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Analysis Of Compressive Strength Of Concrete Using Polyethylene Terephthalate [PET] Fibres

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Abstract

Usage of plastics in our day to day life is getting increased in an alarming manner. Disposal of such non bio degradable materials is a great environmental concern these days. One such effective manner of disposal of such waste material is using it as a building material in concrete. It serves dual purpose of waste disposal as well as effective utilisation of wasteto reduce environmental pollution. One of the waste material is polyethylene terephthalate (PET) which is a polyester material and is produced in large quantities. In this study, thefibres are directly cut from waste PET bottles. The aim of this study is to explore the possibility of PET fibres to be used in concrete as a fibre. PET fibres are manually cut from used bottles and was added to concrete in the various percentages 0. 0%, 0. 25%, 0. 5%, and 0. 75% of fibre in total weight of concrete. Test results shows that compressive strength of cubes improving substantially up to certain limit and if the ratio of fibres is increased, the compressive strength found to be reduced. This study reveals an effective method to create a new building material by using waste PET bottles.

1. Introduction

In India approximately 40 million tons of solid waste is produced, annually. This is increasing at a rate of 1. 5 to 2% every year. Plastics constitute 12. 3% of total waste produced most of which is from discarded water bottles. According to experts, polymer consumption by Indian plastic industry is expected to be double in next 6 years. Polyethylene terephthalate (PET) is one of the most important synthetic fibres for industrial production. The largest use of PET currently is in containers. In this area, beverage and mineral waterbottles are standing in prime position. The current worldwide production of pet exceeds 6. 7 milliontons/year and shows a dramatic increase in the Asian region due to recent increasing demands in China and India. In India, domestic waste plastics are causing considerabledamage to the environment and hence an attempt has been made to understand whether, they can be successfully used in concrete to improve some of the mechanical properties.

The aim of this paper is to explore the possibility of a waste material to be used in concrete as fibre. The purpose of this study is to investigate the mechanical behaviour of concrete cube with pet fibres. The studies were conducted ona M20mix concrete. One of the most important advantages of using PET fibres is reducing environmental problems of PET bottle wastes. It can also provide greater crack control and ductility enhancement capacities for concrete. The dimensions of PET fibres used are 30mm long, 5mm wideand 0. 6mm thick. It was added to concrete in percentages of 0. 0%, 0. 25%, 0. 5%, and 0. 75% of fibre in total weight of concrete and compressive strength of cubes are tested.

2. Literature Review

Dora Foti, presents a study on fibres simply cut from waste polyethylene terepthalate (PET) bottles. PET bottles belongsto the family of polyester. Fibres are cut into two categories - short lamellar of length 32mm and "O" fibers of diameter30-50mm andwidth5mm. PET fibres in the order of 0. 26% of the concrete weight has been added as both lamellar and "O" fibres. Bending and compression tests are conducted.

*J. M. L. Reis et al*In thisstudy, PET waste from beverage containers are collected then washed and crushed into granules by a shred machine. Thenshreded PET waste is used as a replacement for sand in percentage of 5%, 10%, 15% and 20%. Two types of polymer binders - epoxy polymer mortarand polyester polymer mortarare used. The result of flexural modulus and compressive modulus are high at 5% of shreded PET fibrecompare to others.

*J. H. J. Kim et al*In this study, recycled polyethylene terephthalate (RPET) fibresare added to concrete and compared with the polypropylene fibres. The dimensions are 0. 2x1. 3 mm, 0. 38x0. 9 mm, and length 50mm. It was compared with the performance capacity of polypropylene(PP) fibers added to concrete, for fiber fractions of 0. 5%, 0. 75%and 1% with a water cement ratio of 0. 41 to test the flexural strength and ductility. It can also provide crack controlling capacity.

Fernando Fraternali et al Presents an experimental study of thermal conductivity, compressive strength, first crack strength and ductility indices of recycled PET fibre-reinforced concrete(RPETFRC). A comparative study indicates that RPETFRC is also highly competitive over polypropylene fibre-reinforced concrete in terms of compressive strength and fracture toughness.

*Ochi et al*suggested a method can be used to produce concrete-reinforcing PET fibre from used PET bottles. Using this method, the concrete and PET fibres are easily mixed at fibre contents as high as 3%. The issue of concern in the development of PET fibre is its alkali resistance but however they encountered no such problems. Also no toxic gases were generated during the combustion test of PET fibre.

