



Standard Practice for Random Sampling of Construction Materials¹

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1. Scope

1.1 This practice covers the determination of random locations (or timing) at which samples of construction materials can be taken. For the exact physical procedures for securing the sample, such as a description of the sampling tool, the number of increments needed for a sample, or the size of the sample, reference should be made to the appropriate standard method. The selection procedures in Section 4 utilize the table of four-digit numbers given in Table 1.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- C 172 Practice for Sampling Freshly Mixed Concrete²
- C 183 Practice for Sampling and the Amount of Testing of Hydraulic Cement³
- D 75 Practice for Sampling Aggregates⁴
- D 140 Practice for Sampling Bituminous Materials⁴
- D 345 Test Method for Sampling and Testing Calcium Chloride for Roads and Structural Applications⁴
- D 979 Practice for Sampling Bituminous Paving Mixtures⁴
- D 5361 Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing⁴
- E 105 Practice for Probability Sampling of Materials⁵
- E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process⁵
- E 141 Practice for Acceptance of Evidence Based on the Results of Probability Sampling⁵

3. Significance and Use

3.1 This practice is useful for determining the location or time, or both, to take a sample in order to eliminate any

intentional or minimize any unintentional bias on the part of the person taking the sample.

NOTE 1—The effectiveness of this practice in achieving random samples is limited only by the conscientiousness of the user in following the stipulated procedures.

3.2 A less detailed procedure is included in 5.8 for normal usage and is considered the most practical means except where the sampling is deemed extremely critical or where dispute is anticipated.

3.3 The selection procedures and examples in this standard provide a practical approach for ensuring that construction material samples are obtained in a random manner. Additional details concerning the number of sample increments, the number of samples, the quantities of material in each, and the procedures for extracting sample increments or samples from the construction lot or process are contained in Practices C 172, C 183, D 75, D 140, D 979, D 5361, and Test Method D 345.

3.4 This standard contains examples citing road and paving materials. The concepts outlined therein are applicable to the random sampling of any construction material and can easily be adapted thereto.

3.5 Additional sampling guidance is provided in Practice E 105 concerning probability sampling, Practice E 122 concerning choosing sample sizes to estimate the average quality of a lot or process (see Note 2), and in Practice E 141 for acceptance of evidence based on results of probability sampling.

NOTE 2—The guidance contained in Practice E 122 is not available in other documents referenced in this section.

3.6 The best and most practical method for ensuring that samples of construction materials include the full range of a construction process is by incorporating a stratified-random sampling procedure into the sampling process. To implement a stratified-random sampling procedure, divide the lot to be sampled into the desired number of equal sublots and randomly sample each subplot in accordance with this standard.

NOTE 3—If the sublots are of unequal size, it will likely be necessary to weight the samples in order to maintain a fair and defensible sampling process.

¹ This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.30 on Methods of Sampling.

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² *Annual Book of ASTM Standards*, Vol 04.02.

³ *Annual Book of ASTM Standards*, Vol 04.01.

⁴ *Annual Book of ASTM Standards*, Vol 04.03.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.



