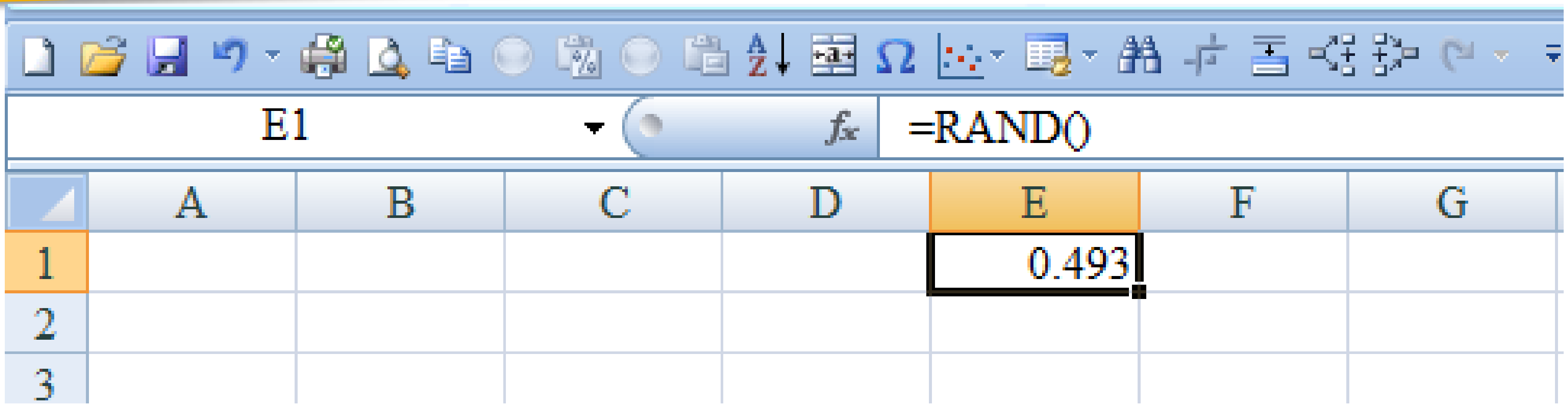
5.2.2.2 Random Sampling

4.2.1.2



Seed Number 0.493 gives what random number?

What’s the next random number?

5.2.2.2 Random Sampling

Column = 4
Row = 93

Random No.
0.410

Next Random No.
0.078

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
. . .										
87	0.681	0.678	0.563	0.851	0.726	0.801	0.573	0.056	0.140	0.641
88	0.404	0.842	0.412	0.893	0.935	0.744	0.386	0.299	0.178	0.881
89	0.033	0.042	0.753	0.660	0.685	0.171	0.408	0.060	0.550	0.302
90	0.128	0.658	0.667	0.926	0.239	0.127	0.903	0.483	0.300	0.597
91	0.973	0.933	0.361	0.595	0.186	0.901	0.914	0.190	0.303	0.098
92	0.672	0.729	0.163	0.310	0.196	0.964	0.486	0.308	0.735	0.474
93	0.524	0.402	0.628	0.410	0.846	0.206	0.585	0.566	0.044	0.627
94	0.720	0.157	0.238	0.078	0.233	0.771	0.533	0.986	0.077	0.101
95	0.983	0.669	0.927	0.066	0.080	0.740	0.969	0.630	0.619	0.200
96	0.294	0.387	0.988	0.961	0.913	0.679	0.284	0.949	0.380	0.785
97	0.668	0.149	0.972	0.187	0.151	0.502	0.718	0.453	0.953	0.491
98	0.130	0.708	0.417	0.594	0.209	0.663	0.908	0.271	0.532	0.741
99	0.883	0.677	0.615	0.469	0.363	0.142	0.952	0.325	0.194	0.847
100	0.889	0.772	0.390	0.571	0.873	0.806	0.448	0.955	0.240	0.074

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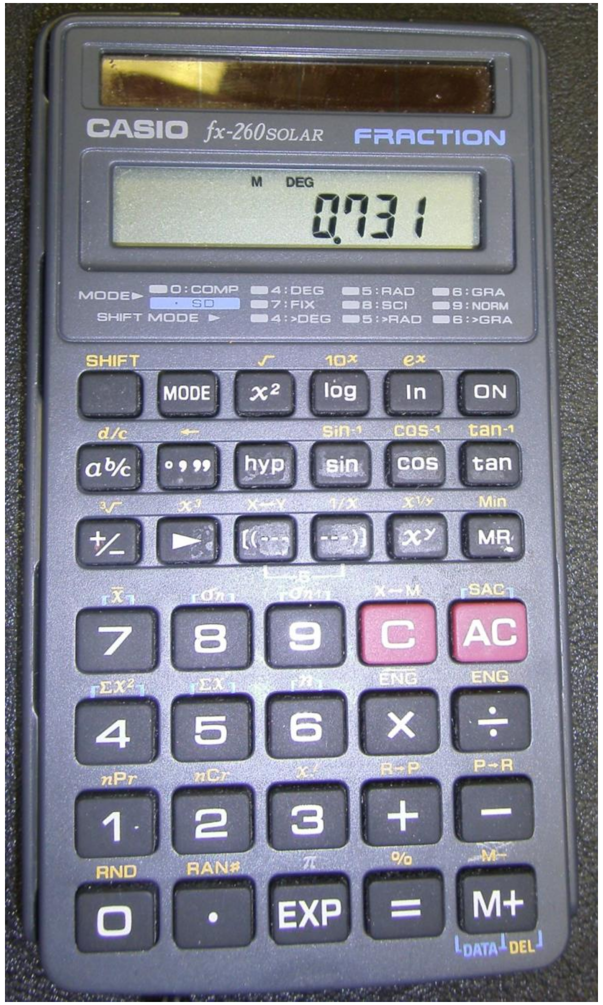
5.2.2.2 Random Sampling

4.2.1.2

Column = 7
Row = 31

What's the random number?

0.545



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5.2.2.2 Random Sampling

4.2.1.1

What's the X random number?

Seed Number: Column = 3 Row = 48

Odometer to get a seed number

5.2.2.2 Random Sampling

Column = 3
Row = 48

<u>Random No.</u>
0.318

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
. . .										
33	0.314	0.032	0.468	0.493	0.252	0.833	0.812	0.445	0.904	0.324
34	0.400	0.422	0.592	0.854	0.832	0.527	0.605	0.797	0.089	0.455
35	0.807	0.593	0.989	0.997	0.910	0.722	0.645	0.534	0.021	0.327
36	0.118	0.377	0.711	0.871	0.024	0.251	0.433	0.814	0.577	0.216
37	0.007	0.288	0.372	0.727	0.014	0.259	0.037	0.922	0.460	0.230
38	0.476	0.011	0.265	0.188	0.317	0.603	0.981	0.198	0.853	0.977
39	0.275	0.700	0.745	0.535	0.179	0.902	0.706	0.737	0.133	0.748
40	0.721	0.237	0.283	0.070	0.644	0.614	0.942	0.747	0.123	0.880
41	0.980	0.716	0.819	0.079	0.526	0.071	0.828	0.536	0.463	0.909
42	0.359	0.789	0.135	0.555	0.394	0.444	0.775	0.269	0.510	0.845
43	0.733	0.598	0.059	0.921	0.816	0.381	0.454	0.477	0.596	0.250
44	0.192	0.968	0.430	0.699	0.295	0.383	0.266	0.401	0.542	0.286
45	0.354	0.799	0.004	0.232	0.633	0.682	0.638	0.897	0.485	0.695
46	0.496	0.012	0.243	0.985	0.355	0.612	0.315	0.760	0.392	0.541
47	0.494	0.113	0.773	0.867	0.824	0.976	0.323	0.134	0.761	0.911
48	0.780	0.687	0.318	0.202	0.331	0.264	0.670	0.848	0.114	0.495
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948

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5.2.2.2 Random Sampling

4.2.1.1

What's the X random number?

Seed Number: Column = 3 Row = 48

0.318

What's the Y random number?

Seed Number: Column = 9 Row = 09

Odometer to get a seed number

5.2.2.2 Random Sampling

Column = 9
Row = 09

Random No.
0.150

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231

Kansas Department of Transportation

5.2.2.2 Random Sampling

4.2.1.1

What's the X random number?

Seed Number: Column = 3 Row = 48

0.318

What's the Y random number?

Seed Number: Column = 9 Row = 09

0.150

Odometer to get a seed number

Kansas Department of Transportation

5.2.2.2 Random Sampling

Which of the following can be used to generate a seed number?

A. Calculator
B. Odometer
C. Spreadsheet
D. All of the above

5.2.2.2 Random Sampling

Which of the following can only be used to generate a seed number, and not a random number?

A. Calculator
B. Odometer
C. Spreadsheet
D. All of the above

Kansas Department of Transportation

5.2.2.2 Random Sampling

Seed Number is 0.097. I need 5 random numbers. What are they?

4.2.1.1. Using an odometer reading such as 78642 as a seed number, use the digit farthest to the right (2) to select the column in the table. Use the next two digits to the left (64) to select the row.

If the seed number for the column is 0, use column 10 and if the seed for the row is 00, use row 100. In this case finding the intersection of the row and the column yields the number 0.338. Use this as a starting position and count down the column for the required number of samples. Selecting numbers for an X coordinate for three samples yields 0.338, 0.763 and 0.043.

If a Y coordinate is also required use the fourth digit from the right for the column and the next two digits to the left, for the row. In this example that would yield column 8 and row 07 producing a starting point at number 0.521. If a total of three samples are required, counting down two more places yields numbers 0.937 and 0.912.

Using this example, pairs of numbers for determining three X and Y coordinates are obtained, (0.338, 0.521), (0.763, 0.937) and (0.043, 0.912). Any amount of numbers required may be selected this way. If ten samples are required count down the column until ten numbers are selected.

Once the bottom of a column has been reached go to the top of the next column to the right and countdown to obtain more numbers, if the bottom of column 10 is reached go to the top of column 1.

5.2.2.2 Random Sampling

Seed Number is 0.097. I need 5 random numbers. What are they?

4.2.1.1. Using an odometer reading such as 78642 as a seed number, use the digit farthest to the right (2) to select the column in the table. Use the next two digits to the left (64) to select the row.

If the seed number for the column is 0, use column 10 and if the seed for the row is 00, use row 100. In this case finding the intersection of the row and the column yields the number 0.338. Use this as a starting position and count down the column for the required number of samples. Selecting numbers for an X coordinate for three samples yields 0.338, 0.763 and 0.043.

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5.2.2.2 Random Sampling

Seed Number is 0.097. I need 5 random numbers. What are they?

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If a Y coordinate is also required use the fourth digit from the right for the column and the next two digits to the left, for the row. In this example that would yield column 8 and row 07 producing a starting point at number 0.521. If a total of three samples are required, counting down two more places yields numbers 0.937 and 0.912.

Using this example, pairs of numbers for determining three X and Y coordinates are obtained, (0.338, 0.521), (0.763, 0.937) and (0.043, 0.912). Any amount of numbers required may be selected this way. If ten samples are required count down the column until ten numbers are selected.

Once the bottom of a column has been reached go to the top of the next column to the right and countdown to obtain more numbers, if the bottom of column 10 is reached go to the top of column 1.

5.2.2.2 Random Sampling

Seed Number is 0.097. I need 5 random numbers. What are they?

0.491
0.741
0.847
0.074
0.293

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
. . .										
91	0.973	0.933	0.361	0.595	0.186	0.901	0.914	0.190	0.303	0.098
92	0.672	0.729	0.163	0.310	0.196	0.964	0.486	0.308	0.735	0.474
93	0.524	0.402	0.628	0.410	0.846	0.206	0.585	0.566	0.044	0.627
94	0.720	0.157	0.238	0.078	0.233	0.771	0.533	0.986	0.077	0.101
95	0.983	0.669	0.927	0.066	0.080	0.740	0.969	0.630	0.619	0.200
96	0.294	0.387	0.988	0.961	0.913	0.679	0.284	0.949	0.380	0.785
97	0.668	0.149	0.972	0.187	0.151	0.502	0.718	0.453	0.953	0.491
98	0.130	0.708	0.417	0.594	0.209	0.663	0.908	0.271	0.532	0.741
99	0.883	0.677	0.615	0.469	0.363	0.142	0.952	0.325	0.194	0.847
100	0.889	0.772	0.390	0.571	0.873	0.806	0.448	0.955	0.240	0.074

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Department of Transportation

5.2.2.2 Random Sampling

Table 1 Random Numbers

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231
28	0.498	0.414	0.576	0.427	0.662	0.345	0.877	0.385	0.122	0.051
29	0.104	0.301	0.346	0.905	0.918	0.572	0.838	0.092	0.282	0.260
30	0.035	0.075	0.518	0.280	0.115	0.611	0.362	0.062	0.578	0.567
31	0.503	0.421	0.697	0.610	0.147	0.049	0.545	0.452	0.852	0.497
32	0.274	0.205	0.778	0.472	0.245	0.951	0.671	0.932	0.713	0.731
33	0.314	0.032	0.468	0.493	0.252	0.833	0.812	0.445	0.904	0.324
34	0.400	0.422	0.592	0.854	0.832	0.527	0.605	0.797	0.089	0.455
35	0.807	0.593	0.989	0.997	0.910	0.722	0.645	0.534	0.021	0.327
36	0.118	0.377	0.711	0.871	0.024	0.251	0.433	0.814	0.577	0.216
37	0.007	0.288	0.372	0.727	0.014	0.259	0.037	0.922	0.460	0.230
38	0.476	0.011	0.265	0.188	0.317	0.603	0.981	0.198	0.853	0.977
39	0.275	0.700	0.745	0.535	0.179	0.902	0.706	0.737	0.133	0.748
40	0.721	0.237	0.283	0.070	0.644	0.614	0.942	0.747	0.123	0.880
41	0.980	0.716	0.819	0.079	0.526	0.071	0.828	0.536	0.463	0.909
42	0.359	0.789	0.135	0.555	0.394	0.444	0.775	0.269	0.510	0.845
43	0.733	0.598	0.059	0.921	0.816	0.381	0.454	0.477	0.596	0.250
44	0.192	0.968	0.430	0.699	0.295	0.383	0.266	0.401	0.542	0.286
45	0.354	0.799	0.004	0.232	0.633	0.682	0.638	0.897	0.485	0.695
46	0.496	0.012	0.243	0.985	0.355	0.612	0.315	0.760	0.392	0.541
47	0.494	0.113	0.773	0.867	0.824	0.976	0.323	0.134	0.761	0.911
48	0.780	0.687	0.318	0.202	0.331	0.264	0.670	0.848	0.114	0.495
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948

Table 1 (Cont)

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
61	0.030	0.167	0.509	0.419	0.508	0.181	0.490	0.875	0.830	0.482
62	0.136	0.065	0.416	0.116	0.907	0.556	0.095	0.110	0.395	0.736
63	0.591	0.600	0.405	0.657	0.013	0.651	0.225	0.340	0.146	0.155
64	0.487	0.338	0.170	0.006	0.263	0.173	0.228	0.008	0.010	0.313
65	0.364	0.763	0.391	0.790	0.589	0.003	0.998	0.257	0.984	0.437
66	0.996	0.043	0.793	0.522	0.705	0.248	0.924	0.609	0.639	0.423
67	0.063	0.810	0.189	0.769	0.488	0.152	0.221	0.978	0.329	0.229
68	0.513	0.333	0.540	0.160	0.461	0.683	0.285	0.750	0.557	0.311
69	0.176	0.054	0.341	0.484	0.860	0.046	0.278	0.244	0.222	0.864
70	0.549	0.835	0.398	0.829	0.459	0.153	0.728	0.822	0.106	0.756
71	0.298	0.514	0.945	0.648	0.784	0.154	0.499	0.415	0.397	0.255
72	0.888	0.764	0.602	0.220	0.684	0.081	0.868	0.272	0.987	0.802
73	0.654	0.995	0.073	0.655	0.041	0.811	0.367	0.226	0.438	0.107
74	0.650	0.467	0.210	0.204	0.762	0.420	0.680	0.334	0.723	0.446
75	0.039	0.022	0.823	0.087	0.076	0.568	0.515	0.223	0.561	0.316
76	0.291	0.791	0.788	0.396	0.212	0.138	0.357	0.304	0.575	0.342
77	0.834	0.373	0.584	0.694	0.613	0.817	0.129	0.546	0.425	0.290
78	0.511	0.375	0.048	0.923	0.001	0.088	0.258	0.166	0.787	0.837
79	0.538	0.174	0.068	0.052	0.640	0.148	0.093	0.553	0.565	0.862
80	0.560	0.724	0.975	0.818	0.796	0.379	0.069	0.034	0.792	0.757
81	0.492	0.820	0.489	0.872	0.770	0.991	0.704	0.050	0.874	0.621
82	0.890	0.356	0.451	0.554	0.649	0.507	0.061	0.479	0.211	0.273
83	0.966	0.798	0.917	0.141	0.368	0.193	0.443	0.751	0.458	0.746
84	0.517	0.715	0.777	0.742	0.839	0.307	0.246	0.956	0.665	0.111
85	0.786	0.328	0.015	0.643	0.882	0.815	0.963	0.590	0.855	0.891
86	0.047	0.702	0.287	0.177	0.164	0.552	0.296	0.413	0.941	0.849
87	0.681	0.678	0.563	0.851	0.726	0.801	0.573	0.056	0.140	0.641
88	0.404	0.842	0.412	0.893	0.935	0.744	0.386	0.299	0.178	0.881
89	0.033	0.042	0.753	0.660	0.685	0.171	0.408	0.060	0.550	0.302
90	0.128	0.658	0.667	0.926	0.239	0.127	0.903	0.483	0.300	0.597
91	0.973	0.933	0.361	0.595	0.186	0.901	0.914	0.190	0.303	0.098
92	0.672	0.729	0.163	0.310	0.196	0.964	0.486	0.308	0.735	0.474
93	0.524	0.402	0.628	0.410	0.846	0.206	0.585	0.566	0.044	0.627
94	0.720	0.157	0.238	0.078	0.233	0.771	0.533	0.986	0.077	0.101
95	0.983	0.669	0.927	0.066	0.080	0.740	0.969	0.630	0.619	0.200
96	0.294	0.387	0.988	0.961	0.913	0.679	0.284	0.949	0.380	0.785
97	0.668	0.149	0.972	0.187	0.151	0.502	0.718	0.453	0.953	0.491
98	0.130	0.708	0.417	0.594	0.209	0.663	0.908	0.271	0.532	0.741
99	0.883	0.677	0.615	0.469	0.363	0.142	0.952	0.325	0.194	0.847
100	0.889	0.772	0.390	0.571	0.873	0.806	0.448	0.955	0.240	0.074

Point Blindly at Random Number Table

Seed Number
0.614

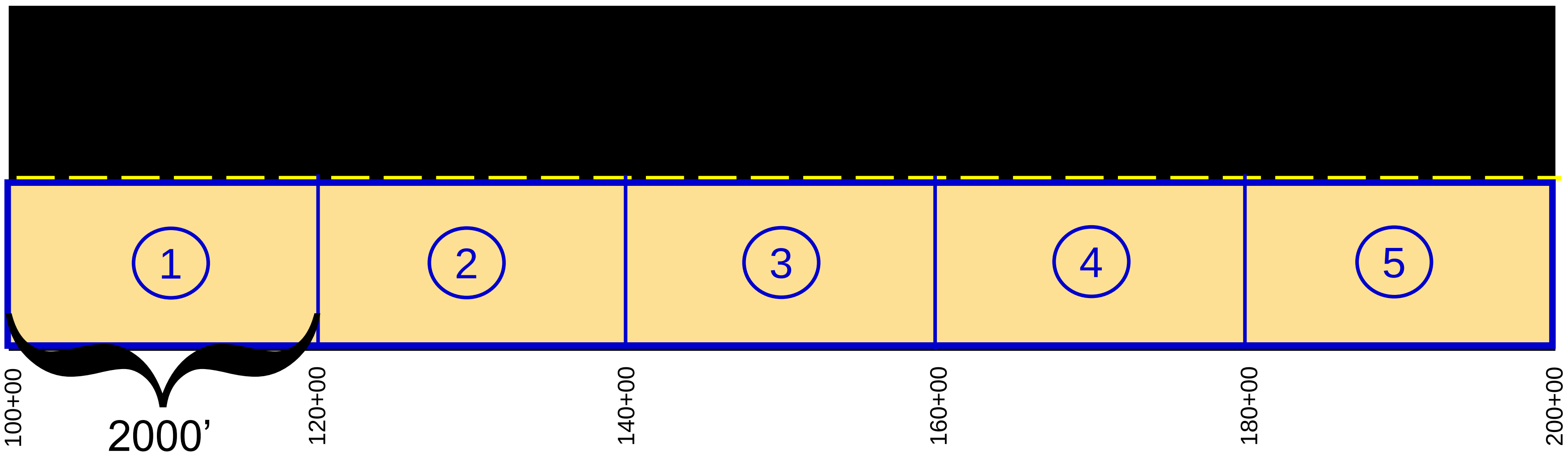
Random Number
0.884

Kansas Department of Transportation

5.2.2.2 Random Sampling

Solving Random Number Problems

1. Draw a picture (it may help).
2. Determine the lot and sublots size and staring positions.
3. Use seed number(s) to find random number(s). How many will I need?
4. Multiply the random number by the sublot size. 0.697*2000’ = 1394’
5. Add that distance to the starting position of the sublot. 100+00 + 1394’ = 113+94



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5.2.2.2 Random Sampling

10 trucks are delivering concrete to a bridge deck placement. Determine which truck to sample for compressive strength cylinders to be molded? Use a seed number of 0.220.

Steps:

1. Draw a picture.

Probably don't need to since there are no sublots.
So all we have is 1 Lot with 10 trucks.

5.2.2.2 Random Sampling

Column = 2
Row = 20

Random No.
0.456

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948

Kansas Department of Transportation

5.2.2.2 Random Sampling

Selected Truck = Random # x Trucks in Lot/Sublot

Selected Truck = 0.456 x 10 = 4.56 = 5th Truck

3.1.1.1 “Round this result up to a whole number”

5.2.2.2 Random Sampling

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
61	0.030	0.167	0.509	0.419	0.508	0.181	0.490	0.875	0.830	0.482
62	0.136	0.065	0.416	0.116	0.907	0.556	0.095	0.110	0.395	0.736
63	0.591	0.600	0.405	0.657	0.013	0.651	0.225	0.340	0.146	0.155
64	0.487	0.338	0.170	0.006	0.263	0.173	0.228	0.008	0.010	0.313
65	0.364	0.763	0.391	0.790	0.589	0.003	0.998	0.257	0.984	0.437
66	0.996	0.043	0.793	0.522	0.705	0.248	0.924	0.609	0.639	0.423
67	0.063	0.810	0.189	0.769	0.488	0.152	0.221	0.978	0.329	0.229
68	0.513	0.333	0.540	0.160	0.461	0.683	0.285	0.750	0.557	0.311
69	0.176	0.054	0.341	0.484	0.860	0.046	0.278	0.244	0.222	0.864
70	0.549	0.835	0.398	0.829	0.459	0.153	0.728	0.822	0.106	0.756
71	0.298	0.514	0.945	0.648	0.784	0.154	0.499	0.415	0.397	0.255
72	0.888	0.764	0.602	0.220	0.684	0.081	0.868	0.272	0.987	0.802
73	0.654	0.995	0.073	0.655	0.041	0.811	0.367	0.226	0.438	0.107
74	0.650	0.467	0.210	0.204	0.762	0.420	0.680	0.334	0.723	0.446
75	0.039	0.022	0.823	0.087	0.076	0.568	0.515	0.223	0.561	0.316
76	0.291	0.791	0.788	0.396	0.212	0.138	0.357	0.304	0.575	0.342
77	0.834	0.373	0.584	0.694	0.613	0.817	0.129	0.546	0.425	0.290

Seed Number is 0.751.

Random Number is 0.016

Kansas Department of Transportation

5.2.2.2 Random Sampling

10 trucks are delivering concrete to a bridge deck placement. Determine which truck to sample for compressive strength cylinders to be molded? Use a seed number of 0.751.

Steps:

1. Draw a picture.

Probably don't need to since there are no sublots.
So all we have is 1 Lot with 10 trucks.

Kansas Department of Transportation

5.2.2.2 Random Sampling

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
61	0.030	0.167	0.509	0.419	0.508	0.181	0.490	0.875	0.830	0.482
62	0.136	0.065	0.416	0.116	0.907	0.556	0.095	0.110	0.395	0.736
63	0.591	0.600	0.405	0.657	0.013	0.651	0.225	0.340	0.146	0.155
64	0.487	0.338	0.170	0.006	0.263	0.173	0.228	0.008	0.010	0.313
65	0.364	0.763	0.391	0.790	0.589	0.003	0.998	0.257	0.984	0.437
66	0.996	0.043	0.793	0.522	0.705	0.248	0.924	0.609	0.639	0.423
67	0.063	0.810	0.189	0.769	0.488	0.152	0.221	0.978	0.329	0.229
68	0.513	0.333	0.540	0.160	0.461	0.683	0.285	0.750	0.557	0.311
69	0.176	0.054	0.341	0.484	0.860	0.046	0.278	0.244	0.222	0.864
70	0.549	0.835	0.398	0.829	0.459	0.153	0.728	0.822	0.106	0.756
71	0.298	0.514	0.945	0.648	0.784	0.154	0.499	0.415	0.397	0.255
72	0.888	0.764	0.602	0.220	0.684	0.081	0.868	0.272	0.987	0.802
73	0.654	0.995	0.073	0.655	0.041	0.811	0.367	0.226	0.438	0.107
74	0.650	0.467	0.210	0.204	0.762	0.420	0.680	0.334	0.723	0.446
75	0.039	0.022	0.823	0.087	0.076	0.568	0.515	0.223	0.561	0.316
76	0.291	0.791	0.788	0.396	0.212	0.138	0.357	0.304	0.575	0.342
77	0.834	0.373	0.584	0.694	0.613	0.817	0.129	0.546	0.425	0.299

Seed Number is 0.751.

Random Number is 0.016

Kansas Department of Transportation

5.2.2.2 Random Sampling

Selected Truck = Random # x Trucks in Lot/Sublot

Selected Truck = 0.016 x 10 = 0.16 = 1st Truck

3.1.1.1 “Round this result up to a whole number”

5.2.2.2 Random Sampling

I need a random location to put my Nuclear Density Gauge on the Cement Treated Base.

My Odometer Reads 159614.7

Sublot starts at 10+00

Sublot length is 500 feet

Width of paving is 12 feet.

X Seed Number = Col 7 Row 14

Y Seed Number = Col 6 Row 59

Kansas Department of Transportation

5.2.2.2 Random Sampling

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231

X Seed Number is 714

Random Number is 0.322

Kansas Department of Transportation

5.2.2.2 Random Sampling

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
61	0.030	0.167	0.509	0.419	0.508	0.181	0.490	0.875	0.830	0.482
62	0.136	0.065	0.416	0.116	0.907	0.556	0.095	0.110	0.395	0.736
63	0.591	0.600	0.405	0.657	0.013	0.651	0.225	0.340	0.146	0.155
64	0.487	0.338	0.170	0.006	0.263	0.173	0.228	0.008	0.010	0.313
65	0.364	0.763	0.391	0.790	0.589	0.003	0.998	0.257	0.984	0.437
66	0.996	0.043	0.793	0.522	0.705	0.248	0.924	0.609	0.639	0.423
67	0.063	0.810	0.189	0.769	0.488	0.152	0.221	0.978	0.329	0.229
68	0.513	0.333	0.540	0.160	0.461	0.683	0.285	0.750	0.557	0.311
69	0.176	0.054	0.341	0.484	0.860	0.046	0.278	0.244	0.222	0.864
70	0.549	0.835	0.398	0.829	0.459	0.153	0.728	0.822	0.106	0.756
71	0.298	0.514	0.945	0.648	0.784	0.154	0.499	0.415	0.397	0.255
72	0.888	0.764	0.602	0.220	0.684	0.081	0.868	0.272	0.987	0.802
73	0.654	0.995	0.073	0.655	0.041	0.811	0.367	0.226	0.438	0.107
74	0.650	0.467	0.210	0.204	0.762	0.420	0.680	0.334	0.723	0.446
75	0.039	0.022	0.823	0.087	0.076	0.568	0.515	0.223	0.561	0.316
76	0.291	0.791	0.788	0.396	0.212	0.138	0.357	0.304	0.575	0.342
77	0.834	0.373	0.584	0.694	0.613	0.817	0.129	0.546	0.425	0.290

Y Seed Number is 659

Random Number is 0.861

5.2.2.2 Random Sampling

Starting Position (P)	Sublot Length (L)	Sublot Width (W)	Seed No.	Rand No.	Location Within Sublot	Location on the Roadway
10+00	500’	12’	(X) 714 (Y) 659	0.322 0.861	161’ 10.3’	11+61 10.3’ from BL

X
500
x 0.322
161
+ 1000
1161

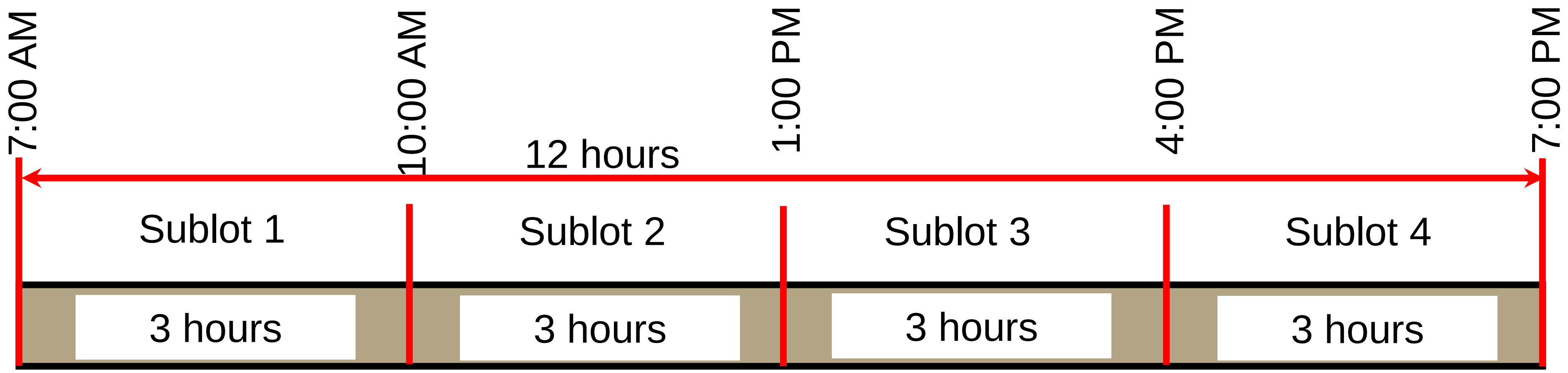
Y
12
x 0.861
10.3

5.2.2.2 Random Sampling

In a 12 hour day I need to take 4 samples.
The day starts at 7:00 AM.
Generate random numbers from a seed number of 0.048.
What time should I take the third sample?

1. Draw a picture
2. Determine the lot and sublots size and starting positions.

   12 hours / 4 sublots = 3 hours per sublot



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5.2.2.2 Random Sampling

3. Use seed number(s) to find random number(s). How many will I need?

Seed No. = 0.048

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
. . .										
47	0.494	0.113	0.773	0.867	0.824	0.976	0.323	0.134	0.761	0.911
48	0.780	0.687	0.318	0.202	0.331	0.264	0.670	0.848	0.114	0.495
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374

Random Number 1 = 0.495

Random Number 2 = 0.360

Random Number 3 = 0.948

Random Number 4 = 0.241

5.2.2.2 Random Sampling (3rd Sample)

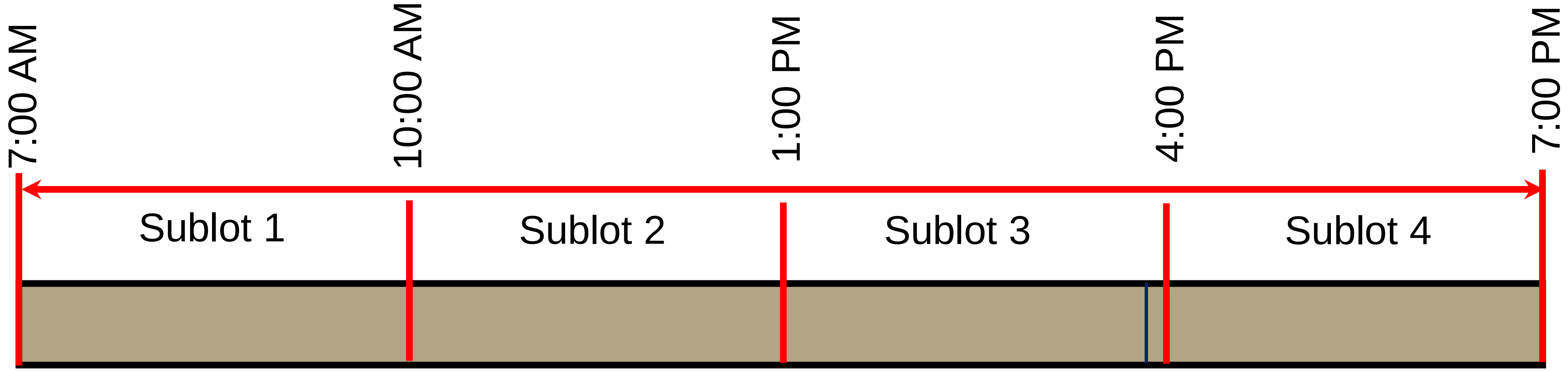
4. Multiply the random number by the sublot size.
5. Add that distance to the starting position of the sublot.

Sublot	Start Time	Rnd #	Sublot Length	Dist into Sublot	Dist into Sublot	Time to Take Sample
1	7:00 AM	0.495	3 hrs			
2	10:00 AM	0.360	3 hrs			
3	1:00 PM	0.948	3 hrs	2.844 hrs	2:51	3:51 PM
4	4:00 PM	0.241	3 hrs			

3
$$\begin{array}{r} 3 \\ \times\ 0.948 \\ \hline 2.844 \end{array}$$

3
$$\begin{array}{r} 0.844 \\ \times\ 60 \\ \hline 51 \end{array}$$

3
$$\begin{array}{r} 1{:}00\text{ PM} \\ +\ 2{:}51 \\ \hline 3{:}51\text{ PM} \end{array}$$



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5.2.2.2 Random Sampling (All Samples)

4. Multiply the random number by the sublot size.
5. Add that distance to the starting position of the sublot.

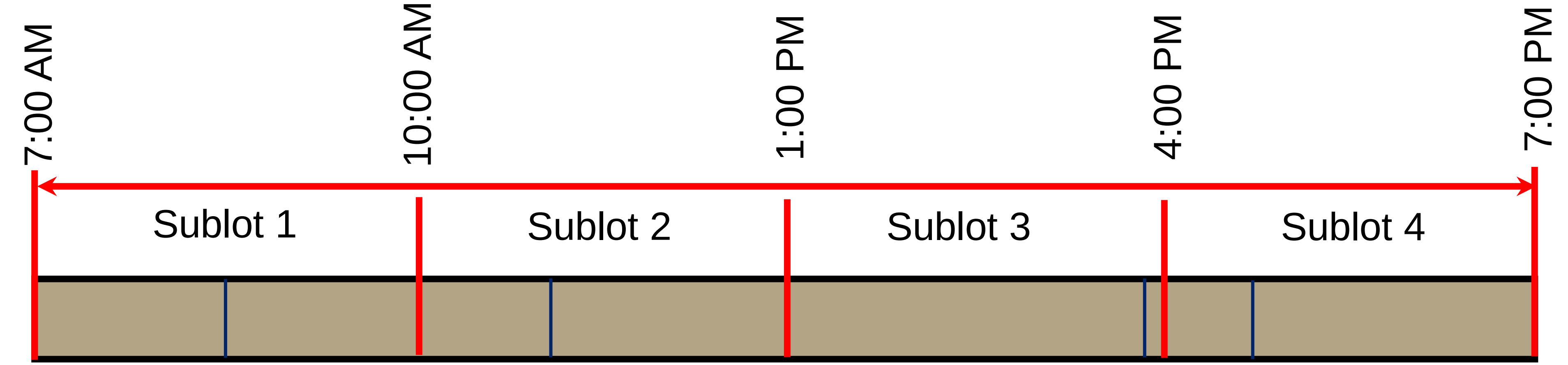
Sublot	Start Time	Rnd #	Sublot Length	Dist into Sublot	Dist into Sublot	Time to Take Sample
1	7:00 AM	0.495	3 hrs	1.485 hrs	1:29	8:29 AM
2	10:00 AM	0.360	3 hrs	1.080 hrs	1:05	11:05 AM
3	1:00 PM	0.948	3 hrs	2.844 hrs	2:51	3:51 PM
4	4:00 PM	0.241	3 hrs	0.723 hrs	0:43	4:43 PM

1 7:00 AM
+1:29
8:29 AM

2 10:00 AM
+1:05
11:05 AM

3 1:00 PM
+ 2:51
3:51 PM

4 4:00 PM
+0:43
4:43



Kansas Department of Transportation

5.2.2.2 Random Sampling

Solving Random Number Problems

1. Draw a picture (it may help).
2. Determine the lot and sublots starting position and size.
3. Use seed number(s) to find random number(s). How many will I need?
4. Multiply the random number by the sublot size.
5. Add that distance to the starting position of the sublot.

5.2.2.2 Random Sampling

1. **OBJECTIVE**

   Determine where or when a random sample should be taken using random numbers obtained from a random number table.

