ALDOT-210-90
SELECTING SAMPLES BY THE RANDOM NUMBERS METHOD

Definition: A random sample is a sample taken by the use of a sampling plan in which each unit of a lot must have an equal chance of being chosen.

The following is an explanation of the procedure of sampling by random numbers. This system of sampling can be used for all types of materials. It can be used to determine the location for sampling (as stations along a roadway and distances from a pavement edge), truck numbers, or the point in production for sampling. We will give five examples. This procedure may be expanded to other materials and circumstances as needed.

Example No. 1

This example procedure will result in stratified random samples. The procedure is used when sampling is accomplished as construction progresses. The material that is to be sampled must be divided into lots. Then it must be determined how many samples will be required to represent a lot so that the lot can be divided into sublots.

In this example we will select stations and distances from the right edge of a base course from which samples shall be taken to represent base course layers for 50 stations of a project. For this example, we will use Station 137+00 to 187+00 as the lot. The width to be sampled will be 24 ft. (7.2 m) and the location of the sample will be measured from the right edge of the base. We will use five samples to represent the 50 station lot. Five sublots will be set up from which the five stratified random samples are selected. Use the following steps to select where the five samples will be taken.

1. The 50 station lot is first divided into 10 station sublots as shown. Each sublot will be 10 stations or 1000 ft (300m) in length.

