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Study of Self Compaction with Recorn 3s Fibre at Different Elevated Temperatures

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ABSTRACT

Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. Self compacting concrete (SCC) was first developed in 1988 in Japan to achieve durable concrete structures. As SCC has various advantages over normal concrete, it also having leakage problems and shrinkage problems. Therefore, in this dissertation work emphasis has been laid to utilize the fibers in the concrete using3s recon (polypropylene) fiber 0,0.1,0.2,0.3,0.4%. Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. the grade of concrete is M35 and efnarc code book, tested and compared in terms of compressive strength and split tensile to the SCC concrete. These tests were carried out to evaluate the properties for 7, 14,28and 90 days. The moulds prepared are as follows 150mm X 150mm X 150mm cubes and cylinders 300mmX150mm at elevated temperatures is 0,200,250,350 degrees. Some types of fibres produce greater impact, abrasion, and shatter–resistance in concrete. Generally fibres do not increase the flexural strength of concrete and so cannot replace moment–resisting or structural steel reinforcement. Indeed, some fibres actually reduce the strength of concrete.

Keywords: M35 Grade, 3s Recon Fibers, Compressive and Split Tensile Strength, At Elevated Temperatures

I. INTRODUCTION

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregate, and water only, but has becomes an engineered custom tailored material with several new constituents to meet the specific needs of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability. In recent years, a lot of research was carried out throughout the world to improve the performance of concrete in terms of its most important properties, i.e.Strength and durability. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties from 1980's onwards. Till 1980 the research study was focused only to flow ability of concrete, so as to enhance the strength however durability did not draw lot of attention of the concrete technologists. This type of study has resulted in the development of self-compacting concrete (SCC), a much needed revolution in concrete industry. Self-compacting concrete is highly engineered concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self-weight only (Okamura 1997). Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties.

Self-compacting concrete is basically a concrete which is capable of flowing in to the formwork, without segregation, to fill uniformly and completely every corner of it by its own weight without any application of vibration or other energy during placing. There is no standard self- compacting concrete. Therefore each self-compacting concrete has to be designed for the particular structure to be constructed. However working on the parameters which affect the basic properties of self-compacting concrete such as plastic viscosity, deformability, flowability and resistance to segregation, self-compacting concrete may be proportioned for almost any type of concrete structure.

To meet the concrete performance requirements the following three types of self-compacting concretes are available.

a) Powder type of self-compacting concrete: This is proportioned to give the required self-compatibility by reducing the water-powder (Material<0.1mm) ratio and provide adequate segregation resistance. Super plasticizer and air entraining admixtures give the required deformability.

b) Viscosity agent type self-compacting concrete: This type is proportioned to provide self-compaction by the use of viscosity modifying admixture to provide segregation resistance. Super plasticizers and air entraining admixtures are used for obtaining the desired deformability.

c) Combination type self-compacting concrete: This type is proportioned so as to obtain self-compatibility mainly by reducing the water powder ratio, as in the powder type, and a viscosity modifying admixture is added to reduce the quality fluctuations of the fresh concrete due to the variation of the surface moisture content of the aggregates and their gradations during the production. This facilitates the production control of the concrete.

Advantages:

SCC yields homogeneous concrete in situations where the castings are difficult due to congested reinforcement, difficult access etc.

SCC shows a good filling ability especially around reinforcement

SCC is very well suited for special and technically demanding structures such as tunnel linings, as the possibility to compact the concrete is limited in the closed space between formwork and rock.

Shows narrow variation in properties on site.

Most suitable for concrete filled tubes (CFT) technology construction for high rise buildings.

Disadvantages:

The production of SCC places more stringent requirements on the selection of materials in comparison with conventional concrete.

An uncontrolled variation of even 1% moisture content in the fine aggregate will have a much bigger impact on the rheology of SCC at very low W/C (~0.3) ratio. Proper stock piling of aggregate, uniformity of moisture in the batching process, and good sampling practice are essential for SCC mixture,

A change in the characteristics of a SCC mixture could be a warning sign for quality control and while a subjective judgment, may sometimes be more important than the quantitative parameters.

