
Testing of concrete —
Part 13:
Properties of fresh self compacting
concrete

Essais du béton —
Partie 13: Titre manqué

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 1920 series can be found on the ISO website.

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Testing of concrete —

Part 13:

Properties of fresh self compacting concrete

1 Scope

This document specifies procedures for testing fresh self-compacting concrete. It specifies the following test methods: determination of consistence (slump flow test), V funnel test, L box test, sieve segregation test, J-ring test and self-compactability test.

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 1920-1, *Testing of concrete — Part 1: Sampling of fresh concrete*

ISO 1920-2, *Testing of concrete — Part 2: Properties of fresh concrete*

ISO 3310-2, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

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 self-compacting concrete SCC

innovative concrete that does not require vibration for placing and compaction because it is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement

3.2 passing ability

ability of fresh concrete to flow through tight openings such as spaces between steel reinforcing bars without segregation or blocking

3.3 segregation resistance

ability of fresh concrete to remain homogeneous in composition while in its fresh state

3.4 slump flow

mean diameter of the spread of fresh concrete from a standardized slump cone

3.5

viscosity

<concrete> resistance to flow of fresh concrete once flow has started

4 Slump-flow test

4.1 General

This test specifies the procedure for determining the slump-flow and t_{500} time for self-compacting concrete. The test is not suitable when the maximum size of the aggregate exceeds 40 mm.

4.2 Principle

The slump-flow test is an indication of the flowability of self-compacting concrete in the absence of obstructions. It is based on the slump test described in ISO 1920-2. The flowability is evaluated by measuring the spreading maximum diameter, $d_{\max}$, and the time it reaches the spreading diameter of 500 mm, t_{500} . The $d_{\max}$ of spreading is a measure of the self-compacting concrete flow range when subjected to load from its own weight. It is an indication of the yield stress of the self-compacting concrete. The t_{500} time is a measure of the speed of flow and an indication of the relative viscosity of the self-compacting concrete. The result is an indication of the filling ability of self-compacting concrete.

The fresh concrete is poured into a cone as specified for the ISO 1920-2 slump test. When the cone is withdrawn upwards, the time from commencing upward movement of the cone to when the concrete has flowed to a diameter of 500 mm is measured; this is the t_{500} time. The largest diameter of the flow spread of the concrete and the diameter of the spread at right angles to it are then measured and the mean is the slump-flow.

4.3 Apparatus

4.3.1 Mould, in accordance with ISO 1920-2:2016, 4.3.2.1 (see [Figure 1](#)).

4.3.2 Rule or measuring tape, of minimum length 1 000 mm and having sub-divisions not greater than 5 mm along its entire length.

4.3.3 Stop watch, capable of measuring to 0,1 s.

4.3.4 Spirit level, for checking horizontality of base plate prior to commencing the test.

4.3.5 Container, to hold the test sample and having a volume of at least 10 l.

4.3.6 Collar, (optional) having a mass of at least 9 kg (see [Figure 2](#)).

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

4.4 Test sample

The sample shall be obtained in accordance with ISO 1920-1.

4.5 Procedure

Place the baseplate on a flat and horizontal surface free from external vibration or shock. Check the top surface for horizontality using the spirit level. Clean the table and the cone and dampen immediately prior to testing, but keep free from excess moisture.

Fit the collar to the cone if being used.

Place the cone centrally within the 200 mm circle on the baseplate and hold in position by standing on the foot pieces (or use the collar), ensuring that no concrete can leak from under the cone.

Fill the cone in one operation without any agitation or mechanical compaction, and strike off surplus from the top of the cone. Allow the filled cone to stand for not more than 30 s; during this time remove any spilled concrete from the baseplate.

Lift the cone vertically in 1 s to 3 s in one movement without interfering with the flow of concrete. If the t_{500} time has been requested, start the stop watch immediately the cone ceases to be in contact with the baseplate and record the time taken to the nearest 0,1 s for the concrete to first touch the 500 mm circle

After the flow of concrete has stabilized without disturbing the baseplate or concrete, measure the largest diameter of the flow spread and record as d_1 to the nearest 10 mm. Then measure the diameter of the flow spread at right angles to d_1 to the nearest 10 mm and record as d_2 to the nearest 10 mm. If the difference between d_1 and d_2 is greater than 50 mm another sample shall be taken and the procedure repeated.

If two consecutive tests show the difference between d_1 and d_2 to be greater than 50 mm, the concrete lacks the necessary flowability for the slump-flow test to be suitable.

Check the concrete spread for signs of segregation and report under item 4.6, f) in a qualitative way, e.g. no indication of segregation, strong indication of segregation.

NOTE Signs of segregation include a ring of cement paste/mortar and segregated coarse aggregate in the central area.

