

Australian Standard®

Methods for sampling and testing aggregates**Method 22: Wet/dry strength variation**

This Standard incorporates Amendment No. 1 (April 2016). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

1 SCOPE

This Standard sets out the method for determining the variation in strength of aggregate tested in both the oven dry and saturated surface dry condition.

A1 | NOTE: This test may be performed on a range of size fractions, and on crushed spalls or crushed drill core.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1141 Methods for sampling and testing aggregates

1141.1 Method 1: Definitions

1141.2 Method 2: Basic testing equipment

1152 Specification for test sieves

2193 Calibration and classification of force-measuring systems

ISO

3310 Test sieves—Technical requirements and testing

3310-1 Part 1: Test sieves of metal wire cloth

3310-2 Part 2: Test sieves of perforated metal plate

3 DEFINITION

For the purpose of this Standard, the definitions in AS 1141.1 and the one below apply.

3.1 Strength

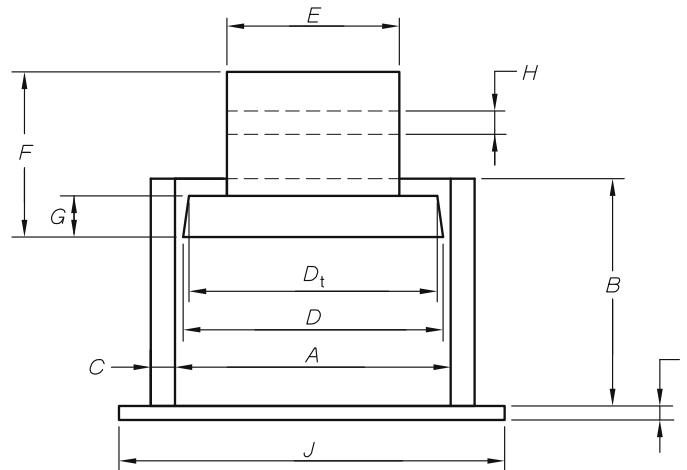
The crushing force which, when applied to a known mass of coarse aggregate, will produce fines amounting to 10 percent of the dry mass of a test portion.

4 APPARATUS

The following apparatus, complying with the relevant provisions of AS 1141.2, shall be required:

(a) *Absorbent cloth or towelling.*

- (b) *Balance* Balances of adequate capacity, with a limit of performance not exceeding ± 5 g for mass determinations greater than 2 kg and ± 0.5 g for mass determinations 2 kg or less.
- (c) *Container* A non-perforated container of sufficient size to contain the test portion during soaking.
- (d) *Cylinder* An open-ended steel cylinder with a tapered plunger and baseplate. The form and dimensions of two sizes of cylinder, plunger and baseplate are given in Figure 1. The surface in contact with the aggregate shall be machined to a reasonably smooth finish and shall have a surface hardness of not less than Rockwell C50.
- (e) *Desiccator* Or sealed containers with a desiccant for storing dry test portions.
- (f) *Dishes* Appropriately sized metal dishes or trays for test portions.
- (g) *Mallet* Rubber mallet with face about 70 mm diameter, mass between 700 g and 1200 g and handle length about 300 mm.
- (h) *Measure* A cylindrical metal measure of sufficient rigidity to retain its form under rough usage. The standard measure shall have an internal diameter of 115 ± 5 mm diameter and an internal height of 180 ± 5 mm. The small measure shall have an internal diameter of 60 ± 3 mm and an internal height of 90 ± 3 mm.
- (i) *Oven* Thermostatically controlled oven with good air circulation, capable of maintaining a temperature within the range of 105°C to 110°C .
- (j) *Sieves* 26.5 mm, 19.0 mm, 13.2 mm, 9.50 mm, 6.70 mm, 4.75 mm (perforated plate), 3.35 mm, 2.36 mm, 1.70 mm, 1.18 mm, 850 μm and 600 μm (wire cloth) sieves as required, complying with AS 1152 or ISO 3310.
- (k) *Straightedge* About 300 mm in length.
- (l) *Testing machine* Compression testing machine that can be loaded to apply a force having a range of at least 500 kN at a uniform rate of application. All testing machines shall comply with the Grade A requirements of AS 2193.



