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Effect of Polypropylene Fiber on Interlocking Paver Block

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***Abstract*:** *Paver block is widely used in various applications in street road and other construction places. Paver block has low maintenance and can easily replace with a newer one in case of breakage or damage. The addition of polypropylene fibers in paver block shows the change in flexural strength, compressive strength and water absorption in comparison with standard block. Also it is helpful to improve the life span of paver block. This paper describes the effect of polypropylene fiber on paver block of two different layers. The layers are of mix proportion 1:1:2.17:3 in the top and 1:1.6:2.15 in the bottom layer of the paver block. Both layers contain the addition of fiber by 0.1%, 0.2%, 0.3%, 0.4% and 0.5% in each mix proportion by weight. Test result indicates that by addition of appropriate percentage of fiber enhances compressive strength and flexural strength of paver blocks at 7, 14 and 28 days and also minimizes water absorption.*

Keywords*—Flexural strength, Compressive strength and Water absorption*

I. Introduction

Interlocking Concrete Block Pavement (ICBP) has been extensively used in a number of countries for quite some time as a specialized problem-solving technique for providing pavement in areas where conventional types of construction are less durable due to many operational and environmental constraints. ICBP consists of a surface layer of small-element, solid un-reinforced pre-cast concrete paver blocks laid on a thin, compacted bedding material which is constructed over a properly profiled base course and is bounded by edge restraints/kerb stones. The block joints are filled using suitable fine material. A properly designed and constructed ICBP gives excellent performance when applied at locations where conventional systems have lower service life due to a number of geological, traffic, environmental and operational constraints. Interlocking pavers are manufactured concrete product that is individually placed in a variety of patterns and shapes as per the requirement. This type of pavement will absorb stress such as small earthquakes, freezes and thaws, and slight ground erosion by flexing. Therefore, they do not easily crack, break or buckle like pouring asphalt or poured concrete. Polypropylene fiber is used in the construction industry as a secondary reinforcement which arrests cracks, increases resistance to impact/abrasion and greatly improves quality of construction.

II. Experimental Study

A. Materials Used

1) Polypropylene fiber

Polypropylene is a thermoplastic polymer used in a wide variety of applications. Polypropylene fiber/filament possesses all the outstanding properties associated with the Polypropylene Polymer. This is therefore used in concrete pavements in order to arrest cracks, increases resistance to impact/abrasion as it has reinforcing effect in concrete. Its usage in concretepavements greatly improves the quality of construction.

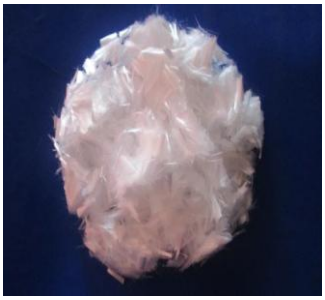

Fig.1 Polypropylene Fibers

2) Cement

Cement basically acts as a binding material that holds all the other components of the block. For making paver block ordinary Portland cement is used. It also imparts strength necessary to the blocks.

Fig.2 Cement

3) White Cement

In tropical countries white cement is used for a pastel colour paint finish. It is also used also because of its low content of soluble alkalis so that staining is available. White cement is made from china clay, which contains little iron oxide and manganese oxide, together with chalk or lime stone free from specified impurities.

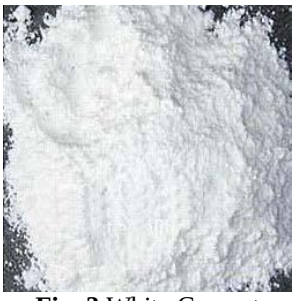

Fig. 3 White Cement

4) Gravel

Gravel is an inert inexpensive material dispersed throughout the cement paste so as to produce a large volume of concrete. In fact, gravel is not truly inert because its physical, thermal and chemical properties influence the performance of concrete.

