Effect of PET Fibers on the Mechanical Properties of Concrete

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Abstract:

The tentative work is carried out by performing the various tests to obtain the split tensile strength and flexural strength of the concrete by adding optimal amount of PET fiber as an constituent to acquire appropriate results for the research. The experimental results revealed that the mechanical properties have improved at certain PET fiber fraction and then trend showed a distinct decline. However, the optimal amount of PET fiber by weight of cement has been ascertained to improve the mechanical properties for the judicious use.

In our investigations PET fibers were mixed in concrete of different grades viz. M_{20}, M_{25} and M_{30} by the volume fraction of cement in 2%, 3%, 4% and 5% and then the mechanical properties of concrete like flexural strength and split tensile strength were compared with the normal concrete to know the effective usage of PET fibers in construction site.

Keywords: *Concrete, Polyethylene Terephthalate (PET), flexural strength, split tensile strength, fiber,*

I. INTRODUCTION

Concrete is a construction material which is being tremendously used in the world for the development of any country, which has resulted in the depletion of concrete constituentsthat has forcedresearchers to find an alternative material to be used with concrete. It was felt that plastic is the material which has shown a great potential in day today life, plastic have been used in huge and beneficial applications. Polyethylene Terephthalate (PET) belongs to the family of polyesters and is thermoplastic resin made up of phthalates which are mainly suitable for food use its use in world is increasing in leaps and bounds and due to its enormous useit has make an alarming threat for solid waste disposal, as the plastic is non biodegradable that requires a large land fill for its disposal. Recycling capacity in India is very less as Compared to its production, PET being chemically inert, corrosion resistant, light in weight are the properties which have made its use in concrete more attractive. Researchers have shown great concern over safeguarding the environment and re-using the non biodegradable (PET) waste.

Fiber reinforced concrete is the combination of concrete constituents and fiber. The idea of using polyethylene Terephthalate fiber in concrete comes from the need to discover a remedy to non biodegradable (PET) waste disposal and the depleting trend of concrete ingredients. Therefore, in this study a tentative program analyses the usage of PET fiber as an eco-efficient concrete constituent.

II. LITERATURE REVIEW

The experimental work of different researchers was broadly studied and the following contributions were considered for studying the effect of PET fibers in the concrete:

T.Senthil Vadivel et al. (2013) used 1, 2, and 3% of PET fibers which were added to the concrete and found a clear impact on its mechanical properties, it was established that after thecomparison between conventional concrete and PFRC, PFRC produced better results. It wasclearly revealed that after every percentage increase in PET fiber, compressive strength wasincreased. From the experimental results it was also observed that 3% addition of fiber provide12.5%increase in compressive strength when compared with conventional concrete. The Experimental results also revealed that there was an increase of 9% in tensile strength and 8.12%in flexure strength when the strength of PFRC with 3% fibers was compared with conventionalconcrete. It was further analyzed that PET fibers acted as crack arresters, hence preventedshrinkage cracks, this property increased with the increase in the addition of quantity of PETfibers. The experimental observations revealed that there was a definite enhancement inmechanical properties of concrete when it was amalgamated with PET fibers

Hassan Taherkhani et al (2014)The effects of using waste PET asfiber is cement concrete has been investigated. PET fibers at different lengths of 1, 2 and 3cm,have been added to the concrete at 0.5 and 1%, by volume of total mixture, and someengineering properties of the mixtures, including workability,

compressive, tensile, flexural andabrasion resistance, and elastic modulus have been investigated. The results show that PET fiberreinforced mixtures have a lower compressive, flexural and tensile strength than the controlmixture without fiber.

Asha S,et al.(2015)Optimizes the benefits of using straight and crimped fibers, from waste Polyethylene Terephthalate (PET) bottles. An experimental investigation was carried out on the specimen's cubes, cylinders and beams which were cast in the laboratory and their behaviorunder the test was observed. The plastic fibers were added from 0 % to 1.5 % for three aspect ratios. The slump test, compressive, split tensile strength and flexural strength tests wereperformed on the concrete after 28 days of curing phaseFrom the experimental results it wasderived that addition of fibers content affects flow properties of concrete. This study investigatedthe use of post consumed waste PET bottles as reinforcing fibers to improve strengthparameters in cement-based composites. The major improvements in strengths were observed with additionof plastic fibers in concrete. The optimum strength wasobtained at 1% of fiber content for all type of strengths there after declinations in strength wereobserved. It was found that the addition of (PET) fibre has changed the behavior from brittle to ductile. From this experimental investigation, it can be concluded that the PET bottles appear to be a low-cost material which would help to solve the solid waste problems and preventing environmental pollution.

E. Mello, et al.(2015) investigated the improvement in concrete properties with addition of cellulose, steel, carbon and PET fibers. Each fiber was added at four percentages to the fresh concrete, which was moist-cured for 28-days and then tested for compressive, flexural and tensile strengths. Changes in strength and increases in cost were analyzed. The addition of PET fibers decreased the compressive strength, tensile and flexural strengths. Although using PET fibers made concrete cheaper, in this research, it worsened concrete performance so much that its use is not advantageous.

