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Enhancement of Concrete Properties by Inducing PET Fibre

Homesh Baghmar[1], Lilesh Sahu[2], Abhijeet Lal[3], Rajan Kumar Singh[4]

[1,2,3,4]*Department of Civil Engineering*
[1,2,3,4]*Shri Shankaracharya Institute of professional Management and Technology, Raipur, Chhattisgarh, India*

Abstract - *Due to the increase in population, the demand for plastic also increases if plastic is formed, therefore plastic waste is also generated. And building construction has also increased, so the shortage of aggregates is a serious problem. To reduce both the problem of plastic waste disposal and saving natural aggregate, we can use plastic bottle fiber waste (PET fiber) in concrete by partially replacing natural aggregate with plastic waste. Replacement of 100 percent of coarse aggregates with plastic fiber isn't possible, partial replacement at varied percentages was considered. Coarse aggregates are replaced at 1%, 3% and 5% by PET fiber. The compressive strength and workability of these concretes prepared with plastic fibers are tested. The test result shows that the slump and compaction factor is reduced at higher percentages of fibers. But the addition 1% of fiber, the slump and compaction factor is not so hampered. Concrete was observed to be good enough and workable in adding 1% of fiber, even with increasing bond strength, fiber content will increase.*

Key Words: **Polyethylene Terephthalate (PET), waste plastic bottles, fiber, concrete**

1. INTRODUCTION

Concrete structure is the most common type of structure, and it keeps developing and improving most expensive and significant ingredient in concrete production. Concrete is the main structural material widely consumed in the world. Most of the infrastructure and building construction in world are using concrete as construction material. Concrete is major construction material. Concrete is a brittle material which is strong in compression and weak in tension. The finding about strengthening these brittle matrixes in the search of improving their mechanical properties have been a continuous process since ancient times, when straws were used to reinforced clay bricks. Since the 1960s, the modern development of fiber-reinforced concrete has grown rapidly.

Normal concrete has two main drawbacks, low tensile strength and low strain at break. The tensile strength of concrete is very low because normal concrete normally contains many microcracks. It is the rapid propagation of these microcracks under applied stress that is responsible for the low tensile strength of the material, ultimately leading to brittle fracture of the concrete. Attempts are made within the past to impart improvements within the tensile properties of concrete members through the utilization of conventional reinforced steel bars and also by applying containment techniques.Although both methods provide lastingness to concrete members, they nevertheless don't increase the lastingness inherent in concrete. It was found that adding small, uniformly dispersed and closely spaced fibers to concrete would act as an anti-enrichment agent and significantly improve its static and dynamic properties. This kind of concrete is termed as fiber reinforced concrete.

Fiber reinforced concrete will be defined as "a material consisting of a mix of cement, mortar or concrete and appropriate staple and distinct fibers uniformly dispersed". The new generation technology uses discrete fibers from 20mm to 40mm in length. The fibers are random throughout the concrete matrix, providing a far better distribution of internal and external stresses employing a three-dimensional network. The main role of fibers in hardened concrete is to modify the cracking mechanism. The cracks are smaller in width, thus reducing the permeability of the concrete and the final deformation of the concrete cracks is improved. Un-reinforced concrete will separate at a crack, reducing the load capability to zero across the crack. The fibers are able to carry a load across the crac.

Fiber-reinforced concrete is becoming an increasingly popular building material due to its improved mechanical properties compared to unreinforced concrete and its ability to improve the mechanical performance of conventional reinforced concrete. Fiber reinforcement is one of the most important modification methods to alter the brittle nature of concrete. The fibers are generally used as crack resistance and reinforcement of concrete. In this work, an experimental study is conducted on the use of plastic waste in concrete cubes with addition percentages ranging from 0% to 5%

2. MATERIALS

2.1 Cement

Cement is one of the binding materials which is generally used in construction work. ACC suraksha cement ordinary Portland Cement (OPC 43) which is used as per IS 1489 (Part-1). When the compressive strength of cement after 28 days as per Bureau of Indian Standards (BIS) specification is 43 MPa or 43 N/mm2, it is called as43 grade cement.

