CRD-C 100-75

METHOD OF SAMPLING CONCRETE AGGREGATE AND AGGREGATE SOURCES, AND SELECTION OF MATERIAL FOR TESTING

1. Scope

1.1 This method outlines procedures for obtaining samples of materials processed for use as concrete aggregate or of raw materials being investigated for such use, and selecting material for testing from the samples so obtained. Procedures applicable to a number of typical situations with respect to the nature, occurrence, and condition of materials, and with respect to the purposes for which the samples are to be taken are described. The procedures outlined do not cover all possible situations, and will therefore require modification in certain circumstances; they are, however, regarded as providing a suitable guide to the types of procedures believed necessary if adequate and representative samples are to be taken either for routine job-control tests or for laboratory testing. The method includes three parts as follows:

Part I: Sampling Concrete Aggregate Sources
Part II: Sampling Processed Aggregate During Construction
Part III: Selecting Material for Testing

2. Applicable Documents

2.1 CRD-C 103 Method of Test for Sieve Analysis of Fine and Coarse Aggregates for Use in Portland-Cement Concrete.

2.2 CRD-C 105 Standard Method of Test for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing.

2.3 CRD-C 106 Standard Method of Test for Unit Weight of Aggregate.

2.4 CRD-C 107 Standard Method of Test for Specific Gravity, Absorption, and Unit Weight of Coarse Aggregate and Riprap.

2.5 CRD-C 108 Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate.

2.6 CRD-C 114 Method of Test for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens.

2.7 CRD-C 116 Standard Method of Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.

2.8 CRD-C 117 Standard Method of Test for Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.

2.9 CRD-C 118 Methods for Reducing Field Samples of Aggregate to Testing Size (ASTM: C 702).

2.10 CRD-C 119 Method of Test for Flat and Elongated Particles in Coarse Aggregate.

2.11 CRD-C 120 Method of Test for Flat and Elongated Particles in Fine Aggregate.

2.12 CRD-C 121 Standard Method of Test for Organic Impurities in Sands for Concrete.

2.13 CRD-C 122 Standard Method of Test for Lightweight Pieces in Aggregate.

2.14 CRD-C 127 Recommended Practice for Petrographic Examination of Aggregates for Concrete.

2.15 CRD-C 130 Method of Test for Scratch Hardness of Coarse Aggregate Particles.

2.16 CRD-C 137 Standard Method of Test for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

2.17 CRD-C 142 Standard Method of Test for Clay Lumps and Friable Particles in Aggregates.

2.18 CRD-C 155 Standard Methods of Sampling Aggregates (ASTM: D 75).

2.19 CRD-C 578 Standard Methods for Collection of a Gross Sample of Coal (ASTM: D 2234).

2.20 CRD-C 579 Standard Recommended Practice for Probability Sampling of Materials (ASTM: E 105).

2.21 CRD-C 580 Standard Recommended Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process (ASTM: E 122).

2.22 CRD-C 581 Standard Recommended Practice for Acceptance of

Evidence Based on the Results of Probability Sampling (ASTM: E 141).

3. Basic Procedure

3.1 Supervision.- Samples to be submitted for tests to provide data for acceptance or rejection of the source of supply shall be taken under the supervision of acompetent inspector or geologist. It is to the best interests of all concerned that the sampler be trained and experienced in his work. He should be conversant with the problems of aggregate production and processing. His knowledge of testing should be sufficient to assure his securing the samples which the testing procedure requires. Finally, he should be familiar with construction practices so that he will place proper emphasis on the sampling of materials.

3.2 Standard Methods.- Standard methods of sampling are given in CRD-C 155, which lists as applicable documents CRD-C 578, 579, 580, and 581.

3.3 Representative Samples.- The importance of obtaining representative samples cannot be emphasized too strongly since failure to do so can provide inaccurate and misleading information even though the tests themselves are conducted properly.

