International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 09 | September - 2022 Impact Factor: 7.185 ISSN: 2582-3930

IMPROVE IN CONCRETE PROPERTIES BY PET FIBRES- A CASE STUDY

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ABSTRACT : Plastics plays an important part in our modern lifestyle, and the global plastic production has increased immensely which contributed greatly to the production of plastic-related waste.This paper summarizes the benefits of using straight fibres from waste polyethylene Terephthalate (PET) bottles .The percentage of fibres added to M30 mix concrete were 0%, 0.6%, 0.8% , 1.0% & 1.2% for three aspect ratios 30,50 and 70.The strength parameters like Compressive, Split tensile ,Flexure tests and Impact tests are studied for 7 das & 28 days.The results of the tests are compared with conventional concrete without any fibre .

Concrete literally plays an vital role in infrastructure due to its workability,durability and strength. However concrete is weak in tension, brittlesnes ,resistance to cracking, impact strength and heavy weight.To improve these weakness of concrete different types of fibres are introduced in concrete and so formed concrete is termed as fibre reinforced concrete. Fiber reinforced concrete is concrete containing fibrous substance which increases its structural integrity.

Disposal of plastic waste has emerged as an important environmental challenge and its recycling is facing roadblocks due to its nondegradable nature. Bottles made of polyethylene terephthalate (PET) can be recycled to reduce the amount of waste going into landfills.PET bottles in fibre forms can be used to get mechanical properties of concrete.

The study was carried out by using PET fibers in aspect ratios 30 (60 mm X 2 mm), 50 (100 mm X 2 mm) and 70 (140 mm X 2 mm) and incorporating them as weight of cement at different intervals 0f 0.6%, 0.8%, 1.0% and 1.2%.

KEYWORDS: Polyethylene Terephthalate (PET) , Compressive Strength , Tensile Strength

1. INTRODUCTION

1.1 GENERAL

2. In this chapter, the properties of PET concrete substances such as fine aggregates, course aggregates, cement, along with other substances like PET fiber are studied with various tests. The properties of PET fiber concrete of different ratios compared with normal concrete. The PET fibres is used in straight and crimped form in aspect ratios 30 , 50 and 70 ,and incorporating them as weight of cement at different intervals 0f 0.6%, 0.8%, 1.0% and 1.2% are used. The number of cubes and cylinders casted respectively for each test and different tests like compaction factor test, compressive strength test, tensile strength test and flexural strength test performed after 7days and 28 days of curing. The fresh and hardened properties of concrete were evaluated by the following tests.

2.1 Plastics

Any substance which possess plasticity, skilled of being re-moulded whenever heat is practical to it, made by polymerization and anything with the aim to be created in softer phase and utilized in solid form is termed as plastics.

Plastics can be broadly be categorize into two categories as

A) Thermosetting, and

B) Thermoplastics.

The former have recyclable characters and are generally recycled in industry. Polythene and polyethylene cover this category. The latter are having the capability of resisting the melting by application of heat. Phenol, epoxy resins and melamine come under this category of plastics.

