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An Experimental Analysis on Self Compacting Concrete with Different Grades

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***Abstract:** Self-compacting concrete (SCC), moreover called self-consolidating concrete. It is able to stream beneath its possess weight to totally fill the formwork and accomplish total compaction, indeed within the case of over-burden fortification. Solidified concrete is thick, homogeneous and has at slightest the same specialized properties and toughness as conventional vibrated concrete. scc can be made utilizing the same fixings as customary concrete. In any case, a more tightly resistance is required to guarantee tight control of processability characteristics. The dosing of self-compacting blend is much more logical than that of standard concrete blends. SCC blend requires tall powder substance, less coarse total, exceedingly viable superplasticizer and VMA (viscosity modifying agent) to provide concrete blends soundness and fluidity. Workability of SCC could be a adjust of ease, deformability, fill capacity and isolation resistance.*

***Keywords:** Superplasticizer and VMA, stability and fluidity of the concrete mixture*

I. INTRODUCTION

With the tremendous improvement of development of expansive structures around the world, the request for the application of self-compacting concrete (SCC) is expanding. Numerous places have issues with fortification over-burden within the guideline of auxiliary components. Issues with the plan are compounded due to the tall chance of the seismic zone, helplessness to cyclonic storms and gigantic extension of power plant capacity on a really huge scale. SCC got to be the as it were choice in such troublesome development location conditions. In a perfect world, the improvement of a concrete blend where arrangement and compaction depend at slightest on the level of craftsmanship accessible at a specific site should make strides the real quality of the concrete within the last development and hence its solidness. This was an critical driving constrain behind the improvement of self-compacting concrete (SCC).

II. OBJECTIVES

The main goal of this experimental work is to study the structural behavior of self-compacting concrete of class M30, M40, M50 cast by partial replacement of cement with a cement substitute.

The objectives are:

1) Determine the mechanical properties of SCC using fly ash.
2) To determine the fluidity of SCC using an admixture.
3) Improve the filling capacity through highly overloaded reinforcement using self-compacting concrete.
4) Reduce construction time in the project.
5) Improve the cohesion of self-compacting concrete by using a powder content that acts as a viscosity-modifying agent.

III. MATERIALS

A. *Ordinary Portland Cement:*

Cement acts as a cover for materials. Cement utilized in development is created by calcination at tall temperature. It may be a blend of calcareous, siliceous, clay substances and smashing clinker into a fine powder. Cement is the foremost costly fabric in concrete and is accessible in different shapes. When cement is blended with water, a chemical response happens, as a result of which the cement glue solidifies into a stone mass.

• In this project we used only regular portland cement.
• Cement Details:

1) Grade of cement - OPC 53 grade
2) Sp. Cement gravity- 3.15

B. Fine Aggregate:

Crushed-Sand plays a very important role in concrete. It can fill gaps between cement and aggregate. Therefore, the sand must be well sorted in terms of particle size in order to guarantee filling between different aggregates as much as possible. The sand may be finer than normal because material less than 150 µ can help increase cohesion and thus resist segregation.

C. Coarse Aggregates:

Coarse aggregate is a term used in the construction industry to describe the type of material commonly used in concrete production. It is usually composed of various materials such as gravel, crushed stone and recycled concrete. Coarse aggregate can vary in size, but is typically between 3/8 inch and 1.5 inches in diameter.

Table I.
Physical properties of coarse and fine aggregates

Sr.no.	Physical properties	Test results	
		Fine aggregates	Coarse aggregates
1	Specific gravity	2.79	2.94
2	Water absorption	3.09%	3.06%
3	Bulk density	1706 Kg/m^3	8 kg/m^3

D. Fly Ash

Fly ash is one of the normally happening items of the coal combustion handle. Fly ash remains may be a wealthy source of silica and alumina, which responds with an antacid arrangement to create an aluminosilicate gel that acts input of cement in concrete. The specific gravity of the Fly ash is 2.1 and the chemical composition of the oxides is shown in the table.

Table II.
Chemical composition of fly ash

Oxides	Percentage	Requirements as per IS 3812-2003
SiO_2	61.24	SiO2 >35% Total - >70%
Al_2O_3	25	
Fe_2O_3	8.71	
CaO	4.22	-
Na2O	0.09	<1.5%
MgO	0.09	<5%
SO_3	0.49	

Fig. 3.1 fly ash

E. Water:

The water used in the design mix was potable tap water; so it did not contain suspended solids and organic materials that could affect the properties of fresh and hardened concrete.

