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Evaluating Fresh & hardened Properties of self-compacting concrete using waste plastic fabrics

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Abstract— Self-Compacting Concrete (SCC) is an innovative concrete that does not require vibration process to its placing. SCC has proven advantages enhancing construction productivity, reducing the overall cost of the structure, improving the work environment, achieving sustainable characteristics, increasing the practically allowable reinforcement rate, and increasing the construction rate and overall quality of the cast structures, SCC is able to flow under its own weight, enables it to meet or filling formwork and reached its highest density. Self-Compacting Concrete (SCC) mixed with fibre is the expected to be a concrete with good performance in fresh state and more enhancement in hardened concrete.This work examines the possibility of using plastic fabrics as a partial replacement of fine aggregate for new concrete. [1] Plastic fabrics are partially replaced as 0.5%, 1.0%, 1.5% and 2.0% and Compressive, Split tensile and flexural strength test are conducted to compare with those of conventional concrete

Keywords —Waste plastic fabric, Workability, Compressive strength test, Split tensile strength test.

INTRODUCTION

The Self Compacting Concrete 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. It is environmental-friendly, as industrial wastes are used .It reduces equipment and labour cost and concrete is not free. Now a days, the ecological trend aims at limiting the use of natural raw materials in the field of building materials and hence there is an increased interest in the use of alternative materials (waste) from industrial activities, [1] which presents significant advantages in economic, energetic and environmental terms.

1.1 Characteristics of Fresh SCC:

Passing ability, Filling ability, Resistance to Segregation. [2]

1.2 Objective of study :

In this research work an extensive study using Plastic fabrics has been carried out to investigate the following

- To find the optimum proportion of plastic fabrics that can be used as a Percentage substiute material for fine aggregate in concrete
- To evaluate workability of fresh concrete by giving various percentage of Plastic fabrics.
- For Hardned concrete to find out Compressive strength,split tensile strength and flexural strength.

II REIVEW OF LITERATURE:

2.1 Sholihin As 'ad, (2011)[1] has investigated that Fresh state behavior of self compacting concrete containing waste material fibres self compacting Concrete (SCC) mixed with fibre is the expected to be a concrete with good performance in fresh state and more enhancement in hardened concrete.

2.2 K.S. Johnsirani (2014 [2] has investigated Experimental Study of Fiber reinforced self compacting concrete research that Self Compacting concrete gets compacted due to its own weight without any external vibration.

2.3 K.C Denesh et al (2014)[3] Experimental Study on Fiber reinforced self compacting concrete research that Self-compacting concrete (SCC) represents one of the most outstanding advances in concrete technology during the last decade.

III. EXPERIMENTAL PROGRAMME:

In this work an attempt has been made to study the various properties of self-compacting concrete when fine aggregate is replaced by different proportions of Plastic waste fibers which can act as binding & ductile material. The flow characteristics of SCC are measured from slump flow, L-box, V-funnel test &J-Ring apparatus. [4] Also the strength characteristics of SCC like compressive strength, split tensile strength, flexural strength are found.

3.1 Materials

3.1.1 Cement

In this experimental study, Ordinary Portland Cement (OPC 53 Grade) Conforming to IS: 8112-1989 was used.

The physical and mechanical properties of the cement used are shown in Table 1.

Table. 1: Properties of Cement

Physical property	Result
Fineness (retained on 4.75 mm) sieve	2.40%
Vicat initial setting time (minute)	95
Vicat final setting time (minute)	395
Specific gravity	3.12

3.1.2 Aggregates

Table No 2: Physical Properties of Coarse and Fine Aggregates

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity	3.11	2.80
Fineness Modulus	2.59	7.69
Surface Texture	Smooth	Irregular
Particle Shape,size	Rounded,4.75 mm	Angular 20 mm

3.1.3 Plastic waste fibers (PP):

plastic waste fibers are used with replacing varying % of fine aggregate.

Fig.1 (a) Waste plastic Grinder,

Fig 2 (b)Crushed waste plastic fabrics

Plastic has many beneficial properties, these include:-

- Lighter weight than other materials.
- Durability and not easy to fail.
- Resistance to chemicals, water and impact.
- Excellent thermal and electrical insulation properties.

