Experimental Study on Ductile Behaviour of RCC Beams using PET Fibre Concrete

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***Abstract*— Concrete is the most widely used construction material. Despite it is versatility in construction, it is known to have several limitations. It is weak in tension, has limited ductility and little resistance to cracking. The fibres act as micro crack arrester in cement composites. Many commercial fibres like steel, carbon, glass etc. are used as an addition or a replacement in the concrete to increase the strength. But use of steel and carbon fibres in concrete may be quite expensive when used in a large scale. So usage of PET fibre in concrete will enhance to reduce the cost as well as the environmental degradation. PET is unreinforced, semi-crystalline thermo-plastic polyester derived from polyester family. PET fibre can be used in concrete to improve its ductile parameters. This study presents the experimental investigation of PET fibre as a building material in concrete. PET fibres are added into the concrete in the percentages of 0.0 to 1.5% by weight of specimen at the increment of 0.5%. This study includes the strength characteristics of PET fibre concrete and investigate the mechanical properties such as compressive strength, Split tensile strength and Flexural strength.**

Keywords*—. *PET Fibre, Compressive Strength Tensile strength, Crack Control, Ductility.

I. INTRODUCTION

. Concrete is a versatile material in civil engineering construction. The properties of concrete are mainly affected by its ingredients. Concrete is strong in compression but weak in tension and a brittle one. The fibres act as micro crack arrester in cement composites. Many commercial fibres like steel, carbon, glass etc. are used as an addition or a replacement in the concrete to increase the strength. But use of steel and carbon fibres in concrete may be quite expensive when used in a large scale. So usage of any waste products in concrete will enhance to reduce the cost as well as the environmental degradation.

PET fibre is unreinforced, semi-crystalline thermo-plastic polyester derived from polyethylene terephthalate. Its excellent wear resistance, low coefficient of friction, superior dimensional stability and high flexural modulus make it a versatile material for designing mechanical and electro-mechanical parts. The possibility of fluid absorption and leakage is virtually eliminated because the PET has no presence of centerline porosity. PET in its natural state is a colorless, semi-crystalline resin. Based on how it is processed, PET can be semi-rigid to rigid, and it is very lightweight. It is strong and impact resistance.

II. LITERATURE REVIEW

Sung Bae Kim et al., (2009) suggested a method to recycle wasted PET bottles, in which short fibres made from recycled PET are used within structural concrete. To verify the performance capacity of recycled PET fibre reinforced concrete, it was compared with that of polypropylene (PP) fibre reinforced concrete for fibre volume fractions of 0.5%, 0.75%, and 1.0%. Flexural tests were performed to measure the strength and ductility capacities of reinforced concrete (RC) members cast with recycled PET fibre reinforced concrete. The results show that compressive strength and elastic modulus both decreased as fibre volume fraction increased. Cracking due to drying shrinkage was delayed in the PET fibre reinforced concrete specimen, compared to such cracking in non-reinforced specimen without fibre reinforcement, which indicates crack controlling and bridging characteristics of the recycled PET fibres.

Dora Foti., (2011) explained the results of tests performed on concrete specimen reinforced with fibres made from waste Polyethylene Terephthalate (PET) bottles. The tests are to be considered an approach to a more extensive investigation on the use of PET as a reinforcing material for concrete and masonry structures. The results that have been obtained are very interesting, especially regarding the adherence between PET and concrete, suggesting a possible use of this material in the form of flat or round bars, or networks for structural reinforcement.

R. N. Nibudey et al., (2013) explained that the post consumed waste mineral water plastic bottles are shredded into fibres of specific size and shape. Several design concrete mixes with different percentages (0 % to 3 %) of waste plastic fibres for two aspect ratios (35 & 50). As the results the improvement in mechanical properties of concrete was observed. The behavior of concrete depending on sizes of fibres is discussed in this paper. The ductility of normal concrete was found higher in PFRC during test as normal concrete was failed suddenly and cubes were broken into pieces, but PFRC cubes were not broken suddenly at ultimate load.

III. MATERIALS USED

A. Cement

Ordinary Portland Cement (OPC) of 53 Grade was used for the entire investigation. The required quantity was produced as a single batch, stored in air tight bags and used for experimental work and having Specific gravity of 3.14.

B. *Water*

Water is the most important and least expensive ingredient of concrete. Ordinary potable water available in the laboratory was used for the experimental investigations and curing purpose.

C. *Fine aggregate*

Depending upon the particle size distribution IS 383-1970 has divided the fine aggregate into four grading zone. Locally available river sand is confirmed to zone II of table 4 of IS 383– 1970 was used. Fine aggregate used for concrete should be properly graded and be free from deleterious materials like clay, silt content and chloride contamination etc. The Size of fine aggregate selected should passing through 4.75mm sieve and Specific gravity of 2.74.

