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Self-compacting concrete: Test methods for SCC

- Workability, air content, density and casting of test specimens
- Annex I: Nordtest NT BUILD Proposal
- Annex II: Test results from concrete production sites



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Abstract: The use of self-compacting concrete has been on the rise in Nordic countries for years. However, no common procedures for documenting the quality of SCC is available taking into account the differences between SCC and conventional concrete, i.e. existing methods for conventional concrete all require compaction of the concrete using vibration, and vibration will cause an SCC to segregate. In an attempt to fill the need of the concrete industry the NICE project 02128 has proposed a new Nordtest NT BUILD “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens”. The selection of recommended procedures for evaluating the passing ability, the filling ability and the resistance to segregation of SCC was made attempting to accommodate the industry’s demand for minimum labor extensiveness while optimizing the information obtained about the SCC being tested. In the selection of procedures the extensive inter-laboratory evaluation of a series of test methods performed by the European project “TESTING-SCC” was used as a reference. The proposed test method was evaluated in practice by the projects industrial partners, and after minor revision reviewed by the “Nordic SCC-net”, a partly NICE financed network who’s members have a special interest in SCC. Finally, the proposed Nordtest NT BUILD was communicated to the standardization committees in the Nordic countries and to the relevant European standardization committee.		
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1. Executive summary

The use of Self-Compacting Concrete (SCC) takes place on an increasing basis in the Scandinavian countries due to advantages relating to better working environment (noise and vibration), higher productivity (faster casting), and better quality (fewer mistakes caused by wrongful vibration). However, if the properties of SCC are to be documented on a legal basis using the existing standard test methods meant for conventional concrete it will have to be done using vibration, i.e. in a fashion that goes against the very basic idea of SCC - that the concrete compacts by its own weight without mechanical treatment¹.

The Nordic concrete industry is therefore in need of methods for documenting fresh SCC, and the main objective of the NICE project 02128 “Test methods for self-compacting concrete” was therefore to recommend by proposing a Nordtest NT BUILD method which methods to use in the daily quality control at the concrete production site. Subsequently, through communication of the Nordtest NT BUILD method to the relevant European committees and national Nordic standardization committees the work of the NICE 02128 will hopefully contribute to a future common European standard.

Workability of SCC can be characterized by three parameters:

- Filling ability - *The ability of the fresh concrete to flow under gravitation, or under pressure (e.g. pumping) and totally fill formwork and enclose reinforcement.*
- Passing ability - *The ability of the fresh concrete to pass confined section of the formwork, dense reinforcement, etc., without the aggregate blocking.*
- Resistance to segregation - *The ability of the fresh concrete to retain its homogeneity during the casting process and when the concrete has come to rest.*

The large EU-funded project “TESTING SCC” during the period 2002-2005 carried out a large inter-laboratory test program evaluating many of the test methods that have over the years been proposed for evaluating the workability of SCC, e.g. slump flow, V-funnel, Orimet, L-box, J-ring, and various segregation tests. “Testing SCC” established the “in laboratory” repeatability and reproducibility of many test methods.

¹ In the Danish national application document DS 2426 (3) to EN 206-1 a test method for workability of SCC was included after this project was started. An ASTM method (2) describing the slump flow test was recently released (Fall 2005), however, no common European description of any test procedure exists.

In terms of workability the task for NICE project 02128 was to build on the results of “TESTING SCC” by selecting the test methods that were best suited for every day use as production control at the concrete production facility, and to subsequently document that the statistical parameters obtained from daily production control are similar to those obtained in the “TESTING SCC” inter-laboratory test program.

In terms of air content, density and casting of specimens the task for NICE project 02128 was to establish the best way of filling the SCC into the air content pressurimeter before testing for air content, and into cube and cylinder moulds before testing of compressive strength etc.

A draft of the proposed Nordtest NT BUILD method was completed in the beginning of the project. This draft test method was then supplied to the four participating concrete producers and concrete laboratories for try-out and evaluation in their daily production at selected production sites. The test procedures proposed for testing three different workability parameters is shown in Table 1.1

Table 1.1: SCC properties and the corresponding proposed test procedures

Property tested	Test procedure
Filling ability	Slump flow - measuring the diameter of spread as well as T_{50} , the time to a spread of 500 mm.
Passing ability	Slump flow with J-ring – measuring the diameter of spread, and the blocking step, the height difference between the center of the concrete and just outside the J-ring.
Resistance to segregation	Slump flow with J-ring as above. The test is performed on the top and bottom part of concrete in a bucket. The relative difference in blocking step between the two measurements is termed the segregation indicator – the higher the value the greater the risk of segregation..

The participating concrete producers collected data using the procedures recommended in the draft of Nordtest NT BUILD “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens”. The concrete producers also were asked to comment on their experience with the test procedures. The response from the producers was generally positive, however minor adjustments were exercised before the Nordtest NT BUILD was communicated to the Nordic SCC Net² for review. Comments from the Nordic SCC network lead to only a couple of minor changes, before the NT BUILD was finalized and sent to Nordtest for consideration. The proposed NT BUILD was also communicated to the NUBS (Nordic Committee on Concrete Standardisation) and to the European CEN committee TC 104/TG 8.

² The Nordic SCC net is network for individuals and companies interested in SCC. The network is partly financed by NICE under project number 03037.

The proposed Nordtest method represents an offer to the concrete industry and standardizing bodies. They now have the possibility to specify and perform documentation of SCC based on test method that specifically address the unique characteristics of SCC. The extent to which the proposed NT BUILD will be used by the concrete industry and the impact that it will have on united European efforts in the field remains to be seen.

2. Introduction

Conventional concrete is cast using mechanical treatment normally in the form of vibration in order to move the concrete to all corner of the formwork, to remove entrapped air, and to fully surround the reinforcement. With the introduction of the latest generation of superplasticizing admixtures it became possible to produce concrete that does not require mechanical treatment – so called self-compacting concrete or self-consolidating concrete (SCC).

The use of SCC takes place on an increasing basis in Scandinavia due to advantages relating to working environment (noise and vibration), productivity (faster casting), and quality (e.g. fewer mistakes caused by wrongful vibration).

However, if the properties of SCC are to be documented on a legal basis using the existing standard test methods it will have to be done in a fashion that goes against the very basic idea of SCC, i.e. that the concrete compacts through its own weight without mechanical treatment.

In the present standards including EN 206 and associated test methods EN 12350-2, -3, -4, -5, -7 and EN 12390-2 all of the existing test methods (workability, air content, density and casting of test specimens) for fresh concrete make use of mechanical compaction of the concrete³.

In practice the so-called slump flow test is used as test method for SCC workability. An ASTM method describing the slump flow test was recently released (2), however, no common European description of the test exists. With respect to determination of density and air content as well as casting of test specimens (e.g. cubes or cylinder for strength testing) it either has to be performed against the text of the relevant standard, or if the standard is followed with a test result that is not representative of the SCC, i.e. laboratory documentation has to be done with vibration, and on the job site the documented SCC will be cast without vibration.

The Nordic concrete industry therefore is in need of methods for documenting fresh SCC, and this report presents the background results and general evaluations of the NICE project 02128 “Test methods for self-compacting concrete” leading to the proposal of the Nordtest NT BUILD method titled “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens”. It is the hope that the proposed Nordtest method will also contribute to a common European standard.

³ In the Danish national application document DS 2426 (3) to version of EN 206-1 a test method for workability of SCC was included after this project was started.

3. Background

Workability of SCC can be characterized by three parameters:

- Filling ability - *The ability of the fresh concrete to flow under gravitation, or under pressure (e.g. pumping) and totally fill formwork and enclose reinforcement.*
- Passing ability - *The ability of the fresh concrete to pass confined section of the formwork, dense reinforcement, etc., without the aggregate blocking.*
- Resistance to segregation - *The ability of the fresh concrete to retain its homogeneity during the casting process and when the concrete has come to rest.*

The large EU-funded project “TESTING-SCC” (1) over the period 2002-2005 carried out a large inter-laboratory test program evaluating many of the test methods that have over the years been proposed for evaluating the workability of SCC, e.g. slump flow, V-funnel, Orimet, L-box, J-ring, and various segregation tests. “Testing-SCC” established in laboratory the repeatability and reproducibility of many test methods (1).

In terms of workability the task for NICE project 02128 was then to build on the results of “TESTING-SCC” by selecting the test methods that were best suited for every day use as production control at the concrete production facility, and to subsequently document the statistical parameters obtained from daily production control to see if they are similar to those obtain in the “TESTING SCC” inter-laboratory test program (1).

In terms of air content, density and casting of specimens the task for NICE project 02128 was to establish the best way of filling the SCC into the air content pressurimeter, cube moulds and cylinder moulds.

Finally, the participating concrete production sites should evaluate if the results obtained with our selected test methods were reasonable for use as quality control measures.

4. Methods

From a concrete casting perspective SCC is often characterized by its filling ability, passing ability, and resistance to segregation. The ideal SCC will thus completely fill the formwork and fully engulf the reinforcement with concrete that has the same composition in all areas of the form, i.e. no segregation. It is important to distinguish between static and dynamic segregation. Static segregation is caused by the concrete mixture being unstable under the force of gravity. Dynamic segregation is a result of instability induced by other forces than gravity. The way the concrete is placed in formwork and the associated flow “pattern” of the concrete is, along with coarse aggregate being restricted in movement by reinforcement, the dominant causes of dynamic segregation. Consequently, dynamic segregation probably always has to be evaluated based on trial castings.

The test methods selected from the “TESTING SCC” portfolio was slump flow for evaluating filling ability, slump flow with J-ring for evaluating passing ability (1). For evaluating resistance to segregation a novel method based on two test of J-ring spread measuring blocking step is proposed. Twelve liters of concrete is placed in a bucket and after 2 minutes stand the top and bottom halves of the concrete is tested using slump flow spread with J-ring. The relative difference between blocking step in the two measurements is expressed as the segregation indicator parameter that provides information about the resistance to segregation, i.e. if the SCC is prone to segregation the difference between two measurements will be high (large segregation indicator parameter), whereas if the SCC is stable the difference between the two measurements will be small.

For air content, density and casting of specimens the specified procedures were chosen as being identical to the existing procedures for testing conventional concrete except that no compaction of the SCC should take place. However, it was evaluated how striking the form sides with a wooden mallet affected the test results.

Based upon the selection of test procedures a draft version of the Nordtest NT BUILD method “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens” was prepared and distributed to the participating concrete producing companies and laboratories.

4.1.1 Participating concrete producers and SCC tested

The participating concrete producing companies Swerock, Färdig Betong, Unicon Norway and Unicon Denmark was asked together with the laboratories at the Swedish National Testing and Research Institute

and the Icelandic Building Research Institute to select SCC recipes and test the same recipe at least 10 times following the proposed Nordtest NT BUILD method titled “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens”.

In the try-out of the proposed NT BUILD eight concrete productions sites and two laboratories took part as shown in Table 4.1.

Table 4.1: Identification of production sites and laboratories participating in testing of SCC according to the proposed Nordtest NT BUILD method.

Production Site	Denmark	Denmark	Norway	Norway	Norway	Sweden	Sweden	Sweden
ID	Fab D1	Fab D2	Fab N1	Fab N2	Fab N3	Fab S1	Fab S2	Fab S3
Laboratory	Sweden	Iceland						
ID	Lab SP	Lab IBRI						

5. Results and discussion

The raw data from the concrete production sites and concrete laboratories participating in project are found in Appendix II.

5.1 Workability

In the preceeding section 6.1.1 – 6.1.5 are the results form the various test of concrete workability presented and discussed.

5.1.1 Slump flow - Inverted slump cone vs. normal cone

In Denmark the EN 206 National Application Document is DS 2426 (3). In the annex a method for documenting SCC is provided. The method describes a slump flow test where an Abram's slump cone is used in inverted position, i.e. smaller diameter downwards. Even though the inverted cone has occasionally seen use in other countries it is fair to say that it is rarely used elsewhere. The inverted cone was not considered in the "TESTING-SCC" project that evaluated a number of the most commonly used test procedures for documenting the workability of SCC.

The two Danish production sites measured slump flow using normal cone position as well as inverted cone position, and in both cases the T_{50} was also recorded. The results are shown in Figure 5.1 and Figure 5.2. As can be seen from Figure 5.1 the measured slump flow using inverted cone is slightly smaller than using normal cone position, the trend is more pronounced at larger slump flow spreads. The difference between the two cone orientations is more significant in the T_{50} -values. Figure 5.2 shows that in general the T_{50} -value obtained using inverted cone is larger than the values obtained using normal cone orientation. The scattering of results is quite substantial for the T_{50} measurements.

The inverted position has no advantage over the normal cone position when the latter is used with a weight ring to avoid the SCC from pushing the cone upwards. Rather the inverted cone position seems more vulnerable to differences in lifting speed of the cone, as the flow of concrete is easily restricted by too slow lifting speed, or the concrete is lifted up inside the cone so quickly that the flow out of the cone is broken.

Consequently, as the results indicate that some difference exists between normal cone orientation and inverted cone orientation the proposed Nord-test method will call for the use of normal cone orientation only.

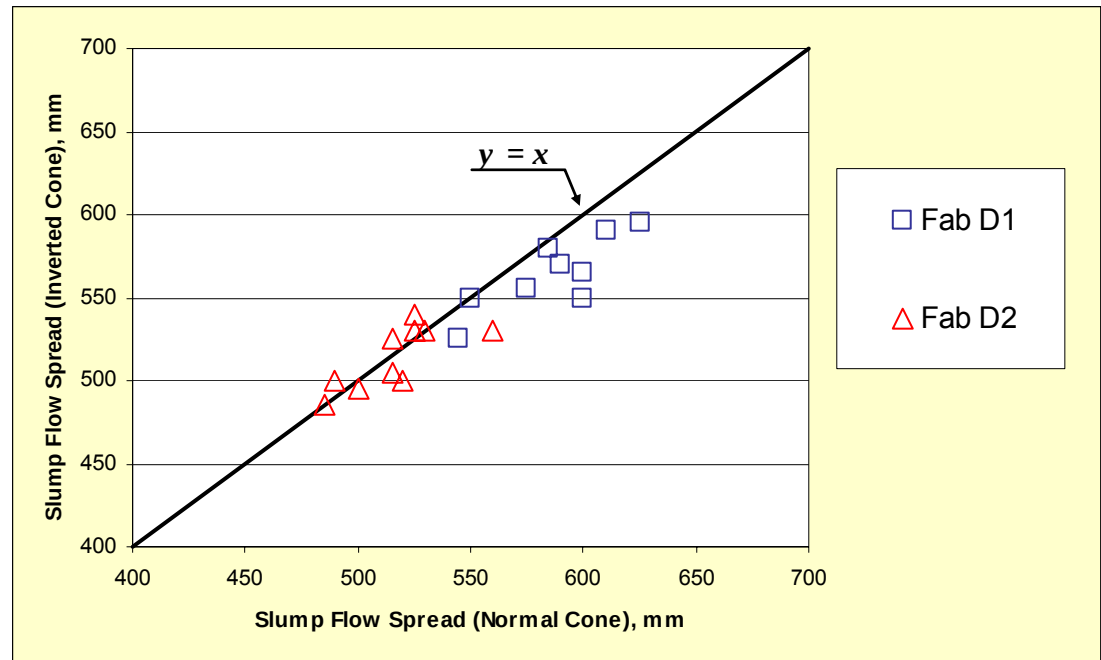


Figure 5.1: The influence of cone orientation when performing slump flow spread testing.