Dimensions in millimetres

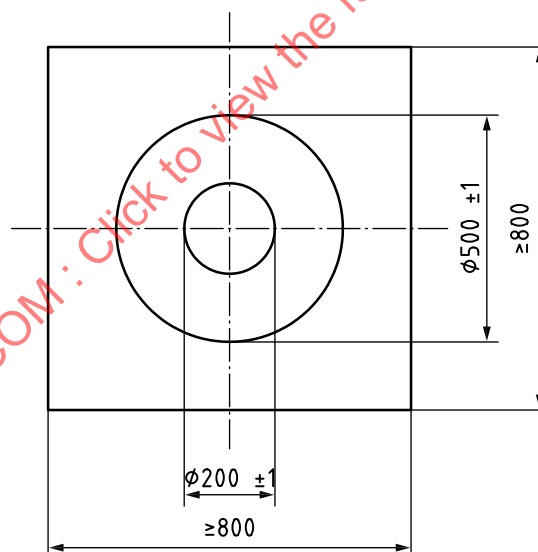


Figure 1 — Baseplate

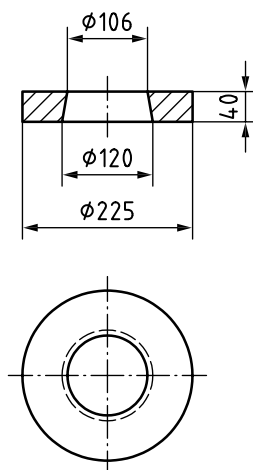


Figure 2 — Example of dimensions of a steelwighted collar

4.6 Test result

The slump-flow, SF , is the mean of d_1 and d_2 , expressed to the nearest 10 mm, given by [Formula \(1\)](#).

$$SF = \frac{(d_1 + d_2)}{2} \quad (1)$$

where

SF is the slump-flow, in millimetres;

d_1 is the largest diameter of flow spread, in millimetres;

d_2 is the flow spread at 90° to d_1 , in millimetres.

The t_{500} time is reported to the nearest 0,5 s.

4.7 Test report

The test report shall include:

- the identification of the test sample;
- the location where the test was performed;
- the date and time of test;
- the slump-flow, SF , to the nearest 5 mm;
- the t_{500} time, to the nearest 0,1 s (when requested);
- any indication of segregation of the concrete;
- any deviation from the standard test method;
- a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in g).

The report may include:

- the temperature of the concrete at the time of test;

— the age of concrete at time of test (if known).

4.8 Repeatability and reproducibility

The repeatability, r , and reproducibility, R , have been determined by a programme including eight laboratories, 16 operators and two replicates, and interpreted in accordance with ISO 5725-2.

The resulting values for r and R are given in [Tables 1](#) and [2](#).

Table 1 — Repeatability and reproducibility for typical values of Slump-flow

Slump-flow, SF mm	<600	600–750	>750
Repeatability, r	n/a	42	22
Reproducibility, R	n/a	43	28

Table 2 — Repeatability and reproducibility for typical values of t_{500} times

t_{500} time seconds	<3,5	3,5–6,0	>6,0
Repeatability, r	0,66	1,18	n/a
Reproducibility, R	0,88	1,18	n/a

5 V funnel test

5.1 General

This test specifies the procedure for determining the V-funnel flow time for self-compacting concrete. The test is not suitable when the maximum size of the aggregate exceeds 25 mm.

5.2 Principle

The relative viscosity is indicated by the time the concrete to flow out of the funnel. And the filling ability is assessed by the time the concrete takes, under the action of its own weight, to flow through section variation of mold. A V-shaped funnel is filled with fresh concrete and the time taken for the concrete to flow out of the funnel is measured and recorded as the V-funnel flow time.

5.3 Apparatus

5.3.1 V-funnel, made to the internal dimensions and tolerances (see [Figure 3](#)), fitted with a quick release, watertight hinged or sliding gate at its base and supported by a frame so that the top of the funnel is horizontal with sufficient clearance beneath the gate to place the container underneath.

The V-funnel shall be made from metal not prone to be readily attacked by cement paste or be liable to rusting; the surfaces shall be smooth, and not readily attacked by cement paste or be liable to rusting.

If the funnel is made from other materials, in-use performance test data shall be available which demonstrates long-term equivalence with metal.

The funnels specified in national standards may be used where applicable.