PET fiber of size 60mm*2mm

1.3 Plastic waste disposal

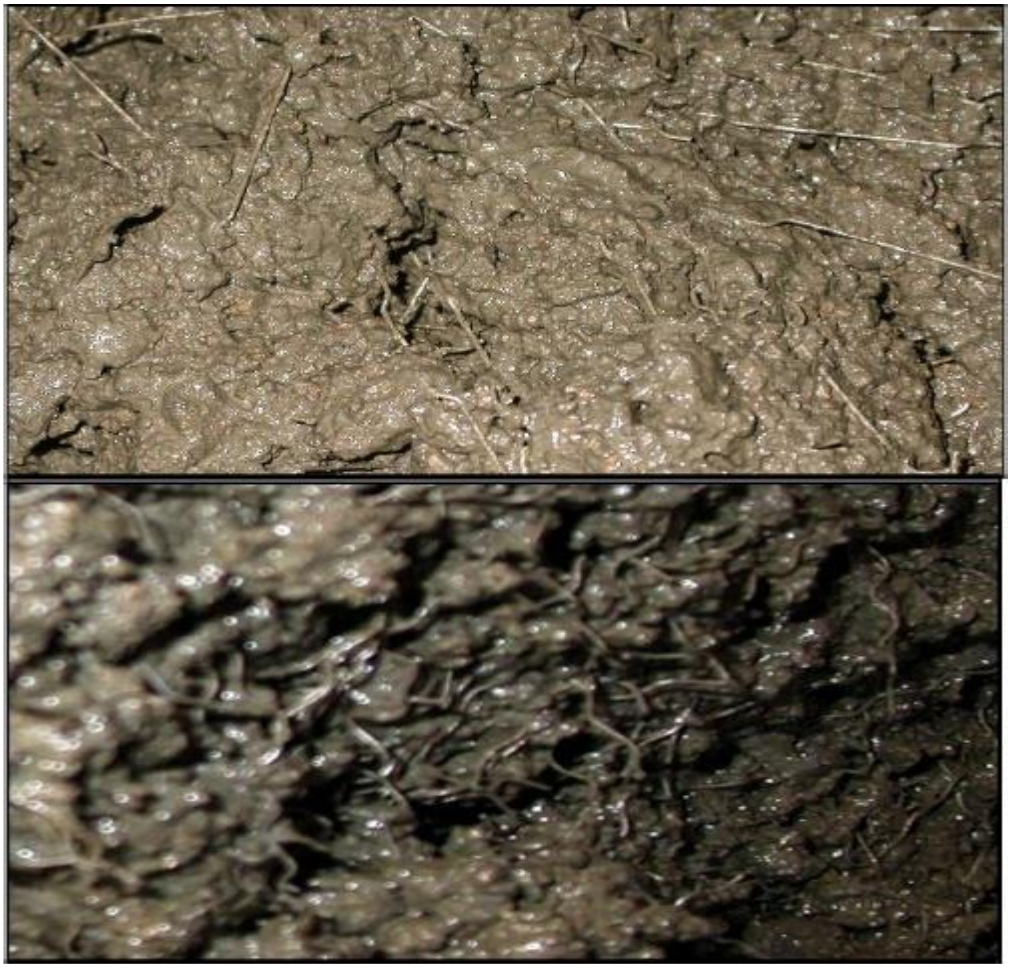
There are many severe issues associated with plastics and their disposal. The major reason for this is the non – biodegradable character associated with them. Almost all types of plastics like bottles and even toys are thrown in landfill and it remains here for centuries as it cannot be decomposed. More the wastage more will be the space required and it will cost some huge sum of money. In spite of being non-biodegradable, there are some good features in it which can help it to be incorporated in concrete

Some of these features which make it to be used in concrete are

- Flexibility
- Tightness or weightiness
- Hardness
- Good resisting capability to chemicals
- Economical or cost effective solution

Tests for fresh properties

i. Compaction factor test



FRC using PET fibre

Test for hardened properties

i. Compressive strength test

ii. Tensile strength test

iii. Flexural strength test

Workability

The workability of the concrete mixes was tested using compaction factor apparatus. Workability value for Controlled mix is 0.873 .

Compaction factor Test for Workability.

Compressive strength

This test used to determine the compressive strength of concrete. The cubes of size 150mm x 150mm x 150mm and compressive testing machine as shown in figure 4.8 used for this test. After removal of cubes from curing tank are cleaned and dried properly. The cubes are placed between the plates of compressive testing machine and load is applied at constant rate. The compressive strength of three specimen for each mix are determined after 7 days and 28 days in order to compare the strength of different concrete mixes.

$$\text{Compressive strength} = \frac{Average\ Load}{Crosssectional\ Area}$$

The maximum compressive strength was noted at 1% fiber ratio in all aspect ratios. The results shows that maximum compressive strength of PET fiber concrete was noted with 1% fiber in concrete at AR50 for both strength and crimped.

Compressive strength test

Split Tensile strength

Cylindrical specimens of concrete with diameter 150 mm and height 300 mm were casted.After removal of cylinders from curing tank are cleaned and dried properly. The cylinders are placed between the plates of compressive testing machine and point load is applied at constant rate of stress. These were then checked for tensile strength in compression testing machine as per IS 516-1959 and IS 5816-1970.

The split tensile strength was checked using the formula; $\sigma_{st}=\frac{2P}{\pi DL}$

Where: σ_{st} stands for split tensile strength in N/mm^2.