TABLE 1 Continued

79	0.0920	0.8663	0.1116	0.2137	0.3356	0.3041	0.8723	0.2818	0.0650	0.8576	0.6910	0.3483	0.0538	0.3915	0.6213	0.1121	0.0854	0.0204	0.9424	0.8979
80	0.9104	0.8658	0.5345	0.0418	0.5930	0.2951	0.3535	0.8534	0.6768	0.8691	0.2676	0.9975	0.0685	0.7064	0.4735	0.9673	0.2285	0.1389	0.1868	0.0776
81	0.2580	0.5557	0.4918	0.1676	0.9764	0.0642	0.6235	0.5465	0.4078	0.3675	0.4685	0.2161	0.2105	0.4367	0.6159	0.6908	0.4144	0.1638	0.4591	0.7101
82	0.6665	0.0251	0.1035	0.7883	0.5475	0.5448	0.1607	0.1583	0.9813	0.2023	0.5306	0.3900	0.0974	0.4669	0.2313	0.1243	0.7646	0.0995	0.2030	0.5674
83	0.0847	0.8263	0.5791	0.1038	0.7323	0.4109	0.2634	0.2066	0.4081	0.0582	0.5343	0.8310	0.2458	0.6361	0.1369	0.1054	0.8216	0.3099	0.1461	0.1071
84	0.9287	0.9177	0.1009	0.7112	0.4326	0.4656	0.7359	0.1181	0.0142	0.6373	0.1180	0.5130	0.0171	0.2186	0.8197	0.6365	0.7547	0.2754	0.1759	0.6882
85	0.7468	0.3793	0.9597	0.3015	0.5902	0.0814	0.0769	0.1750	0.9159	0.6402	0.7887	0.8217	0.8391	0.6147	0.7437	0.2833	0.8983	0.4327	0.1224	0.4349
86	0.7381	0.3458	0.3338	0.9241	0.5336	0.3859	0.4359	0.1895	0.9286	0.8033	0.6071	0.1751	0.6104	0.1831	0.9178	0.8633	0.8509	0.7086	0.0196	0.9200
87	0.4927	0.6663	0.6386	0.9686	0.0408	0.3837	0.4466	0.4157	0.1174	0.1936	0.1580	0.5051	0.0082	0.4176	0.2119	0.3605	0.6985	0.0696	0.3651	0.4919
88	0.4993	0.3986	0.1113	0.6742	0.9229	0.5185	0.8288	0.8793	0.3847	0.6862	0.8354	0.0167	0.9089	0.1021	0.3947	0.3862	0.2840	0.0240	0.5161	0.8003
89	0.7287	0.4249	0.1393	0.9409	0.2956	0.5035	0.8608	0.8326	0.0246	0.5686	0.1777	0.0195	0.0326	0.8910	0.3597	0.0537	0.6061	0.0964	0.8937	0.3598
90	0.8148	0.0930	0.3593	0.5839	0.3104	0.5278	0.5314	0.3399	0.2225	0.9311	0.5780	0.7867	0.5549	0.1881	0.0824	0.1748	0.9074	0.8194	0.7616	0.8667
91	0.9484	0.1042	0.0810	0.2651	0.4983	0.4180	0.3546	0.1774	0.9734	0.0426	0.7241	0.3154	0.4383	0.7045	0.1610	0.0020	0.8858	0.8037	0.8953	0.9526
92	0.7868	0.5509	0.4649	0.3561	0.9582	0.1699	0.6770	0.1401	0.7119	0.0381	0.0330	0.6828	0.7948	0.3424	0.3320	0.7135	0.3018	0.9243	0.2630	0.0792
93	0.1367	0.4017	0.4832	0.2858	0.5319	0.0213	0.0279	0.0525	0.2021	0.4452	0.1817	0.1904	0.4430	0.5754	0.8459	0.3887	0.2559	0.2296	0.2643	0.8958
94	0.9273	0.8932	0.7534	0.2476	0.1510	0.5720	0.5456	0.4708	0.9428	0.6946	0.1710	0.0399	0.2226	0.1946	0.9445	0.4692	0.0295	0.9460	0.0247	0.4244
95	0.7157	0.9778	0.8019	0.8999	0.4097	0.7765	0.3231	0.7514	0.2964	0.7499	0.7944	0.8360	0.4522	0.8229	0.0169	0.5683	0.2141	0.7519	0.2457	0.2459
96	0.6451	0.5704	0.1944	0.1012	0.4491	0.6204	0.7020	0.4793	0.6050	0.0996	0.5668	0.0976	0.0644	0.6350	0.0695	0.2450	0.5311	0.1008	0.6265	0.3133
97	0.0463	0.8554	0.7056	0.9581	0.0863	0.9727	0.2027	0.6347	0.5601	0.4271	0.9455	0.9848	0.3414	0.6344	0.0757	0.6445	0.4060	0.2719	0.8817	0.0409
98	0.0081	0.6275	0.0797	0.5445	0.8158	0.8223	0.4270	0.9910	0.1584	0.9007	0.0574	0.1620	0.6647	0.2255	0.8024	0.1925	0.8651	0.2282	0.7339	0.4239
99	0.0660	0.8542	0.6777	0.0314	0.7357	0.4533	0.9358	0.8529	0.5773	0.9504	0.7280	0.2404	0.2057	0.9728	0.4463	0.3055	0.3525	0.7757	0.9918	0.8484
100	0.4434	0.8270	0.4679	0.1235	0.1842	0.0191	0.4648	0.1338	0.4807	0.6561	0.2981	0.5375	0.5667	0.6448	0.7348	0.6558	0.7939	0.8095	0.5156	0.1589

