Australian Standard®

Methods of testing concrete

Method 3.5: Determination of properties related to the consistency of concrete—Slump flow, T_{500} and J-ring test

AS 1012.3.5:2015

1 SCOPE

This Standard sets out the method for determining the slump flow of self compacting concrete (SCC) with a measurable diameter of spread of the flowing concrete in excess of 500 mm when the nominal size of aggregate does not exceed 20 mm. The Standard also sets out the method of determining the time it takes for the slumping and flowing SCC to reach a diameter of 500 mm (T_{500} time). It sets out the measurement of the J-ring passing ability and the assessment of the stability and resistance to segregation of SCC.

NOTE: This Standard may involve hazardous materials, operations, and equipment. This Standard does not purport to address all of the safety problems 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

The following documents are referred to in this Standard:

AS
1012 Methods of testing concrete
1012.1 Method 1: Sampling of concrete
1012.2 Method 2: Preparing concrete mixes in the laboratory

3 DEFINITIONS

For the purpose of this Standard the definitions below apply.

3.1 J-ring passing ability

The passing ability of SCC.

3.2 Self compacting concrete (SCC)

Concrete that is able to flow and consolidate under its own weight, completely fill the formwork or bore hole even in the presence of dense reinforcement, whilst maintaining homogeneity and without the need for additional compaction. SCC is also known as ‘self-consolidating concrete’ and ‘super-workable concrete’.

3.3 Slump flow

The horizontal flow of the concrete that occurs, when the slump cone is lifted.

3.4 T_{500} time

The time (in seconds) that it takes for the outer edge of the flowing concrete to reach an average diameter of 500 mm.

4 PRINCIPLE

A slump cone is filled with fresh SCC then the support given to the concrete by the slump cone is removed by raising the slump cone vertically upwards away from the concrete.

J-ring passing ability is measured by flow through tight openings such as the spaces between various configurations of vertical steel reinforcement formed by a J-ring assembly as prescribed in this Standard, without segregation or blocking.

NOTE: The slump-flow, T_{500} time and J-ring passing ability are tests that assess the flowability, the flow rate and passing ability of SCC. The result is an indication of the filling ability, resistance to segregation and/or susceptibility to blockage of SCC. The T_{500} time is also a measure of the speed of flow and hence the viscosity (cohesion) of the SCC.

5 APPARATUS

5.1 Mould

The slump cone mould shall be a hollow frustum of a cone made of non-reactive rigid material at least 1.5 mm thick which will hold its shape under the weighted collar, if used, and the internal surface shall be smooth. The bottom and the top of the slump cone shall be open and at right-angles to the axis of the cone. The slump cone shall be provided with a means of holding in place during filling and lifting the slump cone when filled. The internal dimensions of the slump cone shall be as follows:

(a) Bottom diameter (see Figure 2).....200 ±5 mm.

(b) Top diameter .....100 ±5 mm.

(c) Vertical height.....300 ±5 mm.

NOTES:

1 A suitable slump cone is illustrated in Figures 1 to 3.

2 Attachments to the slump cone preferably should be welded. If rivets are used in the construction of the slump cone, they have to be countersunk flush on the inside of the cone.

3 To facilitate holding of the slump cone in place during filling it is possible to place an additional mass onto the slump cone above the handles provided that the mass is sufficient to not allow the concrete to escape from the slump cone during filling and does not interfere with filling the slump cone or lifting operations.

5.2 Rod

The rod used for striking off concrete from the top of the slump cone shall be a metal rod of 16 ±1 mm in diameter, approximately 600 mm long and having at least one end tapered for a distance of approximately 25 mm to a spherical shape having a radius of approximately 5 mm.

5.3 Scoop

The scoop shall be made from non-absorbent material not readily attacked by cement paste of capacity not less than 1 L and suitable for taking increments of the concrete.

5.4 Base plate

The base plate shall be a non-reactive rigid flat plate with smooth, non-absorbent surface, at least 100 mm greater in diameter than the maximum slump flow expected, marked with a circle of 200 mm diameter indicating the central location of the slump cone, and a further concentric circle of 500 mm diameter (see Figures 2, 3 and 4). The base plate shall be constructed in a manner that prevents distortion and does not have a deviation from flatness exceeding 3 mm at any point when a straight edge is placed between the centres of opposing sides.

NOTE: A suitable base plate should be at least 900 mm × 900 mm on which concrete can be placed (see Figures 2, 3 and 4).

5.5 Ruler

A 1 m steel ruler or measuring tape capable of measuring to 1 mm accuracy.

