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Use of Post Consumed Straight And Crimped Waste Plastic Fibres in Concrete

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Abstract: *In this experimental research, the fibres of different geometries, i.e., straight, and crimped, from post consumed waste polyethylene terephthalate (PET) bottles were used. Various design concrete mixes with different percentages (0 % to 1.5 %) of waste plastic fibres for three aspect ratios, were cast. The workability compression, split tensile and flexural tests were carried out. The test results were compared with both types of fibres. The improvements in strength properties of concrete were observed.*
Keywords – *Poly Ethylene Terephthalate Fibres, Straight , Crimped , Fibre Reinforced Concrete*

I. Introduction

Plain concrete is brittle and, have low tensile strength. To get rid of these problems, the use of fibre reinforced has increased over the past few years. The introduction of fibres has become an alternative to enhance the flexural and tensile strengths of concrete.

Plastic is one of the most insignificant innovations of 20th century. A considerable growth in the utilization of plastic was noted all over the world in the past years, which also led to the increase in the production of plastic related waste. The plastic waste has now become a serious environmental threat to modern civilization. Plastic is poised of several toxic chemicals, and therefore plastic pollutes soil, air and water. Since plastic is a non-biodegradable material, land-filling using plastic would mean preserving the harmful material forever. Land-filling of plastic is also dangerous due to its slow degradation rate and bulky nature and also the waste mass may hinder the ground water flow and can also block the movement of plant roots.

One possible way out is using recycled PET as fibre reinforcement in structural concrete. The aim of this study was to understand the mechanical behaviour of concrete reinforced with straight and crimped PET fibres.

II. Scope

Waste plastic bottles are the major reasons of solid waste disposal. Polyethylene Terephthalate (PET) is usually used for carbonated beverage and water bottles. The aim of this thesis is to experimentally quantify the performance of straight and crimped fibres concrete and thus to determine the possibility of using the waste PET bottles at different aspect ratios.

III. Objectives

1. To study the compressive strength, tensile strength and flexural strength of fibre reinforced concrete with different proportions of PET fibres.
2. To adopt the fiber volume of 0.5%, 1% and 1.5%
3. To study the effect of varying aspect ratio of PET fibre on mechanical properties of fibre reinforced concrete.
4. To compare the strength characteristics of fibre reinforced concrete with straight fibres and crimped fibres

IV. Poly ethylene terephthalate fibres

The most common thermoplastic polyester, this polymer is often called just "polyester". PET is a hard, stiff, strong dimensionally stable material that absorbs very little water. It has good gas barrier properties and good chemical resistance except to alkalis (which hydrolyse it). Its crystallinity varies from amorphous to fairly high crystalline; it can be highly transparent and colourless but thicker sections are usually opaque and off-white. Applications include bottles and electrical components but it is probably most widely known as the biaxially oriented and thermally stabilized films used for capacitators, graphics, film base and recording tapes etc.

A. Fibre Dimensions

The Table 1 includes the fibre dimensions of the fibres used in the experimental study.

Table 1. Fibre Dimensions

Sl.No.	Aspect Ratio	Dimension (mm)
1	8	15 x 2
2	15	30 x 2
3	23	45 x 2

V. Concrete Mix Design

The concrete mix design used in the concrete is as given in the Table 2.

Table 2. Concrete Mix Design

	Cement	Fine Aggregates	Coarse Aggregates	w/c Ratio
Mix Ratio	1	1.49	2.8	0.43

VI. Results

The results of the fresh and hardened concrete with Straight and Crimped fibres for different Aspect Ratios are shown in the following Figures.

A. Slump Test

The Slump values for different Aspect Ratios are shown in the following figures.