Mahzabin Afroz, et al (2013) investigated the mechanical behavior of fiber reinforced concrete under tension and shear. Polyethylene Terephthalate (PET-Bottle) synthetic fibers of 40mm long, 1.5 mm width and 0.6mm thickness were added to concrete in various percentages, such as 0.0%, 0.40%, 0.46% and 0.52%as volume fractions. Test results after 28days curing shows that tensile strength and shear strength increased maximum values of about 25% and 70% for the addition of 0.52% and 0.46% respectively, compared to the plain concrete. The results indicate the fact that macro synthetic fiber reinforcement enhanced the shear capacity when fiber volume fraction was optimal. The reduction beyond this percentage may be due to the weak bonding of fiber of fiber to concretematrix.

III. MATERIALS AND METHODS

In this experimental study concrete mixes were made by using ordinary Portland cement (Ultra) crushed coarse aggregates (gravel) of 10mm and 20mm size, fine aggregates of local river of zone iii. The waste PETbottles of "Traesh" were shredded with the help of hand fed shredder to an aspect ratio of 35.As per IS 1026:2009[10] the concrete of grades M20, M25 and M30 were prepared using different proportions of ingredients for the design mix. The PET fibers were added to the concrete by weight of cement in the percentages from 2% to 5% for different specimens of beam size 100 mm x 100m x 500 mm and cylinders of size 200 mm (L) x 100 (D).The specimens were cast as per the requirements of testslaid down by the standard codal practices of Civil Engineering. The casting of beam and cylinder specimens were executed in four different groups which consisted of conventional concrete with the above mentioned grades, percentages of PET from 2 to 5% for M20, M25 and M30 grades. The objective of casting all the specimens was to assess and evaluate the effect of PET fibers on the flexural and split tensile strength of concrete.

Concrete Mix Proportion

Grade of concrete	Cement	Fine aggregates	Coarse aggregates (10mm)	Coarse aggregates (20mm)	Water
M20	320 Kg	697	506	760	160
M25	361 Kg	672	510	765	163
M30	378 Kg	658	513	770	159

IV. RESULTS AND DISCUSSIONS

In this research work, details of results, trends of various experimental analysis and their effect on the flexural and split tensile strength with the addition of polyethylene Terephthalate (PET) fibres in comparison to the normal concrete were ascertained. The experimental test results showed that there was perceptible difference in the flexural and split tensile strengthon addition of PET fibres.

A. Flexural Strength

The flexural strength of natural concrete and the strength of concrete with different amounts of PET fibers are shown in tables and bar charts

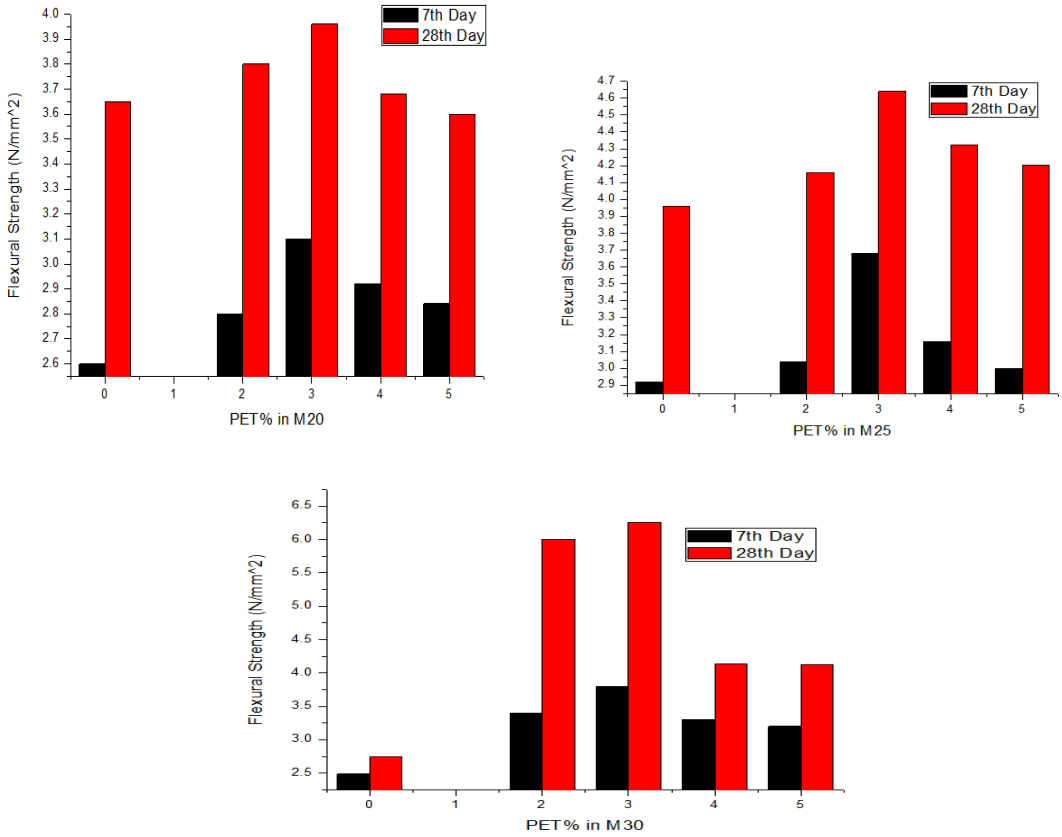
B. Flexural Strength for M20,M25 and M30 PFRC at 7 and 28 days

