

# **Study on Utilization of Straight and Crimped Waste Pet Fibers with Different Aspect Ratios in Cement Concrete**

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**ABSTRACT:** Polyethylene Terephthalate (PET) is usually used for carbonated beverage and water bottles. Plastic is difficult to biodegrade and involves processes either to recycle or reuse. The construction industry is in requiring of finding cost effective materials for increasing the strength of concrete structures. In this paper the fibres from waste plastic bottles were added in different percentages in the M40 grade concrete. The post consumed waste plastic bottles were shredded into fibres of specific size and shape. The plastic fibre dimensions were used corresponding to 30, 50,70 aspect ratio are 60 x 2, 100 x 2, 140 x 2, (length x width). The fine aggregates were replaced by PET fibres with 0.6%, 0.8%, 1.0% and 1.2% by weight. The slump test, compressive, split tensile strength and flexural strength tests were performed on the concrete after 28 days of curing phase. The test results obtained were compared with control specimen and the results were plotted in the form of graph. The compressive strength improved a little with the incorporation of plastic fibre, tensile strength and flexural strength tests gave significant improvement over controlled specimen .optimum dosages of PET fiber volume fractions, such as 1% to attain maximum compressive strength and maximum tensile strength were found for the mix.

**KEYWORDS:** Poly Ethylene Terephthalate Fibres, Biodegrade, Aspect Ratio Effect, waste PET bottles fibers, Concrete.

## **I. INTRODUCTION**

Among the various invented material on the earth, plastic is one of the astonishing invention in the field of materials. The continuous improvement in plastics provide a wide application area like packaging, industrial product transportation, chores, beverage and food packing, garbage collection and like many more. The unexpected revolution in its usage gave a serious threat on the environment and produced an ecology strain which was later identified due to its low biodegradability and a huge waste accumulation of plastics on earth. Concrete is the most widely used construction material due to its high compressive strength, long service life, and low cost etc. However, concrete has inbuilt disadvantages of low tensile strength and crack resistance also. To improve the weaknesses of the material, number of studies on fiber reinforced concrete has been performed. The research result showed that addition of fibers considerably improves the performance of concrete. Over the last two decades, the suitable usage of plastic in concrete and replacement in constituents of concrete is being evaluating which gave a little possibilities of using it in concrete. The depletion in concrete ingredients and increment in waste plastics on earth observed in recent past years is giving a viable alternative for the utilization of plastic.

For evaluating the suitability of plastic in concrete prahallada M.C and Prakash K.B,2013[1] reported plastic fibre 0.5 % by volume with aspect ratio of 50 increases the compressive strength, tensile strength, flexural strength and impact strength of concrete by 11%, 13% 10% and50%. It was also reported that workability increases from 0 to 50aspect ratio, beyond 50 workability decreases. As per this study environment pollutant (plastics) can be possibly used for the production of waste plastic fibre reinforced concrete.

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Vol. 5, Issue 11, November 2016

Nibudey et al., 2013[2] studied the effect of plastic fibre with two distinct aspect ratio (35, 50) on concrete mechanical properties. For plastic fibre aspect ratio 35 compressive strength, split tensile strength and flexural strength of concrete at 1% of fibre content increased with 5.26%, 15.47% and 17.32% and for plastic fibre aspect ratio 50, it improved by 7.35%, 24.91% and 24.105% over control concrete. The aspect ratio 50 significantly improved the concrete strength. At 50 aspect ratio of plastic fibres, concrete properties improved as compare to direct inclusion of plastic fibre in shredded form [6,7, 8,9,10].

This paper presents a detailed study on concrete fresh and mechanical properties with distinct plastic fibre aspect ratio (30, 50, 70) with 0.6%, 0.8%, 1.0% and 1.2% by weight replacement.

## II. EXPERIMENTAL WORK

Before casting the concrete specimens as per design mix, the detailed laboratory tests have been done to meet the codal requirements. The concrete ingredients (cement, fine aggregate, coarse aggregate) evaluated as per IS specifications. The properties of concrete constituents are explained below.