F. Powder Content

1) the powder content (fine particles < 0.125 mm) required for SCC (free flow) should generally in the range of 400 to 600 kg/m3. Given the fluidity and viscosity required; the mixture must be sufficiently cohesive (with enough fine particles). All fly ash, about 10% of zone 1 aggregates.
2) In earlier SCC methods, VMA (viscosity agent) is used, but now in IS (Indian standard) method, powder content is used to achieve better fluidity and viscosity.
3) In this research we used fine particles <0.125 mm in crushed sand as powder content.

Fig. 3.2 Powder content

G. Chemical Admixtures

1) Chemical additives are essential for processability properties. SCC contains additives, namely superplasticizers and sometimes a viscosity adjusting agent.
2) Super plasticizers: Superplasticizers added to SCC concrete can reduce the water-cement ratio and improve the strength, volumetric stability, and handling properties of the wet mix. In general, the workability and compaction standard of the mix will be improved by using some type of water reducing admixture.
3) The superplasticizer used in this study is imperial infra chemicals superplasticizer is a high retarding superplasticizer for high performance concrete mixes.
4) Superplasticizers, when in concrete, can reduce the water-cement ratio and improve the strength, volume stability, and handling wet mix properties. The superplasticizer used in this study is imperial infra chemicals superplasticizer.

Table III.
properties of imperial infra superplasticizer

Aspect	Light brown liquid
Relative Density	1.08 ± 0.01 at 25ºC
p^H	≥ 6
Chloride ion content	< 0.2%

Fig. 3.3 superplasticizer

IV. MIX PROPORTION OF CONCRETE

According to IS:10262-2019, to determine the properties of SCC, in addition to cement substitutes and chemical additives, mix ratios for self-compacting concrete of M30, M40, M50 quality are also prepared. Table No. 4 shows the proportion of the mixture of individual types of self-compacting concrete.

Table IV.
Mix proportions for self-compacting concrete of different grades

Materials	Grade of concrete		
	M30	M40	M50
Cement	293	308	360
Fly ash	73	97	140
Coarse aggregates – 20 mm	234	358	283
Coarse aggregates -10 mm	546	834	660
Fine aggregate	740	750	900
Water	172	170	160
Powder	74	75	90
admixture	1.10%	1.00%	1.20%

V. MECHANICAL PROPERTIES

1) to determine compressive strength Cubes of dimensions 150 mm x 150 mm x 150 mm were cast to carry out this test after a water curing period of 3rd, 7th and 28th day to determine the strength as per codal specification as IS 516- 1959. Concrete cylinders of size 15 cm (diameter) x 30 cm (height) are cast to determine the tensile strength of SCC. The test is performed by placing a cylindrical specimen horizontally between the bed of the compression testing machine and applying the load until the cylinder fails along the vertical diameter. a total of 54 no. samples were cast and tested.
2) Workability properties such as flowability were carried out to determine their filling capacity and creep capacity before determining the hardening properties of the concrete. The creep ability of self-compacting concrete is determined using the creep test. The drop value should be between 600 mm to 800 mm.
3) FE-SEM test is performed to know SCC metrology. FE-SEM is an progressed innovation utilized to capture the microstructural picture of materials. FE-SEM is more often than not performed in tall vacuum since gas particles tend to meddled with the electron bar and the radiated auxiliary and backscattered electrons utilized for imaging. The tests were cut into littler sizes of approximately 5 x 5 x 3 mm and coated with aurum some time recently morphological perceptions.

VI. RESULTS AND DISCUSSION

In this project, the properties of new and solidified self-compacting concrete utilizing fly ash as a halfway substitution for cement were examined.

A. *Fresh Properties*

Test strategy employing a standard Abrams drop cone (upright or modified) on a level surface to degree the unconfined stream and solidness of SCC. The numerical esteem of stream in mm is decided as the normal distance across of the circular store (patty) of SCC at the conclusion of the seating test. The droop values of all SCC blends appeared palatable comes about between 620 mm to 660 mm, demonstrating great deformability of the concrete blend. The values of the sitting test are appeared in table no. V.

Table V.
results of slump flow test

Sr. no.	Grade of concrete	Dose of admixture	Slump flow
1	M30	1.1%	640 mm
2	M40	1%	620 mm
3	M50	1.2%	660 mm

B. Mechanical Properties

The properties of SCC after 3 days, 7 days and 28 days are shown in Figure No. 1 and 2 and Tables 6 and 7 From the results it is clear that the strength of SCC after 28 days can be increased by using Fly ash at 20%, 24% and 28% replacement cement compared to the control mixture at an early stage.

