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Study of Fibre Reinforced Concrete by using Pet Bottles

Bavane Nikhil[1] Vadd Asavari[2], Jamil Attar[3], Wasim Kothiwale[4], Arif Fakir[5]
[1, 2, 3, 4, 5] Civil Engineering Department, Sanjay Ghodawat Institute.

Abstract: Concrete is a composite material consisting of various ingredients such as cement, coarse aggregate, fine aggregate. The recent use of the concrete has constrained many civil engineers to add some relevant constituents in various proportions to the cement or any other. The environmental degradation from various types of non-bio degradable wastes are not only making the environment hazardous but also are having a serious implications on the all living things.. In our investigations PET fibres were adding in the M20 grades of concrete by the weight fraction of cement percentages in 2%, 3%, 4% and 5% and then the mechanical property viz. compressive strength as well as flexural strength of the concrete was compared with the conventional concrete. This paper addresses the results of an investigation on the influence of Recycled PET fibres plastics as reinforcement of cement matrix. In this study, the conventional concrete was reinforced by the plastic fibres obtained from waste plastic bottles. All specimens were tested after 7, 14& 28 days. In this paper the relationship between cube compressive strength for conventional and plastic fibres reinforced concrete were established and compared with standards.
Keywords: Compressive strength, PET fibres, waste plastic bottles, Flexural Strength, PET fibre reinforced concrete (PFRC).

I. INTRODUCTION

Concrete is most frequently used man made versatile material comprising of cement, sand, coarse aggregate and water mixed in an appropriate proportion to obtain the desired strength. It has numerous advantages with the properties such as excellent compressive strength, durability, specific gravity etc. due to which it has proved its effectiveness and metal in the vast field of construction industry to build a distinctive infrastructural applications which include bridges, large and small buildings, dams and a variety of other significant structures in the universe. Concrete have many advantageous properties such as good compressive strength, durability and specific gravity and fire resistance. Some of the properties can be increased by adding fibres with another ingredient of the concrete to improve its weakness. In presence of fibres the crack propagation is delayed which helps in improvement in static and dynamic properties of concrete at normal stages. It is durable, inexpensive and has good compressive strength and stiffness with low tensile strength, low ductility and low energy absorption. The ductility of concrete can be increase by reinforcing with fibres. Consumption of plastic has grown day by day substantially all over the world; it leads to create large quantities of plastic-based waste. Plastic waste is the one of the challenge to dispose and manage as it is non- biodegradable material in nature which is harmful to our beautiful environment. The PET bottles are recycled and used for different purposes. Waste PET bottles were converted into fibres and added in concrete as an additional ingredient of concrete. The cube compressive strength of conventional and plastic fibre reinforced concrete were determined. The present investigation is carried out to study the effect of steel scrap, galvanized iron, polypropylene fibres obtained from industrial waste on various parameters of concrete, so as to produce fibre reinforced concrete. The waste metal or polypropylene fibre reinforced concrete can be denoted as M20. Where M denotes mix and 20 is its characteristic compressive strength after 28days. Whereas, F refers to fibres and 30 is the length of the fibres added to the concrete mix. It has been established that the addition of randomly distributed metal or polypropylene fibres coming from industry to brittle cement based materials can increase their fracture toughness, ductility and impact resistance. This review paper reports the properties of concrete when waste PET bottles are used in fibre form as aggregates in reinforced plain concrete. The aim of the paper is to analyse and study the different experiments, case studies based on researches and experimental works and scientific reports to determine the improvement in selected properties of PET fibre reinforced concrete comparison. Also to convey that the use of PET fibres as reinforcement of cement composites is a promising technique for developing sustainable materials to be applied in the civil construction industry

II. RESEARCH FINDINGS BEFORE WORK

A. Fresh Concrete Properties

1) Air Content: Seven of various lengths and proportions of fibres were made and the results suggest that air content is proportional to the amount and length of fibres. Especially when volume of fibres exceeded 0.23% increase in air content was significant and before that it was equal to or less than that in control beam.