II. METHODS AND MATERIAL

MATERIALS:

CEMENT:

Portland Slag Cement (PSC):

Portland Slag Cement, commonly known as PSC, is blended cement. Slag is, essentially, a non-metallic product comprising of more than 90% glass with silicates and alumina-silicates of lime. At JSW Cement, we use superior quality slag produced at our steel manufacturing plant, conforming to IS: 12089 standards for producing PSC. It is created with a combination of upto 45- 50% slag, 45% – 50% clinker, and 3-5% gypsum. PSC has been voted as the most suitable cement for mass construction because of its low heat of hydration.

The multi-fold advantages of PSC

PSC’s inherent chemistry gives it several advantages over ordinary cement. Apart from being more environment-friendly, it offers;

- Ultimate compressive strength
- Excellent resistance to Chloride & Sulphate attacks
- Low risk of cracking
- Improved workability
- Better compatibility with all types of admixtures
- Superior finish
- Ease of pumping
- Better resistance against alkali-silica reaction
- Minimised shrinkage cracks

Aggregates:

The maximum size of aggregate is generally limited to 10mm. Aggregate of size of 10 mm is desirable for structures having congested reinforcement. Wherever possible size of aggregate higher than 20 mm could also be used. Well graded cubical or rounded aggregate are desirable. Aggregates should be of uniform quality with respect to shape and grading.

Fine aggregate can be natural or manufactured. The grading must be uniform throughout the work. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes.Particles smaller than 0.125mm i.e. 125 micron size are considered as FINES which contribute to the powder content.

Water:

Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen.

Admixtures For SCC:

An admixture is a material other than water, aggregates and cement and is added to the batch immediately before or during its mixing. Admixtures are used to improve or give special properties to concrete. The use of admixture should offer an improvement not economically attainable by adjusting the proportions of cement and aggregates and should not adversely affect any properties of the concrete.

The admixture consist chiefly of those which accelerate and those which retard hydration or setting of the cement, finely divided materials which improves workability, water proofers, pigments, wetting, dispersing and air-entraining agents and Pozzolans.

Admixtures ranging from additions of chemicals to waste materials have been used to improve certain properties of concrete. The admixture is generally added in a relatively minute quantity. The degree of control must be higher to ensure that over dosages are unlikely to occur. Excess quantity of admixture may be detrimental to the properties of concrete. It may be mentioned here that concrete of poor quantity will not be converted to the good quality concrete by adding admixture.

Recorn 3s Fibre:

Recron-3s is a polypropylene monofilament, discrete, discontinuous short fiber that can be used in concrete to control and arrest cracks. Recron 3s fiber was used as a secondary reinforcement material. It arrests shrinkage cracks and increases resistance to water penetration, abrasion and impact. It makes concrete homogenous and also improves the compressive strength, ductility and flexural strength together with improving the ability to absorb more energy. Use of uniformly dispersed Recron 3s fibers reduces segregation and bleeding, resulting in a more homogeneous mix. This leads to better strength and reduced permeability which improves the durability. The physical properties of Recron 3s fiber are given in Table

Physical Properties Of Recron 3s Fiber:

S.No	Product type	Polypropylene
1.	Cross-section	Triangular
2.	Length	6mm
3.	Dispersion	Excellent
4.	Acid resistance	Excellent
5.	Melting point	250^0C

Moulds:

Moulds of required size and shape were prepared for casting process. The dimensions of the moulds for casting cubes 150mmX150mmX150mm and cylinders of dimensions 150mm (dia) X 300mm (depth) are used.

All the moulds are applied lubricant before concreting. After a day of casting moulds are de moulded and then cubes, cylinders are moved to the curing tank carefully for curing.

Data for mix design: design details are shown in below

Procedure for mix design

An example of a procedure for efficiently designing SCC mixes is shown below. It is based on a method developed by Okamura.

The sequence is determined as :

a) Designation of desired air content (mostly 2 %)
b) Determination of coarse aggregate volume
c) Determination of sand content
d) Design of paste composition
e) Determination of optimum water:powder ratio and superplasticizer dosage in mortar
f) Finally the concrete properties are assessed by standard tests.

