WSDOT Test Method T 716

Method of Random Sampling for Locations of Testing and Sampling Sites

A. Scope

1. This method outlines the procedure for selecting sampling and testing sites in accordance with accepted random sampling techniques. It is intended that all testing and sampling locations be selected in an unbiased manner based entirely on chance.
2. Testing and sampling locations and procedures are as important as testing. For test results or measurements to be meaningful, it is necessary that the sampling locations be selected at random, typically by use of a table of random numbers. Other techniques yielding a system of randomly selected locations are also acceptable.

B. Summary of Method for Selecting Random Test Location

- Method A – Determining a Random Location for Hot Mixture Asphalt (HMA) Density Tests
- Method B – Determining Random Test Location for Sampling HMA Mix, Aggregates, and Miscellaneous Materials
- Method C – Determining Random Test Location for Portland Cement Concrete
- Appendix A – Hot Mix Asphalt Density Test Locations for Irregular Paving Areas

C. Procedure for Determining Random Test/Sampling Location

Method A – Selection of Random Location for HMA Density

1. Stationing

   This method outlines the procedure for determining the random location of HMA Density testing sites using stationing.

   Calculate the linear foot distance for tons specified per sublot (i.e. 80 or 100 ton sublots).

   Equations:

$$Sublot\ length\ (ft) = \frac{Sublot\ quantity\ (tons)}{\left(\frac{width\ (ft)\ x\ depth\ (ft)\ x\ 2.05\ tons}{27}\right)}$$

   a. Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

   Note 1: To use the stopwatch method, randomly start and stop the stopwatch 10 or more times, then use the decimal part of the seconds as your entry point.

b. Determine the test station as follows:

   Test Station = (sublot length × "X" multiplier) + beginning station of paving (round to the nearest foot)

c. Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 2. Use the corresponding "Y" multiplier to determine the offset. A new "Y" multiplier is required for every test.

d. Determine the offset as follows:

   Offset = (width of pavement × "Y" multiplier) (round to the nearest 0.1 ft)

   Offset may be figured from the right or left edge of pavement. Tester shall indicate in MATS or approved density form from which edge the offset is measured.

e. If a tester must move a testing location due to an obstruction of other interference, a new random number for the offset and station shall be picked and the location recalculate. Document the new location and the reason the testing location was changed.

Example for a 100 ton sublot:

Given:

Paving width = 12 ft
Paving depth = 0.15 ft
Beginning Station = 10 + 00
Offset from left edge of pavement

Calculations:

$$Sublot\ length\ = \frac{100}{\left(\frac{12\ x\ 0.15\ x\ 2.05}{27}\right)} = 731.7\ lf$$

Ending Station = (Beginning Station + Sublot length) = (1000 + 731.7) = 17 + 32
Random generated number = X=25, Y=10
Beginning Test Location
Enter Table 1 at (25): "X" multiplier = 0.080
Enter Table 2 at (10): "Y" multiplier 0.167
Testing Station = (732 × 0.080) + 1000 =1058.5 = 10 + 59 (round to the nearest ft)
Offset = (12 × 0.167) = 2.00 = 2.0 ft left of pavement edge (round to the nearest 0.1 ft)

2. Milepost

   This method outlines the procedure for determining the random location of HMA Density testing sites using mileposts.

   a. Convert to tons per mile using the roadway area based on the roadway width and depth.

      Equations:

$$Sublot\ length\ (mile) = \frac{Sublot\ quantity\ (tons)}{\left(\frac{width\ (ft) x\ depth\ (ft) x\ 2.05\ tons}{27}\right)\ x\ 5280\ lf}$$

      Round sublot length to the nearest thousandth (0.001) of a mile

      Calculate the location of the test site and offset using the same method as described in Method A Stationing except use tons per mile instead of the tons per *lf*.

