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

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Workbook Introduction
5.2.2.1 – Rounding Off Numbers

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

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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:
$73.2 \div 10 = 7.32 \rightarrow 7.3$

Round to the Nearest 0.01:
$148.656 \div 16 = 9.291 \rightarrow 9.29$

Round to the Nearest Whole Number:
$84.8 \div 2 = 42.4 \rightarrow 42$

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

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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:

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

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.

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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

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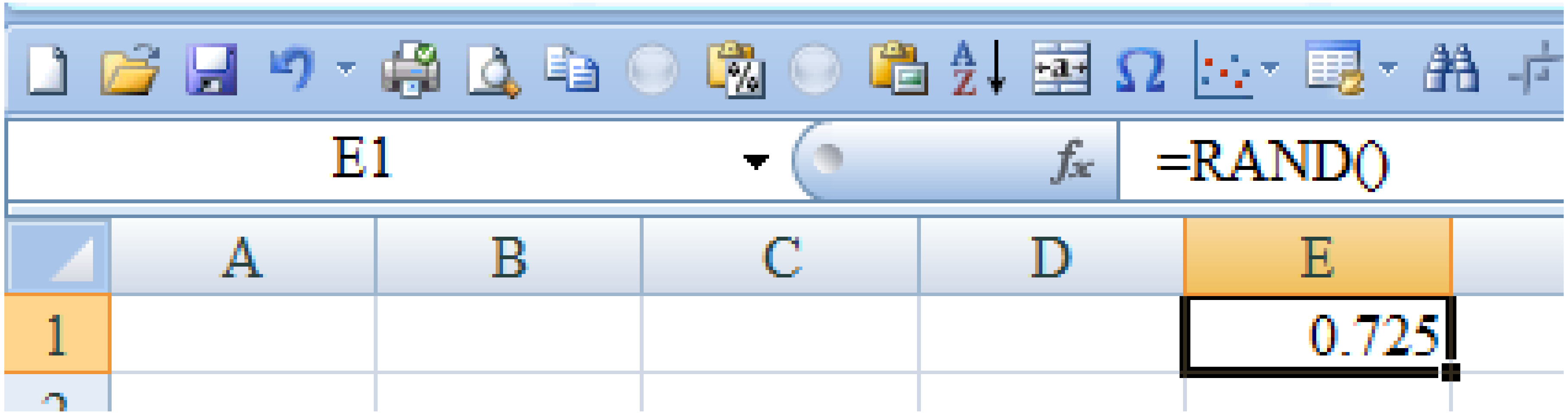
5.2.2.2 Random Sampling

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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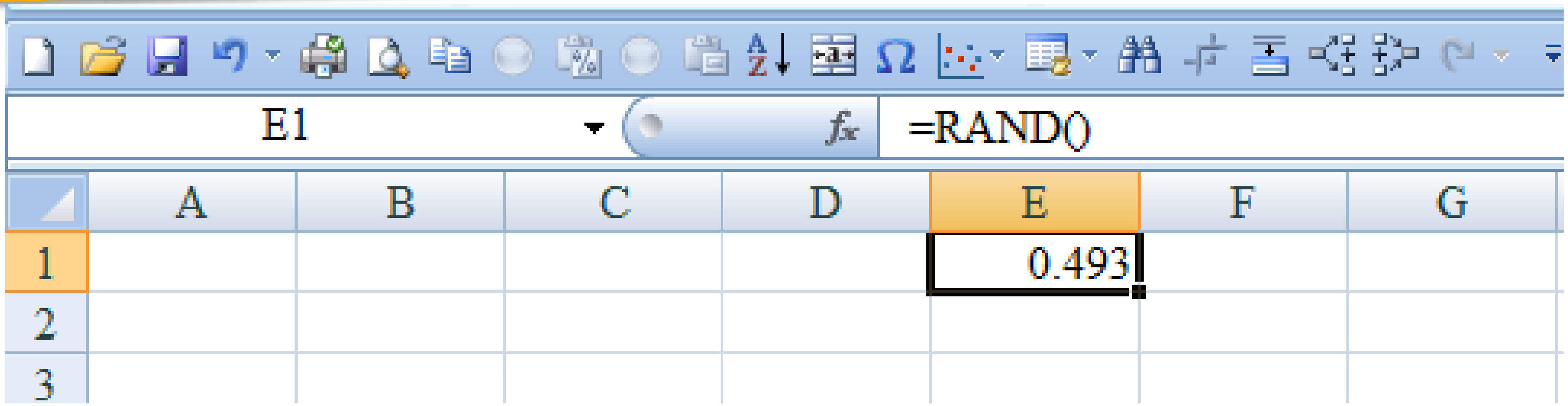
5.2.2.2 Random Sampling