5.2.2. ROUNDING OFF AND RANDOM SAMPLING

5.2.2.1. ROUNDING OFF OF NUMBERS

1. SCOPE

This procedure applies to all specified limits in the specifications. For the purpose of determining conformance with the specifications and observed or calculated value shall be rounded off to the same place as used in expressing the limiting value, in accordance with the following.

2. REFERENCED DOCUMENTS

2.1. None.

3. PROCEDURE

3.1. Determine the last significant digit to be retained.

3.1.1. When the digit next beyond the last place to be retained is less than 5, retain unchanged the digit in the last place retained.

3.1.2. When the digit next beyond the last place to be retained is greater than 5, increase by 1 the digit in the last place retained.

3.1.3. When the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, increase by 1 the digit in the last place retained if it is odd, leave the digit unchanged if it is even. Increase by 1 the digit in the last place retained, if there are digits beyond this 5.

3.1.4. This rounding procedure may be restated simply as follows: When rounding a number to one having a specified number of significant digits, choose that which is nearest. If two choices are possible, as when the digits dropped are exactly a 5 or a 5 followed only by zeros, choose that ending in an even digit.

3.1.5. Examples: The following table indicates correct rounding-off procedures.

Examples of Rounding Off

Specified Limit	Observed or Calculated Value	Rounded to nearest percent	Rounded Off Value to be used for Purpose of Determining Conformance	Conform with a Specified Value
Nickel 57% min.	56.4	1	56	No
	56.5	1	56	No
	56.6	1	57	Yes
Sodium Bicarbonate 0.5% max.	0.54	0.1	0.5	Yes
	0.55	0.1	0.6	No
	0.56	0.1	0.6	No

The rounded-off value should be obtained in one step by direct rounding off of the most precise value available and not in two or more successive roundings. For example, 89,490 rounded off to the nearest 1000 is 89,000; it would be incorrect to round off first to the nearest 100, giving 89,500 and then to the nearest 1000 giving 90,000.

5.2.2.2. RANDOM SAMPLING

1. SCOPE

This method covers procedures for securing random samples from a lot by the use of random numbers obtained from tables or generated by other methods.

Nothing in this method is intended to preclude additional testing if failing or suspect materials or construction is encountered. Testing that is additional to the scheduled testing should occur immediately if failing test results occur or if materials or work appears to be substandard.

2. DEFINITIONS

2.1. Lot: An isolated or defined quantity of material from a single source or a measured amount of construction assumed to be produced by the same process. Specified amounts of asphalt concrete mix, a stockpile of aggregates, or linear feet of roadway constructed in a day are examples of a lot.

2.1.1. Sublot: A portion of a lot. When it is not convenient to sample the entire lot, such as a specified amount of hot mix, then it can be divided into equal sized sublots. The sublots, when combined, would constitute the entire lot.

2.1.2. Random: Without aim or pattern, depending entirely on chance alone (not to be construed as haphazard).

2.1.3. Sample: A small part of a lot or sublot which represents the whole. A sample may be made up of one or more increments or test portions.

2.1.4. Random number: A number selected entirely by chance. Random numbers may be generated electronically such as with a random number function on a calculator or spreadsheet or selected from a table of random numbers (See **Table 1**).

2.1.5. Seed number: A number to provide a starting point for selection of the random numbers. The seed number may be generated from an odometer reading, random number function on a calculator or spreadsheet, or by pointing at the random number table.

3. USE OF RANDOM NUMBERS IN SAMPLING

3.1. Most sampling and testing for construction materials should be randomized to prevent any unintentional bias of the results. Randomization of sampling times or locations is accomplished by using a set of random numbers to determine the time or location for the sample. A table of random numbers is included below.

3.1.1. Example 1: Determining when to sample.

3.1.1.1. As an example, assume ten trucks carrying equal loads are going to be used to deliver concrete during a bridge deck placement. Select which truck to sample for compressive strength cylinders to be molded.

In cases such as number of trucks or tons of production, etc. round up to the next whole number because there will not be a truck “0”. In cases involving things such as stationing there is a zero point so rounding to the nearest number may be justified.

Generate a random number using one of the methods below. Use .456 in this example. Multiply .456 by 10 (the number of trucks) for a result of 4.56. Round this result up to a whole number, 5 in this case. Take the concrete sample from the fifth truck.

This method can be used to select a time of day or the day of the week. If production was to occur during an 8 hour day, multiply 8 by the selected random number, .456, to obtain a result of 3.648. If rounding is used the sample should be taken in the fourth hour of production. Refinement could be used to select a time down to the nearest minute if needed by using the integer, three in this case, as the hour and then multiplying the decimal by 60 to obtain the minute, 60 X .648 or $\pm$ 39 in this case. Sampling would occur three hours thirty nine minutes into production. Use the number seven multiplied by a random number to determine a day of the week. Sampling during production according to units, such as tons of material produced, can be handled in the same fashion. Multiply the lot or sublot size, as required, by the random number selected.

3.2. Example 2: Determining location for sampling.

3.2.1. Given random numbers selected:

X	Y
0.338	0.922
0.763	0.198
0.043	0.737
0.810	0.747

ENGLISH EXAMPLE:

Sampling a large lot may require division into sublots to ensure all portions of a lot are represented. Stratification into sublots is accomplished by dividing the “Lot” material (in this case, a mile of construction or 5280 feet, 12’6” wide) into “four sublots” (each of 1320’ or 1/4 mile).

To locate a sample point station in sublot No. 1, the length of that sublot is multiplied by the “X” coordinate for the “sublot” and the product added to the beginning station for that sublot.

Starting Station = 486 + 15	486 + 15
$(X_1)(1320) = (0.338)(1320) = 446'$	4 + 46
Sample Station =	490 + 61

The sample point distance from the base line (generally centerline or the edge of pavement) is determined by multiplying Y_1 by the available width, in this case, 12.5 feet.

$(Y_1)(12.5') = (0.922)(12.5') = 11.5'$ from base line.

Thus the sample location is Sta. 490 + 61, 11.5’ from base line. Keeping in mind that the second sublot begins at station 499 + 35 (sta. 486 + 15 + 1320’), the second, third and fourth locations are determined by the same technique. These values are:

Sublot # 2 Sta. 509 + 42, 2.5’ from base line.
Sublot # 3 Sta. 513 + 12, 9.2’ from base line.
Sublot # 4 Sta. 536 + 44, 9.3’ from base line.

SI EXAMPLE:

Stratification into sublots is accomplished by dividing the “Lot” material (in this case, 2,000 meters) into “four sublots” [each of 500 meters (2,000/4) long].

To locate a sample point station in sublot No. 1, the length of that sublot is multiplied by the “X” coordinate for the “sublot” and the product added to the beginning station for that sublot.

Starting Station = 1 + 525	1 + 525
$(X_1)(500) = (0.338)(500) = 169$ meters	169
Sample Station =	1 + 694

The sample point distance from the base line (generally centerline or the edge of pavement) is determined by multiplying Y_1 by the available width.

$(Y_1)(3.7\text{ m}) = (0.922)(3.7\text{ m}) = 3.4$ m from base line.

Thus the sample location is Sta. 1 + 694, 3.4 m from base line. Keeping in mind that the second sublot begins at station 2 + 025 (sta. 1 + 525 + 500 m), the second, third and fourth locations are determined by the same technique. These values are:

Sublot # 2 Sta. 2 + 407, 0.7 m from base line.
Sublot # 3 Sta. 2 + 547, 2.7 m from base line.
Sublot # 4 Sta. 3 + 430, 2.8 m from base line.

4. Methods for selection of random numbers.

4.1. Use of calculators or spreadsheet functions.

4.1.1. Many calculators have a random function. Review the manual for a given calculator to determine how to access this function. Sets of random numbers may be generated directly from the calculator by repeated use of this function.

4.1.2. Most spreadsheets also have a function to generate random numbers. Insert the random number function into a cell and press enter. A random number will be generated. Copy that cell as needed to produce the required quantity of random numbers. It may be necessary to reformat the cells to have only three decimal places. Read the manual for the specific spreadsheet for more detail on use.

NOTE: The District Materials Engineer may require a different method of generating random numbers to be used if an electronic method is determined to not be truly random.

4.2. Use of the Random Number Table **(Table 1)**.

4.2.1. Use of the random number table requires the use of “seed” numbers to provide starting points for selection of the random numbers. A seed number can be obtained by several methods including odometer readings, generation by a random number function of a calculator or spreadsheet or by "pointing" if necessary.

4.2.1.1. Using an odometer reading such as 78642 as a seed number, use the digit farthest to the right (2) to select the column in the table. Use the next two digits to the left (64) to select the row.

In this case finding the intersection of the row and the column yields the number 0.338. Use this as a starting position and count down the column for the required number of samples. Selecting numbers for an X coordinate for three samples yields 0.338, 0.763 and 0.043.

If a Y coordinate is also required use the fourth digit from the right for the column and the next two digits to the left, for the row. In this example that would yield column 8 and row 07 producing a starting point at number 0.521. If a total of three samples are required, counting down two more places yields numbers 0.937 and 0.912.

Using this example, pairs of numbers for determining three X and Y coordinates are obtained, (0.338, 0.521), (0.763, 0.937) and (0.043, 0.912). Any amount of numbers required may be selected this way. If ten samples are required count down the column until ten numbers are selected.

Once the bottom of a column has been reached go to the top of the next column to the right and countdown to obtain more numbers, if the bottom of column 10 is reached go to the top of column 1.

If the column value from the seed number 0, then use column 10. If the row value from the seed number is 00, then use row 100.

Use of the odometer to generate seed numbers is not recommended if more than one set of X and Y pairs of random numbers is required in a relatively short period of time due to the slow change of the left odometer numbers.

4.2.1.2. Seed numbers may be obtained by using the random number function of a calculator or spreadsheet. In the above example the same results would have occurred if a calculator returned .264 for the first seed number. Use the first digit (2) to select a column and the second two digits (64) for the row. If using the random number function again produced 0.837, and then the same numbers would have been generated for the Y coordinate as in Example 2.

4.2.1.3. Seed numbers may be obtained by "pointing" also. Lay copies of both pages of **Table 1** side by side and with eyes closed place a pointer on the table to select a seed number. Use this number as in the above example. Suitable pointers would be any device with a small tip such as a pin or a mechanical pencil.

Table 1 Random Numbers

Table 1 (Cont)

	1	2	3	4	5	6	7	8	9	10
1	0.293	0.971	0.892	0.865	0.500	0.652	0.058	0.119	0.403	0.234
2	0.607	0.840	0.428	0.857	0.125	0.143	0.562	0.692	0.743	0.306
3	0.161	0.182	0.544	0.646	0.548	0.384	0.347	0.330	0.869	0.958
4	0.856	0.103	0.019	0.990	0.370	0.094	0.967	0.642	0.332	0.717
5	0.779	0.795	0.262	0.276	0.236	0.537	0.465	0.712	0.358	0.090
6	0.036	0.475	0.100	0.813	0.191	0.581	0.350	0.429	0.768	0.574
7	0.028	0.569	0.915	0.344	0.009	0.523	0.520	0.521	0.002	0.970
8	0.442	0.320	0.084	0.623	0.859	0.608	0.714	0.937	0.559	0.943
9	0.045	0.878	0.108	0.876	0.466	0.117	0.005	0.912	0.150	0.887
10	0.625	0.906	0.957	0.145	0.616	0.606	0.279	0.207	0.337	0.242
11	0.962	0.457	0.424	0.102	0.462	0.885	0.710	0.352	0.617	0.781
12	0.938	0.696	0.085	0.916	0.844	0.281	0.254	0.528	0.470	0.267
13	0.431	0.960	0.653	0.256	0.944	0.928	0.809	0.543	0.739	0.776
14	0.755	1.000	0.072	0.501	0.805	0.884	0.322	0.235	0.348	0.900
15	0.139	0.365	0.993	0.091	0.599	0.954	0.693	0.249	0.925	0.637
16	0.064	0.040	0.219	0.199	0.055	0.732	0.105	0.505	0.661	0.579
17	0.701	0.450	0.950	0.218	0.067	0.531	0.979	0.783	0.934	0.096
18	0.659	0.406	0.800	0.525	0.339	0.936	0.719	0.029	0.825	0.215
19	0.804	0.580	0.754	0.690	0.629	0.794	0.841	0.131	0.388	0.168
20	0.261	0.456	0.158	0.774	0.673	0.289	0.982	0.371	0.666	0.121
21	0.604	0.471	0.020	0.870	0.624	0.349	0.426	0.529	0.634	0.214
22	0.587	0.083	0.635	0.038	0.767	0.473	0.939	0.647	0.449	0.691
23	0.947	0.292	0.217	0.183	0.366	0.172	0.156	0.570	0.583	0.185
24	0.351	0.025	0.224	0.432	0.752	0.636	0.664	0.582	0.622	0.213
25	0.165	0.184	0.516	0.099	0.353	0.920	0.097	0.519	0.197	0.126
26	0.725	0.931	0.309	0.436	0.782	0.389	0.707	0.297	0.709	0.803
27	0.253	0.506	0.656	0.343	0.974	0.898	0.162	0.879	0.393	0.231
28	0.498	0.414	0.576	0.427	0.662	0.345	0.877	0.385	0.122	0.051
29	0.104	0.301	0.346	0.905	0.918	0.572	0.838	0.092	0.282	0.260
30	0.035	0.075	0.518	0.280	0.115	0.611	0.362	0.062	0.578	0.567
31	0.503	0.421	0.697	0.610	0.147	0.049	0.545	0.452	0.852	0.497
32	0.274	0.205	0.778	0.472	0.245	0.951	0.671	0.932	0.713	0.731
33	0.314	0.032	0.468	0.493	0.252	0.833	0.812	0.445	0.904	0.324
34	0.400	0.422	0.592	0.854	0.832	0.527	0.605	0.797	0.089	0.455
35	0.807	0.593	0.989	0.997	0.910	0.722	0.645	0.534	0.021	0.327
36	0.118	0.377	0.711	0.871	0.024	0.251	0.433	0.814	0.577	0.216
37	0.007	0.288	0.372	0.727	0.014	0.259	0.037	0.922	0.460	0.230
38	0.476	0.011	0.265	0.188	0.317	0.603	0.981	0.198	0.853	0.977
39	0.275	0.700	0.745	0.535	0.179	0.902	0.706	0.737	0.133	0.748
40	0.721	0.237	0.283	0.070	0.644	0.614	0.942	0.747	0.123	0.880
41	0.980	0.716	0.819	0.079	0.526	0.071	0.828	0.536	0.463	0.909
42	0.359	0.789	0.135	0.555	0.394	0.444	0.775	0.269	0.510	0.845
43	0.733	0.598	0.059	0.921	0.816	0.381	0.454	0.477	0.596	0.250
44	0.192	0.968	0.430	0.699	0.295	0.383	0.266	0.401	0.542	0.286
45	0.354	0.799	0.004	0.232	0.633	0.682	0.638	0.897	0.485	0.695
46	0.496	0.012	0.243	0.985	0.355	0.612	0.315	0.760	0.392	0.541
47	0.494	0.113	0.773	0.867	0.824	0.976	0.323	0.134	0.761	0.911
48	0.780	0.687	0.318	0.202	0.331	0.264	0.670	0.848	0.114	0.495
49	0.023	0.027	0.930	0.031	0.843	0.730	0.919	0.858	0.866	0.360
50	0.086	0.335	0.631	0.247	0.120	0.965	0.675	0.999	0.601	0.948

	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	0.180	0.478	0.688	0.929	0.674
56	0.588	0.227	0.896	0.758	0.826	0.504	0.512	0.026	0.863	0.481
57	0.305	0.689	0.137	0.319	0.558	0.418	0.277	0.992	0.766	0.447
58	0.831	0.899	0.208	0.698	0.676	0.195	0.808	0.759	0.738	0.439
59	0.626	0.827	0.959	0.440	0.411	0.861	0.850	0.686	0.159	0.374
60	0.201	0.895	0.480	0.270	0.369	0.407	0.082	0.749	0.057	0.435
61	0.030	0.167	0.509	0.419	0.508	0.181	0.490	0.875	0.830	0.482
62	0.136	0.065	0.416	0.116	0.907	0.556	0.095	0.110	0.395	0.736
63	0.591	0.600	0.405	0.657	0.013	0.651	0.225	0.340	0.146	0.155
64	0.487	0.338	0.170	0.006	0.263	0.173	0.228	0.008	0.010	0.313
65	0.364	0.763	0.391	0.790	0.589	0.003	0.998	0.257	0.984	0.437
66	0.996	0.043	0.793	0.522	0.705	0.248	0.924	0.609	0.639	0.423
67	0.063	0.810	0.189	0.769	0.488	0.152	0.221	0.978	0.329	0.229
68	0.513	0.333	0.540	0.160	0.461	0.683	0.285	0.750	0.557	0.311
69	0.176	0.054	0.341	0.484	0.860	0.046	0.278	0.244	0.222	0.864
70	0.549	0.835	0.398	0.829	0.459	0.153	0.728	0.822	0.106	0.756
71	0.298	0.514	0.945	0.648	0.784	0.154	0.499	0.415	0.397	0.255
72	0.888	0.764	0.602	0.220	0.684	0.081	0.868	0.272	0.987	0.802
73	0.654	0.995	0.073	0.655	0.041	0.811	0.367	0.226	0.438	0.107
74	0.650	0.467	0.210	0.204	0.762	0.420	0.680	0.334	0.723	0.446
75	0.039	0.022	0.823	0.087	0.076	0.568	0.515	0.223	0.561	0.316
76	0.291	0.791	0.788	0.396	0.212	0.138	0.357	0.304	0.575	0.342
77	0.834	0.373	0.584	0.694	0.613	0.817	0.129	0.546	0.425	0.290
78	0.511	0.375	0.048	0.923	0.001	0.088	0.258	0.166	0.787	0.837
79	0.538	0.174	0.068	0.052	0.640	0.148	0.093	0.553	0.565	0.862
80	0.560	0.724	0.975	0.818	0.796	0.379	0.069	0.034	0.792	0.757
81	0.492	0.820	0.489	0.872	0.770	0.991	0.704	0.050	0.874	0.621
82	0.890	0.356	0.451	0.554	0.649	0.507	0.061	0.479	0.211	0.273
83	0.966	0.798	0.917	0.141	0.368	0.193	0.443	0.751	0.458	0.746
84	0.517	0.715	0.777	0.742	0.839	0.307	0.246	0.956	0.665	0.111
85	0.786	0.328	0.015	0.643	0.882	0.815	0.963	0.590	0.855	0.891
86	0.047	0.702	0.287	0.177	0.164	0.552	0.296	0.413	0.941	0.849
87	0.681	0.678	0.563	0.851	0.726	0.801	0.573	0.056	0.140	0.641
88	0.404	0.842	0.412	0.893	0.935	0.744	0.386	0.299	0.178	0.881
89	0.033	0.042	0.753	0.660	0.685	0.171	0.408	0.060	0.550	0.302
90	0.128	0.658	0.667	0.926	0.239	0.127	0.903	0.483	0.300	0.597
91	0.973	0.933	0.361	0.595	0.186	0.901	0.914	0.190	0.303	0.098
92	0.672	0.729	0.163	0.310	0.196	0.964	0.486	0.308	0.735	0.474
93	0.524	0.402	0.628	0.410	0.846	0.206	0.585	0.566	0.044	0.627
94	0.720	0.157	0.238	0.078	0.233	0.771	0.533	0.986	0.077	0.101
95	0.983	0.669	0.927	0.066	0.080	0.740	0.969	0.630	0.619	0.200
96	0.294	0.387	0.988	0.961	0.913	0.679	0.284	0.949	0.380	0.785
97	0.668	0.149	0.972	0.187	0.151	0.502	0.718	0.453	0.953	0.491
98	0.130	0.708	0.417	0.594	0.209	0.663	0.908	0.271	0.532	0.741
99	0.883	0.677	0.615	0.469	0.363	0.142	0.952	0.325	0.194	0.847
100	0.889	0.772	0.390	0.571	0.873	0.806	0.448	0.955	0.240	0.074

KT-01: Sampling and Splitting of Aggregates

OBJECTIVE

- Identify the locations and the associated procedures for obtaining an aggregate sample.

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KT-01: Sampling and Splitting of Aggregates

1. **SCOPE**
   - Sampling of coarse and fine aggregates
   - Sampling reflects AASHTO R 90
   - Splitting reflects AASHTO R 76
   - Take samples from the finished product (Practical)
   - May Have to Sample from
     - Hauling units
     - Stockpiles
     - Specified location
   - Frequency and Procedures in Section 5.6

Kansas Department of Transportation

KT-01: Sampling and Splitting of Aggregates

2. REFERENCED DOCUMENTS

- Part V, Section 5.6; Aggregates
- AASHTO R 90; Sampling of Aggregates

- AASHTO R 76; Reducing Samples of Aggregate to Testing Size

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

3. SAMPLING METHODS

3.1. Sampling from Discharge or Flowing Streams

3.2. Sampling from a Stationary Conveyor Belt

3.3. Sampling from Stockpiles

3.4. Plant Mixed Aggregate (Skip)

3.5. Windrows

3.6. Unopened Sand-Gravel Deposits

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

3.1. Sampling from Discharge or Flowing Streams

- At least 3 approximately equal sample increments
  - Selected at random
  - Entire Cross Section
  - Meet or exceed minimum mass requirements

Courtesy of Oklahoma Department of Transportation

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

- **3.1. Sampling from Discharge or Flowing Streams**
  - Special Device to catch the sample
    - Pan of sufficient size to intercept the entire cross section of the discharge stream
    - Hold the sample without overflowing
    - May need set of rails to support pan
    - Can use a loader or other heavy equipment
    - Avoid sampling initial discharge
    - Avoid sampling final few tons

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3.1. Sampling from Discharge or Flowing Streams

	Sampling Methods	1st Test		Sto
	Bins or Belt Discharge			
1.	Receptacle must intersect entire cross-section of stream and be passed through the entire stream without overflowing.	PASS	FAIL	PA:
2.	Obtain at least three approximately equal increments, selected at random and combine to form a field sample, with a mass that equals or exceeds the minimum required. (3.1.)	PASS	FAIL	PA:

Employer:

	Bins or Belt Discharge						
1.	Receptacle must intersect entire cross-section of stream and be passed through the entire stream without overflowing.	PASS	FAIL	PASS	FAIL	PASS	FAIL

Bins or Belt Discharge

1. **Receptacle**
   - Intercept entire X-section
   - Pass through entire stream
   - Cannot overflow
2. **Field Sample**
   - At least 3 increments
     - ~ Equal
     - Randomly Selected
     - Combine to form field sample
   - Mass ≥ Minimum Required

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KT-01: **Sampling** and Splitting of Aggregates

- **3.2. Sampling from a Stationary Conveyor Belt**
  - SAFETY FIRST
  - At least 3 approximately equal sample increments
  - Selected at random
  - Meet or exceed minimum mass requirements

Courtesy of Oklahoma Department of Transportation

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KT-01: **Sampling** and Splitting of Aggregates

- **3.2. Sampling from a Stationary Conveyor Belt**
  - Insert 2 templates
    - Place in the aggregate stream
    - Shape conforms to the shape of the Belt
    - Scoop all material between templates
    - Place in a suitable container
    - Use a brush and dust pan to collect the fines

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3.2. Sampling from a Stationary Conveyor Belt

	Stationary Conveyor Belt
3.	Obtain at least three approximately equal increments, selected at random. Combine to form a field sample with a mass that equals or exceeds the minimum required. (3.2)
4.	Insert two templates, the shape of which conforms to the shape of the belt, in the aggregate stream on the belt. (3.2)
5.	Carefully scoop all material between the templates into a suitable container and collect the fines from the belt with a brush and dust pan. (3.2.)

Stationary Conveyor Belt

3. **Field Sample**
   - At least 3 increments
     - ~ Equal
     - Randomly Selected
     - Combine to form field sample
     - Mass ≥ Minimum Required
4. **Insert Two Templates**
   - Shape conforms to belt
   - In aggregate stream of belt
5. **Scoop All Material**
   - Between Templates
   - Into Suitable Container
   - Collect Fines Using a Brush and Dust Pan

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KT-01: **Sampling** and Splitting of Aggregates

- **3.3 Sampling from Stockpiles**
  - Avoid sampling from stockpiles – representative samples are difficult to obtain.
  - Use loaders to create a smaller stockpile
  - Minimum of 3 bucket loads from varying heights and locations
  - Dump each load on top of the previous
  - Can move the stacker to create the sampling stockpile

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3.3 Sampling from Stockpiles

	Sampling Stockpiles with Power Equipment
6.	Try to avoid sampling from stockpiles because it is nearly impossible to collect a truly representative sample. (3.3.)
7.	Using power equipment, compose a small sampling pile of material drawn from various levels and locations of the main pile. Moveable conveyor equipment may also be used to create the small stockpile. (3.3.)

Sampling Stockpiles with Power Equipment

6. **Avoid Sampling Stockpiles**
   - Nearly impossible to collect a truly representative sample
7. **Small Sampling Pile**
   - Use Power Equipment
   - Get material from main pile
     - From various levels
     - From various locations
   - Can use moveable conveyor equipment

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KT-01: **Sampling** and Splitting of Aggregates

- **3.3 Sampling from Stockpiles**
  - Coarse Aggregate
  - Flatten one side of pile with loader
  - Sample from flattened material
  - Insert shovel vertically at 5 locations (minimum)
  - Combine into a field sample (≥ 75 lbs)

Courtesy of Oklahoma Department of Transportation

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3.3 Sampling Coarse Aggregates from Stockpiles

	Coarse Aggregates
8.	Flatten one side of the small pile with the loader bucket. (3.3)
9.	Sample by inserting a shovel in at least 5 different locations. (3.3.)
10.	Combine the individual increments to produce a sample of not less than 75 lbs. (3.3.)

Coarse Aggregates

8. **Flatten one side of the small sampling pile with loader bucket**
9. **Sample**
   - Insert shovel
   - ≥ 5 different locations
10. **Combine individual increments**
    - Sample ≥ 75 lbs.

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

- **3.3 Sampling from Stockpiles**
  - Fine Aggregate
    - Collect sample using
      - Sampling Tube
        - Diameter ≥ 3 times maximum aggregate size
        - Scalp away outer layer
        - Minimum of 5 increments
        - Taken from each 1/3 volume

Courtesy of Oklahoma Department of Transportation

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

- **3.3 Stockpiles**
  - Fine Aggregate
    - Collect sample using
      - Shovel
        - Scalp away outer layer
        - Minimum of 5 increments
        - Taken from each 1/3 volume
        - Dig hole 1'-2' deep

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3.3 Sampling Fine Aggregates from Stockpiles

	Fine Aggregates
11.	Sample fine aggregate with a shovel or with a sampling tube having a diameter at least 3 times the size of the maximum size aggregate being sampled. (3.3.)
12.	Scalp away the outer layer. Obtain a minimum of five increments at several locations in the pile with samples taken from each 1/3 volume of the pile by inserting the tube or digging a hole 1 to 2 ft deep. (3.3.)
13.	Combine the individual increments to form a field sample. (3.3.)

Fine Aggregates

11. Sampling Tools
- Shovel
- Sampling Tube
  - Dia. ≥ 3x max. agg. size

12. Sampling Procedure
- Scalp away outer layer
- ≥ 5 increments
  - Several locations from pile
  - Each 1/3 volume of pile
- Sampling tube
- Shovel
  - Dig hole 1-2’ deep

13. Field Sample
- Combine individual increments

KT-01: **Sampling** and Splitting of Aggregates

- **3.4 Plant Mixed Aggregate (SKIP)**
  - Asphalt Batch Plants
  - Continuous Flow Plants
  - Screenless Operation Sampling

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KT-01: **Sampling** and Splitting of Aggregates

- **3.5 Windrows**
  - Wait till all blending/mixing is complete
  - Sample through entire cross section
  - May use power equipment to cut through windrow
  - May use a sampling tube
    - ≤10% retained on ⅜" sieve
    - ≤25% crushed

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KT-01: **Sampling** and Splitting of Aggregates

- **3.5 Windrows**
  - Sampling Tube Samples
    - Equal number
    - well-spaced
    - both sides
    - normal to slope of windrow
  - Not less than 75 lb sample is recommended

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KT-01: **Sampling** and Splitting of Aggregates

- **3.6 Unopened Sand-gravel (SSG) Deposits**
  - Drill test holes at regular intervals
  - Examine SSG for changes at each hole
  - Place usable material on a surface other than grass or dirt.
  - Mix a 15 lb. sample for gradations
  - If reasonably uniform, obtain 200 lb. sample for quality testing
    - This sample is tested for information only

Kansas Department of Transportation

KT-01: **Sampling** and Splitting of Aggregates

- **1. Scope**
- **2. Referenced Documents**
- **3. Sampling Methods**
  - 3.1. Sampling from Discharge or Flowing Streams
  - 3.2. Sampling from a Stationary Conveyor Belt
  - 3.3. Sampling from Stockpiles
  - 3.4. Plant Mixed Aggregate (Skip)
  - 3.5. Windrows
  - 3.6. Unopened Sand-Gravel Deposits

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KT-01: Sampling and Splitting of Aggregates

OBJECTIVE

- Identify the locations and the associated procedures for obtaining an aggregate sample.

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KT-01: **Sampling** and Splitting of Aggregates

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KT-01: Sampling and **Splitting** of Aggregates

OBJECTIVE

- Properly reduce the sample size to testing size without segregating or modifying the material.

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KT-01: Sampling and **Splitting** of Aggregates

- **4.1 Quartering Canvas**
  - For samples that weigh 75 lbs or more
  - Spread canvas on smooth level surface
  - Dump sample in a pile in the center
  - Vigorously mix sample by lifting each corner and rolling aggregate toward opp. corner.
  - Flatten to a uniform thickness in center of canvas so each quarter sector contains the material originally in it
  - Use a stick to “quarter” the pile
  - Discard opposite corners

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KT-01: Sampling and **Splitting** of Aggregates

- **4.2 Riffle Splitter**
  - Sample size is at least 4x the required test portion
  - Aggregate Moisture ≤ SSD condition
  - If aggregate needs dried, keep temperature at or below any future testing temperature
  - If moist sample is large, reduce to not less than 5000 g using a mechanical splitter having chute openings ≥ 1 ½”

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KT-01: Sampling and **Splitting** of Aggregates

- **4.2.1 Riffle Splitter Apparatus**
  - Chutes – Even Number, Equal Width
    - Discharge alternately each side
    - 8+ for coarse and mixed aggregates
    - 12+ for fine aggregates
  - Width (minimum)
    - Combined Coarse and Fine Aggregate
      - ~50% larger than largest particle
    - Dry Fine Aggregate (< ⅜" sieve)
      - ½" to ¾" wide

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KT-01: Sampling and **Splitting** of Aggregates

- **4.2.1 Riffle Splitter Apparatus (cont)**
  - Two receptacles to hold the two halves of the sample being split
  - Hopper – width of splitter
  - Flow smoothly without material loss
- **4.2.2 Procedure**
  - Place Sample in hopper
  - Distribute uniformly
  - Introduce into splitter – smooth flow
  - Reintroduce from one of the receptacles until test size is obtained

Kansas Department of Transportation

KT-01: Sampling and **Splitting** of Aggregates

- **4.3 Miniature Stockpile**
  - Use only on wet fine aggregate
  - Clean, hard, level surface
  - Initial sample is 4x size of required test portion
  - Mix by turning it over 3 times with shovel.
  - Create a conical pile
  - Flatten (dia. is 4-8 times thickness)
  - Quarter it
  - Remove opposite corners
  - Repeat till size is obtained

KT-01: Sampling and **Splitting** of Aggregates

OBJECTIVE

- Properly reduce the sample size to testing size without segregating or modifying the material.

5.9.01 SAMPLING AND SPLITTING OF AGGREGATES (Kansas Test Method KT-01)

1. SCOPE

These methods apply to the sampling of coarse and fine aggregates for quality tests and for inspection and testing of aggregates being produced for State construction and maintenance work. **KT-01** reflects testing procedures found in **AASHTO R 90** and **R 76**.

Where practicable, samples to be tested for quality shall be obtained from the finished product. Conditions may require sampling from hauling units or from stockpiles located at the production plant site or a specified location.

General policy regulations covering the frequency of and procedures for sampling aggregates are set forth in **Part V, Section 5.6** of this manual.

2. REFERENCED DOCUMENTS

2.1. KDOT Construction Manual, Part V, Section 5.6; Aggregates

2.2. AASHTO R 90; Sampling Aggregate Products

2.3. AASHTO R 76; Reducing Samples of Aggregate to Testing Size

3. SAMPLING METHODS

3.1. Sampling from Discharge or Flowing Streams:

Obtain at least three approximately equal sample increments, selected at random from the stream and combine to form a field sample that equals or exceeds the minimum required mass. Take each increment from the entire cross section of the material as it is being discharged. It is usually necessary to have a special device constructed for a particular plant. This device consists of a pan of sufficient size to intercept the entire cross section of the discharge stream and hold the required quantity of material without overflowing. A set of rails may be necessary to support the pan as it is passed under the discharge stream. The use of heavy equipment, such as a loader, may also be enlisted for this purpose. Sampling the initial discharge or the final few tons from a bin or conveyor belt increases the chance of obtaining segregated material and should be avoided. To the extent possible, keep bins continuously full to reduce segregation.

3.2 Sampling from a Stationary Conveyor Belt:

Only when the belt is completely stopped and easily within reach, should belt samples be obtained. Never walk on a stopped conveyor belt. Elevated conveyors must be equipped with a suitable walkway and necessary fall protection must be utilized. An individual obtaining a conveyor belt sample must have their own lock out/tag out device(s) in place during sampling.

Insert two templates, the shape of which conform to the shape of the belt, in the aggregate stream on the belt. Carefully scoop all material between the templates into a suitable container and collect the fines from the belt with a brush and dustpan and add to the container. Obtain at least three approximately equal increments, selected at random, and combine to form a field sample with a mass that equals or exceeds the minimum.

3.3. Sampling from Stockpiles:

When possible, avoid sampling from stockpiles. It is very difficult to ensure unbiased samples due to the segregation which often occurs when material is stockpiled with coarse particles rolling to the outside base of the pile.

Loaders must be used to scoop material from the main stockpile and create a separate smaller stockpile. This should be done by loading out a minimum of three buckets from various heights and locations around the main pile and dumping each load on top of the previous in a separate location. When feasible, stockpiles under production can be sampled by moving the stacking or conveyor equipment in order to create the smaller pile for sampling.

For coarse aggregate, the loader should flatten one side of the pile by inserting the bucket vertically at or near the apex of the pile, and backing the material out away from the pile. The flattened material should then be sampled by inserting a shovel vertically in at least 5 different locations. Combine the individual increments to produce a field sample weighing not less than 75 lb (35 kg), mix thoroughly and reduce to the specified size for testing.

For fine aggregate, collect the sample using a sampling tube or shovel. Sample fine aggregate with a sampling tube having a diameter at least three times the size of the maximum size aggregate being sampled. Scalp away the outer layer of fine aggregate to assure the sample has not become segregated. Obtain a minimum of five increments at several locations in the pile with samples taken from each 1/3 volume of the pile by inserting the tube or digging a hole 1 to 2 ft (0.3 to 0.6 m) deep. Combine the individual increments to form a field sample, mix and reduce to proper size for testing.

3.4. Plant Mixed Aggregate: There are several acceptable methods of taking samples from each type of plant. Every situation should be studied and evaluated to determine whether or not the method to be used will provide a representative sample of the material being produced. Plant mixed aggregate samples are generally obtained by one of the following procedures. If these procedures, due to unforeseen circumstances, prove to be unworkable, other procedures may be used if approved in writing by the District Materials Engineer.

3.4.1. Apparatus.

3.4.1.1. For Asphalt Plant Sampling.

3.4.1.1.1. For Batch Plants: A vertical receptacle having a closed bottom and an open top with no dimension in the opening of less than 5 in (125 mm). Appropriate handles for lifting and handling and a wide flat base for vertical stability are recommended. The height of the container must be sufficient that it will not overflow during the discharge of material from the pugmill.

Some containers have been designed to automatically split the material that enters the opening into two or more portions and discard one-half or more of all material received.

3.4.1.1.2. Continuous Flow Plants: A horizontal trough having a minimum width of 5 in (125 mm), a minimum depth of 12 in (300 mm), and a length equal to or greater than the width of the pugmill discharge stream., so constructed that it can be passed through the pugmill stream in a horizontal plane. Appropriate handles for lifting and handling are required. The apparatus shall meet the requirements in **Section 3.1.**, of this test method and be approved by the District Materials Engineer.

3.4.1.2. For Screenless Operation Sampling: The apparatus shall meet the requirements in **Section 3.1.** of this test method and be approved by the District Materials Engineer.

3.4.2. Procedure.

3.4.2.1. For Asphalt Plant Sampling.

3.4.2.1.1. Batch Plant: Center the container under the pugmill discharge, open the gate and empty the pugmill before removing the container.

3.4.2.1.2. Continuous Flow Plants: Pass the container horizontally through the drum discharge stream in such a manner that a representative sample will be obtained, and the container will not be filled to overflowing.

3.4.2.2. For Screenless Operation Sampling: The contractor shall provide a system for sampling the combined material ahead of the mixing chamber. Such a system must be approved by the District Materials Engineer.

3.5. Windrows: Windrows are not to be sampled until all blending and mixing is completed. They must be sampled by methods that will ensure that the sample will be representative of the material within the windrow cross section at the point of sampling. Power equipment is helpful in cutting through a windrow prior to sampling and should be used whenever available. Samples should be ample size to be representative of the windrow at the point of sampling and reduced to proper size for testing.