Identification	Dimension for	Cylinder size	
		75	150
	CYLINDER		
A	Internal diameter	75 ±0.2	150 ±0.2
B	Internal depth	75 to 80	130 to 140
C	Wall thickness (minimum)	8	15
	PLUNGER		
D	Diameter of piston—Bottom	74 ±0.2	148 ±0.2
D _t	Diameter of piston—Top	72 ±0.5	146 ±0.5
E	Diameter of stem	50 to 60	120 to 140
F	Overall length of piston plus stem	70 to 75	110 to 120
G	Depth of piston (minimum)	20	30
H	Diameter (nominal) of hole	10	20
	BASEPLATE		
I	Thickness (nominal)	7.5	7.5
J	Diameter	110 to 120	210 to 230

- A1 NOTE: When using the 75 mm diameter mould, the force applied to the specimen is approximately one quarter the force applied to a specimen in the 150 mm diameter mould. For comparison purposes, the wet and dry strength recorded when using the 75 mm mould could be multiplied by a factor of 4. Experience has shown that the wet to dry ratio is not affected by the diameter of the mould.

DIMENSIONS IN MILLIMETRES

FIGURE 1 CYLINDER DIMENSIONS

5 PREPARATION OF TEST PORTIONS

The test portions shall be prepared as follows:

- (a) Obtain a sample of material large enough to yield the amount of aggregate of required size, as specified in Table 1.

- (b) Prepare this material as follows:
- (i) Choose appropriate 'retaining', 'passing' and 'separating' sieves (refer to Table 1).
 - (ii) Separate the required fraction by sieving. The oversize material may be crushed to the required size fraction. Discard the material retained on the 'passing' sieve and that passing the 'retaining' sieve (see Note 1). If sufficient material of the size fraction is not obtained, refer to Note 2.
 - (iii) Wash (with water) the selected fraction on the 'retaining' sieve (refer to Table 1, Column 2) to remove adhering fines. Do not agitate the material any more than would be achieved by hand sieving. If necessary, soak the material for up to 2 h to assist in the removal of fines.
 - (iv) Record any breakdown that occurs during washing and soaking.
 - (v) Dry to constant mass in the oven.
 - (vi) Sieve over the 'retaining' sieve and discard the dust or fines passing that sieve.
- (c) Determine the mass for each test portion as follows:
- (i) Slowly fill the measure (see Note 3) to approximately one-third capacity, pouring the aggregate from about 100 mm above the measure. Settle the aggregate by tapping the measure with 25 strokes of the mallet evenly distributed around the measure, sufficient to ensure that a settling effect takes place, but not so firm as to dislodge the aggregate.

Repeat this procedure for two further layers of aggregate. Following the settling of the last layer, top up the measure if necessary. Gently level the aggregate with the top of the measure using the straightedge. Alternatively, surface particles may be arranged manually so that none protrude above the top of the mould. In either case take care to avoid compacting or loosening the aggregate any further.
 - (ii) Determine the mass of aggregate in the measure and record as m_A .
 - (iii) The aggregate used in Steps (c)(i) and (c)(ii) to determine m_A may be used as a test portion if no significant breakdown has occurred during tapping. This can be determined by separating the aggregate on the retaining sieve. If more than 0.2% passes the retaining sieve, note this fact and discard the material from the measure.
- (d) Obtain at least five test portions of aggregate of mass m_A as determined in Step (c). Where there is no significant breakdown during the preparation, obtain the portions by quartering or riffing. Where there is significant breakdown, obtain the portions by quartering only.

At least two of the portions are used in Clause 6.2 and at least two are used in Clause 6.3. More portions may be required under some circumstances (for example, when testing aggregates of unknown properties).
- (e) Place all portions in sealed and labelled containers and store until ready for testing. Store all remaining material in a sealed and labelled container in case additional portions are needed (see Note 4 and Clauses 7.3 and 7.4).

NOTES:

- 1 Provision is made for testing of all aggregate sizes in the range 26.5 to 2.36 mm. Larger sizes are tested after crushing to required fraction. Crushing may alter the strength characteristics of the test portion compared to those of the original sample.

- 2 Where sufficient mass of a given size fraction is not available, it is preferable to obtain a new sample. If this is not possible consideration may be given to the following:
 - (a) Combining the size fraction with the next larger or smaller size fraction. The fines are separated on the sieve appropriate to the smaller size fraction. No more than two fractions may be combined in this way. (This provision does not apply to the -19.0 mm, $+9.5$ mm fraction, which is already a combined fraction.)
 - (b) Crushing material from a larger size fraction to make up the difference.

These procedures should not significantly affect the results obtained with aggregates of uniform quality. They should not be used with blended aggregates or aggregates derived from inherently variable sources.

The details of any crushing or combining operations are to be included in the test report.
- 3 Fractions less than 4.75 mm may be tested using the small apparatus (see Table 1). For a given aggregate the force required will be decreased by a factor of about 4 when changing from the larger apparatus to the smaller apparatus.
- 4 Particular care is required to maintain the moisture state of the samples. Some aggregates are known to absorb atmospheric moisture, which may affect the load required to produce 10% of fines (see also Note to Clause 6.2(a)).