Mix proportions by Weight:

Water	Cement	Fine aggregate	Coarse aggregate
178 lts	406.40 kgs	662.16 kgs	1167 kgs
0.438	1.00	1.63	2.87

Preparation of Testing Specimen

Batching:

Batching means measuring the quantities of constituents of concrete required for the preparation of concrete mix. Weight batch method is adopted to measure the quantities. The quantities of fine aggregate, coarse aggregate, cement, water and palm oil fuel ash for each batch were measured by weighing balance according to this mix proportions obtained by the mix design.

Mixing

Mixing of ingredients is done in pan mixer of capacity 40 liters. The cementation materials are thoroughly blended and then the aggregate is added and mixed followed by gradual addition of water and mixing. Recron 3s fibre is also added carefully. Wet mixing is done until a mixture of uniform colour and consistency are achieved which is then ready casting.

Mixing of Recron 3S Fibre in Concrete:

Recron 3Sfibre is added to the nominal mix concrete to obtain the target mean strength. It is added to the concrete mix in 900 g/m3. Take some weight of recron and mix it required water for the concrete mix and stir very well and add some amount of mixed cement & sand material. Then it is poured into the sample and mixed very well.

Casting

The cast iron moulds are cleaned of dust particles and applied with mineral oil on all sides before concrete is poured in to the moulds. The well mixed concrete is filled in to the moulds and kept on vibration table. Excess concrete was removed with trowel and top surface is finished level and smooth as per IS 516-1959. After the specimens were casted they are removed from the moulds after 24 hours and are dried in open air at room temperature for 24 hours.

Curing:

The specimen are left in the moulds understand at room temperature for about 24 hours after casting. The specimen are then removed from the moulds and immediately transferred to the different curing environment tubs i.e cubes are cured in fresh water for a required period of time.

Properties of SCC:

The 3 main properties of SCC in plastic state are

Filling ability (excellent deformability) Passing ability (ability to pass reinforcement without blocking) High resistance to segregation.

Test Methods:

Slump Flow Test:

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

U Box Test Method:

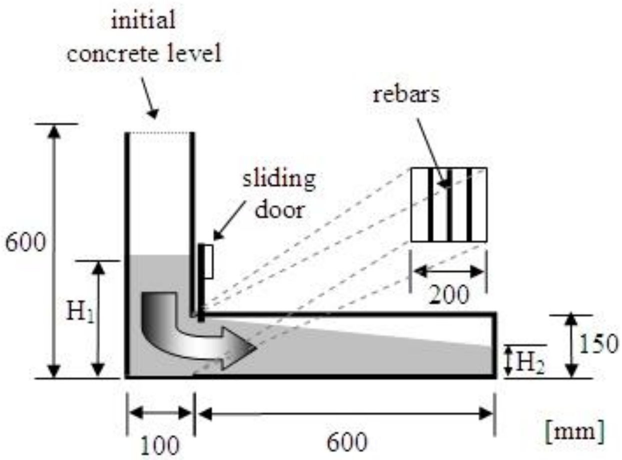
The test was developed by the Technology Research Centre of the Taisei Corporation in Japan. Sometimes the apparatus is called a "box shaped" test. The test is used to measure the filling ability of self- compacting concrete. The apparatus consists of a vessel divided by a middle wall into two compartments.

An operating with a sliding gate is fitted between the two sections. Reinforcing bars with nominal diameters of 13mm are installed at the gate with center-to-Centre spacing of 50mm.This creates a clear spacing of 35mm between the bars. The left hand section is filled with about 20 liter of concrete then the gate lifted and concrete flows upward into the other section. The height of the concrete in both sections is measured.

L Box Test Method:

This test, based on a Japanese design for underwater concrete, has been described by Peterson. The test assesses the flow of the concrete, and also the extent to which it is subjected to blocking by reinforcement. The apparatus is shown in figure.

The apparatus consists of a rectangular section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate, in front of which vertical lengths of reinforcement bars are fitted.



V Funnel Test and V Funnel

The test was developed in Japan and used Ozawa et al. The equipment consists of a V-shaped tunnel, shown in fig. An alternative type of V-funnel, the O funnel, with a circular section is also used in Japan.

The described V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20mm.The funnel is filled with about 12 liter of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increase significantly.