The results shows that maximum split tensile strength of PET fiber concrete was noted with 1% fiber in concrete at AR50 for both strength and crimped. Moreover, the split tensile strength of crimped PET fiber concrete is higher than the straight PET fiber concrete.

Split Tensile strength test

Flexural strength

Beam specimens of dimensions 500 mm X 100 mm X 100 mm of concrete were casted using modules available and then allowed to cure for 7 and 28 days after demoulding. These were then tested in flexural testing machine as per IS 516-1959.

The flexural strength was calculated using the formula; fs= $\frac{PL}{BD2}$ (If a is greater than 13.3 cms)

The flexural strength was calculated using the formula;fs= $\frac{3PL}{BD2}$ (If a is less than 13.3 but greater than 11 cms)

Moreover, it also clearly shows that crimped fibres concrete with addition of 1% fiber by weight at AR50 gives best results among all the mixes .

Flexural strength test

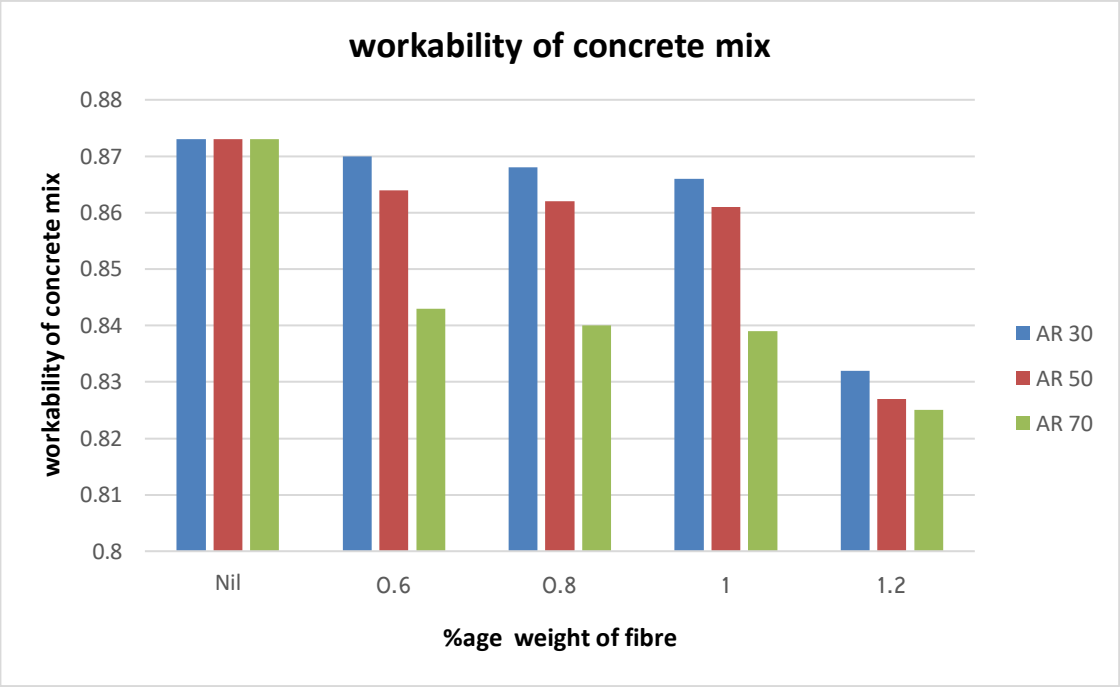
Workability

Table shows the results of workability of concrete mix. The workability of concrete mix decreaseby 0.34%, 0.54%, 0.80% and 4.92% with the addition of PET fibresof 0.6%, 0.8%, 1%, 1.2% respectively for aspect ratio 30 as comparison to controlled mix and workability decreases 1.04%, 1.27%, 1.39% and 5.56% with the addition of PET fibresof 0.6%, 0.8%, 1%, 1.2% respectively for aspect ratio 50 as comparison to controlled mix.

