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Methods for sampling and testing aggregates

Method 3.1: Sampling — Aggregates



AS 1141.3.1:2021

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Method 3.1: Sampling — Aggregates

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Preface

This Standard was prepared by the Standards Australia Committee CE-012, Aggregates and Rock for Engineering Purposes, to supersede AS 1141.3.1—2012.

The objective of this document is to define procedures that enable collection of samples that will represent the properties of aggregates produced from rock, gravel, sand and recycled aggregate plants.

The procedures address the common situations faced when obtaining samples in the field.

The major changes in this edition are as follows:

- (a) Addition of this Preface.
- (b) Additional terms and definitions, see [Clause 3](#).
- (c) Recognition of the variation in test results between plant produced samples and sample crushed in a laboratory, see [Clause 6.4](#).
- (d) The appendix has been reformatted into three informative appendices addressing the following topics:
 - (i) the sample terminology used in the AS 1141 series is discussed in [Appendix A](#);
 - (ii) the issue of segregation in aggregate and methods of sampling to avoid bias is discussed in [Appendix B](#); and
 - (iii) sampling schemes and the evaluation of samples are discussed in [Appendix C](#).

The terms “normative” and “informative” are used in Standards (and other publications) to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

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Methods for sampling and testing aggregates

Method 3.1: Sampling — Aggregates

Section 1 Scope

This document defines requirements and specifies methods for:

- (a) taking samples of coarse and fine aggregates;
- (b) subdividing samples; and
- (c) packing and forwarding samples for examination and testing.

This document is limited to aggregate and rock products with a nominal size of 75 mm or less.

The document may be applied to non-stabilized soil product or soil and rock blends, provided that the maximum particle size is less than 75 mm.

For rock, aggregate and soil products larger than 75 mm, refer to AS 1141.3.2.

NOTE 1 Provided that care is taken in adapting them, the procedures specified in this document may be used for sampling other materials such as compacted layers of soil in earthworks construction, or asphaltic concrete prior to compaction.

NOTE 2 The AS 1289 series refers to this document in relation to soil sampling.

Section 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1141.1, *Methods for sampling and testing aggregates, Part 1: Definitions*

AS 1141.2, *Methods for sampling and testing aggregates, Method 2: Basic testing equipment*

AS 4433.1, *Guide to the sampling of particulate materials, Part 1: Sampling procedures* (withdrawn)

AS 4433.6, *Guide to the sampling of particulate materials, Part 6: Inspection of mechanical sampling systems*

Section 3 Terms and definitions

For the purpose of this document, the terms and definitions given in AS 1141.1 and the following apply.

3.1

body of material

material source from which a representative sample is to be obtained

Note 1 to entry: The body of material includes, but is not restricted to, stockpiles, rock piles, banks, rills, rock faces or outcrop.

3.2

competent person

person who has acquired, through education, training, qualification or experience, or a combination of these, the knowledge and skills to perform the task required

3.3

lot

discrete and defined quantity of material produced by a consistent process

Note 1 to entry: The lot is the fundamental division of a body of aggregate for which material properties are determined. A lot consists of a homogeneous product and may be further defined by the length of the production run or by mass.

3.4

may

indicates the existence of an option

3.5

sampling scheme

set of documented instructions that, as a minimum, establishes the following for each sample:

- (a) Material to be sampled and the size of sample required.
- (b) Purpose for obtaining the sample.
- (c) Size and description of the lot(s), if applicable.
- (d) Sampling procedure to be used.
- (e) Sampling location.
- (f) Location of sampling increments for each sample.
- (g) Testing required on the sample collected.
- (h) Details of sample dispatch.

Note 1 to entry: For further information on sampling schemes, see [Appendix C](#).

3.6

section

part of the main body of material, the main body being regarded as divided into sections of about equal volume

3.7

shall

indicates that a statement is mandatory

3.8

should

indicates a recommendation

3.9**stockpile**

heap or stack of material held in stock for future use

3.10**stratified random sampling**

taking of increments whereby the material being sampled is divided into strata, one increment being taken at random within each strata

Note 1 to entry: Refer to AS 1289.1.4.2 and see [Figure C.1](#) of this document for further explanation of stratified random sampling.

3.11**sub-lot**

approximately equal parts of a lot based on intervals of time, mass or space

Note 1 to entry: A sub-lot is a subdivision of the lot which is used in stratified sampling schemes to ensure that samples are reasonably evenly distributed throughout the lot, rather than being concentrated in one area.