5.3.2 Container, to hold the test sample and having a volume not less than 12 l.

5.3.3 Stop watch, capable of measuring to 0,1 s.

5.3.4 Straight edge, for striking off concrete level with the top of the funnel.

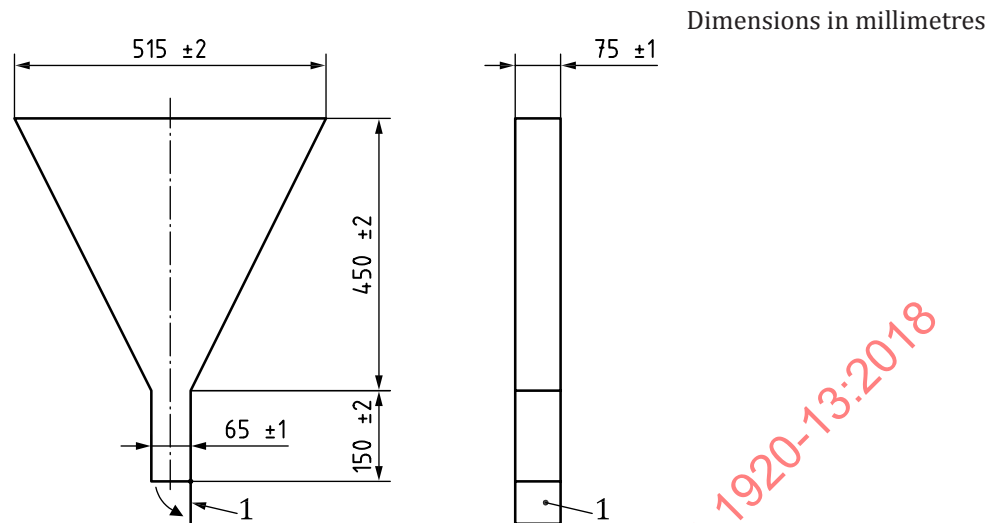


Figure 3 — V-funnel

5.4 Test sample

A sample of at least 12 l shall be obtained in accordance with ISO 1920-1.

5.5 Procedure

Clean the funnel and bottom gate, then dampen all the inside surface including the gate. Close the gate and pour the sample of concrete into the funnel in one operation, without any agitation or mechanical compaction, then strike off the top with the straight edge so that the concrete is level with the top of the funnel. Place the container under the funnel in order to collect the concrete. After a delay of (10 ± 2) s from filling the funnel, open the gate quickly and measure the time, t_v , to 0,1 s, from opening the gate to when it is possible to see vertically through the funnel into the container below for the first time. The time t_v is the V-funnel flow time.

The flow of concrete from the funnel shall be continuous. If a blockage occurs, the test shall be repeated. If a second blockage occurs, the concrete lacks the necessary viscosity and filling ability of self-compacting concrete. Report if a blockage has occurred.

5.6 Test report

The test report shall include:

- the identification of the test sample;
- the location where the test was performed;
- the date and time of test;
- the V-funnel flow time, t_v , to the nearest 0,5 s;
- any deviation from the standard test method;
- a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in e).

The report may include:

- the temperature of the concrete at the time of test;
- the age of concrete at time of test (if known).

5.7 Repeatability and reproducibility

The repeatability, r , and reproducibility, R , have been determined by a programme including 10 laboratories, 20 operators and two replicates, and interpreted in accordance with ISO 5725-2.

The resulting values for r and R are given in [Table 3](#).

Table 3 — Repeatability and reproducibility for typical values of V-funnel flow time

V-funnel flow time, t_v seconds	3,0	5,0	8,0	12,0	>15,0
Repeatability, r	0,4	1,1	2,1	3,4	4,4
Reproducibility, R	0,6	1,6	3,1	5,1	6,6

6 L box test

6.1 General

This test specifies the procedure for determining the passing ability ratio for self-compacting concrete using the L box test according to the maximum size of the aggregates used.

6.2 Principle

The L box test is used to assess the passing ability of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking. There are two variations; the two bar test and the three bar test. The three bar test simulates more congested reinforcement.

A measured volume of fresh concrete is allowed to flow horizontally through the gaps between vertical, smooth reinforcing bars. The heights of the concrete in the vertical section, H_1 , and at the end of the horizontal section, H_2 (see [Figure 4](#)), are measured and the ratio H_2/H_1 determined. This ratio is a measure of the passing or blocking behaviour of self-compacting concrete.

6.3 Apparatus

6.3.1 L box, having the general arrangement and internal dimensions (see [Figure 4](#)).

The L box shall be of rigid construction with surfaces that are smooth, flat and not readily attacked by cement paste or be liable to rusting. The vertical hopper may be removable for ease of cleaning.

