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An Experimental Study on Properties of Concrete using Waste Plastic Scrap Materials as Partial Replacement of Coarse Aggregate

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ABSTRACT

- Investigations were done on M-30grade concrete by replacing coarse aggregate partially by plastic fiber to get maximum strength.
- This work presents the Strength and workability results of waste plastic fiber reinforced concrete (WPFRC). The different percentages of waste plastic fiber reinforced concrete used in the experimentation are 0%, 0.5%, 1%, and 2 % by partial replacement of coarse aggregate using plastic fiber
- This Study presents the satisfactory results on various strength tests of concrete containing plastic fiber as a partial replacement of coarse aggregate and would help to resolve solid waste disposal problem. However, further research work is still necessary in order to have a more in-depth understanding.

INTRODUCTION

Concrete is the most widely used construction material. Because of its specialty of being cast in any desirable shape, it has replaced stone and brick masonry. Plain concrete is weak in tension and has limited ductility and little resistance to cracking. Micro cracks are present in concrete because of its poor tensile strength. The cracks propagate with the application of load, leading to brittle fracture of concrete.

Micro cracks in concrete are formed during its hardening stage. A discontinuous heterogeneous system exists even before the application of any external load. When the load is applied, micro cracks start developing along the planes, which may experience relatively low tensile strains, at about 25-30% of the ultimate strength in compression.

Further application of the load leads to uncontrolled growth of micro cracks. The low resistance to tensile crack propagation in turn results in a low fracture toughness, and limited resistance to impact and explosive loading.

The low tensile strength of concrete is being compensated in several ways, and this has been achieved by the use of reinforcing bars and also by applying pre-stressing force. Though these methods provide tensile strength to concrete, they do not increase the inherent tensile strength of concrete itself.

Fibers in the cement based matrix acts as cracks arrester, which restricts the growth of flaws in the matrix, preventing these from enlarging under load, into cracks, which eventually cause failure. Prevention of propagation of cracks originating from internal flaws can result in improvements in static and dynamic properties of the matrix.

Plastic Fiber Reinforced Concrete

Enhancing the tensile properties of plain concrete numerous strategies have been developed. A considerable lot of the strategies prevailing with regards to making the concrete individuals impervious to strain, however none of them expanded the inborn tractable properties of plain concrete. The scattering of strands in concrete network to enhance its ductile properties has been drilled worldwide more than 3 past decades. The expansion of little firmly separated and consistently scattered filaments to cement would go about as break arrester and would considerably enhance its static and dynamic properties. This sort of concrete is known as fiber reinforced concrete. Fiber strengthened concrete can be characterized as a composite material comprising of blends of bond, mortar, or concrete and broken, discrete, consistently scattered appropriate strands. Consistent lattices, woven textures and long wires or poles are not thought to be discrete fibers.

Objectives

The objectives of the research are outlined below:

- Determination of the compressive strength, split tensile strength, and flexural strength of the concrete with and without plastic fiber scrap material reinforced concrete.

Workability Properties

- Fresh mix characteristics are more emphasized in fiber concrete compared to the plain concrete, generally increasing weight fraction of fibers results in further reduction of fresh concrete workability. In this study, fibers as steel fiber scraps of different volume fractions like 0.5 %, 1 %, 2% and 3 %.

Slump Test

Table 1.1 Slump Test Results

S. No.	% Replacement of Plastic fiber Waste	Slump for M30
1	0 %	69
2	0.5 %	64
3	1 %	56
4	2%	52
5	3%	43

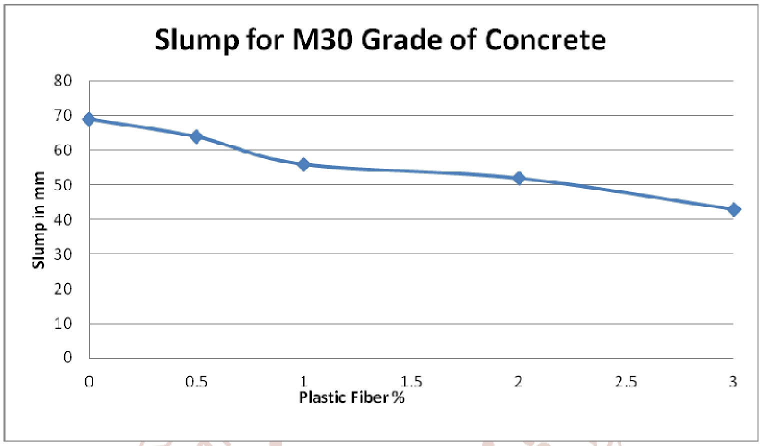

Figure -1.1 slump values with steel fiber (Grade M-30)

Discussion: Slump test an incentive for M-30 review of solid blend with 0%, 0.5%, 1%, 2% and 3% plastic fiber scrap blends are appeared in table and chart. Table-5.1 demonstrates the droop estimations of M-30 review cement and plastic fiber solid extent. Their qualities are watched vary from 69 mm to 39 mm from 0% to 2% Plastic fiber Waste for M30 grade concrete mix. It is observed that with the increase in the addition of Plastic fiber Waste, workability reduces gradually for M-30 grade concrete respectively.