It has been determined that windrows containing aggregate with not more than 10% of material retained on the 3/8 in (9.5 mm) sieve and not more than 25% crushed material may be effectively sampled with a standard sampling tube.

To provide an acceptable sample, the following conditions are required:

3.5.1. A properly mixed and well "peaked" windrow.

3.5.2. Force the tube into the windrow and equal number of times, well-spaced, on each side of the windrow, and in a direction normal to the slope of the windrow face.

3.5.3. Sample size is sufficient for reduction by splitting using the standard procedure. Not less than 75 lb (35 kg) sample is recommended.

3.6. Unopened Sand-gravel Deposits: Unopened deposits of sand-gravel are usually explored by drilling test holes spaced at regular intervals over the area underlaid by the deposit. The holes are extended through the soil and other non-usable over-burden and through the workable depth of the deposit. Remove the sand-gravel from each test hole and examine for major changes in the quality and gradation characteristics, then record such changes. Place all usable material removed from each test hole on a quartering canvas, sheet of plywood, or other material to prevent contamination from grass, topsoil, etc. Thoroughly mix a 15 lb (7 kg) sample for gradation tests.

If the quality of the material removed from all test holes appears to be reasonably uniform, a sufficient amount of material from each test hole should be obtained to produce a 200 lb (90 kg) composite sample for quality testing. This sample will be tested for information only.

4. SAMPLE REDUCTION

4.1. Quartering Canvas Procedure: Samples that weigh 75 lb (35 kg) or more may be reduced to one-half size by using a quartering canvas. The canvas is not to be used as the first step in the reduction of samples smaller than approximately 75 lb (35 kg).

4.1.1. Spread the canvas on a smooth level surface. Dump the sample in a pile near the center and mix by alternately lifting each corner and rolling the aggregate toward the opposite corner. This should be performed in a vigorous manner.

4.1.2. Center the material on the canvas in a uniform pile. Flatten the pile to a uniform thickness and diameter by pressing down the apex with a straight-edge scoop, shovel, or trowel (depending on the size of sample). Press down so that each quarter sector of the resulting pile will contain the material originally in it. The diameter should be approximately four to eight times the thickness.

4.1.3. Insert a rod, shovel handle, or similar object under the canvas and under the center of the pile and lift both ends of the rod to divide the pile into two equal parts. Remove the stick leaving a fold of the blanket between the divided portions. Insert the rod under the canvas and under the center of the resulting two piles at right angles to the first division and again lift the rod to divide the sample into four equal parts.

4.1.4. Discard two opposite quarters, combine the two remaining quarters, mix and reduce to proper size with a riffle splitter or by repeating the quartering procedure.

When a quartering canvas is used, the Field Engineer and District Materials Engineer should be certain that proper procedures are being followed at all times.

4.2. Riffle Splitter: The initial sample size shall be at least four times the size of the required test portion. If use of this method is desired and the sample has free moisture on the particle surfaces, the entire sample must be dried to at least the saturated-surface-dry condition (SSD) using temperatures that do not exceed those specified for any tests contemplated. If the moist sample is very large, a preliminary split may be made using a mechanical splitter having wide chute openings 1 1/2 in (37.5 mm) or more to reduce the sample to not less than 5000 g.

4.2.1. Apparatus: The splitter shall have an even number of equal width chutes, not less than a total of eight for coarse aggregate, or twelve for fine-aggregate, which discharge alternatively to each side of the splitter. For coarse and mixed aggregate the minimum width of the individual chutes shall be approximately 50% larger than the largest particles in the sample to be split. For dry fine aggregate, finer than the 3/8 inch (9.5 mm) sieve, a splitter having chutes 1/2 to 3/4 inches (12.5 to 19 mm) wide shall be used. The splitter shall be equipped with two receptacles to hold the two halves of the sample following splitting. A hopper or straight-edged pan, with a width equal to or slightly less than the overall width of the assembly of chutes, shall be used to feed the sample at a controlled rate to the chutes. The splitter and accessory equipment shall be designed so the sample will flow smoothly without restriction or loss of material.

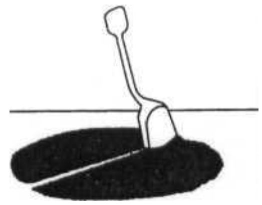
NOTE: Any disputed samples shall be split using the appropriate splitter meeting the above specifications.

4.2.2. Place the original sample in the hopper or pan and uniformly distribute it from edge to edge, so that when it is introduced into the chutes, approximately equal amounts will flow through each chute. The rate at which the sample is introduced shall allow free flowing through the chutes into the receptacles below. Reintroduce the portion of the sample in one of the receptacles into the splitter as many times as necessary to reduce the sample to the size specified for the intended test.

4.3. Miniature Stockpile Sample Reduction Procedure: This method of sample reduction may be used only on wet fine aggregate. For this quartering procedure, wet is defined as free moisture on the surface as approximated by the fine aggregate retaining its shape when molded by hand.

Place the sample on a clean, hard, level surface where there will be neither loss of material nor the accidental addition of foreign material. The initial sample size shall be at least four times the size of the required test portion. Mix the sample thoroughly with a shovel by turning it over completely three times. With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one. Carefully flatten the conical pile to a uniform thickness and diameter by pressing down on the apex with a shovel so that each quarter sector of the resulting pile will contain the material originally in it. The diameter should be approximately four to eight times the thickness. Divide the flattened pile into four equal quarters with a straight edge (trowel or similar metal blade) and remove two pre-selected diagonally opposite quarters, using a brush or broom to clean the cleared space. Repeat the process until the sample is reduced to the proper size.

Quartering on a Hard, Clean, Level Surface

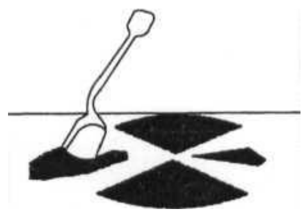


COCO

Cone Sample on Hard Clean Surface

Mix by Forming New Cone

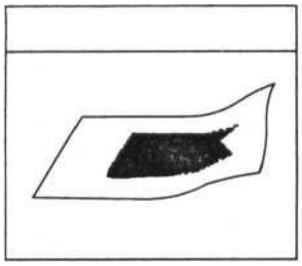
Quarter after Flattening Cone



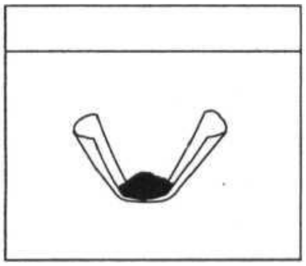
Sample divided into Quarters

Retain opposite Quarters, Reject the other Two Quarters

Quartering on a Canvas Blanket



Mix by Rolling on Blanket



Form Cone After Mixing

Quarter after flattening Cone.

Stick Placed under flattened cone

Sample divided in half

Sample divided into quarters

Retain Opposite Quarters. Reject the Other Two Quarters.

KT-02: Sieve Analysis of Aggregates

OBJECTIVE

- Determine the particle size distribution of aggregates using standard sieves.

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KT-02: Sieve Analysis of Aggregates

1. **SCOPE**

- Determine the particle size distribution of aggregates using standard sieves.
- KT-02 Reflects Procedures in AASHTO T 27

KT-02: Sieve Analysis of Aggregates

2. REFERENCED DOCUMENTS

2.1. Part V, Section 5.9; Sampling and Test Methods Foreword

2.2. KT-01; Sampling and Splitting of Aggregates

2.3. KT-03; Material Passing No. 200 (75µm) Sieve by the Wash Method

2.4. ASTM E11; Wire-Cloth Sieves for Testing Purposes

2.5. AASHTO T 27; Sieve Analysis of Fine and Coarse Aggregates

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KT-02: Sieve Analysis of Aggregates

3. APPARATUS

3.1. Balance – General purpose (Section 5.9 of Part V) and readable to 0.1% of sample mass

3.2. Sieves – Meeting ASTM E11 (minimum set)

⅜" (9.5 mm)	#4 (4.75 mm)	#8 (2.36 mm)
#16 (1.18 mm)	#30 (600 µm)	#50 (300 µm)
#100 (150 µm)	#200 (75 µm)	

- Larger Aggregates – Add appropriate larger sieves to the set

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KT-02: Sieve Analysis of Aggregates

3. APPARATUS (cont)

3.3. Mechanical Sieve Shaker

- Impart Vertical motion
- Or impart a Vertical and Lateral motion
- Cause particles to bounce and turn
- Timely meet the adequacy of sieving per Sections 10 and 11

3.4. Drying oven at continuous 230 ± 9^{o}F (110 ± 5^{o}C)

3.5. Drying Pans

KT-02: Sieve Analysis of Aggregates

4. SAMPLES

4.1. Composition:

- Obtain samples by splitting or quartering
- Quarter fine aggregates
  - Thoroughly Mixed
  - Moist Condition
- Sample size is approximately the desired mass
- Obtain by proper reduction methods
- Do not attempt to reach an exact predetermined mass

4.2. Fine Aggregates: minimum dry mass of 300 g.

4.3. Coarse and mixtures of coarse/fine aggregates: minimum dry mass per Table 1.

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KT-02: Sieve Analysis of Aggregates

Table 1

Sieve Size	Minimum Mass of Samples (g)
2½ in (63 mm) or more	35,000
2 in (50 mm)	20,000
1½ in (37.5 mm)	15,000
1 in (25.0 mm)	10,000
¾ in (19.0 mm)	5,000
½ in (12.5 mm)	2,000
⅜ in (9.5 mm) or less	1,000

- Use largest sieve on which 5% or more is specified to be retained
- Use 12.00 in (300 mm) diameter sieves when testing coarse aggregate and when sample is ≥ 5,000 g; or use split sample procedure (7.2).

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KT-02: Sieve Analysis of Aggregates

5. PREPARATION OF SAMPLES

Note: Remove deleterious material if Specification requires

5.1.
- Dry to constant mass at 230±9°F (110±5°C)
- Determine mass to nearest 0.1% of the sample mass
- Record as total original dry mass of sample (ODM)

5.2.
- Run KT-03
- Redry to a constant mass
- Determine mass to nearest 0.1% of ODM
- Record as dry mass of sample after washing (FDM)

Note: Lightweight Aggregate – Dry Screen per KT-04

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KT-02: Sieve Analysis of Aggregates

5. PREPARATION OF SAMPLES (cont)

5.3.

- May separate coarse and fine aggregates into 2 portions
- Dry screen over #4 sieve

5.3.1.

- Reduce minus #4 material to approximately 1,000 g
- Run KT-03 on both coarse and fine portions
- Conduct sieve analysis on each portion
- See Section 7.2 for calculations

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KT-02: Sieve Analysis of Aggregates

6. TEST PROCEDURES

6.1. Sieves

- Nest in order of decreasing size of opening from top to bottom
- Place sample on the top sieve
- Agitate the sieves for a sufficient period
  - Mechanical Apparatus (Mary Ann®)
  - Establish sufficiency by trial per Section 10

6.1.1.

- If Hand Sieving follow Section 11

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KT-02: Sieve Analysis of Aggregates

6. TEST PROCEDURES (cont)

6.2. Limit quantity on any given sieve

- All particles can reach sieve openings a number of times
- Sieves smaller than No. 4 – mass retained ≤ 4 g/in^2
- Sieves No. 4 and larger – mass retained ≤ 2.5 times sieve opening in mm
- Don't deform the sieves

Note:
- Can regulate amount of material retained on a sieve by:
  - Introduce a larger size sieve immediately above the sieve
  - Test sample in increments

Kansas Department of Transportation

KT-02: Sieve Analysis of Aggregates

Table A3.1 (AASHTO T 27)

Maximum Allowable Mass of Material Retained on a Sieve

Sieve Opening Size	8” Sieves	12” Sieves
¾”	1400 g	3200 g
½”	890 g	2100 g
⅜”	670 g	1600 g
#4	330 g	800 g
#8-#200	200 g	450 g

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KT-02: Sieve Analysis of Aggregates

6. TEST PROCEDURES (cont)

6.3. For coarse/fine aggregates

- - #4 material may be distributed over 2 or more sets of sieves
- Prevents overloading the sieves

6.3.1. - #4 material

- May be reduced using mechanical splitter
- Follow procedure in Section 7.2

Kansas Department of Transportation

KT-02: Sieve Analysis of Aggregates

6. TEST PROCEDURES (cont)

6.4. Determine mass for each sieve to nearest 0.1% of ODM

- Balance conforms to Section 5.9, Part V
- Total mass after sieving must be ≤ 0.3% of FDM for acceptance

6.5. If KT-03 was run, the total - #200 material for the sample is

- - #200 material from KT-02 and
- - #200 material from KT-03

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KT-02: Sieve Analysis of Aggregates

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1. Verify the Efficiency of Mechanical Sieve Shaker Equipment

- Applicable to any manufacturers mechanical sieve shaker
- Not internally verified by KDOT

10.1.1.
- Efficiency is required for all acceptance testing
- Coarse and Fine Aggregate
- Based on Product Type, i.e. Limestone, Siliceous Gravel, Sand, Granite, Calcite Cemented Sandstone, etc.
- Re-evaluate shaker efficiency annually

KT-02: Sieve Analysis of Aggregates

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1.2. Measurement of shaker efficiency is required for all sieves 12” diameter and smaller

Note: Sieves larger than 12” diameter may be difficult to measure sieving efficiency

10.1.3. Nest the sieves, #4 and smaller. Fit with a lid and a pan.

- *Remove Material retained on sieves larger than #4*
- *Use a minimum sample size of 1000 g*

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10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1.4. Determine the initial mass of the sample.
Place sample in sieves
Place in Mechanical Shaker for 6 minutes or the time established by history

10.1.5. Determine and record the percent retained on each sieve
Do not overload sieves (Section 6.2)

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1.6. Collect and recombine the material

10.1.7. Re-shake the material in the Mechanical Shaker

- Use same settings
- Increase time by 1 minute

10.1.8. Determine and record the percent retained on each sieve

Do not overload sieves (Section 6.2)

KT-02: Sieve Analysis of Aggregates

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1.9.
- Compare with values from Section10.1.5.
- Each sieve must be within 0.5% of the previous test run.
- If not, Increase the shaker time by another minute
- Repeat until each sieve is within 0.5% of the previous test.

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1.10. Record the minimum shaker time that was validated by sieving a minute longer.

For instance if the 6 minute shaker time and the 7 minute shaker time met the criteria in 10.1.9, then the 6 minute shaker time is validated.

This shaker time should be used for that classification of aggregate for that year in that shaker

KT-02: Sieve Analysis of Aggregates

11. HAND SIEVING (OPTIONAL)

11.1. Sufficiency → Sieve until ≤ 0.5% of ODM passes any sieve

- After 1 minute of continuous hand sieving
- Snug fitting cover is optional if sieved over an oversized pan (11.2.)
- Strike sieve sharply (upward motion) with heel of hand
  - 150 times per minute
  - turn sieve 1/6 of a revolution for 25 strokes
- Limit +#4 sieves to a single layer thickness
- Use 8" sieves if this procedure is impractical

11.2. Use of oversized pan permitted, provided material that leaves the top of the sieve is returned to the sieve

11.3. Return to Section 6.4 to complete the test

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KT-02: Sieve Analysis of Aggregates

7. CALCULATIONS

7.1. Calculate the total percent of material retained on each sieve

$$\text{Percent Retained} = \frac{100\,(\text{Mass Retained})}{\text{Total Original Dry Mass of Sample}}$$

Percent Passing No. 200 (75 µm) =

$$\frac{100\,(\text{Sum of material Passing No. 200 by Sieve and Wash})}{\text{Total Original Dry Mass of Sample}}$$

Kansas Department of Transportation

KT-02: Sieve Analysis of Aggregates

7. CALCULATIONS (cont)

7.2. Split Sample Procedure (to prevent overloading)

- Note that + #4 and - #4 portions must be recombined in an extra step

- Section 6.3 is for Coarse and Fine Mixtures
  - May be divided into two portions
  - Dry screen over the #4 sieve

- Section 6.3.1 states to reduce the - #4 material to ~ 1000 grams
  - Wash (KT-03) both the + #4 and the - #4 separately

KT-02: Sieve Analysis of Aggregates

8. REPORTING

- Total amount of - #200 material
  - KT-03 (mass lost in the wash)
  - + KT-02 (mass in the pan)
- Report gradations to the nearest whole percent
  Except the percent passing or retained on the #200 Sieve
  - If percent passing the #200 is < 10%, then report
    - Percent passing the #200 sieve to the nearest 0.1%
    - Percent retained on the #200 sieve to the nearest 0.1%
  - If percent passing #200 is ≥ 10%, then report both to the nearest 1%

9. PRECISION (not covered)

Kansas Department of Transportation

KT-02

Sieve Analysis of Aggregate Worksheet

A ODM = Original Dry Mass = ________________ g

B FDM = Final Dry Mass = ________________ g

C =A-B Mass Lost in Wash = ________________ g

Seive	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#16			
#30			
#50			
#100			
#200			
Pan			

E = Mass of minus #200 = (Pan-#200) + C = ________________ g

$$\% \text{ Passing } \#200 = \frac{E}{A} \times 100 = \underline{\hspace{6em}}$$

Test Acceptability = 100(B - Pan)/B = ________________

Kansas Department of Transportation

Example 1

KT-02

Sieve Analysis of Aggregate Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =		g

Kansas Department of Transportation

Example 1

KT-02
Sieve Analysis of Aggregate Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =	583.3	g

Example 1
ODM = 5876.7 g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported
1 1/2"	0.0		
1"	0.0		
3/4"	495.4		
1/2"	1593.8		
3/8"	2476.4		
#4	2859.9		
#8	3528.4		
#16	4271.2		
#30	4793.6		
#50	5012.1		
#100	5135.8		
#200	5260.7		
Pan	5276.5		

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Example 1

ODM = 5876.7 g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported
1 1/2"	0.0		0
1"	0.0		0
3/4"	495.4		
1/2"	1593.8		
3/8"	2476.4		
#4	2859.9		
#8	3528.4		
#16	4271.2		
#30	4793.6		
#50	5012.1		
#100	5135.8		
#200	5260.7		
Pan	5276.5		

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Example 1
ODM = 5876.7 g

A = 5876.7 g

grams retained on the 3/4″ sieve: D = 495.4 g

% retained on the 3/4″ sieve = D(100)/A

= 495.4(100)/5876.7

= 49540/5876.7

= 8.4299%

= 8%

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Example 1
ODM = 5876.7 g

	D	Percent Retained	D(100)/A
Sieve	Cumulative Grams Retained		Reported
1 1/2"	0.0		0
1"	0.0		0
3/4"	495.4	8.4299	8
1/2"	1593.8		
3/8"	2476.4		
#4	2859.9		
#8	3528.4		
#16	4271.2		
#30	4793.6		
#50	5012.1		
#100	5135.8		
#200	5260.7		
Pan	5276.5		

495.4(100)/5876.7

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Example 1

ODM = 5876.7 g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A		
			Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4			
#4	2859.9			
#8	3528.4			
#16	4271.2			
#30	4793.6			
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1

ODM = 5876.7 g

	D	Percent Retained D(100)/A		
Sieve	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9			
#8	3528.4			
#16	4271.2			
#30	4793.6			
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1
ODM = 5876.7 g

	D	Percent Retained	D(100)/A	
Sieve	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4			
#16	4271.2			
#30	4793.6			
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1
ODM = 5876.7 g

	D	Percent Retained	D(100)/A	
Sieve	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2			
#30	4793.6			
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1

ODM = 5876.7 g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2	72.6802	73	4271.2(100)/5876.7
#30	4793.6			
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1

ODM = 5876.7 g

	D	Percent Retained	D(100)/A	
Sieve	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2	72.6802	73	4271.2(100)/5876.7
#30	4793.6	81.5696	82	4793.6(100)/5876.7
#50	5012.1			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

Kansas Department of Transportation

Example 1
ODM = 5876.7 g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2	72.6802	73	4271.2(100)/5876.7
#30	4793.6	81.5696	82	4793.6(100)/5876.7
#50	5012.1	85.2877	85	5012.1(100)/5876.7
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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Example 1
ODM = 5876.7 g

Sieve	D	Percent Retained D(100)/A		
	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2	72.6802	73	4271.2(100)/5876.7
#30	4793.6	81.5696	82	4793.6(100)/5876.7
#50	5012.1	85.2877	85	5012.1(100)/5876.7
#100	5135.8	87.3926	87	5135.8(100)/5876.7
#200	5260.7			
Pan	5276.5			

Example 1
ODM = 5876.7 g

	D	Percent Retained	D(100)/A	
Sieve	Cumulative Grams Retained		Reported	
1 1/2"	0.0		0	
1"	0.0		0	
3/4"	495.4	8.4299	8	495.4(100)/5876.7
1/2"	1593.8	27.1207	27	1593.8(100)/5876.7
3/8"	2476.4	42.1393	42	2476.4(100)/5876.7
#4	2859.9	48.6651	49	2859.9(100)/5876.7
#8	3528.4	60.0405	60	3528.4(100)/5876.7
#16	4271.2	72.6802	73	4271.2(100)/5876.7
#30	4793.6	81.5696	82	4793.6(100)/5876.7
#50	5012.1	85.2877	85	5012.1(100)/5876.7
#100	5135.8	87.3926	87	5135.8(100)/5876.7
#200	5260.7	89.5179	90	5260.7(100)/5876.7
Pan	5276.5			

Example 1

A ODM = Original Dry Mass = 5876.7 g

B FDM = Final Dry Mass = 5293.4 g

C = A-B Mass Lost in the Wash = 583.3 g

Sieve	D Cumulative Grams Retained	Percent Retained	D(100)/A Reported
#50	5012.1	85.2877	85
#100	5135.8	87.3926	87
#200	5260.7	89.5179	90
Pan	5276.5		

E = Mass of minus #200 = (Pan-#200) + C = ____________ g

% Passing #200 = $\frac{E}{A}$ X 100 = ______________

Test Acceptability = 100(B - Pan)/B = ______________

Kansas Department of Transportation

Example 1

A ODM = Original Dry Mass = ______5876.7______ g

B FDM = Final Dry Mass = ______5293.4______ g

C = A-B Mass Lost in the Wash = ______583.3______ g

Sieve	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported
#50	5012.1	85.2877	85
#100	5135.8	87.3926	87
#200	5260.7	89.5179	90
Pan	5276.5		

E = Mass of minus #200 = (Pan-#200) + C = ____599.1____ g

E = (5276.5-5260.7) + 583.3

E = (15.8) + 583.3

% Passing #200 = $\frac{E}{A}$ X 100 = ______________

Test Acceptability = 100(B - Pan)/B = ______________

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Example 1

A ODM = Original Dry Mass = ______5876.7______ g

B FDM = Final Dry Mass = ______5293.4______ g

C = A-B Mass Lost in the Wash = ______583.3______ g

Sieve	D Cumulative Grams Retained	Percent Retained	D(100)/A Reported
#50	5012.1	85.2877	85
#100	5135.8	87.3926	87
#200	5260.7	89.5179	90
Pan	5276.5		

E = Mass of minus #200 = (Pan-#200) + C = ______599.1______ g

- #200 = (599.1/5876.7) x 100
- #200 = (0.1019) x 100

% Passing #200 = $\frac{E}{A}$ X 100 = ______10%______

Test Acceptability = 100(B - Pan)/B = ______________

Example 1

A ODM = Original Dry Mass = 5876.7 g

B FDM = Final Dry Mass = 5293.4 g

C = A-B Mass Lost in the Wash = 583.3 g

Sieve	D Cumulative Grams Retained	Percent Retained	D(100)/A Reported
#50	5012.1	85.2877	85
#100	5135.8	87.3926	87
#200	5260.7	89.5179	90
Pan	5276.5		

$Test_{acc}$= 100(5293.4-5276.5)/5293.4

$Test_{acc}$= 100(16.9)/5293.4

$Test_{acc}$= 1690/5293.4

$Test_{acc}$= 0.3193% = 0.3% ≤ 0.3%

E = Mass of minus #200 = (Pan-#200) + C = 599.1 g

$$\% \text{ Passing } \#200 = \frac{E}{A} \times 100 = 10\%$$

Test Acceptability = 100(B - Pan)/B = 0.3% Okay

Kansas Department of Transportation

KT-02: Sieve Analysis of Aggregates

Test Acceptability

6.4. Determine the mass of each sieve size increment to the nearest 0.1% of the total original dry mass of sample (as define in **Section 5.1.** of this test method) by weighing on a scale or balance conforming to the requirements specified in **Section 3.1.** of this test method**.** The total mass of the material after sieving should check closely with the original mass of sample placed on the sieves. If the amounts differ by more than 0.3%, based on the original mass of sample placed on the sieves, the results should not be used for acceptance purposes.

Kansas Department of Transportation

KT-02

Sieve Analysis of Aggregate Worksheet

A ODM = Original Dry Mass = 5876.7 g

B FDM = Final Dry Mass = 5293.4 g

C = A-B Mass Lost in the Wash = 583.3 g

Sieve	D Cumulative Grams Retained	Percent Retained	D(100)/A Reported
1 1/2"	0.0		0
1"	0.0		0
3/4"	495.4	8.4299	8
1/2"	1593.8	27.1207	27
3/8"	2476.4	42.1393	42
#4	2859.9	48.6651	49
#8	3528.4	60.0405	60
#16	4271.2	72.6802	73
#30	4793.6	81.5696	82
#50	5012.1	85.2877	85
#100	5135.8	87.3926	87
#200	5260.7	89.5179	90
Pan	5276.5		

E = Mass of minus #200 = (Pan-#200) + C = 599.1 g

% Passing #200 = $\frac{E}{A}$ X 100 = 10

Test Acceptability = 100(B - Pan)/B = 0.3

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KT-02: Sieve Analysis of Aggregates

OBJECTIVE

- Determine the particle size distribution of aggregates using standard sieves.

Kansas Department of Transportation

<u>5.9.02 SIEVE ANALYSIS OF AGGREGATES (Kansas Test Method KT-02)</u>

1. SCOPE

This method of test covers procedures for the determination of the particle size distribution of aggregates using standard sieves. **KT-02** reflects testing procedures found in **AASHTO T 27**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword

2.2. KT-01; Sampling and Splitting of Aggregates

2.3. KT-03; Material Passing No. 200 (75µm) Sieve by the Wash Method

2.4. ASTM E11; Woven Wire Test Sieve Cloth and Test Sieves

2.5. AASHTO T 27; Sieve Analysis of Fine and Coarse Aggregates

3. APPARATUS

3.1. The balance shall be readable to 0.1% of the sample mass and conform to the requirements of **Part V, Section 5.9; Sampling and Test Methods Foreword** of this manual for the class of general purpose balance required for the principal sample mass of the sample being tested.

3.2. Sieves meeting **ASTM E11**. As a minimum, set of sieves will include the 3/8 in (9.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No. 50 (300 µm), No. 100 (150 µm) and No. 200 (75 µm) for all aggregates. Gradations with larger sized aggregate will require addition of appropriate larger sieves to the set.

3.3. A mechanical sieve shaker shall impart a vertical, or lateral and vertical motion to the sieve, causing the particles to bounce and turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving is met in a timely manner as described in **Section 9.** of this test method**.**

3.4. An oven of appropriate size capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C).

3.5. Drying pans.

4. SAMPLES

4.1. Composition: Obtain samples for sieve analysis by the use of a sample splitter or by the method of quartering. Fine aggregate sampled by the quartering method shall be thoroughly mixed and in a moist condition. The sample for test shall be approximately the mass desired and shall be the end result of proper reduction methods. Do not attempt the selection of samples of an exact predetermined mass.

4.2. Fine Aggregates: Sample of fine aggregate for sieve analysis shall have a mass, after drying, not less than 300 g.

4.3. Coarse Aggregate: Samples of coarse aggregate and mixtures of coarse and fine aggregate for sieve analysis shall have a mass, after drying, not less than the amounts indicated in **Table 1**.

Table 1

**Sample Size for Determination of
Coarse Aggregate Gradation Tests**

Sieve Size	Minimum Mass of Samples (g)
2 1/2 in (63 mm) or more	35,000
2 in (50 mm)	20,000
1 1/2 in (37.5 mm)	15,000
1 in (25.0 mm)	10,000
3/4 in (19.0 mm)	5,000
1/2 in (12.5 mm)	2,000
3/8 in (9.5 mm) or less	1,000

NOTE: To select the sample size, use the largest sieve on which 5% or more of the material is specified to be retained.

NOTE: 12.00 in (300 mm) diameter sieves should be used for testing coarse aggregates and in testing samples with a mass of 5,000 g or more. If 12.00 in (300 mm) diameter sieves are not available, the split sample procedure in **Section 7.2** of this test method shall be used.

5. PREPARATION OF SAMPLES

NOTE: Remove deleterious material prior to determining the total original dry mass of sample if required by relevant specifications.

5.1. Dry all samples to a constant mass at a temperature of 230 ± 9°F (110 ± 5°C). Determine the mass of the sample to the nearest 0.1% of the sample mass. Record this as the total original dry mass of sample.

5.1.1. In the case of Cold in Place Recycle, air drying is acceptable.

5.2. Wash the sample over the No. 200 (75µm) sieve as specified in **KT-03**. Then redry the sample to constant mass. Determine the mass of the sample to the nearest 0.1% of the total original dry mass of sample. Record this as the dry mass of sample after washing.

NOTE: For lightweight aggregate cover material: Dry-screen lightweight aggregate cover material according to **KT-04** instead of washing. Remove and discard all deleterious material from the sample including clay lumps retained on the No.4 (4.75 mm) sieve before the mass of the sample after dry-screening is determined.

5.3. For convenience, mixtures of coarse and fine aggregates may be separated into two portions by screening the dried sample over a No. 4 (4.75 mm) sieve.

5.3.1 Reduce the material passing the No. 4 (4.75 mm) sieve by means of a sample splitter to a mass of approximately 1,000 g. Wash both the coarse and reduced fine portions of the total sample in accordance with **KT-03** and conduct a sieve analysis on each portion. Calculate the total combined grading in accordance with subsection **Section 7.2** of this test method.

6. TEST PROCEDURES

6.1. Nest the sieves in order of decreasing size of opening from top to bottom and place the sample, or portion of the sample, if it is to be sieved in more than one increment, on the top sieve. Agitate the sieves by mechanical sieve shaker for a sufficient period, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving described in **Section 10.** of this test method.

6.1.1. If a mechanical sieve shaker is not used, follow the procedures for hand sieving in **Section 11**.

6.2. Limit the quantity of material on a given sieve so that all particles have opportunity to reach sieve openings a number of times during the sieving operation. For sieves with openings smaller than No. 4 (4.75 mm) the mass retained on any sieve at the completion of the sieving operation shall not exceed 4 g/in^2 (7 kg/m^2) of sieving surface. For sieves with openings No. 4 (4.75 mm) and larger, the mass in kg/m^2 of sieving surface shall not exceed the product of 2.5 times the sieve opening in mm. In no case shall the mass be so great as to cause permanent deformation of the sieve cloth.

NOTE: The 4 g/in^2 (7 kg/m^2) amounts to 200 g for the usual 8 in (203 mm) diameter sieve and 450 g for a 12 in (305 mm) diameter sieve. The amount of material retained on a sieve may be regulated by (1) the introduction of a sieve with larger openings immediately above the given sieve or (2) testing the sample in a number of increments.

6.3. In the case of coarse and fine aggregate mixtures, the portion of the sample finer than the No. 4 (4.75 mm) sieve may be distributed among two or more sets of sieves to prevent overloading of individual sieves.

6.3.1. Alternatively, the portion finer than the No. 4 (4.75 mm) sieve may be reduced in size using a mechanical splitter according to **KT-01, Section 4.2**. If this procedure is followed, compute the mass of each size increment of the original sample as outlined in **Section 7.2.** of this test method.

6.4. Determine the mass of each sieve size increment to the nearest 0.1% of the total original dry mass of sample (as defined in **Section 5.1.** of this test method) by weighing on a scale or balance conforming to the requirements specified in **Section 3.1.** of this test method**.** The total mass of the material after sieving should check closely with the original mass of sample placed on the sieves. If the amounts differ by more than 0.3%, based on the original mass of sample placed on the sieves, the results should not be used for acceptance purposes.

6.5. If the sample has previously been tested by **KT-03**, add the mass finer than the No. 200 (75 µm) sieve determined by that method to the mass passing the No. 200 (75 µm) sieve by sieving of the same sample in this method.

7. CALCULATIONS

7.1 Calculate the total percent of material retained on each sieve as follows:

Percent Retained=

$$\frac{100\ (\text{Mass Retained})}{\text{Total Original Dry Mass of Sample}}$$

Percent Passing No. 200 (75 µm)=

$$\frac{100\text{ (Sum of material Passing No. 200 (75 µm) by Sieve and Wash)}}{\text{Total Original Dry Mass of Sample}}$$

7.2. Instructions for using split sample procedure (**KDOT Form #645**):

7.2.1. Record the total dry mass of sample before separation as A.

7.2.2. Record the total dry mass of material retained on No. 4 (4.75 mm) sieve following separation as B.

7.2.3. Record the total dry mass of material passing the No. 4 (4.75 mm) sieve following separation as C.

$C = A - B$

7.2.4. Record reduced mass of material passing the No. 4 (4.75 mm) sieve as D.

7.2.5. Compute percent of material passing the No. 4 (4.75 mm) sieve as follows:

$$E = \frac{100(\text{C})}{\text{A}}$$

Where: E= percent of material passing the No. 4 (4.75 mm) sieve in the total sample.

7.2.6. Wash the plus No. 4 (4.75 mm) portion of the sample over the No. 200 (75 µm) sieve as specified in **KT-03**, dry to a constant mass. Weigh and record the mass. Conduct sieve analysis using all regular sieves including the No. 200 (75 µm). Compute the percent of material retained on each sieve as follows:

$$G = \frac{100(\text{F})}{\text{A}}$$

Where: G = Total percent of the entire sample that is retained on each sieve.
F = Total mass of the plus No. 4 (4.75mm) material retained on each sieve size.

Calculate the total percent of material finer than the No. 200 (75 µm) sieve for the plus No. 4 fraction of the original sample by adding the mass determined by **KT-03** to the mass passing the No. 200 (75 µm) sieve by dry sieving, multiplying by 100 and divide by total dry mass of the sample before separation:

$$Q = \frac{100\text{(Sum of material Passing No. 200 (75 µm) by Sieve and Wash)}}{\text{A}}$$

Where: Q = Total percent of the plus No. 4 (4.75 mm) sieve passing the No. 200 (75 µm) sieve.

7.2.7. Wash the reduced sample of minus No. 4 (4.75 mm) material over a No. 200 (75 µm) sieve as specified in **KT-03**, dry to a constant mass. Weigh and record the mass. Conduct sieve analysis using all regular sieves including the No. 200 (75 µm). Compute the total percent of the reduced minus No. 4 (4.75 mm) sample retained on each sieve as follows:

$$J = \frac{100(\text{H})}{\text{D}}$$

Where: J = Total percent of the reduced minus No. 4 (4.75 mm) sample retained on each sieve.

H =Total mass of the reduced minus No. 4 (4.75 mm) material retained on each sieve.
D = Total dry mass of reduced minus No. 4 (4.75 mm).

Calculate the total percent of material finer than the No. 200 (75 µm) sieve for the plus No. 4 (4.75 mm) fraction of the original sample by adding the mass determined by **KT-03** to the mass passing the No. 200 (75 µm) sieve by dry sieving, multiplying by 100 and divide by total dry mass of reduced minus No. 4 (4.75 mm):

$$S = \frac{100(\text{Sum of material Passing No. 200 (75 µm) by Sieve and Wash})}{\text{D}}$$

Where: S = Total percent of reduced minus No. 4 (4.75 mm) material passing the No. 200 (75 µm) sieve

7.2.8. Calculate the adjusted percent retained on each size sieve for the minus No. 4 (4.75 mm) material as follows:

$$K = \frac{(\text{J})(\text{E})}{100}$$

Where: K = Adjusted percent of minus No. 4 (4.75 mm) material.
J = Total percent of reduced minus No. 4 (4.75 mm) sample retained on each sieve.
E = Percent of minus No. 4 (4.75 mm) material in total sample.

7.2.9. Calculate the combined percentage of material retained on each sieve in the series as follows:

R = K + G

7.2.10 Calculate the total material finer than the No. 200 (75 µm) sieve for the original sample as follows:

$$\text{Total \% Passing No. 200 (75 µm) Sieve} = \text{Q} + \frac{(\text{S})(\text{E})}{100}$$

7.2.11. Record the sieve analysis on the proper KDOT form.

NOTE: The use of the "Work Sheet for Split Sample Gradation and Plastic Index Tests", **KDOT Form No. 645,** is provided for the above calculations.

8. REPORTING

The results of the sieve analysis and, when required, the percent passing the No. 200 (75 µm) sieve by the Wash Method (**KT-03**) are reported on appropriate KDOT forms. Report gradation test results to the nearest whole percent, except when the percentage passing the No. 200 (75 µm) sieve is less than 10%. In this case, both the percentage passing the No. 200 (75 µm) sieve and the material retained on the No. 200 (75 µm) sieve shall be reported to the nearest 0.1%. Note that some specifications require these values be reported to the 0.01% such as asphalt mix gradations. The project number, name of producer, location of deposit, and all other pertinent data are shown on each report.

The first aggregate report issued for each project shall list the laboratory number under which the latest Official Quality Sample was tested and the results of such tests with the exception that specific gravities will be reported only if required by the specification. Subsequent reports may list only the laboratory number which the quality tests were conducted.

