Effect of blended mixes in self-compacting concrete

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***Abstract*—A self-compacting concrete (SCC) is the one that can be placed in the form and can go through obstructions by its own weight and without the need of vibration. SCC provides better quality especially in the members having reinforcement congestion or decreasing the permeability and improving durability of concrete. The primary distinction between conventional concrete and SCC lies in the incorporation of mineral admixtures. These admixtures, particularly industrial by-products such as fly ash, ground granulated blast furnace slag (GGBS), and silica fume, are commonly used as partial replacements for cement. Their inclusion not only contributes to improving the rheological properties of SCC but also enhances its mechanical performance and sustainability. The scope is to develop suitable mixes of the work is to containing the mineral admixtures to satisfy the requirements of SCC using local aggregates and to determine the strength and durability of such concrete**

***Index Terms*— self-compacting, EFNARC, flowabality, admixtures, super plasticizers**

I. INTRODUCTION

The development of Self-Compacting Concrete (SCC) represents a significant advancement in the construction industry, addressing several challenges associated with traditional cast-in-place concrete. Unlike conventional concrete, SCC can flow under its own weight, completely filling formwork and achieving full compaction without the need for mechanical vibration. This makes it especially beneficial in complex structures with congested reinforcement or intricate formwork, where traditional compaction methods may be ineffective or labour-intensive.

SCC is largely independent of the skill of workers, the shape or amount of reinforcing bars, and structural complexity. Its high fluidity and resistance to segregation enable it to be pumped over long distances without compromising quality. The concept of SCC was initially proposed by Professor Hajime Okamura in 1986 and later developed into a practical prototype in 1988 by Professor Ozawa at the University of Tokyo. The initial motivation behind its development was to enhance the durability of concrete structures, and since then, SCC has seen widespread application in Japan, particularly by large construction firms.

Subsequent research has focused on establishing rational mix-design methods and standardized testing procedures to evaluate self-compact ability, with the aim of promoting SCC as a mainstream construction material. One of the defining characteristics of SCC is that it does not require internal or external vibration for placement, offering a honey-like flow and achieving a smooth, level surface upon setting.

In terms of composition, SCC contains the same basic ingredients as conventional concrete—cement, aggregates, and water—but incorporates chemical and mineral admixtures in specific proportions to enhance its rheological properties. Common chemical admixtures include high-range water reducers (superplasticizers) and viscosity-modifying agents, which are essential for controlling flow and segregation. Mineral admixtures, such as fly ash and silica fume, are used to refine the mix further. These materials can either supplement or partially replace cement, contributing to improved performance and sustainability. Mixes of the work is to containing the mineral admixtures to satisfy the requirements of SCC using local aggregates are prepared to determine the strength and durability of such concrete

II. METHADOLOGY

Materials:
Self-compacting concrete was made with the cement, manufactured sand, coarse aggregates, water and the mineral admixtures.
Cement: Ordinary Portland cement, 43 grade confirming to IS 8112:2013.
Fine aggregate: Locally available manufactured sand confined to grading zone II of IS: 383-1970.

Coarse aggregates: Locally available crushed granite stones confirming to graded aggregates of sizes 16mm down and 12.5mm down.
Mineral admixtures: ground granulated furnace slag from Jindal steel plant, Class F fly ash, and silica fume were used as mineral admixtures.
Chemical admixtures: Glenium B233 is used as super plasticizer.
Mix design:

Four types of mix proportions were carried out.

Mix 1 Control mix	Self compacting concrete without any replacement to cement
Mix 2	Replacement of cement with Silica fume 10%, GGBS 10%, Fly ash 30%
Mix 3	Replacement of cement with Silica fume 10%, GGBS 20%, Fly ash 20%
Mix 4	Replacement of cement with Silica fume 10%, GGBS 30%, Fly ash 10%

Table 1 showing different mixes.
Mix design was prepared by Okumara method. The table 2 below shows the composition of SCC mixes.