D. *Coarse aggregate*

Coarse aggregate contributes to impermeability concrete provide that it is properly graded and the mix is suitably designed. The aggregate should be sound, free from deleterious materials and must have crushing strength at least 1.5 times that of concrete. The coarse aggregate used for the work was angular. The nominal size of the aggregate was 20mm and having Specific gravity of 2.74.

E. *PET Fibre*

The PET fibres were used in the form of wire which has uniform diameter and length. The fibres were cut into 3cm length and having 2mm diameter. The plastic fibres used were having specific gravity 1.38 and water absorption 0.10%.

TABLE I. PROPERIES OF PET FIBRE

Properties	***Values***
Length (mm)	30mm
Diameter (mm)	2mm
Aspect ratio	15
Specific gravity	1.38
Density (kN/m3)	13.57
Water Absorption (%)	0.10%

Fig. 1. PET FIBRE

IV. TENSILE PROPERTIES OF PET FIBRE USING ELECTRONIC TENSOMETER

The electronic Tensometer is a device used to evaluate the tensile properties of materials such as their Young's modulus (i.e. the degree to which they stretch under stress) and tensile strength. It is a compact and versatile bench model horizontal Tensile Testing.

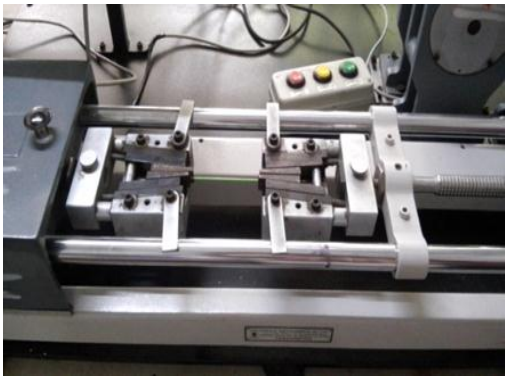

FIG -2: ELECTRONIC TENSOMETER

FIG -3: TESTED FIBRE

The wire form PET fibres were subjected to Tensile strength test using Electronic Tensometer and the corresponding results were indicated in Table 3.5. The load displacement cure and stress strain curve are shown in Fig.3.4 & Fig. 3.5 respectively.

TABLE -2: TENSILE PROPERTIES OF FIBRE

Properties	Values
Ultimate tensile strength (N/mm^2)	166.54
Tensile elongation (%)	33.13

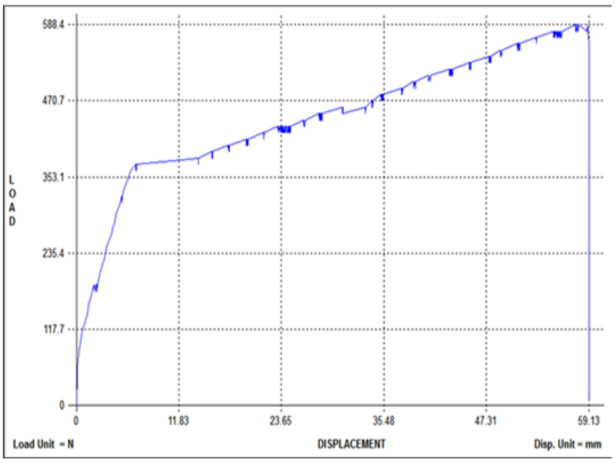

CHART -1: LOAD DISPLACEMENT CURVE

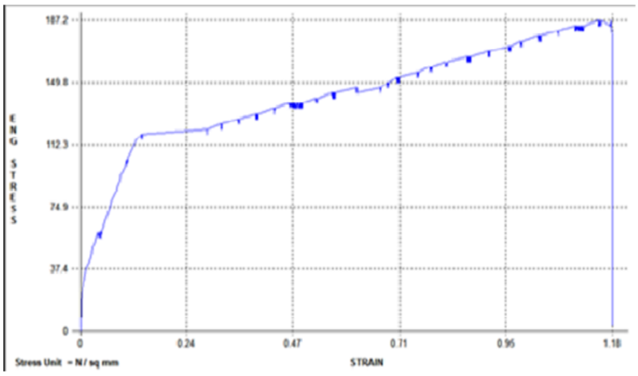

CHART -2: STRESS STRAIN CURVE

V. CASTING AND CURING OF SPECIMEN

The materials were weighed as per the designed mix proportion and they were mixed using concrete mixer. The mixing operation was continued till a good uniform homogeneous concrete was obtained.

Twenty four hours after casting, the specimen were demoulded and all the specimen were kept into the water tub and allow for curing. After 7 days & 28 days of curing, the specimens were taken out from water and allow it for drying for 1 day in shadow. Then the specimen is tested.

VI. EXPERIMENTAL PROGRAMME

A. Tests on fresh concrete

Slump Cone test is performed to check workability of freshly made concrete. It is used to indicate degree of wetness. The slump test is used to ensure uniformity for different batches of concrete under field conditions.

