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Aggregates for concrete — Test methods for mechanical and physical properties —

Part 3: Determination of aggregate crushing value (*ACV*)

Granulats pour béton — Méthodes d'essai relatives aux propriétés mécaniques et physiques —

Partie 3: Partie 3: Détermination de la valeur de concassage des granulats (ACV)

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Foreword

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This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 1, *Test methods for concrete*.

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A list of all parts in the ISO 20290 series can be found on the ISO website.

Aggregates for concrete — Test methods for mechanical and physical properties —

Part 3: Determination of aggregate crushing value (ACV)

1 Scope

This document gives the determination of aggregate crushing value (*ACV*) of aggregates. This gives a relative measure of the resistance of the aggregate crushing under the gradually applied compressive load.

The method is applicable to aggregates passing a 14,0 mm test sieve and retained on a 10,0 mm test sieve. For other size fractions, a recommended method is described in Annex A. The aggregate size fraction taken for this test can also be as per the relevant national standards.

NOTE Minor variations in grading divisions can be allowed in respective national standards.

The method is not suitable for testing aggregates with an aggregate crushing value higher than 30. In such cases, the method described in ISO 20290-4 is applicable.

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. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
aggregate crushing value
ACV
percentage to the first decimal place, of the mass of fines formed to the total mass of the test specimen

4 Principle

A test sample of aggregates is compacted in a specified manner into a steel cylinder fitted with a freely moving plunger. The sample is then subjected to a standard loading regime applied through the plunger. This action crushes the aggregate to a degree which is dependent on the crushing resistance of the material, which is assessed by a sieving test on the crushed specimen and is taken as a measure of the *ACV*.

5 Sampling

The sample used for the test (the laboratory sample) shall be as per Clause 7.

NOTE National standards can also exist regarding the sampling.

6 Apparatus

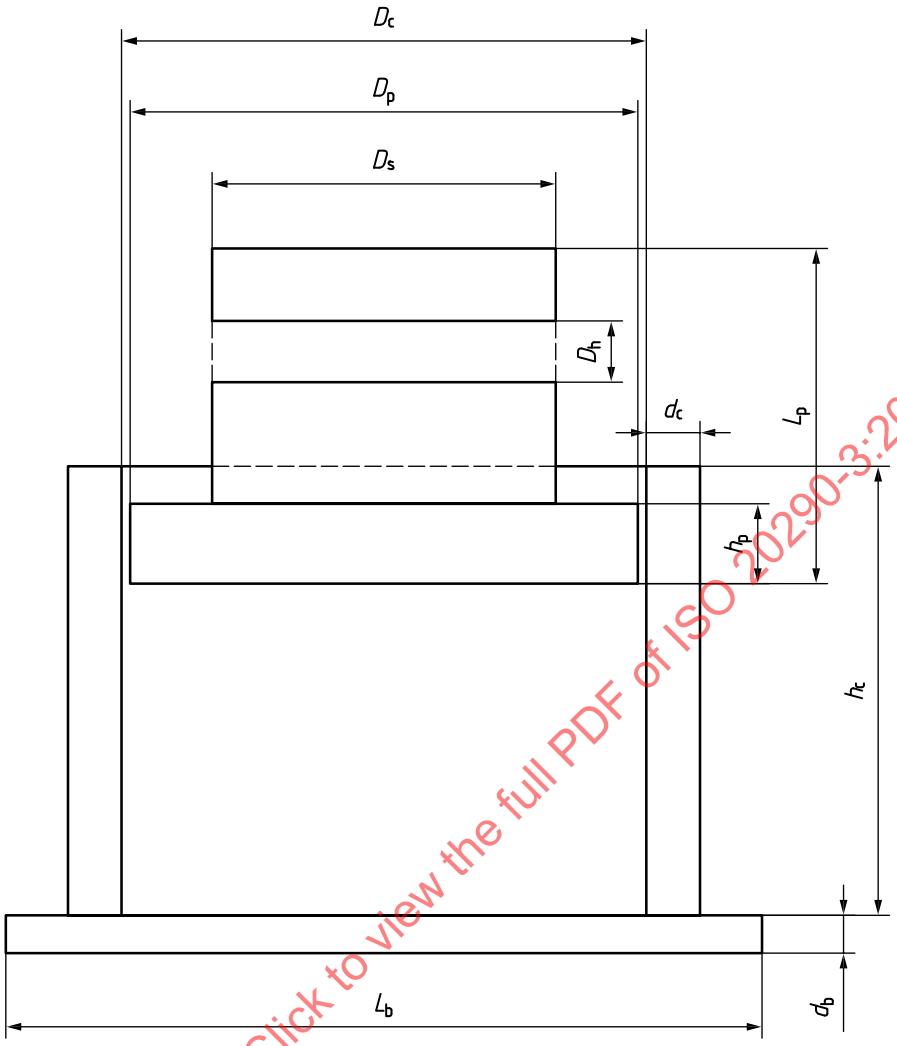
6.1 Compression testing machine, capable of applying any force up to 500 kN and which can be operated to give a uniform rate of loading so that the required force (400 kN) is reached in 10 min (see 8.2).