      Test site = (sublot length × "X" multiplier) + beginning milepost

      Offset = (width × "Y" multiplier)

      Example for 100-ton sublot:
      Given:
      Paving width = 12 ft
      Paving depth = 0.15 ft
      Beginning Milepost (MP) = 1.00
      Offset determined from right side of pavement

Calculations:

$$Sublot\ length\ = \frac{100}{\left(\frac{12\ x\ 0.15\ x\ 2.05}{27}\right)\ x\ 5280} = 0.138$$

Ending MP = (Beginning MP + Sublot length) = (1.00 + 0.138) = 1.138
Random generated number = X=25, Y=90
Beginning Test Location
Enter Table 1 at (25): "X" multiplier = 0.080
Enter Table 2 at (90): "Y" multiplier = 0.060
Testing MP = (.138 × 0.080) + 1.00 = 1.011
Offset = (12 × 0.060) = 0.72 = 0.72 ft right of edge of pavement

Random #	X	Random #	X	Random #	X	Random #	X
1	0.794	26	0.526	51	0.304	76	0.617
2	0.500	27	0.519	52	0.167	77	0.584
3	0.393	28	0.446	53	0.308	78	0.591
4	0.427	29	0.219	54	0.570	79	0.563
5	0.165	30	0.780	55	0.322	80	0.482
6	0.821	31	0.574	56	0.491	81	0.499
7	0.562	32	0.730	57	0.349	82	0.227
8	0.284	33	0.435	58	0.681	83	0.476
9	0.704	34	0.338	59	0.858	84	0.258
10	0.988	35	0.515	60	0.716	85	0.227
11	0.692	36	0.751	61	0.521	86	0.364
12	0.491	37	0.063	62	0.568	87	0.186
13	0.769	38	0.269	63	0.168	88	0.791
14	0.675	39	0.357	64	0.460	89	0.985
15	0.205	40	0.555	65	0.708	90	0.562
16	0.187	41	0.837	66	0.453	91	0.753
17	0.238	42	0.699	67	0.778	92	0.097
18	0.400	43	0.456	68	0.484	93	0.723
19	0.263	44	0.730	69	0.609	94	0.214
20	0.545	45	0.314	70	0.949	95	0.215
21	0.230	46	0.179	71	0.575	96	0.428
22	0.700	47	0.152	72	0.263	97	0.647
23	0.616	48	0.334	73	0.192	98	0.794
24	0.179	49	0.284	74	0.845	99	0.154
25	0.080	50	0.819	75	0.095	100	0.964

Random Number - X
Table 1

Random #	Y	Random #	Y	Random #	Y	Random #	Y
1	0.823	26	0.755	51	0.068	76	0.298
2	0.646	27	0.922	52	0.709	77	0.217
3	0.928	28	0.299	53	0.742	78	0.662
4	0.247	29	0.855	54	0.704	79	0.709
5	0.742	30	0.270	55	0.230	80	0.634
6	0.666	31	0.875	56	0.584	81	0.245
7	0.624	32	0.076	57	0.663	82	0.672
8	0.553	33	0.393	58	0.727	83	0.620
9	0.311	34	0.366	59	0.559	84	0.580
10	0.167	35	0.860	60	0.907	85	0.452
11	0.198	36	0.605	61	0.311	86	0.141
12	0.814	37	0.239	62	0.665	87	0.937
13	0.876	38	0.349	63	0.134	88	0.228
14	0.356	39	0.201	64	0.241	89	0.225
15	0.898	40	0.650	65	0.384	90	0.060
16	0.141	41	0.822	66	0.268	91	0.820
17	0.913	42	0.157	67	0.629	92	0.883
18	0.384	43	0.799	68	0.227	93	0.528
19	0.815	44	0.340	69	0.187	94	0.749
20	0.761	45	0.479	70	0.167	95	0.441
21	0.370	46	0.925	71	0.127	96	0.221
22	0.156	47	0.494	72	0.288	97	0.863
23	0.397	48	0.833	73	0.436	98	0.082
24	0.416	49	0.128	74	0.913	99	0.467
25	0.705	50	0.294	75	0.665	100	0.828

Random Number - Y
Table 2

Method B – Hot Mix Asphalt (HMA) Pavement Mixture or Aggregates

1. Determine the sublot increment of the material.
2. Use a random number generator (i.e. calculator, computer, etc) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X multiplier to determine the offset.
3. A new X multiplier is required for every sublot.
4. Random sample tonnage may be adjusted per sublot to accommodate field testing. Adjustments to random sample tonnage must be documented.
5. Calculate the location of the sampling site as follows:

Equations:

First Sample Site = Sublot increment × “X” multiplier (Table 1)
Subsequent Sites= (sublot increment + (Sublot increment × “X” multiplier)

Aggregate Sample Example:

Given: Crushed Surfacing Base Coarse
Random sample frequency per 9-3.7 =1 per 2,000 tons.
Calculate the location of the first random sample site as follows:

The computer-generated number is 22.
Sublot Increment (Frequency of sampling) = 2,000 tons
Enter Table 1 at (22) “X” = 0.700
Sampling Site = 2000 × 0.700= 1400 tons

Calculate subsequent sample sites as follows:

The computer-generated number is (53).
Sublot Increment (Frequency of sampling) = 2,000 tons
Enter Table 1at 53 “X” = 0.308
Sampling Site = 2000 + (2000 × 0.308) = 2616 tons

Method C Portland Cement Concrete (PCC)

1. Determine subsequent random sampling locations as follows:

   a. Example for less than 100 cubic yards remaining after reducing frequency:

      (1) Determine amount of pour remaining this will be the sublot increment

      (2) Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X multiplier to determine the test station. A new X multiplier is required for every test.

      (3) Determine the sample location as follows:

      Sampling Location = Concrete remaining × "X" multiplier (Table 1)

      Given:

      Total cubic yards (cy) of concrete placement = 80 cy
      Truckload = 10 cy
      Given: First truck is in specification = 10 cy
      Remaining cubic yards = 80 cy - 10 cy = 70 cy < 100 cy
      Sublot increment = 70 cy
      Random number = 30 "X" = 0.780
      Sampling Location = 70 cy × 0.780 = 54.6 = 55 cy or 7th truck

   b. Example for greater than 100 cubic yards remaining after reducing frequency

      (1) ***Given:***

      Pour = 130 cy
      Each truck carries 8 cy of concrete
      First truck is in specification = 8 cy
      Remaining cubic yards = 130 - 8 = 122 > 100 cy
      Sublot Increment = 100 cy

      (2) Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

      (3) Determine the sample location as follows:

      Sampling Location = Sublot increment × "X" multiplier (Table 1)

      Example:

      Random number = 15 "X"= 0.205
      Sample location = 100 cy × 0.205 = 20.5
      Determine where the first sample will be taken:
      Testing location = (accumulated cy of last truck sampled) + sample yardage

Example:

First Sample Location:
Accumulated cy first truck = 8
Sample location = 8 cy + 20.5 cy = 28.5 cy
Truck load = 28.5/8 = 4
Sampling = second half of 4th truck

Determine subsequent sampling locations as follows:

Sublot increment = total pour – (initial loads in specification)-(first sublot increment)
Sublot increment = 130 cy – (8 cy) – (100 cy) = 22 cy
Random number = 52 "X" = 0.167
Testing location = (initial load in specification) + (first sublot increment) + (testing location within the second sublot)
Testing location = (8 cy)+(100 cy)+(0.167 × 22 cy)
Testing location = 111.7 cy or 111.7/8 cy per truck = 14.0 = 14th truck

3. Report

   a. Report the random number used to determine station and offset

   b. Document any changes in station or offset of random testing location

   c. Use one of the following to report random location information:
      - Materials Testing System (MATS)
      - Form approved in writing by the State Materials Engineer

Appendix A

Hot Mix Asphalt Density Test Locations for Irregular Paving Areas

A. Track tonnage placed in the irregular shaped area until specified tons are placed, note the stationing.

B. Measure back to the beginning of the paving or end of the previous lot to obtain the length (this is also your beginning station).

C. Use a computer-generated random number or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

D. Multiply the length by the "X" value and add to the beginning station to locate your testing site.

E. Use a computer-generated random number or a random number determined by a stopwatch (See Note 1) to enter Table 2. Use the corresponding Y value to determine the offset. A new Y value is required for every test.

F. Measure the width at the testing station and multiply the width time the "Y" value to determine the offset of the testing site.

G. Make a sketch of the area to document the test location in the event a retest is required.

Example:

Paving began at Station 101 + 00.

The tester determined Station 105 + 75 was the end of the 100 ton lot.

The width of the pavement began at 0 and transitioned to 12.

Testing Station

Sta 105 + 75 – Sta 101 + 00 = 475 ft
Random number = 45, "X" value = 0.314
475 ft × 0.314= 149.15= 149 Testing station = 10100 + 149 =102 + 49

Testing Offset

Measure width at station 102 + 49
Width = 3.76
Random # 65 "Y" value = 0.384
Offset = 3.76 × 0.384 = 1.44 = 1.4 ft from right edge