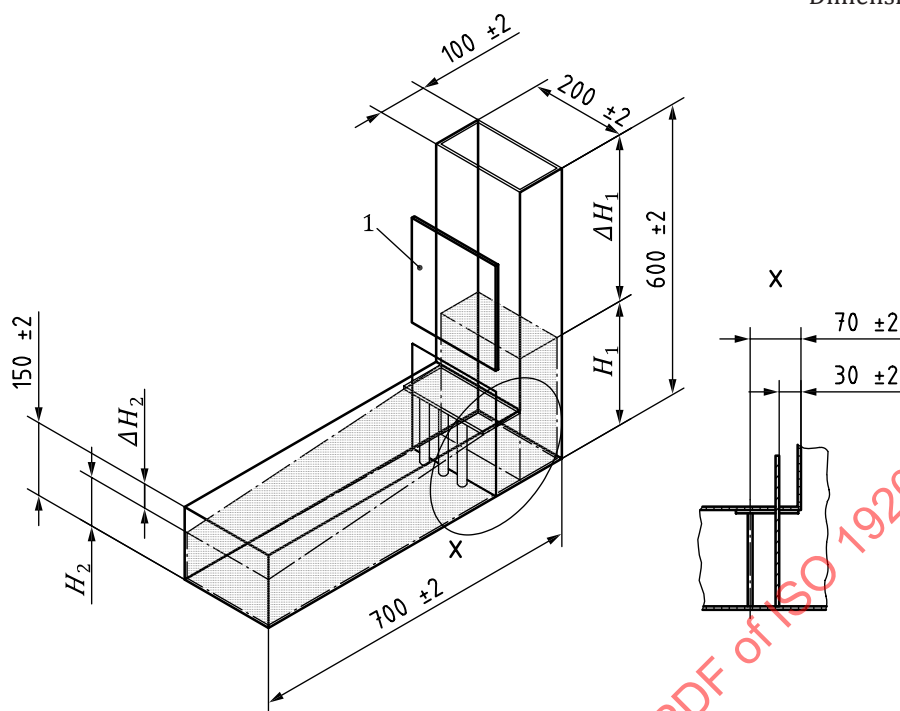
The bar positioning system shall be such that:

- two smooth steel bars of $(12 \pm 0,2)$ mm diameter provide a gap of (59 ± 1) mm for the two bar test; and
- three smooth steel bars of $(12 \pm 0,2)$ mm diameter provide a gap of (41 ± 1) mm for the three bar test.

The system shall locate the bars in the L box so that they are vertical and equidistant across the width of the box (see [Figure 5](#)).

The surface of any material used in the assemblies shall not be readily attacked by cement paste or be liable to rusting.

Dimensions in millimetres



Key

1 sliding gate

Figure 4 — Typical general assembly of L box showing required dimensions

Dimensions in millimetres



a) Clear bar space, (41 ± 1) mm

b) Clear bar space, (59 ± 1) mm

Key

1 $(12 \pm 0,2)$ mm diameter smooth steel bars

Figure 5 — Bar positions in L box

6.3.2 Rule or measuring tape, of minimum length 500 mm and graduated at intervals not exceeding 1 mm, the zero mark being at the extreme end of the rule or measuring tape.

6.3.3 Containers, to hold the sample and having a total volume not less than 14 l.

6.3.4 Spirit level, for checking horizontality of base of L box base prior to commencing the test.

6.3.5 Straight edge, for striking off concrete level with the top of the L box.

6.4 Test sample

A sample of at least 14 l shall be obtained in accordance with ISO 1920-1.

6.5 Test procedure

Support the L box on a level base and check for horizontality using the spirit level. Clean the L box and dampen immediately prior to testing, but keep free from excess moisture. Close the gate between the vertical and horizontal sections. Pour the concrete from the container(s) into the filling hopper of the L box, without any agitation or mechanical compaction, then strike off the top with the straight edge so that the concrete is levelled with the top of the vertical section of the L box and allow to stand for (60 ± 10) s.

Check the concrete for signs of segregation before and after filling of the L box and report under 6.6, d) in a qualitative way (e.g. no indication of segregation, strong indication of segregation).

NOTE Signs of segregation include a layer of cement paste/mortar and segregated coarse aggregate at the top.

Fully open the sliding gate in a smooth continuous action to allow the concrete to flow into the horizontal section. When movement has ceased, measure the drop in height of the level of concrete, ΔH_1 , to the nearest 1 mm in the vertical section on the gate side of the box at three positions equally spaced across the width of the box. The mean depth of the concrete, H_1 , is the difference between the height of vertical section and the average of the three readings of ΔH_1 . Record H_1 to the nearest 1 mm. The same procedure is used to calculate the mean depth of the concrete at the end of the horizontal section of the L box, H_2 , from the difference with the height of the horizontal section and the average of the three readings of ΔH_2 . Record H_2 to the nearest 1 mm.