9. PRECISION

Precision for sieving aggregates are established in **TABLE 2.** The estimates for precision are based on results from the AASHTO Materials Reference Laboratory Reference Sample Program.

TABLE 2

	Total percentage of Material Passing	Standard Deviation (1S), %	Acceptable Range of Two Results (D2S), %
Coarse Aggregates:			
Single-Operator Precision			
	<100 ≥95	0.32	0.9
	<95 ≥85	0.81	2.3
	<85 ≥80	1.34	3.8
	<80 ≥60	2.25	6.4
	<60 ≥20	1.32	3.7
	<20 ≥15	0.95	2.7
	<15 ≥10	1.00	2.8
	<10 ≥5	0.75	2.1
	<5 ≥2	0.53	1.5
	<2 ≥0	0.27	0.8
Multilaboratory Precision			
	<100 ≥95	0.35	1.0
	<95 ≥85	1.37	3.9
	<85 ≥80	1.92	5.4
	<80 ≥60	2.82	8.0
	<60 ≥20	1.97	5.6
	<20 ≥15	1.60	4.5
	<15 ≥10	1.48	4.2
	<10 ≥5	1.22	3.4
	<5 ≥2	1.04	3.0
	<2 ≥0	0.45	1.3
Fine Aggregates:			
Single-Operator Precision			
	<100 ≥95	0.26	0.7
	<95 ≥60	0.55	1.6

	<60 ≥20	0.83	2.4
	<20 ≥15	0.54	1.5
	<15 ≥10	0.36	1.0
	<10 ≥2	0.37	1.1
	<2 ≥0	0.14	0.4
Multilaboratory Precision			
	<100 ≥95	0.23	0.6
	<95 ≥60	0.77	2.2
	<60 ≥20	1.41	4.0
	<20 ≥15	1.10	3.1
	<15 ≥10	0.73	2.1
	<10 ≥2	0.65	1.8
	<2 ≥0	0.31	0.9

NOTE: These numbers represent, respectively, the (1S and D2S) as describe in **ASTM C670.** The precision estimates are based on coarse aggregates with nominal maximum size of 3/4 in (19.0 mm).

10. VERIFICATION OF MECHANICAL SIEVE SHAKER EFFICIENCY

10.1. The following procedure defines a methodology to verify the efficiency of mechanical sieve shaker equipment. This procedure should be applicable to any manufacturers mechanical sieve shaker but has not been verified internally at KDOT.

10.1.1. Shaker efficiency is a requirement for all acceptance testing of fine and coarse aggregate and should be determined based on each product type. As aggregate production and mining operations can cause a change to aggregate properties (soundness, durability, angularity and specific gravity), re-evaluation of shaker efficiency shall be required.

10.1.2. Measurement of shaker efficiency is required for all sieves 12-in. diameter or smaller.

NOTE – Screens larger than 12-in. diameter, i.e. 14 x14 in. or 16 x 24 in., are typically used for aggregate separation and accurate measurement of sieving efficiency may be difficult to determine.

10.1.3. Nest the sieves, No. 4 and smaller, according to product being evaluated. Fit the sieve nest with a lid and a pan.

10.1.4. Determine the initial mass of the sample and shake for 6 minutes or by the time established by product history.

10.1.5. Determine and record the percent retained of each sieve size. Verify the material on each sieve does not exceed the maximum allowable mass per **6.2.** If overloaded, repeat using an adjusted sample mass.

10.1.6. Collect and recombine all of the material.

10.1.7. Re-shake the collected material using the same shaker and settings and increase the time by 1 minute.

10.1.8. Determine and record the percent retained of each sieve size.

10.1.9. Compare the percent retained to the percent retained in 10.1.5. The difference between two percent retained values on any sieve shall not exceed 0.5 percent by mass. If the difference between the two percent retained values on any screen exceeds 0.5 percent by mass, then increase the shaker time another minute and repeat the process until the requirement can be met.

10.1.10. Record the minimum shaker time in which the requirement outlined in 10.1.9 is met as the established shaker time for the aggregate product being evaluated. This established shake time shall be used for testing this product in accordance with the procedure established in **Section 6**. For example, if the requirement was met when placed in the shaker for 6 and then 7 minutes, then the 6 minute time on the shaker provides adequate sieving.

11. HAND SIEVING (OPTIONAL)

11.1. Sieving for a sufficient period and in such a manner that, after completion, not more than 0.5% by mass of the total sample passes any sieve during one minute of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turn the sieve about one-sixth of a revolution at intervals of about 25 strokes. In determining sufficiency of sieving for sizes larger than the No. 4 (4.75 mm) sieve, limit the material on the sieve to a single layer of particles. If the size of the mounted testing sieves makes the described sieving motion impractical, use 8 in (203 mm) diameter sieves to verify the sufficiency of sieving.

11.2.[1] An alternative to maintain a snug fitting pan and cover is to sieve the material over an oversized pan. The pan must be large enough to ensure all material is retained during the hand sieving process. Any material leaving the sieve over the top of the rim must be returned to the sieve.

11.3. Once hand sieving is complete return to **Section 6.4** to complete the test procedure.

[1] **11.2.** is not found in **AASHTO T 27** but provides a realistic approach to monitoring material falling thru the sieve.

KANSAS DEPARTMENT OF TRANSPORTATION

WORK SHEET FOR SPLIT SAMPLE GRADATION AND PLASTIC INDEX TEST

Date ____________________ Inspector ______________________ Proj. No. ______________________

Sample No. _____________ Material ______________________ Spec. No. ______________________

A	Dry Wt. of Total Sample g.	D	Dry Wt. of -4.75 (-4) Reduced g.
B	Dry Wt. of +4.75 (-4) Matl. g.	E	% of -4.75 (-4) in Total Sample
C	Dry Wt. of -4.75 (-4) Matl. g.		

Sieve Size	+4 Material		-4 Material		Combined Gradation			Spec.
	Grams Ret. (F)	$\frac{F}{A} \times 100$ (G)	Grams Ret. (H)	$\frac{H}{D} \times 100$ (J)	$\frac{J \times E}{100}$ (K)	% of +4.75 (G)	K + G (R)	
37.5 (1½")								
25 (1")								
19 (¾")								
12.5 (½")								
9.5 (⅜")								
4.75 (4)								
2.36 (8)								
1.18 (16)								
600 (30)								
425 (40)								
300 (50)								
150 (100)								
75 (200)								
75 (200) Dry								

	Dish No.	Dish + Wet Soil (a)	Dish + Dry Soil (b)	Wt. of Dish (c)	Wt. of Dry Soil (d)	Wt. of Water (e)	% Moist. (f)	P.I. (g)
Liquid Limit								
Plastic Limit								

d = b - c
e = a - b

$f = \frac{e}{d} \times 100$

g = Liquid Limit - Plastic Limit

Rev. 9-95

D.O.T. Form No. 645

KT-03: Material Passing No. 200 (75μm) Sieve by the Wash Method

OBJECTIVE

- Determine quantity of material finer than the #200 sieve in aggregate by the wash method

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

1. **SCOPE**

- Determine quantity of material finer than the #200 sieve in aggregate by the wash method
- Total amount passing the #200 sieve must be determined by a combination of washing, drying and re-screening as outlined in KT-02
- KT-03 Reflects Procedures in AASHTO T 11

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

2. REFERENCED DOCUMENTS

- Part V, Section 5.9; Sampling and Test Methods Foreword
- KT-02; Sieve Analysis of Aggregates
- KT-07; Clay Lumps and Friable Particles in Aggregate
- AASHTO M 92 (ASTM E11); Wire-Cloth Sieves for Testing Purposes
- AASHTO T 11; Materials Finer than #200 (75µm) Sieve in Mineral Aggregates by Washing

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

3. APPARATUS

3.1 Use Two Nested Sieves

- No. 200 (75µm) – lower sieve
- No. 8 (2.36 mm) to No. 16 (1.18 mm) – upper sieve

3.2 Pan – Sufficient Size for vigorous agitation without loss of sample or water

3.3 Drying Pans

3.4 Balance – General purpose (Section 5.9 of Part V)

3.5 Drying oven at continuous 230 ± 9^{o}F (110 ± 5^{o}C)

3.6 Wetting Agent – Promote separation of fine materials

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75μm) Sieve by the Wash Method

3. APPARATUS (cont)

Note: Mechanical Washer not precluded

- Consistent results with hand washing
- May degrade some samples

Courtesy of pavementinteractive.org

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

4. TEST SAMPLE

Sample:

- Thoroughly Mixed
- Sufficient moisture to prevent segregation
- Size – Minimize dry mass from Table 1
- Use largest sieve on which 5% or more is specified to be retained
- Monitor for clay lumps

Sieve Size	Minimum Mass of Samples (g)
1½ in (37.5 mm) or more	5,000
¾ in (19.0 mm)	2,500
⅜ in (9.5 mm)	1,000
No. 4 (4.75 mm) or less	300

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

1104.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

TABLE 1104-1: GRADATION AND PLASTICITY OF AGGREGATES FOR AGGREGATE BASE CONSTRUCTION

Type	Percent Retained-Square Mesh Sieves									P.I.	Liquid Limit (Max.)
	2"	1 ½"	1"	¾"	3/8"	No. 4	No. 8	No. 40	No. 200		
AB-1	0	0-10		5-40		35-75	54-85	78-95	90-98	0-6	25
AB-2*			0		1-35		25-50	60-75	78-90	1-6	25
AB-3**	0	0-5		5-30		35-60	45-70	60-84	80-92	1-8	30

*The fraction passing the No. 200 sieve shall not exceed 2/3 of the fraction passing the No. 40 sieve.

**The fraction passing the No. 200 sieve shall not exceed 3/4 of the fraction passing the No. 40 sieve.

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

4. TEST SAMPLE

Sample:

- Thoroughly Mixed
- Sufficient moisture to prevent segregation
- Size – Minimize dry mass from Table 1
- Use largest sieve on which 5% or more is specified to be retained
- Monitor for clay lumps

Sieve Size	Minimum Mass of Samples (g)
1½ in (37.5 mm) or more	5,000
¾ in (19.0 mm)	2,500
⅜ in (9.5 mm)	1,000
No. 4 (4.75 mm) or less	300

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

5. TEST PROCEDURE

5.1.
- Dry to constant mass at 230±9°F (110±5°C)
- Determine mass to nearest 0.1% of the sample mass
- Record as total original dry mass of sample (ODM)

5.2.
- Place sample in container and add water to cover sample
- Add wetting agent to water (small amount of suds)
- Agitate sample vigorously
  - Completely separate minus #200 material from coarse particles
  - Bring fine material into suspension
- Pour wash water over the nested sieves

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

5. TEST PROCEDURE (cont)

5.3.
- Add a 2nd charge of water without the wetting agent
- Agitate vigorously and Decant
- Repeat process until the water is clear
- Return all material on the sieves back to the washed sample
- All water is decanted through the #200 sieve

- For Mechanical Wash Equipment
  Charging of Water, Agitating and Decanting
  is typically a Continuous Operation

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

5. TEST PROCEDURE (cont)

5.4.
- Dry sample to a constant mass at 230±9°F (110±5°C)
- Weigh the sample to the nearest 0.1% of ODM
- This is the Final Dry Mass (FDM)

  Note that this is the mass placed on the sieves in KT-02

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KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

6. CALCULATIONS

$$P = \frac{(ODM - FDM)}{ODM} \times 100$$

Where: P = Percent of material finer than #200 sieve
ODM = Original Dry Mass
FDM = Final Dry Mass (after washing)

7. CHECK DETERMINATIONS (not covered)

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

8. REPORT

- **Record** the material passing the No. 200 (75µm) by washing to the nearest 0.1% of the ODM
- **Report** the material finer than the No. 200 (75µm) by washing
  - to the nearest 0.1% if less than 10% (7.1%, 3.9%, 9.0%, 0.8%)
  - to the nearest 1% (whole number) if 10% or greater (12%, 17%, 20%)

9. PRECISION (not covered)

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Example 1

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A ODM = Original Dry Mass = ______________________ g

B FDM = Final Dry Mass = ______________________ g

C = A-B Mass Lost in the Wash = ______________________ g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing = ______________________ %

Reported Percent Passing = ______________________ %

Kansas Department of Transportation

Example 1

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =		g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing = ________ %

Reported Percent Passing = ________ %

Kansas Department of Transportation

Example 1

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =	583.3	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \text{X } 100$$

Recorded Percent Passing = ______ %

Reported Percent Passing = ______ %

Kansas Department of Transportation

Example 1

ODM = 5876.7 g
FDM = 5293.4 g

$$P = \frac{ODM - FDM}{ODM} \times 100$$

$$P = \frac{(5876.7 - 5293.4)}{5876.7} \times 100$$

$$P = \frac{(583.3)}{5876.7} \times 100$$

$$P = 0.099256 \times 100$$

$$P = 9.9256\%$$

$$P_{rec} = 9.9\%$$

Kansas Department of Transportation

Example 1

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =	583.3	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing =	9.9	%
Reported Percent Passing =		%

Example 1

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	5876.7	g
B	FDM = Final Dry Mass =	5293.4	g
C = A-B	Mass Lost in the Wash =	583.3	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing =	9.9	%
Reported Percent Passing =	9.9	%

Kansas Department of Transportation

Example 2

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	2644.8	g
B	FDM = Final Dry Mass =	2208.5	g
C = A-B	Mass Lost in the Wash =		g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing = ____________ %

Reported Percent Passing = ____________ %

Kansas Department of Transportation

Example 2

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	2644.8	g
B	FDM = Final Dry Mass =	2208.5	g
C = A-B	Mass Lost in the Wash =	436.3	g

$$\text{Percent Passing} = \frac{\text{ODM} - \text{FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing = ________________ %

Reported Percent Passing = ________________ %

Kansas Department of Transportation

Example 2

$$P = \frac{ODM - FDM}{ODM} \times 100$$

ODM = 2644.8 g
FDM = 2208.5 g

$$P = \frac{(2644.8 - 2208.5)}{2644.8} \times 100$$

$$P = \frac{(436.3)}{2644.8} \times 100$$

$$P = 0.1649652 \times 100$$

$$P = 16.49652\%$$

$$P_{rec} = 16.5\%$$

Example 2

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	2644.8	g
B	FDM = Final Dry Mass =	2208.5	g
C = A-B	Mass Lost in the Wash =	436.3	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing = 16.5 %

Reported Percent Passing = ______ %

Example 2

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	2644.8	g
B	FDM = Final Dry Mass =	2208.5	g
C = A-B	Mass Lost in the Wash =	436.3	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \times 100$$

Recorded Percent Passing =	16.5	%
Reported Percent Passing =	16	%

Kansas Department of Transportation

KT-03: Material Passing No. 200 (75µm) Sieve by the Wash Method

OBJECTIVE

- Determine quantity of material finer than the #200 sieve in aggregate by the wash method

5.9.03 MATERIAL PASSING NO. 200 (75µm) SIEVE BY THE WASH METHOD
(Kansas Test Method KT-03)

1. SCOPE

This method of test covers the procedure for determining the quantity of material finer than the No. 200 (75µm) sieve in aggregate by the wash method. It should be recognized that this procedure will not determine the total amount of material finer than the No. 200 (75µm) sieve and that the total amount must be determined by a combination of washing, drying and re-screening as outlined in **KT-02** of this manual. **KT-03** reflects testing procedures found in **AASHTO T 11**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword

2.2. KT-02; Sieve Analysis of Aggregates

2.3. KT-07; Clay Lumps and Friable Particles in Aggregate

2.4. ASTM E11; Woven Wire Test Sieve Cloth and Test Sieves

2.5. AASHTO T 11; Materials Finer Than No. 200 (75µm) Sieve in Mineral Aggregates by Washing

3. APPARATUS

3.1. A nest of two sieves, the lower being a No. 200 (75µm) sieve and the upper being a sieve with openings in the range of No. 8 (2.36 mm) to No. 16 (1.18 mm), both conforming to the requirements of **ASTM E11**.

3.2. A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water.

NOTE: Pans or vessels shall be solid construction and not contain a screen through which the sample or wash water can pass through.

3.3. Drying pans.

3.4. The balance shall conform to the requirements of **Part V, 5.9**, **Sampling and Testing Methods Foreword** for the class of general purpose balance required for the principal sample mass of the sample being tested.

3.5. Oven capable of maintain uniform temperature of 230 ± 9°F (110 ± 5°C).

3.6. *Wetting Agent*—Any dispersing agent, such as liquid dishwashing detergents, that will promote separation of the fine materials.

NOTE: The use of a mechanical apparatus to perform the washing operation is not precluded, provided the results are consistent with those obtained using manual operations. The use of some mechanical washing equipment with some samples may cause degradation of the sample.

4. TEST SAMPLE

Select the test sample from material that has been thoroughly mixed. Except for plant dried aggregate, the material from which the sample is selected should contain sufficient moisture to prevent segregation. Select a representative sample of sufficient size to yield not less than the mass of dried material shown in **Table 1.**

Table 1
Sample Size for Determination of Percent of Material Passing No. 200 (75 µm) Sieve by Washing

Sieve Size	Minimum Mass of Samples (g)
1 1/2 in (37.5 mm) or more	5,000
3/4 in (19.0 mm)	2,500
3/8 in (9.5 mm)	1,000
No. 4 (4.75 mm) or less	300

NOTE: To select the sample size, use the largest sieve on which 5% or more of material is specified to be retained.

NOTE: Monitor test samples for clay lumps. The percent of clay lumps permitted in these aggregates is covered by a separate specification for the following materials and the method of determination is covered by **KT-07**:

- Concrete (except lightweight aggregate).
- Underdrain.
- Cover Material.
- Subgrade Modification or Reconstruction.
- Surfacing or Resurfacing.
- Surfacing or Subgrade Modification for Secondary Roads.
- Crushed Stone for Backfill.

5. TEST PROCEDURE

5.1. Dry the sample to constant mass at a temperature of 230 ± 9°F (110 ± 5°C). Determine the mass of the sample to the nearest 0.1%. Record this as the total original dry mass of sample.

5.2. Place the test sample in the container. Add sufficient water to cover the sample, and add wetting agent to the water. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the No. 200 (75-µm) sieve from the coarser particles, and to bring the fine material into suspension. The use of a large spoon or other similar tool to stir and agitate the aggregate in the wash water has been found satisfactory. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, as described in **Section 3.1.** of this test method, arranged with the coarser sieve on top. Take care to avoid, as much as feasible, the decantation of coarser particles of the sample.

NOTE: There should be enough wetting agent to produce a small amount of suds when the sample is agitated. The quantity will depend on the hardness of the water and the quality of the detergent. Excessive suds may overflow the sieves and carry some material with them.

5.3. Add a second charge of water (without wetting agent) to the sample in the container, agitate, and decant as before. Repeat this operation until the wash water is clear.

NOTE: A spray nozzle or a piece of rubber tubing attached to a water faucet may be used to rinse any of the material that may have fallen onto the sieves. The velocity of water, which may be increased by pinching the tubing or by use of a nozzle, should not be sufficient to cause any splashing of the sample over the sides of the sieve.

Return all material retained on the nested sieves by flushing to the washed sample.

Following the washing of the sample and flushing any materials retained on the No. 200 (75 µm) sieve back into the container, no water should be decanted from the container except through the No. 200 (75 µm) sieve, to avoid loss of material. Excess water from flushing should be evaporated from the sample in the drying process.

If mechanical wash equipment is used, the charging of water, agitating, and decanting may be a continuous operation.

5.4. Dry all material retained to constant mass at a temperature of approximately 230 ± 9°F (110 ± 5°C). Weigh the sample to the nearest 0.1% of the total original dry mass of sample. Record this as the final dry mass. Note that the final dry mass is the same as the original mass of the sample placed on the sieves in KT-02.

6. CALCULATIONS

Calculate the results by use of the following formula:

$$P = \frac{100(\text{ODM} - \text{FDM})}{\text{ODM}}$$

Where: P = Percent of material finer than No. 200 (75 µm).
ODM= Original Dry Mass.
FDM= Final Dry Mass (after washing).

7. CHECK DETERMINATIONS

When check determinations are desired either evaporate the wash water to dryness or filter it through tared filter paper which shall subsequently be dried and the residue weighed. Calculate the percentage by use of the following formula:

$$P = \frac{100(\text{MR})}{\text{ODM}}$$

Where: P = Percent of material finer than No. 200 (75 µm).
MR= Mass of Residue.
ODM= Original Dry Mass.

8. REPORT

Record the material passing the No. 200 (75 µm) sieve by the wash method to 0.1% of the total original dry mass of sample.

Report the percentage of material finer than the No. 200 (75 µm) sieve by washing to the nearest 0.1%, except if the result is 10% or more, report the percentage to the nearest whole number.

9. PRECISION

The estimates for precision of this test method are based on the results from the **AASHTO Materials Reference Laboratory Proficiency Sample Program** and are presented in **Table 2.**

Table 2

	Standard Deviation (1S), Percent	Acceptable Range of two Results (D2S), Percent
Coarse aggregate:		
Single operator precision	0.10	0.28
Multilaboratory precision	0.22	0.62
Fine aggregate:		
Single operator precision	0.15	0.43
Multilaboratory precision	0.29	0.82

KT-11: Moisture Tests

OBJECTIVE

- Determine the Moisture Content of an Aggregate Sample

KT-11: Moisture Tests

1. **SCOPE**
   - Determination of the moisture content of soil and aggregate.
   - Reflects Testing Procedure in AASHTO T 265

Kansas Department of Transportation

KT-11: Moisture Tests

2. REFERENCED DOCUMENTS

- Part V, Section 5.9; Sampling and Test Methods Foreword
- AASHTO T 217; Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester
- AASHTO T 265; Laboratory Determination of Moisture Content of Soils

Kansas Department of Transportation

KT-11: Moisture Tests

3. CONSTANT MASS METHOD

3.1 Apparatus

3.1.1. Balance - Part V, Section 5.9; General Purpose Class

3.1.2. Oven – Continuously Heated at 230 ± 9°F (110 ± 5°C)

3.1.3. Drying Pans

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KT-11: Moisture Tests

4. TEST PROCEDURE FOR CONSTANT MASS METHOD

4.1 Sample Size – If no amount is indicated in the test method

Maximum Particle Size	Minimum Mass of Sample, g
No. 40 (425 µm) sieve	10
No. 4 (4.75 mm) sieve	100
1/2 in (12.5 mm) sieve	300
1 in (25.0 mm) sieve	500
2 in (50 mm) sieve	1000

Kansas Department of Transportation

KT-11: Moisture Tests

4.2 Test Procedure

1. Weigh clean dry container with lid (soils)
2. Put sample in container and replace lid immediately
3. Weigh container, lid and moist sample
4. Remove lid and put container with moist sample in oven
5. Dry to a constant mass
6. Remove from oven and replace lid
7. Cool to Room Temperature
8. Weigh container, lid and dried sample

KT-11: Moisture Tests

4.2 First NOTE

- Drying over-night is usually sufficient (15-16 hours)
- Can check mass after 2 consecutive drying periods to verify time is adequate – no change in mass
- Sand may often dry in a period of several hours
- Don’t put wet samples in oven with dry samples

Third NOTE

- Moisture content samples for soils should be discarded and not used for other tests

Aggregate Field Testing Technician
KT-11: Moisture Tests

	Test Sample
1.	Select a representative quantity of sample in the amount indicated in the appropriate table. (4.1.)
	Procedure
2.	Weigh a clean, dry container. Record the weight. (4.2.)
3.	Place the moist sample in the container and weigh. Record the weight. (4.2.)
4.	Place the container with the sample in the drying oven at 230 +/- 9 ° F (110 ° +/- 5° C) and dry to a constant mass. (4.2.)
5.	Upon removal from the oven, allow sample to cool to room temperature. (4.2.)
6.	Weigh and record the weight of the container with the dried sample. (4.2.)
7.	Calculate the moisture content. (5.1.)

Kansas Department of Transportation

KT-11: Moisture Tests

5. CALCULATIONS

w=[(mass of moisture)/(mass of oven-dried sample)] x100

$$w=[(W_1-W_2)/(W_2-W_c)] \times 100$$

Where: w = moisture content, percent

W_1 = mass of container and moist sample, g

W_2 = mass of container and oven-dried sample, g

W_c = mass of container, g

Kansas Department of Transportation

KT-11: Moisture Tests

6. REPORT

- **Record** moisture content to nearest 0.01% of mass of the oven dried sample
- **Report** percent of moisture content to the nearest 0.1%

KT-11: Moisture Tests

7. GAS PRESSURE (‘SPEEDY”) METHOD

NOTE: Not to be used on granular materials having more than 5% particles large enough to be retained on a No. 4 (4.75 mm) sieve as determined by a visual estimate.

Therefore, this is not used on Aggregate.

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KT-11: Moisture Test Worksheet Example 1

W_c = mass of container 512.4 g

W_1 = mass of container and moist sample 904.0 g

W_2 = mass of container and oven dried sample 873.5 g

W = moisture content

$$W = \frac{(W_1 - W_2)}{(W_2 - W_c)} \times 100$$

$$\frac{904.0 - 873.5}{873.5 - 512.4} \times 100$$

$$\frac{\text{Mass of Water}}{\text{Mass of Dry Agg.}} = \frac{30.5}{361.1} \times 100$$

Recorded W = 8.45 %

8.4464

Reported W = 8.4 %

Kansas Department of Transportation

KT-11: Moisture Test Worksheet Example 2

W_c = mass of container 838.4 g

W_1 = mass of container and moist sample 1187.3 g

W_2 = mass of container and oven dried sample 1155.5 g

W = moisture content

$$W = \frac{(W_1 - W_2)}{(W_2 - W_c)} \times 100$$

$$\frac{1187.3 - 1155.5}{1155.5 - 838.4} \times 100$$

$$\frac{\text{Mass of Water}}{\text{Mass of Dry Agg.}} = \frac{31.8}{317.1} \times 100$$

Recorded W = 10.03 %   10.02838

Reported W = 10.0 %

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KT-11: Moisture Tests

OBJECTIVE

- Determine the Moisture Content of an Aggregate Sample

Kansas Department of Transportation

5.9.11 MOISTURE TESTS (Kansas Test Method KT-11)

1. SCOPE

This method of test covers the procedure for the determination of the moisture content of soil and aggregate. **KT-11** reflects testing procedures found in **AASHTO T 217** and **T 265**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword

2.2. AASHTO T 217; Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester

2.3. AASHTO T 265; Laboratory Determination of Moisture Content of Soils

3. CONSTANT MASS METHOD

3.1. Apparatus:

3.1.1. The balance shall conform to the requirements of **Part V, 5.9**, **Sampling and Test Methods Foreword** for the class of general-purpose balance required for the principal sample mass of the sample being tested.

3.1.2. Drying oven should be thermostatically controlled, preferably of the forced-draft type. It shall be capable of being heated continuously at a temperature of 230 ± 9°F (110 ± 5°C).

3.1.3. Drying pans.

4. TEST PROCEDURE FOR CONSTANT MASS METHOD

4.1. Select a representative quantity of sample in the amount indicated in the method of test. If no amount is indicated, the minimum mass of the sample shall be in accordance with the following table:

Maximum Particle Size	Minimum Mass of Sample, g
No. 40 (425 µm) sieve	10
No. 4 (4.75 mm) sieve	100
1/2 in (12.5 mm) sieve	300
1 in (25.0 mm) sieve	500
2 in (50.0 mm) sieve	1000

4.2. Weigh a clean, dry container (with its lid if used for soils) and place the moisture content sample in the container. Replace the lid (if used) immediately, and weigh the container, including the lid (if used) and moist sample. Remove the lid (if used) and place the container with the moist sample in the drying oven maintained at a temperature of 230 ± 9°F (110 ± 5°C) and dry to a constant mass. Immediately upon removal from the oven, replace the lid (if used) and allow the sample to cool to room temperature. Weigh the container including lid (if used) and dried sample.

NOTE: Checking every moisture content sample to determine that it is dried to a constant mass is impractical. In most cases, drying of a moisture sample over-night (15 to 16 hours) is sufficient. In cases where there is doubt concerning the adequacy of overnight drying, drying should be continued until the mass after two successive periods of drying indicate no change in mass. Samples of sand may often be dried to constant mass in a period of several hours. Since dry samples may absorb moisture from wet samples, dried samples should be removed before placing wet samples in the oven.

NOTE: (for bulk soil samples): A container without a lid may be used provided the moist sample is weighed immediately after being taken and providing the dried sample is weighed immediately after being removed from the oven or after cooling in a desiccators. This provision does not apply to samples used for plasticity index determination; lids must be used.

NOTE: Moisture content samples for soils should be discarded and should not be used in any other tests.

5. CALCULATIONS

5.1. Calculate the moisture content as follows:

$w=[(\text{mass of moisture})/(\text{mass of oven-dried sample})]\times 100$

$w=[(W_1-W_2)/(W_2-W_c)]\times 100$

Where: w = moisture content, percent
W_1 = mass of container and moist sample, g
W_2 = mass of container and oven-dried sample, g
W_c = mass of container, g

5.2. Calculate the percent of moisture content.

6. REPORT

6.1. Record the moisture content to the nearest 0.01% of mass of the oven dried sample. Report the percent of moisture content to the nearest 0.1%.

7. GAS PRESSURE ('SPEEDY") METHOD

7.1 Significance and Use

This test method outlines procedures for determining the moisture content of soil by chemical reaction using calcium carbide as a reagent to react with the available water in the soil producing a gas. A measurement is made of the pressure produced when a specified mass of wet or moist soil is placed in a testing device with an appropriate volume of reagent and mixed.

This method is not intended as a replacement for Section 3, Constant Mass Method, but as a supplement when rapid results are required, for field use some distance from a lab or where an oven is not practical for use on the project.

This method is applicable for most soils, however, some soils that contain highly plastic clays that are not friable and do not break down may not produce representative results as the reagent may not react with all

the moisture contained in the sample. It is recommended to use Section 3 if highly accurate results are needed.
NOTE: This method shall not be used on granular materials having more than 5% particles large enough to be retained on a No. 4 (4.75 mm) sieve as determined by a visual estimate. The Super 200 D Tester is intended to be used when testing aggregate.

7.2. Apparatus

7.2.1. Calcium carbide pressure moisture tester. **(Figure 1)**

7.2.2. The balance shall conform to the requirements of **Part V, 5.9**, **Sampling and Test Methods Foreword.**

7.2.3. Two 1.25 in (31.75 mm) steel balls.

7.2.4. Cleaning brush and cloth.

7.2.5. Scoop for measuring calcium carbide reagent.

8. MATERIAL

8.1. Calcium carbide reagent.

NOTE: The calcium carbide must be finely pulverized and should be of a grade capable of producing acetylene gas in the amount of at least 2.25 ft^3/lb (90.14 m^3/kg) of carbide.

NOTE: The "shelf life" of the calcium carbide reagent is limited, so it should be used according to manufacturer recommendations.

NOTE: When combined with water, the calcium carbide reagent produces a highly flammable or explosive acetylene gas. Testing should not be carried out in confined spaces or in the vicinity of open flame or other source of heat that could cause combustion.

9. TEST PROCEDURE FOR SPEEDY METHOD

9.1. When using the 20 g or 26 g tester, place three scoops (approximately 24 g) of calcium carbide in the body of the moisture tester. When using the Super 200 D Tester to test aggregate, place 6 scoops (approximately 48 g) of calcium carbide in the body of the moisture tester.

NOTE: Care must be exercised to prevent the calcium carbide from coming into direct contact with water.

9.2. Weigh a sample of the exact mass specified by the manufacturer of the instrument in the balance provided and place the sample in the cap of the tester. When using the 20 g or 26 g size tester, place two 1.25 in (31.75 mm) steel balls in the body of the tester with the calcium carbide.

NOTE: If the moisture content of the sample exceeds the limit of the pressure gauge (12% moisture for aggregate tester or 20% moisture for soil tester), a one-half size sample must be used and the dial reading must be multiplied by 2. This proportional method is not directly applicable to the dry mass percent scale on the Super 200 D Tester.

9.3. With the pressure vessel in an approximately horizontal position, insert the cap in the pressure vessel and seal the unit by tightening the clamp, taking care that no carbide comes in contact with the soil until a complete seal is achieved.

9.4. Raise the moisture tester to a vertical position so that the soil in the cap will fall into the pressure vessel.

9.5. Shake the instrument vigorously so that all lumps will be broken up to permit the calcium carbide to react with all available free moisture. When steel balls are being used in the tester and when using the larger tester to test aggregate, the instrument should be shaken with a rotating motion so the steel balls or aggregate will not damage the instrument or cause soil particles to become embedded in the orifice leading to the pressure diaphragm.

NOTE: Shaking should continue for at least 60 seconds with granular soils and for up to 180 seconds for other soils so as to permit complete reaction between the calcium carbide and the free moisture. Time should be permitted to allow dissipation of the heat generated by the chemical reaction.

9.6. When the needle stops moving, read the dial while holding the instrument in a horizontal position at eye level.

9.7. Record the dial reading.[1]

9.8. With the cap of the instrument pointed away from the operator, slowly release the gas pressure. Empty the pressure vessel and examine the material for lumps. If the sample is not completely pulverized, the test should be repeated using a new sample. Clean the cap thoroughly of all carbide and soil before running another test.

NOTE: When removing the cap, care should be taken to point instrument away from the operator to avoid breathing the fumes and away from any potential source of ignition for the acetylene gas.

9.9. The dial reading is the percent of moisture by wet mass and must be converted to dry mass. With the Super 200 D Tester the dial reading is the percent of moisture by dry mass, and no further calculation is required.

10. CALCULATION

10.1 The percentage of moisture by dry mass of the soil may be determined from the conversion curve either provided with the device, a curve developed from local soils or the calculation provided with the device. Preference should be given to a curve developed from local soils that are to be used on a project.

10.2 Calibration curves are produced by selecting several samples representing the range of soil materials to be tested and having a relatively wide range of moisture content. Utilize the method in Section 3 alongside the Speedy to develop the curve.

[1] **AASHTO T 217** requires recording sample mass and dial reading.

NOTE: A conversion curve, similar to **Figure 2,** is normally supplied with the moisture tester. However, check each moisture tester for accuracy of its gage, or the accuracy of the conversion curve annually[2]. Accuracy of the tester gage may be checked by using a calibration kit (obtainable from the tester manufacturer), equipped with the standard gage; in case of discrepancy, the gage tester should be adjusted to conform to the standard gage. For checking the accuracy of the conversion curve, a calibration should be made for meter readings using locally prepared soils at known moisture contents. Also, additional testing may be necessary to extend the conversion curve (**Figure 2**) beyond 44% moisture content.
NOTE: It may be convenient for field use of the apparatus to prepare a table of moisture tester readings versus oven-dry moisture content for the moisture tester.

11. REPORT

11.1. Record the dial reading to the nearest 0.1% and determine the percent moisture from the conversion chart. Report the percentage of moisture to the nearest whole percent.

[2] KDOT requires that each Speedy Moisture tester be checked annually for accuracy of reading.