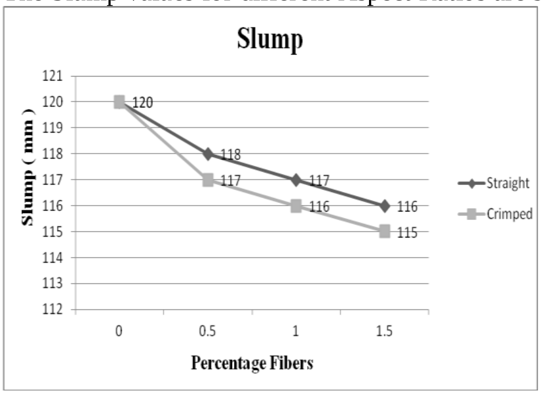

Fig.1. Behaviour of Slump of AR -8 (1.5 x 0.2 mm)

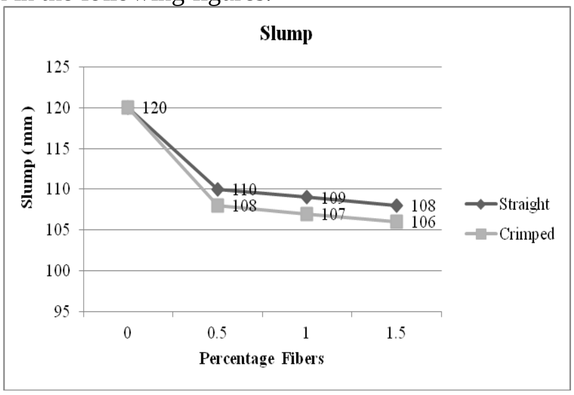

Fig.2. Behaviour of Slump of AR -15 (3 x 0.2 mm)

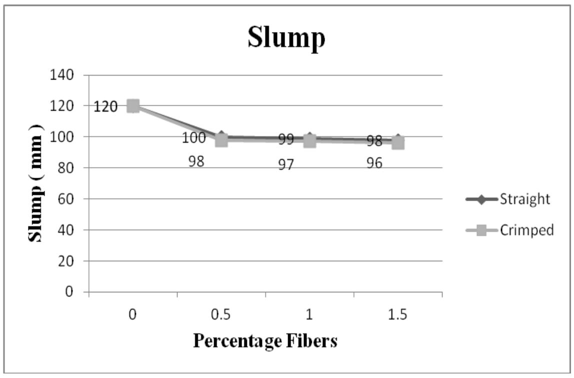

Fig.3. Behaviour of Slump of AR -23 (4.5 x 0.2 mm)

B. Compression Test

The compressive strength values for straight and crimped fibres are shown in the following graphs.

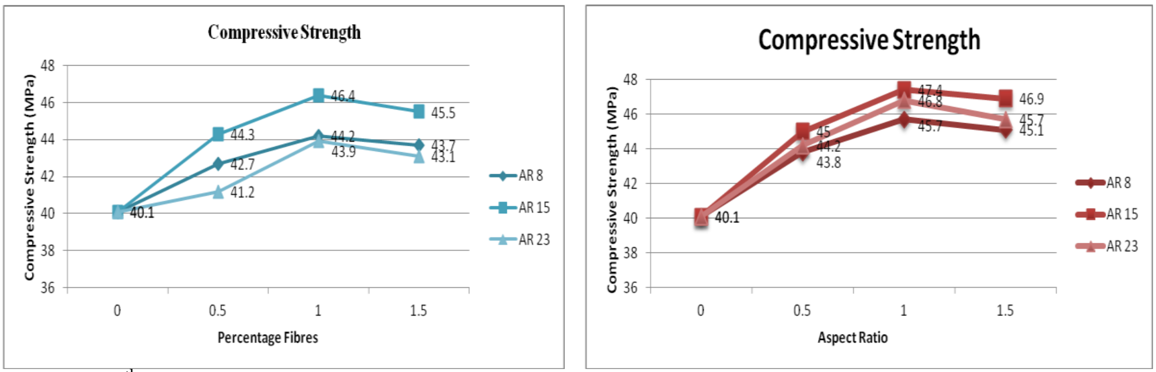

Fig.4. 28 th day compressive strength result of cube specimens with Straight and Crimped PET fibres for different aspect ratios