### (A) CEMENT

The cement used in all mixtures of the study was 53 grade Ordinary Portland cement, which conforming to IS 12269:2013. The physical and mechanical properties of the cement used are listed in Table 1. All the results meet the requirements of IS 12269:2013 specifications.

Table(1) Physical and mechanical properties of the cement used in the Study

Test	Results	Related Standards
Fineness	1%	IS 4031
Standard consistency	36%	IS 4031
Initial setting time	80 min	IS 4031
Final setting time	250 min	IS 4031

The cement was in dry state with fine grey powder form. The cement was used from a single lot throughout the course of the investigation. It was fresh and without any lumps.

### (B) FINE AGGREGATES

The sand used for experimental work was locally procured and confirmed to grading zone III. Sieve analysis of fine aggregate was carried out in the laboratory as per IS 383-1970. The results of physical properties of sand are shown in Table 2. The tests was carried out to find out the physical properties of fine aggregates and tabulated in Table 2.

Table(2) Physical Properties of Fine aggregate

Characteristics	Value
Specific Gravity	2.580
Bulk Density (kg/m <sup>3</sup> )	1.402
Fineness Modulus	2.340
Water absorption %	0.870

### (C) COARSE AGGREGATES

Coarse aggregate 20mm sizes were used for the experimental study. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The tests was carried out to find out the physical properties of fine aggregates and tabulated in Table 3.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

Table(3) Physical Properties of Coarse Aggregates

Characteristics	Value
Color	Grey
Maximum Size	20 mm
Specific Gravity	2.74
Fineness Modulus	6.86

### (D) PET FIBERS

The waste plastic bottles were collected and washed then extruded with cutting tool. The bottle top and bottom part removed first then fibers were obtained into required aspect ratio. The aspect ratio of 30, 50, 70 were prepared for the concrete mix.

### (E) SUPER PLASTICIZER :

Coplast SP 430 (G) was used in the present study. It conforms to IS 9103.

### (F) WATER

Keeping in view the IS 456 provisions, the water supplied to the concrete laboratory of the university was made use for the concrete mixes as well as for curing purposes. The tap water was free from impurities, oil, grease etc.

### (G) MIXING

Mixing was done using a concrete machine mixer. The raw materials were combined and mixed to an even colour prior to adding water. Water was then slowly added with the continuous turning of the mix until slurry having required workability is obtained. It is important that slurry is used within an hour of mixing and should not re-temper by the addition of water. With regards to the curing of specimen, the specimens remained in curing tank for 28 days.

### (H) CASTING

The grade of M40 concrete designed with 1: 1.981: 3.954 ratio and the W/C ratio was 0.4. The fine aggregates replaced by the plastic fibres with the amount of 0.6%, 0.8%, 1.0% and 1.2% by weight. The required amount of water was added in the mix and cube filled by the mix and vibrated on the vibrating table. 150 x 150 x 150mm sizes of cubes, 150x 300mm sizes of cylinders, 500x 100x 100mm sizes of beams were casted for evaluating the mechanical properties of concrete.

## III. RESULT & DISCUSSION

The effects of PET fibre on the strength of concrete were evaluated after 7, 14 and 28 days. The effects of PET fibre on fresh property and mechanical property are described below.

### (A) WORKABILITY

The workability of fresh concrete was measured in terms of slump. Workability has a broad range from very low (at slump 0 to 25 mm) applied for vibrated concrete in roads or other large sections, to high workability (slump 100 to 180 mm). It can be observed from the values of slump that the workability decreases with the increase in percentage of fibre for both straight and crimped PET fibres. For 0% fibres the maximum slump obtained for M40 grade of concrete was observed to be 120 mm. It was also noted that there is decrease in the slump value as the length of the fibre increases.

