The Study of Workability of Self-Compacting Concrete

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ABSTRACT

This study investigates the workability of self-compacting concrete (SCC), a revolutionary material known for its ability to flow and fill formwork without the need for mechanical consolidation. The research evaluates various factors affecting SCC's workability, including mix proportions, aggregate characteristics, and admixture types. The study aims to optimize SCC's workability while maintaining its desirable properties, such as strength and durability.

Key Words: *workability, SCC, characteristics, admixture, properties, strength, durability*

INTRODUCTION

Self-compacting concrete (SCC) stands out as a transformative advancement in the construction sector, heralded as one of the most significant developments in concrete technology in recent decades. Originating in 1986 from the pioneering work of Okamura at Koche University of Technology in Japan, SCC represents a concrete formulation capable of autonomously flowing and consolidating within formwork, even in the presence of dense reinforcement. This remarkable property eliminates the need for manual compaction, ensuring complete formwork filling while maintaining uniformity throughout the structure. The key to SCC lies in its composition characterized by higher paste content and reduced coarse aggregate fraction compared to traditional vibrated concrete. Super plasticizers are essential additives, enhancing paste deformability and thwarting segregation tendencies. Additionally, SCC often incorporates powdered materials such as fly ash, silica fume, and limestone powder to further improve properties and mitigate segregation risks. By leveraging the versatility of SCC and optimizing its constituents, the construction industry can realize enhanced efficiency, durability, and sustainability, paving the way for more resilient and environmentally friendly infrastructure projects.

EXPERIMENTAL INVESTIGATION

1. Cement

Ordinary Portland Cement (OPC) 53 grade was used. OPC 53 grade cement is a high-performance variant renowned for its exceptional compressive strength and rapid setting characteristics. Developed to meet stringent construction requirements, it offers superior durability and early-age strength development compared to lower grade counterparts. With a minimum compressive strength of 53 N/mm^2 (53 MPa) within 28 days of setting, OPC 53 grade cement is ideal for applications demanding structural integrity and resilience, such as high-rise buildings, bridges, and infrastructure projects. Its reliable performance and versatility make it a preferred choice for engineers and contractors seeking to optimize construction timelines and ensure long-term durability in diverse construction environments.

2. Fly Ash

Fly ash, a by-product of coal combustion in power plants, has emerged as a valuable additive in cement production, offering both economic and environmental advantages. When incorporated into cement formulations, fly ash enhances workability, mitigates segregation, and improves long-term durability. Moreover, its pozzolanic properties contribute to enhanced concrete strength and reduced permeability, thus extending the lifespan of structures. By utilizing fly ash in cement, construction practices not only become more sustainable by reducing waste and reliance on virgin materials but also address environmental concerns associated with fly ash disposal. This integration underscores a pivotal step towards more efficient and eco-friendly construction methodologies.

3. Super Plasticizers

Viscoflux 5500 super plasticizer is used. Viscoflux 5500 super plasticizer represents a cutting-edge additive in concrete technology, designed to optimize the performance and workability of concrete mixtures. Developed to address the evolving demands of modern construction, Viscoflux 5500 offers unparalleled fluidity and flow retention, enabling the production of high-quality self-compacting concrete (SCC). By effectively dispersing cement particles and reducing water content, this super plasticizer enhances the cohesiveness and rheological properties of concrete, facilitating effortless placement and consolidation. Its superior compatibility with various cement types and supplementary cementitious materials ensures versatility in application, making it an indispensable tool for achieving optimal concrete performance, increased construction efficiency, and superior structural integrity in diverse projects.

4. Aggregates

Aggregates of mainly 10 mm and 20 mm sized are used. Aggregates are vital components in construction, providing structural stability and durability to various building projects. 10mm and 20mm aggregates refer to the size of the particles used in concrete mixes. Aggregate of 10mm Sized provide good workability and are suitable for thin sections while 20mm aggregates are typically used in structural concrete where higher strength is required. They offer greater resistance to wear and tear, making them ideal for heavy-duty applications like foundations, roads, and pavements. Both sizes play essential roles in achieving the desired properties and performance of concrete structures.

5. Sand

Crushed Sand is used during mixing. In concrete mixes, crush sand serves as a replacement for natural river sand, addressing concerns such as environmental degradation and sand scarcity. Its angular shape and rough texture enhance the bond between particles and cement paste, improving the overall strength and durability of the concrete. Crushed sand also reduces the risk of segregation and bleeding in concrete, ensuring uniformity and consistency in the final product.

6. Mix Design

The mixes of various constituent materials per m3 are given below: -

Table 1: Mix Design for one m^3 concrete of SCC

Mix	Mortar (in Kg/m^3)			Aggregates (in Kg/m^3)		Coarse Aggregate (in %)		W/C Ratio	Water/ Powder Ratio (By Volume)	Super Plasticizer (Kg/m^3)
	Cement	Fly Ash	Silica	Coarse	Fine	10 mm	20 mm			
SCC 1	425	148	18	691	900	50	50	0.33	0.84	5.91
SCC 2	392	136	16	838	888	50	50	0.34	0.84	5.44
SCC 3	381	133	16	778	988	50	50	0.33	0.80	5.30

