Self-compacting Concrete Supplemented with Steel Fibers and Mineral Additives to Prevent Corrosion.

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Abstract - *Concrete that self-compacts (SCC) fill almost entirely while flowing through the formwork because of its inherent weight. It also completely fills in all gaps and voids in structural members with a high proportion of reinforcement. Investigating the new and toughened properties of steel fiber SCC is the aim of the research that is being presented. The findings showed that the compressive and tensile strengths of self-compacting concrete were impacted by the novel qualities of SCC with steel fiber. There was an ideal steel fiber content of 1.5-2.0%, at which better performance was attained for the two aforementioned features. In comparison to the plain mix, all fiber mixtures showed greater flexural, splitting, and tensile strengths at all curing ages. As the fiber content rose, the strength also rose.*

***Key Words*: Conventional concrete, Self-compacting concrete, mineral additives, steel fiber, Compressive Tensile and Flexural strength, Corrosion.**

1.INTRODUCTION:

Self-compacting concrete (SCC) is a kind of concrete that may provide good compaction without the need for outside vibration by flowing under its own weight. Moreover, SCC's cohesive qualities provide it with good resistance to bleeding and segregation. Steel fibre have been used in traditional concrete in place of bar reinforcement to reduce fracture width, boost tensile and flexural strength, and enhance post-cracking behaviour. Improved crack growth resistance, increased surface roughness of individual fractures, and a higher probability of crack branching and multiple crack formation are all effects of steel fibre reinforcing on the way cracks develop in concrete.

Fiber Requirement in SCC:

To improve post-cracking behavior, reduce crack width, boost tensile and flexural strength, and substitute bar reinforcement in traditional concrete, steel fibers have been used. Concrete crack formation can be affected by steel fiber reinforcing, which can lead to enhanced resistance to fracture growth, rougher surfaces for individual cracks, and a higher chance of multiple cracks developing and branching out.

2. AIM AND OBJECTIVE:

- Corrosion is eliminated by the invention of self-compacting concrete with mineral additives.
- To investigate how steel fiber affects the concrete's strength characteristics and examine the compressive, tensile, and flexural strengths of the concrete and draw conclusions about how strong conventional and self-compacting concrete are in these areas.

3. LITRATURE REVIEW:

- **[Aslani and Samali 2014]** performed experiments on SCC with steel, polypropylene (PP) and hybrid fibres. They found that average compressive strength of hybrid FRSCC was more than SCC with steel and PP fibres. Average modulus of rupture (MOR) for SCC reinforced with steel fibres was found to be more than that of SCC with PP and hybrid fibres. The also concluded that compressive strength and MOR properties of FRSCC are decreased with time.

- **[Krishna Rao, et al, 2010]** studied the technical challenges related to the unevenly distribution of steel fibres in the SSC. Commonly placed in the course of concrete stream, due to this form the strength of concrete improves considerably and by use of fibre and its short-term arrangement could enhance the strength of the beam depending on the path of concrete movement. However, the performance is reduced compared to the standard and that is why large plasticizers are needed in large quantities.

- **[El-Dieb, et al, 2008]** researched the installation of Fibers and its advantages through its addition in the SCC, Fibers bridges prevent and promote its spread inside the concrete and ultimately increase the strength and strength of concrete flexibility. Tests demonstrate that it is feasible to retain SCC properties whilst employing fibre reinforcement. The high fibre matter that can be applied without altering the concrete flow was revealed in their experiments, and the kind of fibre can significantly affect the adhesive and mud volume. Conventional OPC has been used in standard silica fire tests and sand is used as silk sand. Several tests were performed in the process and apparently studied the impact and percent of fibre without affecting the SCC structures and various types of fibres.

- **[Donom, et al, 2006]** analysed research cases and future work, studies in the area of composite concrete. As technology advances the SCC now undergoes a mixture of fibres, small reinforcement of cement along with silk, lime, and substitutes part of a good combination of fly ash, dust, marble dust to replace part of the excess metal. Even fibres have a variety of differences in size affect the physical, mechanical and chemical properties and the size of the wires containing the SCC compound will be investigated.

4. MATERIAL REQUIRED FOR SCC:

4.1 Cement: In this experiment, OPC-53 grade cement—which has a specific gravity of 3.16 and a cement fineness of 5.7%—was utilized.

4.2 Coarse Aggregate: The aggregate was employed in a uniform grade with a nominal size of 20 mm. Its specific gravity is 2.61 and its water absorption is 1.1%.

4.3 Fine Aggregate: Zone II natural sand's specific gravity is 2.45, its water absorption is 1.16%, and its fine aggregate nominal size is 4.75 mm.

4.4 Water & Plasticizer: Concrete was mixed and cured using drinking water, and the super-plasticizing additive SUNNDA polytancrete NGT was utilized to create SCC.

