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Experimental Study on Concrete with Straight and Crimped Plastic Fibres

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Abstract: ***Concrete is the most broadly used construction material in the world due to its compressive strength, extended service life, and low cost. This experimental program seeks to optimize the benefits of using straight and crimped plastic fibres, from waste polyethylene terephthalate (PET) bottles. As plastic is non-biodegradable, its disposal become a problem. To prevent this, the fibres from waste bottles were added in different percentages in the M30 grade concrete. The plastic bottles were shredded into fibres of specific size and shape. An experimental set up was carried out in the laboratory and the test were observed. The plastic fibres were added from 0% to 1.5% for different aspect ratios. The various tests were conducted and the results obtained are compared with the control specimen and the results are plotted in the form of graph.***

Keywords: Polyethylene terephthalate fibres, concrete, compressive strength

1. Introduction

Poly ethylene terephthalate commonly abbreviated as PET is a thermoplastic polymer resin of polyester ester family and is used in synthetic fibres, beverage, food and other liquid containers; thermoforming application. PET can cause environmental damage, if it is not disposed properly. Constructing reinforcing fibres from waste PET bottles to control plastic shrinkage cracking in cement based composites is an effective way to reuse the bottles. The characteristics and low surface energy of plastic materials results in a poor mechanical bond with cement based composites.

Low mechanical bond strength may not provide sufficient bridging force to control crack development. Poor mechanical bond strength may also cause internal micro cracks in the interfacial mechanical bond area between a fibre and the cement matrix. One effective way to increase the mechanical bond strength of fibres with low surface energy is to change the fibre geometry and surface. PET bottles are characterized by high strength, low weight and low permeability of gases as well as by their aesthetic appearance.

The advantage of using waste plastic in concrete not only solves the problem of their safe disposal but also improves the basic properties of concrete like compressive strength, tensile resistance, impact resistance, permeability, thermal insulation, flexural strength etc. The main benefits of using plastics in concrete is its durability, resistance to chemicals and light in weight.

The applications of the PET fibres includes bottles and electrical components but it is probably most widely known as the biaxially oriented and thermally stabilized films used for capacitors, graphics , film base and recording tapes etc. They used in the application of mining construction and as pavement of narrow areas. As PET fibre has good mix ability and has satisfactory reinforcing quality, concrete mixed with the PET fibres is used in mining. Passages in tunnel under construction, passages through underground structures, urban alleyways, and bush roads are mostly narrow, winding and steeply. It is important to apply fibre reinforced concrete to the pavement of such narrow sections of road; however, steel fibre if used can puncture tires, and conventional fibre has workability concerns. Thus, it has not been used previously to pave narrow sections of road. So, PET fibre reinforced concrete to pave bush roads was use keeping in mind its easy workability

In this paper, comparison between concrete is mixed with PET fibre and that of conventional concrete is done while considering different aspect ratios and percentage of fibres (0%, 1%, 1.5%).

2. Literature Review

A comprehensive review of the work carried out by the researchers in this field is discussed below:

Ramadevi et al., [1] studied the possibility of using the waste PET bottles as the partial replacement of aggregates in Portland cement. The findings revealed an increase in compressive and tensile strength hence with the increasing demand for fine aggregate, PET bottle fibre replacements can be adopted. The replacement of fine aggregates reduced the quantity of river sand to be used in concrete and also plastic fibres are to be proved to be more economical.

Malagavelli et al., [2] investigated the concrete slabs using the two different fibres namely poly ethylene terephthalate and high density poly propylene. It has been observed that the ultimate load carrying capacity increased considerably by using these two fibres.

Harini and Ramana et al., [3] investigated research on use of recycled plastic waste as partial replacement of fine aggregate in concrete. The various plastic proportions are 5%, 6%, 8%, 10%, 15% and 20% by volume. There is decrease in compressive strength when the ratio of plastic to aggregate was increased. It was noticed that when cement was partially replaced by 10%, 15% of silica fume was higher than reference mix.