J-Ring Test

The principle of J Ring test may be Japanese, but no references are known. The J Ring test itself has been developed at the University of Paisley. The test is used to determine the passing ability of the concrete. The equipment consists of a rectangular section (30mmx25mm) open steel ring, drilled vertically with holes to accept threaded sections of reinforcement bar. These sections of bar can be of different diameters and spaced at different intervals in accordance with normal reinforcement consideration, 3x the maximum aggregate size might be appropriate. The diameter of the ring of vertical bars is 300mm, and the height 100mm.

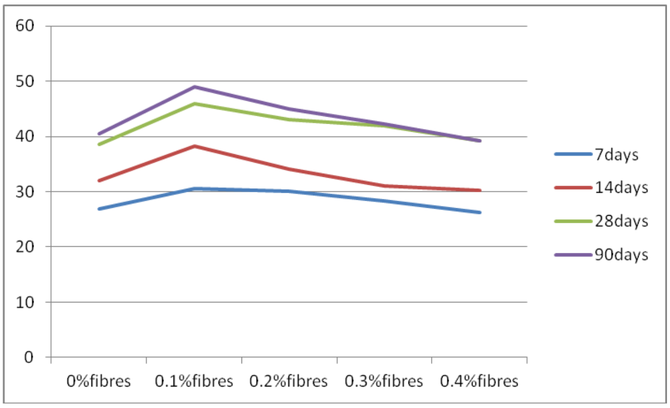
III. RESULTS AND DISCUSSION

Compressive Strength Test and Results:

For studied, the total number concrete cube specimens of (15*15*15cm) was caste and tested at 7,14,28,90 days. The result for average value of specimens, were calculated and is shown in the table below

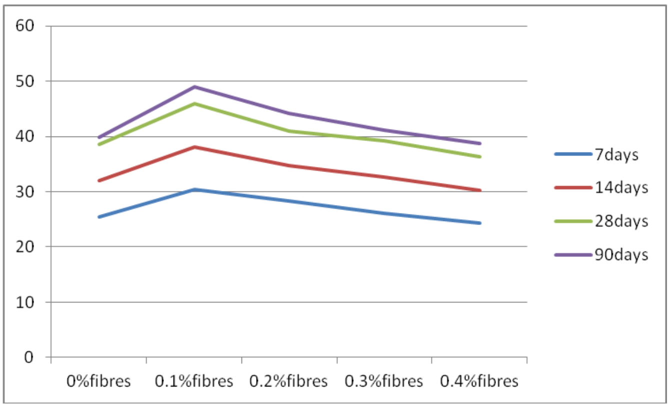
Compression strength using fibres 0%,0.1%,0.2%,0.3%,0.4% at 0^{o}c

compre esive strenght	0% fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	26.85	30.59	30.08	28.32	26.24
14days	31.95	38.24	34	31.03	30.23
28 days	38.52	45.89	43	41.89	39.24
90days	40.50	49	45	42.3	39.26



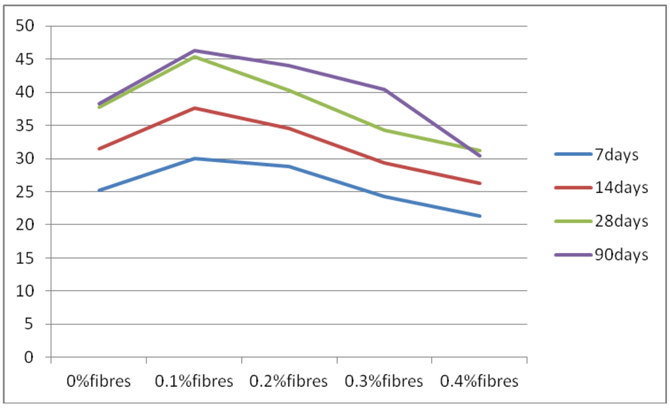
Compression strength using fibres 0%,0.1%,0.2%,0.3%,0.4% at 200^{o}c

compree sive strenght	0% fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	25.4	30.32	28.25	26.14	24.24
14days	31.99	38.11	34.64	32.69	30.28
28 days	38.58	45.9	41.03	39.24	36.32
90days	39.9	48.9	44.2	41.2	38.67