Impact of PET fibres on workability of concrete mix

%age of PET Fiber	workability of concrete mix		
	AR 30	AR 50	AR 70
Nil	0.873	0.873	0.873

0.6	0.870	0.864	0.843
0.8	0.868	0.862	0.840
1.0	0.866	0.861	0.839
1.2	0.832	0.827	0.825



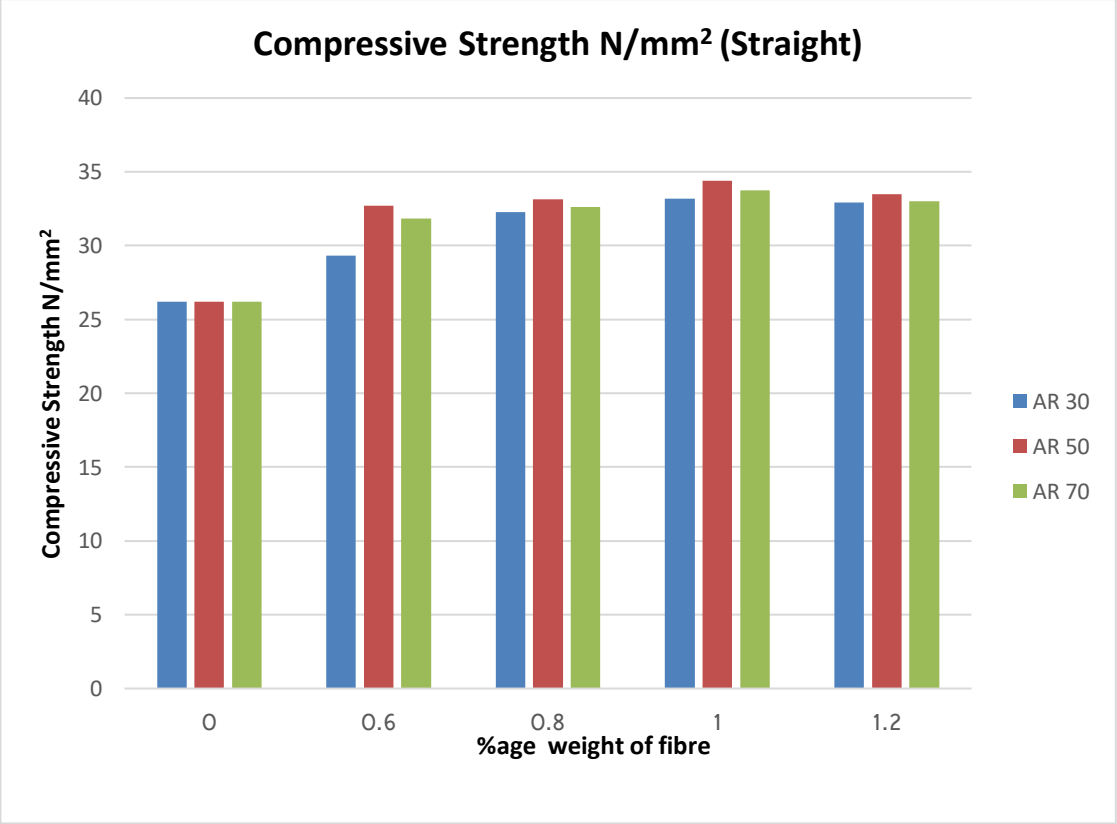
Variation of compaction factor with PET fibres

Compressive strength:

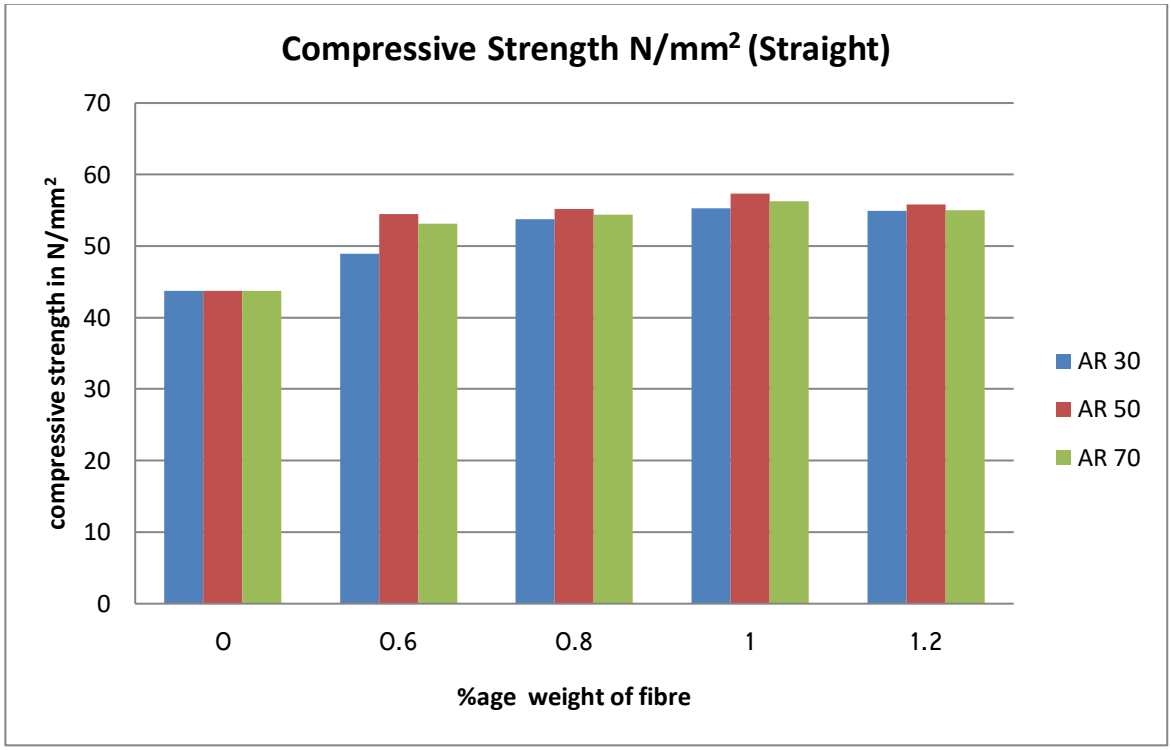
The effects of PET fibres used in straight and crimped form in aspect ratios 30 (60 mm X 2 mm), 50 (100 mm X 2 mm) and 70 (140 mm X 2 mm) and incorporating them as weight of cement at different intervals of 0.6%, 0.8%, 1.0% and 1.2% were carried out in form of compressive strength . Tabulated results of 7 days & 28 days .

%age of PET Fiber	Compressive Strength N/mm^2

	AR 30	AR 50	AR 70
0	26.22	26.22	26.22
0.6	29.34	32.70	31.86
0.8	32.28	33.12	32.60
1.0	33.18	34.38	33.75
1.2	32.94	33.48	33.02



Impact of PET fibres (straight) on compressive strength of concrete after 7 days

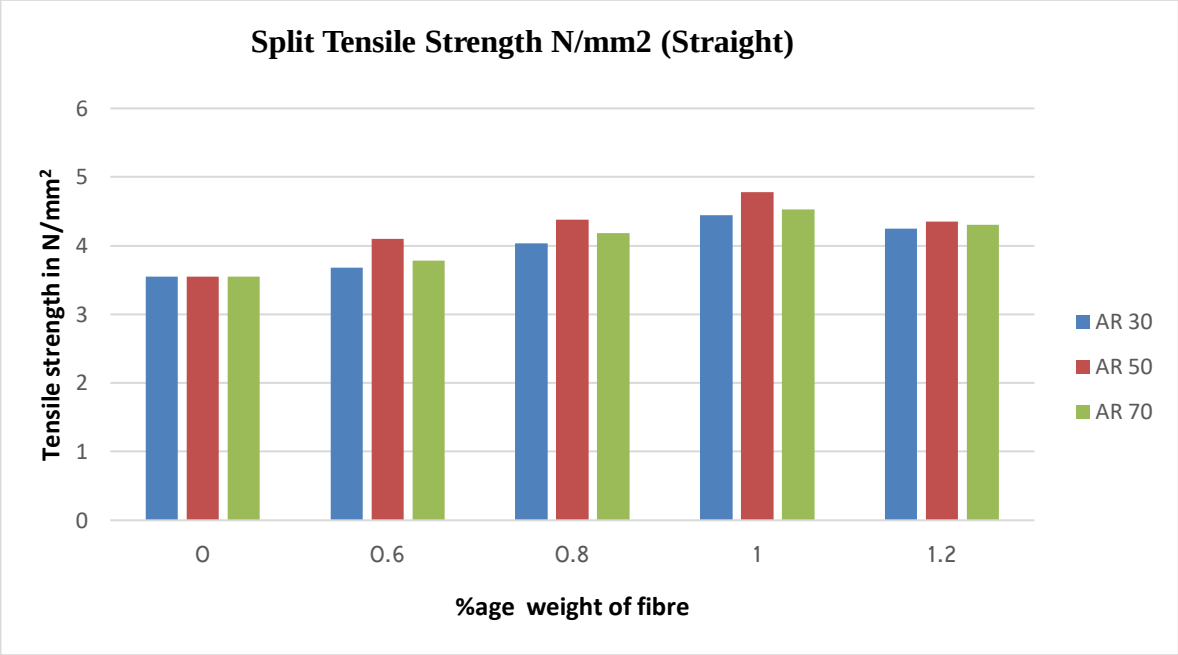


Impact of PET fibres (straight) on compressive strength of concrete after 28 days