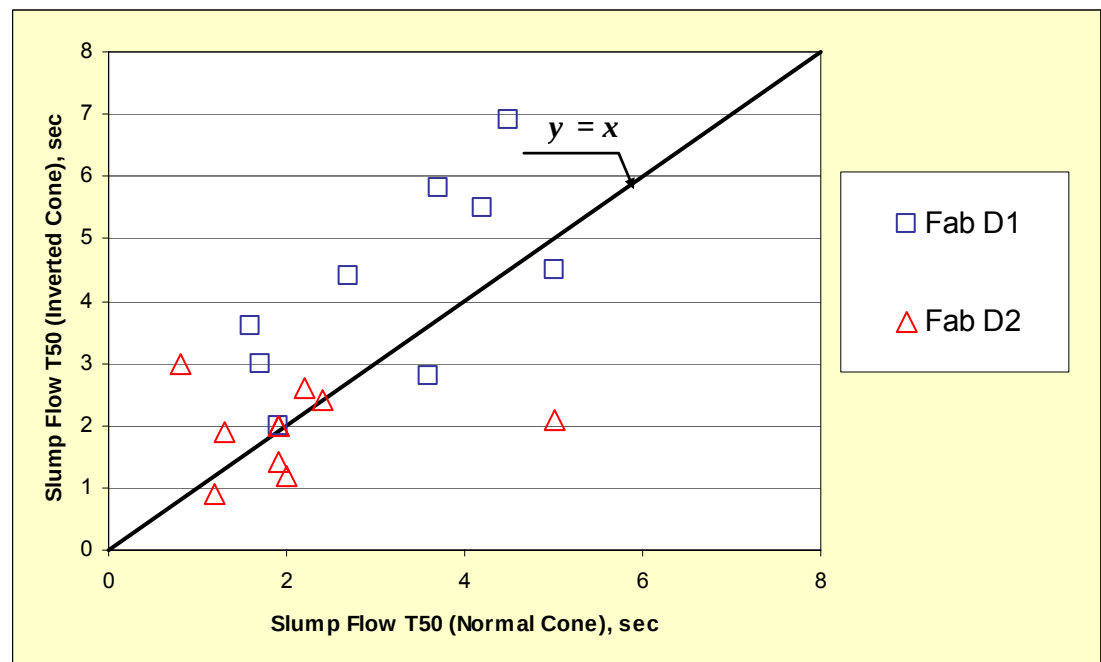


Figure 5.2: The influence of cone orientation when performing slump flow T50 testing.

5.1.2 Slump flow spread and J-ring spread

Corresponding values of slump flow spread and J-ring spread are shown in Figure 5.3., and Figure 5.4 shows the same plot where data point corresponding to concrete exhibiting blocking or segregation have been removed. Blocking in this respect was defined as SCC having a blocking step larger than 20mm, and likewise seg-

regation was defined as a change in blocking step larger than 50%.

As can be seen from Figure 5.3 the majority of data points are within the reproducibility limits (dashed lines) established in the TESTING-SCC project (1). If the concrete mixtures with tendency to blocking or segregation are removed then Figure 5.4 indicates that the reproducibility relationship established in TESTING-SCC (1) holds quite well.

It should be noted that more than 50% of the tested SCC actually exhibited tendency to blocking and segregation with the suggested limiting values being blocking step larger than 20mm and change in blocking step larger than 50%. This seems to indicate that the criteria, particular for poor passing ability, is too strict or that the SCC produced is mainly used for constructions where passing ability is not an issue such as floors or lightly reinforced walls. In the case of the Danish production sites this is certainly true as all the concrete was used for floors.

A different criterion for passing ability using the J-ring found in the literature is a maximum difference between slump flow spread and j-ring spread of 50mm. However, most of the SCC that fall beyond the blocking step limit of 20mm also would be considered as having poor passing ability using criterion of max. 50mm difference between slump flow spread and J-ring spread.

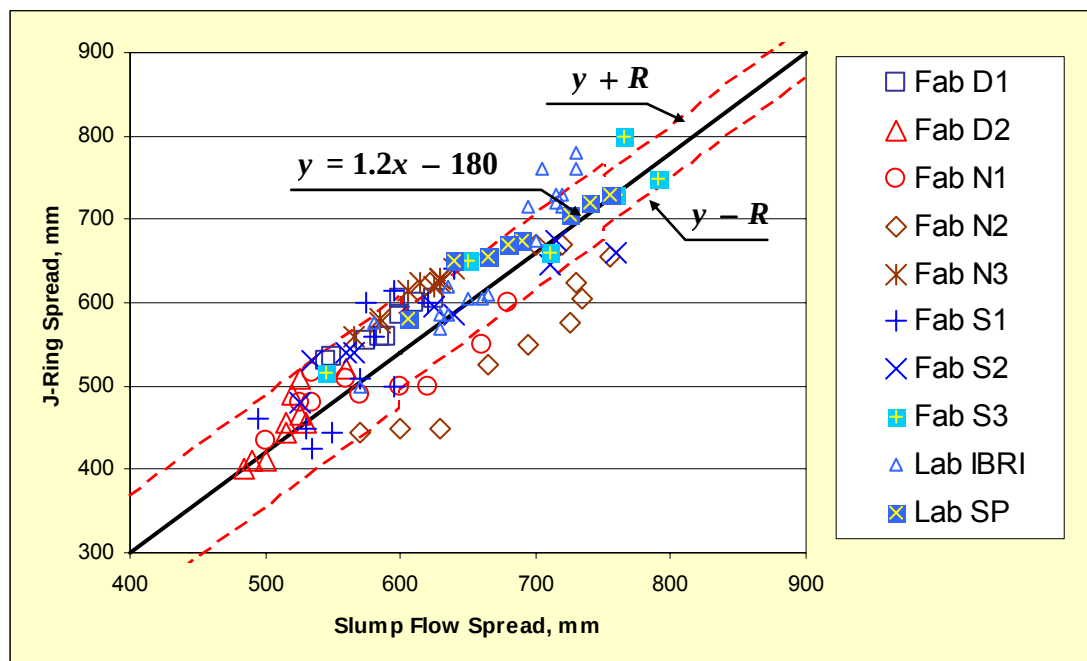


Figure 5.3: All measurements of J-ring spread versus slump flow spread. Dashed lines indicate the reproducibility limits established in the "TESTING SCC" project (1).

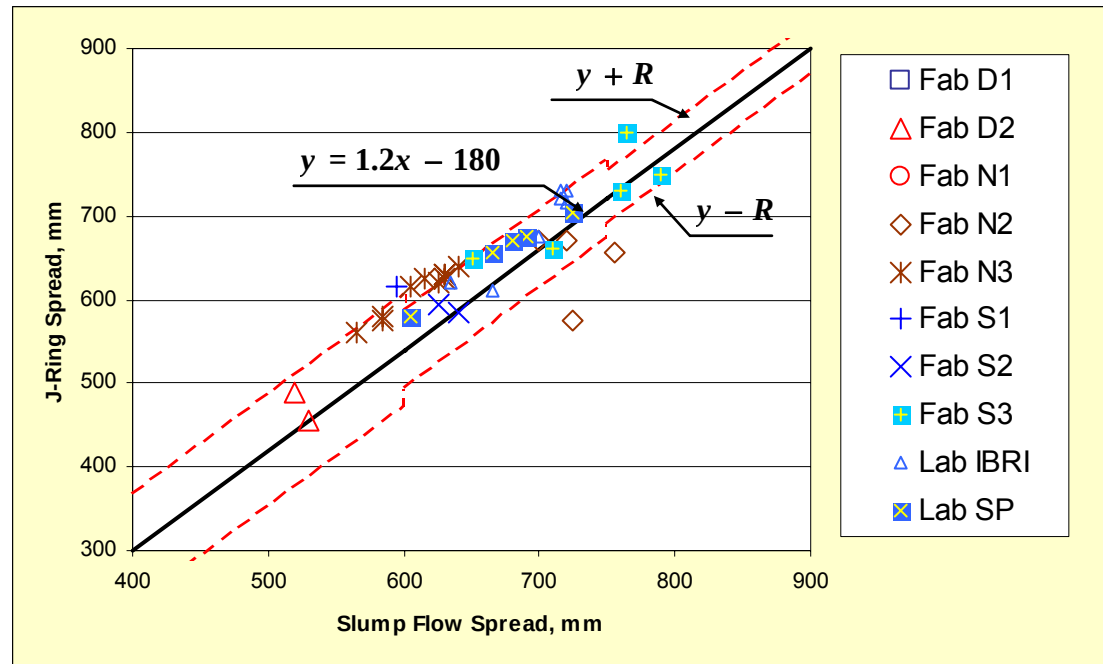


Figure 5.4: Measurements of J-ring spread versus slump flow spread for SCCs not showing blocking ($BJ > 20\text{mm}$) or segregation ($\delta BJ > 50\%$). Dashed lines indicate the reproducibility limits established in the "TESTING SCC" project (1).

5.1.3 Slump flow T_{50} and J-ring slump flow T_{50}

Plots of J-ring T_{50} versus slump flow T_{50} are shown in Figure 5.5 and Figure 5.6. As can be seen there is often considerable difference between J-ring T_{50} and slump flow T_{50} . At least in theory the J-ring T_{50} should be higher than the slump flow T_{50} , as the restriction to the concrete flow imposed by the J-ring bars should increase the T_{50} . Even though this is also the general trend observed a considerable number of tests show the opposite trend. This is perhaps an indication that in practice the T_{50} measurement using a manually operated stopwatch does occasionally result in human measurement errors.

Whereas the T_{50} -value provides information about the rate of deformation within a given flow distance the significance of the J-ring T_{50} measurement is less clear, i.e. the additional information obtained by recording this value is limited at best. Consequently, the measurement the J-ring T_{50} was removed from the proposed NT BUILD method.

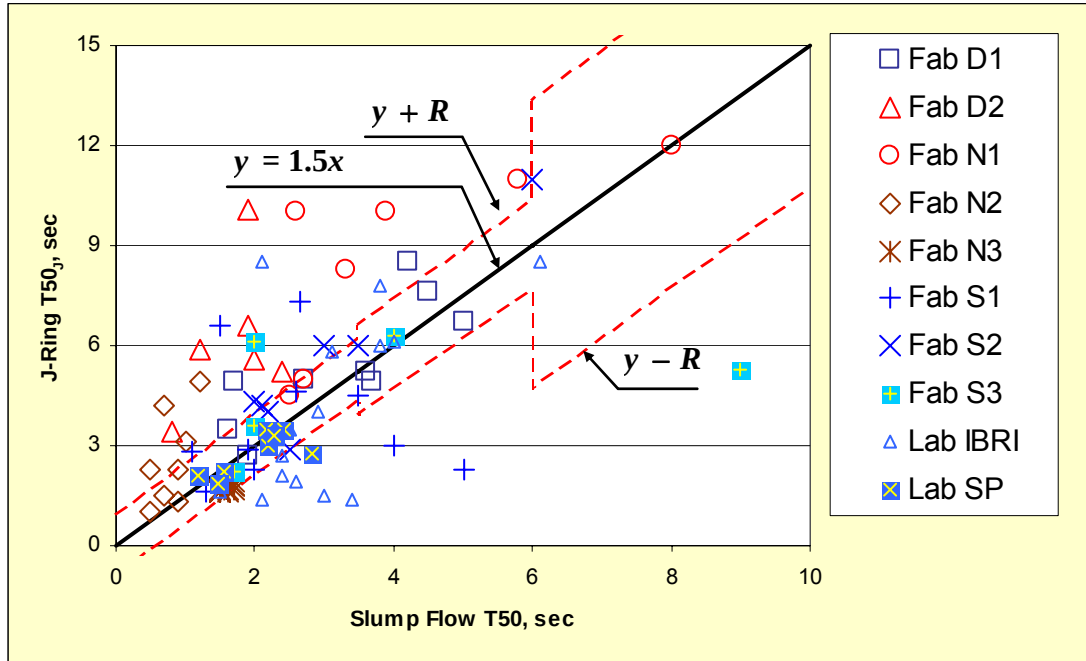


Figure 5.5: All measurements of J-ring T₅₀ versus slump flow T₅₀. Dashed lines indicate the reproducibility limits established in the "TESTING SCC" project (1).