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

<u>Random No.</u>
0.410

<u>Next Random No.</u>
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

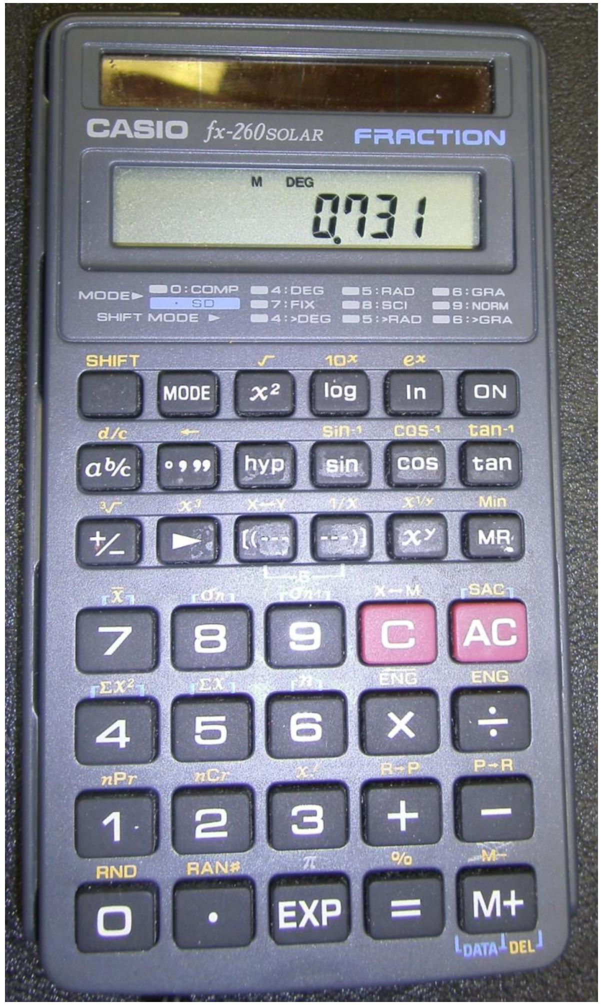
5.2.2.2 Random Sampling

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

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5.2.2.2 Random Sampling

Column = 3
Row = 48

Random No.
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

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

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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

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

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

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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

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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.

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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.

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.

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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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5.2.2.2 Random Sampling

Point Blindly at Random Number Table

Seed Number 0.614

Random Number 0.884

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)

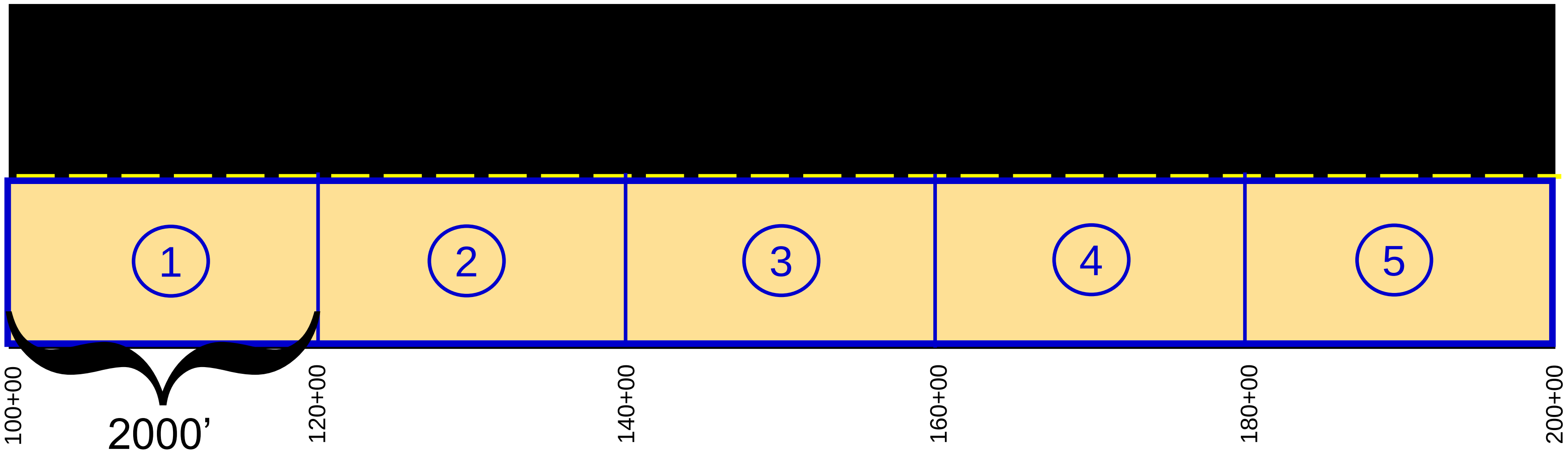
	1	2	3	4	5	6	7	8	9	10
51	0.940	0.312	0.994	0.564	0.946	0.886	0.016	0.112	0.169	0.241
52	0.547	0.336	0.382	0.017	0.836	0.632	0.175	0.053	0.441	0.821
53	0.376	0.620	0.399	0.765	0.618	0.203	0.530	0.124	0.132	0.326
54	0.586	0.268	0.109	0.378	0.434	0.734	0.551	0.894	0.464	0.321
55	0.018	0.409	0.539	0.144	0.703	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

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

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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	[illegible]

Seed Number is 0.751.

Random Number is 0.016

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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 0.751.

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.

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

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

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

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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

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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

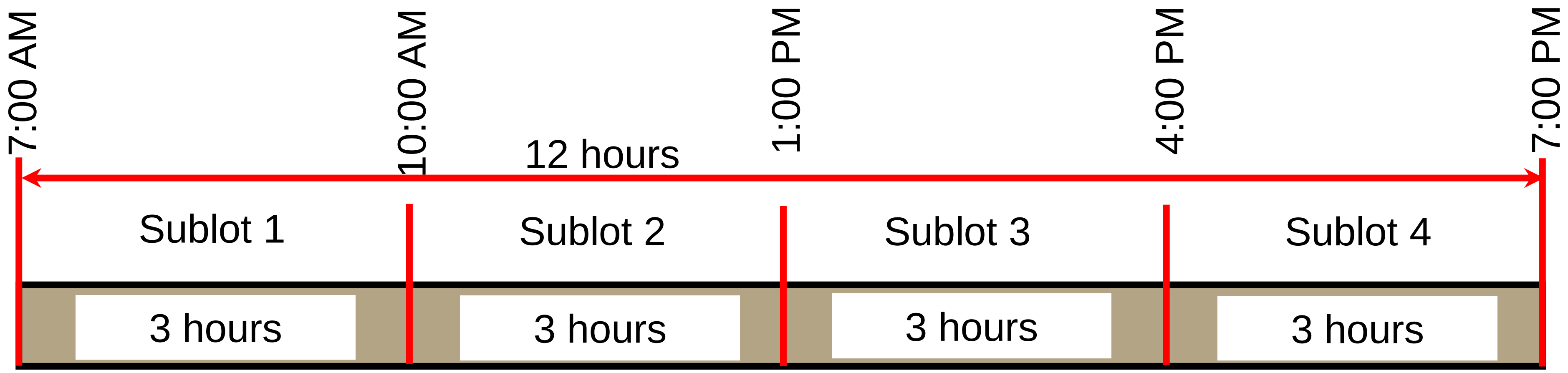
12
x 0.861
10.3

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



5.2.2.2 Random Sampling

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

	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

Seed No. = 0.048

Random Number 1 = 0.495

Random Number 2 = 0.360

Random Number 3 = 0.948

Random Number 4 = 0.241

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5.2.2.2 Random Sampling (3rd Sample)