3.4 Guidance for developing a random sampling procedure based on the theory of probability may be found in CRD-C 579.

Part I: Sampling Concrete Aggregate Sources

4. Sampling Quarries and Quarry Sites

4.1 Samples from developed quarries or undeveloped quarry sites must be taken with care in order that the material selected may be, to the greatest possible extent, typical of the deposit and inclusive of all variations in rock type. Samples should be taken from freshly exposed faces. Fragments composing the sample should be segregated and labeled so that the material from different ledges or different parts of the quarry area will be kept separate.

4.2 Sampling Quarry Faces.- After the opening of a new face or the resumption of operations at an old quarry face, the stone exposed thereby should be measured for total depth or height. The various strata or ledges making up the face should be measured separately, and the percentage of the total rock depth which each stratum or ledge constitutes should be computed. Representative samples of all strata should be taken, in the proportion in which they occur in the quarry face, in amounts calculated to provide an adequate sample for the test program desired. Each piece from each stratum should bear an identifying number. Care should be exercised to exclude material that has fallen and lodged along the exposed face. It is recommended that, when such sampling is necessary, each stone weigh not less than 25 lb (11 kg). Where the quarry face is of such extent that sampling of individual ledges would be hazardous, representative samples should be obtained by cores 6 in. (150 mm) or more in diameter taken back of the existing quarry face. The method of “shooting down” a quarry face is not favored, owing to the problem of obtaining representative samples from the resulting rubble pile on the quarry floor. However, if it is proposed to utilize the entire sample “shot down,” and the quarry floor is clean of contaminating rock from other sources, then “shooting down” would be suitable provided that overburden has been stripped prior to shooting. Samples obtained by this method should not weigh less than 25 tons (20,000 kg).

4.3 Sampling by Core Drilling.- The entire footage included in cores obtained by drilling should be submitted as a sample for test. Any core loss should be clearly and accurately shown in its true position by means of appropriately placed spacer blocks in the core boxes and with written information as to depth and extent. Samples consisting of cores of smaller than nominal 6-in. (150-mm) diam should be avoided except for purely exploratory purposes, and should be supplemented by cores of at least 6-in. (150-mm) diam if the exploratory work indicates the presence of materials that merit further study. Six-in. (150-mm) cores should be taken in duplicate or triplicate if tests are desired on ledges of less than 8 ft

(3 m) in thickness. Final evaluation of sources from which it is proposed to produce 6-in. (150-mm) aggregate should be made on samples from which 6-in. (150-mm) aggregate can be processed; such samples may best be obtained by use of large- (36- to 40-in.) (1-m) diameter calyx core drills. Six-in. (150-mm) aggregate cannot be produced from cores of diameters smaller than 10 in. (250 mm).

5. Sampling Pit-Run (Unprocessed) Sand and Gravel Deposits

5.1 Samples should be representative of the materials that might be produced from the site. They should include only materials taken below the bottom of the waste zone, overburden, or strip zone. If the deposit is worked as an open bank or pit, the sample shall be taken by channeling the face so that it will represent material that visual inspection indicates may be used. Care should be taken to exclude material that has fallen from the face. A sufficient number of test pits and trenches should be opened to insure that samples are representative of those that might be produced. Separate samples should be obtained from the face of the bank and from test pits or trenches; and if visual inspection indicates that there is considerable variation in the material, separate samples shall be obtained at different depths. The sample should not include materials of sizes larger than those specified for use in the project for which the deposit is being considered unless it is proposed that such oversize material be crushed and combined with smaller sizes for use.

