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Evaluation Of Possibility Of Segregation In Self-Compacting Concrete Using Newly Designed Segregation Test Equipment: A Comparative Study With Standard Workability Tests

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This research investigates the possibility of segregation of Self-Compacting Concrete (SCC) using a multi-compartment testing device. SCC is designed to flow under its own weight while maintaining homogeneity, yet its stability is crucial to prevent segregation. The multi-compartment test aims to quantitatively assess segregation and compare results with standard workability tests: Slump Flow, V-Funnel, and L-Box. The influence of parameters such as water-to-cement ratio and aggregate size was analyzed. Findings reveal that the newly designed segregation test Equipmentoffers a practical alternative to detect and quantify segregation potential, supporting or enhancing standard SCC quality assessments.

Keywords: Self-Compacting Concrete, Segregation, Segregation test setup, Slump Flow, L-Box, V-Funnel and U- box Workability Tests

1. INTRODUCTION:

Self-Compacting Concrete (SCC) offers significant advantages in modern construction due to its high flowability under dense reinforcement and ability to compact under its own weight without vibration. However, one of the critical performance criteria of SCC is its resistance to segregation during placement. Traditional methods like Slump Flow, V-Funnel, L-Box and U-box tests are commonly used to evaluate workability and filling ability, but may not adequately quantify segregation.

This study introduces a multi-compartment testing device originally developed for conventional concrete and adapts it for SCC. The device is used to evaluate segregation by examining the bleeding amount. Results are compared with conventional SCC tests to determine correlations and practical implications.

2. EXPERIMENTAL STUDY:

2.1 Materials :

- **Cement:** OPC 53 grade
- **Fine Aggregate:** Zone II river sand
- **Coarse Aggregate:** Crushed granite, 10 mm maximum size
- **Superplasticizer:** Polycarboxylate-based
- **Water:** Potable clean water

2.2 Mix Design: SCC (M30) mixes were designed in accordance with EFNARC guidelines with varying water-to-cement ratios (0.4 to 0.6).

Table 1: Mix Proportions of M30 Grade Concrete

W/C Ratio	Cement (kg/m³)	Water (kg/m³)	Fine Aggregate (kg/m³)	Coarse Aggregate (kg/m³)	Admixture (kg/m³)
0.4	450	180	700	1100	6
0.45	400	180	720	1100	8
0.5	350	175	750	1100	10
0.55	325	180	780	1100	10
0.6	300	180	800	1100	12

2.3 SCC Various tests result:

SCC Tests	Purpose	Test Result Requirement	Result
Flow Table Test	To measure the horizontal spread of SCC and its overall flow ability.	A spread diameter of 500 mm to 800 mm is often expected for SCC, but this can vary by specific application requirements.	Spread Diameter: 600 mm
V Funnel Test	To evaluate the flow ability and viscosity of SCC.	The time taken for the concrete to flow through the V funnel is usually recorded. A flow time of less than 10 seconds is often desirable for SCC.	Flow Time: 9 seconds
L Box Test	To assess the passing ability of SCC through obstacles.	The height difference (h2 - h1) is measured, where h1 is the height of the concrete before it flows and h2 is the height after it has flowed. A typical requirement is that	Ratio (h2/h1): 0.85

		the ratio (h2/h1) should be close to 0.8 or more.	
U Box Test	Similar to the L Box, the U Box test measures the passing ability of SCC through barriers.	The height difference is again measured, and a typical acceptable result could be that the height after flowing (h2) should be at least 80% of the initial height (h1).	Height Difference (h1-h2) : 10 mm

2.4 Specification of equipment:

A segregation test setup is made up of steel and includes four different compartments. This includes a hopper on top, as shown below in Fig. 1, which has a conical shape. The upper diameter of the hopper is 260mm, the lower diameter of the hopper is 130mm, and the height of the hopper is 280mm. Hopper is able to store up to 0.0084 m^3 of concrete. It has a gate at the lower end that can empty the concrete stored in the hopper. The second part of the model is the reinforcement compartment, which has a size of 300 x 300 x 300 mm^3. In this part, 10 mm and 12 mm-diameter bars are provided as shown above. It also has a shutter at the bottom to pass out the concrete. The third component measures 300 x 300 x 300 mm3. It has a sieve at the bottom of it. These sieves are reusable and are 1.18 mm, 2.36 mm, 4.75 mm, and 6 mm. All the sieves are a wired mess. The last and fourth parts are to collect the concrete.

2.4.1Test procedure of newly designed segregation test setup:

In this newly designed segregation test, We are going to find the possibility of segregation in concrete. Weconsider the left slurry at the end of the test. And compare it with existing methods. And make a graph of segregation possibilities.