3.12**windrow**

linear body of material of triangular cross-section usually formed by blading with a grader

Section 4 Apparatus

4.1 General

Apparatus conforming to the relevant provisions of AS 1141.2 and the following shall be used.

4.2 Necessary apparatus

The following apparatus shall be necessary for one or more of the sampling procedures specified in this document:

- (a) *Sampling containers* — To prevent loss of fines or to minimize the loss of moisture or both.
- (b) *Bag ties, labels and marking pens.*
- (c) *Shovel or suitable scoop* — With sides sufficiently high to avoid loss of material from the sides.
- (d) *Power equipment* — This includes front-end loaders, backhoes and excavators with a minimum bucket capacity of 1 m³.

NOTE Power equipment is required in [Clause 9](#).

4.3 Procedural apparatus

The following apparatus may be required depending on the procedure used and whether samples are divided and weighed in the field:

- (a) Balance or scale to determine the mass of samples.

NOTE 1 The scale or balance used to assess the mass of samples or sample increments need not be calibrated but should be checked with known masses annually.

NOTE 2 Normally, the masses of sample increments or of samples are not checked in the field and containers or bags which have a known capacity are used. Regular checks of the amount of material collected should be made.
- (b) Sample divider (riffle splitter) conforming with the requirements of AS 1141.2.
- (c) Sealable containers.
- (d) A robust rectangular sampling frame for use in sampling from a conveyor belt. The cross-section of the frame shall be sufficient to enclose the full cross-section of material on the belt. The bottom edges of the frame shall fit the troughing of the belt. The frame shall be strong enough to withstand, without damage, being forced through the material on a stationary belt. The frame may be provided with lifting lugs or similar devices to facilitate handling. A type of sampling frame is shown in [Figure 1](#).
- (e) Sampling tube — Two types which may be used are shown in [Figure 2\(a\) and \(b\)](#).
- (f) Face sampling shield or board, as shown in [Figure 3](#).

4.4 Additional apparatus

The following equipment may be used:

- (a) *Mechanical sampler* — A device designed to obtain a representative increment by cutting the flow of material at a plant transfer point or by cutting the full width of material on a conveyor belt in motion. Any such device shall conform to the requirements given in AS 4433.6.
- (b) *Rotary sample divider* — A rotary sample divider comprises a number of sector shaped canisters positioned on a platform, and a feeding device. The uniform material stream flows

to a hopper spout and, by relative rotation of these two components, the flow is intercepted by the top edge of the sector shaped canisters, dividing the sample into representative parts.

- (c) *Laboratory crusher* — Access to a laboratory crusher will be required if laboratory tests of restricted upper size are to be performed on larger sized product.

NOTE 1 As an example, if rail ballast is to be tested for durability such as wet/dry strength variation.

NOTE 2 See [Clause 6.4](#) for a discussion of laboratory crushing.

Section 5 Sampling

5.1 General

All samples shall be taken—

- (a) in accordance with site safety procedures; and
- (b) in accordance with a documented sampling scheme for the site or project as specified in [Clause 3.5](#).

Sampling of aggregates shall be performed by a person competent to complete the procedures of this document, usually without supervision. Such a person shall—

- (i) be competent in the procedures;
- (ii) be able to determine the appropriate procedure that will result in unbiased sample;
- (iii) be able to recognize segregation and contamination in aggregate where it occurs and be able to take appropriate action;
- (iv) understand the basic processes of aggregate production and the application of the aggregate product;
- (v) be aware of sources of contamination during production or at the work site being sampled.

The procedures to be followed are determined by the purpose of sampling. Common purposes include:

- (A) the determination of the average properties of the body being sampled; and
- (B) the determination of the average properties and variation in properties within the body being sampled.

Sampling shall be conducted by means that ensure that the samples represent, as far as practicable, the true nature of the lot or the section of the main body of material from which they were drawn. The procedures in this document are designed to achieve this objective, with emphasis on avoiding segregation of the sampled material due to the effects of the sampling techniques. Samples not taken in accordance with this method are more likely to give non-representative test results.

NOTE Further information on the causes and effects of segregation within bodies of aggregate is given in [Appendix B](#).

The lot of material to be sampled may be aggregates or sand in a stockpile, a bin, a conveyor belt, delivery vehicles or a roadbed or earthworks structure.

The end result of the sampling operation is a quantity of material derived from a sample and upon which testing or examination is carried out. The sample is obtained by combining a number of sample increments taken directly from the lot of material. The masses of samples and sample increments shall be adjusted as necessary to suit the purposes of sampling.