6. Sampling Processed Materials

6.1 Samples shall be obtained, where practicable, from the finished product as processed for use. It is very difficult to secure a representative sample from a stockpile at a plant, and if conditions require sampling from this source, it is recommended that separate samples be taken from different parts of the pile, care being taken to avoid any segregated areas and bearing in mind that material near the base of the pile is likely to be segregated and coarser than material in the pile. Samples from stockpiles should be taken at or near the base, midsection area, and top. Three or four such cross-sectional samples should be taken, recombined, and split into the size of sample required for the tests desired. If samples are obtained from a bin, two methods are possible. One method is to place a container of sufficient size to intercept the entire flow directly below the gate, then fully open the gate to obtain the desired sample; the other method is to use some type of sampler that will pass directly through the stream of flowing material. In this method care must be taken that the sampler completely cuts the flow so that the sample represents the entire stream equally. Conveyor belt samples should be secured from locations on the belt selected to insure that the sample is representative.

7. Sizes of Sample

7.1 Samples which have been taken as specified above should consist of not less than the following amounts of material, depending on the testing to which the sample is to be subjected and the condition of the material in the sample:

Purpose and Scope	Size	Amount
Petrographic Examination (CRD-C 127)		
Core samples	4-in. (100-mm) diam	All recovered
Pieces broken from each ledge or bed of a face	At least 1 lb (0.5 kg) each	At least 5 lb (2.5 kg)

(Continued)

Purpose and Source	Size	Amount
Petrographic Examination (CRD-C 127) (Continued)		
Stockpiles of processed crushed stone[a]	Fine aggregate	50 lb (25 kg)
	Coarse aggregate:	
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	50 lb (25 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	100 lb (50 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	200 lb (100 kg)
	3- to 6-in. (75- to 150-mm)	1000 lb[b] (500 kg)
Sand and gravel (processed or pit-run)[a]	Sand	50 lb (25 kg)
	Coarse aggregate:	
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	100 lb (50 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	200 lb (100 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	400 lb (200 kg)
	3- to 6-in. (75- to 150-mm)	1000 lb[b] (500 kg)

Note.- Preliminary evaluation of massive rock may be made on AX (1-1/8-in.) (28.5 mm) core or on complex or thin-bedded rock on NX (2-1/8-in.) (53.5 mm) core.

Sieve Analysis (CRD-C 103)

Processed materials as delivered to the concrete mixer for use in construction	See Section 11.2	

Elementary Tests[c] Only

Fine aggregate		
Processed, natural or manufactured	--	300 lb (150 kg)
Unprocessed sand or rock for sand making	--	500 lb (250 kg)
Coarse aggregate		
Processed	No. 4 to 3/4-in. (4.75- to 19.0-mm)	500 lb (250 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	500 lb (250 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	1000 lb (500 kg)
	3- to 6-in. (75- to 150-mm)	1500 lb (750 kg)
Unprocessed	No. 4 to 3/4-in. (4.75- to 19.0.mm)	1000 lb (500 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	1500 lb (750 kg)
	1-1/2- to 3-in. (37.5- to 75.mm)	1500 lb (750 kg)
	3- to 6-in. (75- to 150-mm)	2000 lb (1000 kg)

Elementary Tests and Freezing-and-Thawing (CRD-C 114)

Fine aggregate		
Processed, well graded	--	1500 lb (750 kg)
Poorly graded or unprocessed sand, or rock for manufacturing fine aggregate	--	2000 lb (1000 kg)

(Continued)

[a] Obtained by compositing and reducing larger samples.
[b] Or not less than 300 pieces, whichever is larger.
[c] Includes, as applicable: CRD-C 103, 105, 106, 107, 108, 137, 117, 119, 120, 121, 116, 122, 130, 142.