6 PROCEDURE

6.1 Load selection and loading rate

The test is performed by applying a predetermined force to the test portion, at a uniform rate of loading, and determining the percentage of fines produced (see Clauses 6.2 and 6.3).

The force to be applied is normally estimated from past experience with the aggregate concerned. Where this is not possible, typical values given in Table 2 may be used as a guide.

The force shall be applied at a uniform rate over 10 min. While small fluctuations in the indicated force may occur due to progressive stone breakage, particularly in the early part of the test, the loading rate shall conform to the following requirements:

- (a) The indicated force after n minutes shall be $(f \times n)/10$, where f is the total force to be applied.
- (b) The maximum deviation from the force calculated in Item (a), after each minute, shall be $f/100$ or 2 kN, whichever is the larger. Both the applied force and allowable deviation are calculated to the nearest kilonewton.

6.2 Dry condition

At least two test portions shall be tested in accordance with the following procedure:

- (a) Prior to commencement of the test ensure that the material is dry.
 NOTE: This may require re-drying the material to constant mass in the oven unless the material prepared in Clause 5 has been stored in a desiccator or sealed containers containing desiccant.
- (b) Place the test portion in the cylinder, which has been positioned on the baseplate. Add the test portion using the procedure described in Clause 5(c)(i). Carefully level the surface of the aggregate and insert the plunger so that it rests horizontally on the aggregate surface, taking care to ensure that the plunger does not jam in the cylinder (see Note). Remove any lifting handles from the plunger.

NOTE: The cylinder should remain level during the test procedure. The gap between the cylinder wall and the plunger is small, so that even a small amount of tilt will result in the plunger coming into contact with the cylinder. Resulting frictional effects may give an anomalous load result. Ensure that the cylinder is well centred on the baseplate. If necessary, use a feeler gauge or similar device to ensure that the plunger is centred and clear of the cylinder wall.

Particular care is needed when using machines with spherical seatings, as the head may rotate during the test, bringing the plunger into contact with the cylinder wall. Where possible, spherical seatings should be locked.

- (c) Place the assembled cylinder, baseplate, test portion and plunger in position between the platens of the compression testing machine (see Note to Step (b)). Apply force at a uniform rate, in accordance with Clause 6.1(b).
- (d) At the end of 10 min, record the maximum force applied to the nearest kilonewton.
- (e) Extract the whole of the test portion from the cylinder by hitting the outside of the cylinder while holding it over a metal dish. Avoid using implements when loosening the aggregate, which will cause further breakage of individual particles.

Place the test portion in the metal dish, taking care to avoid loss of fines.

- (f) Separate the fines from the test portion on the appropriate separating sieve as specified in Table 1, Column 8, using mechanical or hand sieving, until not more than 0.2% by mass of the test portion passes the sieve after a further 1 min of continuous hand sieving. Weigh the mass retained (m_B). Calculate the percentage loss of fines from the following equation:

$$\frac{(m_A - m_B) \times 100}{m_A} \quad \dots 6.1$$

- (g) The percentage of fines shall fall within the range 7.5% to 12.5%. If it does not, take a new test portion and carry out a further test, adjusting the force applied in 10 min to bring the percentage of fines within the range of 7.5% to 12.5%. For the purpose of making this adjustment, the force required to produce 10% fines may be estimated using the following equation:

$$f = \frac{14x}{(4 + y)} \quad \dots 6.2$$

where

f = required force, in kilonewtons

x = force applied in the completed test, in kilonewtons

y = percentage of fines produced in the test (see Note)

NOTE: Equation 6.2 is derived from an average relationship for a wide variety of materials. It may differ significantly from the actual relationship applying to a given sample, but is sufficiently accurate to make a reasonable selection of the next load to be used. It must not be used to calculate the reported wet or dry strength, which has to be obtained by the interpolation procedure.

- (h) Repeat the test with another test portion at a maximum force which will give a percentage fines value within the range of 7.5% to 12.5%. If the value of the first test falls between 7.5% and 10% select a force to provide a result between 10% and 12.5% and vice versa.

6.3 Saturated-surface-dry condition

The test shall be carried out on at least two portions in accordance with the following procedure:

- (a) Immerse the test portion in potable water in the container (Clause 4(c)) at room temperature for a minimum of 24 h and a maximum of 72 h, with a cover of at least 50 mm of water above the top of the aggregate. Do not use meshed or perforated containers to soak the test portion.