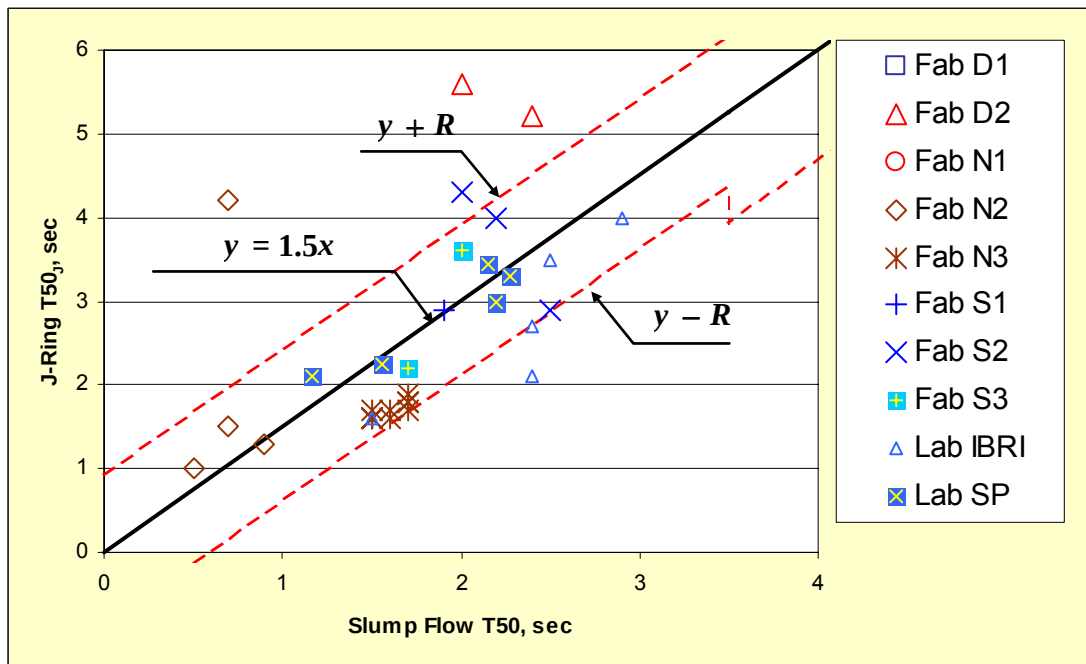


Figure 5.6: Measurements of J-ring T₅₀ versus slump flow T₅₀ for SCCs not being very viscous or showing blocking (BJ > 20mm) or segregation ($\delta BJ > 50\%$). Dashed lines indicate the reproducibility limits established in the "TESTING SCC" project (1).

5.1.4 Passing ability (blocking)

Passing ability is the ability of the fresh concrete to pass confined section of the formwork, dense reinforcement, etc., without the aggregate blocking. Passing ability was evaluated by performing the slump flow test with a J-ring on the base plate. The difference in height between the center of the concrete and the concrete just outside the J-ring is measured and termed the “blocking step” (see appendix I for detailed description of test method).

Figure 5.7 shows all the obtained blocking step values as a function of J-ring spread. Two red lines are drawn on the figure. The horizontal line corresponds to a blocking step value of 20mm, i.e. the current tentative maximum value for good passing ability. The vertical red line corresponds to a J-ring spread of 500mm below which virtually all recorded blocking step values are higher than 20mm, i.e. all SCCs exhibit poor passing ability. Figure 5.7 also shows that up to a J-ring spread of at least 600mm more often than not are poor passing ability observed.

It should be noted that more than 50% of the tested SCC actually exhibited tendency to blocking and segregation with the suggested limiting values being blocking step larger than 20mm and change in blocking step larger than 50%. This seems to indicate that the criteria, particular for poor passing ability, is too strict or that the SCC produced is mainly used for constructions where passing ability is not an issue such as floors or lightly reinforced walls. In the case of the Danish production sites this is certainly true as all the concrete was used for floors.

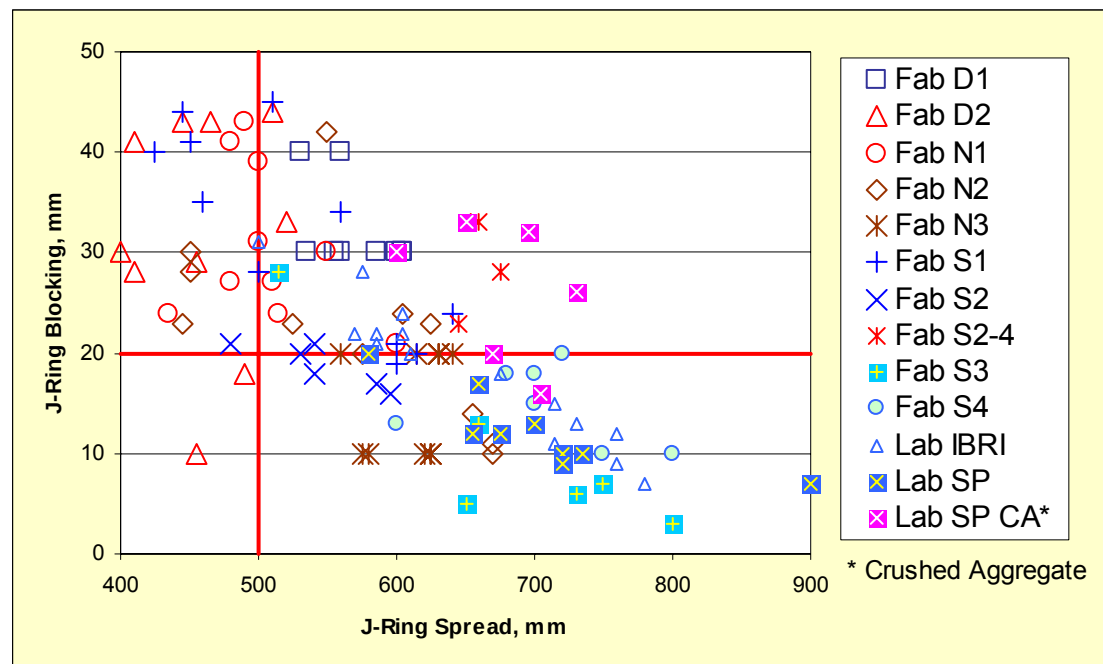


Figure 5.7: All recorded data for J-ring blocking step versus J-ring spread. The vertical line represents a J-ring spread of 500mm and the horizontal line represents a blocking criterion of

blocking step $BJ \geq 20\text{mm}$, i.e. values higher than 20mm indicate risk of blocking.

5.1.5 Segregation

Perhaps the greatest challenge of SCC production is to avoid segregation. Segregation is accounting for most of the cases of SCC failure. However, no commonly accepted method for assessing the tendency to segregation of SCC exists. In the “European Guidelines for Self-Compacting Concrete” (4) a test method is described where concrete is poured into a bucket and allowed to stand for 15 minutes. Hereafter, the upper 5 kg of concrete is poured onto a 5 mm sieve and the amount of concrete passing the sieve in 2 minutes is recorded, and a segregation ratio is calculated as the proportion of material passing through the sieve.

In the present project tendency to segregation was evaluated based on the difference in blocking step between successive J-ring tests on SCC in the top and bottom of a bucket that has been resting for 2 minutes. The segregation indicator is the relative difference in blocking step between the two J-ring measurements. If considerably more coarse aggregate are found in the bottom part of the SCC than in the top then the J-ring blocking step should be significantly higher for the bottom SCC than for the top SCC. As such the test evaluates the tendency to static segregation, and does obviously not provide information about the dynamic segregation which is sometimes seen to take place in formwork due to specific aspects of the particular casting, i.e. the fact the SCC does not exhibit static segregation is no guarantee that it will not segregate during casting. However, if static segregation is detected then there is good reason not to use the concrete for any type of casting, i.e. a poor concrete is always a poor concrete, whereas a good concrete can be turned into a poor concrete due to poor execution.

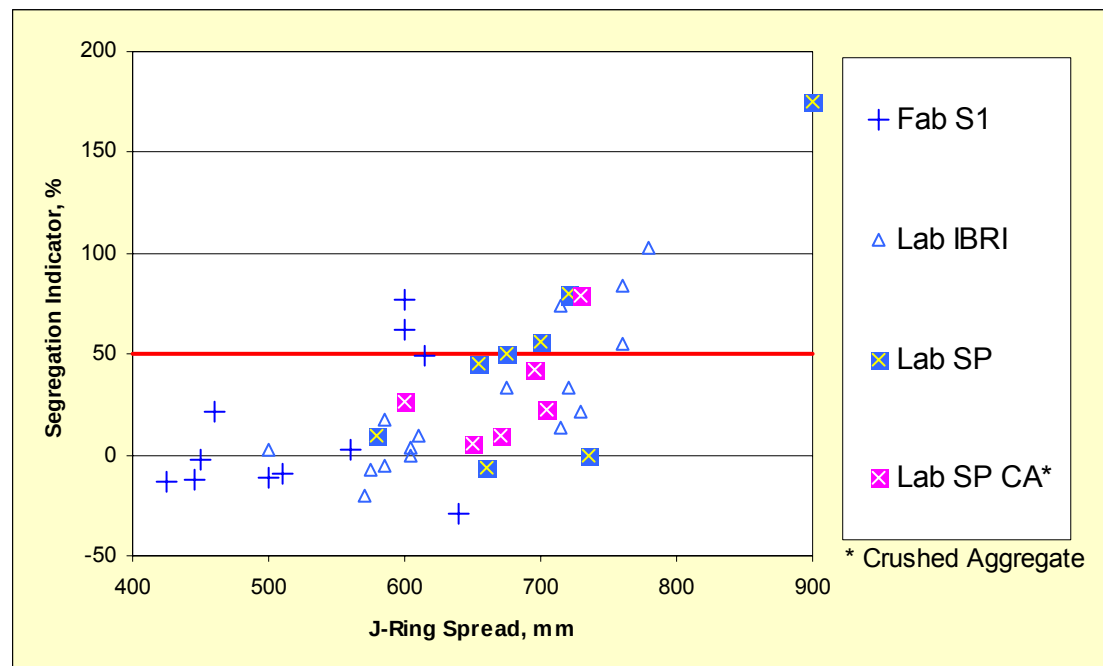


Figure 5.8: All recorded data for resistance to segregation versus J-ring spread. The horizontal line represents a segregation

criterion of “change in blocking step”, $\delta BJ \geq 50\%$, i.e. values larger than 50% indicate risk of segregation.

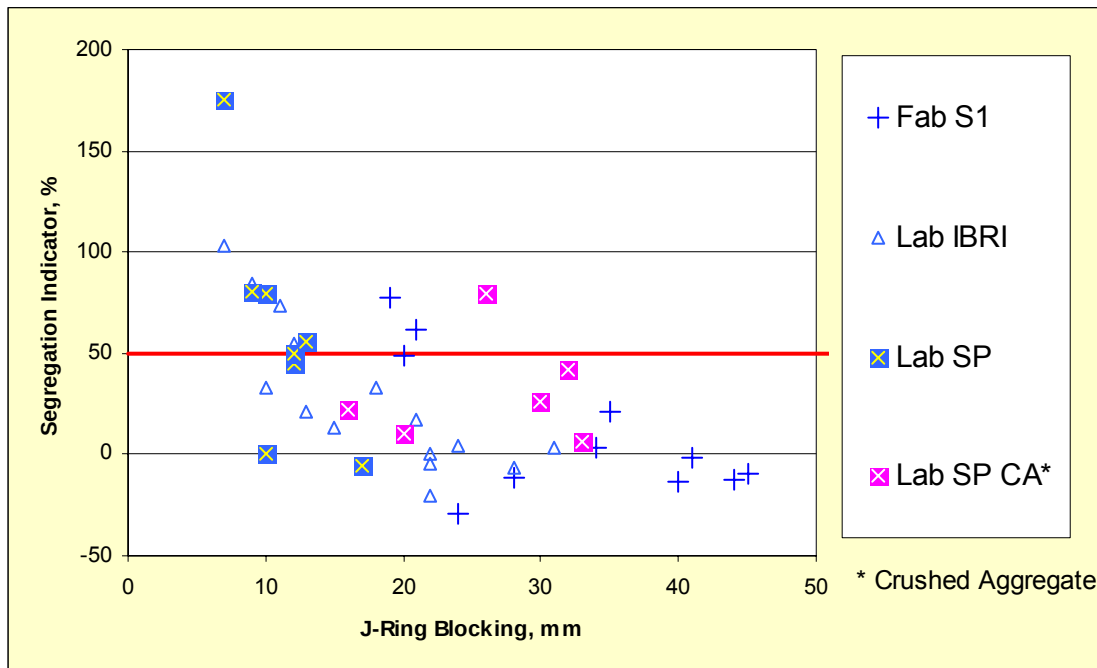


Figure 5.9: All recorded data for resistance to segregation versus J-ring blocking. The horizontal line represents a segregation criterion of “change in blocking step”, $\delta BJ \geq 50\%$, i.e. values larger than 50% indicate risk of segregation.

All the results on tendency to segregation is illustrated in Figures 6.8 and 6.9. The two figures seems to indicate that static segregation is rarely observed for concrete with low filling ability and low passing ability. Rather segregation is much more of a risk for the very flowable concrete with J-ring spreads above 750 mm. This is intuitively not very surprising, and it is an indication that the proposed segregation that has not been tested elsewhere before is yielding promising results.

It would be advisable though to do documentation of the segregation indicator parameter. For instance corresponding values of segregation indicator versus actual segregation in cast concrete specimens would be valuable. The corresponding parameter could be distance from concrete top surface to coarse aggregate particles.

Also, most results on the segregation indicator are from laboratory experiments, and it would be good to have more data from concrete production sites.

5.2 Air content, density and casting of test specimens

The major issue concerning measurement of air content and density and casting of test specimens was how to fill the containers, i.e. whether or not slight compaction should be applied. It was therefore tested whether

striking the container side with a wooden mallet according to Table 5.1 did influence the measured parameters.

Table 5.1: The number of blows to be applied by a wooden mallet to the container with SCC.

Slump flow	< 500	500-600	600-700	>700
Blows by mallet	25	10	5	0

Table 5.2 shows the statistical treatment of results obtained from testing at four different production sites. The data strongly indicate that striking the container by a wooden mallet does not have any significant effect on the measured air content, density or compressive strength. The observations do in most case follow the expected trend that blows by a wooden mallet result in lower air content, higher density and higher strength, however, the trend was by no means perfect and the difference between using a wooden mallet or not was extremely minute. The concrete least affected by the mallet was the one from Fab N1 that had the largest amount of entrained air. On the average the air content was 0.10% lower, the density was 10 kg/m³ higher, and the compressive strength 0.19 MPa higher using the wooden mallet as compared to not using the mallet. Figure 6.10 illustrates the very limited influence of the mallet, as a very close to 1:1 correlation is found between air content, density and strength without mallet versus with mallet.

Table 5.2: Influence on the average, the standard deviation and the coefficient of variation of the parameters air content (%), density (kg/m³), and compressive strength (MPa) from using blows by a wooden mallet on the container/form side. Data obtained from 10-11 measurements on one type of concrete at four different concrete production sites.