Figure 1 Calcium Carbide Gas Pressure Moisture Meter

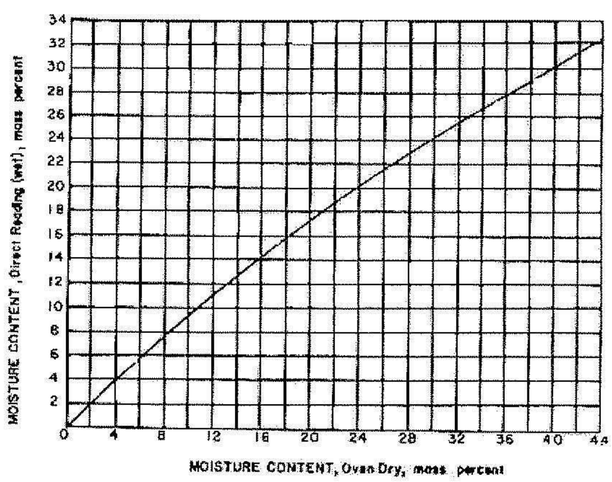

Figure 2 Conversion Curve for Moisture Tester Reading

KT-50: Uncompacted Void Content of Fine Aggregate

OBJECTIVE

- Determine the Uncompacted Void Content of a Sample of Aggregate on a given gradation

KT-50: Uncompacted Void Content of Fine Aggregate

1. **SCOPE**

- Determine the Uncompacted Void Content of a Sample of Aggregate on a given gradation
- Compares other fine aggregates tested and provides a Measure of
  - Aggregate Angularity
  - Aggregate Sphericity
  - Aggregate Texture
- Reflects Testing Procedures in AASHTO T 304 (Distant Cousins)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

2. REFERENCED DOCUMENTS

- Part V, 5.9; Sampling and Test Methods Foreword
- KT-03; Material Passing No. 200 (75 µm) Sieve by the Wash Method
- AASHTO T 304; Uncompacted Void Content of Fine Aggregate
- ASTM B88; Specification for Seamless Copper Water Tube
- ASTM C778; Specification for Standard Sand

KT-50: Uncompacted Void Content of Fine Aggregate

3. APPARATUS

3.1. Oven – Continuously Heated at 230 ± 9°F (110 ± 5°C)
3.2 Funnel (Volume ≥ 200 mL or supplemental container)
3.3 Funnel Stand
3.4 Right Angle Cylinder (100 mL)
3.5 Pan to prevent loss of material
3.6 Metal Spatula
3.7 Balance - Part V, 5.9; Sampling & Test Methods Foreword
3.8 200 mL Flask
3.9 Brush
3.10 Funnel #2 (transfer sample to flask)

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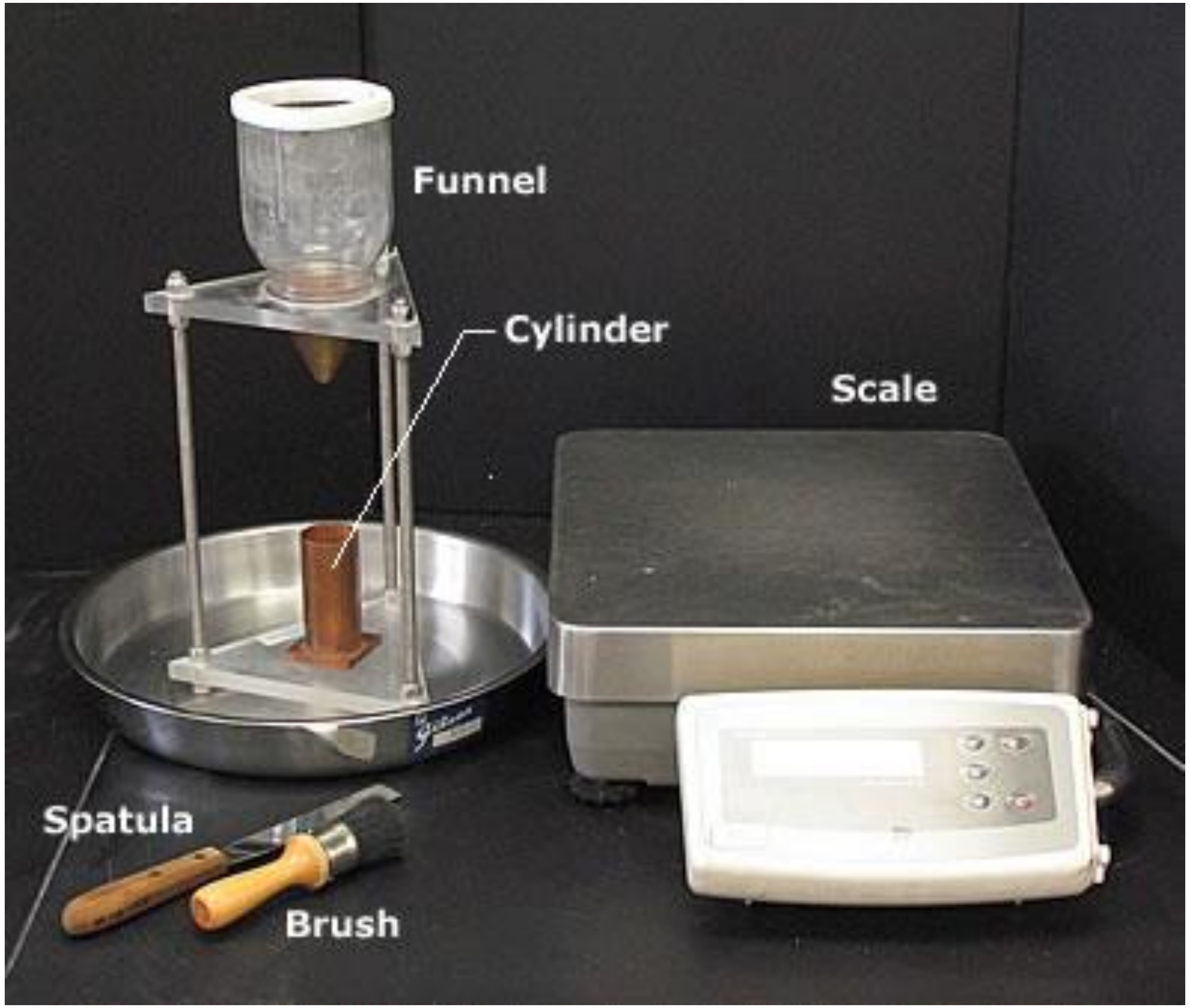
KT-50: Uncompacted Void Content of Fine Aggregate

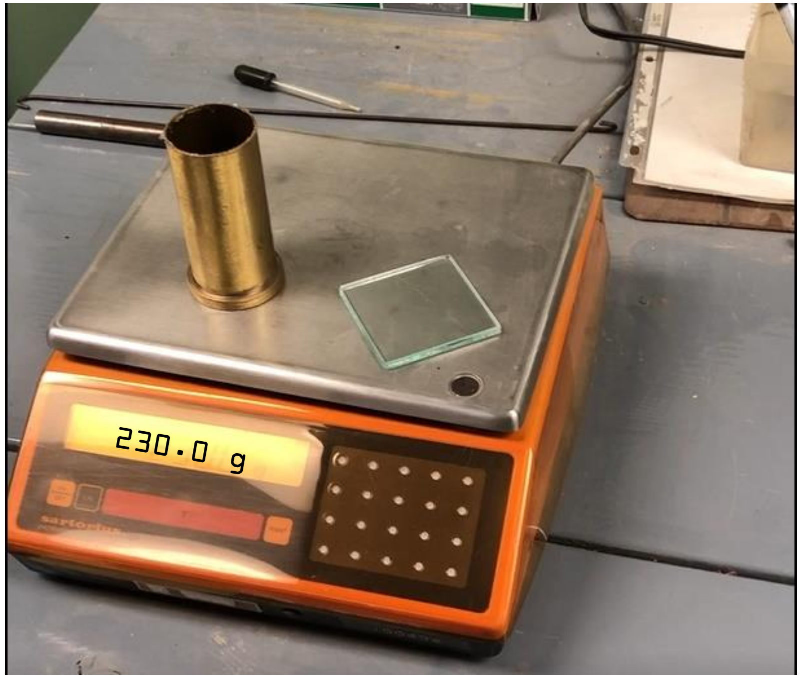


Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

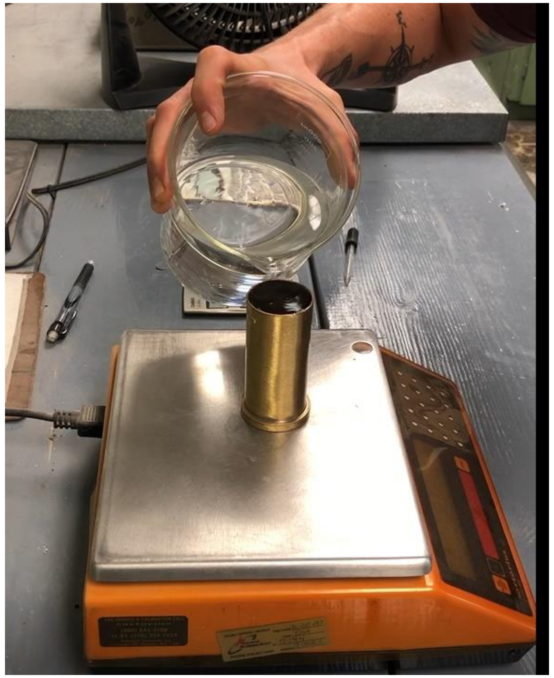
- Apply grease to top edge of dry, empty measure
- Weigh measure, grease and flat glass plate (c)

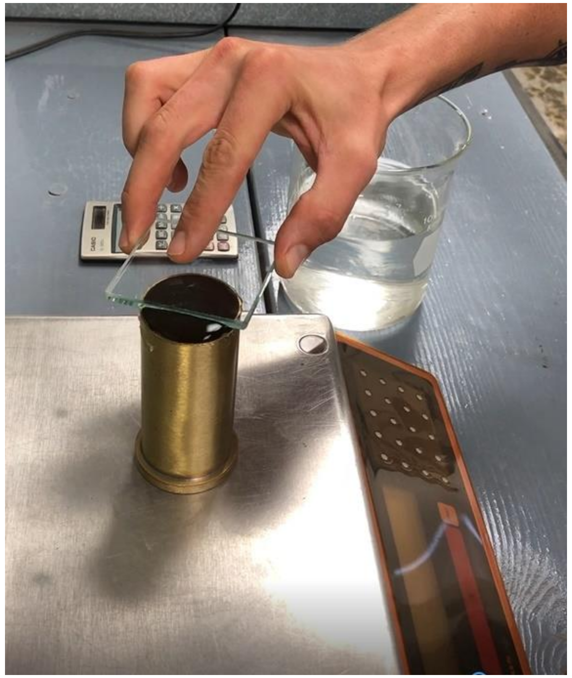


KT-50: Uncompacted Void Content of Fine Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

- Fill measure with distilled/deionized water at 77±2°F (25±1°C)
- Place glass on measure and remove air bubbles





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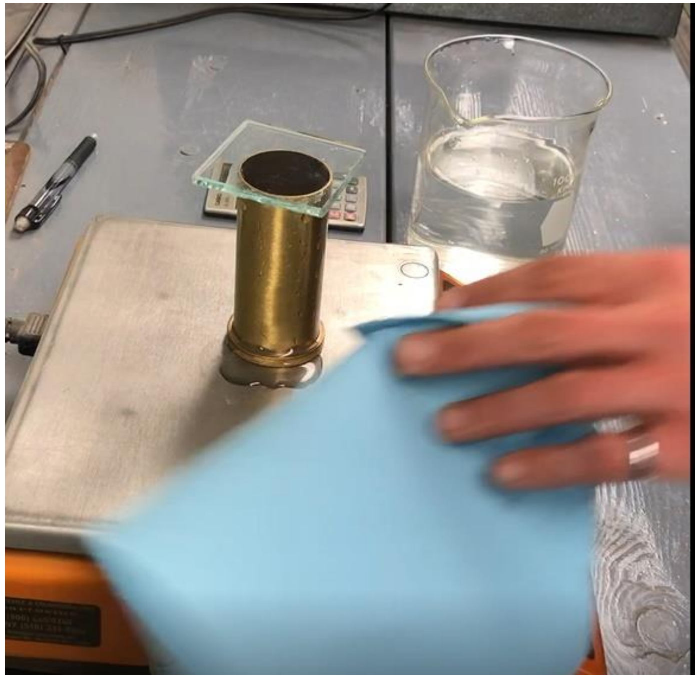
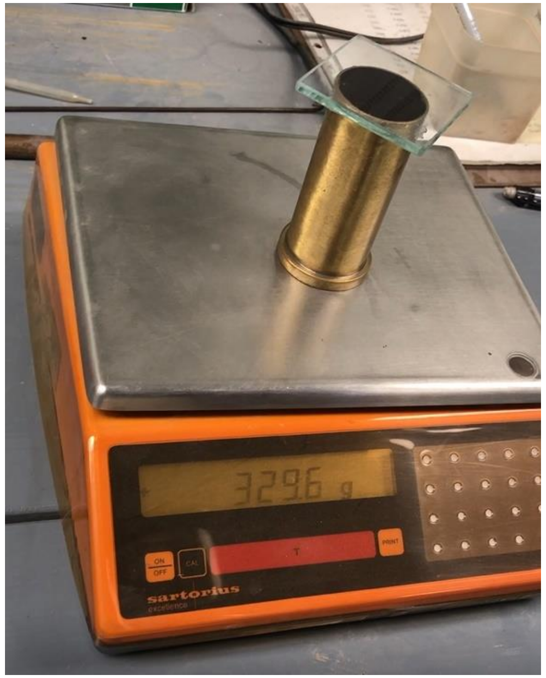
KT-50: Uncompacted Void Content of Fine Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

- Dry the outer surfaces
- Weigh measure, grease, flat glass plate, and water (d)



Perform at least yearly



KT-50: Uncompacted Void Content of Fine Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

- Apply grease to top edge of dry, empty measure
- Weigh measure, grease and flat glass plate (c)
- Fill measure with distilled/deionized water at 77±2°F (25±1°C)
- Place glass on measure and remove air bubbles
- Dry the outer surfaces
- Weigh measure, grease, flat glass plate, and water (d)
- Perform at least yearly

KT-50: Uncompacted Void Content of Fine Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE (cont)

- Calculate the volume of the measure to the nearest 0.1 mL

$$V_c = \frac{W}{0.99704}$$

Where:

V_c = volume of cylinder, mL
W = d – c = net mass of water, g
c = cylinder + glass + grease, g
d = cylinder + glass + grease + water, g
0.99704 g/mL is density of water at 77±2°F (25±1°C)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

KT-50
Uncompacted Void Content of Fine Aggregate
Calibration of Cylinder Worksheet

Cylinder Number ____________

c = Mass of Cylinder + Grease + Glass ____________ g

d = c + Water ____________ g

Temperature of Water ___77___ °F

D = Density of Water at Test Temperature* ___0.99704___ g/mL

W = Mass of Water in Cylinder = (d - c) = ____________ g

V_c = Calibrated Volume of Cylinder

V_c = W/D = ____________ mL

Kansas Department of Transportation

Cylinder Number KT-50-1

c = Mass of Cylinder + Grease + Glass 230.0 g

d = c + Water 329.6 g

W = 329.6 - 230.0

Temperature of Water 77 °F

D = Density of Water at Test Temperature* 0.99704 g/mL

W = Mass of Water in Cylinder = (d - c) = 99.6 g

V_c = Calibrated Volume of Cylinder

$V_c = 99.6 / 0.99704$

$V_c = 99.89569$

Vc = W/D = 99.9 mL

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

5. SAMPLE PREPARATION

5.1.
- Run KT-03: Sections 3 and 5
- Dry Sample to a Constant Mass

5.2. Sieve the material to obtain the following for each test sample

Individual Size Fraction	Mass (g)
#8 to #16	44 ± 0.2
#16 to #30	57 ± 0.2
#30 to #50	72 ± 0.2
#50 to #100	17 ± 0.2
TOTAL	**190**

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

5. SAMPLE PREPARATION (cont)

5.3. Prepare 2 test samples of the above recipe

NOTE: If U_k values have been below the specified (full pay) value the Engineer may increase the number of test samples from 2 to 4 (Section 9)

Kansas Department of Transportation

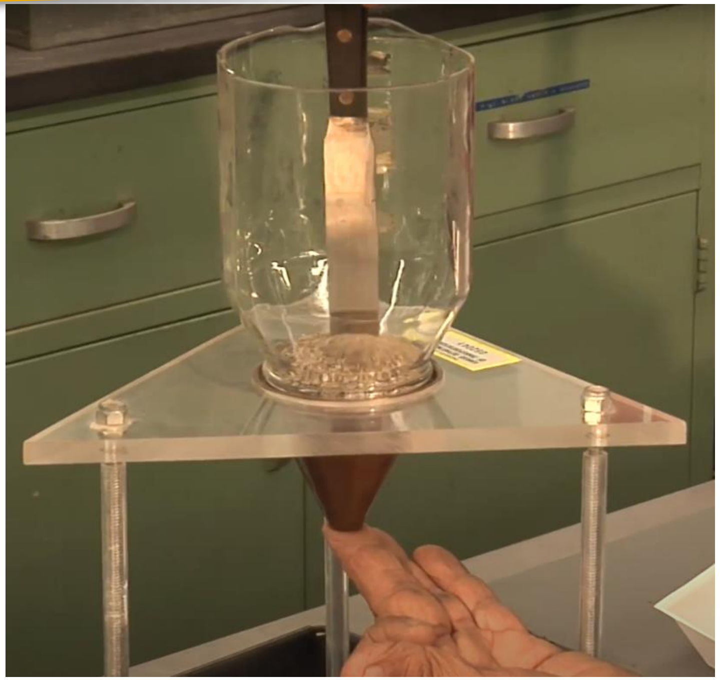
KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE

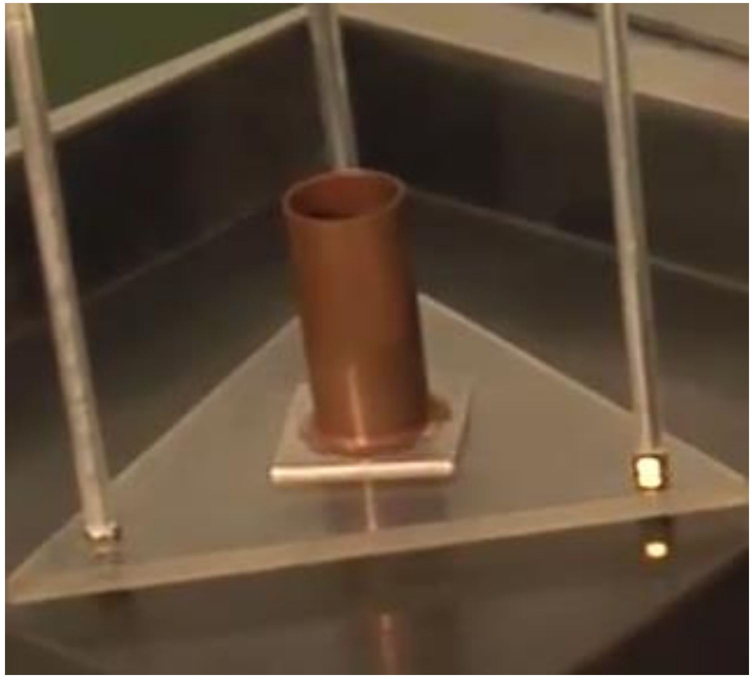
5. Mix the test sample until it is homogenous. (6.1.)

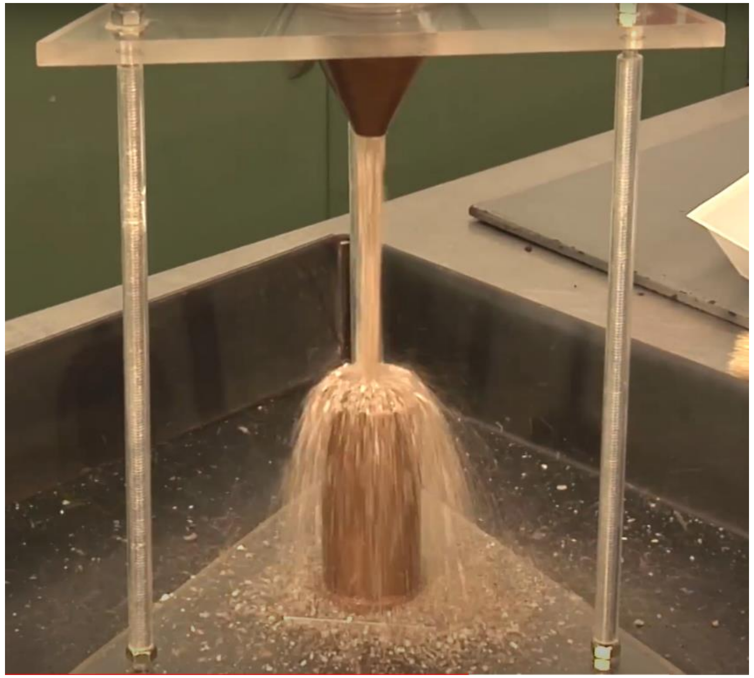
6. Using a finger to block the opening of the funnel, pour the test sample into the funnel. (6.1.)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE





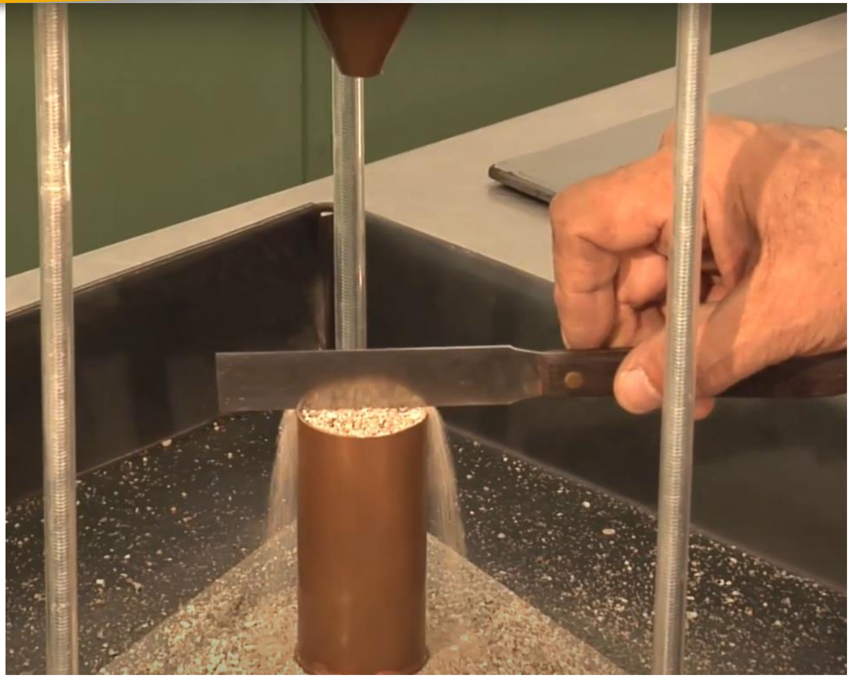


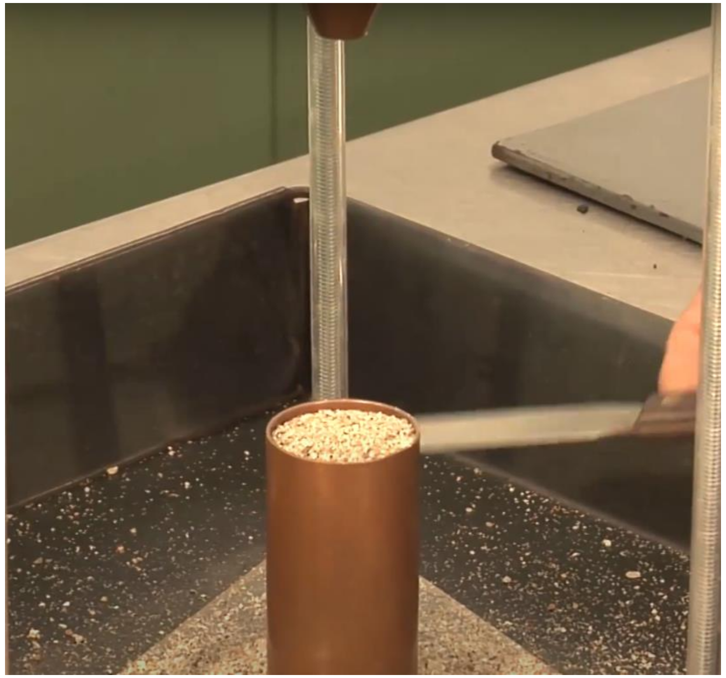
7. Level the material in the funnel with the spatula. Center the measure under the funnel, remove finger and allow the sample to fall freely into the measure. (6.1.)

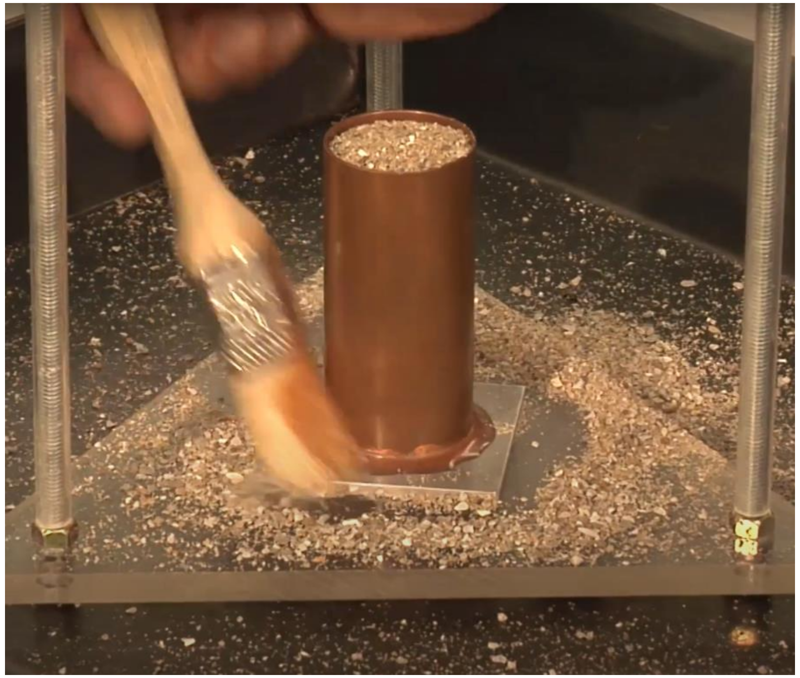
8. Exercise care to avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure. (6.2.)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE







9. After the funnel empties, remove excess aggregate from the measure by a single pass of the spatula with the blade vertical using the straight part of its edge in light contact with the top of the measure. (6.2.)
10. After strike off, tap the measure lightly to compact the sample. Brush adhering grains from the outside of the measure. (6.2.)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE

11. Pour contents of measure into 200 mL volumetric flask using a funnel to assure total transfer of aggregate. (6.3.)

12. Weigh the flask and sample, record as A. (6.4.)

Kansas Department of Transportation

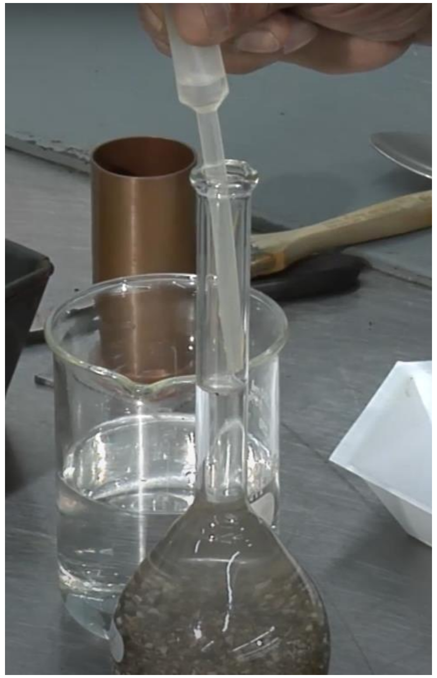
KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE

13. Add distilled water (deionized water can be substituted). Rotate the flask in an inclined position to eliminate all air bubbles. Do not shake. (6.5.)

14. Allow the flask to sit for several minutes then roll flask again. Continue the process until there is no visible air bubbles present or for a maximum of 15 minutes, whichever comes first. Distilled water (and entire test) should be, 77 ± 2^{o}F (25 ± 1^{o}C) (6.5.)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE



15. Adjust distilled water to the calibrated volume mark on the neck of the flask. (6.6.)

16. Weigh flask and contents, record as B. (6.7.)

17. Repeat procedure for the second test sample and record results. (6.8.)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

7. CALCULATIONS

7.1. Calculate the uncompacted void content, (U_k), by this method

$$U_k = \frac{U_1 + U_2}{2}$$

Where: U_1 and U_2 are the uncompacted void content for Trial No. 1 and Trial No.2 respectively, and are determined by:

$$U_{1,2} = \frac{100\,[V_w - V_f + V_c]}{V_c}$$

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

7. CALCULATIONS (cont)

$$U_{1,2} = \frac{100\,[V_w - V_f + V_c]}{V_c}$$

Where:

V_f = volume of flask (manufacturer's calibrated volume), 200 mL

V_c = Calibrated volume of cylinder, mL

V_w = Volume of the water, mL = $\frac{B - A}{0.99704}$

Where:

B = mass of flask, water and aggregate, g

A = mass of flask and aggregate, g

0.99704 g/mL is the density of water at 77 ± 2°F (25 ± 1°C)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

8. REPORT

8.1. Record U_k, U_1, and U_2 to the nearest 0.1%
Report U_k to the nearest 1%

9. CONFIRMATION OF TEST VALUES

9.1. If 2 values differ by more than 1.0%, then run 4 tests

9.2. If test fails the specified value with 2 values, then run 4 tests

- Recall the note under 5.3 where if the previous tests failed on a project, the Engineer can go straight to 4 values.

$$U_k = \frac{U_1 + U_2 + U_3 + U_4}{4}$$

Kansas Department of Transportation

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used ____________	Trial #1	Trial #2
A = mass of the flask and aggregate =	________ g	________ g
B = mass of the flask, water, and aggregate =	________ g	________ g
V_w = volume of water = (B - A)/0.99704* =	________ mL	________ mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = ____________ mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = ____________ % U_2 = ____________ %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ____________ %

Reported U_k = ____________ %

* Requirement for test is 77 ± 2 °F (D = 997.04 kg/m^3)
(correction factors for other temperatures can be found in Table 5.16.15-1 in KT-15)

KT-50: Uncompacted Void Content of Fine Aggregate Example

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-50-1

	Trial #1	Trial #2
A = mass of the flask and aggregate =	249.0 g	248.9 g
B = mass of the flask, water, and aggregate =	390.0 g	390.6 g
V_w = volume of water = (B -A)/0.99704* =	141.4186 mL	142.1207 mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = 99.9 mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = ______ % U_2 = ______ %

$$V_w = \frac{(B\text{-}A)}{0.99704}$$

$$V_{w1} = \frac{(390.0\text{-}249.0)}{0.99704}$$

$$V_{w1} = \frac{(141.0)}{0.99704}$$

$$V_{w1} = 141.4186$$

$$V_w = \frac{(B\text{-}A)}{0.99704}$$

$$V_{w2} = \frac{(390.6\text{-}248.9)}{0.99704}$$

$$V_{w2} = \frac{(141.7)}{0.99704}$$

$$V_{w2} = 142.1207$$

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate Example

$$U_{1,2} = \frac{(V_w - V_f + V_c)}{V_c} \times 100$$

$$U_1 = \frac{(141.4186 – 200 + 99.9)}{99.9} \times 100$$

$$U_1 = \frac{(41.3186)}{99.9} \times 100$$

$$U_1 = 0.413600 \times 100$$

$$U_1 = 41.3600$$

$$U_1 = 41.4$$

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-50-1

	Trial #1	Trial #2
A = mass of the flask and aggregate =	249.0 g	248.9 g
B = mass of the flask, water, and aggregate =	390.0 g	390.6 g
V_w = volume of water = (B - A)/0.99704* =	141.4186 mL	142.1207 mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = 99.9 mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = 41.4 % U_2 = ______ %

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate Example

$$U_{1,2} = \frac{(V_W - V_f + V_c)}{V_c} \times 100$$

$$U_2 = \frac{(142.1207 – 200 + 99.9)}{99.9} \times 100$$

$$U_2 = \frac{(42.0207)}{99.9} \times 100$$

$U_2 = 0.420628 \times 100$

$U_2 = 42.0628$

$U_2 = 42.1$

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-50-1

	Trial #1	Trial #2
A = mass of the flask and aggregate =	249.0 g	248.9 g
B = mass of the flask, water, and aggregate =	390.0 g	390.6 g
V_w = volume of water = (B -A)/0.99704* =	141.4186 mL	142.1207 mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = 99.9 mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = 41.4 % U_2 = 42.1 %

Kansas Department of Transportation

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-50-1

	Trial #1	Trial #2
A = mass of the flask and aggregate =	249.0 g	248.9 g
B = mass of the flask, water, and aggregate =	390.0 g	390.6 g
V_w = volume of water = (B -A)/0.99704* =	141.4186 mL	142.1207 mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = 99.9 mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = 41.4 % U_2 = 42.1 %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = 41.8 %

Reported U_k = 42 %

$$U_k = \frac{(U_1 + U_2)}{2}$$

$$U_k = \frac{(41.4 + 42.1)}{2}$$

$$U_k = \frac{(83.5)}{2}$$

U_k = 41.75

U_k = 41.8 (Recorded)

U_k = 42 (Reported)

Kansas Department of Transportation

KT-50: Uncompacted Void Content of Fine Aggregate

OBJECTIVE

- Determine the Uncompacted Void Content of a Sample of Aggregate on a given gradation

5.9.50 UNCOMPACTED VOID CONTENT OF FINE AGGREGATE (Kansas Test Method KT-50)

1. SCOPE

This method of test covers the determination of the uncompacted void content of a sample of aggregate based on a given gradation. It provides a measure of aggregate angularity, sphericity, and texture compared to other fine aggregates tested. **KT-50** reflects testing procedures found in **AASHTO T 304**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword

2.2 KT-03; Material Passing No. 200 (75 µm) Sieve by the Wash Method

2.3. AASHTO T 304; Uncompacted Void Content of Fine Aggregate

2.4. ASTM B88; Specification for Seamless Copper Water Tube

2.5. ASTM C778; Specification for Standard Sand

3. APPARATUS

3.1. Drying oven capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C).

3.2. The funnel shall be smooth on the inside and at least 1.5 in (38 mm) high. It shall have a volume of at least 200 mL or shall be provided with a supplemental container to provide the required volume. The lateral surface of the right frustum of a cone sloped 60 ± 4 degrees from the horizontal with an opening of 0.50 ± 0.024 in (12.7 ± 0.6 mm) diameter. The funnel and supplemental container shall comply with the apparatus shown in **Figure 1**.

3.3. A funnel stand capable of holding the funnel firmly in position with its axis collinear with the axis of the measure and funnel opening 4.5 ± 0.1 in (115 ± 2 mm) above the top of the cylinder. A suitable arrangement is shown in **Figure 1**.

3.4. A right angle cylinder of approximately 6.1 in^3 (100 mL) capacity having an inside diameter of 1.53 ± 0.05 in (39 ± 1.3 mm), and an inside height of approximately 3.37 in (86 mm), made of drawn copper water tubing meeting **ASTM B88,** Type M or equally rigid material. The bottom of the measure shall be at least 0.24 in (6 mm) thick, shall be firmly sealed to the tubing, and shall be provided with means for aligning the axis of the cylinder with that of the funnel. See **Figure 2**.

3.5. A metal or plastic pan of sufficient size to contain the funnel stand and to prevent loss of material. The purpose of the pan is to catch and retain aggregate grains that overflow the measure during filling or strike off.

3.6. Metal spatula about 4 in (100 mm) long with sharp straight edges. The straight edge of the spatula is used to strike off the fine aggregate.

3.7. The balance shall conform to the requirements of **Part V, 5.9; Sampling and Test Methods Foreword**, for the class of general purpose balance required for the principal sample mass of the sample being tested.
3.8. 200 mL volumetric flasks TC at 68°F (20°C) accurate and readable to ± 0.10 mL.

3.9. A brush small enough to use to dislodge aggregate from the measure's base while inside the funnel stand.

3.10. A small plastic or metal or glass funnel with a neck small enough to insert into the 200 mL volumetric flasks but sufficiently large enough in inside diameter to transfer all the contents of the measure to the flask.

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

Apply a light coat of grease to the top edge of the dry, empty measure. Weigh the measure, grease, and a flat glass plate slightly larger than the diameter of the measure. Fill the measure with distilled/deionized water at a temperature of 77 ± 2°F (25 ± 1°C). Place the glass on the measure, being sure that no air bubbles remain. Dry the outer surfaces of the measure and determine the combined mass of measure, glass plate, grease and water by weighing. This procedure should be done at least once a year.

Calculate the volume of the measure as follows:

$$V_c = \frac{W}{0.99704}$$

Where: V_c = volume of cylinder, mL
W = d-c = net mass of water, g
c = cylinder + glass + grease, g
d = cylinder + glass + grease + water, g
0.99704 g/mL is the density of water at 77 ± 2°F (25 ± 1°C).

Determine the volume to the nearest 0.1 mL.

NOTE: Density of water varies based on temperature. Since the water bath temperature is fixed at 77 ± 2°F (25 ± 1°C), use the specified value of 0.99704 g/mL. For tests not restrained by the 77 ± 2°F (25 ± 1°C) requirement, select the proper density for water from KT-15, Table 1. Divide the value given in the table by 1000 for g/mL.

5. SAMPLE PREPARATION

5.1. Wash the sample over the No. 200 (75 µm) sieve using the equipment and procedures listed in **KT-03, section 3 and section 5.** Dry the plus No. 200 (75 µm) material to a constant mass. Sieve the dry aggregate over the No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No.50 (300 µm) and No. 100 (150 µm) sieves. Discard all the material retained on the No. 8 (2.36 mm) and passed through the No. 100 (150 µm).

5.2. Weigh out and combine the following quantities of dry aggregate from each of the sizes:

Individual Size Fraction	Mass, g
No. 8 (2.36 mm) to No. 16 (1.18 mm)	44
No. 16 (1.18 mm) to No. 30 (600 µm)	57
No. 30 (600 µm) to No. 50 (300 µm)	72
No. 50 (300 µm) to No. 100 (150 µm)	17
TOTAL	**190**

The tolerance on each of these amounts is ± 0.2 g

5.3. Prepare two test samples of the above recipe.

NOTE: If U_k values below the specified (full pay) value have been obtained from previous tests on this project, the Engineer may increase the number of test samples from two to four, and go directly to the U_k determination specified in **section 9.** of this test method. This is in lieu of performing a two-sample test, discarding a failed result, and retesting with four samples.

6. TEST PROCEDURE

6.1. Mix the test sample until it is homogenous. Using a finger to block the opening of the funnel, pour the test sample into the funnel. Level the material in the funnel with the spatula. Center the measure under the funnel, remove the finger and allow the sample to fall freely into the measure.

6.2. After the funnel empties, remove excess heaped aggregate from the measure by a single pass of the spatula with the blade vertical using the straight part of its edge in light contact with the top of the measure. Until this operation is complete, exercise care to avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure. After strike-off the measure may be tapped lightly to compact the sample to make it easier to transfer the measure. Brush adhering grains from the outside of the measure.

6.3. Pour contents of cylinder into 200 mL volumetric flask using a funnel to assure total transfer of aggregate.

6.4. Weigh the flask and sample, record as A.

6.5. Add distilled water (deionized water can be substituted). Rotate the flask in an inclined position to eliminate all air bubbles. Do not shake. Allow the flask to sit for several minutes then roll flask again. Continue the process until there are no visible air bubbles present or for a maximum of 15 minutes, whichever comes first. Distilled water (and entire test) should be at 77 ± 2°F (25 ± 1°C).

NOTE: Bubbles or foam may be dispelled by touching them carefully with a hot wire or the tip of a paper towel.