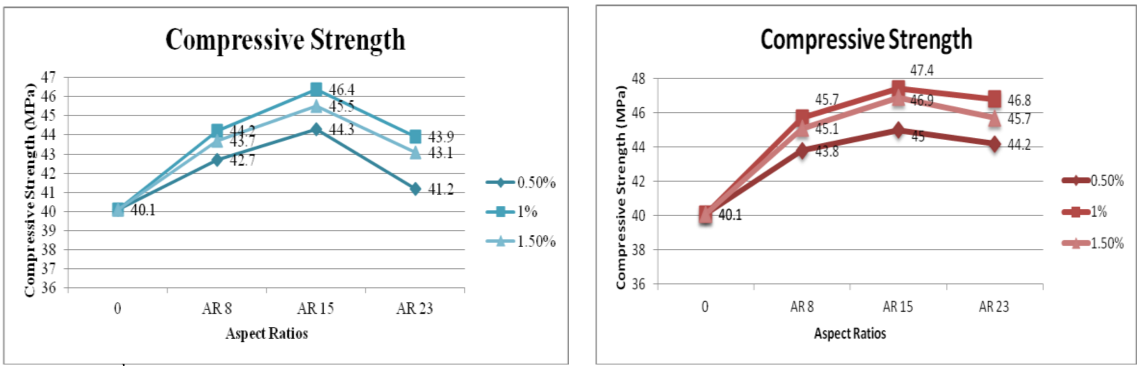

Fig.5. 28 th day compressive strength result of cube specimens with Straight and Crimped PET fibres for different fibre percentages

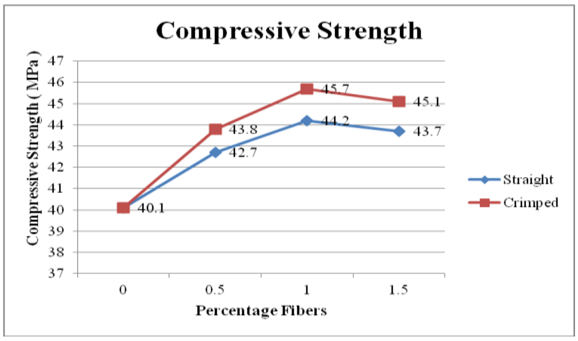

Fig.6. 28 th day compressive strength result of cube specimens with AR-8 Straight and Crimped PET fibres

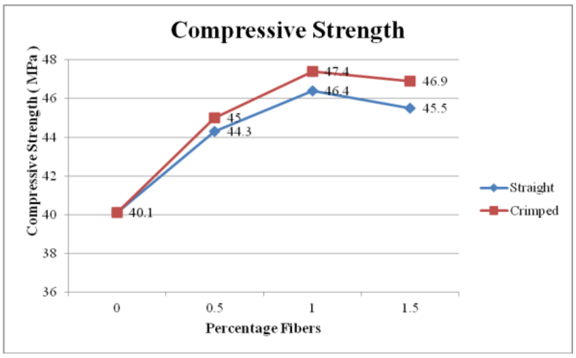

Fig.7. 28 th day compressive strength result of cube specimens with AR-15 Straight and Crimped PET fibres

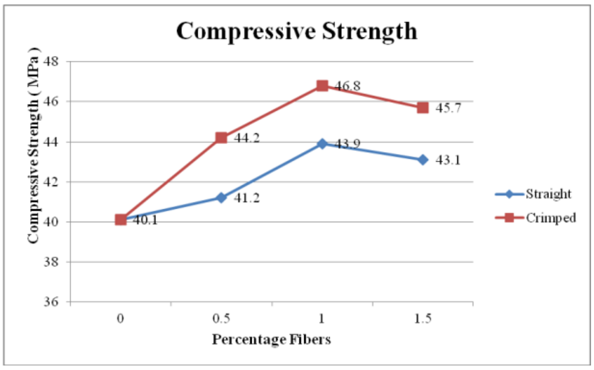

Fig.8. 28 th day compressive strength result of cube specimens with AR-23 Straight and Crimped PET fibres