2.2 Fine aggregate

Fine aggregate can be determined as passing through 4.75mm IS sieve and retained on 0.075mm sieve is termed as fine aggregate. Fine aggregates are obtained from river bed and it provides bulk, certain amount of strength and other properties to construction materials. Fine aggregate used in this experiment which is passing through 2.36mm IS sieve.

Physical properties of fine aggregate

Specific gravity	2.64
Water absorption	0.8%

2.3 Coarse aggregate

Aggregates are used as a base material under the foundations, roads. The different aggregate sizes used are 10mm, 20mm, 31.5mm, 40mm and other sizes as well. For project work, 20 mm aggregates are used. The aggregate used is of good quality and of cubic-angular shape; which provides a good interlocking bond.

Physical properties of Coarse aggregate

Water absorption	0.65%
Specific gravity	2.88

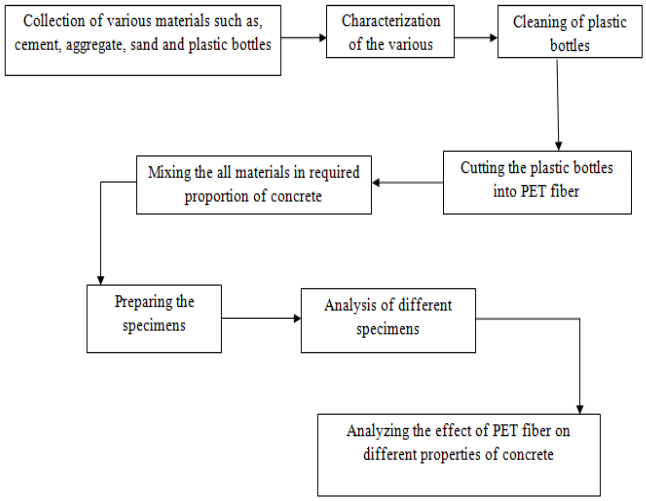
2.4 PET Fiber

The plastic bottles were used to get PET fiber. In this regard, the plastic bottles were collected from the local scrap dealers. All the plastic bottles, used for extracting PET fiber, After the collection process these plastic bottles were brought to laboratory and washed using detergent solution and then left undisturbed for next 24 h for drying. The dried plastic bottles were cut into PET fiber using tools such as, scissors and cutters. Size of the fiber is cutting in length of 30mm-50mm and width 5mm-10mm.

Figure 1 : PET fiber

3. METHODOLOGY

The work is divided into completely different phases. The primary stage includes the choice of materials to be used like cement, natural fine aggregate (NFA), natural coarse aggregate (NCA), PET Fiber.



Flow chart of the methodology

3.1 Cube Casting

The acceptance criteria of concrete are given in IS-456. altogether the cases, for check of the criterion for acceptance or rejection of the concrete is that the compressive strength at 28 days, 7 days compressive strength of concrete also can be wont to get a comparatively quicker idea of quality of concrete.

For the compression strength and testing, four castings were completed with 0%, 1%, 3% and 5% replacement of coarse aggregates with the plastic waste fiber

Figure-2: Casting of cube specimence

4. FRESH CONCRETE TEST RESULT

4.1 Slump cone

According to the obtained results, the PET fiber has a significant decreases slump value compared to the results of normal concrete. This may be due to the fact that the fiber had a different geometric composition. In conclusion, the slump test cannot be considered a suitable test to assess the workability of concrete, this is due to the stiffening effects of the fiber of the plastic bottle which end up influencing the results of the slump test. Difference between the slump values between plain concrete and plain concrete with the addition of PET fiber is 40mm in added fiber content of 1%. the difference in the slump of the fiber-reinforced concrete without plastic bottle fiber and with the addition of plastic bottle fiber is 52mm, 70mm for the percentage of addition plastic bottle fiber of 3% and 5%, respectively.

Table 4.1 Slump value of various concrete mixes

Sample	Fiber content (%)	Slump value
S1	0 %	125mm
S2	1 %	85mm
S3	3 %	73mm
S4	5 %	55mm

4.2 Compaction factor

The results of this analysisn were represented in the form of compaction factor and the results are given in Table 4.2 . The incorporation of PET fiber in the concrete has resulted in reducing compaction factor, as the compaction factor of the normal sample is greater than that of the concrete specimens with PET fiber. Both the types of concrete. The lack of bonding between cement and PET fiber, and low water absorption of PET fiber could be prominent explanation for such a behavior of concrete.