Mix Design And Methodology

The mix design has been prepared according to IS 10262-2009 & EFNARC 2005 for M35 grade of concrete. about of waste plastic fabrics as fine aggregate replacement by mass. Waste plastic fibers are added with various % of fine aggregate as likewise 0.5%, 1.0%, 1.5% and 2.0%, 2.5%, 3.0%. .

Mix design: The Concrete mix design has been carried out for various proportions as per and arrived at final mix proportion after mixing the initial materials in the rotating mixer and adding the fibers. In this research the concrete samples were prepared with fiber ratios of 0, 0.5, 1.0, 1.5 and 2.0, 2.5, 3.0 % by adding in concrete replaced to the fine aggregate. In order to have a proper mixture design as well as the least penetration,

Moulds and Equipment

a) Cubes: Standard cube moulds of 150 × 150 × 150 mm made of cast iron were used for casting and testing the specimens in compression.

b) Cylinders: Standard cast iron moulds of size 150mm diameter and 300mm height were used for casting and testing

the specimen to determine the split tensile strength of concrete.

c) Beams: Standard cast iron moulds of size 100 × 100 × 500mm were used for casting and testing to determine the Dynamic Characteristics of concrete

- Beam specimens were used to determine flexural strength
- Cubes of 150 mm size were used to find the compressive strength, bond strength.
- Cylinder specimens were used to determine the split tensile strength.

IV.DETAILS OF EXPERIMENTAL TESTS:

Fresh characteristics of SCC were evaluated based on the four main measurements; passing ability, flowability, viscosity, and segregation resistance. Those characteristics were measured using following instruments; J-ring Test, Slump flow, L-Box, V-funnel. [4] For the investigation of hardened concrete properties, the compressive, splitting tensile strength, and flexural strength test of SCC were investigated. Concrete specimens were cured with water. Compressive strength tests for all the variants of concrete mixes with different fiber contents. The cubes were cast in steel moulds of inner dimensions of 150 x 150 x 150mm and the cylinders with 150 mm x 300 mm height. Compression test and split tensile tests were performed on cube and cylinder Respectively at uniform rate using the 2000 kN Compression Testing machine.

4.1 Workability Test Methods for Self-Compacting Concrete

Self-compacting concrete presents new challenges for the measurement of workability. Since self-compacting concrete is capable of flowing readily under its own weight,

- **Slump Flow Test** : The simplest and most widely used test method for self-compacting concrete is the slump flow test .
- **V-Funnel Test :**The V-funnel test (EFNARC 2002; Bartos, Sonebi, and Tamimi 2002) is used to measure the filling ability of self-compacting concrete and can also be used to judge segregation resistance.
- **L-Box Test :** The L-box test (EFNARC 2002; Bartos, Sonebi, and Tamimi 2002) measures the filling and passing ability of self-compacting concrete.
- **J-Ring Test**: The J-ring test (EFNARC 2002; Bartos, Sonebi, and Tamimi 2002) extends common filling ability test methods to also characterize passing ability.

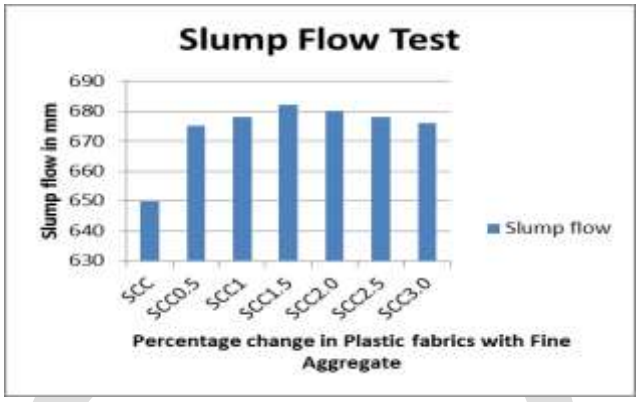
Slump flow value:

Table 3 Denotes Self Compacting concrete (SCC) with % incremental additions plastic fibre as 0, 0.5, 1.0, 1.5 ,2.0, 2.5 & 3.0% were taken and designated as SCC-0.0, SCC-0.5, SCC-1.0, SCC-1.5, SCC-2.0, SCC-2.5, SCC-3.0