Split Tensile strength :

Split tensile strength of the specimens was tested after 7 and 28 days of curing and was tested in compression testing machine. The strength values are tabulated below

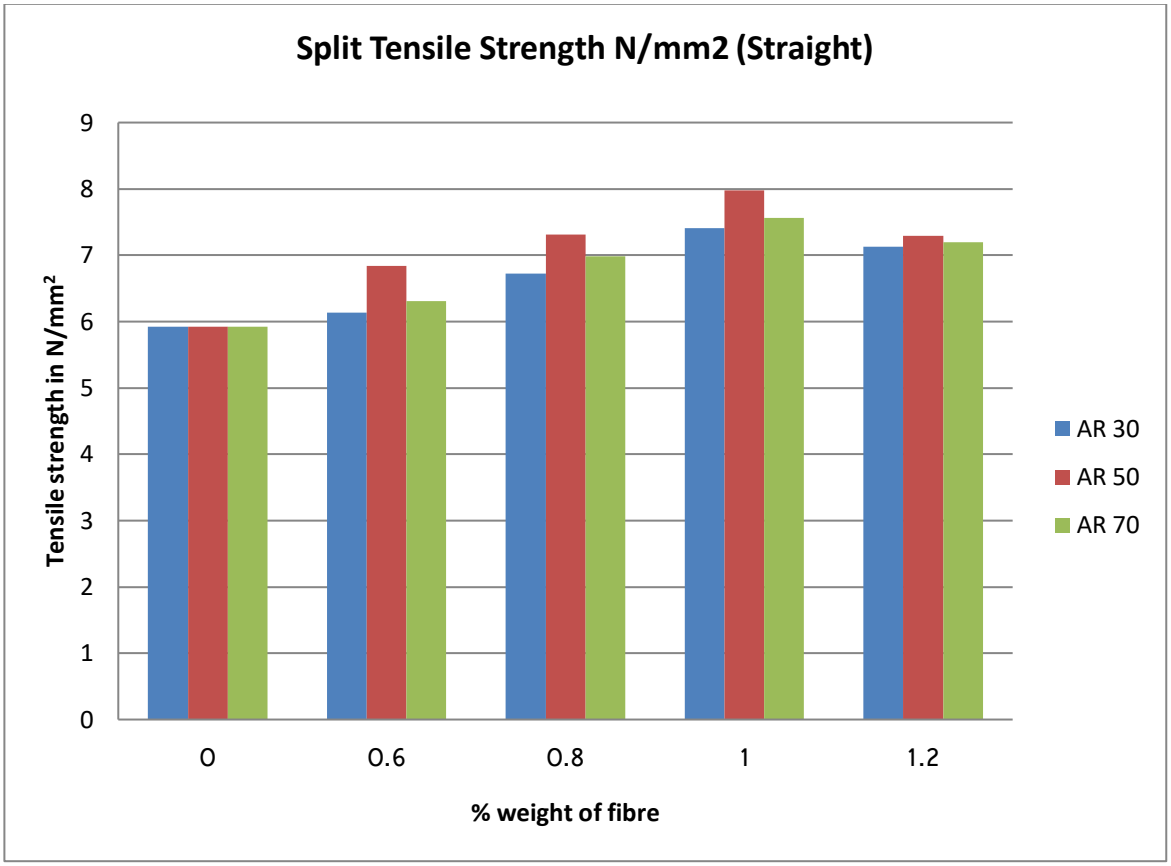
% of PET Fiber	Split Tensile Strength N/mm²		
	AR 30	AR 50	AR 70
0	3.55	3.55	3.55
0.6	3.68	4.10	3.78
0.8	4.03	4.38	4.18
1	4.44	4.78	4.53
1.2	4.25	4.35	4.30