Compression strength using fibres 0%,0.1%,0.2%,0.3%,0.4% at 250^{o}c

compree sive strenght	0% fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	25.18	30.06	28.82	24.32	21.29
14days	31.48	37.56	34.55	29.3	26.26
28 days	37.78	45.3	40.28	34.28	31.24
90days	38.26	46.32	44	40.44	30.46

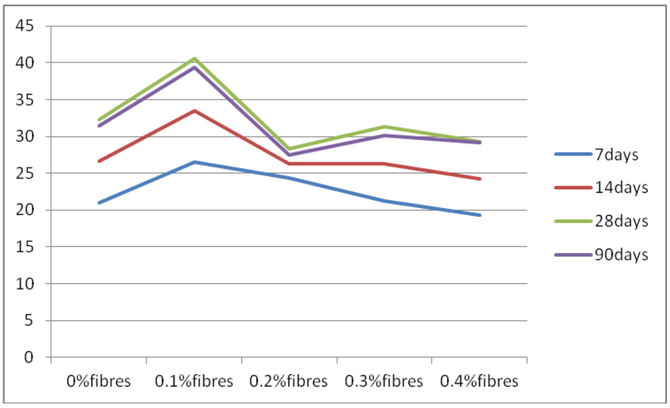


Compression strength using fibres 0%,0.1%,0.2%,0.3%,0.4% at 350^{o}c

compree sive	0% fibre	0.1% fibre	0.2%fibre	0.3%fibre	0.4%fibre

split tensile	0%fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	2.7	3.47	3.47	3.32	2.92
14days	3	3.70	3.51	3.27	2.97
28 days	3.26	3.94	3.56	2.23	2.02
90days	3.3	3.92	3.57	3.44	3.24

strenght					
7 days	21.05	26.46	24.32	21.19	19.28
14days	26.69	33.49	26.30	26.23	24.28
28 days	32.34	40.53	28.29	31.28	29.28
90days	31.45	39.40	27.45	30.11	29.20

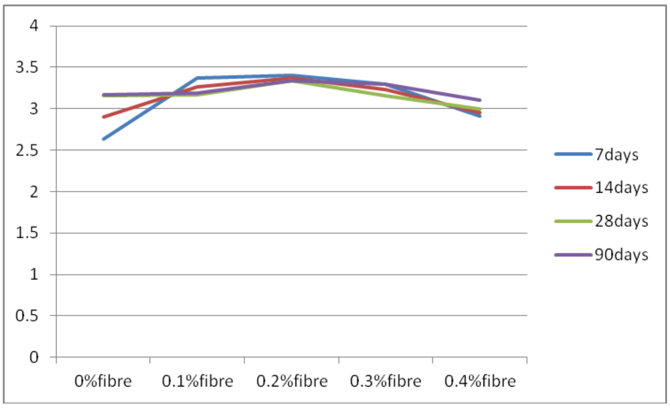


Split tensile Strength Test and Results:

For of studied, the total number of concretespecimens of (300*150cm) was casted and tested at 7,28 days. The result for average value of specimens, were calculated and is shown in the table below.

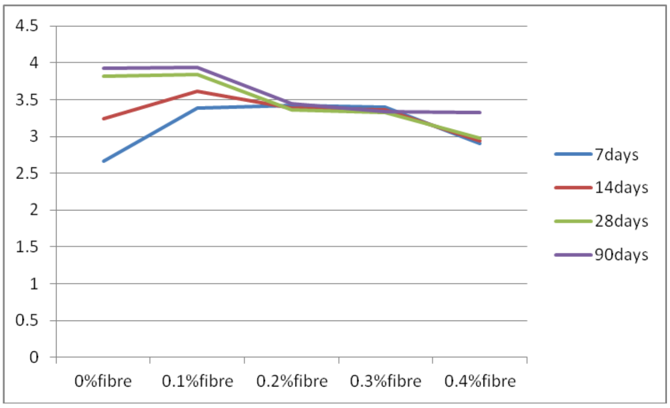
Split tensile strength using 0%,0.1%,0.2%,0.3%,0.4% at 0^{o}c

split tensile	0%fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	2.64	3.37	3.4	3.3	2.91
14days	2.9	3.27	3.37	3.23	2.95
28 days	3.16	3.17	3.34	3.16	3
90days	3.17	3.19	3.34	3.30	3.1