Mechanical Strength

To evaluate the mechanical strength characteristics of concrete reinforced with plastic fibers scraps materials, detailed experimental investigation was carried out and the results are discussed in the forthcoming sections.

Cube Compressive Strength

Totally 108 cube specimens of size 150 mm x150 mm x 150 mm with 3 mixes were casted and tested. Three volume fractions were considered for steel fiber scraps (0.5%, 1% and 2% of Plastic fibers scraps).

Table 1.2 – Compressive Strength of M30 Grade concrete in N/mm²

S. No.	% of Plastic fiber scrap	Grade of Concrete		
		7 Days	14 Days	28 Days
1	0 %	21.40	27.50	30.60
2	0.5%	22.54	29.10	32.90
3	1 %	23.35	30.40	34.70
4	2%	22.78	29.30	32.86

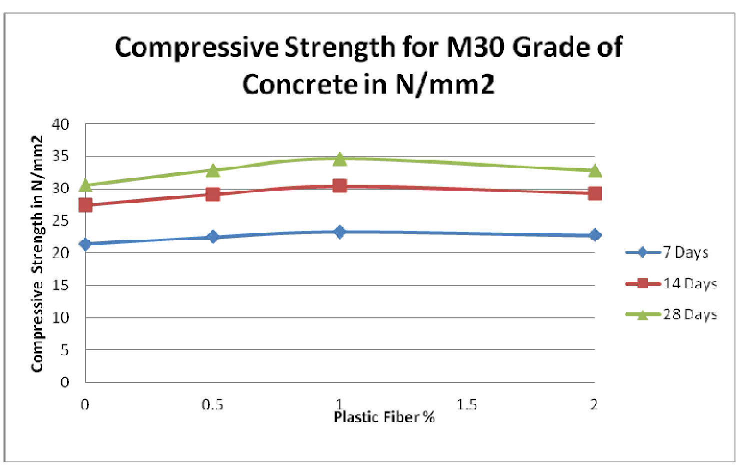

Figure 1.2 – Compressive Strength of M30 Grade concrete

Discussion: The Result of compressive strength for M-30 review of cement on 3D shape example with 0%, 0.5%, 1% and 2% Plastic fiber scrap blends are appeared in table and chart. Table-5.2 gives the compressive quality estimations of M-30 review cement and steel fiber scrap concrete blends at 7, 14 and 28 days curing and their esteems are seen .With expansion of steel fiber scraps, compressive quality bit by bit increments from 21.40 N/mm2 to 34.70 N/mm2 with 0 % to 2 % of plastic fiber waste.

Split Tensile Strength

Totally 36 cylinder specimens of size 100 mm diameter and 300 mm height with 3 different % mixes were casted and tested. Three weight fractions were considered for plastic scrap fibers of constant length. Results for split tensile strength based on the values of test data. A sample comparison Figure for plastic fibers scrap concrete is plotted to study conventional concrete strength which is shown in Fig. 5.5.The values of the split tensile strength of different mixes are shown in Table-5.3

Table 1.3 – Split tensile strength of Cylinder in N/mm^2

	Split Tensile Strength for M30Grade of Concrete in N/mm2		
Plastic Fiber %	7days	14days	28days
0	2.42	2.79	3.76
0.5	2.86	2.98	3.96
1	3.26	3.79	4.2
2	3.58	3.64	3.69

