WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
CONTRACT ADMINISTRATION DIVISION

MATERIALS PROCEDURE

Procedure For Determining The Random Location Of Compaction Tests

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1.0 Purpose

1.1 This procedure provides methods for determining the random locations for compaction tests.

2.0 Scope

2.1 This procedure is applicable for locating all compaction tests.

3.0 Equipment

3.1 Measuring tape, approximately 50 feet (15 m)

4.0 Procedure

4.1 Compaction test site locations are to be randomly located along the roadway centerline (length) and offset (width) randomly from this reference line. Some test site locations, such as pipe backfill, require random selection of lifts for the tests and a random determination of the side of the pipe backfill to test.

4.2 Selection of random numbers

4.2.1 Determine the number of test sites which will be required for the lot or test section.

4.2.2 The table of random numbers (Table I attached) or a calculator, which will generate random numbers, can be used.

4.2.3 The table of random numbers contains 5 sections with 2 columns of numbers in each section.

4.2.3.1 The first column of numbers in each section is for determining the test site along the centerline. The second column of numbers is for determining the distance from the centerline (offset). Either column of numbers can be used for selecting lifts to be tested.

4.2.3.2 To use the table, select a random point on the table by tossing a pencil upon the page or blindly pointing out a location with the finger. The selection of random numbers will consist of a pair of random numbers. Once the point is located, select the number in the first column for the length and the corresponding number in the right column for the width. When more than one pair of random numbers is needed, continue selecting the pairs of numbers down the page. If the bottom of the page is reached, go to the top of the next section to the right or to the top of the first section on the left side of the page if the bottom of the right most section of the page is reached. When selecting lifts to be tested, only single random numbers are needed and can be obtained from any of the columns of numbers.

4.2.3.3 To use a calculator, which will generate random numbers, select all numbers needed for a test site before selecting numbers for additional test sites.

4.3 Location of test sites

4.3.1 There are many variations in the required number of tests and the physical dimensions of the area to be tested.

4.3.2 Random location of tests on a single lift that is rectangular in shape (Example 1 attached)

4.3.2.1 Generally the Materials Procedure used for testing a material and/or Specifications requires a lot, portion of a lot, or a test section to determine the maximum density of a material to be divided into equal sublots or subsections when more than one test is required.

4.3.2.2 Divide the length of the area along the centerline by the number of tests to determine the length of each sublot or subsection.

4.3.2.3 From the beginning station number, add the length of the subsection or sublot to the station number to determine the station number for the beginning of the next sublot or subsection. Next add the length of the subsection or sublot to this station number to determine the station number at the beginning of the next subsection or sublot. Continue this procedure until the beginning station numbers for all subsections or sublots have been calculated.

4.3.2.4 Select the random numbers according to 4.2 through 4.2.3.3.

4.3.2.5 Multiply the length of the subsections or sublots by the random numbers selected for the length.

4.3.2.6 Add the values to the corresponding station numbers for the beginning of each subsection or sublot. The station numbers locate the test sites along centerline.

4.3.2.7 Next multiply the width of the test section or lot by the random numbers selected for the offset.

4.3.2.8 Determine the offset distance of the lot or test section from the centerline when the centerline is not within the area to be tested. This will usually be a constant value. Always calculate the offset by working from the side nearest the centerline. Add each of the values calculated in 4.4.2.7 to the constant value. The values establish the offset distance of each test site from the centerline. Designate rather the offset is left or right of centerline.

When the centerline is contained within the area to be tested, the offset can be calculated from the left or right side of the test area and test location designated in relation to centerline.

4.3.3 Random location of test sites on a single lift that is irregular in shape (Example 2 attached).

4.3.3.1 Determine the dimensions of the area to be tested.

4.3.3.2 Determine the minimum dimensions of a rectangle that will contain the area to be tested and has two sides parallel to centerline.

4.3.3.3 Divide the rectangle into the desired number of subsections or sublots and randomly locate the test sites locations as in sections 4.3.2 - 4.3.2.8 above. If a test site location falls outside the area to be tested, obtain a new set of random numbers for the test site and recalculate the test site location. Continue this procedure until the test site falls within the area to be tested.

4.3.4 Random selection of lifts to be tested (Example 3 attached).

4.3.4.1 When testing certain materials, especially backfill material, where an area to be backfilled will constitute a lot of material to be tested, a random selection of lifts to be tested is required.