6.6. Adjust distilled water to the calibrated volume mark on the neck of the flask.

6.7. Weigh flask and contents, record as B.

6.8. Repeat procedure for the second test sample and record results.

7. CALCULATIONS

7.1. Calculate the uncompacted void content, (U_k), by this method:

$$U_k = \frac{U_1 + U_2}{2}$$

Where: U_1 and U_2 are the uncompacted void content for Trial No. 1 and Trial No.2 respectively, and are determined by:

$$U_{1,2} = \frac{100\,[V_w - V_f + V_c]}{V_c}$$

Where: V_f = Volume of flask (manufacturer's calibrated volume), 200 mL
V_c = Calibrated volume of cylinder, mL
$V_W = \text{Volume of the water, mL} = \frac{B - A}{0.99704}$

Where: B = mass of flask, water and aggregate, g
A = mass of flask and aggregate, g
0.99704 g/mL is the density of water at 77 ± 2°F (25 ± 1°C).

NOTE: Density of water varies based on temperature. Since the water bath temperature is fixed at 77 ± 2°F (25 ± 1°C), use the specified value of 0.99704 g/mL. For tests not restrained by the 77 ± 2°F (25 ± 1°C) requirement, select the proper density for water from KT-15, Table 1. Divide the value given in the table by 1000 for g/mL.

8. REPORT

8.1. Record uncompacted voids to the nearest 0.1%. Report uncompacted voids to the nearest 1%.

9. CONFIRMATION OF TEST VALUES

9.1. If two samples are prepared in **Section 5.3** of this test method, and the raw values of U_1 and U_2 differ by more than 1.0%, discard those U_1 and U_2 values and rerun the full test. Prepare four trial samples instead of two, as specified in **Section 5.3** of this test method. Determine the four trial values, U_1, U_2, U_3 and U_4 and calculate U_k using the following formula:

$$U_k = \frac{U_1 + U_2 + U_3 + U_4}{4}$$

Use this four test value for determining the pay

9.2. If the U_k value is below the specified (full pay) value and based on only two values (U_1 and U_2), discard those values and rerun the full test. Prepare four trial samples in **Section 5.3** of this test method and proceed with the testing. Calculate U_k using the four tests as shown in **Section 9.1.** of this test method. Use this U_k value for determining the pay factor.

10. PRECISION AND BIAS[1]

10.1. Precision

10.1.1. The single-operator standard deviation has been found to be 0.13% voids (1s), using the graded standard silica sand as described in **ASTM C778**. Therefore, results of two properly conducted tests by the same operator on similar samples should not differ by more than 0.37% (d2s).

10.1.2. The multilaboratory standard deviation has been found to be 0.33% (1s) using the standard fine aggregate as described in **ASTM C778**. Therefore, results of two properly conducted tests by laboratories on similar samples should not differ by more than 0.93% (d2s).

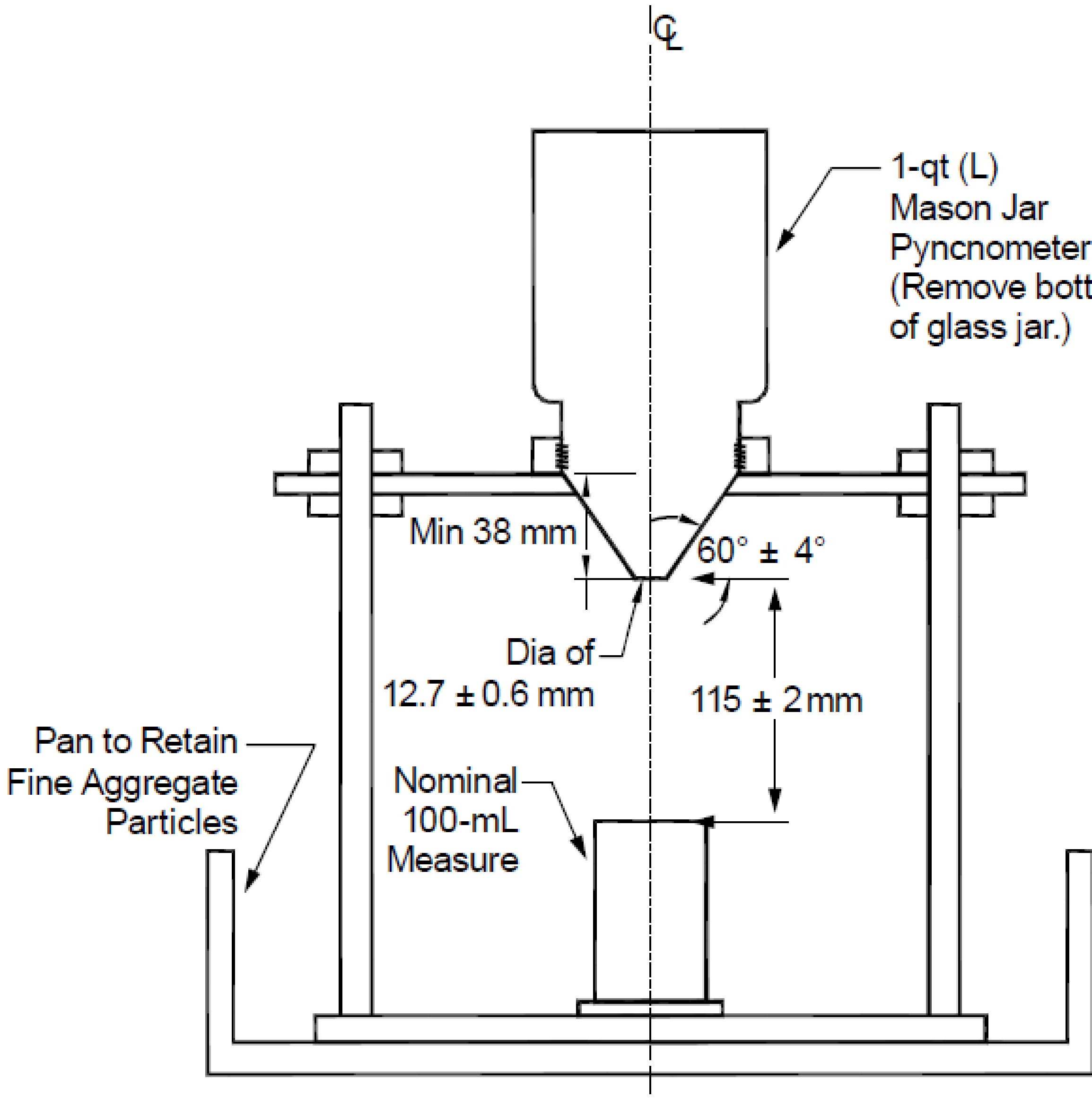
[1] Precision and Bias Statement is taken directly from **AASHTO T 304, Section 13**.

10.1.3. The above statements pertain to void contents determined on "graded standard sand" as described in **ASTM C788**, which is considered rounded, and is graded from No. 30 (600 µm) to No. 100 (150 µm), and may not be typical of other fine aggregates. Additional precision data are needed for tests of fine aggregates having different levels of angularity and texture in accordance with these test methods.

10.2. Bias

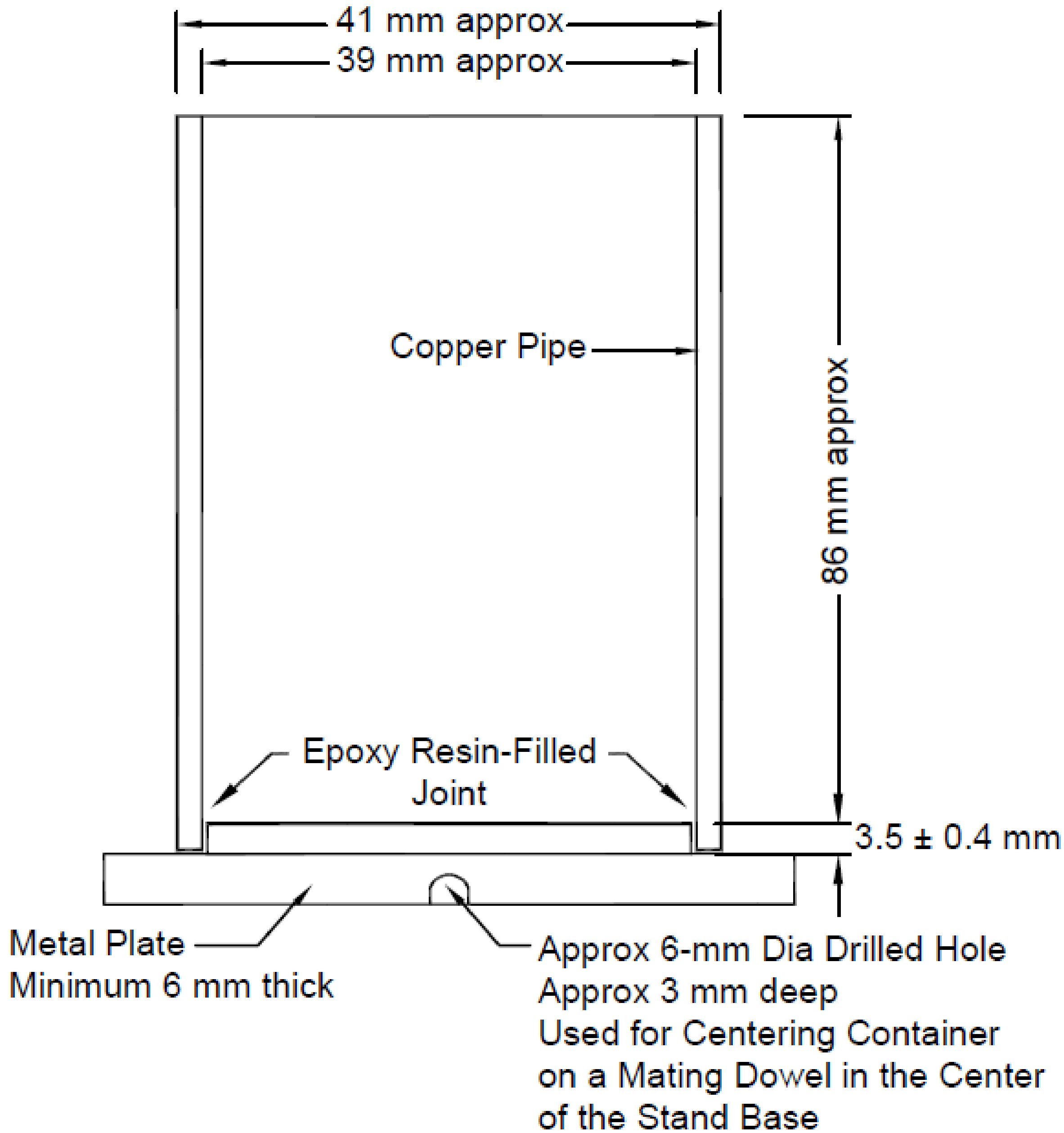
10.2.1. Since there are no accepted reference material suitable for determining the bias for the procedures in these test methods, bias has not been determined.

Figure 1
Suitable Funnel Stand Apparatus with Cylindrical Measure in Place



Section through Center of Apparatus

Figure 2
Nominal 100 mL Cylindrical Measure



KT-80: Uncompacted Void Content of Coarse Aggregate

OBJECTIVE

- Determine the Uncompacted Void Content of a Sample of Coarse Aggregate on a given gradation

KT-80: Uncompacted Void Content of Coarse Aggregate

1. **SCOPE**

- Determine the Uncompacted Void Content of a Sample of Coarse Aggregate.

- When measured on any aggregate of a known grading, void content provides an indication of
  - Aggregate Angularity
  - Aggregate Sphericity
  - Aggregate Texture

- Reflects Testing Procedures in AASHTO T 326

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KT-80: Uncompacted Void Content of Coarse Aggregate

2. REFERENCED DOCUMENTS

- 2.1. Part V, 5.9; Sampling and Test Methods Foreword
- 2.2. KT-01; Sampling and Splitting of Aggregates
- 2.3. KT-02; Sieve Analysis of Aggregates
- 2.4. KT-03; Material Passing No. 200 (75 µm) Sieve by the Wash Method
- 2.5. KT-05; Unit Weight of Aggregate
- 2.6. KT-06; Specific Gravity and Absorption of Aggregate
- 2.7. KT-15; Bulk Specific Gravity and Unit Weight of Compacted Asphalt Mixtures
- 2.8. AASHTO T 326; Standard Method of Test for Uncompacted Void Content of Coarse Aggregate

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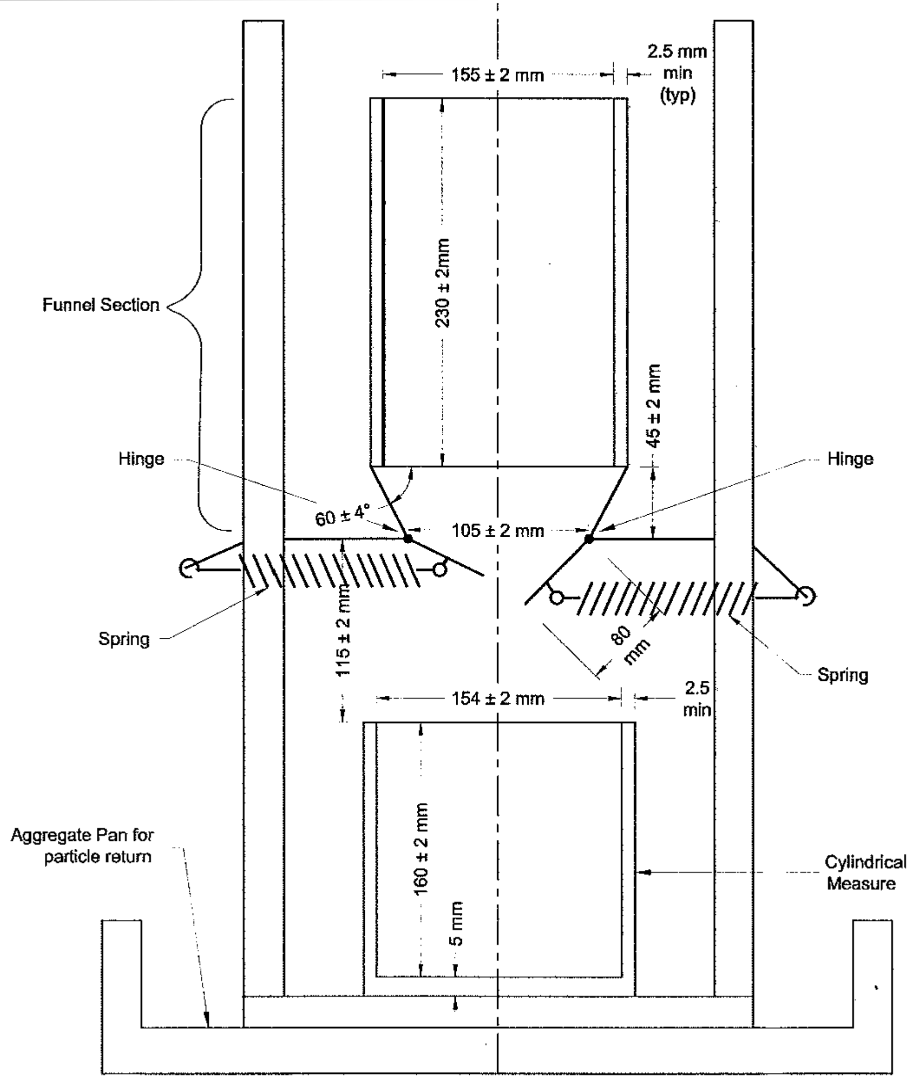
KT-80: Uncompacted Void Content of Coarse Aggregate



KT-80: Uncompacted Void Content of Coarse Aggregate

3. APPARATUS

3.1. Oven – Continuously Heated at 230 ± 9°F (110 ± 5°C)
3.2 Cylindrical Metal Measure
3.3 Funnel
3.4 Stand
3.5 Square Glass Plate
3.6 Oversized Pan
3.7 Flat Metal Straightedge
3.8 Balance - Part V, 5.9; Sampling & Test Methods Foreword

KT-80: Uncompacted Void Content of Coarse Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

- Apply grease to top edge of dry, empty cylindrical measure
- Weigh measure, grease and flat glass plate (c)
- Fill measure with distilled/deionized water at 77±2°F (25±1°C)
- Record the Temperature of the Water
- Place glass on measure and remove air bubbles
- Dry the outer surfaces
- Weigh measure, glass plate, grease, and water (d)
- Clean and dry the cylindrical measure and weigh
- Perform at least yearly

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE (cont)

- Calculate the volume of the measure to the nearest 0.1 mL

$$V_c = \frac{W}{0.99704}$$

Where:

V_c = volume of cylinder, mL
W = d – c = net mass of water, g
c = cylinder + glass + grease, g
d = cylinder + glass + grease + water, g
0.99704 g/mL is density of water at 77±2°F (25±1°C)
or refer to KT-15 for water density at other temperatures

Kansas Department of Transportation

KT-80
Uncompacted Void Content of Coarse Aggregate
Calibration of Cylinder Worksheet

Cylinder Number ____________

c = Mass of Cylinder + Grease + Glass ____________ g

d = c + Water ____________ g

Temperature of Water ______77 °F

D = Density of Water at Test Temperature* ____0.99704____ g/mL

W = Mass of Water in Cylinder = (d - c) = ____________ g

V_c = Calibrated Volume of Cylinder

Vc = W/D = ____________ mL

Kansas Department of Transportation

KT-80
Uncompacted Void Content of Coarse Aggregate
Calibration of Cylinder Worksheet

Cylinder Number KT-80-1

c = Mass of Cylinder + Grease + Glass 2990.0 g

d = c + Water 5837.8 g

W = 5837.8 - 2990.0

Temperature of Water 77 °F

D = Density of Water at Test Temperature* 0.99704 g/mL

V_c = 2847.8 / 0.99704

W = Mass of Water in Cylinder = (d - c) = 2847.8 g

V_c = 2856.25451

Vc = Calibrated Volume of Cylinder

Vc = W/D = 2856.3 mL

Kansas Department of Transportation

5. SAMPLE PREPARATION

5.1.
- Run KT-03: Sections 3 and 5
- Dry Sample to a Constant Mass
- Sieve the material over:
  - ¾" (19 mm)
  - ½" (12.5 mm)
  - ⅜" (9.5 mm)
  - No. 4 (4.75 mm)

KT-80: Uncompacted Void Content of Coarse Aggregate

5. SAMPLE PREPARATION (cont)

5.2.
- Weigh out the following quantities.
- Total sample weight should be 5000 g ± 10 g

Maximum Size of Aggregate	Individual Size Fraction	Mass (g)
¾"	¾" to ½"	1740
	½" to ⅜"	1090
	⅜" to #4	2170
½"	½" to ⅜"	1970
	⅜" to #4	3030

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

5. SAMPLE PREPARATION (cont)

5.3. Determine the specific gravity using KT-06 Procedure I

6. TEST PROCEDURE

6.1. Record the mass of the empty measure

6.2.
- Mix sample until it is homogenous
- Center the measure under the funnel
- Close and latch the doors
- Pour sample into the funnel
- Hold doors shut with finger, open the latch, then remove finger
- Allow aggregate to free fall into the measure

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

6. TEST PROCEDURE (cont)

6.3. Strike off excess heaped aggregate

- Balance projections above the measure with the voids below the top of the measure
- Avoid vibration while performing this step
- Remove aggregates on the outside of measure
- Weigh the measure with the aggregate to the nearest 0.1 g
- Retain all aggregate for a second test run

6.4. Recombine the sample and repeat.
Average the results of the two runs

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

7. CALCULATIONS

7.1. Calculate the uncompacted void content, (U_k), by this method

$$U_k = \frac{U_1 + U_2}{2}$$

Where: U_1 and U_2 are the uncompacted void content for Trial No. 1 and Trial No.2 respectively, and are determined by:

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

7. CALCULATIONS

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

Where:

V_c = volume of cylindrical measure, mL
F = net mass, g, of coarse aggregate in measure (gross mass minus the mass of the empty measure)
G = bulk dry specific gravity of coarse aggregate
U = uncompacted voids, percent, in the material

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

8. REPORT

8.1. Record uncompacted voids to the nearest 0.1%
Report uncompacted voids to the nearest 1%

8.2 Report the specific gravity used in calculation

Kansas Department of Transportation

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

Cylinder Used ____________

	Trial #1	Trial #2
X = mass of the measure =	g	g
Y = mass of the measure and aggregate =	g	g
F = net mass of aggregate (Y-X) =	g	g

G = bulk dry specific gravity of aggregate = ____________

V_c = calibrated volume of cylinder = ____________ mL

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

$U_{1,2}$ = ____________ % ____________ %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ____________ %

Reported U_k = ____________ %

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate Example

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

$F = Y - X$

$F_1 = 5914.3 – 2202.6$

$F_1 = 3711.7$

$F_2 = 5884.9 – 2202.6$

$F_2 = 3682.3$

Cylinder Used KT-80-1

	Trial #1	Trial #2
X = mass of the measure =	2202.6 g	2202.6 g
Y = mass of the measure and aggregate =	5914.3 g	5884.9 g
F = net mass of aggregate (Y-X) =	3711.7 g	3682.3 g

G = bulk dry specific gravity of aggregate = 2.613

V_c = calibrated volume of cylinder = 2856.3 mL

KT-80: Uncompacted Void Content of Coarse Aggregate Example

$$U_{1,2} = \frac{V_c - (F_{1,2}/G)}{V_c} \times 100$$

$$U_1 = \frac{2856.3 - (3711.7/2.613)}{2856.3} \times 100$$

$$U_1 = \frac{2856.3 - (1420.47)}{2856.3} \times 100$$

$$U_1 = \frac{1435.8}{2856.3} \times 100$$

$$U_1 = 0.50268 \times 100$$

$$U_1 = 50.268$$

$$U_1 = 50.3$$

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-80-1

	Trial #1	Trial #2
X = mass of the measure =	2202.6 g	2202.6 g
Y = mass of the measure and aggregate =	5914.3 g	5884.9 g
F = net mass of aggregate (Y-X) =	3711.7 g	3682.3 g

G = bulk dry specific gravity of aggregate = 2.613

V_c = calibrated volume of cylinder = 2856.3 mL

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

$U_{1,2}$ = 50.3 % ______ %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ______ %

Reported U_k = ______ %

KT-80: Uncompacted Void Content of Coarse Aggregate Example

$$U_{1,2} = \frac{V_c - (F_{1,2}/G)}{V_c} \times 100$$

$$U_2 = \frac{2856.3 - (3682.3/2.613)}{2856.3} \times 100$$

$$U_2 = \frac{2856.3 - (1409.22)}{2856.3} \times 100$$

$$U_2 = \frac{1447.08}{2856.3} \times 100$$

$$U_2 = 0.50663 \times 100$$

$$U_2 = 50.663$$

$$U_2 = 50.7$$

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-80-1

	Trial #1	Trial #2
X = mass of the measure =	2202.6 g	2202.6 g
Y = mass of the measure and aggregate =	5914.3 g	5884.9 g
F = net mass of aggregate (Y-X) =	3711.7 g	3682.3 g

G = bulk dry specific gravity of aggregate = 2.613

V_c = calibrated volume of cylinder = 2856.3 mL

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

$U_{1,2}$ = 50.3 % 50.7 %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ______ %

Reported U_k = ______ %

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate Example

$$U_k = \frac{(U_1 + U_2)}{2}$$

$$U_k = \frac{(50.3 + 50.7)}{2}$$

$$U_k = \frac{(101.0)}{2}$$

U_k = 50.5 (Recorded)

U_k = 50 (Reported)

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

Cylinder Used KT-80-1

	Trial #1	Trial #2
X = mass of the measure =	2202.6 g	2202.6 g
Y = mass of the measure and aggregate =	5914.3 g	5884.9 g
F = net mass of aggregate (Y-X) =	3711.7 g	3682.3 g

G = bulk dry specific gravity of aggregate = 2.613

Vc = calibrated volume of cylinder = 2856.3 mL

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

$U_{1,2}$ = 50.3 % 50.7 %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = 50.5 %

Reported U_k = 50 %

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

1103- AGGREGATES FOR HOT MIX ASPHALT (HMA)

SECTION 1103

AGGREGATES FOR HOT MIX ASPHALT (HMA)

1103.1 DESCRIPTION

This specification covers the quality, composition and gradation requirements of aggregates for hot mix asphalt (HMA) on QC/QA projects.

1103.2 REQUIREMENTS

a. Composition Individual Aggregates. Use aggregate from each source that complies with the gradation requirements listed in **TABLE 1103-1**.

(1) Crushed Aggregates. Limit crushed aggregates to the following materials.

(a) Produce Crushed Stone (CS-1) and Crushed Stone Screenings (CS-2) by crushing limestone, sandstone, porphyry, (rhyolite, basalt, granite, and Iron Mountain Trap Rock are examples of porphyry) or other types of stone.

(b) Produce Crushed Gravel (CG) by crushing siliceous gravel containing not more than 15% non-siliceous material. If 95% or more of crushed gravel is retained on the #8 (2.65 mm) sieve, then the material must have a minimum Uncompacted Void Content of Coarse Aggregate (UVA) value of 45 when tested in accordance with KT-80. Testing will be the same frequency as KT-50. Do not use material with a UVA value less than 45.

Kansas Department of Transportation

KT-80: Uncompacted Void Content of Coarse Aggregate

OBJECTIVE

- Determine the Uncompacted Void Content of a Sample of Coarse Aggregate on a given gradation

Kansas Department of Transportation

5.9.80 UNCOMPACTED VOID CONTENT OF COARSE AGGREGATE (As Influenced by Particle Shape, Surface Texture, and Grading) (Kansas Test Method KT-80)

1. SCOPE

This method describes the determination of the loose uncompacted void content of a sample of coarse aggregate. When measured on any aggregate of a known grading, void content provides an indication of the aggregate's angularity, sphericity, and surface texture compared with other coarse aggregates tested in the same grading. **KT-80** reflects testing procedures found in **AASHTO T 326**.

2. REFERENCED DOCUMENTS

2.1. Part V, 5.9; Sampling and Test Methods Foreword

2.2. KT-01; Sampling and Splitting of Aggregates

2.3. KT-02; Sieve Analysis of Aggregate

2.4. KT-03; Material Passing No. 200 (75 µm) Sieve by the Wash Method

2.5. KT-05; Unit Weight of Aggregate

2.6. KT-06; Specific Gravity and Absorption of Aggregate

2.7. KT-15; Bulk Specific Gravity and Unit Weight of Compacted Asphalt Mixtures

2.8. AASHTO T 326; Standard Method of Test for Uncompacted Void Content Of Coarse Aggregate (As Influenced by Particle Shape, Surface Texture, and Grading)

3. APPARATUS

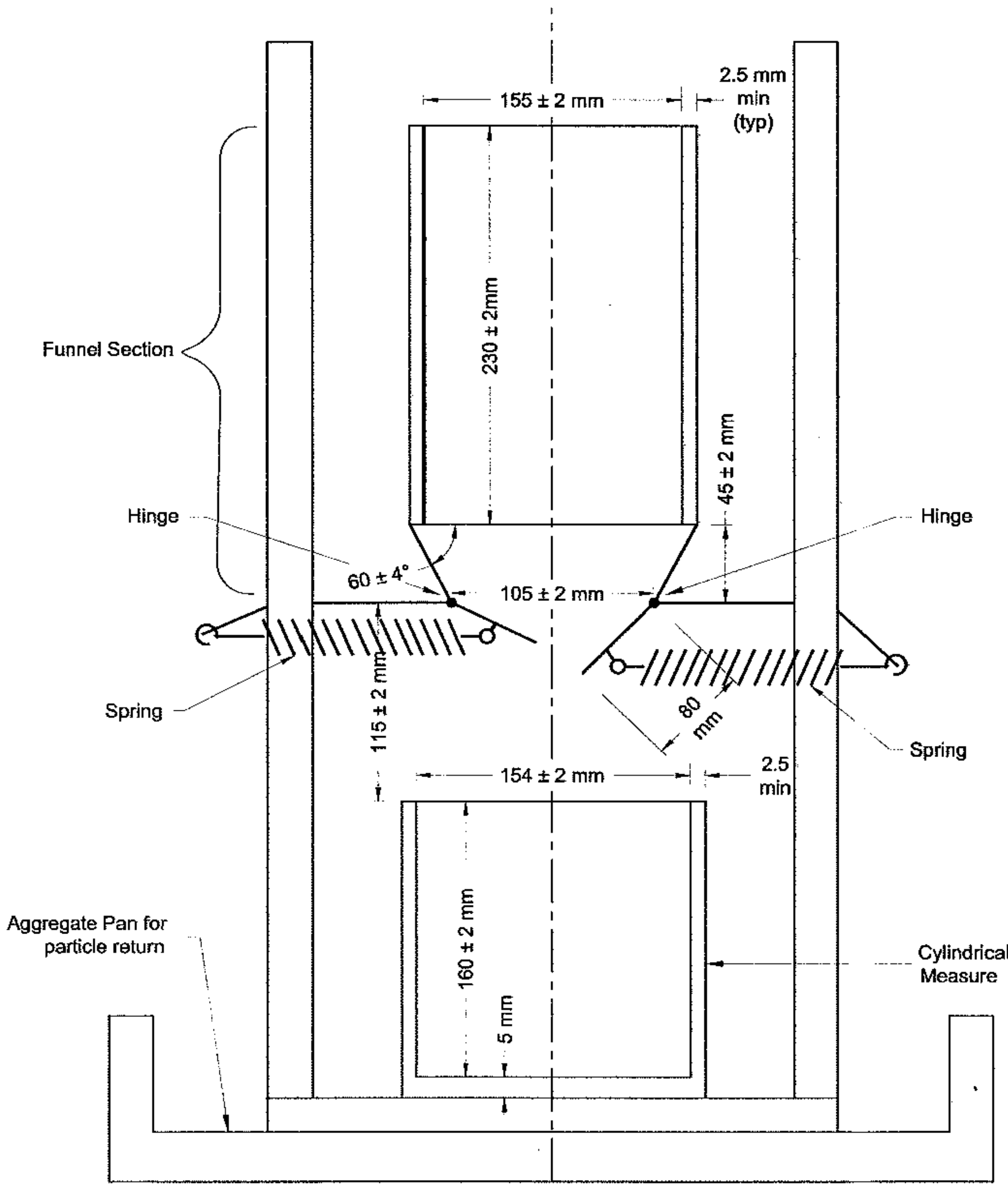
3.1. Drying oven capable of maintaining a uniform temperature of 230 ± 9°F (110 ± 5°C).

3.2. A cylindrical metal measure shall be watertight, with the top and bottom true and even, preferably machined to accurate dimensions on the inside and sufficiently rigid to retain its form under rough usage. The top rim shall be smooth and plane within .01 in (0.25 mm) and shall be parallel to the bottom within 0.5 degrees. The inside diameter shall be 6.0 ± 0.1 in (154 ± 2 mm) and the inside height shall be 6.3 ± 0.1 in (160 ± 2) mm. **Figure 1**.

3.3. The lateral surface of the right frustum of a cone sloped 60 ± 4 degrees from the horizontal with an opening of 4.13 ± 0.1 in (105 ± 2-mm) diameter. The funnel section shall be a piece of metal, smooth on the inside. It shall have a volume of at least two times the volume of the cylindrical measure or shall be provided with a supplemental metal container to provide the required volume. **Figure 1.**

3.4. A support capable of holding the funnel firmly in position with the axis of the funnel colinear [within a four degree angle and a displacement of 0.1 in (2 mm)] with the axis of the cylindrical measure. The funnel opening shall be 4.53 ± 0.1 in (115 ± 2 mm) above the top of the cylinder. **Figure 1**.

Figure 1 Test Apparatus



3.5. A square glass plate approximately 6.75 in by 6.75 in (170 mm by 170 mm) with a minimum thickness of 0.16 in (4 mm) used to calibrate the cylindrical measure.

3.6. A metal or glass pan of sufficient size to contain the funnel stand and to prevent loss of material. The purpose of the pan is to catch and retain aggregate particles that overflow the measure during filling and strike off.

3.7. A flat metal straightedge approximately 12 in (300 mm) length, 1.5 in (40 mm) in width and 0.12 in (3 mm) thickness is used to strike off the top of the container.

3.8. The balance shall conform to the requirements of **Part V, 5.9; Sampling and Test Methods Foreword**, for the class of general purpose balance required for the principal sample mass of the sample being tested.

4. DETERMINATION OF THE VOLUME OF CYLINDRICAL MEASURE

4.1. Determine the following weights to the nearest 0.1 g.

Apply a light coat of grease to the top edge of the dry, empty cylindrical measure. Weigh the measure, grease, and glass plate. Fill the measure with distilled/deionized water at a temperature of 77 ± 2°F (25 ± 1°C). Record the temperature of the water. Place the glass plate on the measure, being sure that no air bubbles remain. Dry the outer surfaces of the measure and determine the combined mass of measure, glass plate, grease, and water by weighing. Following the final weighing, remove the grease, and determine the mass of the clean, dry, empty measure for subsequent tests. This procedure should be done at least once a year.

Calculate the volume of the measure as follows:

$$V_c = \frac{W}{0.99704}$$

Where: V_c= volume of cylinder, mL
W= d-c = net mass of water, g
c= cylinder + glass + grease, g
d= cylinder + glass + grease + water, g

Determine the volume to the nearest 0.1 mL.

NOTE: Density of water varies based on temperature. Since the water bath temperature is fixed at 77 ± 2°F (25 ± 1°C), use the specified value of 0.99704 g/mL. For tests not restrained by the 77 ± 2°F (25 ± 1°C) requirement, select the proper density for water from **KT-15, Table 1**. Divide the value given in the table by 1000 for g/mL.

5. SAMPLE PREPARATION

5.1. Wash the sample over the No. 200 (75 µm) sieve using the equipment and procedures listed in **KT-03, section 3 and section 5.** Dry the plus No. 200 (75 µm) material to a constant mass. Sieve the dry aggregate over the 3/4 in. (19 mm), 1/2 in. (12.5 mm), 3/8 in. (9.5 mm), No.4 (4.75 mm).

5.2. Weigh out and combine the following quantities of dry aggregate from each of the sizes:

Maximum Size of Aggregate	Individual Size Fraction	Mass, g
3/4 in. (19 mm)	3/4 in. (19 mm) to 1/2 in. (12.5 mm)	1740
	1/2 in. (12.5 mm) to 3/8 in. (9.5 mm)	1090
	3/8 in. (9.5 mm) to No. 4 (4.75 mm)	2170
1/2 in. (12.5 mm)	1/2 in. (12.5 mm) to 3/8 in. (9.5 mm)	1970
	3/8 in. (9.5 mm) to No. 4 (4.75 mm)	3030

The total sample weight should be 5000 g ± 10 g.

5.3. If the bulk dry specific gravity of coarse aggregate from the source is unknown, determine it on the plus No. 4 (4.75 mm) sample according to **KT-06**.

6. TEST PROCEDURE[1]

6.1. Record the mass of the empty measure. Also, for each run, record the mass of the measure and coarse aggregate.

6.2. Mix the test sample until it is homogenous. Center the cylindrical measure under the funnel section as shown in **Figure 1**. Close the doors at the bottom of the funnel section and latch them shut. Pour the test sample into the funnel section. Hold the doors shut with one finger and open the latch on the doors. Remove the finger from the doors, allowing the doors to swing open and the aggregate to fall freely into the cylindrical measure.

NOTE: A latch may be placed on the doors for the convenience of the operator or the operator may hold the doors closed with a finger during the filling of the funnel section, in which case the latch on the doors would not be necessary.

6.3. After the funnel empties, strike off excess heaped aggregate from the cylindrical measure. Strike off the surplus aggregate in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure. Until this operation is complete, exercise care to avoid vibration or any disturbance that could cause compaction of the coarse aggregate in the cylindrical measure. Remove any aggregate that may have fallen on the outside of the container and determine the mass of the cylindrical measure and contents to the nearest 0.1 g. Retain all aggregate particles for a second test run.

6.4. Recombine the sample from the retaining pan and cylindrical measure and repeat the procedure. The results of two runs are averaged.

[1] **AASHTO 326** Allows Methods A, B and C. KDOT allows only Method A to be run.

7. CALCULATIONS

7.1. Calculate the uncompacted void content, (U_k), by this method:

$$U_k=\frac{U_1 + U_2}{2}$$

Where: U_1 and U_2 are the uncompacted void content for Trial No. 1 and Trial No.2 respectively, and are determined by:

Calculate the uncompacted voids for each determination as follows:

$$U_{1,2}=\frac{Vc-(F/G)}{Vc}x100$$

where:
Vc = volume of cylindrical measure, mL;
F = net mass, g, of coarse aggregate in measure (gross mass minus the mass of the empty measure);
G = bulk dry specific gravity of coarse aggregate; and
U = uncompacted voids, percent, in the material.

8. REPORT

8.1. Record uncompacted voids to the nearest 0.1%. Report uncompacted voids to the nearest 1%.

8.2. The specific gravity value used in calculation.

5.9. SAMPLING AND TEST METHODS FOREWORD

1. SAFETY

The responsibility for safety rests with each and every employee in the laboratory or field. You must use common sense and work carefully to avoid the hazards your job may expose you to like hazardous chemicals, flying particles and heavy or awkward lifting are a few of the hazards you will be exposed to.

You are responsible to know the hazards that each test may expose you to so that you can work with the right level of protection while completing certain test procedures. Through OSHA 1910 and 1926 and KDOT SOM 2.6.2 your employer is required to tell you what hazards you will be exposed to and how to protect yourself from those hazards.