Murali et al., [4] investigated the influence of addition of waste materials like lathe waste, soft drink bottle caps, empty waste tins, waste steel powder from workshop at a dosage of 1% of total weight of concrete as fibres. It was seen the soft drink bottle caps reinforced blocks exhibited an increase in flexural strength of concrete by 25.88%.

Irwan et al., [5] researched about the performance of concrete with PET waste. In this research PET waste is incorporated with an effective binder namely fly ash. The increase of workability is caused by the small spherical shapes of fly ash that reduces the friction between the cement and aggregates.

3. Experimental Programme

The materials used in this investigation are cement of 53 grade, coarse aggregate of 20 mm size, fine aggregate, PET fibres with different shapes and size, superplastizers, potable water. Mix design is done and based on this, specimens are casted, cured and the various tests are done. The mix taken here is M30 grade and mix proportion is 1:1.49:2.8 (1 parts of cement, 1.49 parts of coarse aggregate, 2.8 parts of fine aggregate) with water cement ratio of 0.43. The plastic fibres were introduced into dry mix in 0%, 0.5%, 1% and 1.5% by weight of cement.

3.1 Slump Test

The workability of fresh concrete is measured in terms of slump. Workability has a board range from very low (0 to 25 mm) to high range (100 to 180 mm).

3.2 Compression Test

Compression test is the common test conducted on hardened concrete, partly because it is an easy test to perform and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

3.3 Flexural Strength Test

The flexural tensile strength test is performed to estimate the tensile load, at which the concrete cracks. This is an indirect test to evaluate the load at failure or modulus of rupture.

3.4 Split Tensile Strength Test

The splitting test is well known indirect test for determining the tensile strength. The test consists of applying compressive line loads along the opposite generators of a cylinder specimens placed with its axis horizontal between the platens. The tensile strength subjects the specimen to a uniaxial tension until it fails. The compression testing machine was used for the splitting tensile test.

3.5 Carbonation Test

Carbonation test is a durability strength test. Carbonation is associated with steel reinforcement corrosion and with shrinkage of concrete. The test proposes to assess the carbon dioxide attack on concrete specimen by measuring the depth of CO_2 penetration into the concrete specimen. The cylindrical specimen is used. The specimen is exposed to natural atmospheric conditions for 90 days. After the specimen is split by applying splitting force. To the split face, phenolphthalein solution is sprayed and the depth of penetration is noted.

3.6 Bulk Diffusion Test

The test proposes to assess the chloride attack on concrete specimen by measuring the depth of chloride penetration into the concrete specimen. The cylindrical specimen is immersed in 1.8 molar NaCl solution for 90 days. After the specimen is split by applying splitting force. To the split face, 0.1 molar silver nitrate solution was sprayed. A white precipitate is formed and the depth of penetration is noted.

4. Results

4.1 Slump Test

For 0% fibres the maximum slump value obtained was 120 mm. It was noticed that there is decrease in slump value as the length of fibre increases.

4.2 Compression Strength

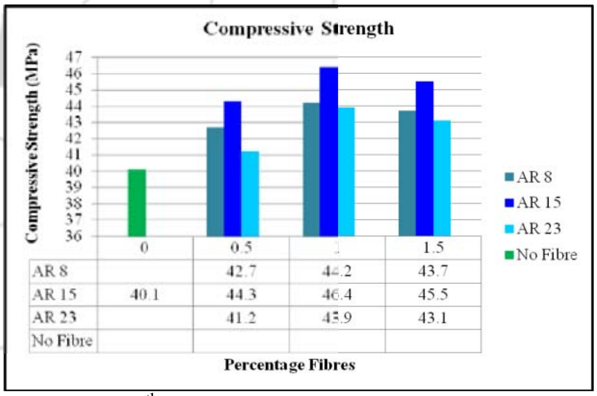

Figure 1: 28th day compressive strength result of cube specimen with straight PET fibres