4.3.4.2 Determine the projected number of lifts to be contained in the lot. Divide the number of lifts by the number of tests in the lot. If the value is not an even number, assign an additional lift to the first sublot and continue to assign a lift to each consecutive sublot until all remaining lifts have been assigned to a sublot.

4.3.4.3 By starting with the bottom lift, number the lifts in the lot.

4.3.4.4 Select a single random number for each test site.

4.3.4.5 Multiply each random number by the number of lifts in each sublot and round the values to whole numbers. Each value designates which lift in each sublot that will be tested.

4.3.5 Once the lifts to be tested have been selected, the random location of the test site on the lift can be determined.

4.3.6 Random selection of the side of backfill for pipe culverts.

4.3.6.1 When a lot of pipe backfill is being tested, tests should be performed on both sides of the pipe. The side to be tested can be randomly selected by using the random numbers selected for the location of the tests along the pipe. If the random number is less than 0.500, the test is on the left side and greater than 0.500 on the right side of the pipe.

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RKT:Sra

Attachments

TABLE 1

RANDOM NUMBERS

.858	.082	.886	.125	.263	.176	.551	.711	.355	.698
.576	.417	.242	.316	.960	.819	.444	.323	.331	.179
.687	.288	.835	.636	.596	.174	.866	.685	.066	.170
.068	.391	.739	.002	.159	.423	.629	.631	.979	.399
.140	.324	.215	.358	.663	.193	.215	.667	.627	.595
.574	.601	.623	.855	.339	.486	.065	.627	.458	.137
.966	.529	.757	.308	.025	.836	.200	.055	.510	.656
.608	.910	.944	.281	.539	.371	.217	.882	.324	.284
.215	.355	.645	.460	.719	.057	.237	.146	.135	.903
.761	.883	.771	.388	.928	.654	.815	.570	.539	.600
.869	.222	.115	.447	.658	.989	.921	.924	.560	.447
.562	.036	.302	.673	.911	.512	.972	.576	.838	.014
.481	.791	.454	.731	.770	.500	.980	.183	.385	.012
.599	.966	.356	.183	.797	.503	.180	.657	.077	.165
.464	.747	.299	.530	.675	.646	.385	.109	.780	.699
.675	.654	.221	.777	.172	.738	.324	.669	.079	.587
.279	.707	.372	.486	.340	.680	.928	.397	.337	.564
.338	.917	.942	.985	.838	.805	.278	.898	.906	.939
.316	.935	.403	.629	.130	.575	.195	.887	.142	.488
.011	.283	.762	.988	.102	.068	.902	.850	.569	.977
.683	.441	.572	.486	.732	.721	.275	.023	.088	.402
.493	.155	.530	.125	.841	.171	.794	.850	.797	.367
.059	.502	.963	.055	.128	.655	.043	.293	.792	.739
.996	.729	.370	.139	.306	.858	.183	.464	.457	.863
.240	.972	.495	.696	.350	.642	.188	.135	.470	.765

EXAMPLE I
ENGLISH

Length of test section = 100 ft
Width of section = 10 ft
Number of tests required = 5
5 equal subsections 100/5 = 20 ft
Test section starts at station 5+46

Station number at the beginning of each subsection

1. 5+46
2. 5+46 + 20 = 5+66
3. 5+66 + 20 = 5+86
4. 5+86 + 20 = 6+06
5. 6+06 + 20 = 6 +26

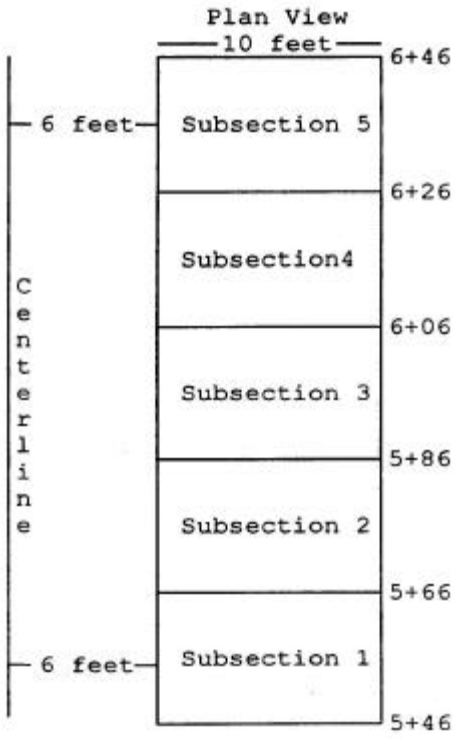
	Random Numbers Length	Width
1.	.869	.222
2.	.562	.036
3.	.481	.791
4.	.599	.966
5.	.464	.747

Multiply the length of each subsection by the random numbers for the length.