Fig. 4 Gravel

5) M-Sand

It is produced from crushing of granite stones in required grading to be used for construction purposes as a replacement for river sand. M-Sand is crushed from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency.

Fig. 5 M-Sand

B. Paver Block

Different types of materials are used in paver block in two layers. For aesthetic purpose, white cement, gray cement, M- Sand and gravel are used in top layer. In bottom layer gray cement, M sand and gravel are used

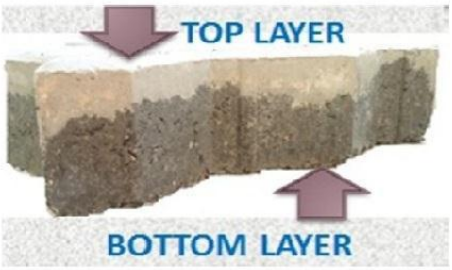

Fig. 6 Layer Distribution of Paver Block

Fig.7 Pattern of Paver Block

C. Test on Materials and Specimen

For the proper and accurate mix design, some properties of the constituents of concrete have to be found out. The required properties are

- Specific gravity of cement and white cement
- Fineness of cement
- Grading of coarse aggregate and fine aggregate
- Specific gravity of fine and coarse aggregate
- Porosity of coarse and fine aggregate
- Standard consistency of cement

TABLE I. Properties of the constituents of concrete

Property	***Constituents***	***Value***
Specific Gravity	Cement	3.12
	White Cement	2.89
	Fine aggregate	2.8
	Course Aggregate	2.67
Porosity	Fine Aggregate	33.22%
	Coarse Aggregate	38.3%
Standard consistency	Cement	36%

D. Mix design

Using the values of specific gravity of cement, white cement, aggregate, M –sand mix design was done for 40 MPa according to IS 10262:2009.

TABLE II. Mix Proportioning

Layer	*Cement*	*Fine aggregate*	*Coarse Aggregate*
Top Layer	1	2.17	3
Bottom Layer	1	1.6	2.15

The top layer of paver block is made of white cement, gray cement, fine aggregate and coarse aggregate for aesthetic purpose. The bottom layer of paver block is made of gray cement, M sand, gravel for obtaining the required strength. In standard paver blocks, polypropylene fiber (PPF) is added in different proportions for different types of paver blocks.

TABLE III. Addition Of Ppf In Concrete Paver Block

Sl. No.	*Types of Paver Block*	*Description of Concrete Paver Block*
1	Type 1	Ordinary
2	Type 2	Ordinary + 0.1% PPF
3	Type 3	Ordinary + 0.2% PPF
4	Type 4	Ordinary + 0.3% PPF
5	Type 5	Ordinary + 0.4% PPF
6	Type 6	Ordinary + 0.5% PPF

Paver block concrete contains white cement, gray cement, m sand, gravel in top layer and in the bottom layer of paver blocks only mixture of grey cement, fine aggregate, coarse aggregate are used. In both layers polypropylene fiber is to be added with 0.1%, 0.2%,0.3%, 0.4% and 0.5% by weight of concrete paver block. For all the tests, four numbers of paver blocks were casted and three blocks for water absorption. Required quantity of water is only added at the time of casting. After about 24 hrs, the specimens were placed at a safe place and water curing continued till the respective specimens tested after 7,14 and 28 days for compressive strength and water absorption tests.

III. Result And Discussions

Compressive Strenth

TABLE IV. Compressive Strength For Different Percentage Of Fiber

Percentage of Fiber added	*7Day Compressive Strenth (N/mm^2)*	*28 Day Compressive Strenth (N/mm^2)*	*28Day Compressive Strenth (N/mm^2)*
0%	32.83	36.56	37.49
0.1%	33.13	36.80	39.70
0.2%	34.41	36.82	40.70
0.3%	35.52	37.80	42.10
0.4%	36.56	38.90	43.59
0.5%	35.8	36.75	42.30