5.2 Common reasons for sampling

5.2.1 General

The procedures in this document specify the common reasons for sampling which is to determine the average properties of a body of material. These procedures specify the appropriate methods of obtaining individual sample increments. However, the locations of sample increments may need to be adjusted according to the purpose of sampling. The principles to be adhered to in making those adjustments are specified below.

5.2.2 Sampling for average properties only

Where it is intended that testing is to provide only a measure of the average value of some property of the material, the sample increments shall be taken at random locations through each section or sub-lot.

5.2.3 Sampling for average properties and variability

Where it is intended that testing is to provide a measure of the average value and variability of some property of the material, the sample increments shall be taken in close proximity within each section or sub-lot. In this case no fewer than five samples (i.e. a total of five sets of five sample increments) shall be taken at random within the main body or lot of material. This procedure should not be used for quantities of less than 250 t of aggregate.

During production of aggregates, single sample increments may be regarded as a sample for testing to provide an indication of production quality, usually as part of an ongoing quality control process.

5.2.4 Sampling for contamination or for a specific property in a limited area of a stockpile

Where it is intended that testing is to provide a measure of some property or contamination in a particular area in the main body of material, that area shall be defined. The total quantity of material at variance to the main body shall be identified. The total quantity of identified material shall be subjected to the appropriate sampling procedure specified in this document. The relevance of this result to the whole body of material or lot shall be evaluated.

5.2.5 Sampling for other purposes

When sampling is conducted for purposes other than those specified in the previous clauses (for example to examine a failure or for research or investigation projects) the reason for the sampling and the details of the sampling procedures to be used shall be specified in the sampling scheme.

NOTE For further information on sampling, see [Appendices A, B and C](#).

Section 6 Samples, increment size, laboratory crushing of samples and sample reduction

6.1 General

Ideally, sample increments should be taken while aggregate is in motion either at a discharge or transfer point or from a moving conveyor, but this practice is dangerous if carried out manually. Sample increments from stopped conveyor belts provide the best alternative to sampling from material in motion. Belt samples are a case where a single sample increment forms the entire sample. The ability to treat a single belt sample of this type as representative of the lot is acceptable when the production process is stable, an entire and full depth sample is taken, and the sample size conforms with the requirements of [Table 2](#).

It is more difficult to obtain fully representative samples from material at rest in stockpiles or trucks. However, adequate samples should be obtained from aggregate in these situations if the instructions of the relevant clauses of this document are conformed to.

Any material that has fallen back into the sampling area after the initial increment has been removed shall not be included in the sample increment. Where it is required that the moisture content is to be determined, special precautions shall be taken to ensure that no loss of moisture occurs during sampling and storage. Sample increments shall be collected as quickly as possible. Increments shall be stored in a sealed container until preparation of the samples.

When obtaining sample increments from pads constructed by power equipment (see [Clauses 8.2, 9.1](#) and [9.3](#)) or from the top of trimmed stockpiles, the following requirements shall be met:

- (a) All sampling locations shall be more than 200 mm from the edge of the pad or the edge of the stockpile.
- (b) Sampling locations shall avoid any areas of obvious segregation caused by the operation of the power equipment.
- (c) If the material in the pad appears homogeneous, material shall be removed to sufficient depth that a sample increment is obtained and conforms with the requirements of [Table 1](#).
- (d) If the material in the pad or stockpile is not homogeneous, then either the material shall be re-blended prior to any sampling, or the number of sample increments be increased to obtain a representative sample.
- (e) Material shall be removed from the pad using a suitable shovel, see [Clause 4.2\(c\)](#). All material removed shall be retained as the sample increment.
- (f) All sample increments that are intended to be combined to form the sample shall be of approximately equal mass or volume.

NOTE 1 This requirement is to avoid biasing testing results towards the material characteristics of the largest sample increment.

NOTE 2 Sample increments can be maintained at approximately equal size by either determining the mass of the increment in the field or by filling standard sized containers to a marked filling point so that each increment is of approximately equal volume. Any practical field method that can be demonstrated to return sample increments of approximately the same mass or volume will satisfy this requirement.

- (g) All material recovered from all sample increment locations shall be combined and blended before any reduction or splitting occurs. The sample provided at the end of these processes shall conform with the requirements of [Table 2](#).

Where it is necessary to retain moisture in the sample, sample increment mixing and division of a sample shall be carried out under cover so as to minimize moisture loss. Immediately on completion of

sample division, the respective samples shall be placed in sealed containers. The container shall be of a size which ensures that when filled, the free air space is at a minimum.