1. 20 x .869 = 17
2. 20 x .562 = 11
3. 20 x .481 = 10
4. 20 x .599 = 12
5. 20 x .464 = 9

Add the values to the beginning station numbers of each subsection to determine the station number for each test.

1. 5+46 + 17 = 5+63
2. 5+66 + 11 = 5+77
3. 5+86 + 10 = 5+96
4. 6+06 + 12 = 6+18
5. 6+26 + 9 = 6 +35



Multiply the width of each subsection by the random numbers for the width.

1. 10 x .222 = 2
2. 10 x .036 = 0
3. 10 x .791 = 8
4. 10 x .966 = 10
5. 10 x .747 = 7

Add the values to the constant distance the test section is from the centerline and label the values as right of centerline .

1. 6 + 2 = 8 ft right of centerline
2. 6 + 0 = 0 ft right of centerline
3. 6 + 8 = 14 ft right of centerline
4. 6 + 10= 16 ft right of centerline
5. 6 + 7 = 13 ft right of centerline

EXAMPLE I
METRIC

Length of test section = 30.00 m
Width of section = 3.00 m
Number of tests required = 5
5 equal subsections 30/5 = 6 m
Test section starts at station 15+340

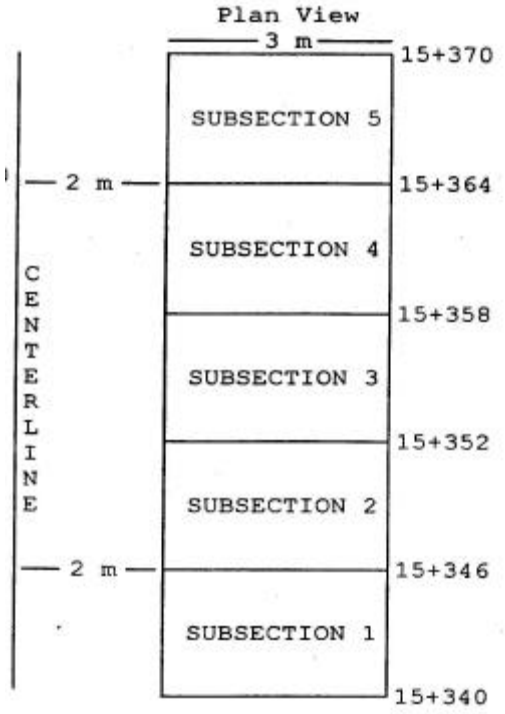
Station number at the beginning of each subsection
1. 15+340
2. 15+340 + 6 = 15+346
3. 15+346 + 6 = 15+352
4. 15+352 + 6 = 15+358
5. 15+358 + 6 = 15+364

Random Numbers

	Length	Width
1.	.869	.222
2.	.562	.036
3.	.481	.791
4.	.599	.966
5.	.464	.747

Multiply the length of each subsection by the random numbers for the length.
1. 6.00 x .869 = 5.2
2. 6.00 x .562 = 3.4
3. 6.00 x .481 = 2.9
4. 6.00 x .599 = 3.6
5. 6.00 x .464 = 2.8