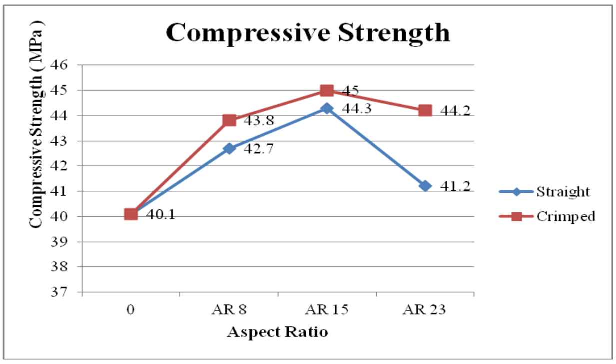

Fig.9.28 th day compressive strength result of cube specimens with 0.5% Straight and Crimped PET fibres

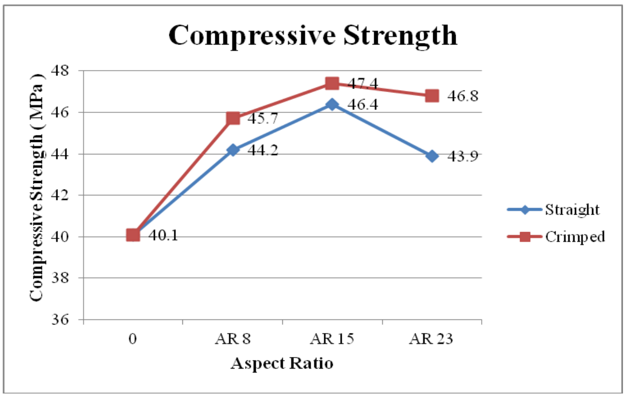

Fig.10. 28 th day compressive strength result of cube specimens with 1% Straight and Crimped PET fibres

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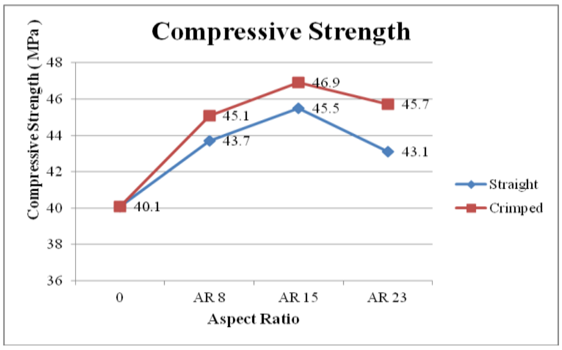

Fig.11. 28 th day compressive strength result of cube specimens with 1.5% Straight and Crimped PET fibres

C. Split Tensile Test

The split tensile strength values for straight and crimped fibres are shown in the following graphs.

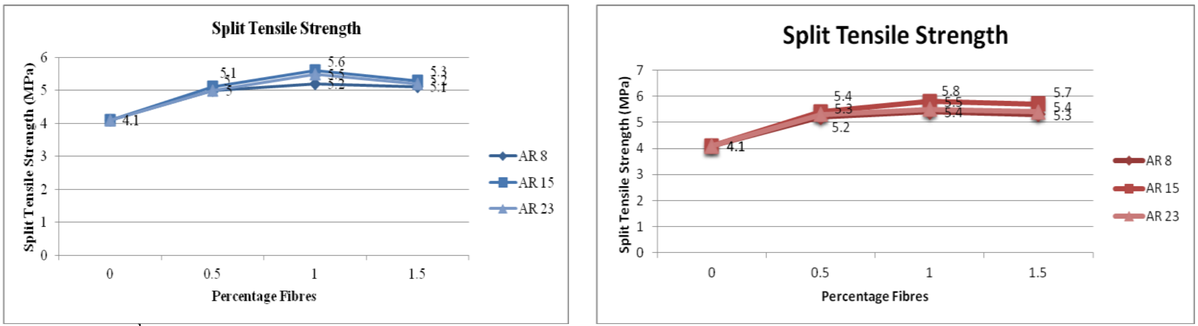

Fig.12. 28 th day Split Tensile strength result of cylinder specimens with Straight and Crimped PET fibres for different aspect ratios