NOTE The moisture content of the sample can be maintained for several days using sealed containers with minimum free air space.

6.2 Sample increment size

The amount of material taken in each sample increment shall be in accordance with the nominal size of aggregate being sampled and be no less than the relevant mass given in [Table 1](#). The size of samples listed in [Table 1](#) are based on normal weight aggregate (particle density 2 100 to 3 200 kg/m³), so for heavy weight (>3 200 kg/m³) aggregates the mass of sample should be increased to obtain sufficient material for the intended tests.

When a single sample increment is used to indicate production quality, the mass of the sample increment shall be in accordance with [Table 2](#).

Table 1 — Minimum mass per sample increment

Nominal size, mm	75	40	28	20	14	10	7	5	< 5
Mass, kg	10	6	5	4	3	2	2	1	1

Table 2 — Minimum mass per sample

Nominal size, mm	75	40	28	20	14	10	7	5	< 5
Mass, kg	50	30	25	20	15	10	10	5	5

6.3 Sample size and composition

Samples shall consist of at least five sample increments of approximately equal mass, [see [Clause 6.1\(e\)](#)] except as provided in [Clauses 5.2.3](#), [6.2](#) and [10.1](#). The amount of material obtained for each sample shall be in accordance with the nominal size of the aggregate being sampled. This sample shall be not less than the relevant mass given in [Table 2](#). Additional material may be required, depending upon the type and number of tests to be performed.

All sample increments shall be combined and mixed thoroughly to form a homogeneous sample prior to any reduction, dividing, or screening of the sample.

NOTE It may be necessary to place the combined sample into a number of containers to facilitate safe handling. If the sample is in multiple containers, each container should be numbered together with an indication of the total number of containers used for the sample, e.g. Container 1 of 5.

If test portions are required for particular tests, they shall be obtained by dividing the sample. The quantity required for each test is specified in the appropriate test method. Material not altered in any way in a test may be re-used for other tests.

In cases where only a fraction of the material is required for testing, e.g. for wet/dry strength variation, the sample may be screened in the field to remove the coarse or fine fraction of aggregate, as required. Any field screening of the sample shall be recorded together with the size of the screen used.

6.4 Laboratory crushing

Samples produced from the procedures specified in this document are typically taken from:

- (a) plant production of crushed aggregates, either directly from the plant or from stockpile; or
- (b) plant production of crushed aggregate from construction sites.

Some test methods defined in the AS 1141 series allow the laboratory crushing of sample oversize with the crushed material, then added back into the sample. Other methods are limited in the maximum particle size that can be tested and, in these cases, large product may be crushed to conduct a test, for example, when crushing gabion material to conduct a durability test.

The relationship of test results from laboratory crushed material to the test results of the same material crushed in a production plant is complex. Among many other factors, laboratory crushing of material will inevitably produce material of differing shapes to that produced from a production plant. Plant production will crush materials of differing strength into differing size fractions. Both these factors cause variation between results obtained from plant produced aggregate to results from laboratory crushed material from the same source.

The procedure for laboratory crushing is as follows:

- (a) Samples taken for testing of dimensional properties (particle size distribution or any shape test) shall be traceable to the production process.
- (b) Other than drying or reduction in mass, samples for dimensional properties shall not be altered by any laboratory process.
- (c) Wherever possible, laboratory crushed oversize should not be combined with production crushed material, unless required by the test method. However, where tests are conducted on samples of crushed oversize or samples containing a portion of laboratory crushed material, this fact shall be recorded and reported.
- (d) When testing large product sizes, methods that are size limited should be conducted on samples that are either:
 - (i) fully laboratory crushed (refer to AS 1141.3.2); or
 - (ii) fully plant produced material of appropriate size from the same source material.

Test reports shall state whether the sample is laboratory crushed or plant produced.

6.5 Sample reduction

6.5.1 General

Where there is a requirement to reduce the amount of material in the sample, the procedures given in the following clauses shall be followed, until the required mass given in [Table 2](#) is obtained.

NOTE When excessive dust is produced during sample reduction adequate steps should be introduced to control the loss of fines.

6.5.2 Reduction by sample divider

The procedure for reducing the aggregate sample using a sample divider (riffle splitter) shall be as follows:

- (a) The sample shall be thoroughly mixed.
- (b) Material being placed in the sample divider shall be distributed evenly along the full length of the divider.
- (c) The sample shall be passed through the sample divider.
- (d) One part of the sample shall be discarded.
- (e) The other part shall be retained and divided again until the correct test portion mass is obtained.