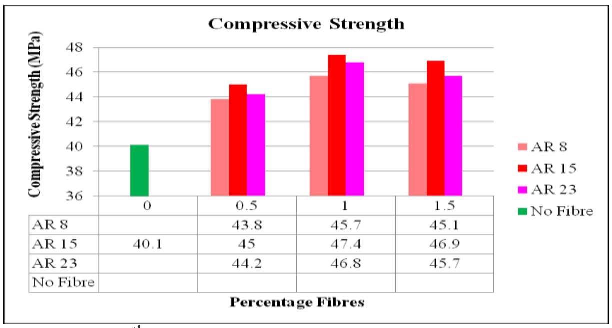

Figure 2: 28th day compressive strength of cube specimen with crimped PET fibres

4.3 Flexural strength

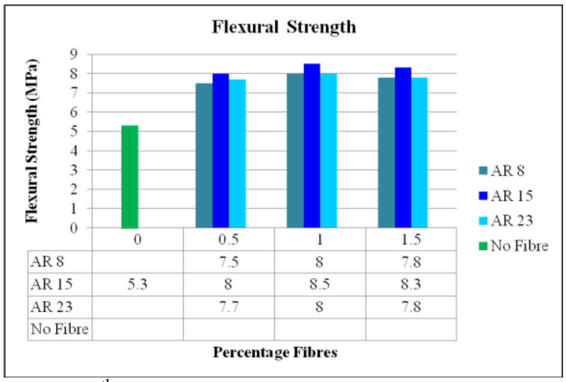

Figure 3: 28th day flexural strength of beam specimen with straight PET fibres

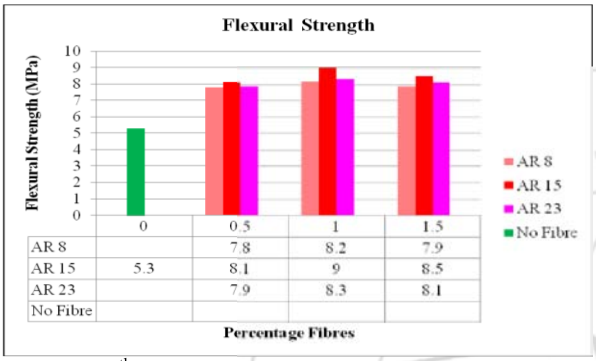

Figure 4: 28th day flexural strength of beam specimen with crimped PET fibres

4.4 Split Tensile Strength

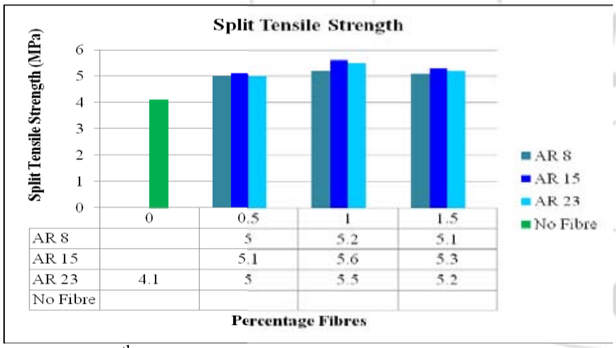

Figure 5: 28th day split tensile strength of cylinder specimen with straight fibres

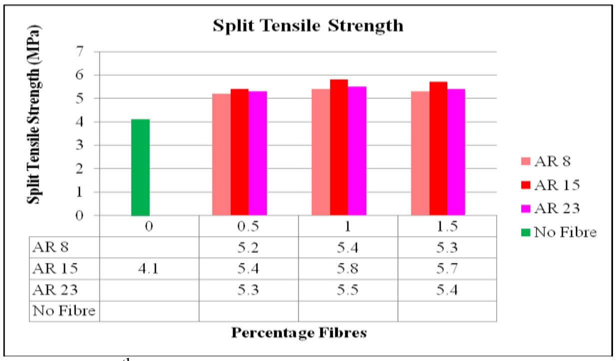

Figure 6: 28th day split tensile strength of cylinder specimen with crimped fibres