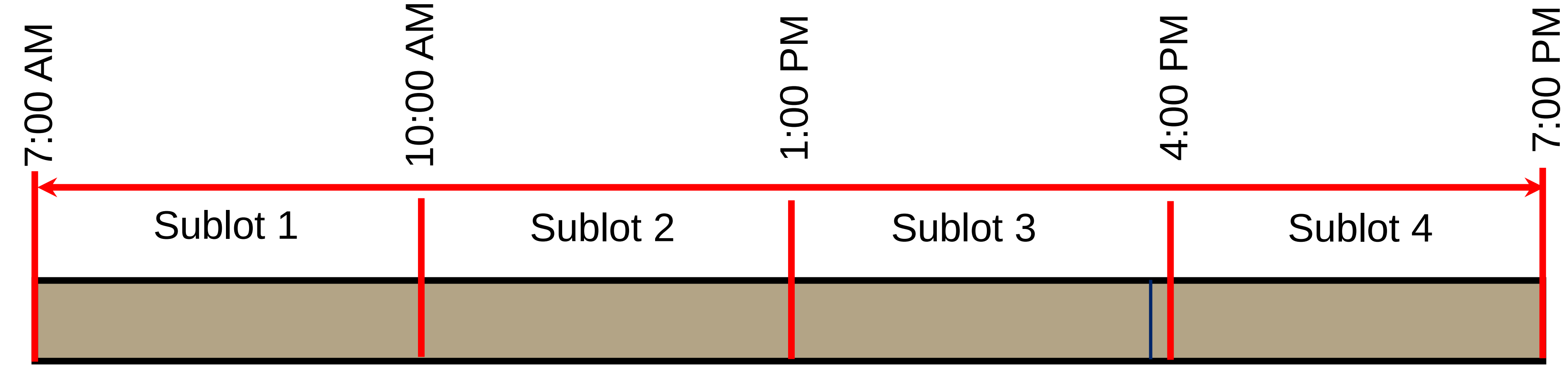
4. Multiply the random number by the sublot size.
5. Add that distance to the starting position of the sublot.

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
3
x 0.948
2.844

3
0.844
x 60
51

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



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.

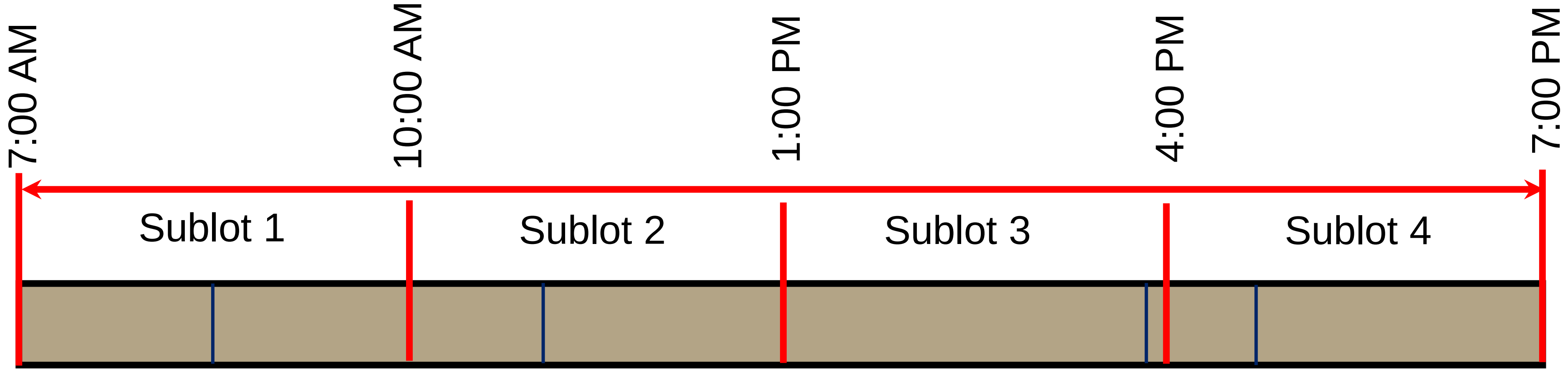
Sublot	Start Time	Rnd #	Sublot Length	Dist into Sublot	Dist into Sublot	Time to Take Sample
1	7:00 AM	0.495	3 hrs	1.485 hrs	1:29	8:29 AM
2	10:00 AM	0.360	3 hrs	1.080 hrs	1:05	11:05 AM
3	1:00 PM	0.948	3 hrs	2.844 hrs	2:51	3:51 PM
4	4:00 PM	0.241	3 hrs	0.723 hrs	0:43	4:43 PM

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



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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.

KT-01: Sampling and Splitting of Aggregates

OBJECTIVE

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

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

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

Courtesy of Oklahoma Department of Transportation

Kansas Department of Transportation

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

Kansas Department of Transportation

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

Kansas
Department of Transportation

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

Courtesy of Oklahoma Department of Transportation

Kansas Department of Transportation

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

Kansas Department of Transportation

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

Courtesy of Oklahoma Department of Transportation

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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

Kansas Department of Transportation

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)

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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.

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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

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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

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

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

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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.