Production site	Fab S1			Fab N1			Fab N2			Fab N3		
	Average	Standard deviation	Coefficient of Variation	Average	Standard deviation	Coefficient of Variation	Average	Standard deviation	Coefficient of Variation	Average	Standard deviation	Coefficient of Variation
Air content, without blows (vol%)	2.1	0.76	35.9	6.1	0.94	15.6	3.7	1.17	31.7	1.1	0.16	14.6
Air content, with blows (vol%)	2.2	0.90	41.5	6.0	1.03	17.3	3.5	1.12	32.4	1.0	0.17	17.6
Density, without blows (kg/m ³)	2409	16.9	0.70	2332	15.5	0.66	2327	29.5	1.27	2297	3.9	0.17
Density, with blows (kg/m ³)	2419	16.9	0.70	2333	17.0	0.73	2341	30.8	1.32	2314	7.4	0.32
28 days strength, without blows (MPa)	41.7	2.49	6.0	37.6	4.03	10.7	59.8	3.61	6.0			
28 days strength, with blows (MPa)	41.7	2.50	6.0	37.2	3.71	10.0	60.7	3.50	5.8			

Based on the very limited effect of the use of the wooden mallet it was decided for the NT BUILD not to recommend use of the mallet, i.e. light compaction of SCC, even for SCC with low filling ability.

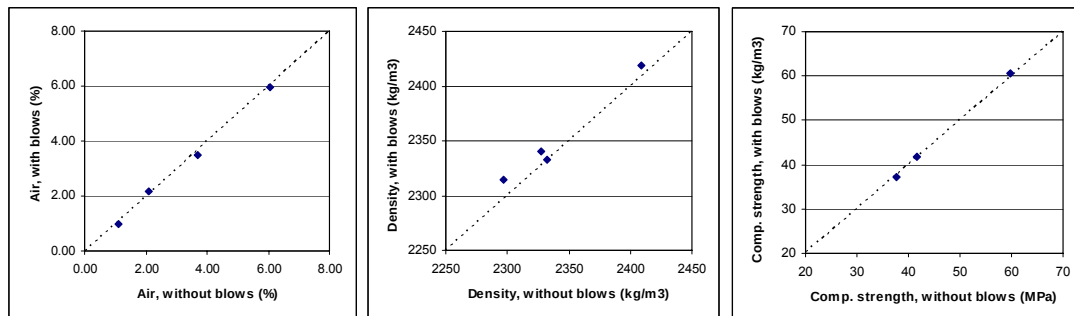


Figure 5.10: Air content, density and compressive strength obtained with or without the use of a wooden mallet to lightly compact the SCC.

6. Dissemination of project results

The main outcome of the present project is the proposed NT BUILD method “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens” which is attached as Appendix I. The experimental work behind the proposed Nordtest method have been summarized in the present report’s preceeding sections, and all the raw data from the concrete production sites are found in Appendix II.

6.1 Comments from Nordic SCC Net

Prior to the completion of the proposed NT BUILD method the draft method was submitted to the Nordic SCC Net⁴ for commenting. The project received back seven responses that were all positive towards the method in general although some were suggesting minor changes in the test procedures. The comments from the Nordic SCC Net resulted in two changes to proposed NT BUILD. One of the sought after elements that the project were unable to accommodate was a guideline on how to interpret the results obtained, i.e. is a slump flow of 570 mm sufficient for an in-situ wall casting where the SCC is being dropped into the formwork, or is a blocking step of 18 mm a problem if the structure to be cast is heavily reinforced. It is the opinion of the project that such construction specific questions cannot in general be answered with the current level of knowledge about SCC. Indeed, the use of common methods of characterizing SCC such as the proposed NT BUILD is needed over an extended period of time to generate sufficient experience to be specific about what SCC parameters are preferred in connection with a particular type of concrete casting. The proposed NT BUILD is therefore a tool offered to the industry that should enable experience to be collected based on the common ground that everybody has been using the same test procedure.

⁴ Nordic SCC Net is a network of concrete technologists with special interest in SCC. The network is financed in part by the Nordic Innovation Centre as project 03037.

6.2 Nordic national standardization committees

The proposed NT BUILD method has been communicated to the members of Nordic Committee on Concrete Standardisation (NUBS - Nordisk Udvalg for BetonStandardisering):

Country	Committee	Person
Denmark	NUBS	Find Meyer Erik Stoklund Larsen Anette Berrig Svend Øjvind Olesen
Sweden	NUBS	Evert Sandahl Bo Westerberg
Norway	NUBS	Steinar Helland Steinar Lievestadt
Finland	NUBS	Tauno Hietanen Casper Ålander Klaus Söderlund
Iceland	NUBS	No current member

6.3 European CEN committee

The proposed NT BUILD has been communicated to the CEN committee TC 104/TG 8.

7. Conclusion

A set of test methods for evaluating the quality of self-compacting concrete was tested in the daily production at different concrete production sites. The methods had previously only been documented in the laboratory. The results from the production sites showed that it was possible to obtain the same statistical accuracy of measurements as in the concrete laboratory. The concrete producers were generally happy with the test methods. The test methods have been combined into the proposed NT BUILD Method titled “Quality control of fresh self-compacting concrete - Workability, air content, density and casting of test specimens” that is submitted to Nordtest for consideration together with the present report. Also, the proposed NT BUILD has communicated to NUBS (Nordic Committee on Concrete Standardisation) and to the European CEN committee TC 104/TG 8.

8. References

1. Testing-SCC, “Measurement of Properties of Fresh Self-Compacting Concrete”, EU Project (5th FP GROWTH) GRD2-2000-30024/G6RD-CT-2001-00580, Deliverable 18, “Evaluation of Precisions of Test Methods for Self-Compacting Concrete - WP6 Report”, 2004.
2. ASTM C 1611/C 1611M – 05, Standard Test Method for Slump Flow of Self-Compacting Concrete
3. DS 2426, Concrete Materials – Rules for application of DS/EN 206-1 in Denmark, Annex U, May 2004.
4. European Guidelines for Self-Compacting Concrete – Specification, Production and Use, BIBM, CEMBUREAU, ERMCO, EFCA, EF-NARC, May 2005.

Appendix I

Nordtest NT BUILD Proposal

**Quality control
of
fresh self-compacting concrete**

- Workability, air content, density
and casting of test specimens**

A Nordtest NT BUILD Proposal

January 2006

CONCRETE, MOTAR AND CEMENT BASED REPAIR MATERIALS: Quality control of fresh self-compacting concrete – workability, air content, density and casting of test specimens

Keywords: Concrete, self-compacting concrete, J-ring, slump flow, workability, air content, density, test specimen

1 SCOPE

This procedure is for the quality control of the of fresh self-compacting concrete.

With respect to air content, density and casting of test specimens this method is in accordance with EN 12350-6, and EN 12350-7 shall be used except for the sections given in the present document. These sections are superior to EN-12350.

2 FIELD OF APPLICATION

The method is applicable to self-compacting concrete with a slump flow of 500 mm or higher as determined by the method described in this procedure without J-ring.

3 REFERENCES

- /1/ Swedish Concrete Association, "Self-compacting concrete – Recommendations for use", Concrete Report No. 10 (E), 2002.
- /2/ Testing-SCC, "Measurement of Properties of Fresh Self-Compacting Concrete", EU Project (5th FP GROWTH) GRD2-2000-30024/G6RD-CT-2001-00580, Deliverable 18, "Evaluation of Precisions of Test Methods for Self-Compacting Concrete - WP6 Report", 2004.
- /3/ NICE project report, Final report "Test methods for SCC".
- /4/ EN 12350-1, Testing fresh concrete Part 1: Sampling
- /5/ EN 12350-7, Testing fresh concrete Part 6: Density
- /6/ EN 12350-7, Testing fresh concrete Part 7: Air content - Pressure method

4 DEFINITIONS

SCC: The abbreviation of self-compacting concrete.

Workability: The filling properties of fresh concrete in relation to the behaviour of the concrete in the production process, described in the terms of filling ability, passing ability and resistance to segregation.

Filling ability: The ability of the fresh concrete to flow under gravitation, or under pressure (e.g. pumping) and totally fill formwork and enclose reinforcement.

Passing ability: The ability of the fresh concrete to pass confined section of the formwork, dense reinforcement, etc., without the aggregate blocking.

Resistance to segregation: The ability of the fresh concrete to retain its homogeneity during the casting process and when the concrete has come to rest.

5 TEST METHODS

It is of outmost importance that the concrete tested is representative. When sampling concrete from a truck 0.3 m³ should be emptied before taking the sample for testing.

5.1 Workability

5.1.1 Principle

The test aims at evaluating the workability of fresh SCC. The slump flow without J-ring indicates the free, unrestricted deformability of SCC (filling ability), while the slump flow with J-ring indicates the restricted deformability of SCC due to blocking effect of reinforcement bars (passing ability). The flow-time T50 indicates the rate of deformation within a defined flow distance. The difference in test results from different sampling indicates the inhomogeneity of SCC due to e.g. segregation.

If there is a requirement to passing ability, the test of slump flow with J-ring can be used.

On the suspicion that segregation might occur, two tests of slump flow with J-ring can be carried out, one with the fresh SCC from the upper portion of the sample in a bucket and another with the fresh SCC from the lower portion of the sample in the same bucket.

5.1.2 Apparatus

- Base plate of size at least 900 × 900 mm, made of impermeable and rigid material (steel or plywood [Note 1]) with smooth and plane test surface (deviation of the flatness not exceed 3 mm [Note 2]), and clearly marked with circles of Ø200 mm and Ø500 mm at the centre, as shown in Annex 1.
- Abrams cone with the internal upper/lower diameter equal to 100/200 mm and the height of 300 mm.
- J-ring (dimensions as shown in Annex 2).
- Weight ring (>9 kg, to keep Abrams cone in place during sample filling. An example of its dimensions is given in Annex 3). Alternatively, a cast iron cone may be used as long as the weight of the cone exceeds 10 kg. As a second alternative the cone may be kept in position by human force.
- Cleaning rag.
- Stopwatch with the accuracy of 0.1 second.
- Straight rod with for example triangular cross section with a length of about 400 mm and the flexure on at least one flat side < 1 mm.
- Ruler (graduated in mm).
- Clean, wetted and squeezed towel or cloth.

- Bucket, made of rigid plastic or metal with the inside diameter of 300 ± 10 mm and capacity of about 14 litres.

Note 1: Wear or damage of the surface coating of plywood plates may affect the flow of concrete.

Note 2: The deviation of the flatness of the test surface is defined as the greatest difference in height between the highest and the lowest points on that surface, while disregarding any small single cavities in the surface.

5.1.3 Test procedures

5.1.3.1 Sampling

Fill the bucket with about 6 litres of representative fresh SCC. Let the sample stand still for about 1 minute (± 10 seconds).

If the resistance to segregation is to be tested an additional bucket is filled with 12 litres of representative fresh SCC. Let the sample stand still for 2 minutes (± 10 seconds).

5.1.3.2 Testing

- Pre-wet the surface of the base plate with water and remove the surplus either by a cleaning rag or by placing the plate vertically.
- Place the cleaned base plate in a stable and level position.
- Place the cone (interior moistured with a towel) in the center of the base plate on the 200 mm circle and put the weight ring on the top of the cone to keep it in place. (If a heavy cone is used, or the cone is kept in position by hand no weight ring is needed).
- Fill the cone with the sample from the bucket without any external compacting action such as rodding or vibrating. The surplus concrete above the top of the cone has to be struck off, and any concrete remaining on the base plate has to be removed.
- Check and make sure that the test surface is neither too wet nor too dry. No dry area on the base plate is allowed and any surplus of the water has to be removed – the moisture state of the plate has to be 'just wet'.
- If passing ability or resistance to segregation is to be evaluated then place the J-ring around the cone.
- After a short rest (no more than 30 seconds for cleaning and checking the moist state of the test surface), lift the cone perpendicular to the base plate in a single movement, in such a manner that the concrete is allowed to flow out freely without obstruction from the cone. Start the stopwatch the moment the cone loses contact with the base plate. Stop the stopwatch when the front of the concrete first touches the circle of diameter 500 mm. The stopwatch reading is recorded as the T50 value. The test is completed when the concrete flow has ceased. Do not touch the base plate or otherwise disturb the concrete until the measurements described below are completed.

If the J-ring is used, lay the straight rod with the flat side on the J-ring and measure the relative height differences (as shown in Annex 2) between the lower edge of the straight rod 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). For non-circular concrete spreads the x -direction is that of the largest spread diameter. By means of these height differences the value of blocking step B_J (the difference in height in the centre and outside the ring) can be calculated.

The largest diameter of the flow spread, $d_{\max}$, and the one perpendicular to it, d_{perp} , are measured using the ruler (reading to nearest 5 mm). Care should be taken to prevent the ruler from bending.

After testing, the base plate and cone should be cleaned to keep their surface conditions constant.

If resistance to segregation is to be tested, the above procedures should be performed twice using the top half and the bottom half respectively of the 12 litres sample in the bucket as described in 5.1.3.1. The change in the blocking step between the two measurements is an indication of segregation resistance. When the relative change is larger than 50% and the absolute difference in blocking step between the two measurements is larger than its repeatability limit (see Table 1 in 5.1.5.1), there is a risk of segregation.

5.1.4 Expression of the results

- Flow spread [mm]: The flow spread S is the average of diameters $d_{\max}$ and d_{perp} , as shown in Equation (1). S is expressed in mm to the nearest 5 mm. If the J-ring is used, the symbol S_J can be used to differ from that without J-ring.

$$S = \frac{(d_{\max} + d_{\text{perp}})}{2} \quad (1)$$

- Blocking step B_J [mm] (for the test with J-ring): See Equation (2), expressed to the nearest 1 mm.

$$B_J = \frac{(\Delta h_{x1} + \Delta h_{x2} + \Delta h_{y1} + \Delta h_{y2})}{4} - \Delta h_0 \quad (2)$$

- Change in the blocking step δ_{BJ} (for the test of resistance to segregation): See Equation (3), expressed to the nearest 1%.

$$\delta_{BJ} = \frac{(B_{J2} - B_{J1})}{B_J} \times 100 \quad (3)$$

where, B_{J1} and B_{J2} denote the blocking step from the first and the second measurements, respectively, and $\overline{B_J}$ is the mean value of the two measurements.

5.1.5 Accuracy

5.1.5.1 Repeatability

The repeatability r is defined as a maximal difference between any two values from 20 measurements by the same operator. The values of r for flow spread, T50 and J-ring blocking step are given in Table 1.

Table 1: Repeatability values*

Flow spread S [mm]	≤ 600	600 ~ 750	> 750
	N.A.	40	20
Flow spread S _J [mm]	≤ 600	600 ~ 750	> 750
	60	45	25
T50 [sec]	≤ 3.5	3.5 ~ 6	> 6
	0.70	1.20	N.A.
Blocking step B _J [mm], [Note 3]	< 20	>20	
	5	8	

* Based on the inter-laboratory test in /2/ with 2 replicates and 8 laboratories.