4.5 Carbonation Test

Table 1: Carbonation test result with straight PET fibres

S.No	*Penetration depth*
Straight AR 8	0.3
Straight AR 15	0.4
Straight AR 23	0.3
Average depth	0.33

4.6 Bulk Diffusion Test

Table 2: Bulk diffusion test result of specimen with straight PET fibres

S.No	*Penetration depth*
Straight AR 8	2.4
Straight AR 15	1.2
Straight AR 23	2.1
Average depth	1.9

5. Conclusions

From the experimental results the foremost conclusions were deprived as follows:

Addition of fibres content affects flow properties of concrete. From this slump test it was obtained that workability of plain PET fibre reinforced concrete was decreased with the increase in percentage of fibre volume fraction and this may due to the resistance offered by the fibres against the movement of aggregates.

The major improvements in strength were observed with addition of plastic fibres in concrete. The optimum strength was obtained at 1% of fibre content for all types of strengths there after declination in strength were observed. It can be observed from the test results than for aspect ratio 15, strength development was higher. The tensile strength and flexural strength at relatively low fibre content (up to 1%) are affected by fibre geometry. Therefore, the crimped type fibre, which had superior mechanical bond strength, conferred the best resistance to strength parameters.

Spalling of concrete was observed while the tests were conducted in the control cement concrete cube. However the failure mode of fibre content was bulging in transvers direction. From the test results it was observed that the tensile strength was increased with increase in fibres with the concrete. Moreover, the control batch specimens containing no fibres failed suddenly once the concrete cracked, while the PET fibre reinforced concrete specimens still remained as unique. The addition of straight and crimped PET fibres to concrete improved the shear capacity. These results indicate the fact that macro synthetic fibre reinforced enhanced the shear capacity although the 1% fibre volume fraction is seems to be optimal. The reduction beyond this percentage may be due to the weak boding of fibre to concrete matrix.

It was found that normal concrete specimens failed suddenly into two pieces at ultimate strength whereas PET fibre specimens did not fail suddenly. A change in nature of failure occur from brittle to ductile when plastic fibres were introduced into the concrete. 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.

5.1 Scope for Future Work

The present study was focused on examining the strength and behavior of fibre reinforced concrete with PET straight fibre and PET crimped fibre. Further research can be done with different aspect ratios and also by combining both PET straight fibre and PET crimped fibre. A volume fraction of 1% could be adopted for both PET straight fibre and PET crimped fibre.

References

[1] K. Ramadevi, R. Manju, "Experimental investigation on the properties of concrete with plastic PET fibres as fine aggregates," International journal of Emerging Technology and Advanced Engineering, pp. 42-46,2012.
[2] G. Murali, C. M. Vivek Vardhan, R. Prabhu, Z. Mohammed Sadaquath Ali Khan, T. Aarif Mohammed and T. Suresh, "Experimental investigation on fibre reinforced concrete using waste materials," International Journal of Engineering Research and Applications, pp. 278-283,2012.
[3] Venu Malagavelli, Rao P. N, "Effect of non-biodegradable waste in concrete slabs," International journal of Civil and Structural Engineering, pp. 449-457, 2010.
[4] B.Harini,K. V. Ramana, "Use of recycled plastic waste as partial replacement for fine aggregate in concrete," International journal of Innovative Research in Science, Engineering and Technology, pp. 8596-8603, 2015.
[5] J. M. Irwan, S. K. Faisal, N. Othman, Wan Ibrahim M. H, R. M. Asyraf, M.M. K. Annas, "Performance of concrete using light weight PET fibres," Advanced Material Research, pp. 352-355, 2013.

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