6.6 Test result

The passing ability ratio, PL , as measured by the L box test, is calculated to the nearest 0,01 from [Formula \(2\)](#):

$$PL = \frac{H_2}{H_1} \quad (2)$$

where

PL is the passing ability ratio measured by the L box test;

H_1 is the mean depth of concrete in the vertical section of the box, in millimetres;

H_2 is the mean depth of concrete at the end of the horizontal section of the box, in millimetres.

6.7 Test report

The test report shall include:

- the identification of the test sample;
- the location where the test was performed;
- the date and time of test;
- any segregation or bleeding observed during filling of the L box;
- a statement of whether two bar or three bar test;
- the passing ability ratio, PL , to the nearest 0,05;

- g) any deviation from the standard test method;
- h) a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in g).

The report may include:

- Temperature of the concrete at the time of test;
- Age of concrete at time of test (if known).

6.8 Repeatability and reproducibility

The repeatability, r , and reproducibility, R , have been determined by a programme including 11 laboratories, 22 operators and two replicates, and interpreted in accordance with ISO 5725-2.

The resulting values for r and R for the three bar test are given in [Table 4](#).

Table 4 — Repeatability and reproducibility for typical values of passing ability ratio

Passing ability ratio, PL	$\geq 0,8$	$< 0,8$
Repeatability, r	0,11	0,13
Reproducibility, R	0,12	0,16

7 Sieve segregation test

7.1 General

This test specifies the procedure for determining the sieve segregation resistance of self-compacting concrete.

NOTE This test is not applicable to concrete containing fibres or lightweight aggregate.

7.2 Principle

The sieve segregation resistance test is used to assess the resistance of self-compacting concrete to segregation.

After sampling, the fresh concrete is allowed to stand for 15 min and any separation of bleed water is noted. A defined top part of the sample is then poured onto a sieve with 4,75 mm and/or 5 mm square apertures. After 2 min the weight of material which has passed through the sieve is recorded. The segregation ratio is then calculated as the proportion of the sample and the material passing through the sieve.

7.3 Apparatus

7.3.1 Perforated plate sieve, having 4,75 mm and/or 5 mm square apertures, frame diameter not less than 300 mm and a height of at least 30 mm, conforming to ISO 3310-2, complete with a receiver from which the sieve can easily be removed by lifting vertically.

7.3.2 Balance, having a flat platform which can accommodate the sieve receiver and having a capacity of at least 10 kg, capable of determining the mass to an accuracy of 0,01 kg.

7.3.3 Sample container, a rigid container made from a non-absorbent material and having a minimum internal diameter of 200 mm and a capacity of at least 11 l with a 10 l point indicated on the inside of the container.

7.3.4 Timer, capable of measuring to 1 s.

7.3.5 Thermometer, capable of measuring to 1 °C.

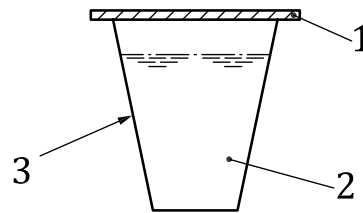
7.4 Test sample

A sample shall be obtained in accordance with ISO 1920-1.

7.5 Procedure

Take and record the temperature of the concrete to the nearest 1 °C by using the thermometer.

Place $(10 \pm 0,5)$ l of concrete in the sample container and cover to prevent evaporation (see [Figure 6](#)).



Key

- 1 cover
- 2 concrete
- 3 sample container

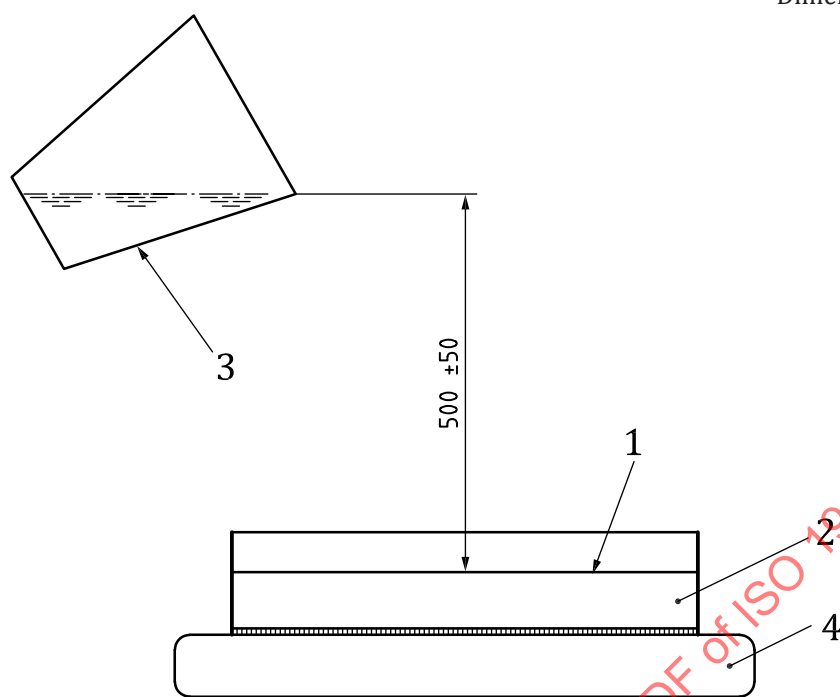
Figure 6 — Sample container and cover

Allow to stand in a level position, without disturbance, for $(15 \pm 0,5)$ min.