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”

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

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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

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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-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

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

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

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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

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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

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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)

KT-02: Sieve Analysis of Aggregates

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)

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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.

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KT-02: Sieve Analysis of Aggregates

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

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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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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) =

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

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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

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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)

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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

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

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

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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

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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

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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		
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%

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
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

	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			
#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	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			

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			
#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			
#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

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			
#100	5135.8			
#200	5260.7			
Pan	5276.5			

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			
#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	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			

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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	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

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

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		

E = (5276.5-5260.7) + 583.3

E = (15.8) + 583.3

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

% 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 = ______________

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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

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

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

$Test_{acc}$= 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%

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

Kansas Department of Transportation

KT-02: Sieve Analysis of Aggregates

OBJECTIVE

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

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

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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

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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.

Kansas Department of Transportation

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

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

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

Kansas Department of Transportation

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

6. CALCULATIONS

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

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 =		%

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 =	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

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

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

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

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

$$P = 0.1649652 \times 100$$

$$P = 16.49652\%$$

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

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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

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

Recorded Percent Passing =	16.5	%
Reported Percent Passing =		%

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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	%

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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

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

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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

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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

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

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

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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

Kansas Department of Transportation

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

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.

Kansas Department of Transportation

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

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

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

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

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 %

Kansas Department of Transportation

KT-11: Moisture Tests

OBJECTIVE

- Determine the Moisture Content of an Aggregate Sample

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

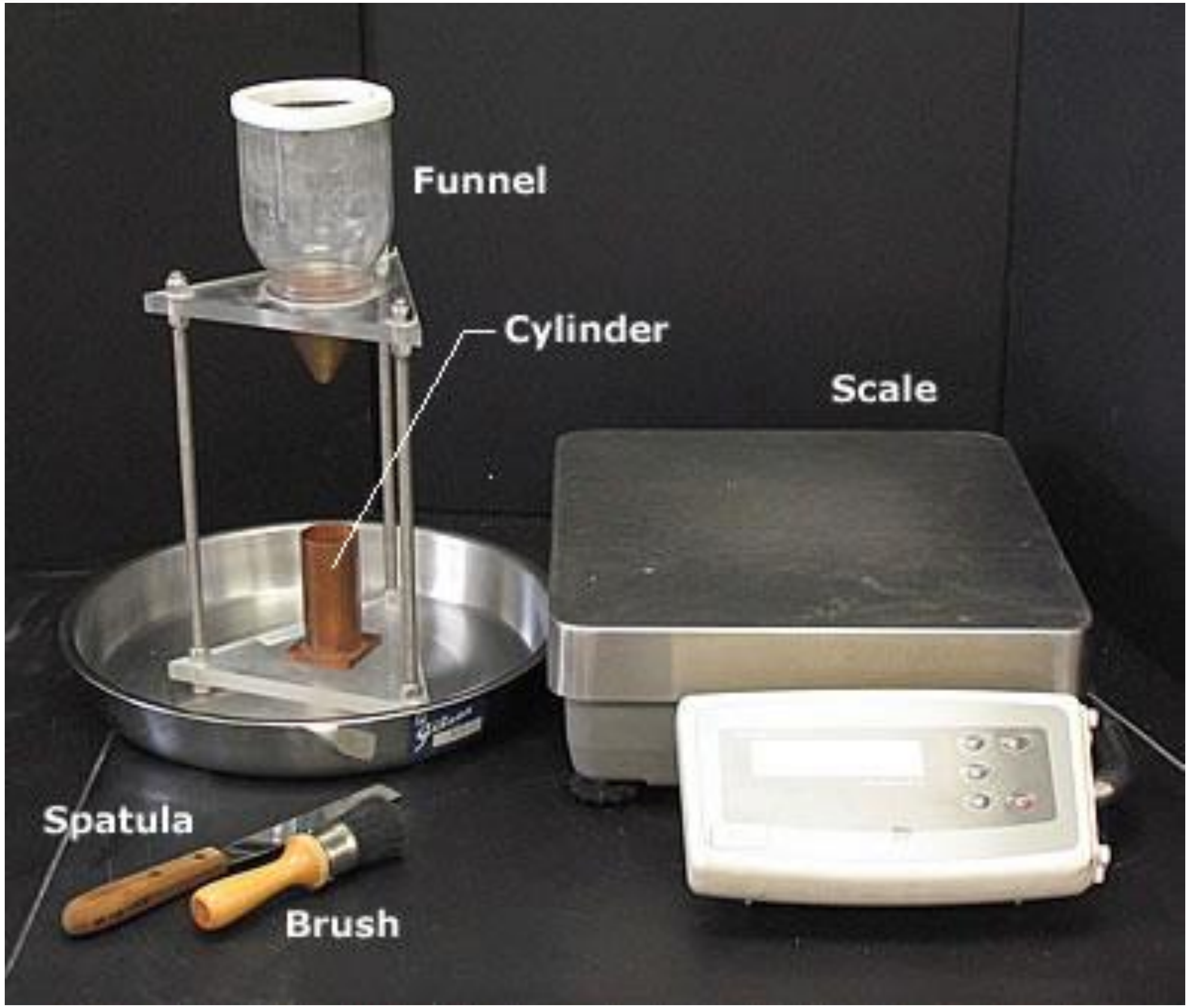
Kansas Department of Transportation

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)