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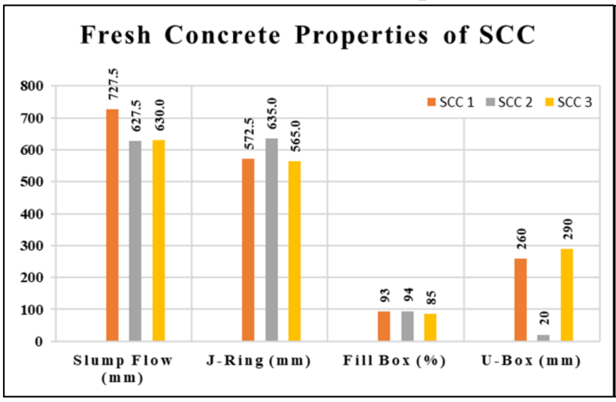
RESULTS AND DISCUSSION

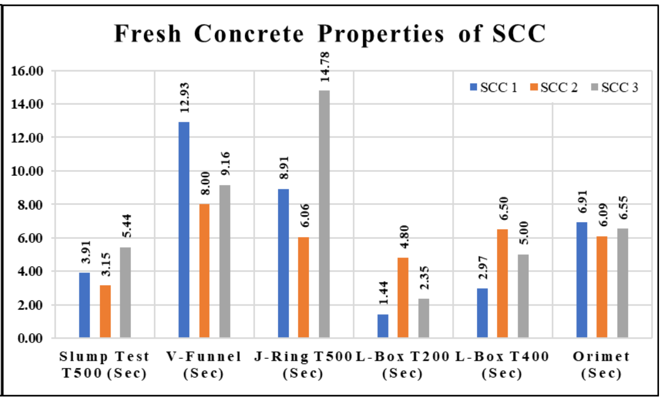
Results were obtained on three trials of SCC with different materials content as well as different super plasticizer content of same brand. The graphs were plotted on the basis on table no. 2 fresh concrete properties of SCC showing different test performed on fresh concrete after batch mixing. Each test is performed on Fresh concrete and results were obtained

Table 2: Fresh Concrete Properties of SCC

Mix	Slump Test		V-Funnel (Sec)	J-Ring		L-Box		Orimet (Sec)	Fill Box (%)	U-Box (mm)
	Slump Flow (mm)	T500 (Sec)		(mm)	T500 (Sec)	T200 (Sec)	T400 (Sec)			
SCC 1	727.5	3.91	12.93	572.5	8.91	1.44	2.97	6.91	93	260
SCC 2	627.5	3.15	8.00	635.0	6.06	4.80	6.50	6.09	94	20
SCC 3	630.0	5.44	9.16	565.0	14.78	2.35	5.00	6.55	85	290

Graphs: Fresh Concrete Properties of SCC





CONCLUSION

The study revealed that variations in mix proportions significantly impacted the workability of self-compacting concrete (SCC), with higher cementitious content leading to improved flow ability. Additionally, the use of super plasticizers enhanced SCC's flow ability while maintaining adequate stability, highlighting the importance of proper admixture selection in optimizing SCC's workability.

REFERENCES

[1] *Comparison of Traditional Concrete with Self-Compacting Concrete along with its properties*[Mr. Onkar V. Sapate[1], Arch Bridge Technologies[2], Mr. Harsh B. Dandade[3], Mr. Himanshu K. Mundekar[3], Mr. Kirnoday D. Wandhare[3], Mr. Prajat M. Jambhale[3]([1]Assistanat Professor, Dept. of Civil Engineering, Priyadarshini J. L. College of Engineering, Nagpur)([2]Arch Bridge Technologies, Nagpur)([3]Student, Dept. of Civil Engineering, Priyadarshini J. L. College of Engineering, Nagpur)]

[2] *Incorporating European Standards for Testing Self-Compacting Concrete in Indian Conditions* [Dr. Hemant Sood[1], Dr.R.K.Khitoliya[2], S. S.

Pathak[1] ([1]Dept. of Civil Engineering, N.I.T.T.T.R; Chandigarh, India)]

[3] *Mixing Time Effects on Properties of Self-Compacting Concrete* [M. M. Rahman, M. H. Rashid, M. A. Hossain, F. S. Adrita and T. Hossain (Department of Civil Engineering, Khulna University of Engineering and Technology (Kuet), Bangladesh)]

[4] *A Review on Studies of the Mechanical Properties of Self-Compacting Concrete* [M. Alsheltat, A. Ramadhan G Student (Department of Civil Engineering, Cyprus International University, Cyprus)]

[5] *Experimental Study of Self-Compacting Concrete Using Portland Cement and Mineral Admixture* [Nisheeth Agnihotri[1], Ravi Agarwal[2], U.S.Vidyarthi[3] (Central Soil and Materials Research Station, New Delhi)]

[6] *An Experimental Study on Self- Compacting of Concrete* [[1]M.Tech Student, [2]associate Professor (Department of Civil Engineering, Usharama College of Engineering and Technology, Telaprolu, Krishna District, Andhra Pradesh, India)]

[7] *Concrete Technology* [Chapter No. 2, 3, 5, 6, 7, 9, 10 & 11] By M. S. Shetty (Publication: New Delhi S. Chand And Company Ltd. 2010)

[8] *WRD Handbook* [Chapter No.3] Self-Compacting Concrete (Maharashtra Engineering Research Institute, Water Resource Department, Nashik-04, April 2019.