Ensure the balance is level and free from vibration. Place the sieve receiver on the balance and record its mass, m_p , in grams. Then place the dry sieve on the receiver and again record the mass or zero the balance.

At the end of the standing period remove the cover from the sample container and record whether any bleed water has appeared on the surface of the concrete.

With the sieve and receiver still on the balance, and with the top of the sample container (500 ± 50) mm above the sieve, steadily and carefully pour $(4,8 \pm 0,2)$ kg of concrete (including any bleed water) onto the centre of the sieve (see [Figure 7](#)) in one operation. Record the actual mass of concrete, m_c , in grams on the sieve.

**Key**

- 1 sieve
- 2 sieve receiver
- 3 sample container
- 4 balance

Figure 7 — Measurement of segregated portion

Allow the concrete to stand in the sieve for (120 ± 5) s and then remove the sieve vertically without agitation.

Record the mass of the receiver, including the material that has passed through the sieve, m_{ps} , in grams.

7.6 Test result

The segregated portion, SR , is calculated from [Formula \(3\)](#) and reported to the nearest 1 %.

$$SR = \frac{(m_{ps} - m_p)}{m_c} \times 100 \quad (3)$$

where

SR is the segregated portion in percent;

m_{ps} is the mass of sieve receiver plus passed material, in grams;

m_p is the mass of the sieve receiver, in grams;

m_c is the initial mass of concrete placed onto the sieve, in grams.

7.7 Test report

The test report shall include:

- the identification of the test sample;
- the location where the test was performed;
- the date and time of test;
- the temperature of the concrete at the time of test, to the nearest 1 °C;
- the presence of bleed water, if any, after standing for 15 min;
- the segregated portion, *SR*, to the nearest 1 %;
- any deviation from the standard test method;
- declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in g).

The report may include the age of concrete at time of test (if known).

7.8 Repeatability and reproducibility

The repeatability, *r*, and reproducibility, *R*, have been determined by a programme including 11 laboratories, 22 operators and two replicates, and interpreted in accordance with ISO 5725-2.

The resulting values for *r* and *R* are given in [Table 5](#).

Table 5 — Repeatability and reproducibility for typical values of segregated portion

Segregated portion, <i>SR</i> percent	≤20	>20
Repeatability, <i>r</i>	3,7	10,9
Reproducibility, <i>R</i>	3,7	10,9

8 J-ring test

8.1 General

This test specifies the procedure for determining the passing ability (measured by the blocking step), the flow spread and *t*_{500j} flow time of self-compacting concrete as the concrete flows through the J-ring.

The test is not suitable when the maximum size of aggregate exceeds 40 mm.

NOTE In respect to the relationship between aggregate size and bar spacing, the test is intended to assess the passing ability of the concrete proposed with the bar spacing typically in the works. If the concrete blocks, then the aggregate size can be too large for the particular application.

8.2 Principle

The J-ring test is used to assess the passing ability of self-compacting concrete to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blocking.

A narrow and wide bar spacing test is described. The narrow bar spacing simulates more congested reinforcement.

The J-ring test is an alternative to the L box test in [Clause 6](#) although the result is not directly comparable.

The method follows the procedure detailed in [Clause 4](#) except that, before filling the mould (slump cone) with concrete, the J-ring, consisting of a ring of evenly spaced vertical smooth bars, is placed over the cone.

In addition, the time when the concrete has flowed to a diameter of 500 mm t_{500j} shall be measured, when specified.

J-rings specified in national standards may be used where applicable.

8.3 Apparatus

The apparatus shall be in accordance with [Clause 4](#) with the following additional items.

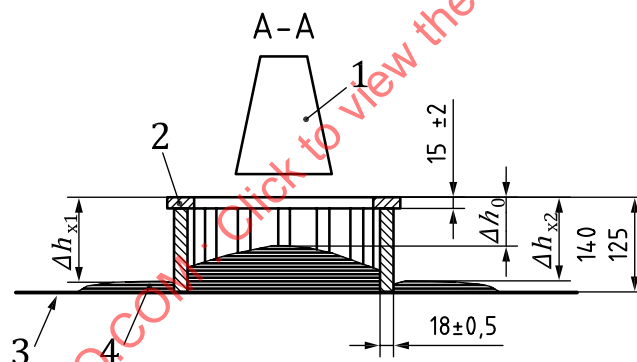
NOTE The feet to the slump cone can be removed to fit inside the J-ring or if their presence prevents free upward movement from within the J-ring.