- As needed, place a sieve on the lower box and reinforcement bars on the upper box.
- Using the hand scoop, carefully fill the upper hopper with the concrete sample until it is level.
- Open the hopper's bottom trapdoor to let concrete drop into the lower box. With the road, gently push the concrete that is sticking out on its sides.
- Allow the concrete to fall into the lower box, which has a sieve at its lower part, by opening the Shutter at the bottom of the upper box.
- Finally, let the concrete fall into the collection box by opening the Shutter of the lower box as well.

- Measure the quantity of left-over slurry in the box.

Fig 1:Segregation Test equipment

3. TEST RESULTS:

- The Segregation Test results for this study are shown in table 2. Also show the graph of Relationship between Water/Cement (W/C) Ratio and Bleeding of self-compacting concrete For M30.

Table 2: Bleeding of SCC (M30) from different sieves size

W/C ratio	Bleeding from different sieve size (ml)		
	1.18mm sieve	2.36mm sieve	4.75mm sieve
0.4	0.118	0.155	0.140
0.45	0.125	0.165	0.151
0.5	0.172	0.184	0.173
0.55	0.261	0.285	0.265
0.6	0.308	0.343	0.334

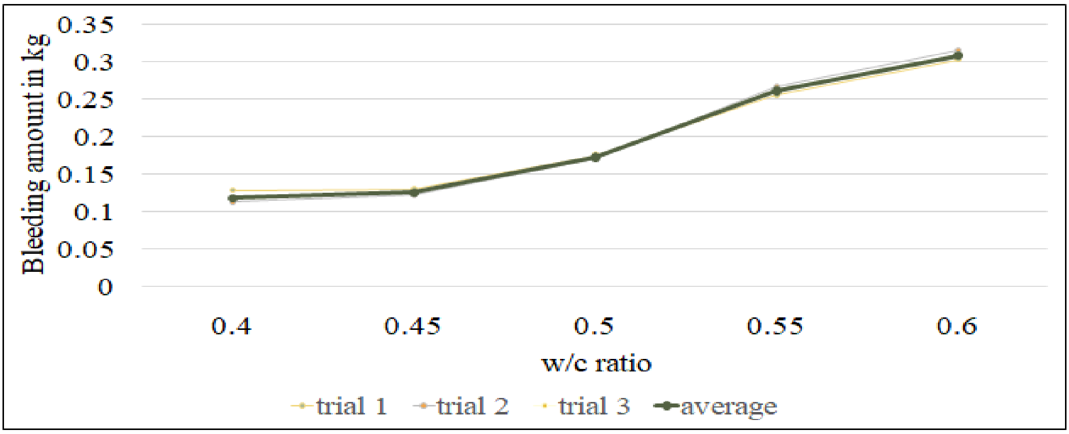

Fig 2: Graph of Relationship between the Water/Cement Ratio and Bleeding of SCC (M30) from 1.18mm sieve size

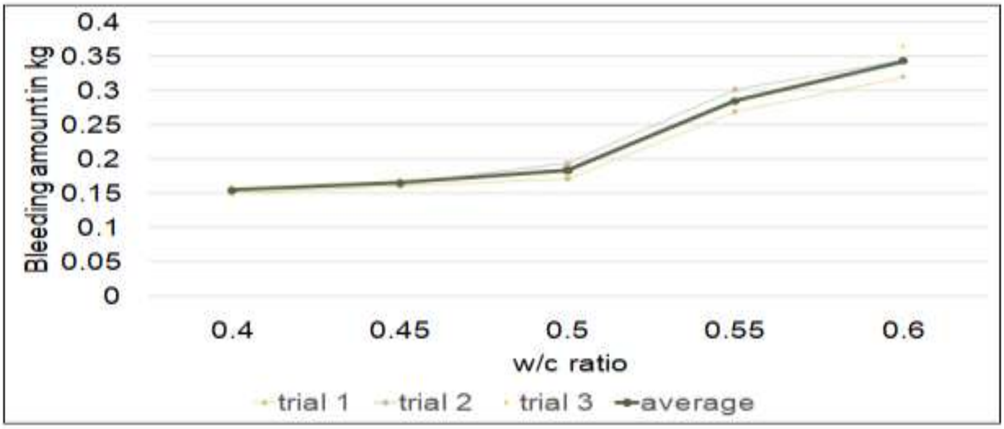

Fig 3: Graph of Relationship between the Water/Cement Ratio and Bleeding of SCC (M30) from 2.36mm sieve size

