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 subplot (i.e. 80 or 100 ton sublots).

   Equations:

   \[
   \text{Sublot length (ft) = } \frac{\text{Sublot quantity (tons)}}{(\text{width (ft)} \times \text{depth (ft)} \times 2.05 \text{ tons})} \]

   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.

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

\[
\text{Sublot length} = \frac{100}{\left(\frac{12 \times 0.15 \times 2.05}{27}\right)} = 731.7 \text{ lf}
\]

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:

\[
Sublot \ length \ (\text{mile}) = \frac{\text{Sublot quantity (tons)}}{\left(\frac{\text{width (ft)} \times \text{depth (ft)} \times 2.05 \text{ tons}}{27}\right) \times 5280 \text{ lf}}
\]

**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 \times “X” multiplier) + beginning milepost**

**Offset = (width \times “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:**

\[
Sublot \ length = \frac{100}{\left(\frac{12 \times 0.15 \times 2.05}{27}\right) \times 5280} = 0.138
\]

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 \times 0.080) + 1.00 = 1.011

Offset = (12 \times 0.060) = 0.72 = 0.72 \text{ ft right of edge of pavement}
### Table 1

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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:**

   \[
   \text{First Sample Site} = \text{Sublot increment} \times \text{“X” multiplier (Table 1)}
   \]

   \[
   \text{Subsequent Sites} = (\text{sublot increment} + (\text{Sublot increment} \times \text{“X” multiplier})
   \]

   **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 \times 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 1 at 53 “X” = 0.308
   Sampling Site = 2000 + (2000 \times 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