KT-50: Uncompacted Void Content of Fine Aggregate



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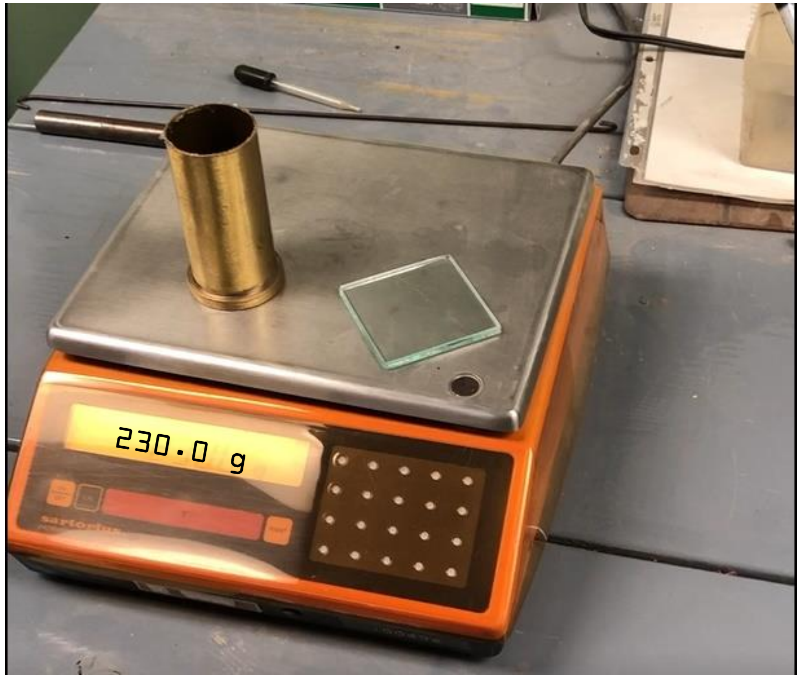
KT-50: Uncompacted Void Content of Fine Aggregate

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)



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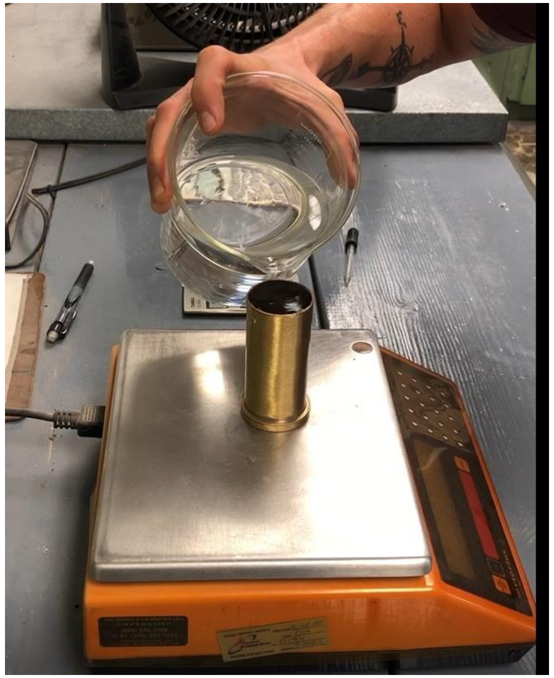
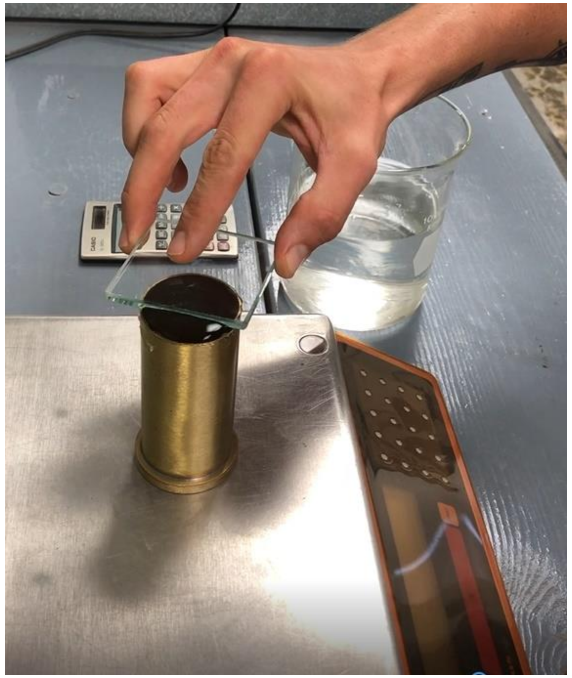
KT-50: Uncompacted Void Content of Fine Aggregate

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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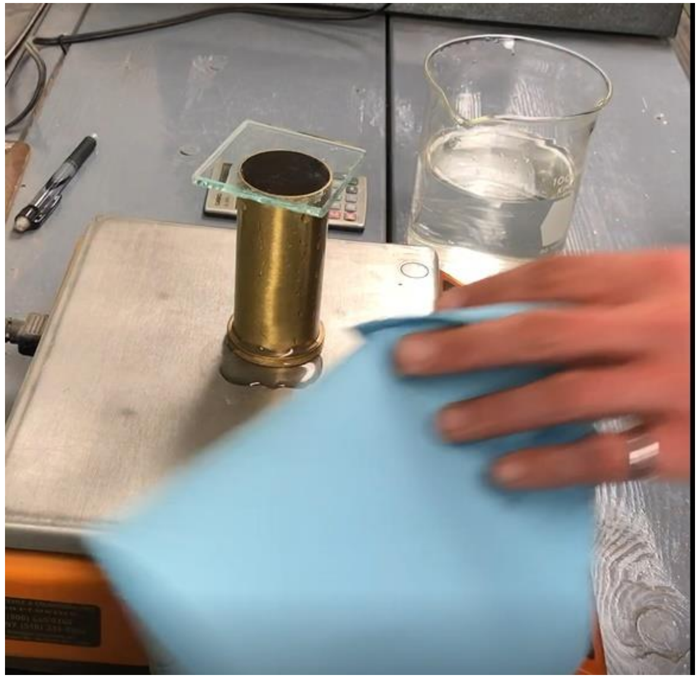
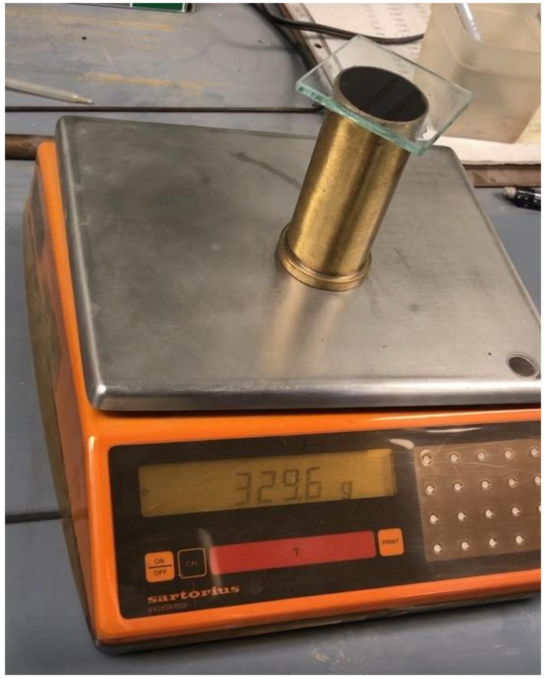
KT-50: Uncompacted Void Content of Fine Aggregate