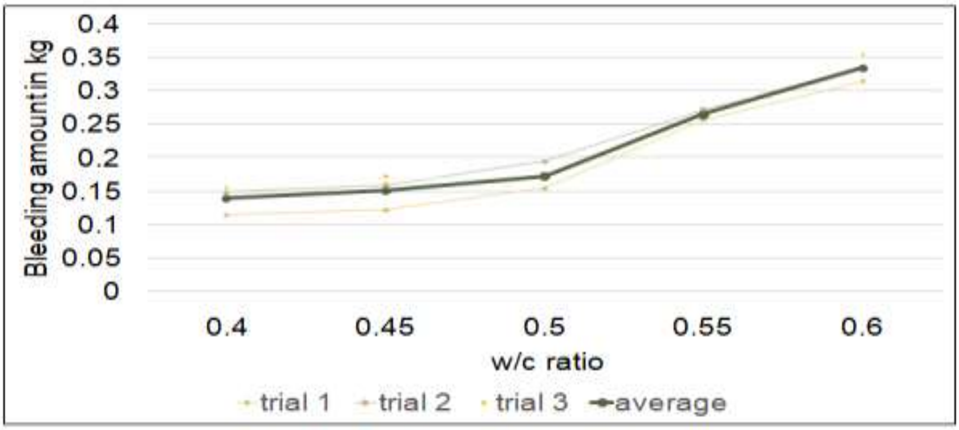

Fig 4 : Graph of Relationship between the Water/Cement Ratio and Bleeding of SCC (M30) from 4.75 mm sieve size

4. CONCLUSION

In this research, a new test setup for segregation is introduced. On the basis of the study of already available tests of workability and segregation, this new model has been developed. Done tests on M30 grades of self-compacting concrete and found bleeding amounts from different sizes of the sieve of 1.18mm, 2.36mm and 4.75mm, compared all their results with existing methods. Plotted a graph of the bleeding amount and W/C ratio. From all these results, they prepared a segregation possibility curve of self-compacting concrete. It has been observed from test results the possibility of segregation increased if the water to cement (w/c) ratio is more than 0.50 and if more coarser aggregates are including as per our regression analysis.

REFERENCES:

1. EFNARC. (2005). The European Guidelines for Self Compacting Concrete: Specification, Production and Use. European Federation of Producers and Applicators of Specialist Products for Structures.
2. ASTM C1611/C1611M-18. (2018). Standard Test Method for Slump Flow of Self-Consolidating Concrete. ASTM International.
3. ASTM C1621/C1621M-17a. (2017). Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring. ASTM International.
4. ASTM C1610/C1610M-14. (2014). Standard Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique. ASTM International.
5. Okamura, H., & Ouchi, M. (2003). Self-Compacting Concrete. Journal of Advanced Concrete Technology, 1(1), 5–15. https://doi.org/10.3151/jact.1.5
6. Khayat, K. H. (1999). Workability, Testing, and Performance of Self-Consolidating Concrete. ACI Materials Journal, 96(3), 346–353.
7. Sonebi, M. (2004). Medium strength self-compacting concrete containing fly ash: Modelling using factorial experimental plans. Cement and Concrete Research, 34(7), 1199–1208. https://doi.org/10.1016/j.cemconres.2003.12.022
8. Assaad, J. J., Khayat, K. H., & Mesbah, H. A. (2003). Assessment of Thixotropy of Flowable and Self-Consolidating Concrete. Materials and Structures, 36, 657–664. https://doi.org/10.1617/13728
9. Ferraris, C. F., Obla, K. H., & Hill, R. (2001). The Influence of Mineral Admixtures on the Rheology of Cement Paste and Concrete. Cement and Concrete Research, 31(2), 245–255.
10. Toutou, Z., & Roussel, N. (2006). Multi-scale experimental study of concrete rheology: from water scale to gravel scale. Materials and Structures, 39(2), 189–199. https://doi.org/10.1617/s11527-005-9003-2
11. Yahia, A., & Khayat, K. H. (2001). Analytical Models for Estimating Yield Stress of High-Performance Pseudo-Plastic Grout. Cement and Concrete Research, 31(5), 731–738.
12. Koehler, E. P., & Fowler, D. W. (2007). Development of a Portable Rheometer for Fresh Portland Cement Concrete. ICAR Report No. 105-3F, The University of Texas at Austin.
13. BS EN 12350-11:2010. (2010). Testing fresh concrete. Part 11: Self-compacting concrete - Sieve segregation test. British Standards Institution.
14. Lachemi, M., Hossain, K. M. A., Lambros, V., & Nkinamubanzi, P. C. (2004). Performance of new viscosity modifying admixtures in enhancing the rheological properties of self-consolidating concrete. Cement and Concrete Research, 34(6), 917–926.
15. Mindess, S., Young, J. F., & Darwin, D. (2003). Concrete (2nd ed.). Prentice Hall.