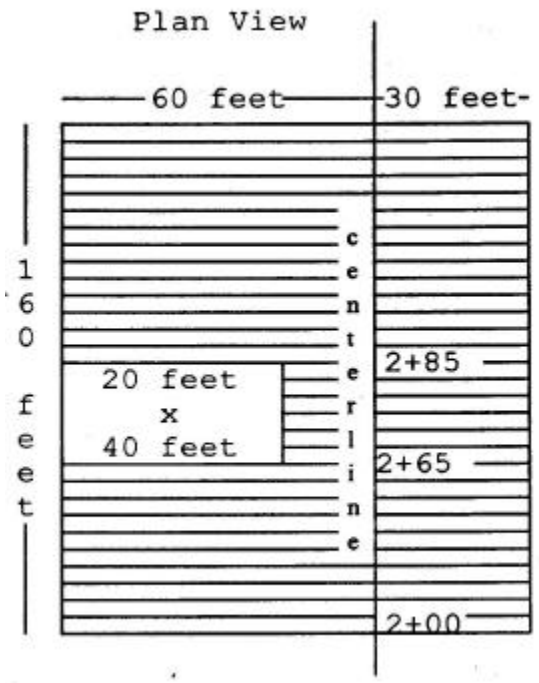
Add the values to the beginning station numbers of each subsection to determine the station number for each test site.
1. 15+340 + 5.2 = 15+345.2
2. 15+346 + 3.4 = 15+349.4
3. 15+352 + 2.9 = 15+354.9
4. 15+358 + 3.6 = 15+361.6
5. 15+364 + 2.8 = 15+366.8



Multiply the width of the test section by the random numbers for the width.
1. 3.00 x .222 = 0.7
2. 3.00 x .036 = 0.1
3. 3.00 x .791 = 2.4
4. 3.00 x .966 = 2.9
5. 3.00 x .747 = 2.2

Add the values to the constant distance the test section is from the centerline and label the values as right of centerline.
1. 2.00 + 0.7 = 2.7 m rt of centerline
2. 2.00 + 0.1 = 2.1 m rt of centerline
3. 2.00 + 2.4 = 4.4 m rt of centerline
4. 2.00 + 2.9 + 4.9 m rt of centerline
5. 2.00 + 2.2 = 4.4 m rt of centerline

EXAMPLE 2
METRIC



The shaded area designates the lift to be tested. For this example, 2 sublots are required with 1 test in each sublot.

Since the area to be tested is not rectangular in shape, place the smallest rectangle around the area that will include all the shaded area.

Divide the rectangle into 2 equal areas (160 feet long by 90 feet wide).

Since the centerline is located within the area to be tested, the offset can be calculated and measured from either side. For this example, work from the right side.

Determine the station number for the beginning of each sublot.

Sublot No. 1 2.+00
Sublot No. 2 2+00 + 80 = 2+80

Random Numbers	
Length	Width
.902	.850
.275	.023
.794	.850

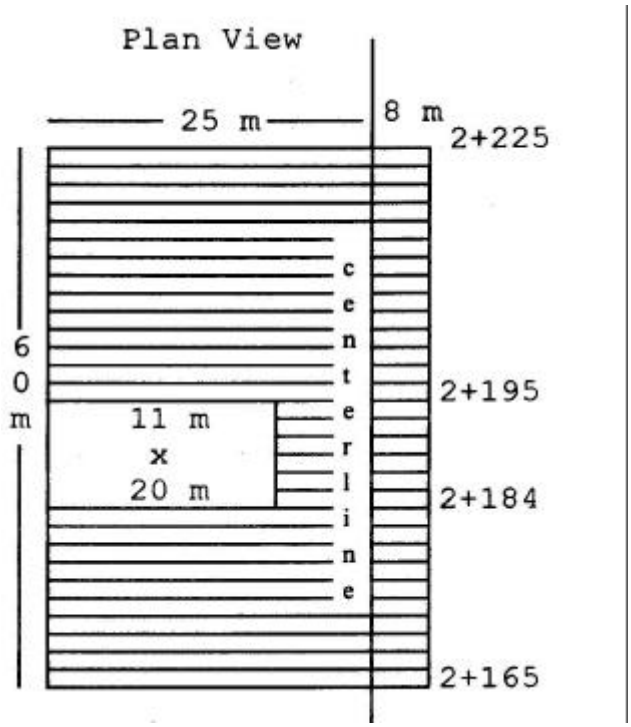
Since there is the possibility that the location of a test site may fall outside the area to be tested, an additional set of random numbers was selected.

Multiply the random number by the length of the sublot (80 x .902 = 72 feet). Add the value of the beginning station number (2+00 + 72 = 2+72). Multiply the width of the sublot by the random number (90 x .850 = 76 feet). By working from the right side, it is 30 feet to the centerline, therefore the test site is 76 – 30 = 46 feet to the left of centerline. The test site falls outside the teSt area.