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)

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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

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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 = 99.6 / 0.99704

V_c = Calibrated Volume of Cylinder

V_c = 99.89569

V_c = 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**

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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)

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.)

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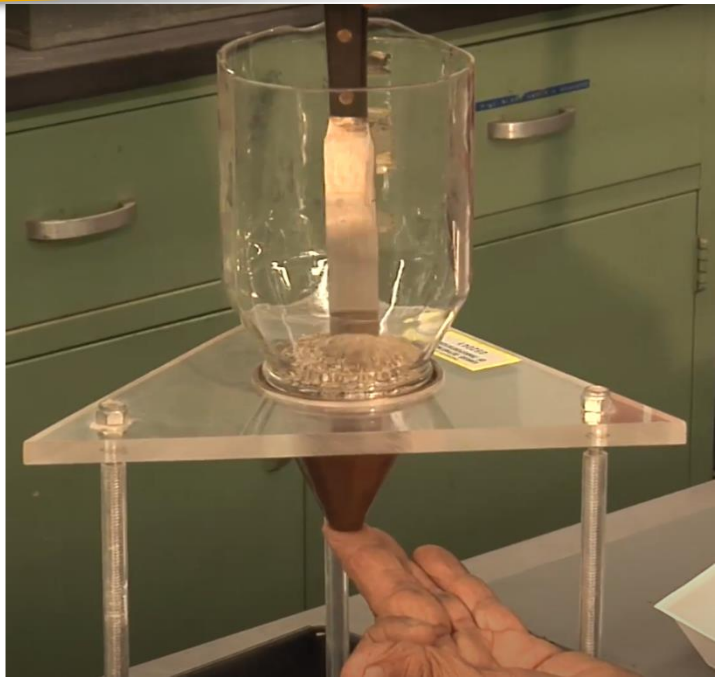
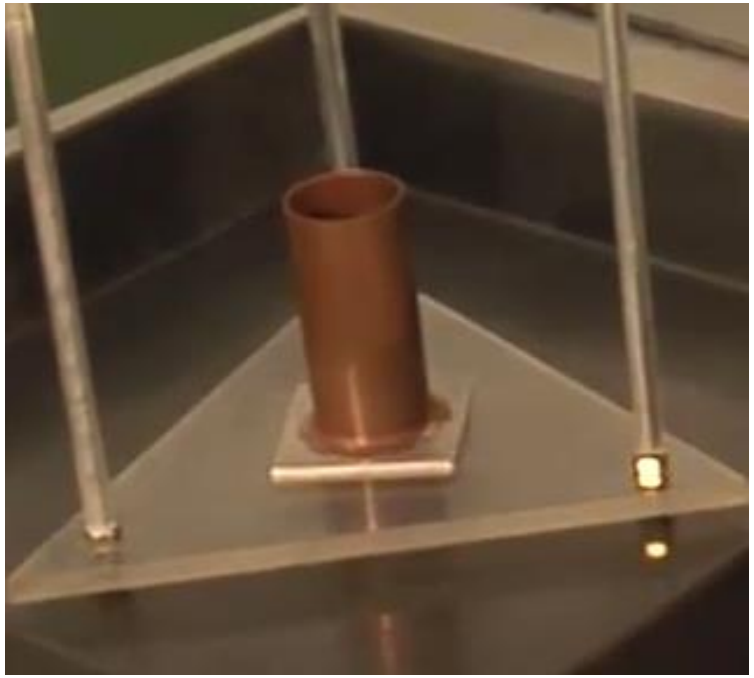
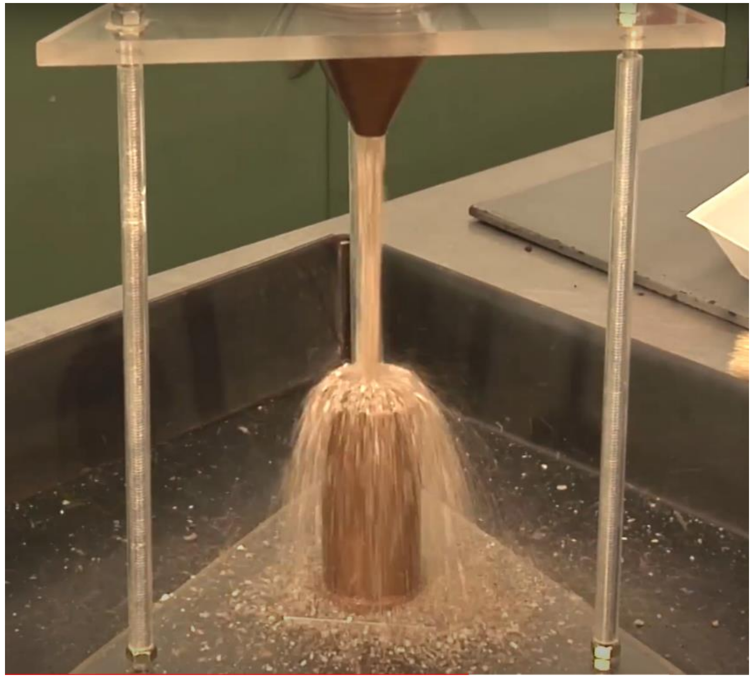
KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE

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.)