OSHA 1910 and 1926 also makes it the employee's responsibility to understand and follow the safety programs provided by their employers to protect them. SOM 2.6.2 refers to the KDOT safety Manual which requires employees to follow the guidelines of KDOT Hazardous Communications Program and the KDOT Personal Protection Program. These two programs will assist you with how to read an MSDS and provide information on the type of personal protection required to protect you from the physical, chemical, biological and ergonomic hazards you will be exposed to while performing the tests in this manual.

2. SCOPE

The purpose of this section is to standardize the testing procedures used throughout the State by all laboratories. A hierarchy for test methods exists in order to establish a specific test procedure for a given circumstance.

Test method hierarchy corresponds to the following publications unless otherwise stated in the Standard Specifications, plans or project specifications:

First - Kansas Department of Transportation Construction Manual, Part V.

Second - Standards published by the American Association of State Highway and Transportation Officials (AASHTO).

Third - Standards published by the American Society for Testing and Materials (ASTM).

Each test method is an independent document, page numbered and printed individually. The primary number linking it to this manual is the sub-paragraph number. Any future corrections, additions or revisions will be printed and forwarded to the manual holders at the time they occur, to reflect current testing procedures.

Footnotes at the bottom of the page of a test procedure are a quick check for contractors or consultants to determine differences between KT methods and AASHTO/ASTM standards. **ALL PROCEDURES ARE TO BE PERFORMED AS STATED WITHIN KT METHODS, EXCLUDING THE INFORMATION FOUND IN THE KT FOOTNOTES**.

Unless noted in the test method, the use of potable water is required.

Unless otherwise stated in the test method, drying to a constant mass means less than 0.1% mass decrease from the previous measurement after 1 hour following the temperature requirements in the test method.

Consult the Bureau of Construction and Materials and in case of ambiguity or difficulty in the interpretation of testing procedures.

3. ACCURACY

As a general guideline use the following for an accuracy requirement when not stated within the test procedure:

Thermometers: Temp $\leq$ 140ºF (60ºC), accuracy of 0.2ºF (0.1ºC); Temp > 140ºF (60ºC), accuracy of 2ºF (1ºC).

Balances/Scales: Accuracy is equal to the mass stated or 0.1 percent of the test load, whichever is greater, throughout the range of use. The following table shows the various classes as established in AASHTO M 231:

Class	Readability and Sensitivity	Accuracy*
G1	0.01 g	0.02 g or 0.1 percent
G2	0.1 g	0.2 g or 0.1 percent
G5	1 g	2 g or 0.1 percent
G20	5 g	5 g or 0.1 percent
G100	20 g	20 g or 0.1 percent

* Accuracy equal to the mass stated or 0.1 percent of the test load, whichever is greater, throughout the range of use.

4. SI UNITS

The following information provides the user of these test procedures with specific comparisons between metric (SI) and English units and nomenclature.

Where possible, "Hard Conversion" practices are used converting the testing procedures from English to SI units. This system establishes an approximate measurement in SI units compared to the English units. An example of this is to convert one inch to SI units. One inch is equal to 25.4 millimeters (1 in = 25.4 mm). Using Hard Conversion, 25 mm is the new measurement, and compared to the 25.4 mm, is easier to verify. However, where test methods requires rigidly specified equipment or procedures measured in English units, a soft conversion will be shown. These cases should be obvious due to the outrageous metric number presented.

The nomenclature used to represent SI units are as follows (conversions originated or derived from ASTM E 380):

SI (full name) = ENGLISH (full name) X Conversion

AREA

mm^2 (millimeter^2)	in^2 (inches^2)	645.16
m^2 (meters^2)	ft^2 (feet^2)	0.092903
m^2	yd^2 (yard^2)	0.8361274

DENSITY (MASS PER UNIT VOLUME)

kg kilogram lb or pound 16.01846

m^3 meter^3	ft^3 feet^3 (also known as PCF)		

FORCE

N (Newton)	lbf (pound-force)	4.448222

LENGTH

mm (millimeters)	in (inches)	25.4
m (meters)	ft (feet)	0.3048
km (kilometer)	(mile)	1.609347

<u>SI (full name) = ENGLISH (full name) X Conversion</u>

MASS

g (gram)	lb (pound)	453.5924
kg (kilogram)	lb (pound)	0.4535924
Mg (megagram)	TONS	0.9071847

PRESSURE (FORCE PER UNIT AREA)

kPa (kilopascal)	psi or $\frac{\text{pound-force}}{\text{inches}^2}$	6.894757

TEMPERATURE

ºC (Celsius)	ºF (Fahrenheit)	$t_C = (t_F - 32)/1.8$

VOLUME

mm^3 (millimeters^3)	in^3 (inches^3)	16,387.06
m^3 (meters^3)	ft^3 (feet^3)	0.02831685
m^3	yd^3 (yards^3)	0.7645549
mL (milliliter)	in^3	16.38706
L (Liter)	qt (quart)	0.9463529
L	gal (gallon)	3.785412
L	ft^3	28.31685

NOTE: $1\ m^3 = 1{,}000\ L$
$1\ L = 1{,}000\ mL$

KANSAS DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION TO THE
STANDARD SPECIFICATIONS, 2015 EDITION

Delete the entire SECTION 1103 and replace with the following:

SECTION 1103

AGGREGATES FOR HOT MIX ASPHALT (HMA)

1103.1 DESCRIPTION

This specification covers the quality, composition and gradation requirements of aggregates for hot mix asphalt (HMA) on QC/QA projects.

1103.2 REQUIREMENTS

a. Composition Individual Aggregates. Use aggregate from each source that complies with the gradation requirements listed in **TABLE 1103-1 and 1103-2**.

(1) Crushed Aggregates. Limit crushed aggregates to the following materials.

(a) Produce Crushed Stone (CS-1) and Crushed Stone Screenings (CS-2) by crushing limestone, sandstone, porphyry, (rhyolite, basalt, granite, and Iron Mountain Trap Rock are examples of porphyry) or other types of stone.

(b) Produce Crushed Gravel (CG) by crushing siliceous gravel containing not more than 15% non-siliceous material. If 95% or more of crushed gravel is retained on the #8 (2.65 mm) sieve, then the material must have a minimum Uncompacted Void Content of Coarse Aggregate (UVA) value of 45 when tested in accordance with KT-80. Testing will be the same frequency as KT-50. Do not use material with a UVA value less than 45.

(c) Provide Chat (CH-1) obtained during the mining of lead and zinc ores in the tri-state mining district.

(d) Consider materials complying with Mineral Filler Supplements MFS-1, MFS-2, MFS-4, and MFS-7 as crushed aggregate.

(e) Produce Crushed Steel Slag (CSSL) by crushing electric furnace steel slag. Some sources of steel slag are angular when produced and may be treated the same as crushed gravel and manufactured sand. Use steel slag with an Uncompacted Void Content of the Fine Aggregate “U” Value, determined by test method KT-50, of more than 42and the Coarse Aggregate Angularity greater than the minimum specified value. The maximum allowable quantity of crushed steel slag is 50% of the total aggregate weight.

(f) Manufactured sand shall have an Uncompacted Void Content of the Fine Aggregate “U” Value, determined by test method KT-50, greater than or equal to 42. Produce manufactured sand by crushing siliceous sand and gravel (designate as crushed gravel (CG-2, CG-3, etc) in the mix design), or by washing or screening crushed stone (designate as crushed stone (CS-2, CS-3, etc) in the mix design), or by washing or screening chat (designate as chat (CH-2, CH-3, etc) in the mix design).

(2) Uncrushed Aggregates. Limit uncrushed aggregates to the following materials.

(a) Produce Sand-Gravel (SSG) by mixing natural sand and gravel formed by the disintegration of siliceous and/or calcareous materials.

(b) Provide Natural Sand consisting of particles formed by the natural disintegration of siliceous and/or calcareous materials. Use natural sand with an Uncompacted Void Content “U” value of less than 42.

(c) Provide Grizzly (Grizzly Waste) consisting of the matrix or bedding material occurring in conjunction with calcitic or dolomitic cemented sandstone "Quartzite", generally separated from the sandstone prior to crushing.

(d) Provide Wet Bottom Boiler Slag (WBBS) consisting of a hard angular by-product of the combustion of coal in wet-bottom boilers. Quality requirements do not exist for this material. Obtain written approval by the Chief of Construction and Materials for use in HMA. The use of WBBS does not modify the requirements for minimum contents of either crushed stone or natural sand.

(3) Mineral Filler Supplement. Provide a mineral filler supplement that is easily pulverized and free of cemented lumps, mudballs, and organic materials that complies with the following and the general requirements in **subsection 1103.2c**. Do not blend 2 or more materials to produce mineral filler supplement. Provide only 1 mineral filler supplement in each HMA design.

(a) Mineral Filler Supplement designation MFS-1 is Portland cement, blended hydraulic cements, or crushed stone.

(b) Mineral Filler Supplement designation MFS-2 is crushed limestone.

(c) Mineral Filler Supplement designation MFS-3 is water or wind deposited silty soil material.

(d) Mineral Filler Supplement designation MFS-4 is Hydrated lime. The minimum allowable quantity of MFS-4 or Hydrated Lime is 1% of the total aggregate weight when required as a supplement on the Contract Documents.

(e) Mineral Filler Supplement designation MFS-5 is volcanic ash containing a minimum of 70% glass shard. The maximum allowable quantity of MFS-5 is 5% of the total aggregate weight when specified as acceptable mineral filler supplement.

(f) Mineral Filler Supplement designation MFS-6 is fly ash. Fly ash is the finely divided residue resulting from the combustion of ground or powdered coal and is transported from the boiler by flue gasses. The maximum allowable quantity of MFS-6 is 3% of the total aggregate weight when specified as acceptable mineral filler supplement.

(g) Mineral Filler Supplement designation MFS-7 is processed chat sludge that has been dewatered at the source of supply, and does not exceed 15% moisture content by weight at the time of shipping.

(4) Reclaimed Asphaltic Pavement (RAP). Use RAP in HMA only when such an option is permitted by Contract Special Provision. Subject the RAP to the limitations (i.e. source, max. percent allowed in mix, etc.) shown on the Contract Documents and contained in the appropriate Contract Special Provisions. Screen the RAP through a 2 ¼ inch screen or grizzly before it enters the HMA plant.

Fractionated Reclaimed Asphaltic Pavement (FRAP) is defined as having two or more RAP stockpiles, where the RAP is divided into a minimum of two fractions consisting of coarse and fine fractions. Subject the FRAP to the same limitations shown on the Contract Documents and contained in the appropriate Contract Special Provisions for RAP. Comprise the maximum percentage of FRAP of coarse or fine FRAP or a combination of coarse and fine FRAP, unless otherwise stated in the Contract Documents. Utilize a separate cold feed bin for each stockpile of FRAP used. Add FRAP to the mix through the RAP collar. Include the processing requirements for each FRAP stockpile within the Quality Control Plan.

(5) Recycled Asphalt Shingles**.** Recycled Asphalt Shingles (RAS) are allowed in any mixture specified to use RAP. The Contractor may use the %RAP as shown in the Contract Special Provision **<u>or</u>** a maximum of 5% RAS and 15% total recycled material.

Drop the grade of the virgin binder one grade from both the top and the bottom grade specified for 0% RAP. For example, if a PG 64-22 is specified for 0% RAP, then the virgin grade of the binder for up to 5% RAS and 15% total recycled material is PG 58-28.

Comply with the Kansas Department of Health and Environment's Bureau of waste Management Policy 2011-P3 or current version and other regulations pertaining to the recycling of shingles.

Grind the shingles to a minus 3/8-inch size. Remove deleterious materials from waste, manufacturer, or new shingles. Use post-consumer RAS that contains less than 0.5% wood by weight or less than 1.0% total deleterious by weight. Determine the gradation of the aggregate by extraction of the binder or by using **TABLE 1103-A** as a standard gradation:

TABLE 1103-A: SHINGLE AGGREGATE GRADATION	
Sieve Size	**Percent Retained**
3/8 in.	0
No. 4	5
No. 8	15
No. 16	30
No. 30	50
No. 50	55
No. 100	65
No. 200	75

b. Quality of Individual Aggregates.

- Soundness, minimum (KTMR-21) 0.90
  Soundness requirements do not apply to aggregates having less than 10% material retained on the No. 4 mesh sieve.
- Wear, maximum (AASHTO T 96)... 40%
  Wear requirements do not apply to aggregates having less than 10% retained on the No. 8 sieve.
- Absorption, maximum (KT-6) 4.0%
  Test aggregates for absorption as follows:
  - Crushed Stone (CS-1) ....Test Method KT-6, Procedure I
  - Screenings (CS-2)...Test Method KT-6, Procedure II
  - Sand Gravel (SSG)/Crushed Gravel (CG) ....Test Method KT-6, Procedures I & II

  Apply the specified maximum absorption to both the fraction retained on the No. 4 sieve and the fraction passing the No. 4. Screenings produced concurrently with CS-1 will be accepted without tests for absorption.
  Crushed aggregates with less than 10% materials retained on the No. 4 sieve (excluding mineral filler supplements) must be produced from a source complying with the official quality requirements of this Section prior to crushing.
- Plasticity Index, the maximum P.I. for MFS-1, MFS-2, MFS-3, MFS-5, and MFS-7 is 6.

c. Product Control of Individual Aggregates

(1) Size Requirements. Produce each individual aggregate that complies with **TABLE 1103-1 and 1103-2.**

(2) Deleterious Substances. Provide combined aggregates free from alkali, acids, organic matter, or injurious quantities of other foreign substances that does not exceed the following maximum percentages by weight.

- Shale or Shale-like (KT-8) 1.0%
- Clay lumps and friable particles (KT-7) 1.0%
- Sticks (wet) (KT-35) 0.1%
- Coal (AASHTO T-113) 0.5%

TABLE 1103-1: REQUIREMENTS FOR INDIVIDUAL AGGREGATES								
Designation	**Material**	**Percent Retained – Square Mesh Sieves**						
		1”	**½”**	**3/8”**	**No. 4**	**No. 8**	**No. 30**	**No. 200**
CS-1	Crushed Stone	0						95.5-100.0
CS-2	Crushed Stone Screenings		0	0 - 5				60-100
CG	Crushed Gravel	Blend gradation with other aggregates in the mix.						
CH-1	Chat	Blend gradation with other aggregates in the mix						
SSG	Sand & Sand Gravel	0						80-100
WBBS	Wet Bottom Boiler Slag		0	Blend gradation with other aggregates in the mix.				
CSSL	Crushed Steel Slag	Blend gradation with other aggregate in the mix.						

TABLE 1103-2: REQUIREMENTS FOR MINERAL FILLER SUPPLEMENTS								
Designation	**Material**	**Percent Retained – Square Mesh Sieves**						
		1”	**½”**	**3/8”**	**No. 4**	No. 8	No. 30	No. 200
MFS-1	Cement or Crushed Stone			0		0-5	0-8	0-40
MFS-2	Crushed Limestone			0		1-10		60-80
MFS-3	Silt			0	0-5			0-40
MFS-4	Hydrated Lime	Blend gradation with other aggregate in the mix						
MFS-5	Volcanic Ash			0		0-5	0-8	0-40
MFS-6	Fly Ash	Blend gradation with other aggregate in the mix						
MFS-7	Processed Chat Sludge			0		0-5	0-8	0-40

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.

e. Special Requirements for aggregates used in ultrathin bonded asphalt surface (UBAS). Produce each individual aggregate that complies with the gradation requirements in **TABLE 1103-1 and 1103-2** and the requirements listed in **TABLE 1103-3 and 1103-4.**

TABLE 1103-3: INDIVIDUAL COARSE AGGREGATE PROPERTIES		
Property	**Test Method**	**Limits**
Coarse Aggregate Angularity (% min.)	KT-31	95/90 [a]
Los Angeles Abrasion (% max.) [b]	AASHTO T 96	35 [c]
Micro-Deval,(% max.) [b]	AASHTO T 327	18[d]
Soundness (% min.)	KTMR-21	0.90 [d]
Absorption (% max.)	KT-6	4.0 [d]
Methylene Blue (% max.)	AASHTO T 330	10 [e]

An individual aggregate will be considered a coarse aggregate source if it contributes more than 5% of the total plus No. 4 sieve material of the combined aggregate (individual aggregate contribution No. 4 / total JMF retained No. 4 > 5%).

a – 95% of the coarse aggregate has one fractured face & 90% has two or more fractured faces.
b – Sample from stockpiled material with top size aggregate not larger than the maximum aggregate size for the mix designation type from **TABLE 613-1**.
c - For calcitic or dolometic cemented sandstone “quartzite”, the maximum percent is 40.
d - May use KDOT’s Official Quality results
e – Perform this test on all individual aggregates that contribute more than 1.0% to the JMF for the material passing the No. 200 sieve.

TABLE 1103-4: INDIVIDUAL FINE AGGREGATE PROPERTIES		
Property	**Test Method**	**Limits**
Methylene Blue (% max.)	AASHTO T 330	10
Soundness (% min.)	KTMR-21	0.90 [a]
Los Angeles Abrasion (% max.)	AASHTO T 96	40 [a]
Absorption (% max.)	KT-6	4.0 [a]

a –May use KDOT’s Official Quality results.

- The above requirements for wear do not apply for aggregates having less than 10% material retained on the No. 8 sieve.
- The above requirements for soundness do not apply for aggregates having less than 10% material retained on the No. 4 sieve.

1103.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTIONS 1115 and 2501**.

1103.4 PREQUALIFICATION

Prequalify aggregate sources according to **subsection 1101.4**.

1103.5 BASIS OF ACCEPTANCE

Aggregates covered by this subsection are accepted based on the procedure described in **subsection 1101.5.**

06-22-16 C&M (BTH)
Oct-16 Letting

SECTION 1104

AGGREGATES FOR AGGREGATE BASE CONSTRUCTION

1104.1 DESCRIPTION

This specification covers aggregates for use in aggregate base construction.

1104.2 REQUIREMENTS

a. Composition.

(1) Type AB-1 or AB-2 may be singularly or any combination of crushed stone, crushed or uncrushed gravel, sand, sand-gravel, or limestone gravel mixed with soil or other qualified binder material.

(2) Type AB-3 is at least 85% limestone or dolomite produced by mechanical crushing.

b. Quality[1].

- Soundness[2], minimum (KTMR-21) 0.85
- Wear[3], maximum (AASHTO T 96) 50%

[1]Crushed aggregates with less than 10% material retained on the No. 4 sieve (excluding mineral filler supplements) must be produced from a source complying with the official quality requirements of this Section prior to crushing.

[2]The above requirements for soundness do not apply for aggregates having less than 10% material retained on the No. 4 sieve.

[3]The above requirements for wear do not apply to aggregates having less than 10% material retained on the No. 8 sieve.

c. Product Control.

(1) Gradation and Plasticity. Provide a uniformly mixed final product that complies with **TABLE 1104-1**.

(2) Deleterious Substances. Provide aggregates 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.

1104.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

TABLE 1104-1: GRADATION AND PLASTICITY OF AGGREGATES FOR AGGREGATE BASE CONSTRUCTION

Type	Percent Retained-Square Mesh Sieves									P.I.	Liquid Limit (Max.)
	2”	1 ½”	1”	¾”	3/8”	No. 4	No. 8	No. 40	No. 200		
AB-1	0	0-10		5-40		35-75	54-85	78-95	90-98	0-6	25
AB-2*			0		1-35		25-50	60-75	78-90	1-6	25
AB-3**	0	0-5		5-30		35-60	45-70	60-84	80-92	1-8	30

*The fraction passing the No. 200 sieve shall not exceed 2/3 of the fraction passing the No. 40 sieve.
**The fraction passing the No. 200 sieve shall not exceed 3/4 of the fraction passing the No. 40 sieve.

1104.4 PREQUALIFICATION

Prequalify aggregate sources according to **subsection 1101.4**.

1104.5 BASIS OF ACCEPTANCE

Aggregates covered by this subsection are accepted based on the procedures described in **subsection 1101.5.**

SECTION 1113

AGGREGATES FOR SHOULDER CONSTRUCTION

1113.1 DESCRIPTION

This specification covers types of aggregates for shoulder construction.

1113.2 REQUIREMENTS

a. Composition.

(1) Type AS-1 is a mixture of aggregate and binder with at least 85% the material produced by the mechanical crushing of limestone, dolomite or sandstone.

b. Quality[1].

- Soundness[2], minimum (KTMR-21) 0.85
- Wear[3], maximum (AASHTO T 96) 50%
- Specific Gravity[4] (dry), minimum (KT-6 Procedure I) 2.20

[1]Crushed aggregates with less than 10% material retained on the No. 4 sieve (excluding mineral filler supplements) must be produced from a source complying with the official quality requirements of this Section prior to crushing.
[2]The above requirements for soundness do not apply for aggregates having less than 10% material retained on the No. 4 sieve.
[3]The above requirements for wear do not apply to aggregates having less than 10% material retained on the No. 8 sieve.
[4]Apply the specific gravity requirement to individual materials and to any combination of materials required to meet the grading and plasticity requirements.

c. Product Control.

(1) Gradation and Plasticity. Provide aggregate that complies with **TABLE 1113-1**.

TABLE 1113-1: GRADING AND PLASTICITY REQUIREMENTS FOR AGGREGATES FOR SHOULDER CONSTRUCTION

Type	Percent Retained - Square Mesh Sieves								P.I.	L.L.[3] (Max)	Ratio[4] (Max)
	2”	1½”	¾”	3/8”	No. 4	No. 8	No. 40	No. 200			
AS-1	0	0-5	5-30		35-60	45-70	60-84	80-92	1-8[1] 4-8[2]	30	3/4

[1]Crushed Limestone or Dolomite
[2]Crushed Sandstone
[3]Liquid Limit
[4]Ratio of percent passing the No. 200 sieve to the percent passing the No. 40 sieve.

(2) Deleterious Substances. Provide aggregates for shoulder construction that are free from grass, weeds, roots, sticks, 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.

1113.3 TEST METHODS

Test aggregates according to the applicable provisions of **SECTION 1115**.

1113.4 PREQUALIFICATION

Prequalify aggregate sources according to **subsection 1101.4**.

1113.5 BASIS OF ACCEPTANCE

Aggregates covered by this subsection are accepted based on the procedures described in **subsection 1101.5**.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 200							
COMPACTION OF EARTHWORK Sec. 204, 205 & 208							
Compaction Type B	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-51	INF			a	4 per day per lift when visual determination is not possible.
Moisture Content (MR-90)	Moisture Tests (0.1 g or 0.01% of mass)	KT-13 or KT-51	INF			a	4 per day per lift when visual determination is not possible.
Backfill Type B	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-51	INF				1 per structure minimum (each side).
Backfill Moisture Content (MR-90)	Moisture Tests (0.1 g or 0.01% of mass)	KT-13 or KT-51	INF				1 per structure minimum (each side).
Compaction Types AAA, AA, or A	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-51	ACC			a b	1 per every 1000 CY of compacted earthwork
Moisture Content Requirements for MR-0, MR-3, MR-3-3 or MR-5	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACC			e	1 per every 1000 CY of compacted earthwork
SPECIAL FILL Sec. 209	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-51	INF				1 per lift per 300 feet of wall or once daily
MECHANICALLY STABILIZED EARTH FILL Sec. 214	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-51	INF				1 per lift per 300 feet of wall or once daily

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (See also Division 1100 regarding aggregates)							
SUBGRADE MODIFICATION Sec. 301, 1110 & 1112							
Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	Once in the AM and once in the PM or every 500 TONS whichever is less frequent.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08				e	
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	ACC			b c	Once in the AM and once in the PM or every 500 TONS whichever is less frequent.
	Sticks in Aggregate (0.01% of mass)	KT-35				e	
CALCIUM CHLORIDE Sec. 301, 305 & 1702			VER		Sample first container received on project.		
LIME TREATED SUBGRADE Sec. 302, 2000 & 2400	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			e	
	Sieve Analysis for Acceptance of Lime or Cement Treated Subgrade (1% of mass)	KT-42	INF			e	
	Percent Solids of Lime Slurry (WPG 0.01 g, Slurry Solids 0.1%)	KT-62	INF				1 per day or batch, whichever is greater.

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**	**AWP**	**CODE**	**VERIFICATION SAMPLES & TESTS (Note f)**	**CODE**	**ACCEPTANCE SAMPLES & TESTS**
DIVISION 300 (continued)							
LIME TREATED SUBGRADE Sec. 302, 2000 & 2400 (continued)	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-51	ACC				1 per 1500 SY
HYDRATED LIME AND PEBBLE QUICKLIME Sec. 302, 1103, 2002 & 2003		KT-29	VER	a	1 sample for each 10 loads.		See Standard Specifications.
CEMENT OR FLY ASH TREATED SUBGRADE Sec. 303, 2000, & 2400	Sieve Analysis for Acceptance of Lime or Cement Treated Subgrade (1% of mass)	KT-42	INF			e	
	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-51	ACC				1 per 1500 SY
FLY ASH FOR STABILIZATION AND COLD RECYCLE Sec. 303, 604, & 2005		KT-29	VER	a	2 samples per month per source per district.		See Standard Specifications.
CRUSHED STONE SUBGRADE Sec. 304, 1100, & 2400	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-41	INF			e	
	Relative Density	KT-69	INF				Submit samples to MRC as required.
CRUSHED STONE FOR BACKFILL Sec. 304 & 1107	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	Once in the AM and once in the PM or every 500 TONS whichever is less frequent.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)							
AGGREGATE BASE COURSE Sec. 305 and 1104							
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			
Binder Material	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			
Combined Aggregate	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	1 per 500 Tons
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	ACC			a c	1 per 1000 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			e	
Completed Base	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-41	ACC			a	1 per 500 tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41	INF			b	

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)							
AGGREGATE SHOULDERS Aggregate, Non-HMA Sec. 305 and 1113							
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			
Binder Material	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			
Combined Aggregate	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	1 per 500 tons
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	ACC			a c	1 per 1000 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			e	
Completed Shoulder	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-41	ACC			b	1 per 500 tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41	INF			b	

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)							
CEMENT TREATED BASE (CTB) **Sec. 306 & 1105**							
	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	INF			a	1 in A.M. and 1 in P.M. or each 500 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41	INF			e	Minimum 1 per day.
	Density (0.1 lb/ft^3 or 0.1% of optimum density)	KT-37 or KT-20*	VER	e	Minimum of 1 per day		
Completed Base (CTB)	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-41	ACC			a	1 per 2500 SY or 1 per 500 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41	ACC			a	1 per 5000 SY or 1 per 1000 Tons
GRANULAR BASE Sec. 307 and 1106							
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			
Binder Material	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e			
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	VER	e			

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 300 (continued)							
GRANULAR BASE Sec. 307 and 1106 (Continued)							
Pulverization	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER			e	Minimum 1 per day.
Combined Aggregate	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	1 per 500 Tons
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	ACC			a	1 per 1000 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			e	
Completed Work	Field Density Tests ($0.1\ lb/ft^3$ or 0.1% of optimum density)	KT-13 or KT-41	ACC			a	1 per 500 Tons
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	ACC			a	1 per 1000 Tons
DIVISION 400 (See also Division 1100 regarding aggregates)							
PORTLAND CEMENT CONCRETE STRUCTURES AND MISCELLANEOUS CONSTRUCTION Sec. 401, 402, 703, 710 and 717	Slump (0.25 in)	KT-21	ACC			h	As needed to control product, min. 1 set of tests every 50 yd^3. Select initial sample from first 2 or 3 loads and then on a random basis or as conditions indicate.
	Temperature (1 °F)	KT-17	ACC				
	Mass per cubic foot ($0.1\ lb/ft^3$)	KT-20	ACC				
	Air Content (0.25%)	KT-18 or KT-19	ACC				

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	AWP	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)	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 ($0.1\ lb/ft^3$)	KT-36	VER			a b	1 per 150 yd^2 for thin overlays and bridge deck wearing surfaces.
	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, 0.1 in, 1 psi)	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.		
		KT-22 and KT-76	VER	k	Thin Overlays and Bridge Deck Surfacing Min. of 1 set of 3 per 150 yd^2 per placement or major mix design change.		

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	AWP	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, 0.1 in, 1 psi) (continued)	KT-22 and KT-76	VER		Drilled Shafts 1 set of 3 per shaft minimum and 1 set of 3 per 100 yd^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 yd^3. Waive the 2 sets of 3 minimum for pours of less than 20 yd^3 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.)		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 500 (See also Division 1100 regarding aggregates)							
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 401, 403, 502 and 503	Mass per cubic foot (0.1 lb/ft3)	KT-20	ACC				As often as needed to control product. Min. of 1 set of tests per each half day and/or per 4000 yd^2.
	Temperature (1 °F)	KT-17	ACC				
	Slump (0.25 in)	KT-21	ACC				
	Air Content (0.25%)	KT-18 or KT-19	ACC		Determine the air loss due to paving operations once in the AM and once in the PM. Determine the difference between the air content from concrete sampled before the paver, and concrete sampled behind the paver.		Refer to SS 2015 403.4. For all mainline paving, test the concrete at the beginning of the day's operation and approximately every 2 hours thereafter for air content. For all other slipformed pavement, test for air content at the beginning of a day's operation and approximately every 4 hours thereafter. Test hand placements for air content at least once daily.
	Beams (1 psi)	KT-22 & KT-23	VER	a			1 set of 3 as required for opening to traffic. See SS 2015 502.3i.(3)

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 500 (continued)							
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 401, 403, 502 and 503 (continued)	Profilograph	KT-46	VER	e		b	Testing by contractor. Results reviewed by KDOT.
	Moisture in Aggregate (0.1 g or 0.01% of mass)	KT-24	VER	a	Minimum of 1 in AM and 1 in PM during concrete mixing operations.		
	Thickness - Cored by District or Contractor (0.01 in)	KT-49	INF				See SS 2015 section 502.3m.
	Density of Fresh Concrete (0.1 lb/ft^3)	KT-38	VER			a b	Initially, 1 complete transverse profile. Thereafter, 5 per day.
	Air Void Analyzer (0.0001 in)	KT-71			1 test randomly during every 4 weeks of production.		Prequalification of mix required as per SS 2015 sec. 403.4.
	Permeability (0.01%, KT-73; 10 coulomb, AASHTO T 277; 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.
	Vibrator Frequency Per Standard Specifiction 154.2e	SS 154.2e			Daily by KDOT		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 600 (See also Division 1100 regarding aggregates)							
HMA (Plant Mix) Sec. 603, 611, 1103 & 15-06001							
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	INF	e		b h i	1 per lot.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07		e			
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08		e			
	Percent Crushed Particles in Crushed Gravel (0.1%)	KT-31	VER	b h	500 TONS.		
	Sticks in Aggregate (0.01% of mass)	KT-35		e			
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50	VER	e			
Mineral Filler Supplement	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER			a	250 TONS.
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	INF			c h	250 TONS.
Combined Aggregate	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	INF				1 per sublot.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 600 (continued)							
HMA (Plant Mix) (continued) Sec. 603, 611, 1103 & 15-06001							
Combined Aggregate (continued)	Sand Equivalent Test (1%)	KT-55	INF			h	1 per sublot. (District tested)
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	VER	a	Minimum of 1 per day.		
HMA Mixtures (Field Lab)	Density (0.1 lb/ft^3 or 0.01% of optimum density)	KT-15 and KT-58	VER	a	Minimum of 1 set per day.		
	Voids (0.01%)						
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			a	Minimum of 1 per day.
Asphalt Binder	Binder Sampling	KT-26	VER	e b	1 sample per 3 loads.		1 per project.
HMA Mixtures (District Lab)	Density (0.1 lb/ft^3 or 0.01% of optimum density)	KT-15 and KT-58	VER	a	Minimum of 1 set per project. (District molded)		
	Voids (0.01%)						
	Stability (1 lbf)						
	Flow (0.01 in)						
	Gradation (1%, 0.1% for the No. 200 sieve, of mass)	KT-34					
	Asphalt Content (0.1 g or 0.01%)	KT-57					

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 600 (continued)							
HMA (Plant Mix) (continued) Sec. 603, 611, 1103 & 15-06001							
BM-Mixes (Field Lab)	Theoretical Maximum Specific Gravity of Asphalt Paving Mixtures (G_{mm} = 0.001)	KT-39	VER		1 per lot with a minimum of 1 per day.		
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			a	Minimum of 1 per day.
BM-Mixes (District Lab)	Air Voids (V_a = 0.01%; G_{mb} = 0.001)	KT-15 and KT-58	VER	j	Minimum of 1 set per project. (District molded)		
	Theoretical Maximum Specific Gravity of Asphalt Paving Mixtures (G_{mm} = 0.001)	KT-39					
	Gradation (1%, 0.1% for the No. 200 sieve, of mass)	KT-34					
	Asphalt Content (0.1 g or 0.01%)	KT-57					
Federal Aid Projects (Field or District Labs)	Asphalt Content (0.1 g or 0.01%)	KT-57	VER		Minimum of 1 in AM and 1 in PM, or 1 per 1000 TONS.		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 600 (continued)							
HMA (Plant Mix) (continued) Sec. 603, 611, 1103 & 15-06001							
Completed Road Work Field Density Tests (Use Cores, Nuclear Density, or the Approved Rolling Procedure method on all HMA roadway or shoulder construction)	Field Density - Cores (G_{mb} = 0.001; 0.1 lb/ft^3 or 0.01% of optimum density) Note: If specified [plan] lift thickness is less than 1.5", none required.	KT-15	INF			a b	Shoulders 1 set per shoulder per mile per lift. Surf. & Base Courses 1 set per lane per mile per lift. Min. of 1 per day.
Completed Road Work (continued) Field Density Tests (Use Cores, Nuclear Density, or the Approved Rolling Procedure method on all HMA roadway or shoulder construction)	Field Density - Nuclear Density (0.1 lb/ft^3 or 0.01% of optimum density) Note: If specified [plan] lift thickness is 1.5" or less, none required.	KT-32	INF			a b	Shoulders 3 locations per shoulder per mile per lift. Surf. & Base Courses 3 locations per lane per mile per lift. Min. of 1 per day.
	Field Density - Approved Rolling Procedure (0.1 lb/ft^3 or 0.01% of optimum density) Note: If specified [plan] lift thickness is 1.5" or less.	SS 2015 602.4e.	INF			a b	1 in AM and 1 in PM.
	Profilograph	KT-46	INF	e		b	Testing by contractor. Results reviewed by KDOT.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 600 (continued)							
HMA (Plant Mix) (continued) Sec. 603, 611, 1103 & 15-06001							
Commercial Grade	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC				1 test for each 500 ton lot or fraction thereof. Also see SS 2015 section 611.2d.
SURFACE RECYCLE Section 605	Asphalt Rejuvenating Agent	KT-26	VER		See section 5.7.1.5.2. of this manual.		
	Depth of Recycling (0.01 ft)	KT-47	INF			a	1 per hour of operation.
Field Density Tests	Field Density - Approved Rolling Procedure (0.1 lb/ft^3 or 0.01% of optimum density)	SS 2015 605.3e.(1)(b)	INF			a	1 in AM and 1 in PM.
COVER MATERIAL FOR ASPHALT SEAL Sec. 608, 609, 610, & 1108	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	250 TONS or 250 yd^3.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08				e	
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF			e	
	Sticks in Aggregate (0.01% of mass)	KT-35				e	

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 700 (See also Division 1100 regarding aggregates)							
REINFORCING STEEL BARS Sec. 711, 1601 & 1602			VER		1 per month per plant.		
PAINT Sec. 712, 1800		KT-28	VER		1 per source per project.		See Standard Specifications.
POST-TENSIONING (Haunched Slab Bridges) Sec. 716, 1731	Cylinders for grout (1 lbf, 0.1 in, 1 psi)	KT-22	VER				3 cylinders per truck load.
	Infrared Spectroscopy		VER		Sample 1 quart and send to MRC.		
SLIPFORMING CONCRETE BARRIER FOR BRIDGES Sec. 720							
Combined Aggregate	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	INF				1 per bridge.
Concrete	Air Content (0.25%)	KT-19	ACC				As needed to control product, minimum 1 set of tests every 50 yd^3.
	Slump (0.25 in)	KT-21	ACC				As needed to control product.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 700 (continued)							
MULTI-LAYER POLYMER CONCRETE OVERLAY **SLURRY POLYMER CONCRETE OVERLAY** **REPAIR OF EXISTING POLMER CONCRETE BRIDGE DECK OVERLAY** Sec. 729, 739, 740 and 1730							
Polymer Resins	Infrared Spectroscopy		VER		Sample 1/2 pint of each lot of each component and send to MRC 1 week prior to placement.		
Aggregate	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF				
Prepared Bridge Deck Surface	Moisture in Deck	KT-82					Prior to application of overlay.
Overlayed Bridge Deck	Surface Preparation and Adhesion (10 lbf or 10 psi)	KT-70					Test by contractor, KDOT to witness. Once every span or every 300 yd^2 of prepared deck surface, whichever is smaller.
DIVISION 800 (See also Division 1100 regarding aggregates)							
STONE FOR RIPRAP WASH CHECKS & OTHER MISC. USES Sec. 815, 816, 829, & 1114	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 [75 µm] sieve, of mass)	KT-02	ACC			a	500 TONS or 500 yd^3. Tests to be done at production site. Type III Stone for Filter Course may be accepted visually.
UNDERDRAIN AGGREGATE Sec. 822 and 1107	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	500 TONS.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 800 Continued							
UNDERDRAIN AGGREGATE Continued	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08				e	
	Sticks in Aggregate (0.01% of mass)	KT-35				e	
DIVISION 1100							
INDIVIDUAL AGGREGATE QUALITY (Applies to all aggregates)			OFQ VER		Aggregate quality only - One sample per source per year per district.		Prior approval required.
ON-GRADE CONCRETE (OGCA) Sec. 1116			QPS		See 5.6 Sect. 5.4.4 of this manual.		
AGGREGATE FOR CONCRETE Sec. 1102, 1116	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	VER	e	As needed to control aggregate used in accepted stockpiles.	a	1 per 350 TONS of combined aggregate.
	Unit Weight – lightweight aggregates only (0.1 lb or 0.1% of mass)	KT-05	VER			e	
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08				e	
	Sticks in Aggregate (0.01% of mass)	KT-35				e	

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 1100 (continued)							
AGGREGATE FOR CONCRETE (continued) Sec. 1102, 1116	Coal	AASHTO T 113				e	
	Organic Impurities	AASHTO T 21				e	
AGGREGATE FOR STRUCTURE AND PIPE BACKFILL Sec. 204, 817, 1107	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	500 TONS.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08				e	
	Sticks in Aggregate (0.01% of mass)	KT-35				e	
BACKFILL FOR MSE WALLS Sec. 1107	Sampling Aggregates	KT-01					Send representative samples to the MRC (Attn: Geot. Eng.) for acceptance prior to placement of material on project.
SURFACE OR RESURFACING AGGREGATE Sec. 1111 & 1112	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	ACC			a	Once in the AM and once in the PM or every 500 TONS whichever is less frequent.