Purpose and Source	Size	Amount
Elementary Tests and Freezing-and-Thawing (CRD-C 114) (Continued)		
Coarse aggregate		
Processed	No. 4 to 3/4-in. (4.75- to 19.0-mm)	1500 lb (750 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	1500 lb (750 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	1000 lb (500 kg)
	3- to 6-in. (75- to 150-mm)	1500 lb (750 kg)
Unprocessed	No. 4 to 3/4-in. (4.75- to 19.0-mm)	3000 lb (1500 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	3000 lb (1500 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	1500 lb (750 kg)
	3- to 6-in. (75- to 150-mm)	2000 lb (1000 kg)
Mixture Proportioning Studies (per Mixture)[d]		
3/4-in. (19.0-mm) aggregate mixture	Fine aggregate	800 lb (400 kg)
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	1200 lb (600 kg)
	Cement	400 lb (200 kg)
1-1/2-in. (37.5-mm) aggregate mixture	Fine aggregate	1000 lb (500 kg)
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	1000 lb (500 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	1000 lb (500 kg)
	Cement	400 lb (200 kg)
3-in. (75-mm) aggregate mixture	Fine aggregate	2000 lb (1000 kg)
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	1500 lb (750 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	1000 lb (500 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	2000 lb (1000 kg)
	Cement	500 lb (250 kg)
6-in. (150-mm) aggregate mixture	Fine aggregate	3000 lb (1500 kg)
	No. 4 to 3/4-in. (4.75- to 19.0-mm)	2000 lb (1000 kg)
	3/4- to 1-1/2-in. (19.0- to 37.5-mm)	1500 lb (750 kg)
	1-1/2- to 3-in. (37.5- to 75-mm)	2500 lb (1250 kg)
	3- to 6-in. (75- to 150-mm)	3000 lb (1500 kg)
	Cement	700 lb (350 kg)

(Continued)

[d] Processed materials complying with applicable specifications for grading for mixture proportioning studies only.

Purpose and Source	Size	Amount
Mixture Proportioning Studies (per Mixture) (Continued)		
Airfield pavement mixtures (Note)	Fine aggregate Coarse aggregate[a] cement	3000 lb (1500 kg) (e) 1600 lb (800 kg)
Unprocessed Rock Samples (for Tests Other than Petrographic Examination)		
6- in. (150-mm) core for processing to fine or coarse aggregate and elementary tests only	Per ledge or zone	20 ft (6.09 m)
36- to 40-in. (900- to 1000-mm) calyx core or quarry or ledge rock for processing to fine and coarse aggregate for elementary and freezing-and-thawing tests	Per aggregate	25 tons (22,680 kg)

[a] Coarse aggregate minimum requirements:

	Amount, lb, Passing Sieve Sizes				
Maximum Size, in.	No. 4 to 3/4-in.	No. 4 to l-in	3/4- to 1-1/2-in.	1- to 2-in.	1-1/2- to 2-1/2-in.
1	--	5000	--	--	--
1-1/2	3000	--	3000	--	--
2	--	3000	--	3000	--
2-1/2	2500	--	2500	--	2500

	Amount, kg, Passing Sieve Sizes				
Maximum Size, mm	4.75- to 19.0-mm	4.75- to 25-mm	19.0- to 37.5-mm	25- to 50-mm	37.5-to 63-mm
25	--	2500	--	--	--
37.5	1500	--	1500	--	--
50	--	1500	--	1500	--
63	1250	--	1250	--	1250

Note.- These quantities represent minimum amounts needed to establish optimum mixture proportions using three cement factors or water-cement ratios, and molding sufficient 6- by 6-in. (150- by 150-mm) beams for nine flexural strength tests at each of three test ages from mixtures representing each cement factor or water-cement ratio. Should investigation of additional mixtures or additional tests be desired, the quantities must be increased proportionally. These quantities must also be increased proportionally if the grading of the samples submitted is such that reprocessing at the laboratory is required.

8. Preparation of Composite Samples

8.1 Preparation of composite samples or reduction of large samples to smaller volumes should be accomplished with care to insure that the composited or reduced sample faithfully represents the larger volume from which it was prepared. The procedures given in CRD-C 118 should be followed.

9. Data to be Provided with Samples

9.1 All samples shall be properly identified, and in addition to the general information furnished with all samples, the following specific data shall be supplied.

9.1.1 Site Map.- Showing locations of source of supply of the aggregates under investigation with relation to the site of the project on which they are proposed for use.