### (B) COMPRESSIVE STRENGTH

Compression test is the most 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. For the experiment, cube size of 15 x 15 x 15 cm was adopted. After 28th days of curing, the specimens were taken out and allow it for dry. Then the specimens were subjected to compression on compression testing machine. The compressive test results of the cube specimen with Straight and Crimped fibres are as follows:

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

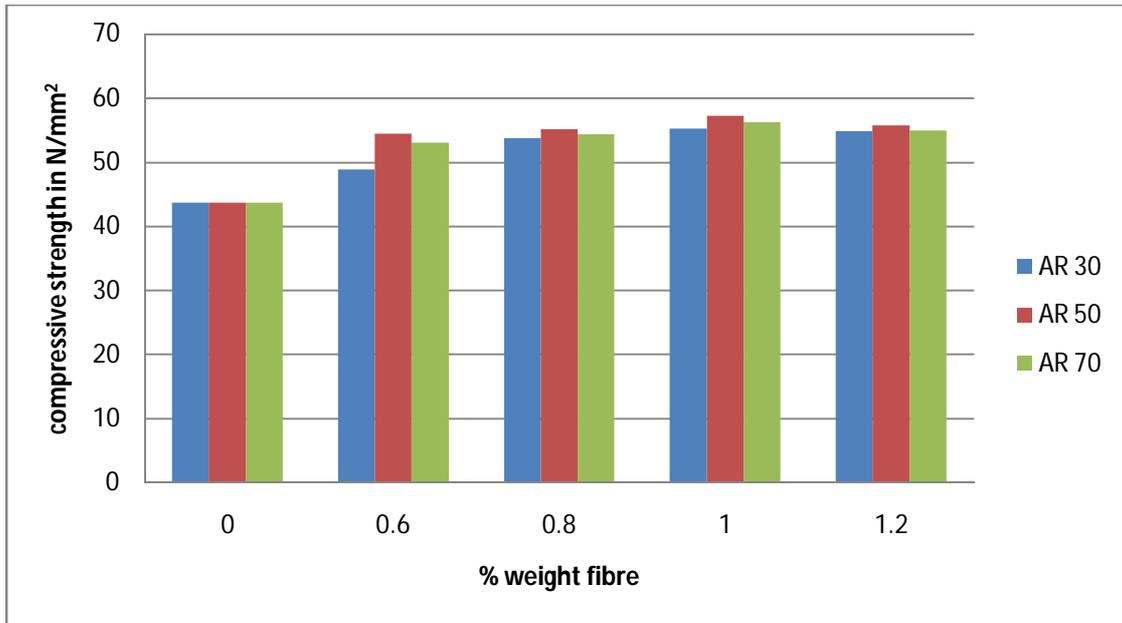


Fig.(1) Variation of Compressive strength with %age weight fiber for different aspect ratios in straight fibers