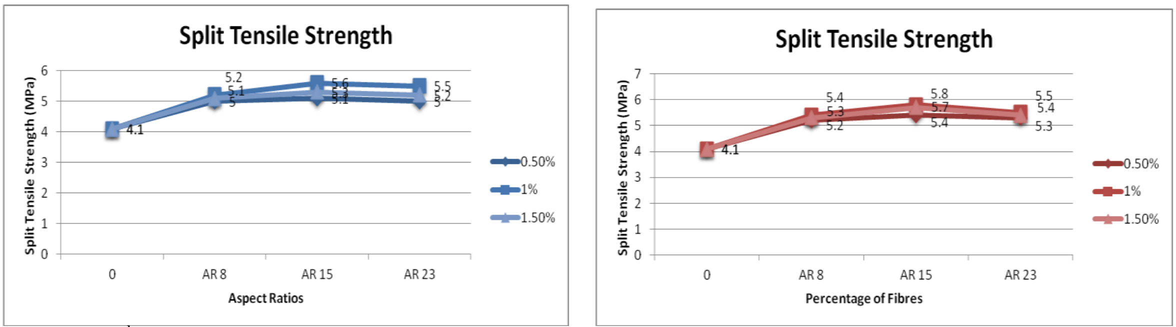

Fig.13. 28 th day Split Tensile strength result of cylinder specimens with Straight and Crimped PET fibres for different fibre percentages

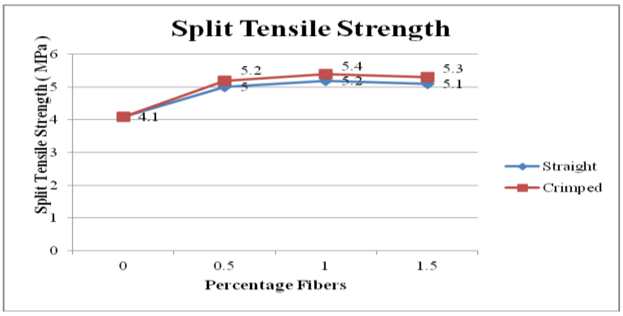

Fig.14.28 th day Split Tensile Strength result of cylinder specimens with AR-8 Straight and Crimped PET Fibres

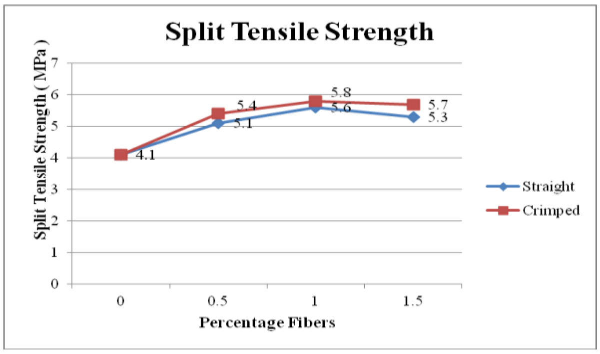

Fig.15.28 th day Split Tensile Strength result of cylinder specimens with AR-15 Straight and Crimped PET Fibres

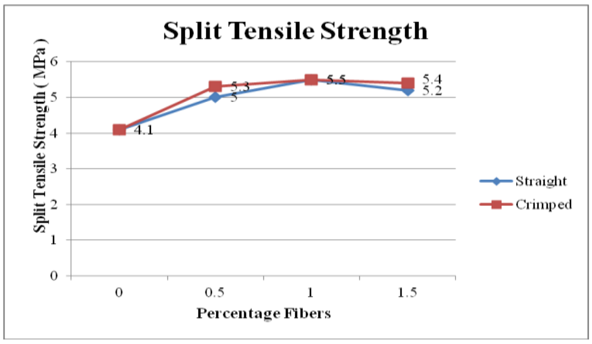

Fig.16.28 th day Split Tensile Strength result of cylinder specimens with AR-23 Straight and Crimped PET Fibres