NOTE: A 300 mm ruler capable of measuring to the nearest 1 mm accuracy is suitable for measurements for the J-ring passing ability tests.

5.6 Stopwatch

An appropriate stopwatch capable of recording time to 0.1 second.

5.7 J-ring assembly

A ring assembly capable of rigidly fixing standard steel reinforcement vertical in a 300 mm diameter circle, at standard intervals (see Figure 3). Standard steel reinforcement at least 100 mm in length and spacing intervals based on the SCC ranking required, as follows:

(a) Rank 1—18 × 12 mm reinforcement at 40 ±2 mm spacing.

(b) Rank 2—15 × 12 mm reinforcement at 50 ±2 mm spacing.

(c) Rank 3—12 × 12 mm reinforcement at 66 ±2 mm spacing.

NOTE: The choice of SCC ranking required is influenced by the spacing of the steel bars and the density or congestion of the steel reinforcement in the concrete member.

5.8 Weighted collar

Weighted collar (optional), having a mass of at least 9 kg, to fit slump cone [see Figure 3(b)].

NOTE: The weighted collar allows the test to be carried out by one person.

5.9 Spirit level

Suitable to check that the base plate is level.

5.10 Buckets and funnel (collar)

To obtain, remix and pour the concrete into the mould.

6 SAMPLING

6.1 Field sampling

For concrete sampled in the field, the test sample shall be obtained in accordance with the requirements of AS 1012.1.

6.2 Laboratory sampling

For concrete made in the laboratory, the test sample shall be prepared in accordance with AS 1012.2.

7 PROCEDURE

The procedure shall be as follows:

(a) For concrete sampled in the field and in the laboratory commence the test immediately following the completion of mixing the test sample.

(b) Remix samples of concrete prior to testing by transferring from initial sub-sample buckets into other buckets of equivalent size to ensure a homogenous sample.

(c) Ensure that the internal surface of the slump cone is clean and free from set concrete.

(d) Moisten the internal surfaces of the sample bucket, funnel and slump cone and the base plate by wiping with a damp cloth immediately before commencing each test.

(e) If required, place the specified J-ring assembly in the centre of the 200 mm diameter circle marked on the base plate.

(f) Place the slump cone carefully on a stable and levelled base plate, which is free from vibration or shock. Hold the slump cone firmly in place. Position the slump cone with the larger opening coincident with the 200 mm circle on the base plate (see Figure 2). Maintain the slump cone in position while it is being filled, ensuring that no concrete can leak from under the cone (see Figure 3).

(g) Ensure that the procedure from the start of filling to the removal of the slump cone [i.e. Steps (h) to (l)], is carried out without interruption and is completed within an elapsed time of 2.5 min.

(h) Fill the slump cone by pouring in concrete continuously until it reaches the top edge without vibration or tamping. Over-fill the slump cone slightly and if a detachable conical collar or funnel is used (see Note) then remove this.

NOTE: A detachable conical collar or funnel may be used to facilitate filling the slump cone. The collar or funnel should not penetrate the slump cone by more than 5 mm.

(i) Strike off the surface of the concrete level with the top of the slump cone by means of a screeding and rolling motion of the rod so that the slump cone is filled exactly. Quickly remove any concrete overflow from around the base of the mould to preclude interference with the movement of the flowing concrete and while doing so avoiding any movement or vibration of the slump cone.

(j) Maintain a firm downward pressure at all times until the slump cone is removed. Immediately remove the slump cone from the concrete by raising it slowly and carefully in a vertical direction, allowing the concrete to subside as it flows concentrically along the test surface. Complete the operation of raising the slump cone in 3 ±1 s in a steady vertical lift without causing any tilting, lateral or torsional movement of the slump cone and without interfering with the flow of the concrete.

(k) If the T_{500} time (flow rate) is required, start the stopwatch immediately the slump cone ceases to be in contact with the base plate and record the time to the nearest 0.1 second, for the spreading concrete to reach the marked 500 mm (see Figure 2) circle at any point.

NOTE: It is possible for the stopwatch to be operated by the concrete tester or another person under the concrete tester's supervision.

(l) Wait for the concrete to stop flowing and without disturbing the base plate or concrete measure and record the largest diameter (d_1) of the resulting circular spread of concrete to the nearest 5 mm. Measure and record a second diameter (d_2) of the circular spread at an angle approximately perpendicular to the first measured diameter (d_1), to the nearest 5 mm. [See Figure 4(a).]

If the measurement of the two diameters differs by more than 50 mm, the test is invalid and shall be repeated.