Sample	Fiber content (%)	Compaction factor
S1	0 %	0.89
S2	1 %	0.84
S3	3 %	0.86
S4	5 %	0.81

Table 4.2 Compation factor value of various concrete mixes

5. HARDENED CONCRETE TEST RESULTS

The results of compressive strength at 7 and 28 days have been presented in Tables 5.1 and 5.2. The compressive strength of concrete continues to increase with increasing percentage of plastic parts (plastic bottle fiber) but the rate of increase of compressive strength is only slightly higher with 1% addition of plastic fiber. This low strength may be due to the decrease in bonding due to the introducing of PET fiber. From 1% to 5% plastic fiber added , the compressive strength of the concrete with the addition of fibers at 1% the concrete strength increases but beyond 3% decrease in strength is observed compared to to the other percentage of addition. However, the maximum increase in characteristic strength is observed in 1% added for the concrete mix.

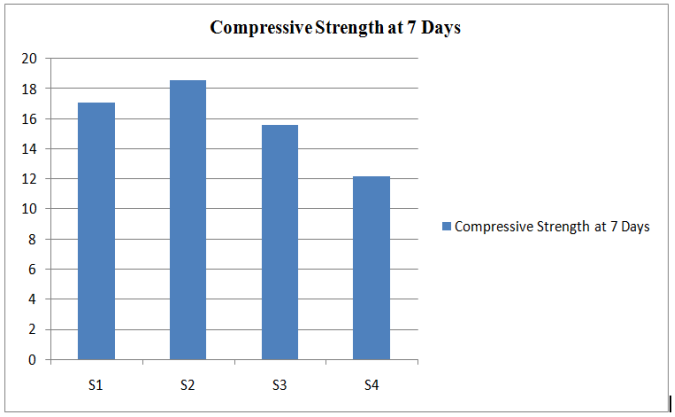
Table 5.1 : Compressive strength of concrete after 7 day

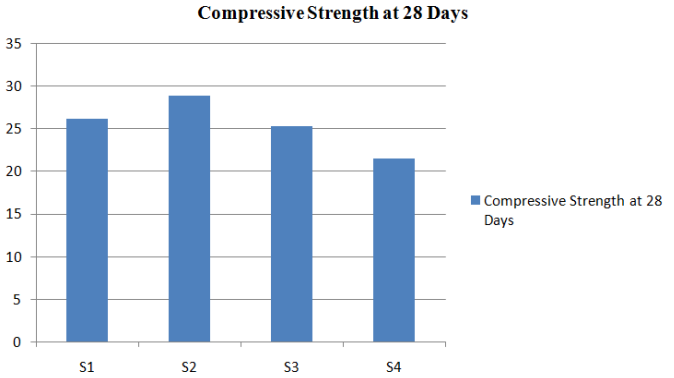
Sample	Fiber content (%)	Compressive strength at 7 day
S1	0	17.1 N/mm^2
S2	1	18.6 N/mm^2
S3	3	15.6 N/mm^2
S4	5	12.2 N/mm^2

Sample	Fiber content (%)	Compressive strength at 28 day
S1	0	26.2 N/mm²
S2	1	28.9 N/mm²
S3	3	25.3 N/mm²
S4	5	21.5 N/mm²

Table 5.2 : Compressive strength of concrete after 28 day

5.1 GRAPHICAL REPRESENTATIONS





6. CONCLUSIONS

1. The compressive strength of concrete is affected by the addition of plastic fibers and it goes on increasing with the percentage of plastic fiber. Adding 1% plastic to concrete results in an increase in strength of approximately 10.3% after 28 days of curing.
2. Thus it is conclude that the use of plastic bottle fiber is possible to increase the strength of concrete.
3. But after increasing the percentage of PET fiber beyond 3% , the compressive strength of concrete is decreases. So do not increase the volume of PET fiber above 3%.
4. Incorporation of fibers leads to decrease in workability. This may be due to the fact that the larger surface area provided by higher aspect ratio of PET fibers, can lead to loss of slump.
5. By the using this replacement, we can say that it can reduce the plastic waste up to some extent.

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