Effect Of Mineral and Chemical Admixture on Fiber Reinforced Self Compacting Concrete

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Abstract: **The objective of this work is to investigate the toughness property of the fiber reinforced self compacting concrete (FRSCC) through experimental studies. Fibers are used to arrest the cracks in the concrete, and also improve the toughness property of the concrete. In this work, different (0.5%, 1.0%, 1.5%, and 2%) percent of steel fibers are added by volume of concrete and (0.5% & 1.0%) percent of poly-propylene are added by mass of compendious material.**

The mix design of self compacting concrete has been done according to the EFNARC guidelines. The limitations stipulated in European guidelines are also achieved according to the European guidelines. By using different types of fibers the toughness property of the FRSCC has been studied. It has been observed that the toughness increased with increase in % of fibers up to 1.5%. While, increase in % fiber content beyond 1.5% resulted in lower toughness for the steel fibers. It gives a conclusion that the only the limitation of steel fiber for SCC is up to 1.5% of volume of concrete. The comparative study also recorded mechanical properties of poly- propylene fiber reinforced self compacting concrete.

Key word: **Cement, compressive strength, FLY ASH and fibers.**

1. Introduction

Concrete plays an extremely important role in the construction of various structures for the improvement of our living environment. An enormous amount of concrete has been used as a construction material. There is no doubt that its use as a major construction material will continue in the future. Concrete for the 21st century will have to be more durable, easier to apply, more predictable and greener. At the same time it will have to be more cost competitive. In fact there is extensive evidence to show that concrete materials and concrete structures all over the world are deteriorating at a rapid rate, and that it has not been possible to ensure their long-term durable service life performance. A durable, efficient and effective infrastructure system is fundamental to economic prosperity, stability and the quality of human life. However, sustainability in construction cannot be achieved if used materials and built structures cannot give durable service life.

Self compacting concrete (SCC) is used in new design and casting of non conventional architectural details and shapes. There is no need for compacting concrete can be flown in to tight and inaccessible spaces without requiring vibration. For SSC, it is required to use the super plasticizers in order to obtain the flow ability and also the viscosity modifier admixture to reduce the segregation. As SCC demand more of finer material, the powder materials like fly ash, silica flume, lime stone powder, are to be added.

2. Objectives of the study

The objective of this study is to assess the effects of high volume fly ash replacement on the fresh and hardened properties of SCCs incorporating steel fibers. Even though, the suitability of using such a fly ash needs much detailed investigations, this study covers some fresh and hardened properties of mixtures In addition to the fly ash; steel fibers were used at different aspect ratio and volume fraction in making the concrete. Total mass of cementations materials is 600 kg/m3, in which 35% of cement is replaced by the fly ash and the water powder ratio, was constant at 0.31. For comparison, a control plain normal compacting concrete (NCC) of M40 grade mixture without any fly ash and a control plain self compacting concrete (A0V0) was also produced. The commercially available chemical admixtures used in this study included a viscosity modifying admixture (VMA) and a polycarboxylic based super plasticizer (SP).

3. Materials used.

A) CEMENT:

In this experiment 53 grade ordinary Portland cement is used. The testing of cement is done as per IS 4031-11-1988 code. The specific gravity of cement is 3.02.

B) FINE AGGREGATE:

In this experiment the locally available sand is used. The specific gravity of fine aggregate is to be obtained by using IS 2720 part 3.The specific gravity Of fine aggregate is 2.6.The fine aggregate is used which passes through the 4.75mmsieve.

C) COARSE AGGREGATE:

In this experiment also locally available aggregate is used and the specific gravity of coarse aggregate is to be obtained by using IS 2386 part31963 code. The specific gravity of coarse aggregate is 2.7.The coarse aggregate is which passes through the 20mm sieve.

D) WATER:

The least expensive but the most important ingredient of concrete is water. The water which is used for mixing concrete was clean and free from harmful impurities such as oil, alkali, acid etc. The portable water was used for mixing and curing work. The specific gravity of water is 1.