9.1.2 Geological Data.- Classification of deposit giving geologic description, field log, and any other available data.

9.1.3 Location.- Precise location of the samples under investigation such as producer, state, county, township, range, section, etc.

9.1.4 Quarry Description.- If more than one ledge or stratum is under consideration the percentage of each ledge or stratum with respect to the total depth or height of the quarry face shall be furnished.

Part II: Sampling Processed Aggregate During Construction

10. Basic Procedure

10.1 The essential requirement for the sampling of processed aggregates during the course of concrete construction is that a sufficient number of properly taken samples be obtained and tested at proper time intervals to insure that satisfactory particle shape, grading, and the degree of uniformity of grading and free moisture content required by the specifications are being obtained.

11. Size of Samples

11.1 General.- Samples shall consist of approximately the following amounts of material, depending on the size range of the aggregate being sampled:

Size Range	Sample Size, lb (kg)
Fine aggregate	10 (5)
No. 4 to 3/4-in. (4.75- to 19.0-mm)	25 (12.5)
3/4- to 1-1/2-in. (19.0- to 37.5-mm)	50 (25)
1-1/2- to 3-in. (37.5- to 75-mm)	100 (50)
3- to 6-in. (75- to 150-mm)	300 (150)

11.2 Sieve Analysis.- Section 11.1 gives the minimum sample sizes which should be taken for each size aggregate. Sample sizes for sieve analysis are given in CRD-C 103. For fine aggregate and the finer sizes of coarse aggregate the samples obtained in accordance with Section 11.1 may be reduced in size before the sieve analysis is made. This reduction should be accomplished by a sample splitter or by carefully following the instructions for quartering given in CRD-C 118. For aggregate sizes less than 1-1/2 in. (37.5 mm) the required sample sizes are sufficiently large in relation to individual particle size so that compliance with the grading specification maybe fairly determined by a single test. For 1-1/2 in. (37.5 mm) and larger sizes, however, this is not true. For these size groups, the sample sizes given in Section 11.1, while representing a practical size for testing by ordinary equipment, are subject to large random sampling errors. Therefore, compliance with specifications should be determined from the average of five consecutive tests. Whenever a single test result shows a major deviation from specification requirements, the frequency of sampling and testing should be accelerated to as great an extent as practical until it is established whether the indicated noncompliance was the result of sampling error or the result of an actual deficiency in the aggregate processing equipment. Sometimes a single retest will be sufficient to establish the cause of the noncompliance. If sampling and testing equipment is installed which is capable of handling specimens five times as large as those required by Section 11.1, the averaging of test results is not necessary.

12. Location for Sampling

12.1 Samples shall be taken from the location in the plant that will yield material most representative of the grading and moisture condition that will exist when batched into the concrete mixer. The sampling location may, in certain cases, be designated in consideration of the desirability of obtaining test results on the sample before the materials represented by the sample are used in concrete. It is believed that, in most cases, the best sampling location will be at the weigh batcher during filling.

13. Sampling Procedure

13.1 The sampling procedure and sampling devices employed will depend on the nature of the plant installation at which the sampling is being done and the maximum size of the aggregate being sampled. A sampling device that can be swung through the

stream shall be used whenever feasible. Large quantities of aggregate in storage may be sampled by taking representative grab portions by means of a shovel or a clamshell, provided that at least three portions are taken, each composed of not less than the amount specified for the sample to be tested. Trench sampling may be used, provided the sample represents a layer of approximately uniform thickness across the entire length of the floor of a trench dug from one end to the other of the material, provided the trench has been dug so as to minimize the possibility of aggregate falling or sliding into the trench, and provided the trench is of sufficient depth to insure that handling or surface segregation has not caused the sampled material to be nonrepresentative. Continuous segment samples may be taken from the flow along a conveyor belt or from a bin discharge, provided it is assured that the sampled aggregate does not represent a fraction where retarded or accelerated flow has caused the fraction to be nonrepresentative. Sampling from a conveyor belt requires that the belt be stopped. All the material, including dust, shall be removed from a segment of the belt to provide the size sample required. The procedures described in Par. 6 may be employed in sampling processed aggregate to the extent appropriate.