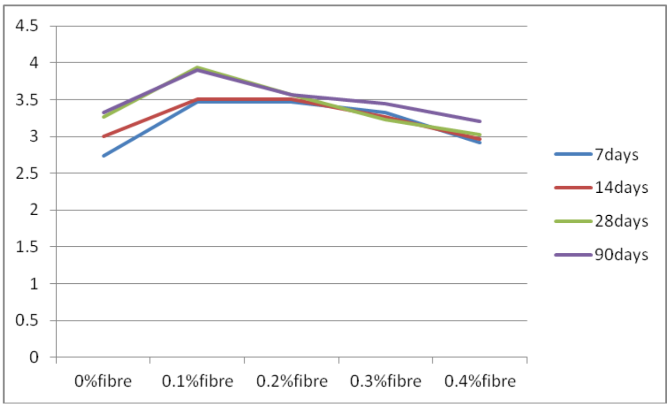
Split tensile strength using 0%,0.1%,0.2%,0.3%,0.4% at 200^{o}c

split tensile	0%fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	2.66	3.38	3.42	3.4	2.9
14days	3.24	3.61	3.39	3.36	2.94
28 days	3.82	3.84	3.36	3.32	2.98
90days	3.92	3.94	3.44	3.34	3.33

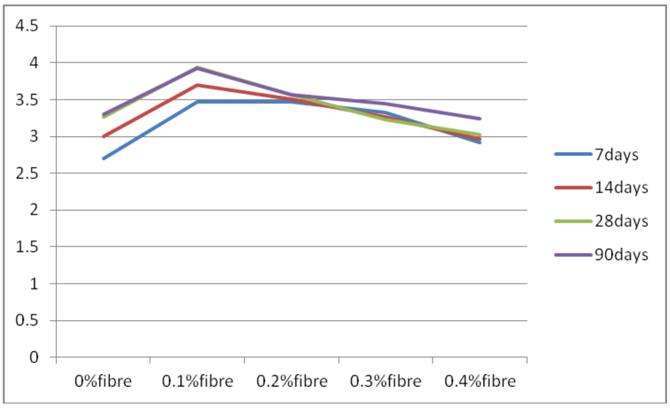


Split tensile strength using 0%,0.1%,0.2%,0.3%,0.4% at 250^{o}c

split tensile	0%fibre	0.1%fibre	0.2%fibre	0.3%fibre	0.4%fibre
7 days	2.74	3.47	3.47	3.32	2.92
14days	3	3.51	3.51	3.27	2.97
28 days	3.26	3.94	3.56	3.23	3.02
90days	3.32	3.90	3.56	3.45	3.20



Split tensile strength using 0%,0.1%,0.2%,0.3%,0.4% at 350°c



IV. CONCLUSION

The following important result can be summarized by the investigation carried out on the different mix of SCC tests:

1. The SCC made with fiber 0,0.1,0.2,0.3,0.4% gave satisfactory result after the 7 ,14,28and 90days of testing. Compressive strength for M35 grade of SCC was found to be 40.28MPa at 90 days and 250 degree is the maximum temperature.
2. On the base of above result, .The SCC made with fiber 0,0.1,0.2,0.3,0.4% gave satisfactory result after the 7,14 ,28 and 90 days of testing. Compressive strength for M35 grade of SCC was found to be 40.28MPa at 90 days and 0.2 % fiber is maximum utilization.
3. On the above mix polypropylene fiber was added in various percentages to enhance the properties of SCC and it was found that considerable change in compressive strength was found to increase for 0.1%. But with further increase in the % of polypropylene modulus of rupture was found to decrease.
4. On the above mix polypropylene fiber was added in various percentages to enhance the properties of SCC and it was found that considerable change in split tensile strength was found to increase for 0.1%. But with further increase in the % of polypropylene modulus of rupture was found to decrease.
5. Compressive test results was found 0.1% is maximum ultilization and 250 degrees is the maximum temperature.
6. Split tensile test results was found 0.1% is maximum ultilization and 250 and 350degrees is the maximum temperature.

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