NOTE National standards can also exist regarding the requirements of the compression testing machine.

6.2 Steel cylinder and plunger, with an open-ended steel cylinder of nominal 150 mm internal diameter and with plunger and base plate as per Figure 1 and Table 1.

Table 1 — Principal dimensions of cylinder and plunger apparatus

Component	Dimensions (see Figure 1)	Nominal 150 mm internal dimeter of cylinder mm	Nominal 75 mm internal diameter of cylinder (see Annex A) mm
Cylinder	Internal diameter, D_c	154 ± 0,5	78,0 ± 0,5
	Internal depth, h_c	125 to 140	70,0 to 85,0
	Minimum wall thickness, d_c	16,0	8,0
Plunger	Diameter of piston, D_p	152 ± 0,5	76,0 ± 0,5
	Diameter of stem, D_s	>95 to ≤D_p	>45 to ≤D_p
	Overall length of piston plus stem, L_p	100 to 115	60,0 to 80,0
	Minimum depth of piston, h_p	not less than 25,0	not less than 19,0
	Diameter of hole, D_h	20,0 ± 0,1	10,0 ± 0,1
Baseplate	Minimum thickness, d_b	10	10
	Length of each side of square, L_b	200 to 230	110 to 115



NOTE See Table 1.

Figure 1 — Outline form of cylinder and plunger for aggregate crushing value test.

The surfaces in contact with the aggregate shall be machined and maintained in a smooth condition and preferably case hardened.

6.3 Tamping rod, made out of straight iron or steel bar of circular cross-section, diameter of (16 ± 1) mm and (600 ± 5) mm long, with both end semi-spherical.

6.4 Balance, of at least 3 kg capacity, readable to 1 g.

6.5 Cylindrical metal measure, for measuring the sample, of sufficient rigidity to retain its form under rough usage and having an internal diameter of (115 ± 1) mm and an internal depth of (180 ± 1) mm.

6.6 Test sieves, with square-hole perforated plate of sizes 14,0 mm and 10,0 mm and a woven wire 2,36 mm test sieve. The test sieves shall comply with ISO 565 or relevant national standards.

6.7 Well-ventilated oven, thermostatically controlled at a temperature of (105 ± 5) °C.

6.8 Metal tray, of known mass large enough to contain 3 kg of aggregate.

6.9 Rubber mallet, of suitable handle and minimum weight of 400 g.

6.10 Brush, with stiff bristles.

NOTE Minor variations in apparatus' ranges/dimensions can be allowed in respective national standards.

7 Preparation of test portions and specimens

7.1 Test portions

Reduce the laboratory sample to produce a test portion of sufficient mass to produce three test specimens of 14 mm to 10 mm size fraction.

NOTE A single test specimen is that quantity of material required to fill the cylinder (see 8.1 and Table 2).

Table 2 — Guide to minimum mass of test portions required to obtain a suitable mass of material to determine the ten percent fines value

Grading of the aggregate mm	Minimum mass of the test portion[a] kg
All-in aggregate 40 max. size	60
All-in aggregate 20 max. size	45
Graded aggregate 40 to 5	40
Graded aggregate 20 to 5	25
Graded aggregate 14 to 5	15

[a] For normal density aggregates.

NOTE In case of single size aggregates being supplied for the test, the minimum mass of the test portion can vary accordingly.

7.2 Preparation of test specimens

7.2.1 Thoroughly sieve the entire surface dry test portion on the 14 mm and 10 mm test sieves to remove the oversize and undersize fractions. Divide the resulting 14 mm to 10 mm fraction to produce three test specimens each of mass such that the depth of the material in the cylinder is approximately 100 mm after tamping as described in 7.1 (see Note).

NOTE The appropriate quantity of aggregate can be found conveniently by filling the cylindrical measure in three layers of approximately equal depth. Tamp each layer 25 times, from a height of approximately 50 mm above the surface of the aggregate, with the rounded end of the tamping rod. Level off using the tamping rod as a straight edge.

7.2.2 Dry the test specimens by heating at a temperature of (105 ± 5) °C for a period of not more than 4 h. Cool to room temperature before testing. For temperature-sensitive recycled aggregates, a drying temperature of (40 ± 5) °C shall be used. Record the mass of material comprising the test specimens before testing.

8 Procedure

8.1 Place the cylinder of the test apparatus in position on the baseplate and add the test specimen in three layers, each layer being subjected to 25 strokes of the tamping rod distributed evenly over the surface of the layer and dropping from a height approximately 50 mm above the surface of the aggregate.