Table VI.
compressive strength of self-compacting concrete

Grade of concrete	3 days (N/mm^2)	7 days (N/mm^2)	28 days (N/mm^2)
M30	17.68 N/mm^2	21.49 N/mm^2	39.77 N/mm^2
M40	21.40 N/mm^2	28.91 N/mm^2	50.22 N/mm^2
M50	32.35 N/mm^2	40.64 N/mm^2	60.88 N/mm^2

Table VII.
splitting tensile strength of self-compacting concrete

Grade of concrete	3 days (N/mm^2)	7 days (N/mm^2)	28 days (N/mm^2)
M30	2.12 N/mm^2	2.35 N/mm^2	2.88 N/mm^2
M40	2.22 N/mm^2	2.79 N/mm^2	3.38 N/mm^2
M50	3.74 N/mm^2	3.93 N/mm^2	4.46 N/mm^2

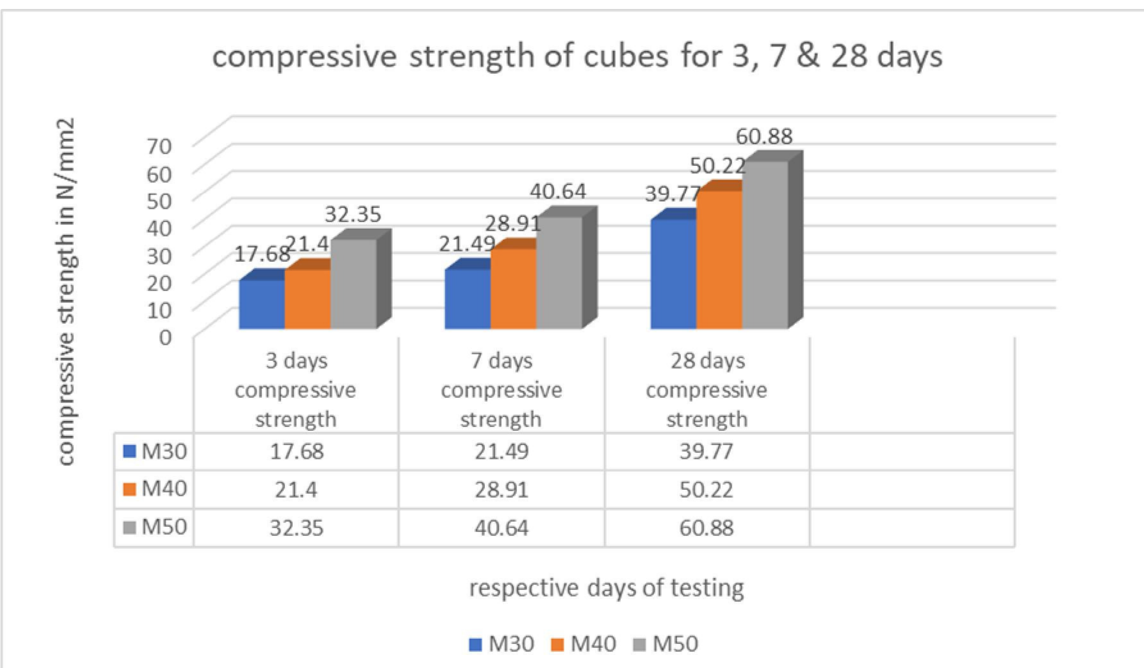

Fig. B.1 compressive strength of self-compacting concrete

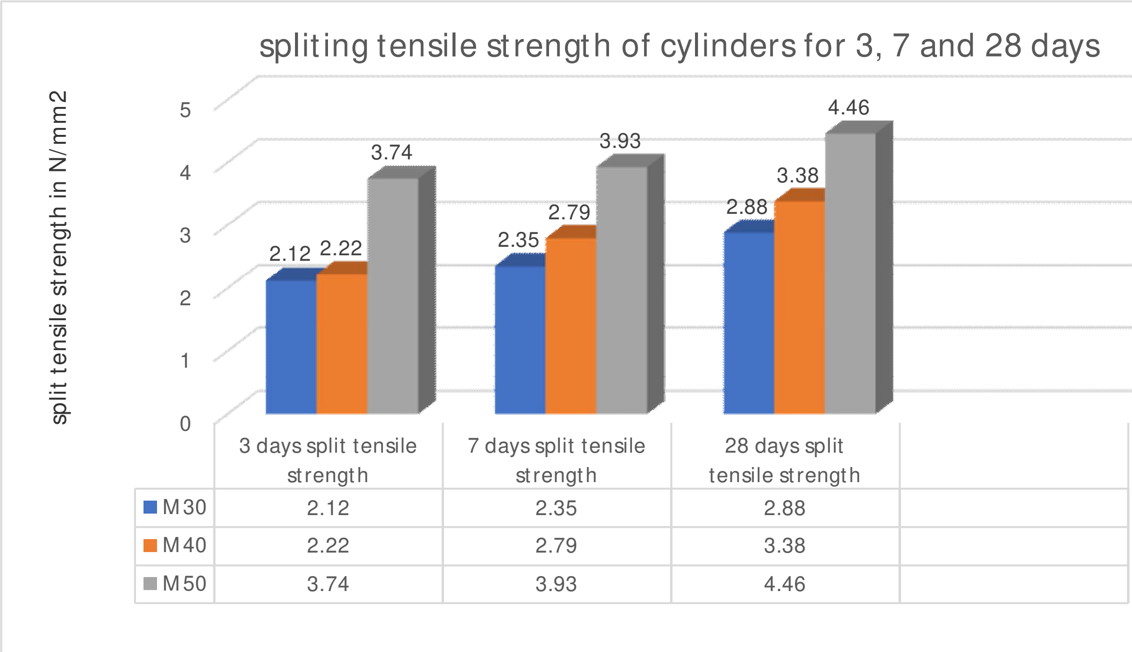