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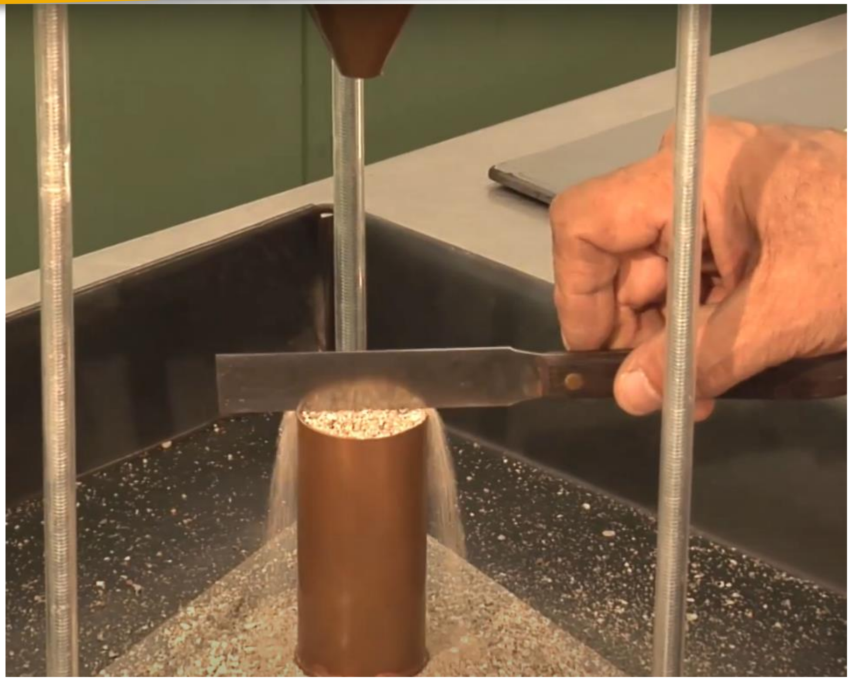
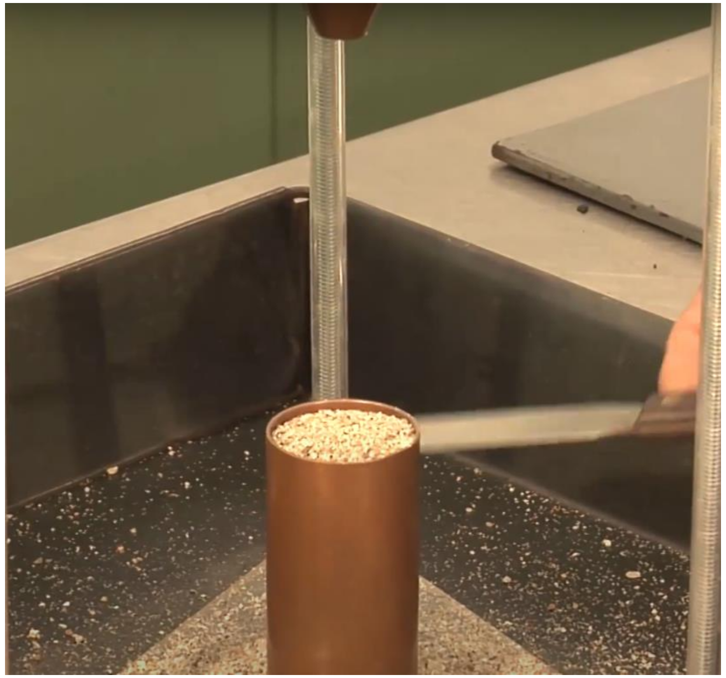
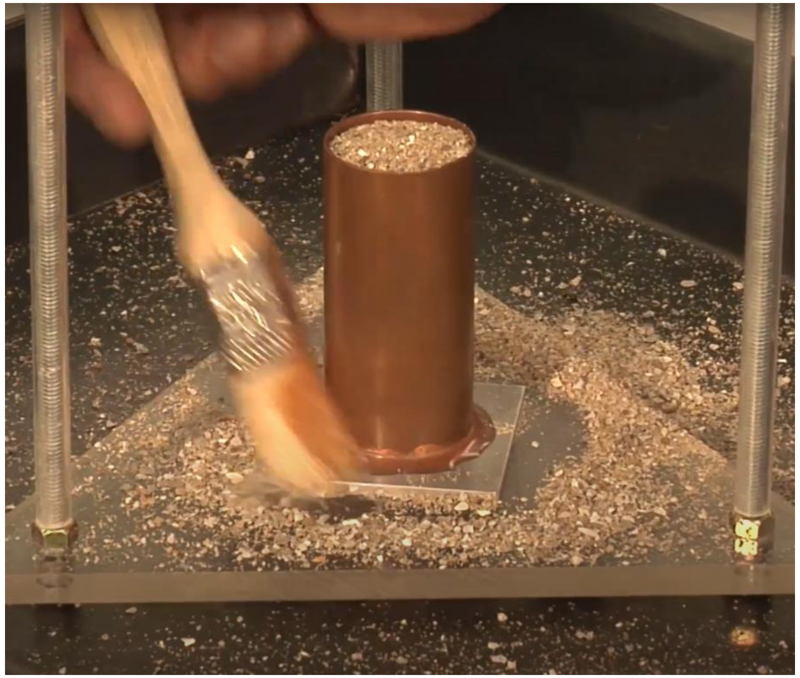
KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE

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.)

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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.)

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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.)