Table No :3 Slump Flow Test Result in mm

Sr.no	% of waste Plastic Fabrics	Slump flow
		mm
1	SCC	650
2	SCC-0.5	675
3	SCC-1.0	678
4	SCC-1.5	682
5	SCC-2.0	680
6	SCC-2.5	678
7	SCC-3.0	676

Graph No: 1 % change in plastic fabrics Vs Slump flow



4.2 Strength Investigations

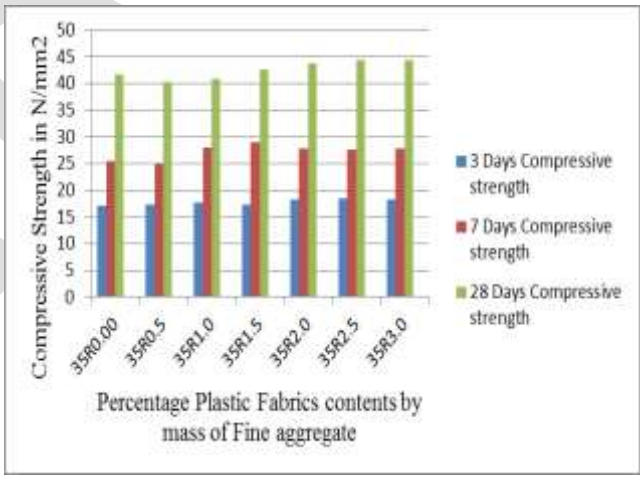
4.2.1 Compressive strength : The result of the variation of compressive strength of concrete with respect to age of concrete for different percentages of Plastic Fabrics is shown in Table 4.2. It is observed that all the mixes achieved the target strength of 43.25 MPa. The results indicate a decreasing trend in the compressive strength towards the high level of the Plastic Fabrics content.

Table 4. Denotes 35R 0,0.5, 1.0, 1.5 ,2.0, 2.5 & 3.0 with % incremental additions plastic fibre as 0, 0.5, 1.0, 1.5 ,2.0, 2.5 & 3.0% were taken and designated as 35 grade of concrete.R means revision.

Table No: 4 Compressive Test Result

Concrete type	% change in Comp.strength N/mm^2		
	3 Days	7 Days	28 Days
35R0.0	17.03	25.56	41.67
35R0.5	17.32	24.85	40.32
35R1.0	17.72	27.98	40.95
35R1.5	17.39	29.06	42.67
35R2.0	18.33	27.77	43.81
35R2.5	18.51	27.69	44.29
35R3.0	18.37	27.77	44.31

Graph No :2 % change in plastic fabrics Vs Compressive strength



4.2.2 Split tensile strength : The cylinder specimens were of size 150mm diameter and 300mm height were tested on compression testing machine of capacity 2000KN. The compression testing machine for split tensile strength and the axis of the specimen was carefully aligned at the center of loading frame.

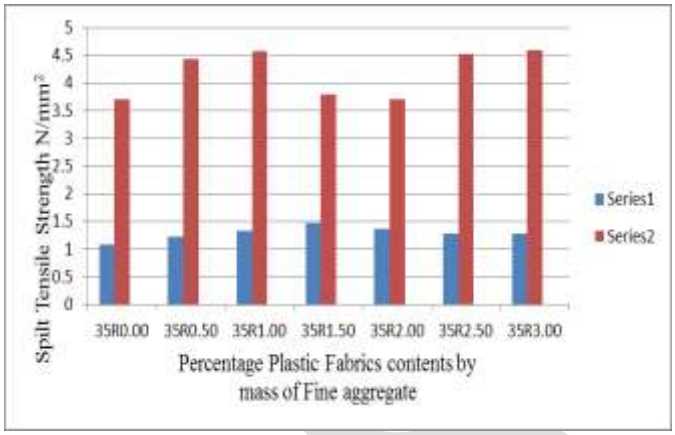
$$\mathbf{fst} = \frac{2P}{\pi X LD}$$

Where, P is the load on the cylinder is the length of the cylinder is the diameter