(m) When the J-ring passing ability is required, measure and record the height of concrete at four locations just inside the J-ring bars and at four locations just outside and adjacent to the bars, the locations being at the 0, 90, 180 and 270 degree positions around the J-ring. [See Figure 4(b).] Record and report if blocking of aggregate has occurred.

(n) When segregation assessment is required, assess the stability and resistance to segregation of the SCC by checking the concrete spread for detectable blocking and/or segregation. Record and report as either segregated or not segregated.

NOTE: Blocking and/or segregation is detected visually. The cement paste/mortar may segregate from the coarse aggregate to give a ring of paste/mortar extending beyond the coarse aggregate. Segregated coarse aggregate may also be observed in the central area. In the case of severe segregation, most coarse aggregate remains in the centre of the ring and mortar paste moves to the periphery.

8 CALCULATIONS

8.1 Slump flow

Slump flow shall be calculated as follows:

$$\text{Slump flow} = (d_1 + d_2)/2 \quad \ldots (1)$$

where

d_1 and d_2 are measured in accordance with Clause 7.

8.2 J-ring passing ability difference (j_r)

The following shall be calculated:

(a) Calculate the difference in concrete height at each of the four locations measured in Clause 7, Step (m).

(b) Calculate the J-ring passing ability difference (j_r) as the average of the difference in concrete height at the four locations.

9 RECORDS

The following information shall be recorded:

(a) Identification of the concrete.

(b) Job site or laboratory where tested.

(c) Date and time of test.

(d) Slump flow, in millimetres.

(e) If determined, the T_{500} time (flow rate) in seconds, to the nearest 0.1 s.

(f) If determined, the J-ring passing ability difference, in millimetres.

(g) Whether blocking or segregation has occurred.

(h) Identification of testing operator.

(i) Reference to this Standard, i.e. AS 1012.3.5.

10 REPORT

In the event of a report being prepared, the following information shall be included:

(a) Identification of the concrete.

(b) Date of test.

(c) Slump flow in millimetres, to the nearest 5 mm.

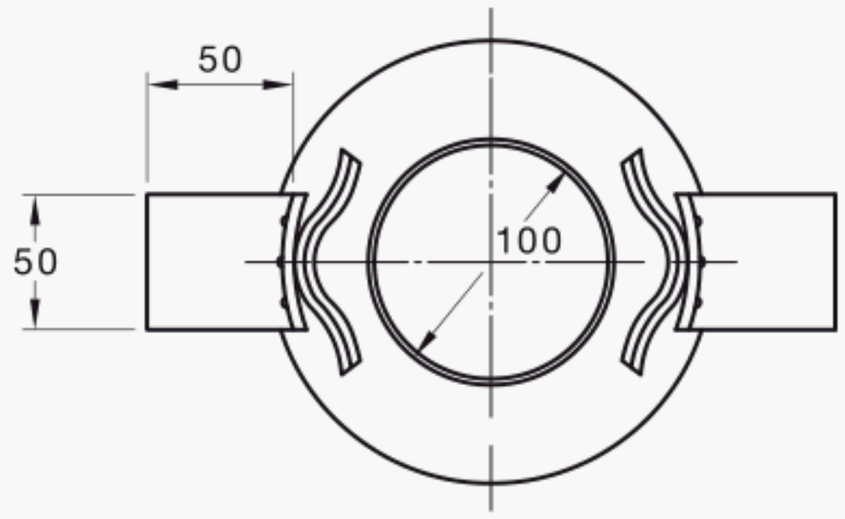
(d) If determined, the T_{500} time (flow rate) in seconds, to the nearest 0.2 s.

(e) If determined, the J-ring passing ability in millimetres, to the nearest 1 mm.