E) *FLY ASH*

CLASS F FLY ASH

The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Alternatively, the addition of a chemical activator such as sodium silicate (water glass) to a Class F ash can leads to the formation of a geopolymer.

CLASS C FLY ASH

Fly ash produced from the burning of younger lignite or sub bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO4) contents are generally higher in Class C fly ashes. Class F fly ash was used in this study. Its chemical composition is shown in Table 3. It is important to have a sufficient amount of cement paste in SCC. Total 30% of mass of cement was replaced with fly ash since it has been used to increase the cement paste hence it flows easily.

Table 1 Chemical analysis of fly ash

S.No	Compound	ASTMC618 Requirements,%
1	**$SiO_{2+}Al_2O_3$ +Fe_2O_3, Min**	70
2	**SO_3 Max**	5
3	**Moisture Content**	3
4.	**LOI**	6

F) *SUPER PLASTICIZER*

In the present work, a super plasticizer (SP) of poly carboxylic ether (GELENIUM, BASF Co.) with 1.1 g/cm3 specific gravity (at 20^o C) was used. The properties are given in Table 4.4 In developing a SSC, the super plasticizer is used to get workability and viscosity properties.

Table 2.Propertiesof Chemical Admixture

Specific Gravity	pH	Solid Conte nt	Recommende d per100 Kg of Cement Content	Componen t
1.115	5-8	40	0.8-2.0 Lit	Poly Carboxylic Ether

4. Experimental Tests

COMPRESSIVE STRENGTH:

The compressive strength of 150x150x150 mm cubes of M25grade concrete with 30% of cement replaced with fly ash and addition of (0.5%,1.0%, 1.5%, and 2.0%) volume of steel fiber and (0.5% and 1.0%) mass of poly-propylene fiber for 28 days curing are shown in Table 4.1 Fig 4.1 shows that the strength of concrete is increased when the percentage of volume of fibers is increased. However there is small decrement of strength for 2.0% of volume of fibers. Addition of steel fibers aids in converting the properties of brittle concrete to a ductile material. For poly-propylene fibers the compressive strength of concrete is increased gradually.

SPLIT TENSILE STRENGTH

The Split tensile strength of 150x300 mm cylinder of M25grade concrete with 30% of cement replaced with fly ash and addition of (0.5%,1.0%, 1.5%, and 2.0%) volume of steel fiber and (0.5% and 1.0%) mass of poly-propylene fiber for 28 days curing are shown in Table 4.2 and Figure 4.2 shows that when addition of steel fibers the split tensile strength of concrete is increased when the percentage of volume of fibers is increased. Addition of poly-propylene fibers aids in converting the properties of brittle concrete to a ductile material. When adding the poly propylene fibers the split tensile strength of concrete is decreased gradually.

7.1 FLEXURAL STRENGTH

The results of flexural strength are shown in Table4.3 .It has been observed that from Figure 4.3 that the strength of concrete is increased when the percentage of volume of fibers is increased. However there is small decrement of strength for 2.0% of volume of fibers. Addition of steel fibers aids in converting the properties of brittle concrete to a ductile material. For poly propylene fibers the compressive strength of concrete is increased gradually.

5. RESULT AND DISCUSSION:

Table.4.1 Compressive Strength of FRSCC For 28 Days

S.No	Specimen	Compressive Strength for 28 days (N/mm^2)
1	0.5% of PP	36.95
2	1.0% of PP	42.50
3	0.5% of Steel	36.48
4	1.0% of Steel	49.13
5	1.5% of Steel	49.98
6	2.0% of Steel	49.09

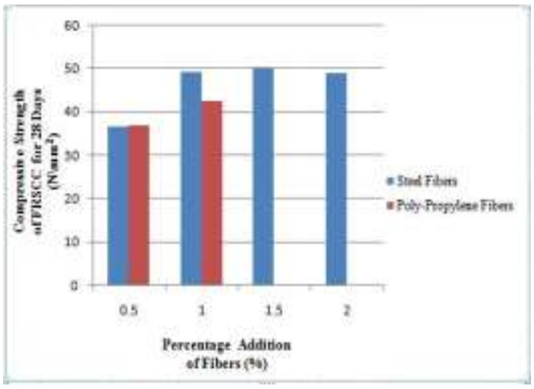

Fig.4.1: Compressive Strength of FRSCC for 28 Days

Table4.2: Split Tensile Strength of FRSCC for 28 Days

S.No	Specimen	Split Tensile Strength for 28 days (N/mm^2)
1	0.5% of PP	3.21
2	1.0% of PP	3.15
3	0.5% of Steel	2.82
4	1.0% of Steel	3.85
5	1.5% of Steel	4.47
6	2.0% of Steel	4.70

