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Influence of PET bottle mesh in Flexural behaviour of concrete beam

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Abstract— Polyethylene Terephthalate (*PET*) is among the most widely used plastic resins around the world with increased recycling rates every year. Many studies have been done using waste plastic fibers in short, dispersed and continuous forms to reinforce concrete. Test of beams with PET fiber in mesh form and that in tension zone region has not yet reported. This paper presents a study of the flexural behaviour of concrete beams with PET mesh in tension zone. The results of 28 days flexural strength test and its comparison with ordinary concrete on 6 simply supported beams are presented.

Keywords — PET, PET mesh, Tension zone, Flexural behaviour, Flexural strength test

INTRODUCTION

Concrete is one of the most widely used construction material in the world and it is strong in compression but weak in tension and brittle one. The ductility of concrete can be increased by reinforcing with fibers. In recent year all over the world, there is increased production of the plastic waste and improper disposal of this plastic leads to a serious environmental problem. Plastic is composed of various toxic chemicals and materials thereby pollutes air, soil and also water because plastic is a non biodegradable material. Due to slow degradation rate plastic is dangerous to nature and also it can block the plant roots movement. Therefore, it is necessary to find alternatives about recycling and reusing the waste plastic materials. The potential of PET waste in replacing aggregates in concrete which represents a better option than landfill. Number of studies has been conducted using waste plastic as components in cement pastes, mortar and concrete. It has been reported that, concrete reinforced with short, dispersed and continuous plastic fibers drastically improves the performance of concrete and eliminates its disadvantages.

METHODOLOGY

In the present research, experimental investigations were conducted for assessing the flexural strength of concrete provided with continuous PET fiber in mesh form which was incorporated in the tension zone. PET fibers were extracted from washed bottles collected from household waste. A hand tool made of wood was used to extract continuous fibers. Uniform width of 10mm was fixed for fiber as shown in Fig 1. Thickness of PET fiber was found to be 0.5mm using a vernier scale. Mesh size obtained is 25mm x 25mm as the size of coarse aggregate used is 20mm. For transforming continuous fibers to mesh form, a synthetic based adhesive called Fevibond were used. The tensile strength of PET strip obtained is 460 N/mm^2. Totally 2 types of concrete beam specimens of size 500 x 100 x 100 mm were used for the research. Control beams are those which were made with plain concrete of M25 mix without any reinforcement. Second type is beam with plain concrete of same M25 mix with the PET mesh in tension zone. Test setup has shown in Fig.2. Beams were casted with design mix ratio of 1:1.45:2.68 with w/c ratio 0.45. The mix was prepared and evenly filled till thickness reached 25mm. Prepared mesh was then placed over it as shown in Fig 3. Slowly rest of the mould portion was filled. The beams were then tested under two point loading test after 28 days water curing.

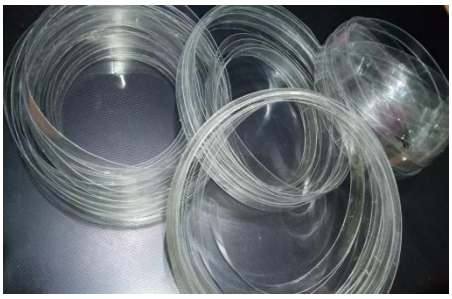

Fig. 1 Peeled PET fiber

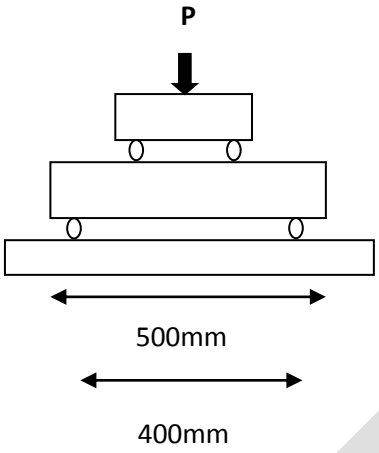

Fig. 2 Schematic Setup for Testing

Fig. 3 Placing of mesh during casting

RESULTS

The failure modes of control beams and beams with PET are shown in fig 4 and fig 5 respectively. Control beams showed the pure brittleness of concrete by giving sudden collapse.

Fig. 4 Failure of control beam

Fig. 5 Failure of Beam with PET mesh

The beams with PET mesh showed flexural failure without any collapse. Beams with PET mesh showed much higher load carrying capacity when compared with control beams. Crack propagation rate was very less when PET mesh was introduced to tension zone of beams.

DISCUSSION

The ultimate loading carrying capacity of control beam was obtained as 8.5 kN and the ultimate load carrying capacity of beams with PET mesh was obtained as 13 kN. Flexural strength for control beams and beams with PET was found to be 4.25 N/mm^2 and 6.5 N/mm^2 respectively.

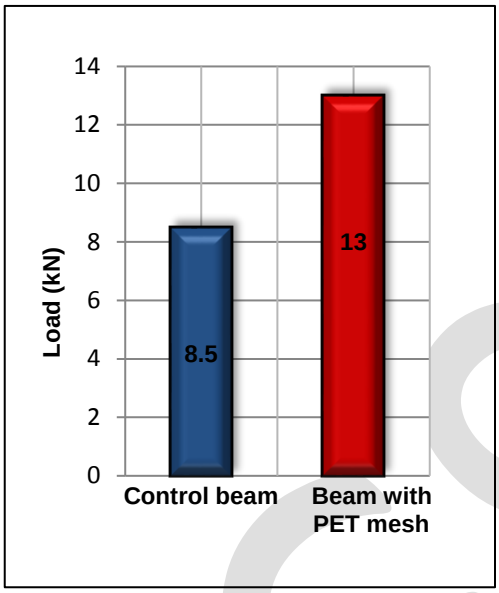

Fig. 6 Ultimate Load Carrying Capacity

CONCLUSIONS

The research work included the testing of concrete beams, each having a span of 500 mm and incorporated PET mesh in tension zone to increase the flexural strength of beams. Flexural strength comparison between control beam and other types of beams casted for the present investigation is illustrated as follows:

a) The flexural strength of concert beam with PET mesh is far greater than that of control beams and also the crack propagation rate of the concrete beam with PET mesh is greatly decreased due to the tensile property of PET fiber whereas the control beam exhibited brittle failure.
b) The post cracking behaviour of the beam with PET mesh shows the nature of PET fibers with hardened concrete offering little more resistance even after the failure.
c) The ultimate load carrying capacity of beam with PET mesh is around 50% more than the conventional RC beams.
d) A high adherence between PET fibers and concrete matrix was achieved.
e) Waste PET bottle fibers could be considered for the reinforcement of concrete; further studies could elucidate if these fibers may be used as structural material like reinforced beams, slabs, etc, and for other construction works.

Furthermore, the fact of using waste PET bottles as reinforcing material contributes to generate a benefit to the environmental preservation.

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