Impact of PET fibres (straight) on split tensile strength after 7 days

Impact of PET fibres (straight) on split tensile strength after 28 days

%age of PET Fiber	Split Tensile Strength N/mm²		
	AR 30	AR 50	AR 70
0	5.92	5.92	5.92
0.6	6.13	6.84	6.31
0.8	6.72	7.31	6.98
1	7.41	7.98	7.56
1.2	7.13	7.29	7.2



Impact of PET fibres (straight) on split tensile strength after 28 days

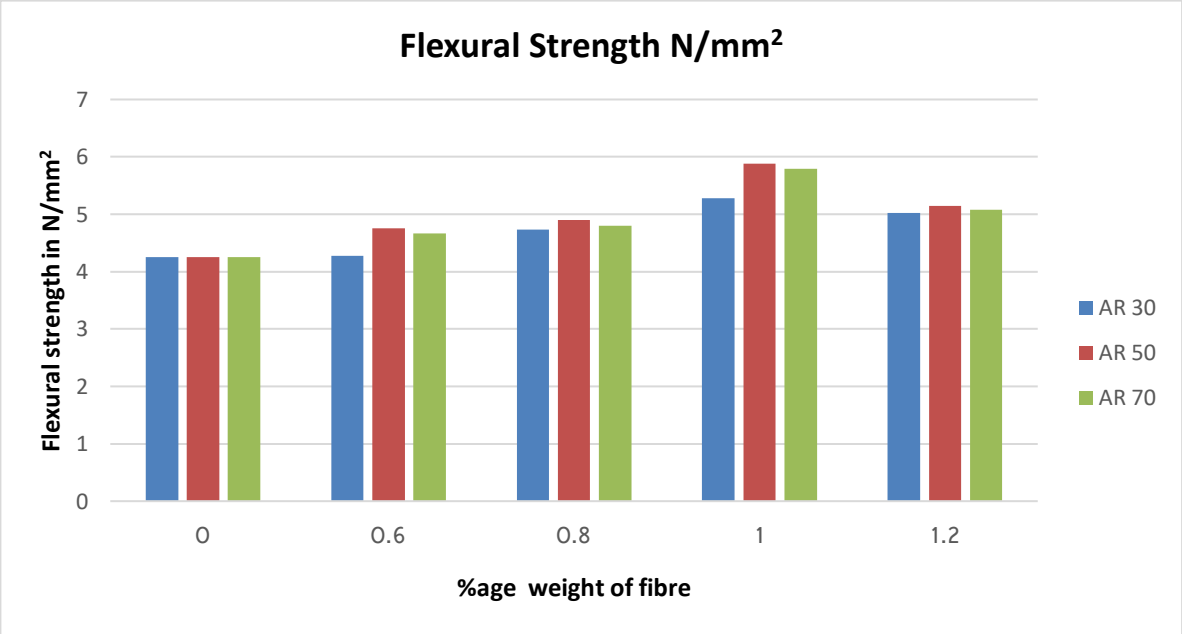
Flexural strength :

The flexural strength of specimens was tested in flexural testing machine after 7 days and 28 days of curing. The strength values are tabulated below

Table 4.10 Impact of PET fibres (straight) on flexural strength after7 days

% of PET Fiber	Flexural Strength N/mm²		
	AR 30	AR 50	AR 70
0	4.25	4.25	4.25
0.6	4.27	4.76	4.66

0.8	4.73	4.90	4.80
1	5.28	5.88	5.79
1.2	5.02	5.14	5.08



Impact of PET fibres (straight) on flexural strength after 7 days

Impact of PET fibres (straight) on flexural strength after 28 days

%age of PET Fiber	Flexural Strength N/mm²		
	AR 30	AR 50	AR 70
0	7.09	7.09	7.09
0.6	7.13	7.94	7.78