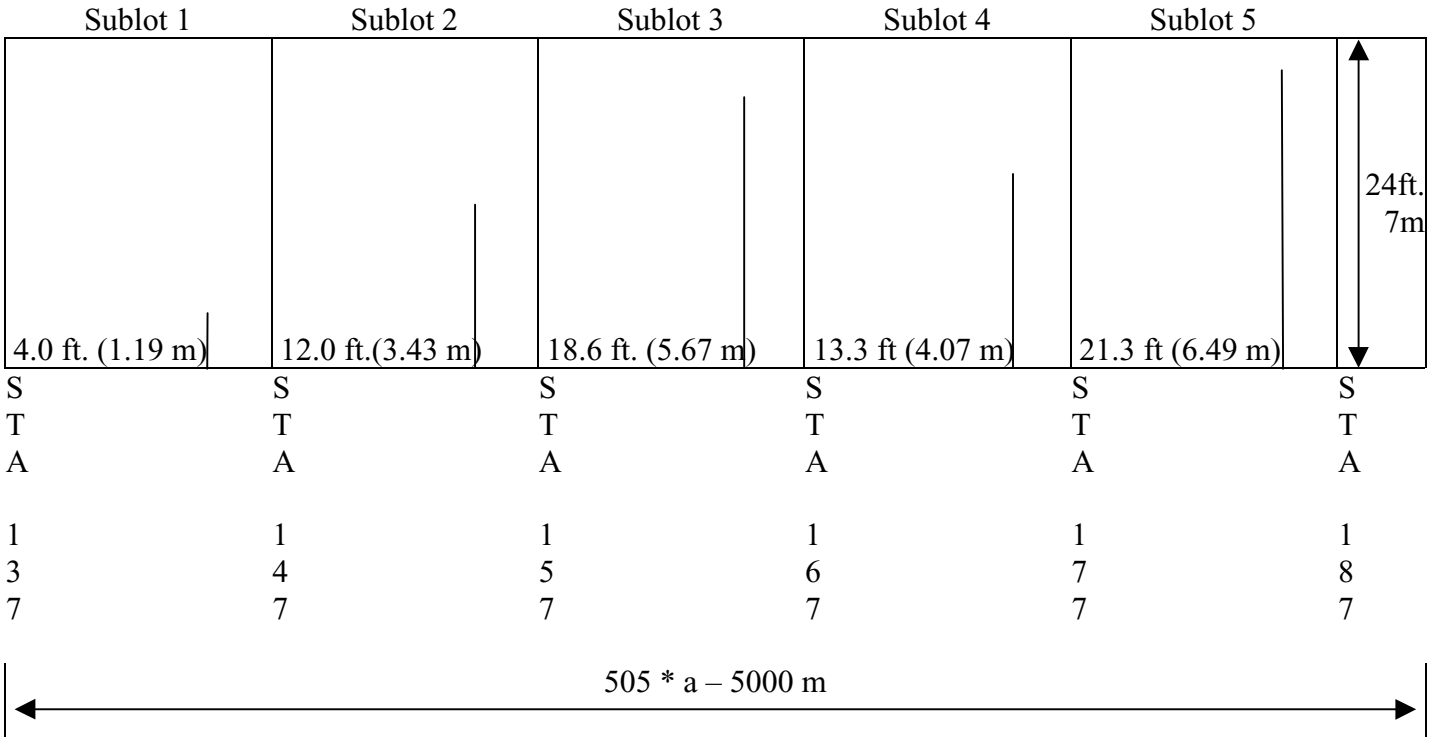


Figure 1. Stratified Random Samples for 50 Station Lot

2. Select five consecutive random numbers to locate the samples in each sublot (0.947, 0 942, 0.150, 0.195 and 0.448). The preferred method of generating the five consecutive random numbers is with an electronic calculator. However, the included Table of Random Numbers may be used. The five numbers above were from Block "A." The Table of Random Numbers may be entered at any point to select these numbers. If the table is used, an effort should be made to randomize the selection of the starting point.

3. The five consecutive random numbers are multiplied by 10, which is the total number of stations in each sublot. The product is added to the beginning station for the sublots, as shown below, to determine the longitudinal stationing at which samples are taken. 100 ft. (100 m) = 1 station.

Sample Number	
1	0.947 x 10 = 9.47 or 9+47 Stations + 137+00 = Station 146+47
2	0.942 x 10 = 9.42 or 9+42 Stations + 147+00 = Station 156+42
3	0.150 x 10 = 1.50 or 1+50 Stations + 157+00 = Station 158+50
4	0.195 x 10 = 1.95 or 1+95 Stations + 167+00 = Station 168+95
5	0.448 x 10 = 4.48 or 4+48 Stations + 177+00 = Station 181+48

You will note that the above results in two stations being selected close together. This is acceptable when the sampling is done by randomization.

4. To select the transverse distance from the right edge of the base course, five additional consecutive random numbers are selected and calculations are made using the 24 ft (7.2 m) distances from the right edge of the base. The numbers below are from Block "B" in the Table of Random Numbers.

Sample Number	
1	0.165 x 24 ft.(7.2 m)= 3.96 ft. (1.19 m) from right edge of base course
2	0.477 x 24 ft. (7.2 m) = 11.4 ft (3.43 m)from right edge of base course
3	0.788 x 24 ft.(7.2 m) = 18..9 ft. (5.67 m)from right edge of base course
4	0.566 x 24 ft. (7.2 m)= 16.0 ft. (4.07 m)from right edge of base course
5	0.901 x 24 ft. (7.2 m)= 21.6 ft. (6.49 m) from right edge of base course

5. From the above calculations we find the following sampling schedule for the fifty station lot:

Sample Number	**Station**	**Distance From Right Edge**
1	146+47	3.96 ft (1.19m)
2	156+42	11.4 ft (3.43m)
3	158+50	18.9 ft (5.67m)
4	168+95	16.0 ft (4.07m)
5	181+48	21.6 ft (6.49m)

Example No. 2

This example procedure will result in random samples. The procedure is used when the entire population is available for sampling at one time. The project shows 9,657 reflective roadway markers are required. The specifications require that each 3,000 unit lot be represented by 50 units or samples. This will result in four lots to represent the project. The markers are packaged 50 fifty to each carton. The following procedure is used to select random samples to represent this project.

1. Separate the 9,657 markers into four lots. This will result in 60 cartons to each whole lot.

2. Stack the cartons for each lot in an arrangement that will permit numbering each carton consecutively from one to 60.

3. Select 50 consecutive random numbers with an electronic calculator or the Table of Random Numbers. The following numbers are from Block "C" of the Table of Random Numbers. Multiply each number by 3,000. This product is the roadway marker number selected for one sample of 50 samples to represent the lot of 3,000 markers.