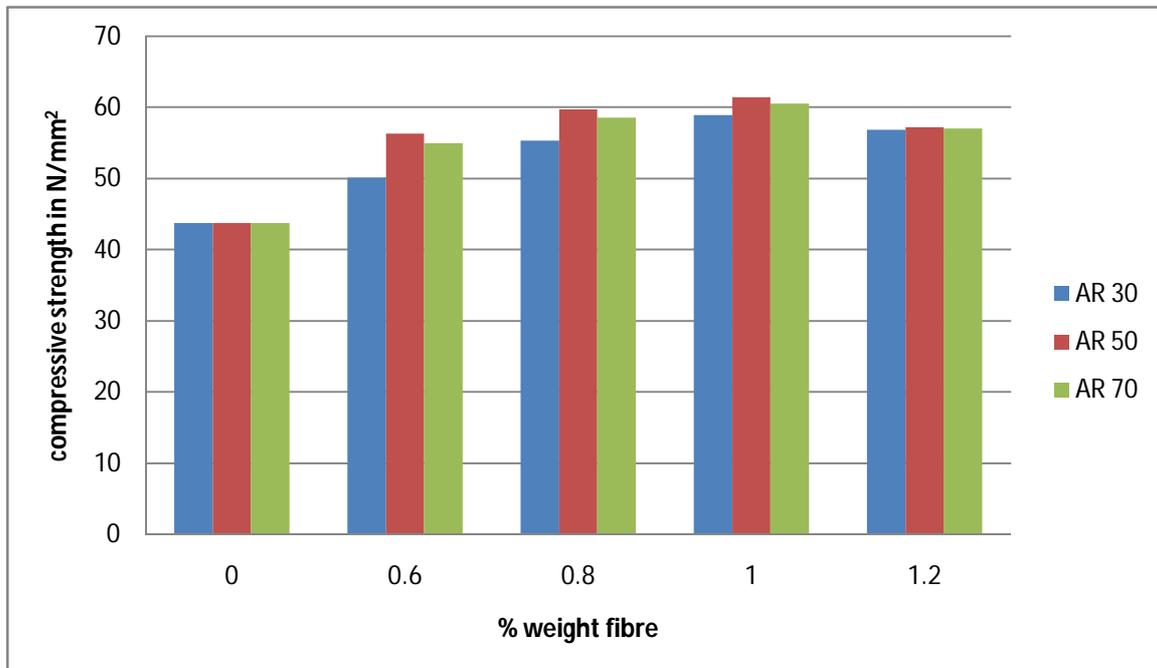


Fig.(2) Variation of Compressive strength with %age weight fiber for different aspect ratios in Crimped fibers

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

### ( C )SPLIT TENSILE STRENGTH

The splitting test is well known indirect tests used for determining the tensile strength. The test consists of applying compressive line loads along the opposite generators of a cylinder specimen placed with its axis horizontal between the platens. The tensile test subjects the specimen to a uniaxial tension until it fails. The compression testing machine was used for the splitting tensile test. The main advantage of this method is that the same type of specimen and the same testing machine as are used for the compression test can be employed for this test.

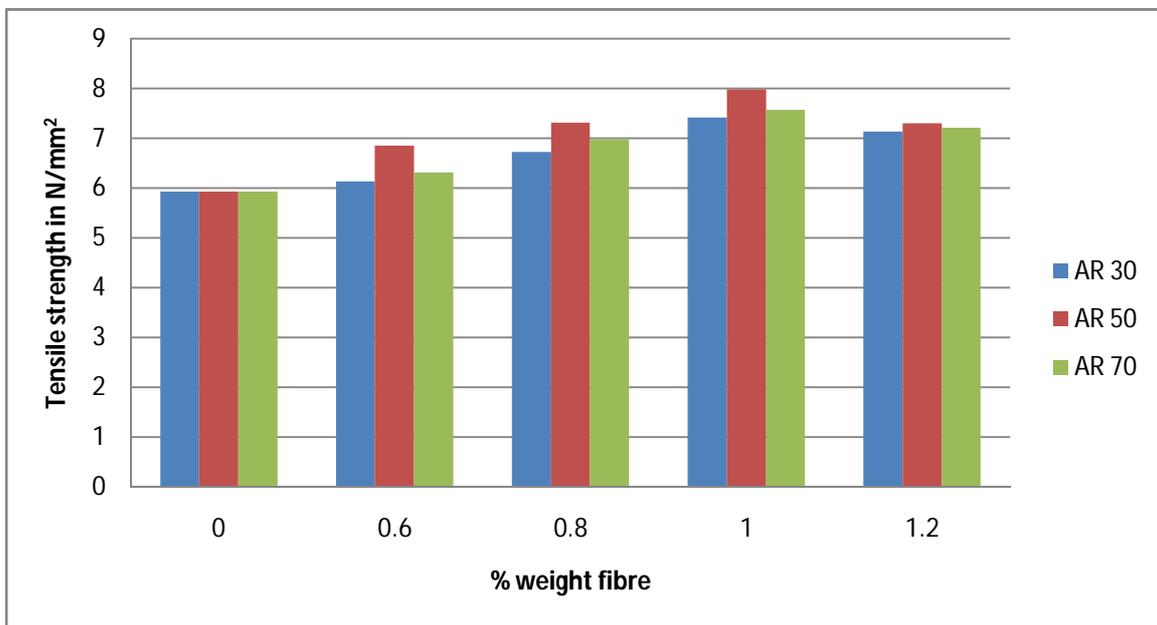


Fig.(3)Variation of split tensile strength with %age weight fiber for different aspect ratios in straight fibers