Fig. B.2 Split-tensile strength of self-compacting concrete

C. Field Emission Scanning Electron Microscopy (FE-SEM)

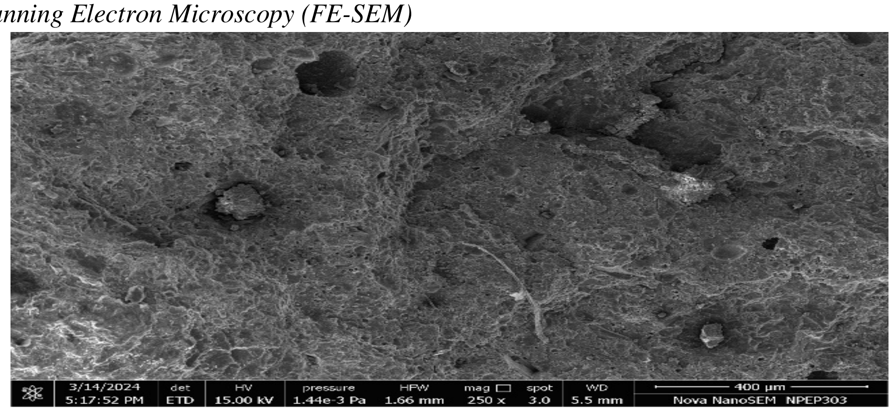

Fig. C.1 morphological surface

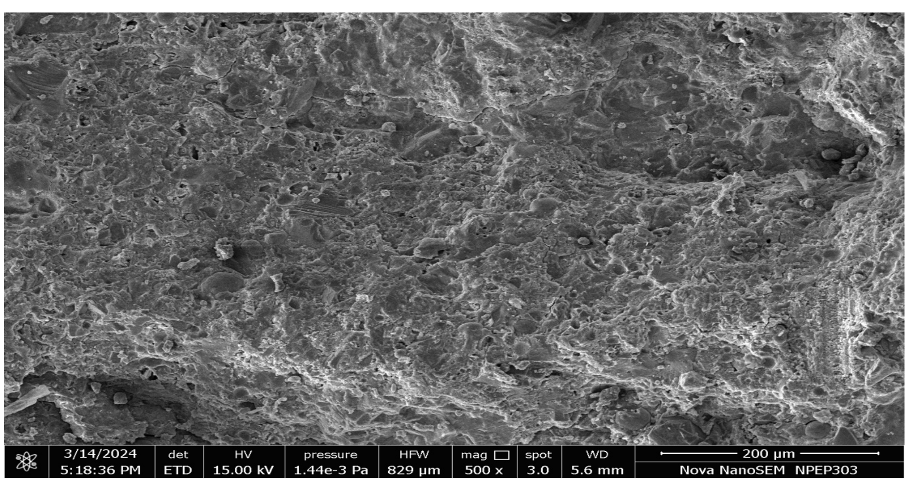

Fig. C.2 porous surface

1) In this test, we tested a concrete sample of size 5 mm X 5 mm X 3 mm.
2) a 400 nanometer precision microscope is used for pore and texture analysis.
3) This figure shows the interference transition zone in hardened SCC that affects the compressive strength.
4) the sample is tested with accuracy of 200 nanometers, we know that the correct bond between the filler material and the aggregate led to better strength values.