Carefully level the surface of the aggregate and insert the plunger so that it rests horizontally on this surface. Take care to ensure that the plunger does not jam in the cylinder.

8.2 Place the apparatus, with the test specimen prepared as described in 7.2 and plunger in position, between the platens of the compression testing machine and load it at as uniform a rate as possible (see Note) so that the required force of 400 kN is reached in 10 min ± 30 s.

When, during the early stages of the test, there is a significant deformation, it may not be possible to maintain the required loading rate and variations in the loading rate can occur especially at the beginning of the test. These variations should be kept to a minimum with the principal object of completing the test in the overall time of 10 min ± 30 s.

8.3 Record the maximum force, F_{max}, applied to produce the required penetration. Release the force and remove the crushed material by holding the cylinder over a clean tray of known mass and hammering on the outside of the cylinder with the rubber mallet until the particles are sufficiently disturbed to enable the mass of the specimen to fall freely on to the tray.

If this fails to remove the compacted aggregate other methods should be used but take care not to cause further crushing of the particles.

Transfer any particles adhering to the inside of the cylinder, the baseplate and the underside of the plunger to the tray by means of a stiff bristle brush.

Weigh the tray and the aggregate and record the mass of aggregate used, M_1, to the nearest gram.

8.4 Sieve the whole of the specimen in the tray on the 2,36 mm test sieve until no further significant amount passes during a further period of 1 min. Weigh and record the masses of the fractions passing and retained on the sieve to the nearest gram, M_2 plus M_3 respectively. If the total mass, M_2 plus M_3, differs from the initial mass, M_1, by more than 10 g, discard the result and repeat the complete procedure using a new test specimen.

NOTE 1 In all the procedures described in 8.3 and 8.4, take care to avoid loss of fines and overloading the sieves.

NOTE 2 Mechanical sieving can be avoided for aggregates which degrade under its action.

8.5 Repeat the complete test procedure with the same mass of aggregate at the same force that gave a percentage fines value within the range 7,5 % to 12,5 %.

9 Calculation and expression of results

9.1 Calculate the aggregate crushing value, *ACV*, expressed as a percentage to the first decimal place, of the mass of fines formed to the total mass of the test specimen from Formula (1):

$$ACV = \frac{M_2}{M_1} \times 100 \quad (1)$$

where

M_1 is the mass of the test specimen, in g;

M_2 is the mass of the material passing the 2,36 mm test sieve, in g.

9.2 Calculate the mean of the two results to the nearest whole number. Report the mean as the aggregate crushing value, unless the individual results differ by more than 0,07 times the mean value. In this case repeat the test on two further specimens, calculate the median of the four results to the nearest whole number, and report the median as the aggregate crushing value.

NOTE The median of four results is calculated by excluding the highest and the lowest result and calculating the mean of the two middle results.

10 Test report

The report shall affirm that the aggregate crushing value was determined in accordance with document and state whether or not a certificate of sampling is available. If available, a copy of the certificate of sampling shall be provided. The test report shall contain the following additional information:

a) sample identification and sample description;

b) the aggregate crushing value (*ACV*);

In addition, any variation in the test procedure to meet the requirements of national standards may be reported.

Annex A
(informative)

Recommended method for determining the aggregate crushing value for other size fractions of aggregate

A.1 General

A.1.1 When required, or if the definitive size fraction passing the 14 mm test sieve and retained on a 10 mm test sieve is not available, tests may be made on aggregates of other sizes larger than the definitive size, up to a size which passes a 28,0 mm test sieve, using the apparatus in Clause 6. Alternatively, tests may be made on aggregates smaller than the definitive size down to a size which is retained on a 2,36 mm test sieve, using either the same apparatus or that described in A.2 which is referred to as the smaller apparatus.

A.1.2 Owing to the non-homogeneity of aggregates, the results of tests on non-definitive size fractions are not likely to be the same as those obtained from standard tests. In general, the smaller sizes of aggregate give a lower aggregate crushing value and the larger sizes a higher value, and the relationship between the values obtained varies from one aggregate to another. However, the results obtained with the smaller apparatus have been found to be slightly higher than those with the standard apparatus and the errors for the smaller sizes of aggregate tested in the smaller apparatus are therefore compensatory.

A.2 Apparatus

A.2.1 General

The apparatus is as described in Clause 6, or for testing aggregate smaller than 10 mm in particle size, as described in A.2.2 to A.2.7.

A.2.2 A steel cylinder, open-ended with plunger and base plate, generally as described in 6.2, with a nominal internal diameter of 75 mm. The general form of dimensions of the cylinder and of the plunger are shown in Figure 1 and given in Table 1.

A.2.3 A tamping rod, made out of straight steel of circular cross-section, diameter of 8 mm and 300 mm long. One end shall be rounded.

A.2.4 A balance, of at least 500 g capacity readable to 0,2 g.