By using the next set of random numbers, calculate the test site location.
80 x .275 = 22 feet 90 x .023 = 2 feet
2+00 + 22 = 2+22 30 – 2 feet = 28 feet right of centerline
The test site for sublot 1 now falls within the test area.

Calculate the test location for sublot 2.
80 x .794 = 64 feet 90 x .850 = 76 feet
2+80 + 64 = 3+44 76 - 30 = 46 feet left of centerline

EXAMPLE 2
METRIC



The shaded area designates the lift to be tested. For this example, 2 sublots are required with 1 test in each sublot.

Since the area to be tested is not rectangular in shape, place the smallest rectangle around the area that will include all the shaded area.

Divide the rectangle into 2 equal areas (30 m long by 33 m wide).

Since the centerline is located within the area to be tested, the offset can be calculated and measured from either side. For this example, work from the right side.

Determine the station number for the beginning of each sublot.

Sublot No. 1 2.+165
Sublot No. 2 2+165 + 30 = 2+195

Random Numbers

Length	Width
.902	.850
.275	.023
.794	.850

Since there is the possibility that the location of a test site may fall outside the area to be tested, an additional set of random numbers was selected.

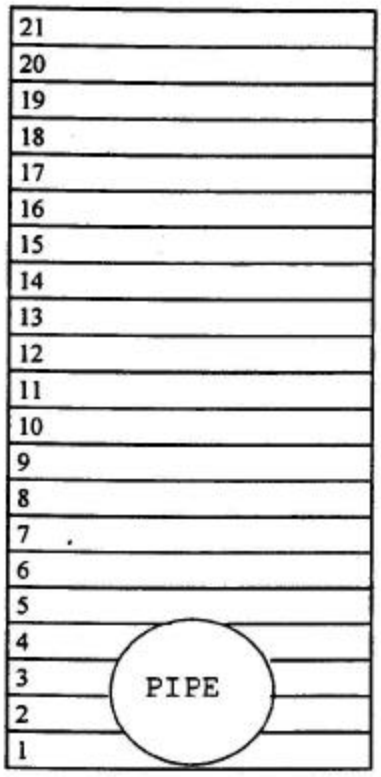
Multiply the random number by the length of the sublot (30 x .902 = 27.1 m). Add the value of the beginning station number (2+165 + 27.1 = 2+192.1). Multiply the width of the sublot by the random number (33 x .850 = 28.1 m). By working from the right side, it is 8 m to the centerline, therefore the test site is 28.1 – 8 = 20.1 m to the left of centerline. The test site falls outside the teSt area.

By using the next set of random numbers, calculate the test site location.
30 x .275 = 8.2 m 33 x .323 = 0.8 m
2+165 + 8.2 = 2+173.2 8 – 0.8 m = 7.2 m right of centerline
The test site for sublot 1 now falls within the test area.

Calculate the test location for sublot 2
30 x .794 = 23.8 m 33 x .850 = 28.0 m
2+195 + 23.8 = 2+218.8 28 – 8 = 20 m left of centerline

EXAMPLE 3

CROSS SECTION OF PIPE BACKFILL



21 lifts of material are required to backfill the pipe.

All of the backfill material is included in 1 lot. There are 5 tests required with 1 test in each sublot.

Divide the number of lifts by the number of sublots to determine the number of lifts in each sublot (21/5 = lifts with 1 lift left over). This includes the lift in sublot number 1.

Sublot Number 1	Lifts 1 – 5
Sublot Number 2	Lifts 6 - 9
Sublot Number 3	Lifts 10 - 13
Sublot Number 4	Lifts 14 - 17
Sublot Number 5	Lifts 18 – 21

Random numbers
1. .599
2. .464
3. .675
4. .279
5. .338

Multiply the number of lifts in the sublot by the random numbers. The values determine which lift in each sublot to test.

1. 5 x .599 = 3	Test lift 3 in sublot number 1, Lift number 3
2. 4 x .464 = 2	Test lift 2 in sublot number 2, Lift number 7
3. 4 x .675 = 3	Test lift 3 in sublot number 3, Lift number 12
4. 4 x .279 = 1	Test lift 1 in sublot number 4, Lift number 14
5. 4 x .338 = 1	Test lift 1 in sublot number 5, Lift number 18