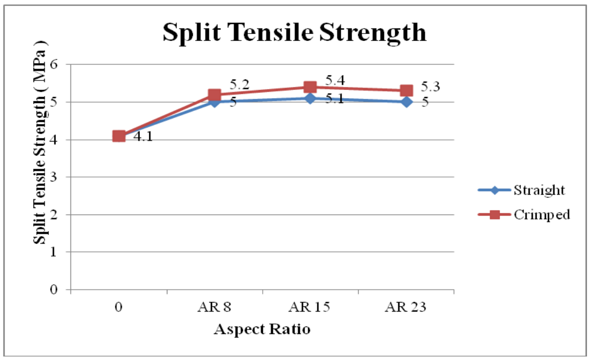

Fig.17.28 th day Split Tensile Strength result of cylinder specimens with 0.5 % Straight and Crimped PET Fibres

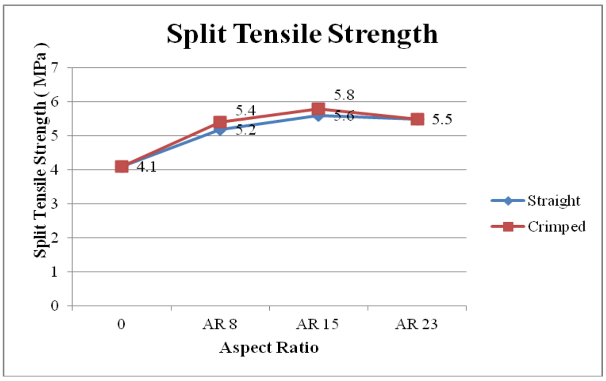

Fig.18. 28 th day Split Tensile Strength result of cylinder specimens with 1 % Straight and Crimped PET Fibres

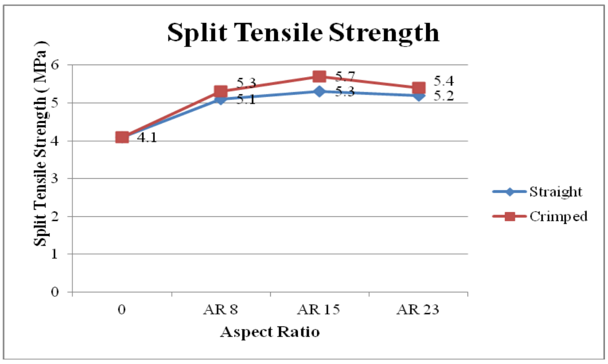

Fig.19. 28 th day Split Tensile Strength result of cylinder specimens with 1.5 % Straight and Crimped PET Fibres

D. Flexural Strength

The flexural strength values for straight and crimped fibres are shown in the following graphs.

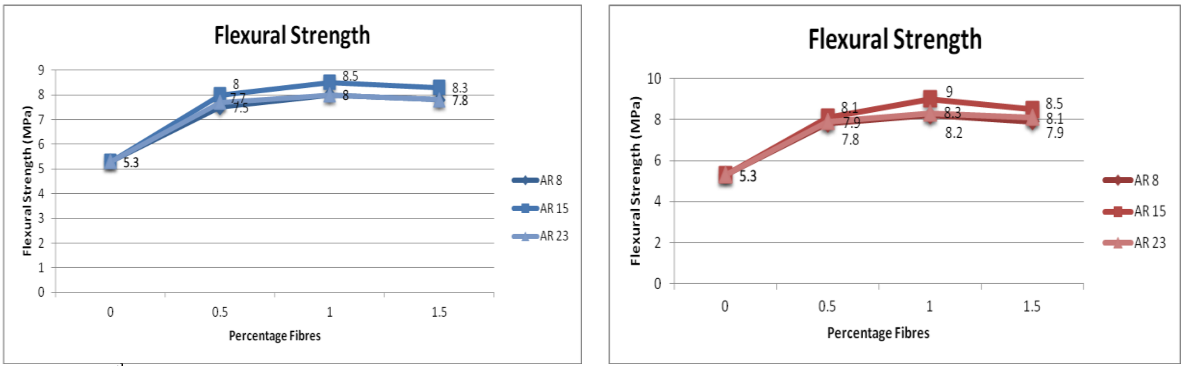

Fig.20. 28 th day Flexural Strength result of beam specimens with Straight PET fibres for different aspect ratios