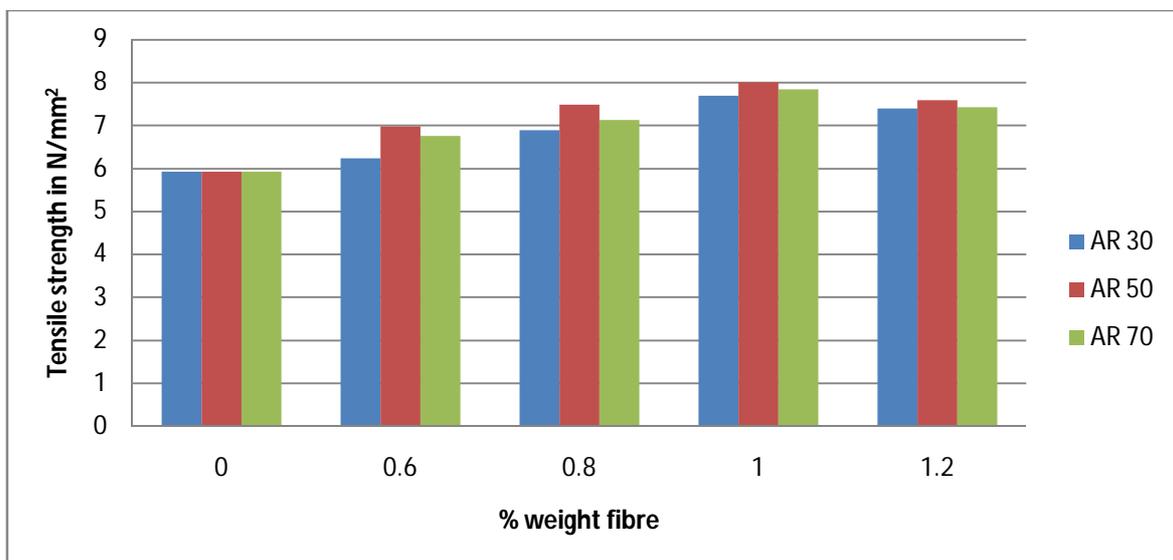


Fig.(4)Variation of split tensile strength with %age weight fiber for different aspect ratios in crimped fibers

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 11, November 2016

### (D) FLEXURAL STRENGTH

The flexural tensile strength test is performed to estimate the tensile load, at which the concrete cracks. This is an indirect test for assessing the tensile strength at failure or modulus of rupture. The test was carried out on beam having 10 x 10 x 50 cm size and the load was applied continuously until it fails. The flexure strength test results of the specimens with Straight and Crimped fibres were noted and graphs were prepared as follows.

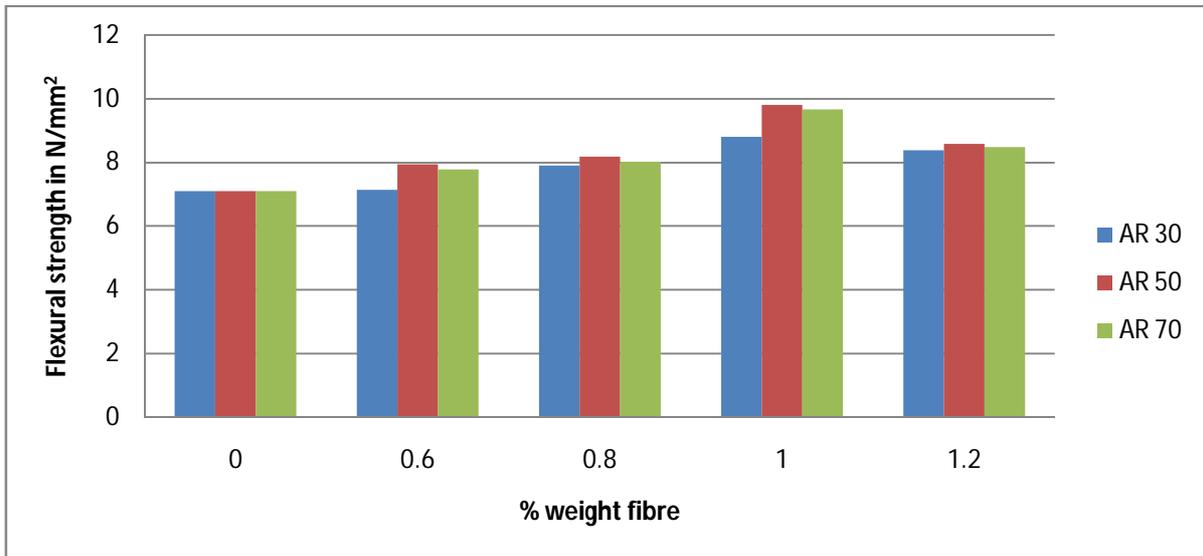


Fig.(5) Variation of Flexural strength with %age weight fiber for different aspect ratios in straight fibers