2) Workability: This paper reviews slump test and inverted slump test. Both these tests are helpful in determining the workability of fresh concrete, where inverted slump test is specifically used in case of fibre reinforced concrete. Bayasi and zeng conducted slump and inverted slump cone tests, to check the effects of addition of polypropylene on concrete. Their results state that inverted slump cone time increased, thus it can be inferred that air entrainment becomes difficult and hence its use in corrosion prone structures should be avoided. Another result yields that fibre volume up to 0.23%, has significant effect on fresh mix workability but it affected as the fibre volume increases. In fact increase in inverted slump cone time was critically affected by 19mm than 12.7mm in the experiment.

B. Hardened Concrete Properties

1) Compressive Strength: Experiments were conducted where waste fibres of metal and polypropylene were taken and tested as given in table. The results show that the addition of short fibres (<30mm) result in decrease of compressive strength and that of long fibres shows no change in compressive strength. Since addition of fibres increases pore volume, it can be inferred that high fibre volume lead to high porosity and hence decrease in compressive strength.

2) Flexural Behaviour: Flexural strength for M20 grade concrete was found to be highest with 1% galvanized wire and 2% lathe scrap. Waste metal fibre reinforcement should a great amount of increase in flexural strength till 3% volume.

3) Durability: Durability is the most important factor of concrete for long service life, and this paper aims to review durable and sustainable concrete .The result shows that fibres did not show any reduction in tensile properties.

4) Permeability: Permeability of concrete is a major contributor to its durability. WPF induces more void spaces in the total volume than the WMF, due to the high surface area of PF than MF. This increase in porosity tends to increase permeability.

*5) Toughness and Impact Resistance***:** The Toughness of FRC is considered as its ability to absorb energy across the crack and is found in this experiment by using area under load displacement curve. By finding toughness indices, it was concluded that WPF provided more toughness than MF. Impact resistance is said to be increased with addition of fibres.

III. MATERIAL AND EXPERIMENTAL METHODOLOGY

A. Material

Portland Pozzolona Cement was used in this experimentation conforming to IS: 1489-1991 (Part I). The physical properties of cement used in the study are as given in Table.

Table no. I

Fineness	Normal consistency	Initial setting time	Final setting time	Specific Gravity	Compressive strength
2.7%	32%	240min.	350min.	3.12	40.8mPa

1) Aggregates: Locally available natural sand from river was used in this study as fine aggregate and the crushed stone aggregates were collected from the local query. The maximum sizes of aggregates were 20 mm and 10 mm. The fine and coarse aggregates were tested as per IS: 383-1970 and 2386-1963 (Part I, II and III) specifications. The physical properties of aggregates are as shown in Table.

Table .II The physical properties of fine aggregates

Specific gravity	Water Absorption %	Bulk density kg/cum	Fineness modulus	Silt Content
2.54	1.43	1718.53	2.64	0.58

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Table III The physical properties of coarse aggregates

Max size of aggregates	Specific gravity	Bulk density	Fineness modulus	Water Absorption
20mm	2.31	1718.52kg/cum	2.8	1.02%

2) Plastic Fibres: The post consumed PET mineral water bottles of single brand were collected from local restaurants & from waste. The fibres were cut after removing the neck and bottom of the bottle. The length of fibres was kept 20 mm and the breadth was 1 mm and 2 mm.

3) Water: Potable water was used for mixing and curing of specimens throughout the experimentation.

Fig I Cube Compaction Factor Test

Fig II Cube Workability Test

B. Experimental Methodology

1) Concrete Mix: Based on the trial mixes for different proportion of ingredients the final design mix was selected for M20 grade of concrete as per IS 10262:2009, the concrete mix proportions given in table. The plastic fibres were added into dry mix of concrete in the percentages of 0.1 to 3.0% by weight of cement in the increment of 0.5 %. The different cube specimens as per requirements of tests were casted as per code of practices. These specimens were tested after 28 days of curing. The average values of compressive strengths are reported in histogram.