TABLE -3: SLUMP TEST RESULTS

PET fibre	Slump in mm
0	64
0.5	52
1	45
1.5	34

B. Test on harden concrete

The Mechanical properties of concrete for 0.5 %, 1 % and 1.5 % of PET fibre were studied.

1. *Compressive strength test*

The cubes were tested by Universal Testing Machine (UTM). The average compressive strength of cube specimens made with various proportions of PET fibres. From the result we found that the compressive strength of the concrete specimen increased upto 1% of fibre content. In 1% addition of fibre content, 2.94% of increase in compressive strength is observed when compared to conventional concrete.

Only the slight increase in compressive strength is observed. At 1.5% of fibre content the concrete strength suddenly decreases.

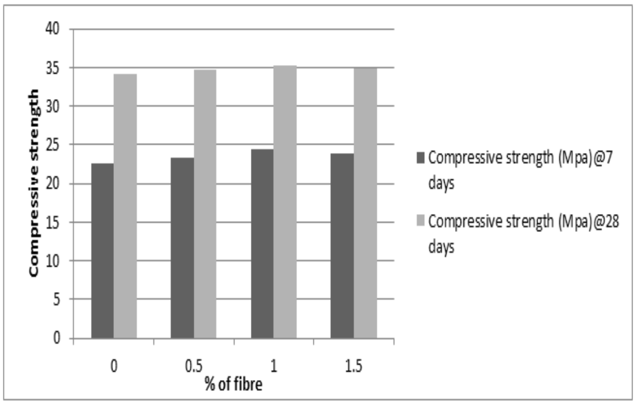

CHART -3: VARIATION IN COMPRESSIVE STRENGTH

2. Split Tensile strength test

The average split tensile strength of cylinder specimens made with various proportions of PET fibres. From the result we found that the Split tensile strength of the concrete specimen increased up to 1% of fibre content, 17.6% of increase in Split tensile strength is observed. At 1.5% of fibre content the concrete strength suddenly decreases.

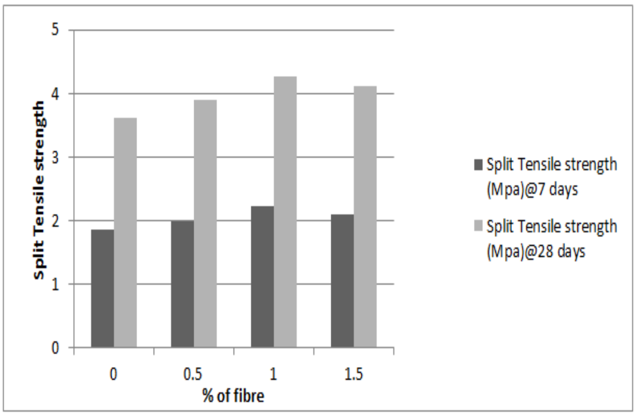

CHART -4: VARIATION IN SPLIT TENSILE STRENGTH

3. Flexural strength test

The average flexural strength of prism specimens made with various proportions of PET fibres. From the result we found that the flexural strength of the concrete specimen increased upto 1% of fibre content, 22.8% of increase in flexural strength is observed. At 1.5% of fibre content the concrete strength suddenly decreases.

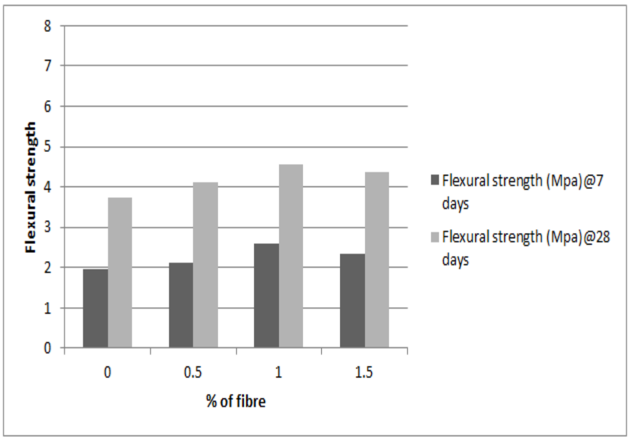

CHART -5: VARIATION IN FLEXURAL STRENGTH

VII. CONCLUSIONS

An experimental work with PET fibre in wire form is an experimental work with PET fibre in wire form is presented in this project. In 1% addition of PET fibre content, 2.94% of increase in compressive strength is observed when compared to conventional concrete. Only the slight increase in compressive strength is observed. In split tensile test, 17.6% of increase in Split tensile strength is observed. In flexural test, 22.8% of increase in flexural strength is observed.

The significant improvements in strengths were observed with inclusion of plastic fibres in concrete. And also it was found that normal concrete specimen was suddenly broken into two pieces at ultimate strength but PET fibre specimen did not suddenly break. The optimum strength was observed at 1% of fibre content for all type of strengths. From this experimental investigation, the composites would appear to be low-cost materials which would help to resolve some solid waste problems and preventing environment pollution.

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