N.A.: Not available.

Note 3: SCC of limited filling ability (small flow spreads) may inherently have a blocking step B_J value higher than 20mm even though no apparent blocking can be visually observed. In such cases B_J values higher than 20mm reflects the SCC's inability to pass form-work confinement and reinforcement caused by its low filling ability.

5.1.5.2 Reproducibility

The reproducibility *R* is defined as a maximal difference between any two values from 20 measurements by different operators. The values of *R* for flow spread, T50 and J-ring blocking step are given in Table 2.

Table 2: Reproducibility values*

Flow spread S [mm]	≤ 600	600 ~ 750	> 750
	N.A.	40	30
Flow spread S _J [mm]	≤ 600	600 ~ 750	> 750
	65	45	30
T50 [sec]	≤ 3.5	3.5 ~ 6	> 6
	0.90	1.20	N.A.
Blocking step B _J [mm], [Note 3]	< 20	>20	
	5	8	

* Based on the inter-laboratory test in /2/ with 2 replicates and 8 laboratories.

N.A.: Not available.

5.1.6 Test report

The test report should, if known, include the following information:

- Reference to this standard
- Concrete mixture identification
- Time elapsed from adding the mixing water to sampling
- Test result as well as individual measurement values
- Visual observations if any
- Any deviations from the standard test procedure
- Composition of the concrete

5.2 DENSITY AND AIR CONTENT

5.2.1 Principle

The method for determination of density and air content of SCC is based on EN 12350.

5.2.2 Apparatus

- Pressurimeter of nominal 8L volume. The weight and volume of the container should be known.
- Bucket, made of rigid plastic or metal with the inside diameter of 300 ±10 mm and capacity of about 14 litres.
- Balance with a maximum reading of minimum 25 kg, and an accuracy of ± 0.020 kg.
- Straight edge.

5.2.3 Test procedures

The test procedure is as follows:

- Fill the bucket with 9-10 litres of representative SCC.
- Place the pressurimeter container in a stable and level position.
- Fill the pressurimeter by pouring concrete from the bucket without entrapping excess air [Note 4].
- Level the upper surface of the container using the straight edge.
- Measure the weight of the container with concrete and calculate the density to the nearest 10 kg/m³.
- Place the pressurimeter lid on the container and measure the air content to the nearest 0.1% as described in EN 12350-7.

Note 4: Another way to fill the pressurimeter with concrete is to place an Abrams cone in the pressurimeter container with the smallest diameter downwards (inverted position), and fill the cone with concrete from the bucket without any compacting action. Slowly lift the cone to let the concrete flow into the container without entrapping excess air.

5.2.4 Expression of the results

The results are expressed according to EN 12350.

5.2.5 Accuracy

The accuracy is assumed to be equivalent to EN 12350. However, no investigation of accuracy is currently available.

5.2.6 Test report

The test report should be according to EN 12350.

5.3 TEST SPECIMENS

5.3.1. Principle

Test specimens for e.g. documentation of compressive strength should be cast according to a modified EN 12350.

5.3.2. Apparatus

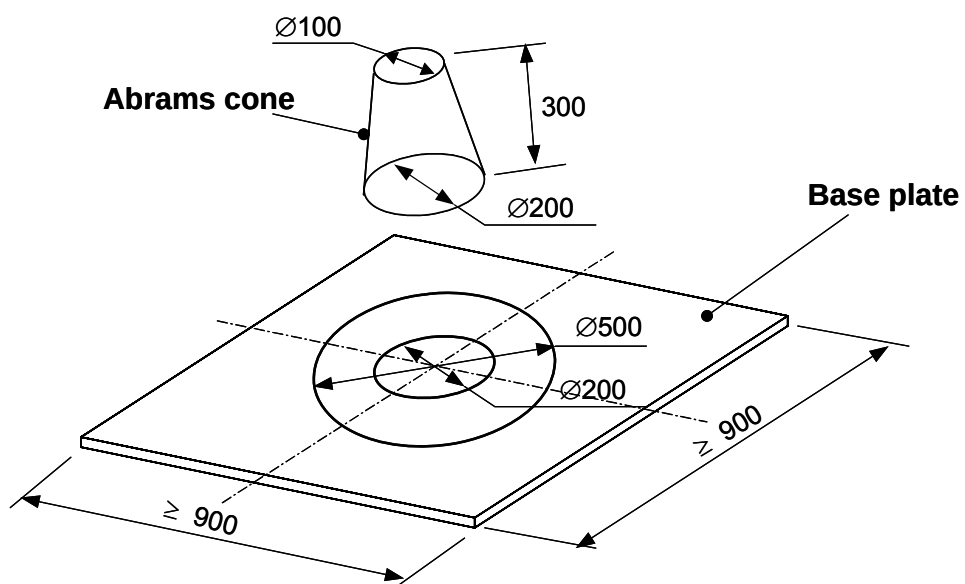
- Mould/form
- Bucket(s)

5.3.3. Test procedures

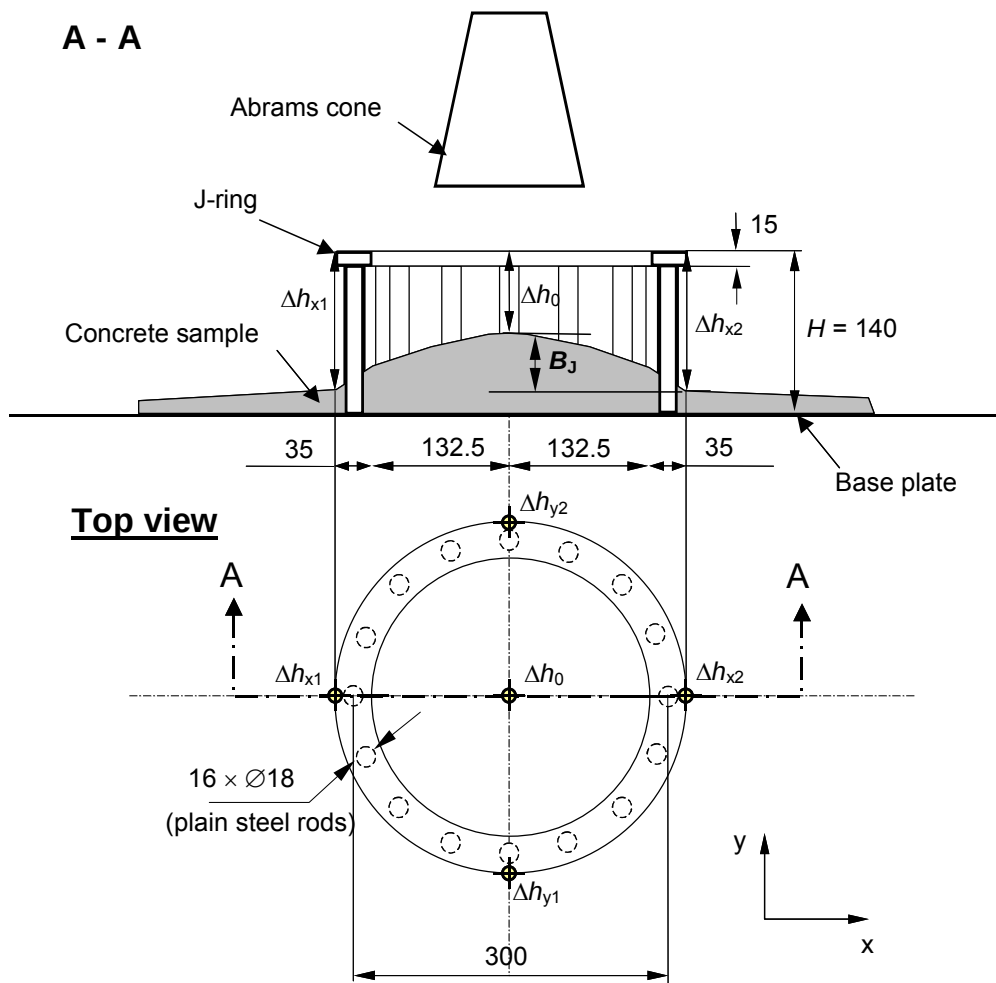
The test procedure is as follows:

- The mould/form is filled with representative SCC by pouring from a bucket.
- The upper surface of the mould/form is levelled with the straight edge.
- The mould/form is stored and cured according to EN 12350.

Annex 1: Dimensions of the base plate and Abrams cone



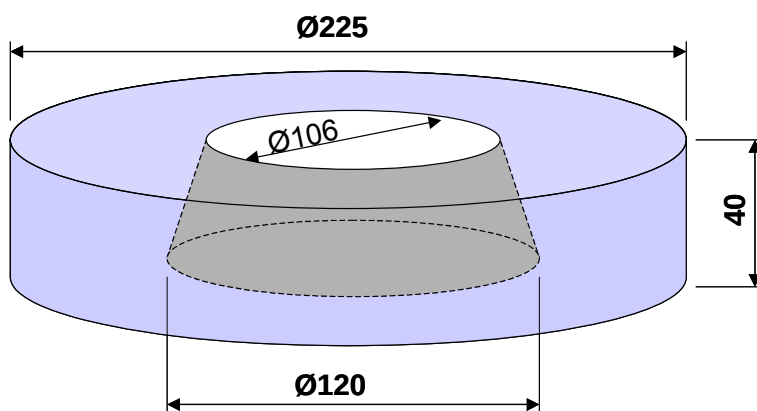
Annex 2: Dimensions of the J-ring and positions for measurement of height differences



Explanations:

- ⊕ Measurement position
- All dimensions in mm

Annex 3: Example of weight ring's dimensions and application in the J-ring test



Material density: 7.8~7.9 g/cm³



Appendix II

**Test results from
concrete production sites**

Protocol for NIC-project

IMPORTANT: Fill the data in the yellow cells ONLY!!!

Test laboratory		IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI	IBRI
Mix ID		42-a	42-b	42-c	43-a	43-b	43-c	44-a	44-b	44-c	45-a	45-b	45-c	46-a	46-b	46-c	47-a	47-b	47-c
Operator		GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK	GK
Date [yyyy-mm-dd]		2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/29	2005/09/30	2005/09/30	2005/09/30	2005/09/30	2005/09/30	2005/09/30	2005/09/30	2005/09/30	2005/09/30
Batch discharge time [hh:mm]		~11:00	~11:00	~11:00	~13:15	~13:15	~13:15	~15:00	~15:00	~15:00	~10:05	~10:05	~10:05	~11:20	~11:20	~11:20	~13:20	~13:20	~13:20
Time, testing start																			
Method	Measurement Items																		
Slump Flow	T50 [sec] (to 0.1 sec)		2.1	6.1	4	3.8	2.9	3.6	3.8	2.9	2.1	3	2.4	2.5	2.6	1.5	3.1	2.4	3.4
	Largest spread d_{max} [mm]	670	630	600	650	640	640	580	670	720	740	740	730	700	700	730	650	720	720
	Perpendicular spread d_{perp} [mm]	660	630	560	620	620	630	560	650	710	720	720	710	700	685	710	650	710	690
J-Ring Test 1	Slump Flow S_f [mm]	665	630	580	635	630	635	570	660	715	730	730	720	700	695	720	650	715	705
	T50 [sec] (to 0.1 sec)	5.2	8.5	8.5	6.1	6		16.2	7.8	4	1.4	1.5	2.7	3.5	1.9	1.6	5.8	2.1	1.4
	Δh_0 [mm]	100	94	89	94	94		84	92	111	118	113	109	105	112		97	111	115
	Δh_{c1} [mm]	120	114	118	115	115		115	119	121	126	125	122	123	126		120	122	124
	Δh_{c2} [mm]	121	113	119	120	115		116	115	122	125	125	125	122	121		120	125	125
	Δh_{c1} [mm]	115	116	115	111	116		114	112	121	124	124	124	122	123		115	126	123
	Δh_{c2} [mm]	125	121	115	114	118		114	117	121	126	125	124	125	121		120	124	125
	Blocking step B_f [mm]	20	22	28	21	22	0	31	24	10	7	12	15	18	11	0	22	13	9
	Largest spread d_{max} [mm]	610	580	590	600	590	625	510	630	730	790	760	720	680	720	735	620	730	770
	Perpendicular spread d_{perp} [mm]	610	560	560	570	580	615	490	580	710	770	760	710	670	710	725	590	730	750
	Spread through J-ring S_f [mm]	610	570	575	585	585	620	500	605	720	780	760	715	675	715	730	605	730	760
J-Ring Test 2	T50 [sec] (to 0.1 sec)	5.6	7.9	18.1	8.5	6.4	4.5	J*	8	5.3	2.9	3.3	4.3	7.4	3.1	2.8	7.9	3.7	3.9
	Δh_0 [mm]	98	94	85	92	92	98	77	94	108	102	103	104	98	100	103	92	108	103
	Δh_{c1} [mm]	115	108	110	119	114	118	111	119	122	122	123	121	126	123	124	111	122	124
	Δh_{c2} [mm]	122	109	107	112	112	119	104	121	123	125	126	124	123	124	125	116	127	125
	Δh_{c1} [mm]	122	115	112	118	108	111	108	116	121	122	122	119	118	124	123	117	122	127
	Δh_{c2} [mm]	122	117	115	117	119	119	114	120	123	125	123	121	123	124	125	112	124	122
	Blocking step B_f [mm]	22	18	26	25	21	19	32	25	14	22	21	17	25	24	21	22	16	22
	Largest spread d_{max} [mm]	610	590	550	580	590	600	520	600	700	690	680	690	630	670	670	550	690	700
	Perpendicular spread d_{perp} [mm]	590	570	520	540	560	600	470	580	700	660	650	660	600	630	670	550	660	620
	Spread through J-ring S_f [mm]	600	580	535	560	575	600	495	590	700	675	665	675	615	650	670	550	675	660
	Segregation Indicator COV_{SI} [%]	10	-20	-7	17	-5	200	3	4	33	103	55	13	33	74	200	0	21	84
Density without blows	t_{v1} , time of termination of test [hh:mm]																		
	Volume (L)																		
	Mass of container (g)																		
Density with blows	Mass of container + concrete (g)																		
	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Volume (L)																		
Air content	Mass of container (g)																		
	Mass of container + concrete (g)																		
	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Strength without blows	Air content, without blows (vol%)																		
	Air content, with blows (vol%)																		
	Air content, without blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Strength with blows	Air content, with blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28 days strength (MPa)																		
	28 days strength (MPa)																		
Visual observations:	28 days strength (MPa)																		
	28 days strength (MPa)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Strength based on (cubes/cylinders)																		
	28 days strength (MPa)																		
	28 days strength (MPa)																		
	28 days strength (MPa)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	28 days strength (MPa)																		
	28 days strength (MPa)																		
	Strength based on (cubes/cylinders)																		
Visual observations:								J* flow stopped after 18.5 sec											blocking was clearly visible after the second blocking test

Protocol for NIC-project

VIGTIGT Udfyld kun de gule felter!