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 1100 (continued)							
SURFACE OR RESURFACING AGGREGATE Sec. 1111 & 1112 (continued)	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07				e	
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11	INF				
	Sticks in Aggregate (0.01% of mass)	KT-35				e	
DRAINABLE BASE Special Provisions	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	INF			a	Minimum of 1 in AM and 1 in PM, or 1 per 500 TONS.
DIVISION 1200							
PERFORMANCE GRADED ASPHALT BINDER, CUTBACK ASPHALT, EMULSIFIED ASPHALT, AND REJUVENATING AGENTS Sec. 1201, 1202, 1203, 1204, & 1205		KT-26	VER	a	See section 5.7.1.4. and 5.7.1.5.2 of this manual, and the Standard Specifications.		
DIVISION 1400							
LIQUID MEMBRANE FORMING COMPOUND Sec. 1404	Infrared Spectroscopy		VER		2 per product per year per district.		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 1500							
MATERIALS FOR FILLING AND SEALING JOINTS IN PIPE Sec. 1505	Sampling Joint Compound Material	KT-27					Each lot.
SAND FOR BRIDGE JOINT GAP REPAIR SYSTEM	Sieve Analysis of Aggregate (1% of mass)	KT-02					Test prior to use.
DIVISION 1600							
REINFORCING STEEL BARS Sec. 1601 & 1602			VER		1 per month per plant.		
WIRE FABRIC Sec. 1603			VER		1 plant per district per year.		
DIVISION 1700							
ABUTMENT STRIP DRAIN Sec. 1706			VER		2 per source, per District per year		
ANTI-GRAFFITI COATING Sect. 1729	Infrared Spectroscopy		VER		1 per project, per manufacturer, per District		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 2000							
PORTLAND CEMENT, BLENDED HYDRAULIC CEMENT, FLY ASH FOR USE IN CONCRETE Sec. 2001, 2004, & 2005		KT-29	VER		Cement: See section 5.7.9 of Part V, and the Standard Specifications. Fly Ash: Minimum of 1 semi-annual sample per source per concrete project.		See section 5.7.9 of this manual, and Standard Specifications.
DIVISION 2200							
PAVEMENT MARKING							
Cold Plastic Sec. 2207			VER ACC		Except for symbols, 1 per lot per color.		
Patterned Cold Plastic Sec. 2208			VER ACC		Except for symbols, 1 per lot per color.		
High Durability Sec. 2209			VER ACC		Except for symbols, 1 per lot per color.		
Thermoplastic Sec. 2211	Field Sampling of Thermoplastic Pavement Marking Material	KT-30	VER ACC		1 from 1 lot per color per project.		
Preformed Thermoplastic Sec. 2212			VER ACC		Except for symbols, 1 on each lot.		

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	AWP	CODE	VERIFICATION SAMPLES & TESTS (Note f)	CODE	ACCEPTANCE SAMPLES & TESTS
DIVISION 2200 (continued)							
PAVEMENT MARKING (continued)							
Sprayed Thermoplastic Sec. 2213	Field Sampling of Thermoplastic Pavement Marking Material	KT-30	VER ACC		1 from 1 lot per color per project.		
Epoxy Sec. 2214			VER ACC		1/2 pint per each component lot per color per project. DO NOT MIX!		
Pavement Marking Paint Sec. 2215			VER ACC		2 samples per color per project.		
Multi-component Sec. 2216			VER ACC		1/2 pint per each component lot per color per project.		

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 300						
CEMENT TREATED BASE (CTB) Sec. 306 & 1105	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c h	1 per day.		1 per week.
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41		4 per day per design.		1 per week.
	Density (0.1 lb/ft^3 or 0.1% of optimum density)	KT-37 or KT-20*		1 per day per design (* KT-20 option is only permitted in conjunction with a fluid mix.)		1 per project per design.
	Compressive Strength (1 psi)	KT-37		1 specimen per sublot		1 specimen per lot.
Completed Base	Field Density Tests (0.1 lb/ft^3 or 0.1% of optimum density)	KT-13 or KT-41		4 per day per design.		1 per week per design.
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11 or KT-41		4 per day per design.		1 per week per design.
DIVISION 500						
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 501 & 503	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c m	1 per 350 TONS of combined aggregate.		1 per project.
Individual Aggregates	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07	c h			As required.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 500 (continued)						
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 501 & 503 (continued) **Individual Aggregates (continued)**	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08	c h			As required.
	Sticks in Aggregate (0.01% of mass)	KT-35	c h			As required.
	Unit Weight – lightweight aggregates only (0.1 lb or 0.1% of mass)	KT-05	c k			As required.
	Moisture in Aggregate (0.1 g or 0.01% of mass)	KT-24	p	1 per 1/2 day.		1 per week.
	Coal	AASHTO T 113				As required.
	Organic Impurities	AASHTO T 21				As required.
Concrete	Mass per cubic foot (0.1 lb/ft^3)	KT-20	a	1 per 500 yd^3.		1 per day.
	Slump (0.25 in)	KT-21	a	1 per 500 yd^3.		1 per day.
	Temperature (1 °F)	KT-17	a	1 per 500 yd^3.		1 per day.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 500 (continued)						
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 501 & 503 (continued) **Concrete (continued)**	Air Content (0.25%)	KT-18 or KT-19	a	1 per 500 yd^3 or every 2 hours (mainline), every 4 hours (other slipformed pvmt), whichever is more frequent. Determine the air loss due to paving operations once in the AM and once in the PM. Determine the difference between the air content from concrete sampled before the paver, and concrete sampled behind the paver.		1 per day.
	Density of Fresh Concrete (0.1 lb/ft^3)	KT-38		Initially, 1 complete transverse profile, then 1 density per ½ day.		1 density per week.
	Beams (1 psi)	KT-22 & KT-23		1 set of 3 as required for opening to traffic.		1 set of 3 per week as required for opening to traffic.
	Cores (1 lbf, 0.01 in, 1 psi)	KT-49		As required in SS 2015 section 501.5g.		Thickness measurement and compression test – 1 per lot.

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 500 (continued)						
PORTLAND CEMENT CONCRETE PAVEMENT Sec. 501 & 503 (continued) **Concrete** (continued)	Air Void Analyzer (0.0001 in)	KT-71		Prequalification of mix required as per SS 2015 sec. 403.4.		1 test randomly during every 4 weeks of production.
	Permeability (0.01%, KT-73; 10 coulomb, AASHTO T 277; nearest 0.1 kΩ-cm, KT-79	KT-73 or AASHTO T 277 or KT-79	o			1 per mix design per project.
	Profilograph	KT-46		2 tracks per 12 ft of width for the full length of the project.		At the Engineer’s discretion.
	Vibrator Frequency Per Standard Specification 154.2e	SS 154.2e		Every 4 hours		Daily
ON-GRADE CONCRETE (OGCA)						See 5.6 Section 5.4.4 of this manual.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600						
HMA (Plant Mix) Sec. 602, 603, 611 & 1103						
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c	1 per 1000 TONS for each individual aggregate.		1 during the first 5000 TONS of HMA produced for each individual aggregate.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07	c h			As required.
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08	c h			As required.
	Sticks in Aggregate (0.01% of mass)	KT-35	c h			As required.
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50	l	1 on the first lot then 1 per 10,000 TONS of crushed gravel.		1 during the first 5000 TONS of HMA produced.
	Uncompacted Void Content of Coarse Aggregate (0.01%)	KT-80	l	1 on the first lot then 1 per 10,000 TONS of crushed gravel.		1 during the first 5000 TONS of HMA produced.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
HMA (Plant Mix) continued Sec. 602, 603, 611 & 1103						
Mineral Filler Supplement	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c h	1 per 250 TONS.		1 during the first 5000 TONS of HMA produced.
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	c h	1 per 250 TONS.		
Combined Aggregate	Coarse Aggregate Angularity (Determination of Crushed Particles in Crushed Gravel) (0.1% of mass)	KT-31	c g	1 per lot		1 per week or 1 per 10,000 TONS.
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50		1 on the first lot then 1 per 10,000 TONS of combined aggregate.		1 during the first 5000 TONS of HMA produced.
	Sand Equivalent Test (1%)	KT-55	f	1 per lot.		
	Flat or Elongated Particles (1%)	KT-59		1 on the first lot.		
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11		1 per lot.		
Asphalt Material	Sampling	KT-26	b e	Sample per sampling frequency level chart		
HMA Mixtures	Percent Moisture in Mixture (0.1 g or 0.01% of mass)	KT-11		1 per lot.		1 during the first 5000 TONS of HMA produced.
	Air Voids (V_a = 0.01%; G_{mm} & G_{mb} = 0.001)	KT-15, KT-39, KT-58, & SF Manual	q	1 per sublot. (See code n for G_{mm})	j	1 per lot. [Compact split sample on KDOT Gyratory – 1 per week or every 15,000 TONS]

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
HMA (Plant Mix continued) Sec. 602, 603, 611 & 1103						
HMA Mixtures (continued)	Binder Content (by ignition) (0.1 g or 0.01% of mass)	KT-57		1 per sublot.	j	1 per lot.
	Mix Gradation (after ignition) (0.1 g or 0.01% of mass)	KT-34		1 per sublot.		1 per lot.
	Moisture Damage to Mix (Modified Lottman) (0.1%)	KT-56	d	1 on first lot then 1 per week or every 10,000 TONS.		1 during the first 5000 TONS of HMA produced. Performed by the District Lab.
Reclaimed Asphalt Pavement (RAP)	Binder Content in RAP (by ignition) (0.1 g or 0.01% of mass)	KT-57		1 during the first lot then 1 per 1000 TONS of RAP.	j	1 during the first lot then 1 per 4000 TONS of RAP.
	RAP Gradation (after ignition) (0.1 g or 0.01% of mass)	KT-34		1 per 1000 TONS of RAP.		1 during the first 5000 TONS of HMA produced.
	Percent Moisture in RAP (0.1 g or 0.01% of mass)	KT-11		1 per lot.		
Recycled Asphalt Shingles (RAS)	Binder Content in RAS (by ignition) (0.1 g or 0.01% of mass)	KT-57		1 during the first lot then 1 per 1000 TONS of RAP + RAS.	j	1 during the first lot then 1 per 4000 TONS of RAP + RAS.
	RAS Gradation (after ignition) (0.1 g or 0.01% of mass)	KT-34		1 per 1000 TONS of RAP + RAS.		1 during the first 5000 TONS of HMA produced.
	Percent Moisture in RAS (0.1 g or 0.01% of mass)	KT-11		1 per lot.		

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
HMA (Plant Mix continued) Sec. 602, 603, 611 & 1103						
Completed Road Work Field Density Tests (Use Cores or Nuclear Density Gauge on all HMA roadway or shoulder construction greater than or equal to 1.5 inches)	Field Density - Cores or Nuclear Density Gauge (G_{mb} = 0.001; 0.1 lb/ft^3 or 0.01% of G_{mm})	KT-15 or KT-32	i	10 tests per lot.	i	5 companion tests per lot.
(Use approved rolling procedure and Nuclear Density Gauge on all HMA roadway or shoulder construction less than 1.5 inches)	Field Density -Nuclear Density Gauge (G_{mb} = 0.001; 0.1 lb/ft^3 or 0.01% of G_{mm})	KT-32	i	10 Nuclear Gauge readings per lot Verify Approved Rolling Procedure every 2 hours		
	Profilograph	KT-46		2 tracks per 12 ft of width for the full length of the project.		At the Engineer's discretion.
Cold In-Place Recycle (CIR) Sec. 604	Sampling Aggregate	KT-01		2 per mile. (Sieve according to specification.)	k	1 per day.
	Percent Retained on the #200 Sieve by Dry Screen	KT-04		2 per day.		
	Field Moisture Tests (0.1 g or 0.01% of mass)	KT-32				Minimum 1 per day. Use nuclear gauge w/o correction. (Test before overlay or seal.)
	Field Density (G_{mb} = 0.001; 0.1 lb/ft^3 or 0.01% of G_{mm})	KT-32				3 locations per width laid per mile per lift. Minimum of 1 per day.

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
Asphalt Material (Emulsion)	Sampling	KT-26	b	1 sample for every 3 loads.	b	
Lime Slurry	Percent Solids of Lime Slurry	KT-62		1 at beginning of project then 1 at each mix design change.	k	
MICROSURFACING Sec. 606 & 1109	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c	1 per 250 TONS for each individual aggregate.		1 per day.
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11		3 per day.		1 per day.
	Emulsified Asphalt	KT-26		1 per project.	k	
	Sampling Cement	KT-29		1 per project.	k	
	Percent Crushed Particles in Crushed Gravel (0.1%)	KT-31		1 per project.	k	
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50		1 per project.	k	
	Sand Equivalent Test (1%)	KT-55		1 per project.	k	
ULTRATHIN BONDED ASPHALT SURFACE (UBAS) Sec. 613 & 1103						
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c h	1 per 1000 TONS for each individual aggregate.		1 per project per individual aggregate.
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50	l	1 on the first lot then 1 per 10,000 TONS of crushed gravel.		1 per project.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
ULTRATHIN BONDED ASPHALT SURFACE (UBAS) Sec. 613 & 1103 (continued)						
Mineral Filler Supplement	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c h	1 per 250 TONS.		1 per project.
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	c h	1 per 250 TONS.		1 per project.
Combined Aggregate	Coarse Aggregate Angularity (0.1% of mass)	KT-31	c g h	1 per lot of combined aggregate		1 per week or 1 per 10,000 TONS.
	Uncompacted Void Content of Fine Aggregate (0.1%)	KT-50	f	1 on the first lot then 1 per 10,000 TONS of combined aggregate.		1 per project.
	Sand Equivalent Test (1%)	KT-55	f	1 per lot.		1 per project.
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11		1 per 2000 TONS of combined mix.		1 per project.
Asphalt Material	Sampling	KT-26	b e	Sample per sampling frequency level chart		
HMA Mixtures	Percent Moisture in Mixture (0.1 g or 0.01% of mass)	KT-11		1 per 2000 TONS of combined mix.		1 per project.
	Theoretical Maximum Specific Gravity (Rice) (G_{mm} = 0.001)	KT-39	n	1 per sublot.		1 per lot.
	Binder Content (by ignition) (0.1 g or 0.01% of mass)	KT-57		1 per sublot.	j	1 per lot.
	Mix Gradation (after ignition) (0.1 g or 0.01% of mass)	KT-34		1 per sublot.		1 per lot.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
HMA Base [Reflective Crack Interlayer (RCI)] Sec. 614						
Individual Aggregates	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c	1 per 1000 TONS for each individual aggregate.		1 during the first 5000 TONS of HMA produced for each individual aggregate.
	Clay Lumps and Friable Particles in Aggregate (0.1 g or 0.01% of mass)	KT-07	c h			As required.
	Shale or Shale-Like Materials in Aggregate (0.1 g or 0.01% of mass)	KT-08	c h			As required.
	Sticks in Aggregate (0.01% of mass)	KT-35	c h			As required.
Mineral Filler Supplement	Sieve Analysis of Aggregate (1%, 0.1% for No. 200 sieve, of mass)	KT-02	c h	1 per 250 TONS.		1 during the first 5000 TONS of HMA produced.
	Plasticity Tests (0.01 g or 0.1% of mass)	KT-10	c h	1 per 250 TONS.		
Combined Aggregate	Sand Equivalent Test (1%)	KT-55	f	1 per lot.		
	Flat or Elongated Particles (1%)	KT-59		1 on the first lot.		
	Moisture Tests (0.1 g or 0.01% of mass)	KT-11		1 per lot.		
Asphalt Material	Sampling	KT-26	b e	Sample per sampling frequency level chart		
HMA Mixtures	Percent Moisture in Mixture (0.1 g or 0.01% of mass)	KT-11		1 per lot.		1 during the first 5000 TONS of HMA produced.

SAMPLING AND TESTING FREQUENCY CHART
CONTRACTOR QUALITY CONTROL TESTING

CONSTRUCTION OR MATERIAL TYPE 2015 Std. Spec. (SS 2015)	TESTS REQUIRED (RECORDED TO)	TEST METHOD	CODE	QUALITY CONTROL BY CONTRACTOR	CODE	VERIFICATION BY KDOT
DIVISION 600 (continued)						
HMA Base [Reflective Crack Interlayer RCI)] Sec. 614 (continued)						
HMA Mixtures (continued)	Air Voids (Va = 0.01%; G_{mm} & G_{mb} = 0.001)	KT-15, KT-39, KT-58, & SF Manual	q	1 per sublot. (See code n for G_{mm})	j	1 per lot. [Compact split sample on KDOT Gyratory – 1 per week or every 15,000 TONS]
	Binder Content (by ignition) (0.1 g or 0.01% of mass)	KT-57		1 per sublot.	j	1 per lot.
	Mix Gradation (after ignition) (0.1 g or 0.01% of mass)	KT-34		1 per sublot.		1 per lot.
Completed Road Work	Field Density Approved Rolling Procedure Nuclear Gauge (Gmb = 0.001; 0.1 lb/ft^3 or 0.01% of Gmm)	KT-32		Verify Approved Rolling Procedure every 2 hours 10 Nuclear Gauge readings per day		

Aggregate Field Testing Technician
KT-01 Sampling And Splitting Of Aggregates (Sampling)
Revised August 2021

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.
Underlined items will be administered orally.

Applicant: ______________________ **CIT #:** ______________

Employer: ______________________

		1st Test	Stopped Test	Re-Test
	Sampling Methods			
	Bins or Belt Discharge			
1.	<u>Receptacle must intersect entire cross-section of stream and be passed through the entire stream without overflowing.</u> (3.1)	PASS FAIL	PASS FAIL	PASS FAIL
2.	<u>Obtain at least three approximately equal increments, selected at random and combine to form a field sample, with a mass that equals or exceeds the minimum required.</u> (3.1.)	PASS FAIL	PASS FAIL	PASS FAIL
	Stationary Conveyor Belt			
3.	<u>Obtain at least three approximately equal increments, selected at random. Combine to form a field sample with a mass that equals or exceeds the minimum required.</u> (3.2)	PASS FAIL	PASS FAIL	PASS FAIL
4.	<u>Insert two templates, the shape of which conforms to the shape of the belt, in the aggregate stream on the belt.</u> (3.2)	PASS FAIL	PASS FAIL	PASS FAIL
5.	<u>Carefully scoop all material between the templates into a suitable container and collect the fines from the belt with a brush and dust pan.</u> (3.2.)	PASS FAIL	PASS FAIL	PASS FAIL
	Sampling Stockpiles with Power Equipment			
6.	<u>Try to avoid sampling from stockpiles because it is nearly impossible to collect a truly representative sample.</u> (3.3.)	PASS FAIL	PASS FAIL	PASS FAIL

		1st Test		Stopped Test		Re-Test	
7.	Using power equipment, compose a small sampling pile of material drawn from various levels and locations of the main pile. Moveable conveyor equipment may also be used to create the small stockpile. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
	Coarse Aggregates						
8.	Flatten one side of the small pile with the loader bucket. (3.3)	PASS	FAIL	PASS	FAIL	PASS	FAIL
9.	Sample by inserting a shovel in at least 5 different locations. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
10.	Combine the individual increments to produce a sample of not less than 75 lbs. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
	Fine Aggregates						
11.	Sample fine aggregate with a shovel or with a sampling tube having a diameter at least 3 times the size of the maximum size aggregate being sampled. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
12.	Scalp away the outer layer. Obtain a minimum of five increments at several locations in the pile with samples taken from each 1/3 volume of the pile by inserting the tube or digging a hole 1 to 2 ft deep. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
13.	Combine the individual increments to form a field sample. (3.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL

Aggregate Field Testing Technician
KT-01 Sampling And Splitting Of Aggregates (Sampling)
Revised August 2021

Overall Score

Circle One

1st Test	**Stopped Test**	**Re-Test**
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

Aggregate Field Testing Technician
KT-01 Sampling And Splitting Of Aggregates (Splitting)
Revised August 2021

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.

Applicant: ______________________________ **CIT #:** ____________________

Employer: ____

		1st Test	Stopped Test	Re-Test
	Sampling Methods			
	Using a Quartering Canvas			
1.	<u>The canvas is not to be used as the first step in the reduction of samples smaller than approximately 75 lb.</u> (4.1.)	PASS FAIL	PASS FAIL	PASS FAIL
2.	Spread the canvas on a smooth level surface, dump the sample in a pile near the center. (4.1.1.)	PASS FAIL	PASS FAIL	PASS FAIL
3.	Mix by alternately lifting each corner and rolling the aggregate toward the opposite corner. Perform this in a vigorous manner. (4.1.1.)	PASS FAIL	PASS FAIL	PASS FAIL
4.	Center the material on the canvas in a uniform pile. Flatten the pile to a uniform thickness and diameter by pressing down the apex with a straight-edge scoop, shovel, or trowel so that each quarter sector of the resulting pile will contain the material originally in it. (4.1.2.)	PASS FAIL	PASS FAIL	PASS FAIL
5.	Insert a rod, shovel handle, or similar object under the canvas and under the center of the pile and lift both ends of the rod to divide the pile into two equal parts. Leaving a fold of canvas between the piles, repeat at a right angle to divide the sample into four equal parts. (4.1.3.)	PASS FAIL	PASS FAIL	PASS FAIL
6.	Discard two opposite quarters, combine the two remaining quarters, mix and reduce to proper size with a riffle splitter or by quartering procedure. (4.1.4.)	PASS FAIL	PASS FAIL	PASS FAIL

Aggregate Field Testing Technician
KT-01 Sampling And Splitting Of Aggregates (Splitting)
Revised August 2021

		1st Test	Stopped Test	Re-Test
	Riffle Splitter Procedure			
7.	Check sample splitter chute openings [their number and width relative to maximum size of aggregate]. (4.2.1.)	PASS FAIL	PASS FAIL	PASS FAIL
8.	Place original sample in the pan and uniformly distribute it from edge to edge. (4.2.2.)	PASS FAIL	PASS FAIL	PASS FAIL
9.	Introduce the sample into the splitter so that it flows freely through the chutes. (4.2.2.)	PASS FAIL	PASS FAIL	PASS FAIL
10.	Retrieve one of the two catch pans from the splitter, replace with an empty pan, and repeat steps 8 and 9 as many times as necessary to reduce the sample to the specified size. (4.2.2.)	PASS FAIL	PASS FAIL	PASS FAIL
	Miniature Stockpile Sampling (*wet fine aggregate only)*			
11.	Place original sample on hard, clean, level surface. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL
12.	Mix the sample thoroughly with a shovel or trowel by turning the entire sample over three times. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL
13.	With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL
14.	Carefully flatten the conical pile to a uniform thickness and diameter by pressing down on the apex with a shovel or trowel so that each quarter sector of the resulting pile will contain the material originally in it. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL
15.	Divide the flattened pile into four equal quarters with a straight edge and remove two pre-selected diagonally opposite quarters, using a brush or broom to clean the cleared space. Repeat the process until the sample is reduced to the proper size. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL

Aggregate Field Testing Technician
KT-01 Sampling And Splitting Of Aggregates (Splitting)
Revised August 2021

Overall Score

Circle One

1st Test	**Stopped Test**	**Re-Test**
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

Aggregate Field Testing Technician
KT-02 Sieve Analysis of Aggregate
Revised June 2022

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.

Applicant: ______________________________ **CIT #:** ____________________

Employer: ____

		1st Test	Stopped Test	Re-Test
	Fine Aggregates			
1.	Fine aggregates shall have a mass, after drying, no less than 300 g. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
	Coarse Aggregates			
2.	See TABLE 1 for Sample size. (4.3.)	PASS FAIL	PASS FAIL	PASS FAIL
	Sample Preparation			
3.	Dry test sample to a constant mass. (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL
4.	Record the original dry mass of the sample. Determine mass to the nearest 0.1%. (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL
5.	Wash samples over the No. 200 (75 µm) sieve according to procedure specified in KT-03. (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
6.	Redry sample to constant mass. Determine the mass of the sample to the nearest 0.1% of the original dry mass. Record this as the dry mass of sample after washing (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
	Test Procedure			
7.	Nest appropriate sieves in order of decreasing size. (6.1.)	PASS FAIL	PASS FAIL	PASS FAIL
8.	Place sample on top of sieve. (6.1.)	PASS FAIL	PASS FAIL	PASS FAIL
9.	Agitate sieves by hand or mechanical methods. (6.1. & 6.1.1.)	PASS FAIL	PASS FAIL	PASS FAIL
10.	Limit the quantity of material on a given sieve to prevent overloading. (6.2)	PASS FAIL	PASS FAIL	PASS FAIL

		1st Test	Stopped Test	Re-Test
11.	When hand sieving, sieve until not more than 0.5% of the original sample mass passes any given sieve during 1 minute of sieving. (11.1.)	PASS FAIL	PASS FAIL	PASS FAIL
12.	Determine the mass (cumulative) of material retained on each sieve. (6.5.)	PASS FAIL	PASS FAIL	PASS FAIL
13.	Total the mass of all individual sieves and the pan and check that it is within 0.3% of the original mass placed on the sieves. (6.4.)	PASS FAIL	PASS FAIL	PASS FAIL
14.	Calculate percentage retained on each sieve and the percent passing the No. 200 (75 µm) sieve. (7.1.)	PASS FAIL	PASS FAIL	PASS FAIL

TABLE 1

Sample Size for Determination of Coarse Aggregate Gradation Tests

Sieve Size	Minimum Mass of Samples (g)
2 1/2 in (63 mm) or more	35,000
2 in (50 mm)	20,000
1 1/2 in (37.5 mm)	15,000
1 in (25.0 mm)	10,000
3/4 in (19.0 mm)	5,000
1/2 in (12.5 mm)	2,000
3/8 in (9.5 mm) or less	1,000

Aggregate Field Testing Technician
KT-02 Sieve Analysis of Aggregate
Revised June 2022

Overall Score

Circle One

1st Test	**Stopped Test**	**Re-Test**
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

Aggregate Field Testing Technician
KT-03 Material Passing the No. 200 (75 µm) Sieve by the Wash Method
Revised August 2021

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.

Applicant: ________________________ **CIT #:** ______________

Employer: ________________________________

	Test Procedure	1st Test	Stopped Test	Re-Test
1.	Dry the test sample to a constant mass and record the original dry mass to the nearest 0.1%. (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL
2.	Place sample in container. (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
3.	Cover sample with potable water. Add a wetting agent. (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
4.	Agitate sample vigorously to separate fine particles from coarse particles. (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
5.	Immediately pour the wash water over the nested sieves (No. 8 (2.36 mm) to No. 16 (1.18 mm) over the No. 200 (75 µm)). (5.2.)	PASS FAIL	PASS FAIL	PASS FAIL
6.	Repeat steps 3 through 5 (excluding addition of wetting agent), until wash water is clear. (5.3.)	PASS FAIL	PASS FAIL	PASS FAIL
7.	Return all material retained on the nested sieves by flushing to the washed sample. (5.3)	PASS FAIL	PASS FAIL	PASS FAIL
8.	Dry the material to a constant mass. (5.4.)	PASS FAIL	PASS FAIL	PASS FAIL
9.	Record the mass of the sample after washing. (5.4.)	PASS FAIL	PASS FAIL	PASS FAIL
10.	Calculate the percentage passing the No. 200 (75 µm) by wash. (6.)	PASS FAIL	PASS FAIL	PASS FAIL

Aggregate Field Testing Technician
KT-03 Material Passing the No. 200 (75 µm) Sieve by the Wash Method
Revised August 2021

Overall Score

Circle One

1st Test	Stopped Test	Re-Test
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

Aggregate Field Testing Technician
KT-11 Moisture Tests (Constant Mass Method)
Revised August 2021

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.

Applicant: ______________________ **CIT #:** ______________

Employer: ______________________

		1st Test	Stopped Test	Re-Test
	Test Sample			
1.	Select a representative quantity of sample in the amount indicated in the appropriate table. (4.1.)	PASS FAIL	PASS FAIL	PASS FAIL
	Procedure			
2.	Weigh a clean, dry container. Record the weight. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
3.	Place the moist sample in the container and weigh. Record the weight. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
4.	Place the container with the sample in the drying oven at 230 ± 9°F (110 ± 5°C) and dry to a constant mass. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
5.	Upon removal from the oven, allow sample to cool to room temperature. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
6.	Weigh and record the weight of the container with the dried sample. (4.2.)	PASS FAIL	PASS FAIL	PASS FAIL
7.	Calculate the moisture content. (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL

Aggregate Field Testing Technician
KT-11 Moisture Tests (Constant Mass Method)
Revised August 2021

Overall Score

Circle One

1st Test	**Stopped Test**	**Re-Test**
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

Aggregate Field Testing Technician
KT-50 Uncompacted Void Content Of Fine Aggregate
Revised August 2021

Two attempts may be made by the applicant. The applicant may stop themselves once and not have that count as one of the two attempts. If the applicant stops voluntarily, draw a line at that point and note that the applicant stopped themselves then restart at the top of the next attempt.

Applicant: ______________________________ **CIT #:** ____________________

Employer: ____

		1st Test	Stopped Test	Re-Test
	Sample Preparation			
1.	Wash the sample over the No. 200 (75 µm) sieve. Dry the plus No. 200 (75 µm) material to a constant mass. (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL
2.	Sieve the dry aggregate over the No. 8 (2.36 mm), No. 16 (1.18mm), No. 30 (600 µm), No. 50 (300 µm), and No. 100 (150 µm). Discard all material retained on the No. 8 (2.36 mm) and passed through the No. 100 (150 µm). (5.1.)	PASS FAIL	PASS FAIL	PASS FAIL
3.	Weigh and combine the quantities of dry aggregate from each of the sizes shown on the chart. (5.2)	PASS FAIL	PASS FAIL	PASS FAIL
4.	Prepare two test samples from the recipe. (5.3.)	PASS FAIL	PASS FAIL	PASS FAIL
	Test Procedure			
5.	Mix the test sample until it is homogenous. (6.1.)	PASS FAIL	PASS FAIL	PASS FAIL
6.	Using a finger to block the opening of the funnel, pour the test sample into the funnel. (6.1.)	PASS FAIL	PASS FAIL	PASS FAIL
7.	Level the material in the funnel with the spatula. Center the measure under the funnel, remove finger and allow the sample to fall freely into the measure. (6.1.)	PASS FAIL	PASS FAIL	PASS FAIL

Aggregate Field Testing Technician
KT-50 Uncompacted Void Content Of Fine Aggregate
Revised August 2021

		1st Test		Stopped Test		Re-Test	
8.	Exercise care to avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure. (6.2.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
9.	After the funnel empties, remove excess aggregate from the measure by a single pass of the spatula with the blade vertical using the straight part of its edge in light contact with the top of the measure. (6.2.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
10.	After strike off, tap the measure lightly to compact the sample. Brush adhering grains from the outside of the measure. (6.2.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
11.	Pour contents of measure into 200 mL volumetric flask using a funnel to assure total transfer of aggregate. (6.3.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
12.	Weigh the flask and sample, record as A. (6.4.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
13.	Add distilled water (deionized water can be substituted). Rotate the flask in an inclined position to eliminate all air bubbles. Do not shake. (6.5.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
14.	Allow the flask to sit for several minutes then roll flask again. Continue the process until there is no visible air bubbles present or for a maximum of 15 minutes, whichever comes first. Distilled water (and entire test) should be at 77 ± 2°F (25 ± 1°C). (6.5.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
15.	Adjust distilled water to the calibrated volume mark on the neck of the flask. (6.6.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
16.	Weigh flask and contents, record as B. (6.7.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
17.	Repeat procedure for the second test sample and record results. (6.8.)	PASS	FAIL	PASS	FAIL	PASS	FAIL
	Calculations						
18.	Calculate the uncompacted voids. (7.1.)	PASS	FAIL	PASS	FAIL	PASS	FAIL

Aggregate Field Testing Technician
KT-50 Uncompacted Void Content Of Fine Aggregate
Revised August 2021

Overall Score

Circle One

1st Test	**Stopped Test**	**Re-Test**
PASS	PASS	PASS
FAIL	FAIL	FAIL

Witness Examiner: ______________________ ______________________
(First Try) Signature Date

Witness Examiner: ______________________ ______________________
(Stopped Try) Signature Date

Witness Examiner: ______________________ ______________________
(Re-Test) Signature Date

KT-02

Sieve Analysis of Aggregate Worksheet

A ODM = Original Dry Mass = ____________________ g

B FDM = Final Dry Mass = ____________________ g

C =A-B Mass Lost in Wash = ____________________ g

Seive	D Cumulative Grams Retained	Percent Retained D(100)/A	Reported
1 1/2"			
1"			
3/4"			
1/2"			
3/8"			
#4			
#8			
#16			
#30			
#50			
#100			
#200			
Pan			

E = Mass of minus #200 = (Pan-#200) + C = ____________________ g

$$\% \text{ Passing } \#200 = \frac{E}{A} \times 100 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Test Acceptability = 100(B - Pan)/B = ____________________

KT-03

Material Passing #200 (75µm) Sieve by the Wash Method Worksheet

A	ODM = Original Dry Mass =	______________________	g
B	FDM = Final Dry Mass =	______________________	g
C = A-B	Mass Lost in the Wash =	______________________	g

$$\text{Percent Passing} = \frac{\text{ODM - FDM}}{\text{ODM}} \text{ X 100}$$

Recorded Percent Passing = ______________________ %

Reported Percent Passing = ______________________ %

KT-11

Moisture Test Worksheet

W_c = mass of container ____________ g

W_1 = mass of container and moist sample ____________ g

W_2 = mass of container and oven dried sample ____________ g

W = moisture content

$$W = \frac{(W_1 - W_2)}{(W_2 - W_c)} \times 100$$

Recorded W = ________________________ %

Reported W = ________________________ %

KT-50
Uncompacted Void Content of Fine Aggregate
Calibration of Cylinder Worksheet

Cylinder Number ____________

c = Mass of Cylinder + Grease + Glass ____________ g

d = c + Water ____________ g

Temperature of Water ______77____°F

D = Density of Water at Test Temperature* ____0.99704___ g/mL

W = Mass of Water in Cylinder = (d - c) = ____________ g

V_c = Calibrated Volume of Cylinder

V_c = W/D = ____________ mL

* Requirement for test is 77 ± 2 °F (D = 997.04 kg/m^3)
(correction factors for other temperatures can be found in Table 5.16.15-1 in KT-15)

KT-50
Uncompacted Void Content of Fine Aggregate
Test Data and Calculation Worksheet

Cylinder Used ____________

	Trial #1	Trial #2
A = mass of the flask and aggregate =	________ g	________ g
B = mass of the flask, water, and aggregate =	________ g	________ g
V_w = volume of water = (B -A)/0.99704* =	________ mL	________ mL

V_f = volume of flask = 200 mL

V_c = calibrated volume of cylinder = ____________ mL

$$U_{1,2} = \frac{V_w - V_f + V_c}{V_c} \times 100$$

U_1 = ____________ % U_2 = ____________ %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ____________ %

Reported U_k = ____________ %

* Requirement for test is 77 ± 2 °F (D = 997.04 kg/m^3)
(correction factors for other temperatures can be found in Table 5.16.15-1 in KT-15)

KT-80

Uncompacted Void Content of Coarse Aggregate

Calibration of Cylinder Worksheet

Cylinder Number ____________

c = Mass of Cylinder + Grease + Glass ____________ g

d = c + Water ____________ g

Temperature of Water ___77 °F___

D = Density of Water at Test Temperature* ____0.99704___ g/mL

W = Mass of Water in Cylinder = (d - c) = ____________ g

V_c = Calibrated Volume of Cylinder

Vc = W/D = ____________ mL

* Requirement for test is 77 ± 2 °F (D = 997.04 kg/m^3)
(correction factors for other temperatures can be found in Table 5.16.15-1 in KT-15)

KT-80
Uncompacted Void Content of Coarse Aggregate
Test Data and Calculation Worksheet

Cylinder Used ____________

	Trial #1	Trial #2
X = mass of the measure =	______ g	______ g
Y = mass of the measure and aggregate =	______ g	______ g
F = net mass of aggregate (Y-X) =	______ g	______ g

G = bulk dry specific gravity of aggregate = ____________

V_c = calibrated volume of cylinder = ____________ mL

$$U_{1,2} = \frac{V_c - (F/G)}{V_c} \times 100$$

$U_{1,2}$ = ____________ % ____________ %

$$U_k = \frac{U_1 + U_2}{2}$$

Recorded U_k = ____________ %

Reported U_k = ____________ %