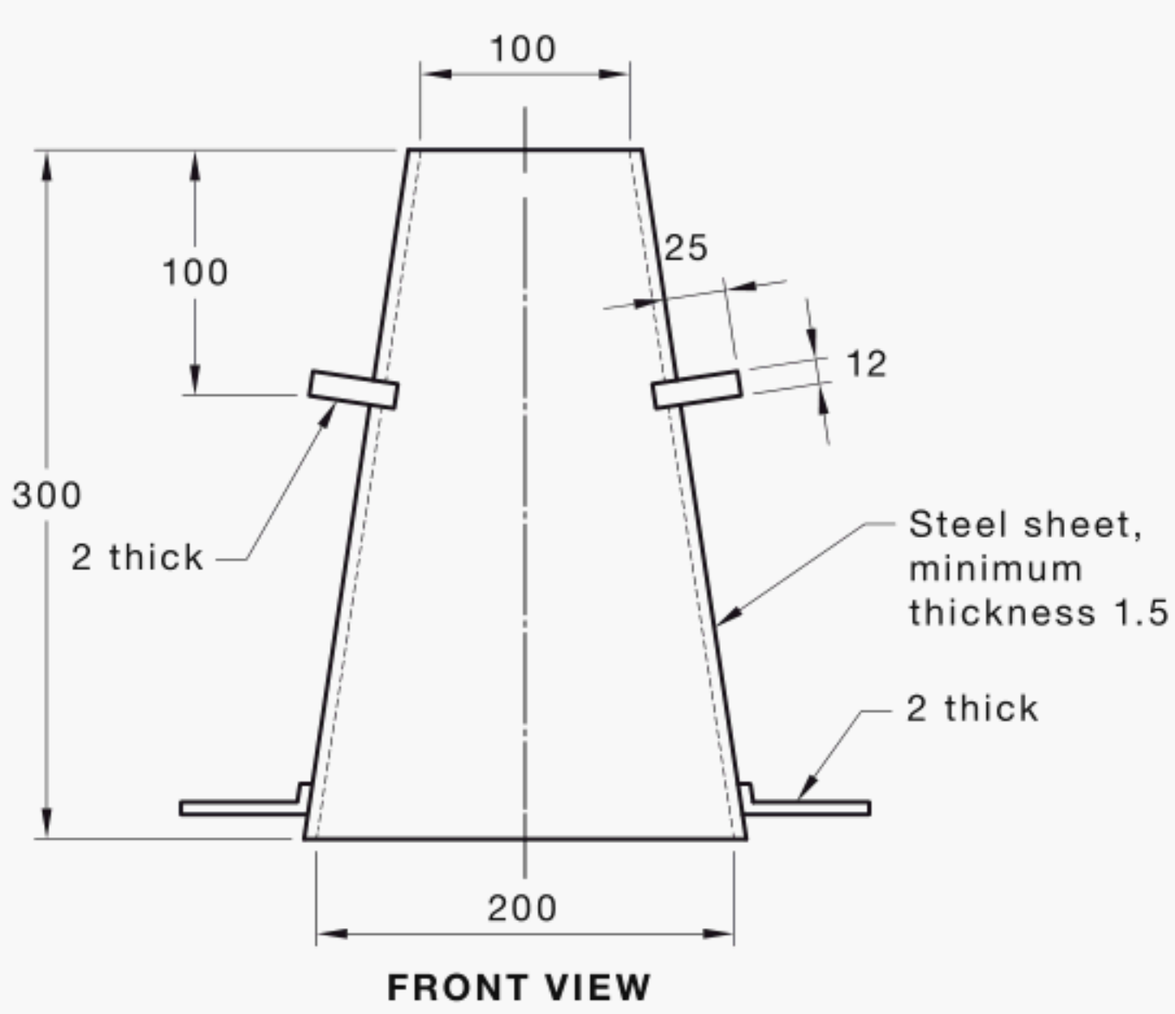
(f) If determined, whether blocking or segregation has occurred.

(g) Reference to this Standard, i.e. AS 1012.3.5.

(h) Such other information contained in the sampling records (see AS 1012.1) as may be requested.