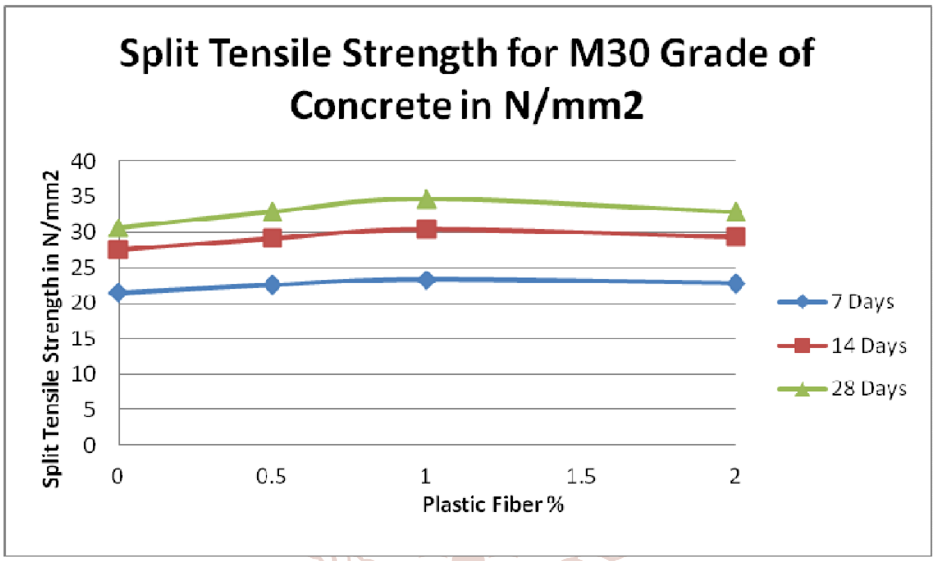

Figure 1.3 Split tensile strength of Cylinder

Discussion: for M-30 review of cement on chamber example with 0%, 0.5%, 1% and 2% plastic fiber scrap blends are appeared in table and chart. Table-5.5 demonstrates the split quality estimations of M-30 review cement and plastic fiber scrap concrete blends at 28 days curing and their esteems are watched. With the expansion of plastic fiber scraps, the split rigidity of chamber expanding bit by bit from 2.42N/mm2 to 4.2 N/mm2 with 0% to 2 % of plastic fiber waste.

Flexural strength of Concrete:

The determination of flexural strength of the prepared samples is carried out as per IS code. The following table shows the flexural strength of various samples using different percentage of plastic fiber scraps.

Table 1.4 – Flexural Strength of concrete Beam in N/mm^2

	Flexural Strength of M-30grade concrete Beam in N/mm2		
Plastic Fiber %	7days	14days	28days
0	4.23	5.78	6.22
0.5	4.46	5.86	6.79
1	4.53	5.69	7.19
2	4.02	4.79	6.19

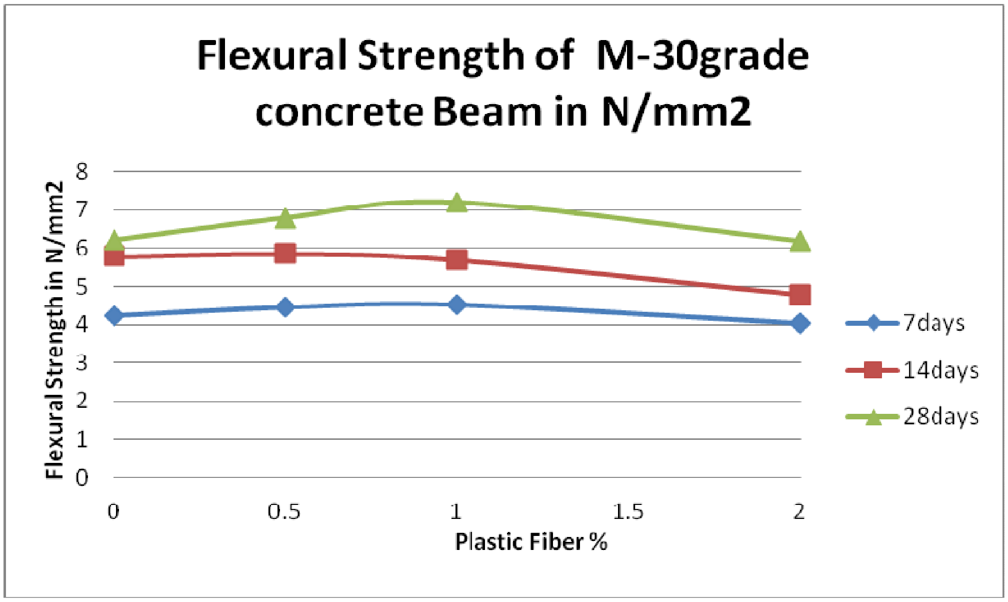

Figure 1.4 – Flexural Strength of concrete Beam

Discussion:
The Result of split rigidity for M-30 review of cement on pillar example with 0%, 0.5%, 1% and 2% Plastic Fiber Waste blends following 28 days of curing are appeared in table and diagram. It is seen that with the expansion of Plastic Fiber Waste flexural quality esteem expanding step by step from 4.23N/mm2 to 7.19N/mm2 with 0% to 1 % of plastic fiber waste.

Conclusion
Based on the experimental investigation the following conclusion is given within the limitation of the test result.
- It can be concluded that higher strength and workability characteristics of waste plastic fiber reinforced concrete and conventional aggregates can be obtained with 1% addition of fibers into it
- Addition of plastic fiber waste resulted in significant improvement on the quality properties of solid (M-30) grade.

Future scope of work
- This research was intended to find out the influence of steel fiber as a partial replacement coarse aggregate in concrete for M30 mix in future different grade of concrete is investigated.

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