S.No	Volume fraction PET	flexural strength at 7 days (N/mm^2)	flexural strength at 28days (N/mm^2)
1	0%	2.6	3.65
2	2%	2.8	3.80
3	3%	3.10	3.96
4	4%	2.92	3.68
5	5%	2.84	3.6

S.No	Volume fraction PET	flexural strength at 7 days (N/mm^2)	flexural strength at 28days (N/mm^2)
1	0%	2.92	3.96
2	2%	3.04	4.16
3	3%	3.68	4.64
4	4%	3.16	4.32
5	5%	3.0	4.20

S.No	Volume fraction PET	flexural strength at 7 days (N/mm^2)	flexural strength at 28days (N/mm^2)
1	0%	2.49	2.74
2	2%	3.4	6.0
3	3%	3.8	6.26
4	4%	3.3	4.14
5	5%	3.2	4.12

C. Barcharts Showing the Effect of PET Fiber on Different Grades of Concrete.



D. Split Tensile Strength

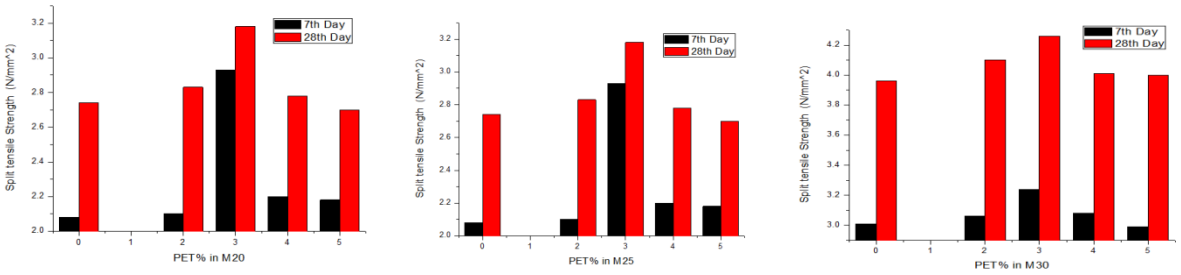
The cylinders of standard size and of different grades viz. M20, M25 and M30 and with variable percentage of PET fibres were caste. All the cylinders were cured and the results obtained are shown in the table 4.7, specimens were tested at 7, and 28 days and a comparative statement was established. The bar chart clearly shows the difference in strength between conventional concrete and the concrete with PET

E. Split tensile Strength for M20,M25 and M30 PFRC at 7 and 28 days

S.No	Volume fraction PET	Split tensile Strength at 7 days (N/mm^2)	Split tensile Strength at 28days (N/mm^2)
1	0%	2.08	2.74
2	2%	2.10	2.83
3	3%	2.93	3.18
4	4%	2.20	2.78
5	5%	2.18	2.70

S.No	Volume fraction PET	Split tensile Strength at 7 days (N/mm^2)	Split tensile Strength at 28days (N/mm^2)
1	0%	2.08	2.74
2	2%	2.10	2.83
3	3%	2.93	3.18
4	4%	2.20	2.78
5	5%	2.18	2.70

S.No	Volume fraction PET	Split tensile Strength at 7 days (N/mm^2)	Split tensile Strength at 28days (N/mm^2)
1	0%	3.01	3.96
2	2%	3.06	4.10
3	3%	3.24	4.26
4	4%	3.08	4.01
5	5%	2.99	4.0



Bar Chart for "7 & 28 days" Split Tensile Strength of Normal Concrete and PET Fibre Concrete.

V. CONCLUSION

- The experimental investigations revealed that the different percentages of PET fiber concrete were compared with the conventional concrete in terms of flexural strength and split tensile strength.
- The data trends revealed that the different percentages of PET fibre concrete were compared with the conventional concrete of M20, M25 and M30 grades for a duration of 7 and 28 days.
- It was observed that the flexural as well as split tensile strength of the concrete initially followed an ascending trend by adding PET fibres from 2% to 3% and then showed a considerable descending trend with the addition of 4% to 5%.PET fibres.

- The optimum value of strength was obtained on addition of 3% of PET fibre to concrete.

Recommendation

The present research work was confined to the addition of concrete with PET fibres of the size 1 mm x 25 mm, rectangular shape and maximum percentage of 5% PET fibres by weight of concrete. The experimental work had yielded appreciable dividends in terms of improving the mechanical properties of concrete at the optimum percentage of 3% PET fibres. However, the research work can be carried forward in many dimensions to further strengthen other properties of the concrete, which at the same time will be more eco-friendly.

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