Table No:5 Split Tensile Test Result :

Mix Type	Spilt Tensile Strength N/mm^2	
	7 Days	28Days
35R0.00	1.08	3.70
35R0.50	1.23	4.43
35R1.00	1.34	4.57
35R1.50	1.47	3.8
35R2.00	1.36	3.7
35R2.50	1.28	4.53
35R3.00	1.28	4.60

Graph No: 3 % change in plastic fabrics Vs Split tensile strength



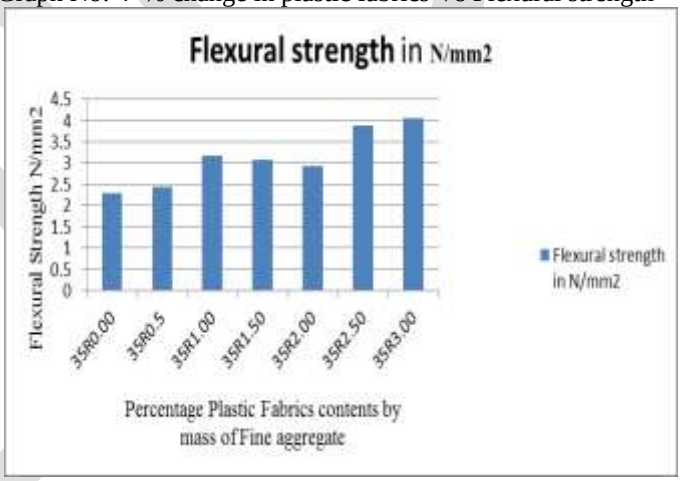
4.2.3 Flexural strength :Testing Machine is digitally control universal testing machine of 1000 KN capacity and +80mm stroke (displacement) was used for testing the beams.. The method used in testing is two point loading .The test specimen should be turned its sides with respect to its portion moulded and centered on bearing blades.

$$F = P X \frac{L}{b} x\ d2$$

Table No:6 Flexural Strength Test Result :

Mix Type	Flexural Strength N/mm^2
	28 Days
35R0.00	2.30
35R0.50	2.43
35R1.00	3.17
35R1.50	3.08
35R2.00	2.93
35R2.50	3.89
35R3.00	4.05

Graph No: 4 % change in plastic fabrics Vs Flexural strength



V. RESULTS AND DISCUSSION

Fresh Characteristics:

Effects of waste plastic fibers addition on the fresh characteristics of Self-Consolidating Concrete need to be measured to evaluate its workability performance criteria. Comparison of the measured flow ability, viscosity, passing ability and segregation ratio of the fresh SCC mixes can be observed in the following Table.

Table No :7 Effects of Waste plastic Fiber Addition on Fresh Characteristics of SCC

Test Result on Fresh SCC Mixes				
Sr.no	Method	Unit	Conventional Concrete	SCC with plastic fabrics
1.	Slump flow test	mm	675	650
2.	V-funnel test	Sec	7	9
3.	L-Box test	H2/H1	0.8	0.9
4.	J-Ring	mm	7	9

Hardened Characteristics:

The compressive strength of self compacting concrete with waste plastic fabrics increases upto 0.264% fiber content by mass of fine aggregate and then reduces.The split tensile of self compacting concrete with waste plastic fabrics increses their split tensile with 0.12 % fiber content by mass of fine aggregate similarly to compressive strength of self compacting with plastic fabrics,it is observed that the flexural strength increases upto 0.25 % fiber content by mass of fine aggregate and then reduces their flexural strength.

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CONCLUSION:

Recycling is a critical issue in these environmental conscious times. It aims to:-

- Preserve natural resources also Minimize transportation & its associated cost.
- Reduce the environmental load caused by waste material especially land requirement.
- It was observed according Workability test results, that more plastic waste fabrics content increases the fluidity of concrete improves, that is favorable for concretes.
- This improvement can be attributed to the fact that plastic particles have an outer smoother surface than that of the sand. The plastic cannot absorb water, therefore an excess of water which improves the workability
- By using waste plastic fabrics at 2.5% the hardned concrete (compressive strength) is improved.

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