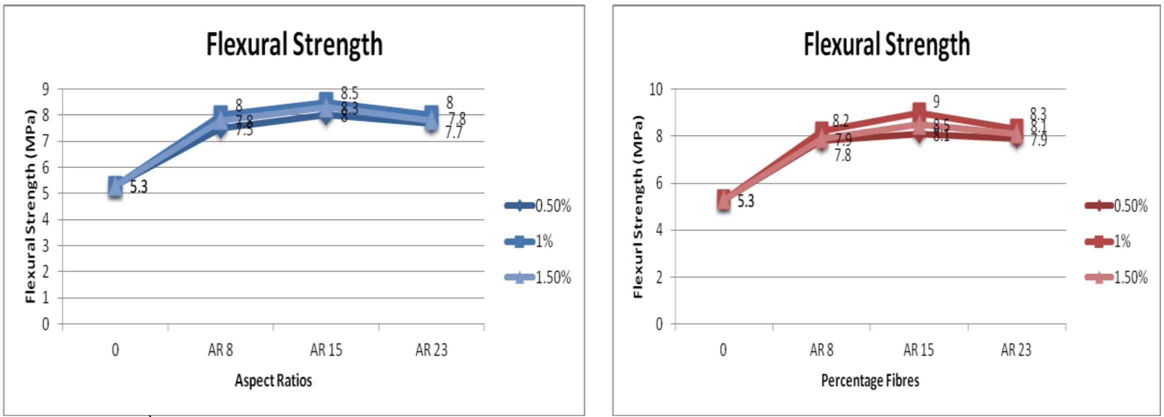

Fig.21. 28 th day Flexural Strength result of beam specimens with Straight PET fibres for different fibre percentages

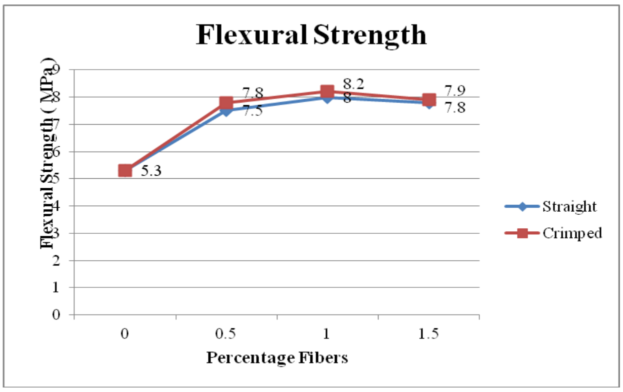

Fig.22. 28 th day Flexural Strength result of beam specimens with AR-8 Straight and Crimped PET Fibres

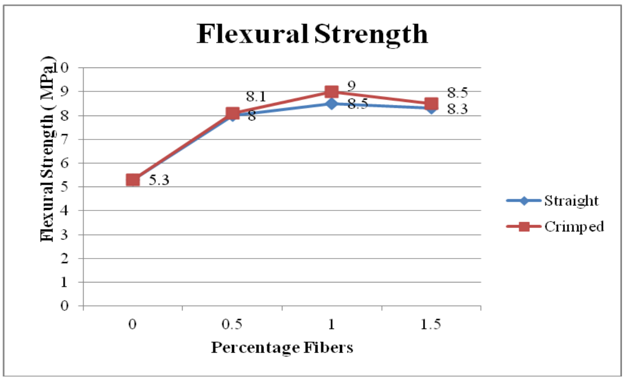

Fig.23. 28 th day Flexural Strength result of beam specimens with AR-15 Straight and Crimped PET Fibres

