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Experimental Study on Utilization of Hybrid Fibers in Self-Compacting Concrete

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ABSTRACT

Self compacting concrete is a non segregating concrete that is placed by means of its own weight. It is highly flow able concrete that can spread without need of vibration. In this study steel and polypropylene fiber are used as hybrid fiber to enhance the workability of the concrete. In addition to this, CONPLAST SP 430 is used as a chemical admixture which is added to SCC by the volume of 2% of cement. These components like hybrid fiber and super plasticizer are added to the concrete to improve the better strength and durability of SCC. In this study, the various mix proportions of fibers discussed in this study are 0%, 0.25%, 0.5%, 0.75%, 1%, 1.5% determined by preliminary test on self compacted materials. By this desired compositions test for fresh concrete such as slump flow, L-box and V-funnel, U box, J ring are performed for SCC. It is found that compression and split tensile strength has been improved by the addition of hybrid fibers at 1% respectively. This experimental investigation is carried out to improve the compressive, split tensile and flexural strength in SCC for obtaining the optimum value.

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1. INRODUCTION

Self-compacting concrete is a fluid mixture suitable for placing in structures with congested reinforcement without vibration. Self-compacting concrete development must ensure a good balance between deformability and stability. Also, compatibility is affected by the characteristics of materials and the mix proportions; it becomes necessary to evolve a procedure for mix design of SCC. For SCC, it is generally necessary to use super plasticizers in order to obtain high mobility. Adding a large volume of powdered material or viscosity modifying admixture can eliminate segregation. The powdered materials that can be added are fly ash, silica fume, lime stone powder, glass filler and quartzite filler.

SCC can also provide a better working environment by eliminating the vibration noise. Such concrete requires a high slump that can easily be achieved by super plasticizer addition to a concrete mixture. However, for such concrete to remain cohesive during handling operations, special attention has to be paid to mix proportioning.

SCC is an extremely fluid mix with the following distinctive practical features it flows very easily within and around the formwork, can flow through obstructions and around corners "passing ability", is close to self-leveling does not require vibration or tamping after pouring, and follows the shape and surface texture of a mold very closely once set. As a result, pouring SCC is also much less labor-intensive compared to standard concrete mixes. Once poured, SCC is usually similar to standard concrete in terms of its setting and curing time, and strength. SCC does not use a high proportion of water to become fluid – in fact SCC may contain less water than standard concretes. Instead, SCC gains its fluid properties from an unusually high proportion of fine aggregate, such as sand, combined with super plasticizers and viscosity modifying agent (VMA).

Self compatibility can be achieved by the following mechanism

1. Limited aggregate content
2. Low water –powder ratio
3. Use of super plasticizer

1.1. ADVANTAGES OF SCC

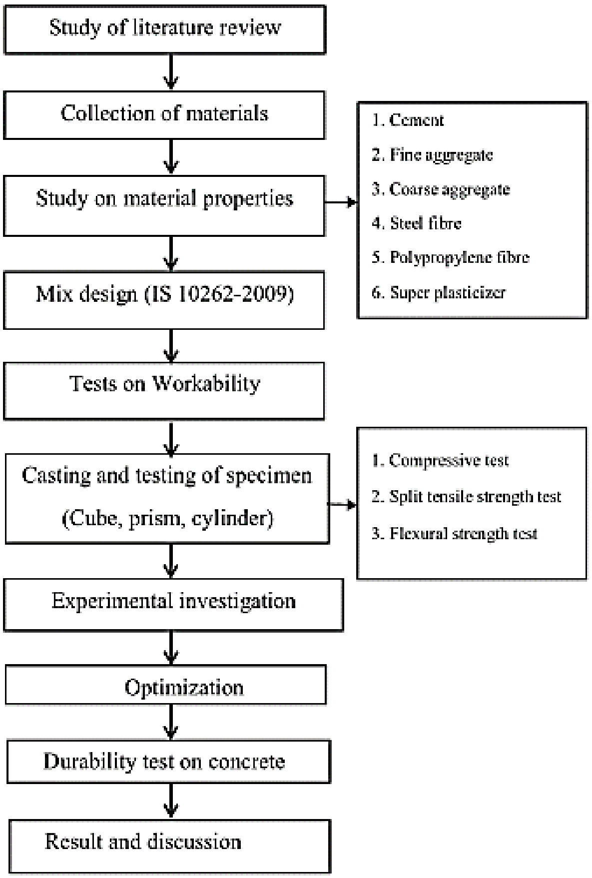
- Safe working environment.
- Speed of placement, resulting in increased production efficiency.
- Ease of placement, requiring fewer workers for a particular pour.
- Better assurances of adequate uniform consolidation.