Table 2 showing composition of SCC mixes

Mix	OPC Kg/m3	GGBS kg/m3	Fly ash kg/m3	Silica fume kg/m3	Fine aggregate kg/m3	Coarse aggregate kg/m3	Water kg/m3
Mix 1	595.3	0	0	0	819.6	766.85	189
Mix2	279.7	51.0	122.4	40.07	819.6	766.85	189
Mix3	279.7	102.0	81.6	40.07	819.6	766.85	189
Mix4	279.7	153.1	40.8	40.07	819.6	766.85	189

III. Test methods
Fresh state Properties: Slump flow test, T5o time funnel time, L box test, U box test, J ring tests were performed for determining the workability properties of self compacting concrete to meet the EFNARC standards.
Hardened tests: The hardened properties investigated in this study are compressive strength tests and splitting tensile strength test. Compressive strength test was performed on (15x15x15) cm cubes where as tensile strength was assessed indirectly by the splitting test on cylinders.

IV. TEST RESULTS

Fresh state Properties:
Table 3 shows the results of fresh properties of Self compacting concrete mixes.

Mix	Slump flow in mm	*T50 time in seconds*	*V funnel time in seconds*	*L box ratio*	*U box (h2-h1) in mm*	*J ring h in mm*
Mix 1	650	4.8	12	0.82	19	10
Mix 2	690	3.2	7.8	0.92	9	6
Mix 3	680	3.9	8.6	0.89	13	7
Mix4	675	4	10	0.85	16	8

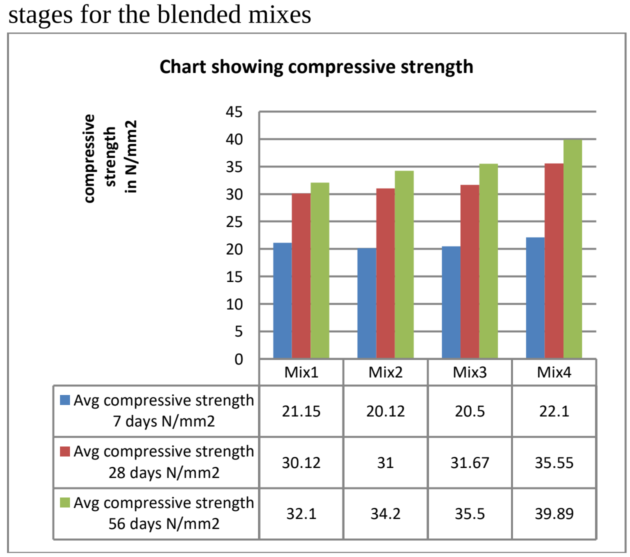
Table 3 showing fresh properties of different mixes.

In terms of slump flow, all SCC mixes exhibited satisfactory slump flows in the range of 650-690 which is a sign of good deformability.

All the fresh concrete properties were in good agreement with the range of values given by EFNARC.

Hardened state properties:
The strength parameters were studied through compressive strength and split tensile strength.

Among the mixes, the strength in blended combination of OPC replacement with 30% GGBS, 10% FA, 10% SF is found higher than other blended combinations where as it is lesser for the control mix. The early age strength is lesser or marginally higher when compared to the control mix whereas strength exceeded at later stages for the blended mixes



V. CONCLUSION

Based on the experimental investigations carried out, the following conclusions were drawn:

Mixes incorporating mineral admixtures such as silica fume (SF), ground granulated blast furnace slag (GGBS), and fly ash (FA) demonstrated superior workability when compared to the control mix containing 100% Ordinary Portland Cement (OPC).
The 28-day compressive strength of all blended mixes was found to be higher than that of the control mix. This enhancement in strength can be attributed to the increased pozzolanic activity and the synergistic effect of the combined mineral admixtures.
Among the various blended mixes tested, Mix 4, which replaced 30% OPC with GGBS, 10% with fly ash, and 10% with silica fume, exhibited the highest compressive strength, outperforming all other combinations. In contrast, the control mix recorded the lowest strength.

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