4. Selection Procedures

4.1 Sampling from a Belt or Flowing Stream of Material:

4.1.1 Determine the length of time, t , in minutes, for the lot of material to be sampled to pass the sampling point and determine the number of samples, n , to be taken from the lot. Following the instructions accompanying Table 1, pick n numbers to determine the times t to select the necessary samples.

4.1.2 Example:

4.1.2.1 The lot of material to be sampled from a flowing stream at a transfer point is defined as 480 min of production. Five samples are required from the lot. From Table 1, the following five numbers were picked:

0.0918
0.4205
0.2171
0.3702
0.0061

The first three digits are used directly (decimals disregarded) to determine the sample selection times. Any number over 480 should be discarded and another chosen.

4.1.2.2 Thus, samples will be taken at the following times after production begins (to the nearest 1 min and arranged in chronological order):

min
6
91
217
370
420

NOTE 4—The user may wish to decide a minimum time to allow the plant to become fully operational. In cases where the picked number results in a time less than this, the user should discard the picked number and choose another.

NOTE 5—While the above exact times were picked, in practice, the user may wish to round off actual sampling times to the nearest 5 min.

4.2 Sampling From a Windrow of Material:

4.2.1 Determine the total length of one windrow in metres that represents a lot of material and determine the number of samples, n , to be taken from the lot. Following the instruction accompanying Table 1, pick n numbers to determine the length, (l), from the start of the windrow from which samples will be taken.

4.2.2 Example:

4.2.2.1 A lot of material has been placed in windrows 900 m in length. It is desired to secure three samples from this lot. From Table 1 the following three numbers are picked:

0.5269
0.7044
0.1931

4.2.2.2 These numbers are then multiplied by 900 giving the number of metres from the beginning of the windrow at which to sample. Thus, samples (rounded to the nearest metre and arranged in sequence) are selected at the following intervals:

174 m (900×0.1931)
474 m (900×0.5269)
634 m (900×0.7044)

4.3 Sampling In-Place Paving Material:

4.3.1 Determine the length of one pavement representing a lot of material, the width of the pavement, w , and the number

of samples needed for each lot, n . Following the instructions accompanying Table 1, pick l numbers corresponding to the length of pavement, followed by picking w numbers for width determination.

4.3.2 Example:

4.3.2.1 A lot is defined as 1.6 km of in-place 3.6-m wide pavement. Two samples are to be taken from each lot. Since there are 1600 m in the lot, enter the table and pick two numbers, which are then multiplied by 1600 m. In this instance, the two numbers chosen were:

0.3768
0.5295

4.3.2.2 Thus, the two samples will be taken at 603 and 847 m from the beginning of the pavement.

4.3.2.3 Determine the location from the edge of the pavement by selecting two additional numbers from Table 1, which are then multiplied by 3.6. In this case, the two numbers chosen were:

0.5127
0.7082

4.3.2.4 Therefore, the first sample should be taken 603 m from the beginning of the pavement (see 4.3.2.2) and 1.8 m from the designated (right or left) edge of the pavement.

4.3.2.5 The second sample should be taken 847 m from the beginning of the pavement and 2.5 m from the designated (right or left) edge of the pavement.

4.4 Sampling From a Loaded Truck:

4.4.1 Determine the number of truck loads that represent a lot of material and determine the number of samples, n , needed from each lot. To determine which trucks to sample, pick n numbers from Table 1 and multiply these numbers by the number of trucks in the lot. To determine the quadrant in each truck to be sampled, choose n numbers from Table 1 and multiply by 4. Select the quadrant in accordance with the following criteria. Quadrant locations of the truck are numbered as shown in Fig. 1.