8.3.1 Narrow gap J-ring, with smooth steel bars, $(18 \pm 0,5)$ mm diameter, secured to a ring (300 ± 2) mm diameter (bar spacing of (41 ± 1) mm) with the dimensions as shown in [Figures 8](#) and [9](#).

8.3.2 Wide gap J-ring, with smooth steel bars, $(18 \pm 0,5)$ mm diameter, secured to a ring (300 ± 2) mm diameter (bar spacing of (59 ± 1) mm) with the dimensions as shown in [Figures 8](#) and [10](#).

8.3.3 Straight edge, for aligning the reference line for the height measurements, with a length of about 400 mm.

Dimensions in millimetres



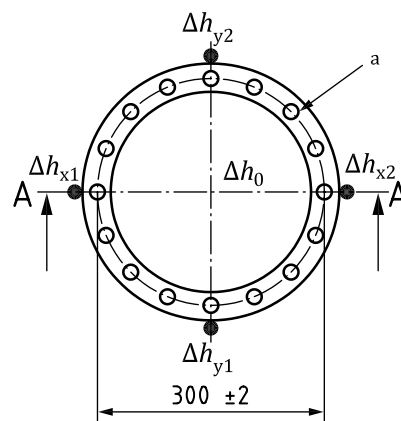
Key

- 1 mould (slump cone)
- 2 J-ring
- 3 baseplate
- 4 concrete

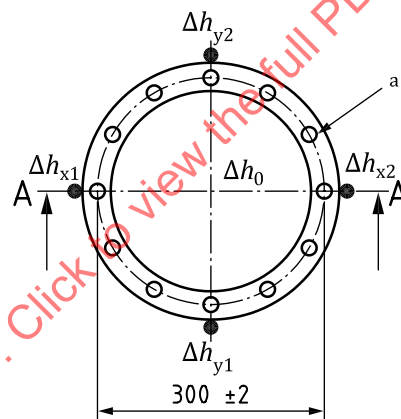
Δh difference in height between top of J-ring and top of the concrete at points referenced

Figure 8 — Section A-A across J-ring

Dimensions in millimetres

**Key**a 16 equally spaced smooth steel bars ($\pm 0,5$ mm). Δh difference in height between top of J-ring and top of the concrete at points referenced**Figure 9 — Narrow gap J-ring**

Dimensions in millimetres

**Key**a 12 equally spaced smooth steel bars ($\pm 0,5$ mm). Δh difference in height between top of J-ring and top of the concrete at points referenced**Figure 10 — Wide gap J-ring****8.4 Test sample**

The sample shall be obtained in accordance with ISO 1920-1.

8.5 Procedure

Prepare the cone and baseplate as described in [Clause 4](#).

Place the cone centrally within the 200 mm circle on the baseplate and hold in position (or use the weighted collar), ensuring that no concrete can leak from under the cone.

Place the J-ring on the base plate, concentrically around the cone.

Fill the cone in one operation without any agitation or mechanical compaction, and strike off surplus from the top of the cone. Allow the filled cone to stand for not more than 30 s; during this time remove

any spilled concrete from the baseplate and ensure the baseplate is damp all over but without any surplus water.

Lift the cone vertically in 1 s to 3 s in one movement without interfering with the flow of concrete. If the t_{500} time has been requested, start the stop watch immediately the cone ceases to be in contact with the baseplate and record the time taken to the nearest 0,1 s for the concrete to reach the 500 mm circle at any point.

Without disturbing the baseplate or concrete, measure the largest diameter of the flow spread and record as d_1 to the nearest 10 mm. Then measure the diameter of the flow spread at right angles to d_1 to the nearest 10 mm and record as d_2 to the nearest 10 mm.

Lay the straight edge on the top side of the J-ring and measure the relative height differences between the lower edge of the straight edge and the concrete surface at the central position Δh_0 and at the four positions outside the J-ring, two Δh_{x1} , Δh_{x2} in the x-direction and the other two Δh_{y1} , Δh_{y2} in the y-direction (perpendicular to x), as shown in [Figures 9](#) and [10](#), measured to the nearest 1 mm.

Check the concrete spread for signs of segregation and report under 8, h) in a qualitative way, e.g. no indication of segregation, strong indication of segregation.

Calculate the difference between the slump flows with and without a J-ring (see [Clause 4](#)).

NOTE Signs of segregation include a ring of cement paste/mortar and segregated coarse aggregate in the central area.