	Provningslaboratorium	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg	Mobillab Esbjerg
	Receipt ID	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--	P25RSFEM16IF-KNV--
	Operator	BJCL	BJCL	BJCL	BJCL	BJCL	BJCL	BJCL	BJCL	BJCL	BJCL
	Dato år-måned-dag	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16	2005/06/16
	Blandetidspunkt	05:46	06:20	06:28	06:36	07:14	07:55	08:25	08:44	08:52	09:07
	Provningsens start	07:02	07:25	07:35	07:45	08:20	08:55	09:20	09:40	09:50	10:05
Method	Måleemner										
Slump Flow DS 2426	T50 sekunder med 0,1 sek	2.4	1.2	2.0	2.6	1.4	1.9	2.0	2.1	0.9	3.0
	Største udbredelse , mm	500	540	550	500	550	510	520	500	540	530
	Vinkelret udbredelse , mm	495	520	530	490	500	500	480	470	520	525
	Udbredelsesmål annekts U , mm	500	530	540	495	525	505	500	485	530	530
Slump Flow	T50 sekunder med 0,1 sek	2.4	2.0	1.9	2.2	1.9	1.3	1.9	5.0	1.2	0.8
	Største udbredelse , mm	520	530	530	510	520	530	510	490	540	570
	Vinkelret udbredelse , mm	520	530	520	490	510	500	470	480	510	550
	Udbredelsesmål NT BUILD	520	530	525	500	515	515	490	485	525	560
J-Ring Test 1	T50 sekunder med 0,1 sek	5.2	5.6	6.6	Uendelig	10.1	Uendelig	Uendelig	Uendelig	5.9	3.4
	Δh ₀ [mm]	100	110	80	95	90	80	85	100	80	85
	Δh _{k1} [mm]	115	120	120	120	120	120	140	140	1254	115
	Δh _{k2} [mm]	115	120	130	130	125	130	120	135	125	120
	Δh _{k1} [mm]	120	120	120	120	120	120	125	120	120	120
	Δh _{k2} [mm]	120	120	120	120	110	120	120	125	125	115
	Blokeringsstrin	18	10	43	28	29	43	41	30	326	33
	Største udbredelse , mm	520	490	500	460	470	460	430	420	535	535
	Vinkelret udbredelse , mm	460	420	430	360	440	430	385	380	480	500
	Udbredelsesmål med J-ring	490	455	465	410	455	445	410	400	510	520
	Volume (L)										7.903
	Vægt af beholder										4.55
Density without blows	Vægt af beholder og beton										22.82
	Densitet kg/m3	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	2.312
Air content	Luftindhold i pct										5.7
	Luftindhold i pct	0.0				0.0	0.0	0.0	0.0	0.0	5.7
Strength without blows	28 dogns styrke MPa										
	28 dogns styrke MPa										
	28 dogns styrke MPa										
	28 dogns styrke MPa	#DIVISION/0!				#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Stryrken målt på											
Andre observationer:					Betonen				Beton blev		
Alle prøver er udtaget					mere stenet				markant stivere		
på byggeplads efter pumpe					end øvrige læs				under prøvningsforløb		

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Andre gule felter!	Kontrolatt:	1495	1499	1502	1532	1534		
	Prøvningslaboratorium	Helsingør	Helsingør	Helsingør	Helsingør	Helsingør	helsingør	Helsingør
	Receipt ID	p20rsfea16lf-knv--heha	p16r-fea16lf-knv--heha	p16r-fea16lf-knv--heha	e40lsfee16lf-ksv--heha	m30rsfea16lf-knv--chth	p25rsfea16-knv--chth	m30rsfee16lf-knv--heha
	Operator							
	Dato år-måned-dag	2005/03/03	2005/03/04	2005/03/17	2005/03/18	2005/03/21	2005/03/22	2005/03/30
	Blandetidspunkt	09:28	12:23	08:20	11:32	10:54	09:25	13:46
	Prøvningens start	09:34	12:27	08:25	11:37	10:59	09:35	13:51
Method	Måleemner							
Slump Flow DS 2426 omvendt kegler	T50 sekunder med 0,1 sek	2.8	4.5	4.4	5.8	3.6	3.0	5.5
	Største udbredelse , mm	560	570	600	540	560	580	560
	Vinkelret udbredelse , mm	540	560	580	510	550	560	540
	Udbredelsesmål anneks U , mm	550	565	590	525	555	570	550
Slump Flow retvendt kegler	T50 sekunder med 0,1 sek	3.6	5.0	2.7	3.7	1.6	1.7	4.2
	Største udbredelse , mm	610	600	620	550	590	590	560
	Vinkelret udbredelse , mm	590	600	600	540	560	590	540
	Udbredelsesmål NT BUILD	600	600	610	545	575	590	550
J-Ring Test 1 retvendt kegler	T50 sekunder med 0,1 sek	5.2	6.7	5.0	4.9	3.5	4.9	8.5
	Δh ₀ [mm]	90	90	90	80	90	80	90
	Δh _{x1} [mm]	120	120	120	120	120	120	120
	Δh _{x2} [mm]	120	120	120	120	120	120	120
	Δh _{y1} [mm]	120	120	120	120	120	120	120
	Δh _{y2} [mm]	120	120	120	120	120	120	120
	Blokeringstrin	30	30	30	40	30	40	30
	Største udbredelse , mm	610	590	620	540	580	570	540
	Vinkelret udbredelse , mm	600	580	580	520	530	550	530
	Udbredelsesmål med J-ring	605	585	600	530	555	560	535
Density without blows	Volume (L)	7.999	7.999	7.999	7.999	7.999	7.999	7.999
	Vægt af beholder	5.76	5.76	5.76	5.76	5.76	5.76	5.76
	Vægt af beholder og beton	24.06	23.70	23.70	23.80	23.50	23.88	23.57
	Densitet kg/m³	2,288	2,243	2,243	2,255	2,218	2,265	2,226
Air content	Luftindhold i pct	4.0	4.8	4.6	6.0	6.0	4.0	7.0
	Luftindhold i pct	4.0	4.8	4.6	6.0	6.0	4.0	7.0
Strength without blows	28 døgns styrke MPa	29.9	25.1		51.3			
	28 døgns styrke MPa	30.5	25.1		48.4			
	28 døgns styrke MPa				51.7			
	28 døgns styrke MPa	30.2	25.1	#DIVISION/0!	50.5	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Stryken målt på	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders
	Andre observationer							

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Prøvningslaboratorium	Helsingør	Helsingør				
Receipt ID	p16r-fea16if-knv--	p25rsfea16if-knv--				
Operator	heha	heha				
Dato år-måned-dag	2005/03/31	2005/04/13				
Blandetidspunkt	11:46	10:17				
Prøvningens start	11:51	10:25				

[illegible]

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Test laboratory: Mix ID: Operator: Date [yyyy-mm-dd]: Batch discharge time [hh:mm]: Time, testing start	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand	Kr.sand
	511102	511102	511102	511102	511102	511102	511102	511102	511102	511102
	ESDA	ESDA	ESDA	ESDA	ESDA	ESDA	ESDA	ESDA	ESDA	ESDA
	2005-05-26	2005-06-27	2005-06-27	2005-29-06	2005-30-06	2005-27-07	2005-29-07	2005-29-07	2005-16-08	2005-16-08
	13:05	10:30	13:15	13:00	12:20	11:00	12:35	14:45	15:45	16:15
	13:10	10:35	13:20	13:05	12:25	11:05	12:40	14:50	15:50	16:20

Method	Measurement Items										
Slump Flow	T50 [sec] (to 0.1 sec)	1.5	1.7	1.5	1.6	1.7	1.5	1.6	1.5	1.7	1.7
	Largest spread d_{max} [mm]	650	590	630	640	640	610	620	640	570	590
	Perpendicular spread d_{perp} [mm]	630	580	620	620	620	600	610	620	560	580
	Slump Flow S [mm]	640	585	625	630	630	605	615	630	565	585
J-Ring Test 1	T50 [sec] (to 0.1 sec)	1.6	1.9	1.6	1.6	1.8	1.7	1.7	1.6	1.8	1.7
	Δh_0 [mm]	100	100	100	100	100	100	100	100	110	110
	Δh_{k1} [mm]	120	110	110	120	110	120	110	120	130	120
	Δh_{k2} [mm]	120	110	110	120	110	120	110	120	130	120
	Δh_{y1} [mm]	120	110	110	120	110	120	110	120	130	120
	Δh_{y2} [mm]	120	110	110	120	110	120	110	120	130	120
	Blocking step B_j [mm]	20	10	10	20	10	20	10	20	20	10
	Largest spread d_{maxj} [mm]	640	580	620	630	630	620	630	630	560	580
	Perpendicular spread d_{perpj} [mm]	640	570	620	630	620	610	620	630	560	580
	Spread through J-ring S_j [mm]	640	575	620	630	625	615	625	630	560	580
J-Ring Test 2	T50 _j [sec] (to 0.1 sec)										
	Δh_0 [mm]										
	Δh_{k1} [mm]										
	Δh_{k2} [mm]										
	Δh_{y1} [mm]										
	Δh_{y2} [mm]										
	Blocking step B_j [mm]	0	0	0	0	0	0	0	0	0	0
	Largest spread d_{maxj} [mm]										
	Perpendicular spread d_{perpj} [mm]										
	Spread through J-ring S_j [mm]	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Density without blows	Segregation Indicator COV _{Bj} [%]	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
	t _{V1} , time of termination of test [hh:mm]	13:15	10:45	13:30	13:15	12:35	11:15	12:50	15:00	15:55	16:25
	Volume (L)	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Mass of container (g)										
	Mass of container + concrete (g)	18315	18380	18360	18330	18410	18380	18400	18380	18400	18390
	Density (kg/m3)	2289	2298	2295	2291	2301	2298	2300	2298	2300	2299
	Volume (L)	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Mass of container (g)										
	Mass of container + concrete (g)	18565	18480	18410	18440	18600	18490	18520	18520	18565	18540
	Density (kg/m3)	2321	2310	2301	2305	2325	2311	2315	2315	2321	2318
Air content	Air content, without blows (vol%)	1.3	1.1	0.9	1.1	0.8	1.1	1.0	1.1	1.3	1.2
	Air content, with blows (vol%)	1.2	1.0	0.8	1.0	0.6	1.0	0.9	1.0	1.1	1.1
	Air content, without blows (vol%)	1.3	1.1	0.9	1.1	0.8	1.1	1.0	1.1	1.3	1.2
	Air content, with blows (vol%)	1.2	1.0	0.8	1.0	0.6	1.0	0.9	1.0	1.1	1.1
Strength without blows	28 days strength (MPa)										
	28 days strength (MPa)										
	28 days strength (MPa)										
	28 days strength (MPa)	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Strength with blows	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
	28 days strength (MPa)										
	28 days strength (MPa)										
	28 days strength (MPa)										
	28 days strength (MPa)	#####	#####	#####	#####	#####	#####	#####	#####	#####	#####
Strength with blows	Strength based on (cubes/cylinders)										

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Method	Test laboratory	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya	Unicon Sjursoya
	Mix ID:	223102	223102	223102	223102	223102	223102	223102	223102	223102	223102	223102
	Operator:	OB	OB	OB	OB	OB	OB	OB	OB	OB	OB	OB
	Date [yyyy-mm-dd]:	2005/06/30	2005/06/30	2005/07/04	2005/07/06	2005/07/06	2005/07/06	2005/07/06	2005/07/12	2005/07/12	2005/07/13	2005/07/13
	Batch discharge time [hh:mm]:	10:13	12:34	12:35	09:08	10:17	11:26	13:44	10:43	12:42	09:14	10:36
Method	Time, testing start	10:15	12:37	12:45	09:15	10:25	11:35	13:50	10:50	12:50	09:25	10:45
	Measurement Items											
	T50 [sec] (to 0.1 sec)	0.7	1.6	0.9	1.2	0.5	0.5	0.7	1.5	1.0	0.9	1.3
	Largest spread d_{max} [mm]	740	600	730	700	760	720	770	640	700	720	640
	Perpendicular spread d_{perp} [mm]	710	540	730	690	710	720	740	560	630	680	620
Slump Flow	Slump Flow S [mm]	725	570	730	695	735	720	755	600	665	700	630
	T50 [sec] (to 0.1 sec)	4.2	∞	2.3	4.9	2.3	1.0	1.5	∞	3.1	1.3	∞
	Δh_0 [mm]	100	88	100	80	94	110	107	82	86	110	82
	Δh_{k1} [mm]	120	110	120	118	120	122	123	115	111	119	110
	Δh_{k2} [mm]	123	110	125	127	111	120	120	111	107	120	105
J-Ring Test 1	Δh_{k1} [mm]	120	115	123	121	122	122	121	116	110	123	113
	Δh_{k2} [mm]	115	110	125	123	118	121	118	104	109	118	111
	Blocking step B_j [mm]	20	23	23	42	24	11	14	30	23	10	28
	Largest spread d_{max} [mm]	580	460	630	590	620	680	660	470	530	690	450
	Perpendicular spread d_{perp} [mm]	570	430	620	510	590	660	650	430	520	650	450
J-Ring Test 2	Spread through J-ring S_j [mm]	575	445	625	550	605	670	655	450	525	670	450
	T50 _j [sec] (to 0.1 sec)											
	Δh_0 [mm]											
	Δh_{k1} [mm]											
	Δh_{k2} [mm]											
J-Ring Test 2	Δh_{k1} [mm]											
	Δh_{k2} [mm]											
	Blocking step B_j [mm]	0	0	0	0	0	0	0	0	0	0	0
	Largest spread d_{max} [mm]											
	Perpendicular spread d_{perp} [mm]											
Density without blows	Spread through J-ring S_j [mm]	#####	#####	#####	#####	#DIVISION/0!	#####	#####	#####	#####	#####	#####
	Segregation Indicator COV _{Bj} [%]	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
	v_{t1} , time of termination of test [hh:mm]	10:45	13:00	13:00	9:30	10:45	11:50	14:05	11:05	13:00	6:40	11:00
	Volume (L)											
	Mass of container (g)											
Density with blows	Mass of container + concrete (g)											
	Density (kg/m3)	2325	2304	2341	2339	2363	2365	2335	2274	2291	2335	
	Volume (L)											
	Mass of container (g)											
	Mass of container + concrete (g)											
Air content	Density (kg/m3)	2325	2320	2376	2348	2373	2375	2355	2300	2291	2342	
	Air content, without blows (vol%)	3.4	5.1	3.0	3.8	3.5	1.6	2.8	5.4	5.1	2.8	4.2
	Air content, with blows (vol%)	3.5	4.4	2.4	3.4	3.4	1.4	2.6	5.1	4.9	2.9	4.2
	Air content, without blows (vol%)	3.4	5.1	3.0	3.8	3.5	1.6	2.8	5.4	5.1	2.8	4.2
	Air content, with blows (vol%)	3.5	4.4	2.4	0.4	3.4	1.4	2.6	5.1	4.9	2.9	4.2
Strength without blows	28 days strength (MPa)	64.8	57.5	60.6	63.8	60.7	62.9	61.7	53.3	59.0	57.9	56.7
	28 days strength (MPa)	64.5	57.9	62.1	65.5	58.7	62.0	63.6	54.1	53.7	57.4	55.8
	28 days strength (MPa)	64.7	59.0	59.8	62.7	62.0	61.4	63.6	52.0	57.0	59.3	56.4
	28 days strength (MPa)	64.7	58.1	60.8	64.0	60.5	62.1	63.0	53.1	56.6	58.2	56.3
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
Strength with blows	28 days strength (MPa)	64.7	59.8	65.7	65.6	62.3	61.2	64.4	56.2	57.7	56.3	56.4
	28 days strength (MPa)	64.2	57.2	63.7	65.7	61.4	61.4	64.8	55.7	58.0	57.7	56.6
	28 days strength (MPa)	64.0	61.1	63.7	63.5	61.8	60.7	64.4	57.0	57.0	56.9	56.7
	28 days strength (MPa)	64.3	59.4	64.4	64.9	61.8	61.1	64.5	56.3	57.6	57.0	56.6
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
Visual observations:		Målt betongtemperatur 26 °C Termingene som ble stjept uten slag ble ved en feil trykket en dag for tidlig (27 døgn).										
		Betongtemp målt 24 °C	Betongtemp målt 24 °C	Betongtemp målt 24 °C	Betongtemp målt 25 °C	Betongtemp målt 25 °C	Betongtemp målt 25 °C		Målt betongtemperatur 27 °C	Målt betongtemperatur 25 °C	Målt betongtemperatur 26 °C	