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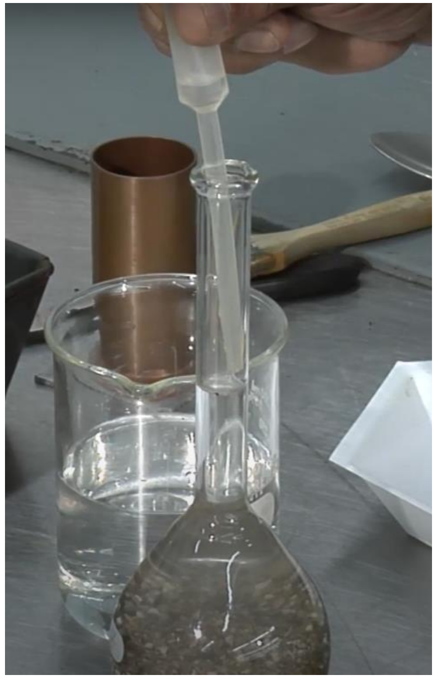
KT-50: Uncompacted Void Content of Fine Aggregate
6. TEST PROCEDURE



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.)

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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:

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

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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)

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KT-50: Uncompacted Void Content of Fine Aggregate Example

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

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

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

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

$V_{w1} = 141.4186$

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 = ________ %

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

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

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

$V_{w2} = 142.1207$

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 = ______ %

KT-50: Uncompacted Void Content of Fine Aggregate Example

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

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

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

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

$U_2 =$ 0.420628 x 100

$U_2 =$ 42.0628

$U_2 =$ 42.1

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 %

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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)

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KT-50: Uncompacted Void Content of Fine Aggregate

OBJECTIVE

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

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KT-80: Uncompacted Void Content of Coarse Aggregate

OBJECTIVE

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

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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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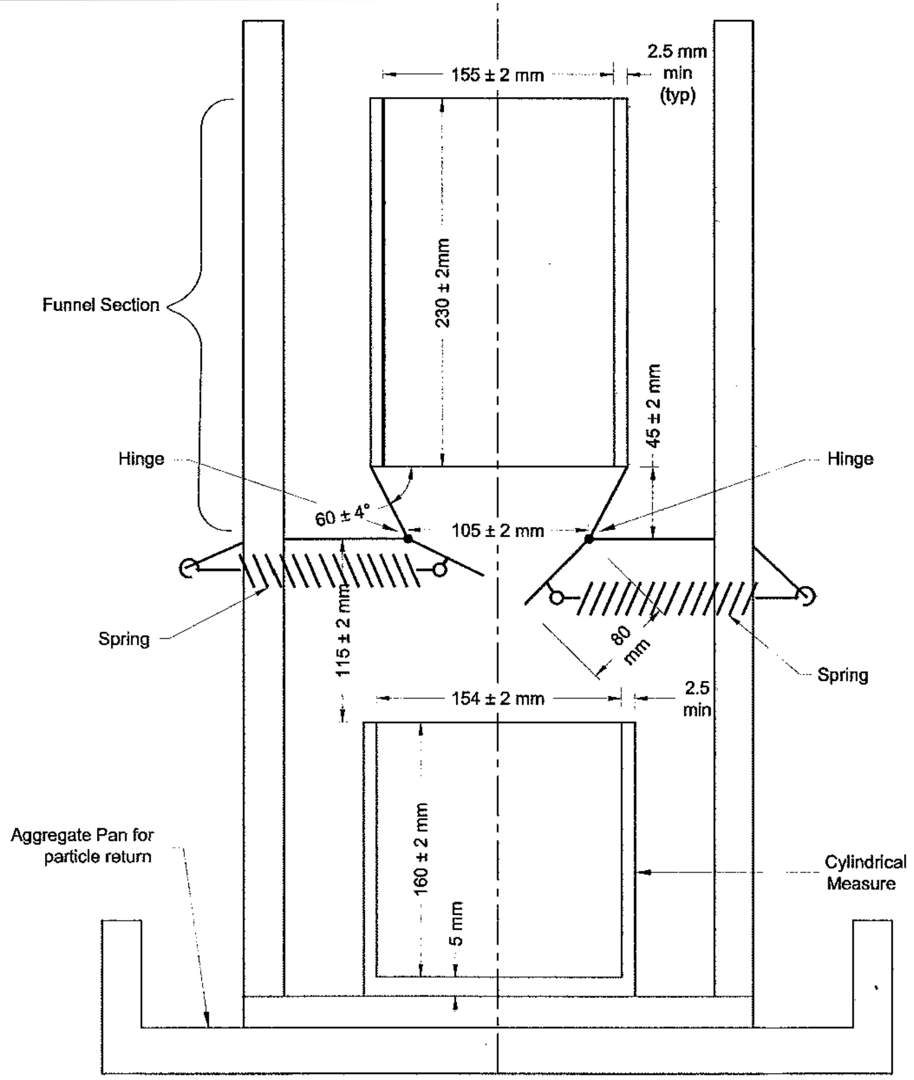
KT-80: Uncompacted Void Content of Coarse Aggregate



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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

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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

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

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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

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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

V_c = Calibrated Volume of Cylinder

V_c = W/D = 2856.3 mL

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KT-80: Uncompacted Void Content of Coarse Aggregate

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)

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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

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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

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

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:

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

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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

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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

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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 = ____________ %

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KT-80: Uncompacted Void Content of Coarse Aggregate Example

$F = Y - X$

$F_1 = 5914.3 - 2202.6$

$F_1 = 3711.7$

$F_2 = 5884.9 - 2202.6$

$F_2 = 3682.3$

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

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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 = ______ %

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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 = ______ %

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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

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 = 50.5 %

Reported U_k = 50 %

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KT-80: Uncompacted Void Content of Coarse Aggregate

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.

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KT-80: Uncompacted Void Content of Coarse Aggregate

OBJECTIVE

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