Table IV The concrete mix proportions

Grade of Concrete	Cement	Fine aggregate	Coarse aggregate	Water
M20	394kg/m3	805.53kg	1353.43kg	213.69lit.

2) Properties of Concrete: The workability of green concrete and compaction factor test for each percentage of plastic fibres shown was determined with the help of slump cone test. These tests were carried out at every batch of the concrete and average value is reported.

3) Specimen Dimensions and Different Tests: The cubical specimens of size 150 mm x150 mm x 150 mm were casted with different percentages of PET fibres. All the concrete filled moulds were compacted on Table vibrator in the laboratory. The specimens were tested under compression testing machine

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4) Workability and Dry Density: The following Table shows the results of Slump and Compaction factor and dry density of reference concrete for M20 grades. Factor test results and Figure shows the dry density of PFRC at different volume fractions. The workability of green concrete founds decreases as fibre content increases in both tests. It was observed that workability decreases for higher aspect ratio for both M20 grades. The dry density was also found decreases on increasing plastic fibre content in concrete. Slump, Compaction factor and dry density of reference concrete.

Table. V

Grade of Concrete	Slump	Compaction factor	Dry Density(KN/cum)
43grade	24mm	0.7743	23.13

Fig III Slump test

IV. COMPRESSIVE STRENGTH

A. Compression Test Values of FRC

The compressive strength test is the most appropriate test to evaluate the strength of the normal concrete on addition of PET fibres to the concrete by weight. The compressive strength of normal as well PET fibres concrete composition has been determined at 7 days curing. The standard cube specimen of size 150 mm x150 mm x 150 mm for normal concrete as well as concrete with PET fibre was cast. Once the casting was done and after curing the concrete at 7, 14 and 28 days, the ultimate compressive strength for the average loads of the specimens was obtained as highlighted in the above tables.

Table VI Average compressive strength for M20 PFRC at 7, 14 and 28 day

S.N	Volume Fraction Pet	Compressive strength at 7days (N/mm2)	Compressive strength at 14 days(N/mm2)	Compressive strength at 28days(N/mm2)
1	0%	16.88	24.17	28.53
2	2%	18	30.27	32.22
3	3%	19.7	33.52	34.56
4	4%	14.96	23.12	24.7
5	5%	6.58	11.38	12.8

V. RESULTS AND DISCUSSION

In this experimental work detail of the results, trends of various experimental analyses and their effect on the compressive strength with the incorporation of polyethylene terephthalate (PET) fibres in comparison to the conventional concrete were ascertained. The experimental test analysis established that there was reasonable variation in the compressive strength by the addition of PET fibres.

VI. SCOPE FOR FUTURE STUDY

This paper primarily reviews the various effects of addition of fibres in concrete with regard to compression, durability, flexure, permeability, fresh concrete properties and toughness. Apart from checking the strength variation comparison between the percentages of fibre with respect to the concrete volume is presented. And hence the optimum amount of percentage of fibres with respect to maximizing strength, durability and utility are to be noted. In future, FRC design fundamentals for waste, macro and crimped fibres can be established for both metal and plastic fibres. This has a great future and can give us economical, sustainable and durable concrete for construction work.

VII.CONCLUSION

Following are some of the conclusions which can be shown from the research milestones while considering the various grades of concrete and incorporating required amount of pet fibres. When the different percentages of PET fibre concrete were compared with the conventional concrete in terms of compressive strength of M20 grade for 7, 14 and 28 days, and it was observed that the compressive strength of the concrete initially increased by adding PET fibres from 2% to 4% and then showed a considerable descending trend with the addition of 5% to 6%, .PET fibres. The optimum compressive strength of the concrete was achieved with the addition of 3% PET fibres.