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	Test laboratory:	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG	Unicon FG
	Mix ID:	L531112:1	L531112:2	L531112:3	L531112:4	L531112:5	L531112:6	L531112:1	L531112:2	L531112:3	L531112:4
	Operator:	Stig	Stig	Stig	Stig	Stig	Stig	Stig	Stig	Stig	Stig
	Date [yyyy-mm-dd]:	2005/06/08	2005/06/08	2005/06/08	2005/06/13	2005/06/13	2005/06/13	2005/06/29	2005/06/29	2005/06/29	2005/06/29
	Batch discharge time [hh:mm]:	10:37	12:38	13:57	12:16	13:06	14:15	10:37	12:38	13:57	12:16
Method	Time, testing start	10:40	12:50	14:10	12:25	12:15	14:20	10:40	12:50	14:10	12:25
	Measurement Items										
	T50 [sec] (to 0.1 sec)	8.0	3.3	3.3	8.0	2.6	5.8	3.9	2.5	2.7	5.0
	Largest spread d_{max} [mm]	560	600	570	500	525	545	620	570	680	535
	Perpendicular spread d_{perp} [mm]	560	600	565	500	520	525	620	680	660	535
Slump Flow	Slump Flow S [mm]	560	600	570	500	525	535	620	680	660	535
J-Ring Test 1	T50 [sec] (to 0.1 sec)	12	8.3	20		10	11	10	4.5	5	
	Δh_0 [mm]	95	90	80	85	90	92	84	104	93	81
	Δh_{x1} [mm]	122	113	120	103	118	1215	124	125	123	125
	Δh_{x2} [mm]	122	125	120	106	115	118	123	124	121	122
	Δh_{y1} [mm]	115	121	118	113	113	112	122	125	123	120
	Δh_{y2} [mm]	130	125	135	113	122	118	124	125	126	122
	Blocking step B _J [mm]	27	31	43	24	27	299	39	21	30	41
	Largest spread d_{maxJ} [mm]	510	500	495	440	480	520	500	600	550	480
	Perpendicular spread d_{perpJ} [mm]	510	500	485	430	475	510	500	600	550	480
	Spread through J-ring S _J [mm]	510	500	490	435	480	515	500	600	550	480
	T50 _J [sec] (to 0.1 sec)										
	Δh_0 [mm]										
J-Ring Test 2	Δh_{x1} [mm]										
	Δh_{x2} [mm]										
	Δh_{y1} [mm]										
	Δh_{y2} [mm]										
	Blocking step B _J [mm]	0	0	0	0	0	0	0	0	0	0
	Largest spread d_{maxJ} [mm]										
	Perpendicular spread d_{perpJ} [mm]										
	Spread through J-ring S _J [mm]	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#####	#####
	Segregation Indicator COV _{Bj} [%]	-200	-200	-200	-200	-200	-200	-200	-200	-200	-200
	t _{v1} , time of termination of test [hh:mm]										
	Volume (L)										
Density without blows	Mass of container (g)										
	Mass of container + concrete (g)						2344				
	Density (kg/m3)	2318	2330	2353	2334	2305	2344	2318	2330	2353	2334
	Volume (L)										
Density with blows	Mass of container (g)										
	Mass of container + concrete (g)										
	Density (kg/m3)	2317	2328	2364	2327	2326	2331	2317	2328	2364	2327
	Volume (L)										
Air content	Air content, without blows (vol%)	7.3	6.4	5.9	7.0	7.3	5.9	5.1	4.8	4.9	5.9
	Air content, with blows (vol%)	7.4	6.2	5.8	7.0	7.0	5.9	4.6	4.9	4.5	6.3
	Air content, without blows (vol%)	7.3	6.4	5.9	7.0	7.3	5.9	5.1	4.8	4.9	5.9
	Air content, with blows (vol%)	7.4	6.2	5.8	7.0	7.0	5.9	4.6	4.9	4.5	6.3
Strength without blows	28 days strength (MPa)	32.3	32.7	32.7	35.5	35.4	39.9	41.8	39.4	40.0	44.3
	28 days strength (MPa)	32.9	33.5	32.9	37.4	35.3	41.0	39.9	41.8	39.1	43.3
	28 days strength (MPa)	32.0	33.7	32.1	38.2	35.0	41.8	41.1	42.1	38.5	42.4
	28 days strength (MPa)	32.4	33.3	32.6	37.0	35.2	40.9	40.9	41.1	39.2	43.3
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
	28 days strength (MPa)	32.2	32.4	32.5	38.1	35.5	40.1	40.9	40.9	39.5	42.2
Strength with blows	28 days strength (MPa)	30.6	34.2	31.6	37.6	35.4	39.4	40.9	39.5	38.1	41.7
	28 days strength (MPa)	34.5	32.9	32.4	37.7	34.3	39.1	40.3	41.4	38.2	42.3
	28 days strength (MPa)	32.4	33.2	32.2	37.8	35.1	39.5	40.7	40.6	38.6	42.1
	Strength based on (cubes/cylinders)	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders
	28 days strength (MPa)	32.2	32.4	32.5	38.1	35.5	40.1	40.9	40.9	39.5	42.2
	28 days strength (MPa)	30.6	34.2	31.6	37.6	35.4	39.4	40.9	39.5	38.1	41.7

IMPORTANT: Fill the data in the yellow cells ONLY!!!

Mix ID:

[yy-mm-dd]:

discharge time [hh:mm]:

Time, testing start

Method	Measurement Items											
Slump Flow	T50 [sec] (to 0.1 sec)	3.5	5.0	4.0	1.6	2.0	1.9	1.5	1.3	2.6	1.1	2.6
	Largest spread d_{max} [mm]	580	580	580	620	600	600	530	640	500	540	550
	Perpendicular spread d_{perp} [mm]	570	560	580	620	590	590	530	640	490	530	550
	Slump Flow S [mm]	575	570	580	620	595	595	530	640	495	535	550
J-Ring Test 1	T50 _j [sec] (to 0.1 sec)	4.5	2.3	3.0	2.1	2.3	2.9	6.6	1.6	4.6	2.8	7.3
	Δh_0 [mm]	95	70	80	90	80	90	65	90	70	65	65
	Δh_{x1} [mm]	110	120	115	110	110	110	110	115	105	105	110
	Δh_{x2} [mm]	115	115	110	115	110	110	105	110	105	105	110
	Δh_{y1} [mm]	115	110	115	110	110	110	105	115	105	105	105
	Δh_{y2} [mm]	115	115	115	110	100	110	105	115	105	105	110
	Blocking step B_j [mm]	19	45	34	21	28	20	41	24	35	40	44
	Largest spread d_{maxj} [mm]	600	520	560	600	500	620	450	650	470	440	450
	Perpendicular spread d_{perpj} [mm]	600	500	560	600	500	610	450	630	450	410	440
	Spread through J-ring S_j [mm]	600	510	560	600	500	615	450	640	460	425	445
J-Ring Test 2	T50 _j [sec] (to 0.1 sec)	9.0	10.0	4.0	7.6	4.9	4.9	8.4	2.1	5.1	3.7	11.0
	Δh_0 [mm]	70	75	75	70	80	75	70	95	65	70	65
	Δh_{x1} [mm]	110	115	110	110	105	105	110	115	110	105	105
	Δh_{x2} [mm]	110	110	110	110	105	105	110	115	110	105	110
	Δh_{y1} [mm]	110	120	110	110	105	105	110	110	105	105	100
	Δh_{y2} [mm]	120	120	110	110	105	115	110	110	105	105	100
	Blocking step B_j [mm]	43	41	35	40	25	33	40	18	43	35	39
	Largest spread d_{maxj} [mm]	500	520	570	480	500	520	500	670	460	500	480
	Perpendicular spread d_{perpj} [mm]	490	500	560	470	460	500	490	640	440	490	450
	Spread through J-ring S_j [mm]	495	510	565	475	480	510	495	655	450	495	465
Density without blows	Segregation Indicator COV_{Bj} [%]	77	-9	3	62	-11	49	-2	-29	21	-13	-12
	t_s , time of termination of test [hh:mm]	13:30	14:25	13:25	15:00	13:20	15:05	13:20	13:32	13:00	14:37	13:20
	Volume (L)	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Mass of container (g)	5052	5052	5076	5076	5070	5086	5080	5072	5108	5090	5080
	Mass of container + concrete (g)	24442	24482	24414	24440	24320	24128	24402	24414	24478	24333	24158
	Density (kg/m3)	2424	2429	2417	2421	2406	2383	2390	2418	2421	2405	2381
	Volume (L)	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000	8.000
	Mass of container (g)	5052	5052	5076	5076	5070	5086	5080	5072	5108	5090	5080
	Mass of container + concrete (g)	24485	24484	24570	24356	24320	24348	24204	24520	24574	24574	24248
	Density (kg/m3)	2429	2429	2437	2410	2406	2408	2391	2431	2433	2436	2396
Air content	Air content, without blows (vol%)	1.8	2.0	1.6	1.6	2.0	1.4	3.5	1.0	2.5	2.8	3.0
	Air content, with blows (vol%)	1.8	2.4	1.6	1.6	1.8	1.4	4.0	0.8	2.6	2.8	3.0
	Air content, without blows (vol%)	1.8	2.0	1.6	1.6	2.0	1.4	3.5	1.0	2.5	2.8	3.0
	Air content, with blows (vol%)	1.8	2.4	1.6	1.6	1.8	1.4	4.0	0.8	2.6	2.8	3.0
Strength without blows	28 days strength (MPa)	45.1	40.8	42.6	42.3	42.9	42.4	42.7	44.8	40.0	37.9	37.3
	28 days strength (MPa)	44.1	41.6	40.8	42.4	42.6	41.6	42.8	45.3	40.8	37.4	37.4
	28 days strength (MPa)	43.9	41.9	42.7	43.2	43.6	42.4	42.2	45.7	41.4	37.4	36.9
	28 days strength (MPa)	44.4	41.4	42.0	42.6	43.0	42.1	42.6	45.3	40.7	37.6	37.2
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
Strength with blows	28 days strength (MPa)	42.8	44.1	43.2	43.4	42.5	42.0	42.3	44.9	39.7	37.5	37.7
	28 days strength (MPa)	42.2	42.8	42.8	43.3	41.0	42.5	42.5	44.9	39.7	37.2	36.5
	28 days strength (MPa)	42.7	44.1	42.7	44.4	41.9	41.8	42.5	45.6	40.5	37.9	37.7
	28 days strength (MPa)	42.6	43.7	42.9	43.7	41.8	42.1	42.4	45.1	40.0	37.5	37.3
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
	Concrete temperature	33.0	31.0	26.0	24.0	24.0	23.0	24.0	25.0	24.0	26.0	26.0

Protocol for NIC-project

IMPORTANT: Fill the data in the yellow cells ONLY!!!