0.8	7.89	8.18	8.01
1	8.8	9.8	9.65
1.2	8.38	8.58	8.47

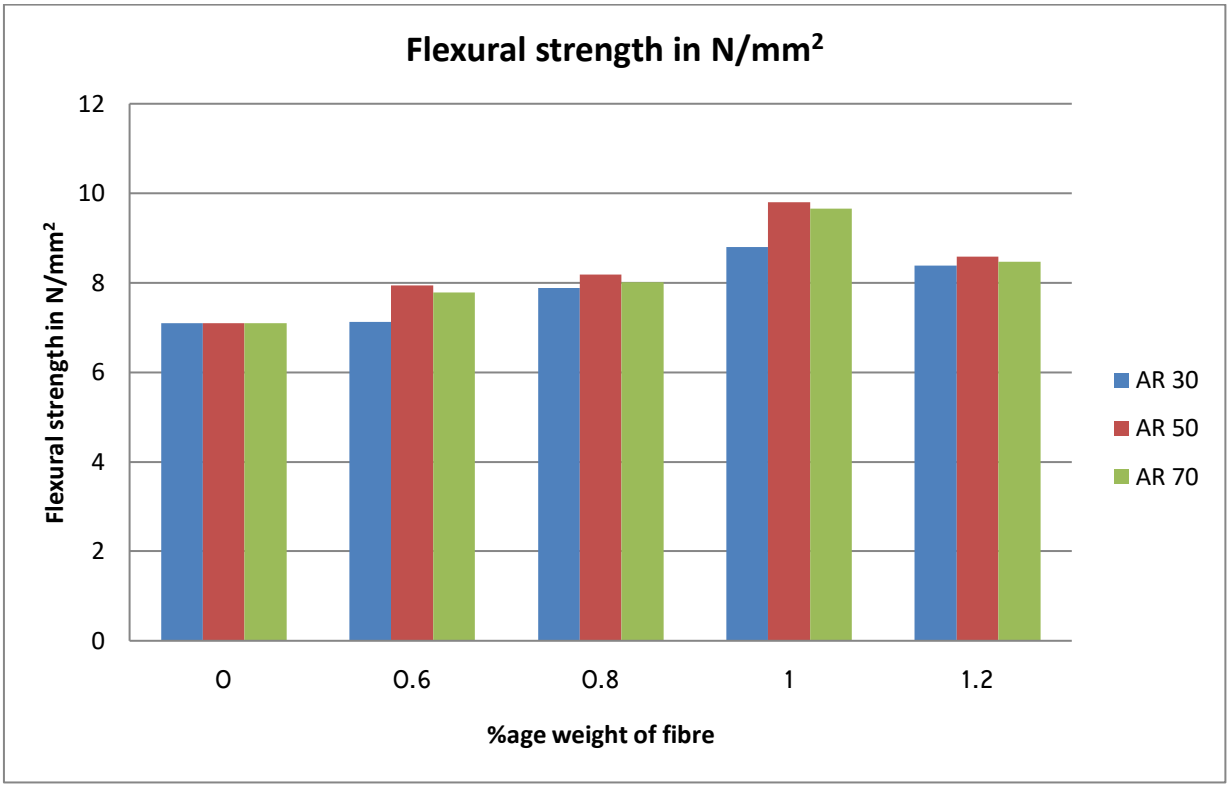


Figure 4.11 Impact of PET fibre (straight) on flexural strength after28 days

Conclusion :

Based on the entire study conducted on Straight and Crimped PET fibres, following inferences can be drawn out:

1. The workability of the concrete mix decreases linearly with incorporation of PET fibres for all the aspect ratios.

2. The straight PET fiber concrete had high workability than the crimped PET fiber concrete.
3. The compressive strength of PET fiber concrete with the addition of 1% fiber and at AR50, gives good results among all the mixes of PET fiber concrete.
4. The crimped PET fiber concrete have high compressive strength as compare to the straight PET fiber concrete.
5. The split tensile strength of PET fibres increased up to 1% incorporation level for all the aspect ratios. However it was higher for higher aspect ratios than that of lower aspect ratios. And crimped have high value of split tensile strength than the straight fiber concrete.
6. The flexural strength of PET fibres is also increased up to 1% incorporation level for all the aspect ratios. However it was higher for higher aspect ratios than that of lower aspect ratios.
7. The fiber incorporation has the tendency to change the breaking pattern of the specimens. The controlled specimens which suddenly broke down into pieces changed into ductile ones due to fiber incorporation.
8. So in general, we can say that use of PET fibres can be an economical or most probably cost effective method to minimize the plastic waste disposal problem. The utilization of PET fibres in small amounts also increase the strength.
9. From this experimental investigation the PET bottles appeared to be low cost substance which would help to resolve waste problem and preventing environmental problems.

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