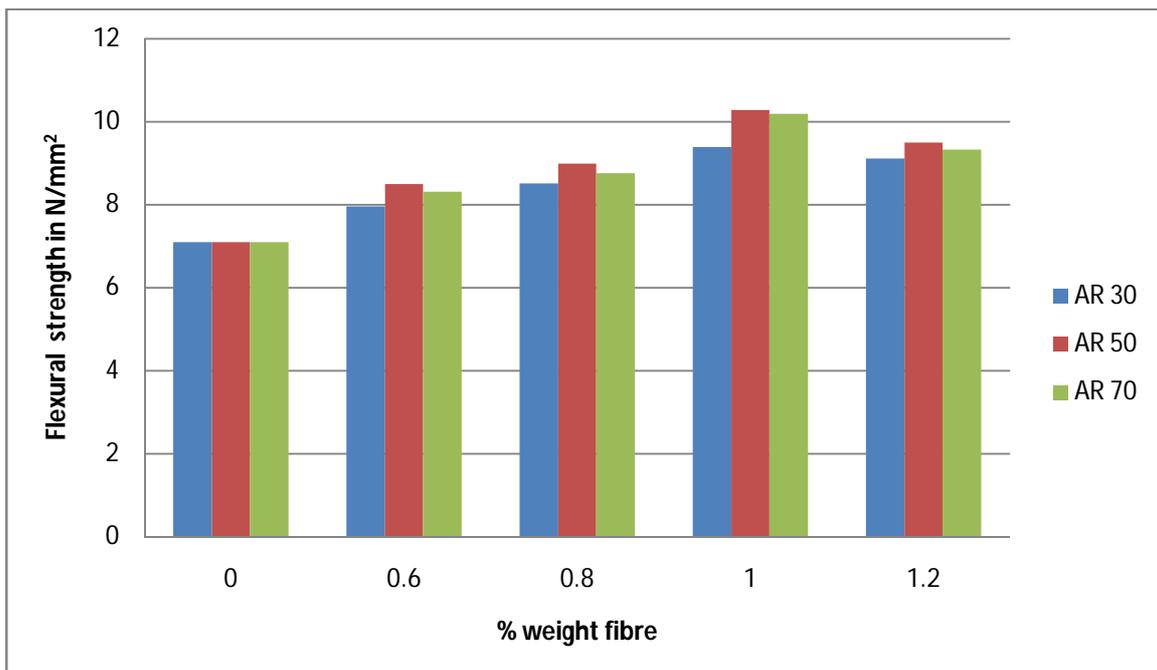


Fig (6) Variation of Flexural strength with %age weight fiber for different aspect ratios in crimped fibers

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## IV. CONCLUSION

1. 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 be due to the resistance offered by the fibres against the movement of aggregates.
2. The major improvements in strengths were observed with addition of plastic fibres in concrete. The optimum strength was obtained at 1% of fibre content for all type of strengths there after declinations in strength were observed.
3. 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.
4. It can be Identified from test results that development in all types of strength was higher for aspect ratio 50.
5. The plastic fibre act as a crack arrester for the concrete during the loading. it helps to delay the propagation of crack.
6. The maximum compressive strength obtained with 1% plastic fibre at 50 aspect ratio. The maximum percentage increase is 31.12% in case of straight fibre and 40.36% in case of crimped fibres.
7. 1% of plastic fibre reinforced concrete with aspect ratio 50 gives the maximum value of split tensile strength. Maximum %age increase in case of straight fibres is 34.79% and in case of crimped fibre is 35.30%.
8. The maximum flexural strength obtained with 1% plastic fibre at 50 aspect ratio. The maximum percentage increase is 38.22% in case of straight fibre and 44.99% in case of crimped fibres.

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