.265 x 3000 = 795	.106 x 3000 = 318	.220 x 3000 = 660
.217 x 3000 = 651	.398 x 3000 = 1194	.631 x 3000 = 1938
.307 x 3000 = 921	.698 x 3000 = 2094	.432 x 3000 = 1296
.879 x 3000 = 2637	.796 x 3000 = 2388	.082 x 3000 = 246
.755 x 3000 = 2265	.348 x 3000 = 1044	.296 x 3000 = 888
.007 x 3000 = 21	.358 x 3000 = 1074	.602 x 3000 = 1806
.649 x 3000 = 1947	.698 repeated number	.602 x 3000 = 1806
	skip to next number	.919 repeated number
.841 x 3000 = 2523	.864 x 3000 = 2592	skip to next number
.062 x 3000 = 186	.335 x 3000 = 1005	.648 x 3000 = 1944
.446 x 3000 = 1338	.909 x 3000 = 2727	.239 x 3000 = 717
.998 x 3000 = 2994	.740 x 3000 = 2220	.291 x 3000 = 873
.749 x 3000 = 2247	.601 x 3000 = 1803	.858 x 3000 = 2574
.517 x 3000 = 1551	.425 x 3000 = 1275	.761 x 3000 = 2283
.253 x 3000 = 759	.428 x 3000 = 1284	.463 x 3000 = 1389
.640 x 3000 = 1920	.919 x 3000 = 2757	.993 x 3000 = 2979
.904 x 3000 = 2712	.892 x 3000 = 2676	.919 repeated number
.231 x 3000 = 693	.195 x 3000 = 585	skip to next number
.986 x 3000 = 2958	.058 x 3000 = 174	.501 x 3000 = 1503

The above gives the exact number of each sample. The sample can be located by dividing each number by 50 to determine the carton number. For example, to locate Sample No. 795, 795 is divided by 50. This division yields 15.9 which represents 15 full cartons plus 0.9 x 50 = 45 additional markers. This means the sample will be in carton 16. Count to the forty-fifth marker, by any system in carton 16, and select that marker to represent Sample No. 795. If the samples were packaged 100 to the carton, then, 795 divided by cartons of 100 markers = seven full cartons with the ninety-fifth sample in carton eight being the one desired. Repeat the above procedure to find each sample.

Example No. 3

This example procedure will result in stratified random samples where a lot is represented by one day's production of hot bituminous mixture. The procedure is used when sampling is accomplished during production.

In this example, specifications require that a sample be taken for each testing increment. One sample of each testing increment will be picked randomly and split between the State and the Contractor.

1. The day's production is divided into several testing increments depending upon how many tons are produced. For this example three testing increments of 400 T (t) each will be used.

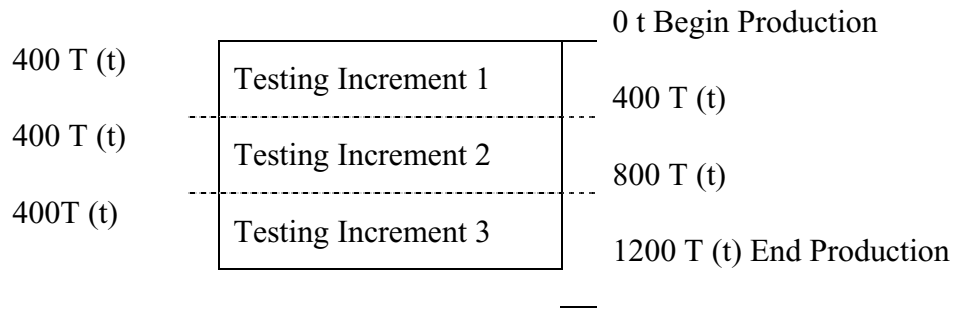


Figure 2. Stratified Random Samples for One Day Production Lot

2. The Departments technician will select three consecutive random numbers with an electronic calculator or from a table of random numbers.

   For the example random numbers 0.117, 0.239, and 0.491 were determined. These random numbers are multiplied by the testing interval of 400 T (t).

   0.117 x 400 = 47 T (t)
   0.239 x 400 = 96T (t)t
   0.491 x 400 = 196T(t)

3. Add the products from the above multiplications to the starting tonnages of the three testing intervals to determine the production ton for obtaining samples. The State technician will notify the Contractor no more than 15 minutes before each sampling time.