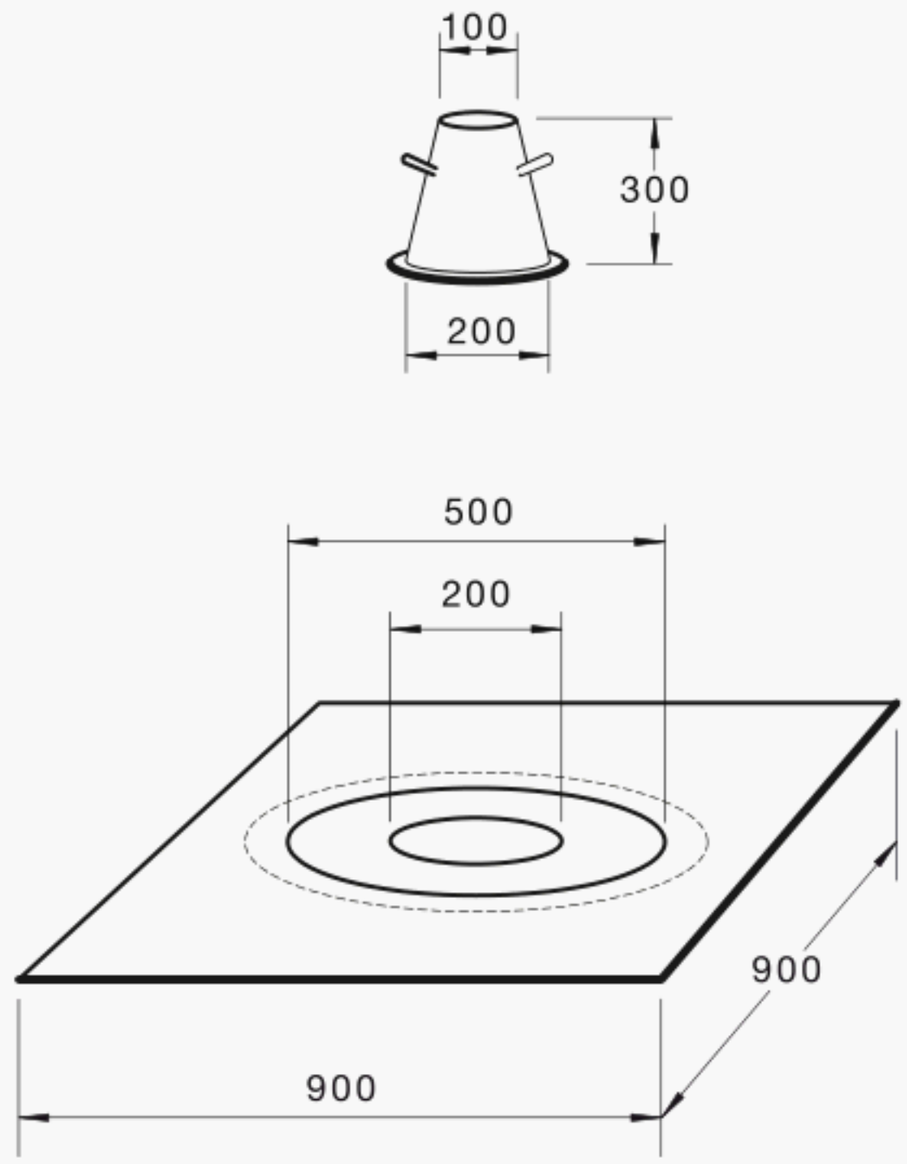
TOP VIEW



FRONT VIEW

DIMENSIONS IN MILLIMETRES

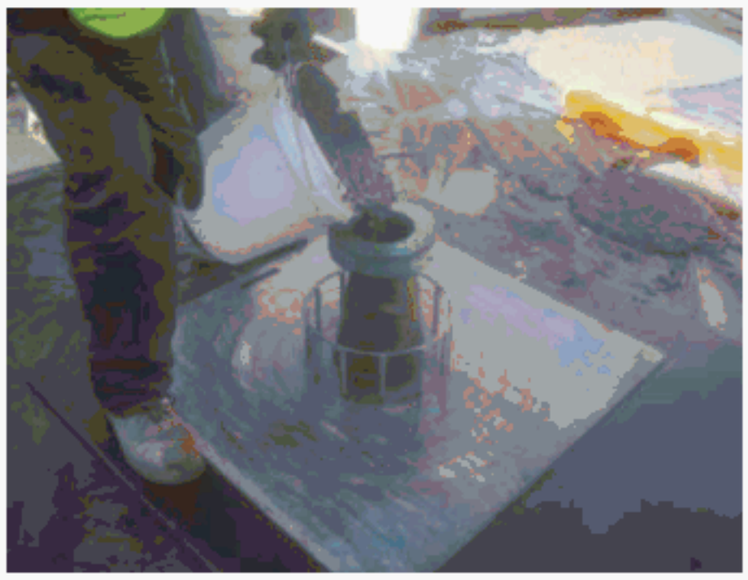
FIGURE 1 TYPICAL SLUMP CONE MOULD FOR THE SLUMP FLOW TEST



DIMENSIONS IN MILLIMETRES

FIGURE 2 EXAMPLE OF A TYPICAL MODIFIED SLUMP CONE AND BASE PLATE

(a) Slump flow cone, plate, J-rings, level and wedges



(b) Placing self-compacting concrete into the mould held down by a 9 kg weighted collar

FIGURE 3 SLUMP FLOW AND J-RING APPARATUS

(a) Measurement of the slump flow

(b) Measurement of the J-ring passing ability

FIGURE 4 MEASUREMENT OF SLUMP FLOW AND PASSING ABILITY

NOTES

NOTES

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