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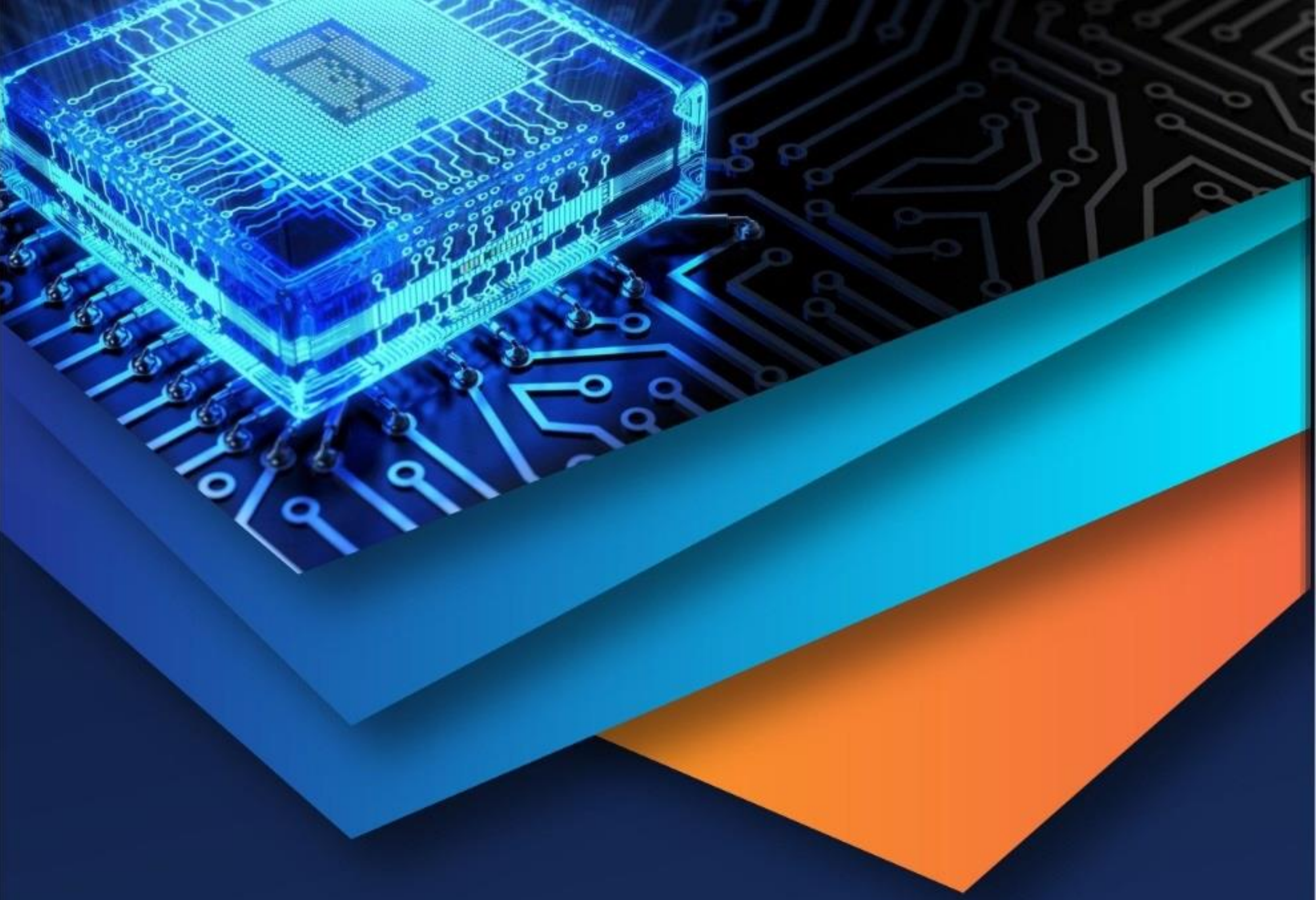

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