3. Experimental Investigation

3. 1 Materials

3. 1. 1 Cement: Portlandpozzolona cement conforming to IS: 12269 -1987 was used for the present experimental investigation. Its specific gravity is 3. 00.

3. 1. 2 Fine Aggregate: Clean river sand conforming to IS 2386-1968 is used as fine aggregate. The specific gravity and fineness modulus were found to be 2. 65 and 2. 54 respectively.

3. 1. 3 Coarse Aggregate:Coarse aggregates conforming to IS: 383-1987 of size20mm having the specific gravity of 2. 87 was used. Bulk density was calculated as 2018Kg/m. ^{3}

3. 1. 4 PET Fibre:The main components of the polymeric fibre used in this study were Polyethylene terephthalate (PET) fibres. This fibre was prepared by manually cutting the used mineral water bottle with size such as - nominal length of 30 mm, average width of 0. 5 mm and average thickness of 0. 6mm. The fibre had an aspect ratio of 30.

3. 2 Preparation of Pet Fibre:

Used PET water bottle containers were collected and PET fibres of required dimension are cut manually. The manually cut fibres are shown in Fig 1.

3. 3 Preparation ofTest Specimen:

The Cubes of size 150mm x150mm X150 mm, were prepared using the standard moulds. A total of 12 cubes were casted for testing the compressive strength. The specimens were later demoulded and placed immediately in water tank for further curing. Specimens were tested for 7 days and 28days.

Fig 1. Manually cut fibres

Fig. 2. Pet Fibre Addition in Concrete

4. Results and Discussions:

For compressive strength tests on concrete using PET fibres, cubes of size 150 mm are used. For the present investigation, cubes are tested by compression testing machine as per IS 516-1959 after 7 days and 28 days of curing. A total of 12 cubes are casted, 3 each for 0%, 0. 25%, 0. 50% and 0. 75% of PET fibres added to concrete. The results are shown in Table 1.

Fig 3. Compressive Test

Table 1: Compressive Strength Test Results

S. No	Fibre Percentage	Compressive Strength (N/mm^2) (7 days)	Compressive Strength (N/mm^2) (28 days)
1	0%	14. 6	21. 4
2	0. 25%	15. 2	22. 5
3	0. 5%	17. 3	23. 4
4	0. 75%	14. 9	20. 3

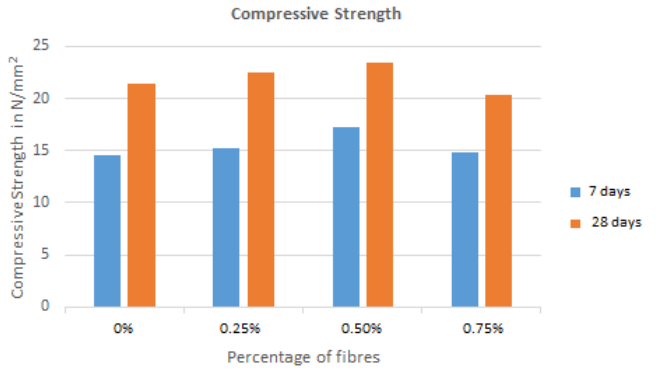

Fig 4. Compressive strength of concrete with PET Fibres

From the results it was observed that upto 0. 5% of fibers added to concrete, the compressive strength of concrete is found to be improving. But it tends to reduce if the fibres are added beyond 0. 5%. From our test results, the compression strength of concrete cubes with 0. 75% fibres is reducing when compared with other specimen. Also the crack resistance of cubes with fibres are found to be significantly good when compared to specimen without fibres. The fibres also blend well with the concrete.

5. Conclusion

The pet fibres used in concrete gradually increasesthe compressive strength when added in limited quantities in the range ofabout 0. 50%. Moreover the durability properties are found to be improved significantly than compressive strength. Crack resistance is more for specimen with PET fibres than normal concrete specimen. From the tests conducted, the optimum percentage of fibre is found to be 0. 5% in both strength and durability point of view. All the tests are conducted without adding any super plastizers. Further works can be carried out by the addition of suitable super plasticizers for higher percentage of fibres. Durability properties can be extensively tested with long term tests. From this experimental investigation, the PET fibres appear to be easily available low-cost materials which would help to resolve some solid waste problems preventing environmental pollution.

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