- Improved durability and reliability of concrete.
- Increased bond strength.
- Best suited where reinforcement congestion is a problem.
- Economic efficient.

- Reduces construction noise and health hazards.
- Bleeding and segregation problems are almost nil.
- It produces a smooth and well-finished surface at the end of concreting.
- The permeability of the concrete structure is decreased.

2. METHODOLOGY

Fig. 2.1Flow chart for Methodology



3. TESTING OF MATERIALS

3.1. CASTING OF SPECIMEN

Cubes, Prism and Cylinder specimens will be casted for Self-Compacting Fibre Reinforced Concrete to determine the optimum percentage for the addition of steel and polypropylene fibre.

3.1.1. Mixing

The test specimens were casted in wooden moulds and cylinders were casted in PVC mould. The inside of the moulds were applied with oil to facilitate the easy removal of specimens. For obtaining the binder content, fibers, fine aggregate and the coarse aggregate were thoroughly mixed with one another in dry condition. The coarse aggregate, cement were placed in a concrete mixture machine and then mixed thoroughly in dry condition. For addition of water initially 75% of the mix water is added to the dry mix and then mixed thoroughly.

Fig.3.1 mixing of materials

3.1.2. Placing

Then the mixture is placed inside the mould After 24 hours the test specimen were remolded and placed in the water tank for curing, till the age of test.

Fig. 3.2 placing of mixture to the mould

3.1.3. Curing

The curing process for specimen is fully immersed in water up to 28 days. The hydration process will happens when the specimen is immersed in water for curing process.

Fig.3.3 curing of specimen

Fig.3.4 casting of specimen

3.1.4. TEST METHODS TO ASSESS WORKABILITY CHARACTERISTICS

The tests results obtained for fresh properties of self-compacting concrete to assess workability are discussed below. The slump flow test was conducted to determine the filling ability of concrete and its resistance to segregation. The spread diameter of the slump flow and T 50 slump flow has been measured and it is shown in Figure 3.5. To determine the passing ability of concrete J-Ring test was measured in mm and is shown in the figure to evaluate the viscosity of SCC,

V-funnel tests were carried out and the time taken to drain the funnel was measured in seconds. To assess the filling and passing ability of SCC L-box tests was conducted and the blocking ratio was determined. The L-box test setup is shown on Figure 3.6. The test Values obtained satisfy the recommended value and they are listed in Table 3.1. The European guidelines EFNARC has proposed five test methods to fully characterize an SCC mix.

Fig.3.5 Slump flow

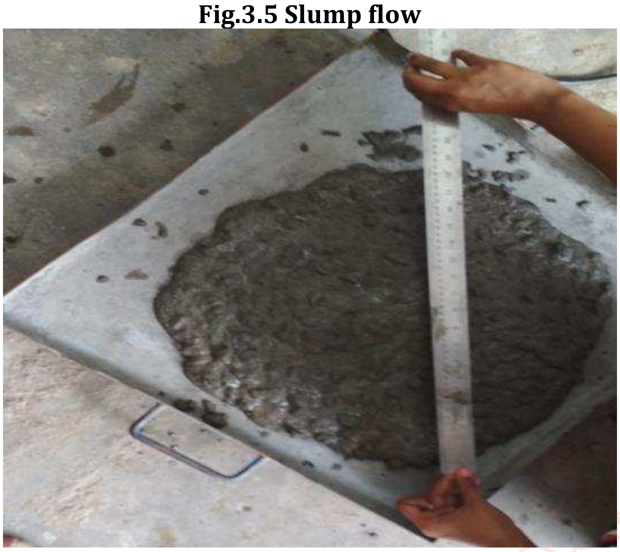


Fig.3.6 Slump flow

Table 3.1 Recommended limits as per EFNARC guidelines.