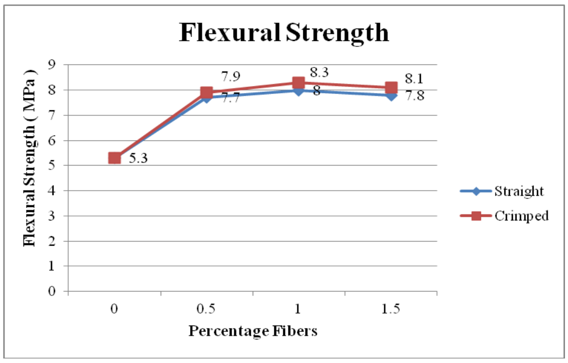

Fig.24. 28 th day Flexural Strength result of beam specimens with AR-23 Straight and Crimped PET Fibres

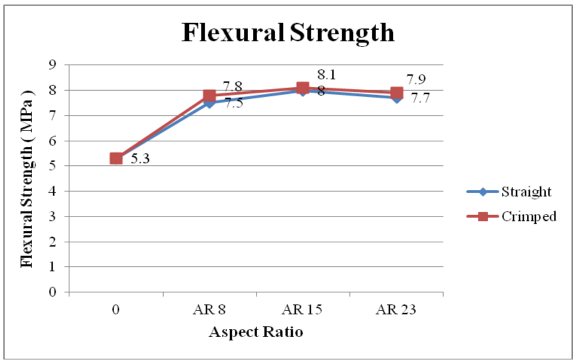

Fig.25. 28 th day Flexural Strength result of beam specimens with 0.5 % Straight and Crimped PET Fibres

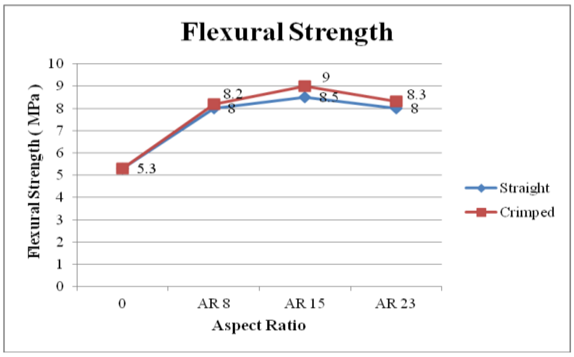

Fig.26. 28 th day Flexural Strength result of beam specimens with 1 % Straight and Crimped PET Fibres

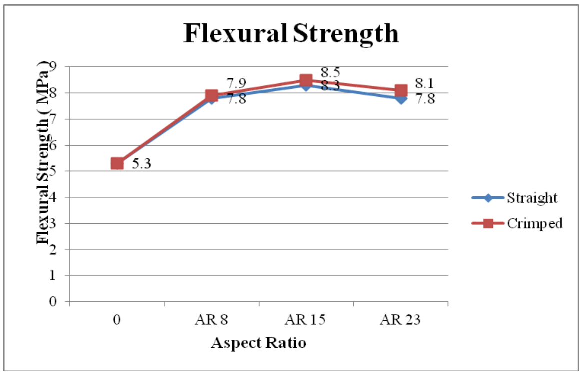

Fig.27. 28 th day Flexural Strength result of beam specimens with 1.5 % Straight and Crimped PET Fibres

VII. Results

The major conclusions based on the results obtained in the experiments are as follows.

- Inclusion of fibres content affects flow properties of concrete.
- The significant improvements in strengths were observed with inclusion of plastic fibres in concrete.
- The optimum strength was observed at 1% of fibre content for all type of strengths there after reductions in strength were observed.
- It can be observed from the test results that development in strength was higher for aspect ratio 15. The fibre geometry, i.e., the mechanical bond strength, affected the tensile strength and flexural strength at relatively low fiber fractions by volume, up to 1 %.
- Therefore, the crimped type fibre, which had superior mechanical bond strength, conferred the best resistance to strength parameters.
- The mode of failure was changed from brittle to ductile failure due to inclusion of plastic fibres into the concrete.
- From this experimental investigation, the PET bottles would appear to be low-cost materials which would help to resolve solid waste problems and preventing environment pollution.

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