14. Frequency of Sampling

14.1 The frequency with which samples are taken and tested will vary with the requirements of the project specifications and the degree of uniformity of grading, moisture content, and particle shape of the aggregates being supplied for use.

15. Treatment of Samples

15.1 Samples shall be carefully protected from gaining or losing moisture between the time when they are taken and the time when they are tested for free moisture. The procedures by which portions of samples are selected for testing shall be carefully conducted in a standard manner to insure that the portion tested is representative of the material in the sample. The applicable portions of the standard methods of testing shall be followed in all operations.

Part III: Selecting Material for Testing

16. General Considerations

16.1 All samples representing processed materials and materials that will be processed without major crushing or milling should be quartered and tested for sieve analysis in the condition in which they are received, regardless of whether the results of such tests are to be used to establish compliance with applicable grading requirements for acceptance or rejection purposes, or for information. Once it has been established that the grading of a given sample of aggregate does or does not comply with the specified requirements, the subsequent treatment of the sample can be determined.

17. Samples Having Gradings Within Specification Limits

17.1 Any sample which, when tested for sieve analysis, has a grading within the limits of the applicable grading requirements for the size range of material represented, and for the project on which it may be or is being used, may be treated for testing purposes as prescribed in the sample-preparation procedure portions of the applicable methods of testing.

18. Samples Having Gradings *Not* Within Specification Limits

18.1 Any sample which, when tested for sieve analysis, has a grading that does not comply with the applicable specification requirements for grading for the size range of material represented, and for the project on which it may be or is being used, will be treated as described below before additional tests are conducted.

18.2 Samples of Processed Aggregate Taken During Construction.- The nature of the departure of the grading of the sample from the specified requirements shall be reported promptly

and instructions requested as to whether additional work shall be done on the sample. Under these circumstances, noncompliance will frequently provide a proper basis for discontinuing work on such a sample. If testing is to continue, instructions should be obtained on whether the additional tests should be done on the sample as received, or whether the grading deficiency should first be corrected by laboratory regrading if possible. If regrading is to be done, it should be determined whether the regrading should be just sufficient to bring the material within the required limits, or sufficient to bring the material essentially to the midrange of the limits.

18.3 Samples of Processed Aggregate or Pit-Run Sand and Gravel Taken from a Potential Aggregate Source.- When the sample, as received, does not comply with the grading requirements applicable to the work in which it is proposed for use, the as-received grading will be reported as information, but *all* other tests in which representative samples are required shall be performed on regraded material that does comply with the grading specifications. When the nature of the deposit and the nature of the departure from compliance suggest strongly that the logical means for producing material that complies with specifications would consist of scalping, washing, or similar procedures that will yield a product that is within the limits by enough to take care of variations in processing and testing, the sample should be so processed or such processing should be simulated. In other cases the sample should be regraded essentially "down the middle" of the grading requirements.

18.4 Samples of Rock to be Evaluated for Use as Crushed Stone, or Manufactured Sand, or Both.- Such materials will be crushed or milled as appropriate and regraded to meet specifications. The crushed or mill product maybe tested for sieve analysis as desired or required, but all other tests will be made on regraded material meeting the specifications and preferably "down the middle" of the specifications.

18.5 Sieve Fractions.- When material available for test is in the form of individual sieve fractions, all tests requiring representative portions of graded materials will be performed by using proportionate quantities of the several sieve fractions as needed to produce a graded product meeting the specifications for the appropriate size range; or, in cases where tests are made on sieve fractions, any weighted averages shall be calculated using a hypothetical grading "down the middle" of the requirements for the size range, unless other procedures have been specifically authorized.