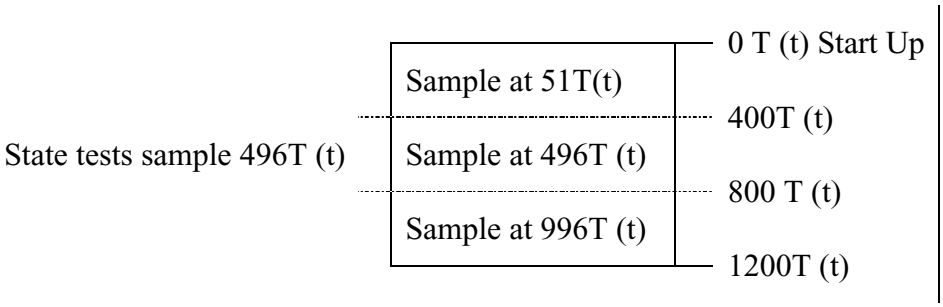
Sample		**Sampling Ton**
1	0 t + 47	51 T*(51t*)
2	400 t + 96	496 T (496t)
3	800 t + 196	996 T (996 t)

The first 50 T(t)being exempted from test, the 51st T(t) is sampled.

4. The Departments technician will select another random number to determine which split sample will be tested for verification purposes. For the example random number 0.333 is used. This number is multiplied by the number of tons in the lot (day's total production tonnage).

   0.333 x 1200 = 400 T (t)

   The sample taken nearest to this ton is tested by the State to verify the contractor's test results. In this example the second sample is tested for verification.



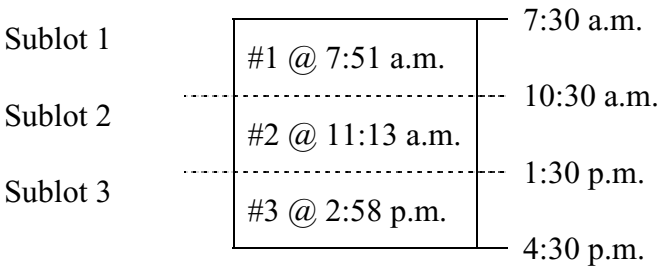
Example No. 4

This example procedure will result in stratified random samples where a lot is represented by one day's production of hot bituminous mixture. The procedure is used when sampling is accomplished during production.

In this example, assume the plant will operate nine hours, beginning at 7:30 a.m. and operating continuously (through lunch) until 4:30 p.m.

Specifications require a three hour testing increment. Using the following steps three sample times will be selected:

1. The day's production is divided into sublots using a three hour testing increment. The intervals are set up on production time and can be converted to clock time as illustrated below.



2. Select three consecutive random numbers with an electronic calculator or from the Table of Random Numbers. Random numbers (0.117, 0.239, and 0.491) are generated with an electronic calculator. These random numbers are multiplied by the time interval of 180 minutes (three hours) as shown below:

   0.117 x 180 = 21 min.
   0.239 x 180 = 43 min.
   0.491 x 180 = 88 min.

3. Add the products from the above multiplications to the starting times for the four intervals to determine the clock times for obtaining samples.

Sample		Sampling Time
1	7:30 a.m. + 21 min.	7:51 a.m.*
2	10:30 a.m. + 43 min.	11:13 a.m.
3	1:30 p.m. + 88 min.	2:58 p.m.

The first 50 T (t) being exempted from test, sampling may wait until the 51T*(51t*).

Samples should be secured from the truck being loaded at the sampling time or the next truck loaded following the scheduled sampling time. For the purpose of sampling, production time shall be defined as beginning with the loading of the first truck and ending with the loading of the last truck. Only in the case of there being no material available to sample, or no trucks from which to sample for at least 30 minutes, (and that time span includes a designated sampling time) should production time be suspended. If production time is suspended 30 minutes or more, sampling time will be adjusted accordingly. For this example, if no trucks were loaded from 2:30 p.m. until 3:30 p.m., the third sampling time would be adjusted one hour from 2:58 p.m. to 3:58 p.m. If no trucks were loaded from 2:30 p.m. until 2:59 p.m., there is no adjustment in sampling time.

Example No. 5

This example procedure will result in stratified random samples where a lot is represented by one day's production. The procedure is used when sampling is accomplished as construction progresses.

In this example, we will select stations and distances from he center line of a bituminous pavement from which samples shall be taken to represent the density for every 1000 ft. (300 m)of pavement. For this example, we will use Station 150+00 to Station 200+00 as the lot. The width to be sampled will be12 ft.(4 m)and the location of he sample will be measured from the centerline of the pavement. Use the following steps to select where the sample will be taken.

1. Select consecutive random numbers with an electronic calculator or from the Table of Random Numbers. Random numbers (0.284, 0.802, 0.146, 0.696, and 0.887) are selected from the Table of Random Numbers. The random numbers are multiplied by 10 which is the total number of stations in each test section3000 ft (1000 m).