4.5 Mineral Admixture (Calcium Nitrate): This substance was used to strengthen the steel fiber's ability to withstand corrosion in powdered form. The specific gravity is 1.87.

Fig-1: Calcium Nitrate

4.6: Fibers: Steel fiber with straight ends and a cylindrical shape was employed in this project. The steel fiber had the following properties: length 30mm diameter 0.25mm, specific gravity 7.81, tensile strength 900 MPa. As tested by ASTM A820M-11, it passed.

Fig-2: steel fiber.

5. MIX DESIGN FOR CONCRETE:

As Indian standard recommended method for concrete based on {IS10262-2019}.

(A) Steps for mixed design for concrete:

1. Grade of Concrete = M40
2. Type of cement = OPC-53
3. Size of aggregate = 20 mm nominal size
3. Degree of site control = Good
4. Exposure-condition = Extreme
5. Workability = 75 mm
6. Method of concrete placing = manual mixing
7. Minimum cement content = 360 kg/m^3

(B) Test result for material:

1. Specific gravity of cement = 3.16
2. Specific gravity of coarse-aggregate = 2.61
3. Specific gravity of fine-aggregate = 2.45
4. Water absorption of coarse-aggregate = 1.1
5. Water absorption for fine-aggregate = 1.16
6. Zone of sand = II
7. Type of aggregate = uniformly-graded-aggregate.

(C) Target mean strength = 48.25 N/mm^2

(D) Selection of water-cement ratio = 0.50

(E) Selection of water content = 212.11 kg/m^3

(F) Cement content =363.383 kg/m^3

(G) Coarse aggregate (per m^3) = 1186.157 kg

(H) Fine aggregate (per m^3) = 625.93 kg

5.1 Tests on concrete:

Workability test: The slump test method is for figuring out how consistent fresh concrete is. The horizontal free flow of self-compacting concrete in the absence of obstacles is evaluated using a test. Slump was determined as the basis for the test procedure that affects workability. C:S:A::1:65:3.13 is the mix ratio for conventional concrete, and C:S:A::1:1.72:3.26 is the mix ratio for self-compacted concrete.

Table-1 Slump Values of Conventional Concrete.

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.40	80	80.00
02	0.40	78	
03	0.40	82	

Table-2 Slump Values of Self-compacting Concrete.

S. No.	W/C Ratio	Slump Value(mm)	Average Value
01	0.50	83	83.00
02	0.50	80	
03	0.50	85	

Chemical and mineral admixture inclusion improves workability.

6. RESULT AND DISCUSSION:

The specimens were cast in accordance with IS 10086-1982. The cube, cylinder, and beam samples were cured in a water pond for a period of 28 days. At seven and twenty-eight days, the strength metrics of self-compacted concrete were compared to those of conventionally cured concrete.

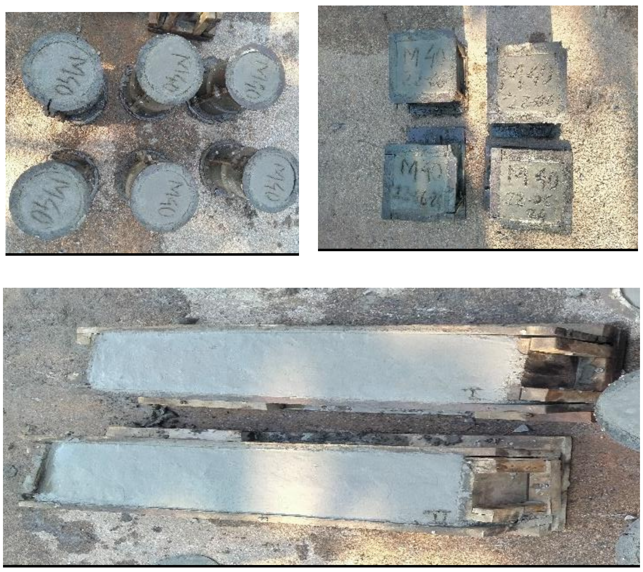

Fig-3: Casting of Cylinder, Cube & Beam.

6.1 TEST OF SPECIMEN:

Compressive Strength test: A 150 × 150 × 150 mm concrete cube was cast, and it was tested for seven and twenty-eight days. Compressive Strength is equal to P/A, where A is the cross-sectional area (150 × 150 x 150 mm) and P is the applied load.