Calculated Random Number, N	Quadrant
$N \leq 1.0$	1
$1.0 < N \leq 2.0$	2
$2.0 < N \leq 3.0$	3
$3.0 < N \leq 4.0$	4

4.4.2 Example:

4.4.2.1 Twenty trucks are considered a lot and three samples are required. Using Table 1, the following three numbers were picked:

0.2516
0.4243
0.8657

4.4.2.2 Thus, trucks numbered 5 (0.2516×20), 8 (0.4243×20), and 17 (0.8657×20) should be sampled.

4.4.2.3 To determine the quadrant locations, the following numbers were picked:

0.1100
0.3809
0.0641

These are multiplied by 4 with the following results:

Quadrant 1 from truck No. 5 (4×0.1100)
Quadrant 2 from truck No. 8 (4×0.3807)
Quadrant 1 from truck No. 17 (4×0.0641)

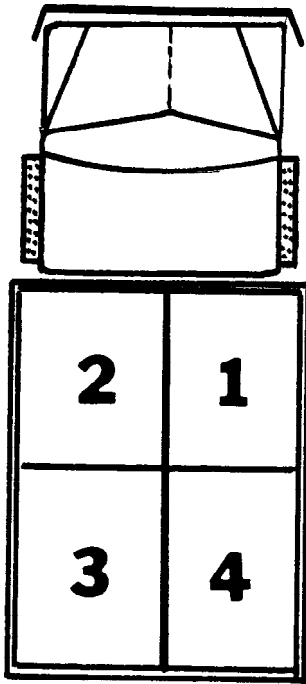


FIG. 1 Quadrants for Random Sampling from a Loaded Truck

5. Instructions for Using the Four-Digit Table of Numbers (Table 1)

5.1 Table 1 consists of all numbers from 0.0000 to 1.0000. Each number appears only once.

5.2 Electronic calculators or random number generators can be used to select rows and columns. Another method is to use Table 1 and a pointer. To eliminate bias when the pointer method is used, copy Table 1 from the book and place the pages on a flat surface in such a manner that the entire 100 line by 100 column table is assembled on the flat surface. Point without looking to a number in the table. The pointer may be a mechanical pencil with the lead retracted, the tip of a letter opener, or other pointed device.

5.3 After picking a number, the basis is established for locating the sought-after number in a more random, unbiased method.

5.4 Examine the first two digits of the four-digit number chosen. This number locates the column number (the horizontal line at the top) to be used in finding the sought-after number.

NOTE 6—The digits 0.0000 to 0.0099 are used for column number 100.

5.5 Once the column number is chosen, repeat the procedure in 5.2 and, using the first two digits, pick the line number (the vertical column on the left of the table).

5.6 The intersection of the results from 5.4 and 5.5 is the sought-after number.

5.7 The procedure, to be unbiased, must be followed as detailed in the foregoing or by some other locally devised method by which the user has no control over the numbers chosen. The table must be entered separately for any and all numbers selected. Repeat the selection procedure if an unusable number results.

5.8 Two alternative methods are described in 5.8.1 and 5.8.2. They are not considered as correct theoretically as the procedure described in 5.2 through 5.7; however, except in cases of dispute, they are considered to be acceptable alternatives for normal usage.

5.8.1 *Alternative 1*— Enter the table as described in 5.2, deciding beforehand that the required number of digits will be selected by moving up, down, right, or left from the number picked. Discard unusable numbers, and continue to the next number in the same direction. Decide beforehand what action to take when a number on the periphery of the table is reached and additional selections are needed.

5.8.2 *Alternative 2*— The user decides beforehand to begin in the top left corner (or top center, or bottom right, etc.) and move right and down (or left and up) picking the number of required usable numbers. Other variances might be: moving in the preplanned direction, picking every other number, or every third number, etc. Exercise care in using this method, giving numbers in the middle of the table an equal chance of being selected for any given time period.

6. Keywords

6.1 random number tables; sampling, random

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