VII. CONCLUSION

1) The maximum compressive strength of SCC accomplished at the age of 28 days is
- M30 grade: 39.77 N/mm^2
- M40 grade: 50.22 N/mm^2
- M50 grade: 60.88 N/mm^2

2) The maximum split tensile strength of SCC accomplished at the age of 28 days is
- M30 grade: 2.88 N/mm2
- M40 grade: 3.38 N/mm2
- M50 grade: 4.46 N/mm^2

3) The workability achieved by SCC at 1%, 1.1%, 1.2% dosage of superplasticizer
- M30 grade: 640 mm
- M40 grade: 620 mm
- M50 grade: 660 mm

4) By FE-SEM analysis we observed from the fig. C.1 & C.2 that the no. of pores present in the concrete is less and proper binding between aggregates and filler materials is done and compaction is done properly so its results in better strength values.
From the above conclusion and results it is observed that the M50 grade of SCC is achieved the higher workability, compressive strength and splitting tensile strength.

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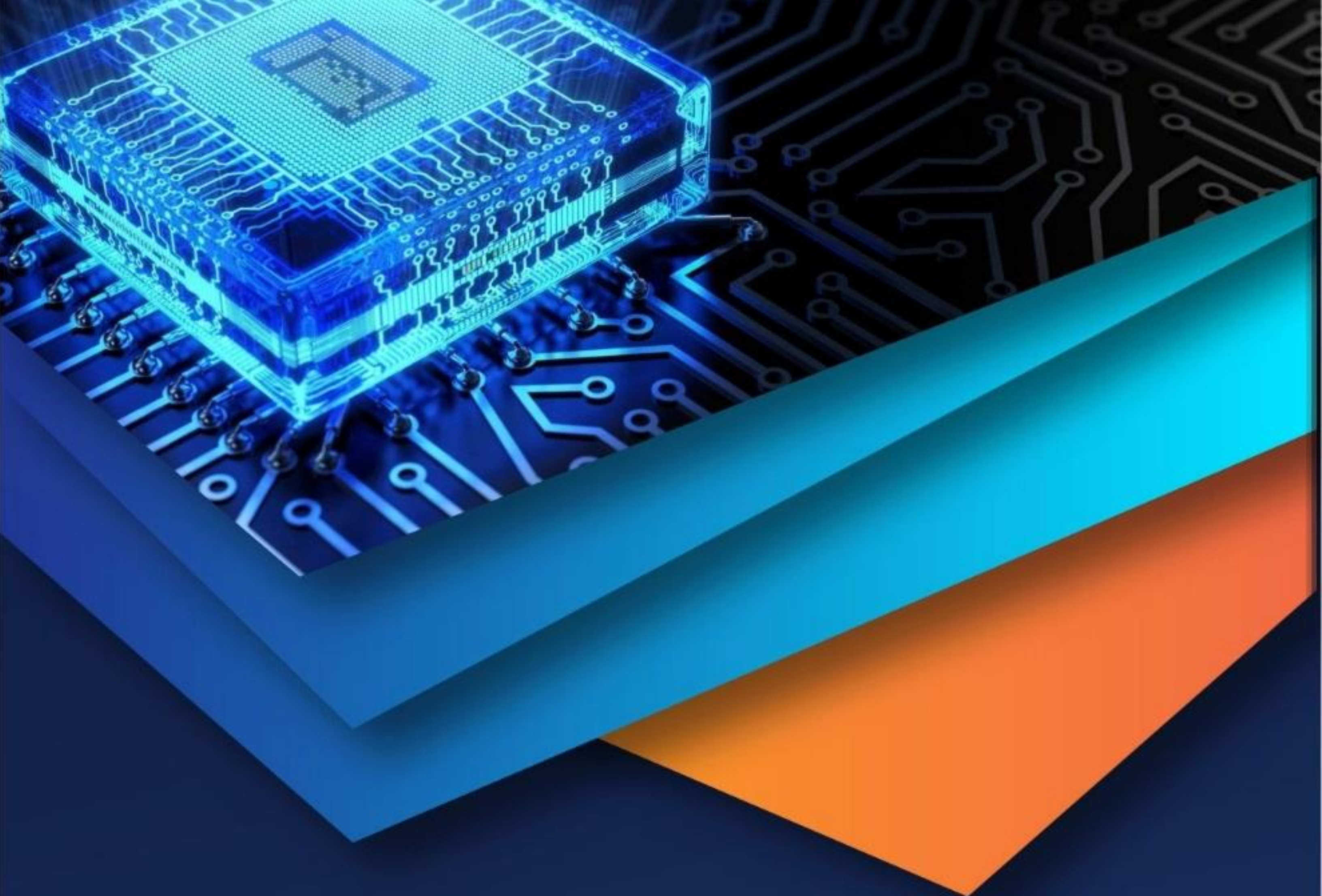

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