Fig-4: Compressive strength test in UTM

TABLE-3: Compressive Strength results of Concrete:

S. No.	Mix Proportion	% of steel fiber	% of mineral admixture ($Ca(NO_3)_2$)	Age	Compressive strength (N/mm^2)	Average of compressive strength in (N/mm2)
01	Conventional concrete	0	0	7 days	24.77 23.50 25.84	24.70
				28 days	45.12 47.69 41.06	44.62
02	SCC MIX1	1.50	2.50	7 days	24.16 29.50 27.06	26.90
				28 days	41.42 46.73 52.41	46.85
03	SCC MIX2	1.75	2.25	7 days	26.44 27.86 30.12	28.14
				28 days	46.56 50.86 45.25	47.55
04	SCC MIX3	2.00	2.00	7 days	28.77 32.39 34.16	31.77
				28 days	53.27 47.49 49.05	49.93

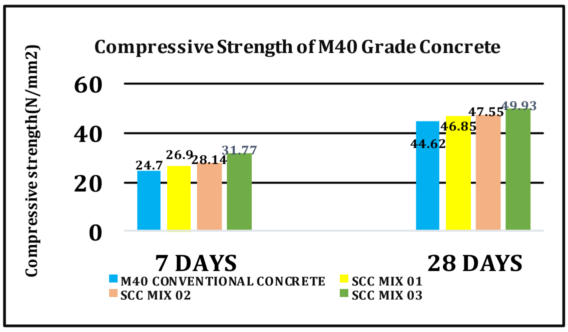

Chart-1: Compressive strength for conventional concrete after 7, and 28-days vs self-compacting concrete.

Split tensile strength test: utilizing 300mm-high and 150mm-diameter cylinders. In 7 and 28 days, the cylinder was tested after it was cast. Split tensile strength is equal to

2P/πDL, where P stands for load, D for cylinder diameter, and L for cylinder length.

Fig- 5: Split tensile strength test in UTM

TABLE-4: Tensile Strength results of Concrete:

S. No.	Mix Proportion	% of steel fiber	% of mineral admixture (Ca(NO₃)₂)	Age	Compressive strength (N/mm²)	Average of compressive strength in (N/mm2)
01	Conventional concrete	0	0	7 days	24.77 23.50 25.84	24.70
				28 days	45.12 47.69 41.06	44.62
02	SCC MIX1	1.50	2.50	7 days	24.16 29.50 27.06	26.90
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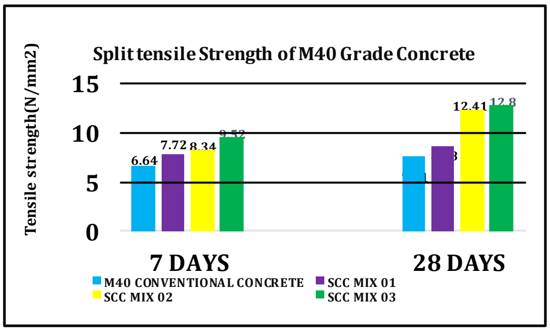

Chart-2: Tensile strength of conventional concrete after 7 and 28-days vs Self compacting concrete.

Flexural Strength test: A universal testing equipment applies a 2000 KN force to a 150 x 150 x 700 mm beam specimen to generate pure bending. Recorded is the maximum applied load on the specimen. At 7, 14, and 28 days, we noticed that the concrete mix's strength had increased. f strength is equal to WL/bd.

Fig-6: flexural strength test of concrete in UTM

Table-5: Flexural Strength results of Concrete.

S. No.	Mix Proportion	% of steel fiber	% of mineral admixture (Ca(NO₃)₂)	Age	Average of compressive strength in (N/mm2)
01	Conventional concrete	0	0	7 days	0.47
				28 days	0.74
02	SCC MIX1	1.50	2.50	7 days	1.20
				28 days	1.99
03	SCC MIX2	1.75	2.25	7 days	1.77
				28 days	2.80
04	SCC MIX3	2.00	2.00	7 days	2.11
				28 days	3.18

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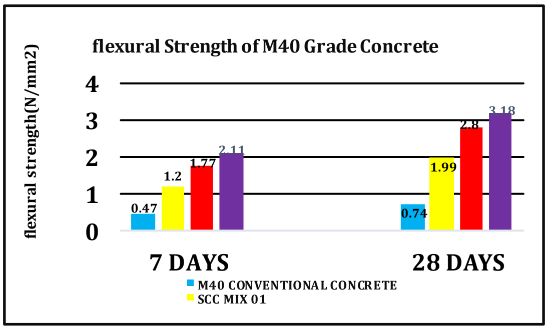

Chart-3: flexural strength OF Conventional concrete after 7 and 28-days vs Self compacting concrete.

7. CONCLUSION:

1. Deflection capacity and flexural strength of SCC are both enhanced by the inclusion of steel fibre.
2. Mineral admixtures are quite beneficial when utilizing SCC for cement in practical modern concrete construction.
3. Similarly, split tensile and flexural strengths have significantly increased, and steel fibers help to explain this increase in strengths.

8. SCOPE OF RESEARCH:

- Find the optimum used of steel fibre and Mineral admixture.

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