8.6 Expression of results

8.6.1 Passing ability PJ

The J-ring passing ability, PJ , measured by the blocking step, is calculated using [Formula \(4\)](#) and expressed to the nearest 1 mm.

$$PJ = \frac{(\Delta h_{x1} + \Delta h_{x2} + \Delta h_{y1} + \Delta h_{y2})}{4} - \Delta h_0 \quad (4)$$

where

PJ is the passing ability, measured by the blocking step, in millimetres;

Δh are the measurement heights, in millimetres.

8.6.2 Flow spread SF_J

The J-ring flow spread, SF_J , is the mean of d_1 and d_2 , expressed to the nearest 10 mm given by [Formula \(5\)](#):

$$SF_J = \frac{(d_1 + d_2)}{2} \quad (5)$$

where

SF_J is the flow spread, in millimetres;

d_1 is the largest diameter of flow spread, in millimetres;

d_2 is the flow spread at 90° to d_1 , in millimetres.

8.6.3 Flow time, t_{500j}

The J-ring flow time, t_{500j} , is the period between the moment the cone leaves the base plate and SCC first touches the circle of diameter 500 mm. The time t_{500j} is expressed in seconds to the nearest 0,5 s.

8.7 Test report

The test report shall include:

- the identification of the test sample;
- the location where the test was performed;
- the date and time of test;
- a statement whether narrow or wide gap J-ring used;
- the passing ability, PJ , measured by the blocking step, to the nearest 1 mm;
- the flow spread, SF_J , to the nearest 5 mm;
- the t_{500j} time, to the nearest 0,1 s (when requested);
- any indication of segregation of the concrete;
- any deviation from the standard test method;
- a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in i);
- the difference between the slump flows with and without a J-ring.

The report may include:

- the temperature of the concrete at the time of test;
- the age of concrete at time of test (if known).

8.8 Repeatability and reproducibility

The repeatability, r , and reproducibility, R , have been determined for the narrow gap J-ring by a programme including 8 laboratories, 16 operators and 2 replicates, and interpreted in accordance with ISO 5725-2.

The resulting values for r and R when using the narrow gap J-ring are given in [Tables 6, 7](#) and [8](#). No data exists for the wide gap J-ring.

Table 6 — Repeatability and reproducibility for typical values of the narrow gap J-ring passing ability, PJ , measured by the blocking

J-ring passing ability, PJ , measured by the blocking step mm	≤20	>20
Repeatability, r	4,6	7,8
Reproducibility, R	4,6	7,8

Table 7 — Repeatability and reproducibility for typical values of the narrow gap J-ring flow spread, SF_J

J-ring flow spread, SF_J mm	<600	600–750	>750
Repeatability, r	59	46	25
Reproducibility, R	67	46	31

Table 8 — Repeatability and reproducibility for typical values of the narrow gap J-ring time, t_{500j}

J-ring time, t_{500j} s	<3,5	3,5–6	>6
Repeatability, r	0,70	1,23	4,34
Reproducibility, R	0,90	1,32	4,34

9 Drop and fill height test for self-compactability of fresh concrete

9.1 General

The level of self-compactability shall be determined considering the shape, dimensions and bar arrangement for the structure to which concrete is to be placed. The level of self-compactability shall be appropriately determined for the concrete before placing in the formwork. This test method specifies the procedure for quantifying the level of self-compactability of fresh concrete.

9.2 Principle

This method covers testing of the self compactability of fresh concrete with a maximum coarse aggregate size of not more than 25 mm using a drop and fill height test. A measured volume of fresh concrete is allowed to flow through the gapped gate between vertical, deformed reinforcing bars to the adjacent closed space. The fill height of the concrete is measured. This height is a measure of the passing or blocking behaviour of self-compacting concrete.

9.3 Apparatus

The test apparatus shall conform to the following:

- The fill tester shall be a U-shaped or box-shaped container with the shape and dimensions as shown in [Figure 11](#) that is made of a material with flat and smooth surfaces, and shall be sufficiently robust.

NOTE 1 The inside surfaces of the container shall be flat and smooth to minimize friction between concrete and the container. Although any material that is robust and smooth-surfaced can be used, a transparent material which allow observation of the state of flow of concrete.

- The fill tester shall be of a structure having an obstacle in the centre made of deformed reinforcing bars vertically arranged in a row as shown in [Figure 11](#).

NOTE 2 There are two types of obstacles: Obstacle R1 consisting of five D10 bars and Obstacle R2 consisting of three D13 bars. An appropriate type shall be selected from these obstacles according to the purpose of testing.

- The tester shall be of a structure that is separable into two rooms, A and B, by inserting a partition board fitted with an obstacle, which can be opened and closed using a partition gate, into a groove cut in the centre of the bottom.