S. No	Test	Recommended limits
1	Slump flow (mm)	650 – 800
2	T50 Slump flow (sec)	2 – 5
3	J-Ring (mm)	0 – 10
4	V-Funnel (sec)	8 – 12
5	L – Box (h1/h2)	0.8 -1.0
6	U – Box (mm)	0 - 30

3.1.5. U – Box test

U Box test is used to measure the filing ability of self compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments an opening with a sliding gate is fitted between the two sections. Reinforcing bar with nominal diameter of 134 mm are installed at the gate with centre to centre spacing of 50 mm. this create a clear spacing of 35 mm between bars. The left hand section is filled with about 6 liter of concrete then the gate is lifted and the concrete flows upwards into the other section. The height of the concrete in both sections is measured. It's determined by the U - Box as shown in Figure 3.7.

Fig.3.7 U-Box

4. TEST RESULTS AND DISCUSSION

The main objective of the present study is to determine the compression strength and split tensile strength. This chapter discusses about the experimental study on self compacting fiber reinforced concrete. Based on EFNARC guidelines and trial & error method SCC mix proportion for M 25 was designed. Table 4.1 shows the mix proportion for SCC. In this study 20% of cement is replaced by fly ash as powder content.

Table 4.1 Mix ratio for SCC

MATERIAL	MIX RATIO
Cement	1
Fine Aggregate	1.58
Coarse Aggregate	1.55
Water/Cement ratio	0.34

The various mix proportions (0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%) are represented in the below table respectively.

Table 4.2 Mix Identification

MIX ID	DESCRIPTION
SCC	SCC with 0% of fibres
SCC M1	SCC with 0.25% of fibres
SCC M2	SCC with 0.50% of fibres
SCC M3	SCC with 0.75% of fibres
SCC M4	SCC with 1% of fibres
SCC M5	SCC with 1.25% of fibres

4.1. COMPRESSIVE STRENGTH TEST

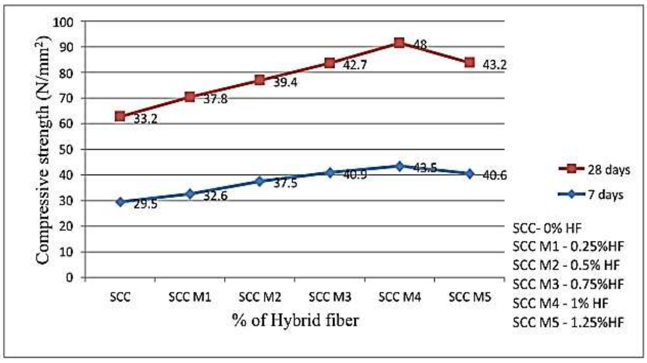
Cubes were casted and cured for 28 days. After curing 28 days compressive strength of the cubes were tested. The compressive strength at 28 days of M 25 grade of SCC increased as the addition of hybrid fibres. There is an increase in compressive strength for 0.25% replacement of cement with steel fibre and polypropylene fiber.

Fig.4.1 compression strength test set up

Table 4.3 compression strength results

S. No	MIX ID	7 DAYS (N/mm2)	28 DAYS (N/mm2)
1	SCC	29.5	33.2
2	SCC M1	32.6	37.8
3	SCC M2	37.5	39.4
4	SCC M3	40.9	42.7
5	SCC M4	43.5	48
6	SCC M5	40.6	43.2

Fig.4.2 compression strength



5. CONCLUSION

- By the use of super plasticizers at constant dosage for all the mixes of SCC has showed good flow able property of the concrete.
- The fresh and the hardened properties of the Self-compacting concrete with hybrid fibres have been determined.
- The fresh properties of SCC were checked by conducting various tests which has been satisfied the recommended values given by EFNARC guidelines and showed the good workability.
- The mechanical properties such as compressive strength and the split tensile strength has been increased 44.58% and 57.69% of the addition of 1% hybrid fibres in the concrete.
- The flexural strength of concrete is increased 50% with addition of hybrid fiber than the split tensile strength.

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