Test laboratory:	Orebro	Orebro	Orebro	Orebro	Orebro	Orebro	Orebro
Mix ID:	C45/55	C45/55	C45/55	C45/55	C45/55	C45/55	C45/55
Operator:	MH	MH	MH	MH	MH	MH	MH
Date [yyyy-mm-dd]:	2005/10/13	2005/10/13	2005/10/13	2005/10/13	2005/10/17	2005/10/17	2005/10/17
Batch discharge time [hh:mm]:							
Time, testing start	12:25	13:35	14:00	14:35	08:00	08:20	09:10

Method	Measurement Items							
Slump Flow	T50 [sec] (to 0.1 sec)							
	Largest spread d_{max} [mm]							
	Perpendicular spread d_{perp} [mm]							
	Slump Flow S [mm]	#####	#####	#####	#####	#####	#####	
J-Ring Test 1	T50 _f [sec] (to 0.1 sec)	3.0	2.6	3.2	3.8	3.1	1.8	2.1
	Δh_0 [mm]	100	110	110	110	110	120	110
	Δh_{x1} [mm]	110	120	130	130	120	130	120
	Δh_{x2} [mm]	120	130	130	130	130	130	130
	Δh_{y1} [mm]	110	110	130	120	130	130	130
	Δh_{y2} [mm]	110	120	130	130	130	130	120
	Blocking step B _f [mm]	13	10	20	18	18	10	15
	Largest spread d_{max} [mm]	600	750	720	700	680	800	700
	Perpendicular spread d_{perp} [mm]							
	Spread through J-ring S _j [mm]	600	750	720	700	680	800	700
J-Ring Test 2	T50 _f [sec] (to 0.1 sec)							
	Δh_0 [mm]							
	Δh_{x1} [mm]							
	Δh_{x2} [mm]							
	Δh_{y1} [mm]							
	Δh_{y2} [mm]							
	Blocking step B _f [mm]	0	0	0	0	0	0	0
	Largest spread d_{max} [mm]							
	Perpendicular spread d_{perp} [mm]							
	Spread through J-ring S _j [mm]	#####	#####	#####	#####	#####	#####	#####
	Segregation Indicator COV _{Bj} [%]							
	t _{v1} , time of termination of test [hh:mm]							
Density without blows	Volume (L)							
	Mass of container (g)							
	Mass of container + concrete (g)							
	Density (kg/m3)	#####	#####	#####	#####	#####	#####	#####
Density with blows	Volume (L)							
	Mass of container (g)							
	Mass of container + concrete (g)							
	Density (kg/m3)	#####	#####	#####	#####	#####	#####	#####
Air content	Air content, without blows (vol%)							
	Air content, with blows (vol%)							
	Air content, without blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Air content, with blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Strength without blows	28 days strength (MPa)							
	28 days strength (MPa)							
	28 days strength (MPa)							
	28 days strength (MPa)	#####	#####	#####	#####	#####	#####	#####
	Strength based on (cubes/cylinders)	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes	Cubes
Strength with blows	28 days strength (MPa)							
	28 days strength (MPa)							
	28 days strength (MPa)							
	28 days strength (MPa)	#####	#####	#####	#####	#####	#####	#####
	Strength based on (cubes/cylinders)	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders	Cylinders
Visual observations:								

Protocol for NIC-project

IMPORTANT: Fill the data in the yellow cells ONLY!!!

	Mix 1			Mix 2		Mix 3	Mix 4		
	TCG C.Lab	TCG C.Lab	new operator	TCG C.Lab	new operator	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab
Test laboratory:	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab	TCG C.Lab
Mix ID:	Fsedel 10641	Fsedel 10642	Fsedel 10642*	M 2	M 2 *	M 1	SKB055RÖN	SKB055RÖN	SKB055RÖN
Operator:	MK	CM	MK	CM	OE	CM	CM	CM	CM
Date [yyyy-mm-dd]:	2005/05/17	2005/05/17	2005/05/17	2005/05/19	2005/05/19	2005/05/19	2005/10/10	2005/10/10	2005/10/10
Batch discharge time [hh:mm]:	07.21	08.40	08.40				10.00	10.00	14.30
Time, testing start	07.35	08.45	08.55				10.10	11.00	14.40

Method	Measurement Items									
Slump Flow	T50 [sec] (to 0.1 sec)	2.5	2.1		2.2	2.0	4.2	3.0	3.5	6.0
	Largest spread d_{max} [mm]	560	570	560	630	640	530	720	710	760
	Perpendicular spread d_{perp} [mm]	510	560	560	620	640	520	710	710	760
	Slump Flow S [mm]	535	565	560	625	640	525	715	710	760
	T50 _f [sec] (to 0.1 sec)	2.9	4.2		4.0	4.3	-	6.0	6.0	11.0
J-Ring Test 1	Δh_0 [mm]	94	95	94	99	98	88	90	92	86
	Δh_{x1} [mm]	114	116	110	107	115	110	118	118	120
	Δh_{x2} [mm]	112	113	112	115	115	105	115	114	118
	Δh_{y1} [mm]	114	116	112	117	114	107	118	112	118
	Δh_{y2} [mm]	115	118	112	119	116	113	119	115	121
	Blocking step B _j [mm]	20	21	18	16	17	21	28	23	33
	Largest spread d_{maxJ} [mm]	550	550	540	600	600	490	680	645	700
	Perpendicular spread d_{perpJ} [mm]	510	530	540	590	570	470	670	645	620
	Spread through J-ring S _j [mm]	530	540	540	595	585	480	675	645	660
	T50 _f [sec] (to 0.1 sec)									
J-Ring Test 2	Δh_0 [mm]									
	Δh_{x1} [mm]									
	Δh_{x2} [mm]									
	Δh_{y1} [mm]									
	Δh_{y2} [mm]									
	Blocking step B _j [mm]	0	0	0	0	0	0	0	0	0
	Largest spread d_{maxJ} [mm]									
	Perpendicular spread d_{perpJ} [mm]									
	Spread through J-ring S _j [mm]	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Segregation Indicator COV _{Bj} [%]									
Density without blows	t _{v1} , time of termination of test [hh:mm]									
	Volume (L)									
	Mass of container (g)									
	Mass of container + concrete (g)									
Density with blows	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Volume (L)									
	Mass of container (g)									
	Mass of container + concrete (g)									
Air content	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Air content, without blows (vol%)	2.6								
	Air content, with blows (vol%)	2.5								
	Air content, without blows (vol%)	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Strength without blows	Air content, with blows (vol%)	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28 days strength (MPa)									
	28 days strength (MPa)									
	28 days strength (MPa)									
Strength with blows	28 days strength (MPa)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)	39.0			35.0					
	28 days strength (MPa)	42.0			36.0					
Strength without blows	28 days strength (MPa)									
	28 days strength (MPa)									
	28 days strength (MPa)									
	28 days strength (MPa)									
Strength with blows	28 days strength (MPa)	40.5	#DIVISION/0!	#DIVISION/0!	35.5	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
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	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
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	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
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	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
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	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
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Strength without blows	28 days strength (MPa)									
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Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
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Strength without blows	28 days strength (MPa)									
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	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
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	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength without blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									
Strength with blows	28 days strength (MPa)									
	Strength based on (cubes 150 mm)									

Protocol for NIC-project

IMPORTANT: Fill the data in the yellow cells ONLY!!!

Test laboratory:		FBHALL	FBHALL	FBHALL	FBHALL	FBHALL	FBHALL
Mix ID:		SKB ANL8	SKB ANL8	SKB ANL8	SKB ANL8	SKB ANL8	SKB ANL8
Operator:		JB	JB	JB	JB	JB	JB
Date [yyyy-mm-dd]:		2005/10/18	2005/10/18	2005/10/18	2005/10/18	2005/10/18	2005/10/18
Batch discharge time [hh:mm]:		10.15	10.15	11.15	11.15	11.40	11.15
Time, testing start		10.30	11.10	11.30	12.30	11.50	12.35

Method	Measurement Items						
Slump Flow	T50 [sec] (to 0.1 sec)	-	9.0	2.0	4.0	1.7	2.0
	Largest spread d_{max} [mm]	800	650	780	550	780	690
	Perpendicular spread d_{perp} [mm]	780	650	740	540	750	730
	Slump Flow S [mm]	790	650	760	545	765	710
J-Ring Test 1	T50 _f [sec] (to 0.1 sec)	2.6	5.3	3.6	6.3	2.2	6.1
	Δh_0 [mm]	110	110	109	80	115	102
	Δh_{x1} [mm]	116	115	115	110	117	114
	Δh_{x2} [mm]	118	115	116	107	117	115
	Δh_{y1} [mm]	116	113	115	106	118	115
	Δh_{y2} [mm]	117	115	115	108	119	115
	Blocking step B_j [mm]	7	5	6	28	3	13
	Largest spread d_{max} [mm]	770	660	750	530	820	640
	Perpendicular spread d_{perp} [mm]	730	640	710	500	780	680
	Spread through J-ring S_j [mm]	750	650	730	515	800	660
	T50 _f [sec] (to 0.1 sec)						
J-Ring Test 2	Δh_0 [mm]						
	Δh_{x1} [mm]						
	Δh_{x2} [mm]						
	Δh_{y1} [mm]						
	Δh_{y2} [mm]						
	Blocking step B_j [mm]	0	0	0	0	0	0
	Largest spread d_{max} [mm]						
	Perpendicular spread d_{perp} [mm]						
	Spread through J-ring S_j [mm]	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
	Segregation Indicator COV_{Bj} [%]						
	t_{v1} , time of termination of test [hh:mm]						
Density without blows	Volume (L)						
	Mass of container (g)						
	Mass of container + concrete (g)						
	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Density with blows	Volume (L)						
	Mass of container (g)						
	Mass of container + concrete (g)						
	Density (kg/m3)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Air content	Air content, without blows (vol%)						
	Air content, with blows (vol%)						
	Air content, without blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0
	Air content, with blows (vol%)	0.0	0.0	0.0	0.0	0.0	0.0
Strength without blows	28 days strength (MPa)						
	28 days strength (MPa)						
	28 days strength (MPa)						
	28 days strength (MPa)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Strength with blows	Strength based on (cubes/cylinders)						
	28 days strength (MPa)						
	28 days strength (MPa)						
	28 days strength (MPa)						
	28 days strength (MPa)	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!	#DIVISION/0!
Visual observations:					Slump flow with ring larger spread through with ring. Possible separation		

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Method	Measurement Items															
Slump Flow	T50 [sec] (to 0.1 sec)	1.6	1.2	1.5	2.2								2.4	2.8	2.2	2.3
	Largest spread $d_{\max}$ [mm]	670	695	755	610								775	640	700	750
	Perpendicular spread d_{perp} [mm]	660	680	720	595								735	635	660	700
	Slump Flow S [mm]	665	690	740	605	#####	#####	#####	#####	#####	#####	#####	755	640	680	725
J-Ring Test 1	T50 _j [sec] (to 0.1 sec)	2.2	2.1	1.9	3.5	2.3		4.7	1.7	0.7	0.5	12.7	7.5	3.5	2.7	3.0
	Δh_0 [mm]	101	101	105	91	106.5		98.5	101	105	110	86	87	92	83	95
	Δh_{x1} [mm]	113	112	114	111	112		111	116	113	116	116	120	119	116	115
	Δh_{x2} [mm]	113	114	115	111	119		119	112	115	114	118	119	117	116	114
	Δh_{y1} [mm]	113	115	114	109	112		111	112	114	119	112	119	118	116	115
	Δh_{y2} [mm]	113	112	115	112	121		120	117	112	118	116	119	119	115	116
	Blocking step B _j [mm]	12	12	10	20	10		17	13	9	7	30	32	26	33	20
	Largest spread $d_{\max j}$ [mm]	660	680	720	600	740		670	700	710	900	600	695	730	680	670
	Perpendicular spread $d_{\text{perp}j}$ [mm]	650	670	720	560	730		650	700	730	900	595	695	725	620	665
	Spread through J-ring S _j [mm]	655	675	720	580	735		660	700	720	900	600	695	730	650	670
	T50 _j [sec] (to 0.1 sec)	2.6	3.0	2.9	4.3	3.8		6.3	1.9	1.3	N.D.		15.4 > 10	10.65	3.22	3.8
	Δh_0 [mm]	95	94	93	88	104		92.5	91	92	16	77	68	57	81	91
	Δh_{x1} [mm]	113	115	113	112	111		106	114	112	120	115	118	112	116	115
	Δh_{x2} [mm]	114	113	115	110	115		109	113	113	118	115	116	120	116	112
	Δh_{y1} [mm]	112	114	116	108	116		110	115	113	117	116	117	117	116	112
	Δh_{y2} [mm]	116	112	119	109	114		110	113	114	119	118	118	118	116	112
J-Ring Test 2	Blocking step B _j [mm]	19	20	23	22	10		16	23	21	103	39	49	60	35	22
	Largest spread $d_{\max j}$ [mm]	645	660	650	580	765		630	670	670	500	550	590	530	620	650
	Perpendicular spread $d_{\text{perp}j}$ [mm]	640	620	630	560	680		610	660	660	500	540	550	520	600	610
	Spread through J-ring S _j [mm]	645	640	640	570	725		620	665	665	500	545	570	525	610	630
	Segregation Indicator COV _{Bj} [%]	45	50	79	10	0		-6	56	80	175	26	42	79	6	10
	Δh_{11} [mm]	198	198	205	187			199	200	205	210	-47	-43	63	168	191
	Δh_{12} [mm]	198	198	205	187			195	199	204	210	-47	-43	63	166	191
	Δh_{13} [mm]	198	198	205	187			197	199	205	210	-47	-43	63	170	191
	Δh_{21} [mm]	67	66	65	73			68	64	65	60	127	122	102	80	71
	Δh_{22} [mm]	69	68	66	76			70	66	67	60	130	124	104	81	74
L-Box	Δh_{23} [mm]	69	68	66	77			70	65	65	60	130	124	104	82	74
	H ₁ [mm]	102	102	95	113	#####		103	101	95	90	347	343	237	132	109
	H ₂ [mm]	82	83	84	75	#####		81	85	84	90	21	27	47	69	77
	Passing Ratio PR	0.8	0.81	0.88	0.66	#####		0.79	0.84	0.88	1	0.06	0.08	0.2	0.52	0.71
	Weight of pan [g]	443.8	444	447.1	444.3	450.2		451.5	451.7	450.5	451.9	443.1	444.7	444.2	445.6	446.2
	Weight of sample [g]	4844.3	4808.2	4898.3	4955.8	4820.8		4883.4	4860	4855.9	4920.4	4938.8	5174.2	4813.2	5589	4968.9
	Weight of pan+laitance [g]	1148.9	1222.7	1437	1084.2	1442.5		1193.1	1597.9	2021	4191.4	524.5	785.5	1107.4	1070	813
	Weight of laitance [g]	705	779	990	640	992		742	1146	1571	3740	81	341	663	624	367
	Sieved portion π [%]	15	16	20	13	21		15	24	32	76	2	7	14	11	7
	Remarks:															

Nordic Innovation Centre

The Nordic Innovation Centre initiates and finances activities that enhance innovation collaboration and develop and maintain a smoothly functioning market in the Nordic region.

The Centre works primarily with small and medium-sized companies (SMEs) in the Nordic countries. Other important partners are those most closely involved with innovation and market surveillance, such as industrial organisations and interest groups, research institutions and public authorities.

The Nordic Innovation Centre is an institution under the Nordic Council of Ministers. Its secretariat is in Oslo.

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