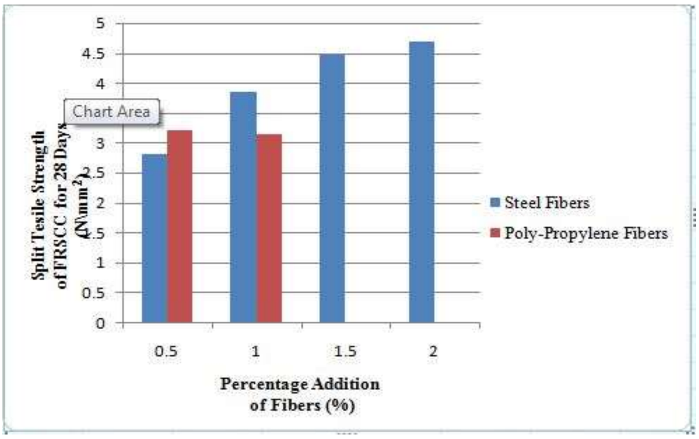

Fig.4.2: Split Tensile strength of FRSCC for 28 Days

Table.4.3: Flexural Strength of FRSCC for 28 Days

S.No	Specimen	Flexural Strength for 28 days (N/mm^2)
1	0.5% of PP	7.24
2	1.0% of PP	9.38
3	0.5% of Steel	7.49
4	1.0% of Steel	9.30
5	1.5% of Steel	12.46
6	2.0% of Steel	11.97

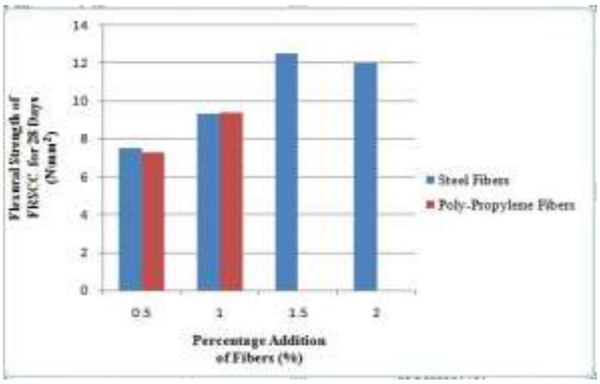

Fig.4.3: Flexural Strength of FRSCC for 28 Days

Conclusion:

- The characteristic properties of FRSCC satisfied the European guideline for SCC. The flowablity obtained (640 mm), according to EFNARC (SP1 550-650mm).
- Addition of (up to 1.5%) steel fibers to SCC, although compressive strength was improved 49.98 MPa, for 2% of steel fibers it decreased slightly 49.09 MPa. By adding the poly-propylene fibers (0.5% and 1.0%)

to fresh concrete the compressive strength is increased by 15%.

- Split tensile strength of steel fibers increased gradually for different volume of fibers 4.7 MPa. For polypropylene (1.0%) fibers split tensile strength was reduced slightly compared with (0.5%) addition of fibers.
- The flexural strength of concrete for poly-propylene fiber (12.46 MPa) increased gradually for steel fibers marginal decrement (3.9%) by adding 2% volume.
- The toughness of the steel fibers RSCC is higher as compared to that of PP RSCC. From the above it is concluded that the limitation of steel fiber for SCC is up to 1.5% of volume of concrete. For poly-propylene fiber the limitation is 1.0% of mass of binder material.
- It is observed that 1.5% of steel fibers is the limitation and up to this percentage it can be used in SCC and will yield good results.

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