Sample Number	
1	0.284 x 10 = 2.84 or 2+84 stations + 150+00 = 152+84
2	0.802 x 10 = 8.02 or 8+02 stations + 160+00 = 168+02
3	0.146 x 10 = 1.46 or 1+46 stations + 170+00 = 171+46
4	0.696 x 10 = 6.96 or 6+96 stations + 180+00 = 186+96
5	0.887 x 10 = 8.87 or 8+87 stations + 190+00 = 198+87

2. To select the transverse distance from the centerline of the pavement, five additional consecutive random numbers are selected and calculations are made using the 12 ft (4 m) distance from the centerline of the pavement. The numbers below are selected from the Table of Random Numbers.

Sample Number	
1	0.195 x 12(4) = 2.34 ft (0.78 m) from centerline of pavement
2	0.673 x 12(4) = 8.0 ft. (2.69 m) from centerline of pavement
3	0.112 x 12(4) = 1.34 ft. (0.45 m) from centerline of pavement
4	0.193 x 12(4) = 2.3 ft. (0.77 m) from centerline of pavement
5	0.651 x 12(4) = 7.8 ft. (2.60 m) from centerline of pavement

3. From the above calculations, we find the following sampling schedule for the lot:

Sample Number	Station	Distance from the Centerline
1	152+84	2.34 ft. (0.78m)
2	168+02	8.0 ft. (2.69m)
3	171+46	1.34 ft (0.45m)
4	186+96	2.3 ft. (0.77m)
5	198+87	7.8 ft. (2.60m)

Table of Random Numbers

.576	.730	.430	.754	.271	.870	.732	.721	.998	.239
.892	.948	.858	.025	.935	.114	.153	.508	.749	.291
.669	.726	.501	.402	.231	.505	.009	.420	.517	.858
.609	.482	.809	.140	.396	.025	.937	.310	.253	.761
.971	.824	.902	.470	.997	.392	.892	.957	.640	.463
.053	.899	.554	.627	.427	.760	.470	.040	.904	.993
.810	.159	.225	.163	.549	.405	.285	.542	.231	.919
.081	.277	.035	.039	.860	.507	.081	.538	.986	.501
.982	.468	.334	.921	.690	.806	.879	.414	.106	.031
.095	.801	.576	.417	.251	.884	.522	.235	.398	.222
.509	.025	.794	.850	.917	.887	.751	.608	.698	.683
.371	.059	.164	.838	.289	.169	.569	.977	.796	.996
.165	.996	.356	.375	.654	.979	.815	.592	.348	.743
.477	.535	.137	.155	.767	.187	.579	.787	.358	.595
.788	.101	.434	.638	.021	.894	.324	.871	.698	.539
.566	.815	.622	.548	.947	.169	.817	.472	.864	.466
.901	.342	.873	.964	.942	.985	.123	.086	.335	.212
.470	.682	.412	.064	.150	.962	.925	.355	.909	.019
.068	.242	.667	.356	.195	.313	.396	.460	.740	.247
.874	.420	.127	.284	.448	.215	.833	.652	.601	.326
.897	.877	.209	.862	.428	.117	.100	.259	.425	.284
.875	.969	.109	.843	.759	.239	.890	.317	.428	.802
.190	.696	.757	.283	.666	.491	.523	.665	.919	.146
.341	.688	.587	.908	.865	.333	.928	.404	.892	.696
.846	.355	.831	.218	.945	.364	.673	.305	.195	.887
.882	.227	.552	.077	.454	.731	.716	.265	.058	.075
.464	.658	.629	.269	.069	.998	.917	.217	.220	.659
.123	.791	.503	.447	.659	.463	.994	.307	.631	.422
.116	.120	.721	.137	.263	.176	.798	.879	.432	.391
.836	.206	.914	.574	.870	.390	.104	.755	.082	.939
.636	.195	.614	.486	.629	.663	.619	.007	.296	.456
.630	.673	.665	.666	.399	.592	.441	.649	.270	.612
.804	.112	.331	.606	.551	.928	.830	.841	.602	.183
.360	.193	.181	.399	.564	.772	.890	.062	.919	.875
.183	.651	.157	.150	.800	.875	.205	.446	.648	.685