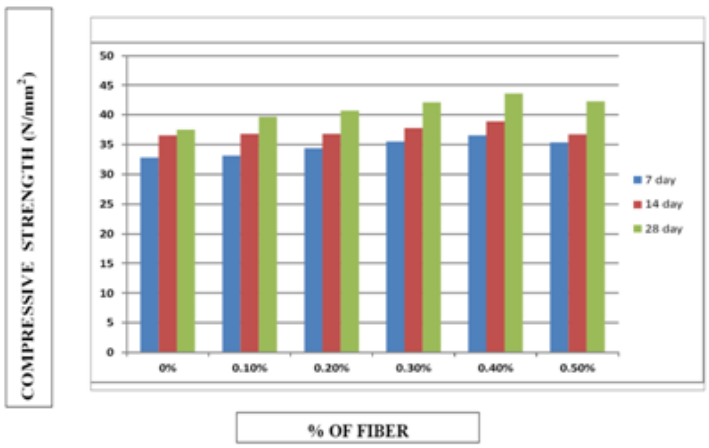

Fig. 6 Variation of Compressive Strength with % of fiber

For 0.4% of polypropylene fiber maximum compressive strength is obtained. The maximum strength is for 0.4% of fiber the strength will slightly decreases when 0.5% of fiber added.

E. Water Absorption

TABLE V. Water Absorption

Percentage of Fiber	*Weight of Block Before Curing*	*Weight of Block After Curing*	*Water Absorption (%)*
0%	6.33	6.58	3.86
0.1%	6.7	6.94	3.58
0.2%	6.3	6.51	3.33
0.3%	6.72	6.91	2.83
0.4%	6.2	6.35	2.42
0.5%	6.57	6.74	2.59

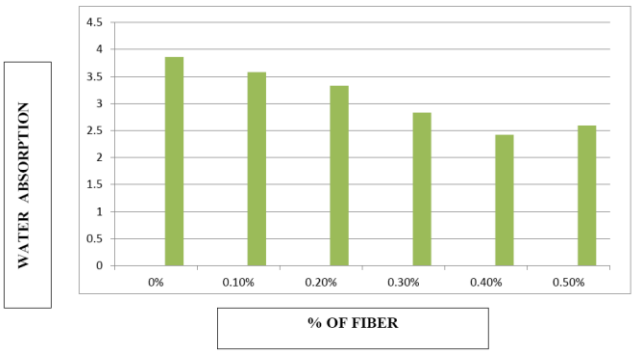

Fig. 7 Variation of Water Absorption with % of Fiber

The water absorption value was minimum when 0.4% fiber is added. On further addition of fiber will increase the water absorption value. The water absorption needs to be minimum.

F. Flexural Strength Test

TABLE VI. Flexural Strength

Percentage Of Fiber	*Average Flexural Strength (N/mm^2)*
0%	3.8
0%	4.16
0%	4.58
0%	4.92
0%	5.75
0%	5.42

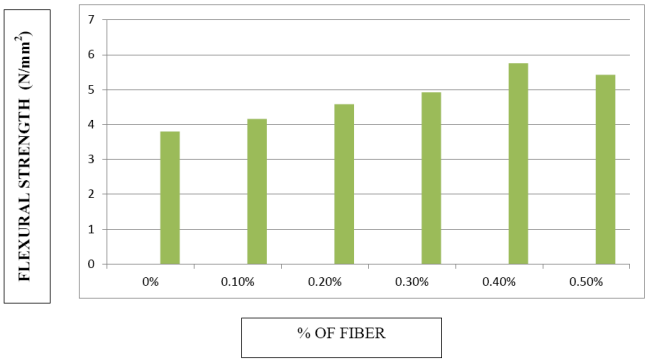

Fig 15: flexural strength v/s % of fiber

Fig. 8 Variation of Flexural Strength with % of Fiber

The flexural strength is maximum when 0.4% fiber is added. On further increase of fiber will decrease the flexural strength value.

IV. CONCLUSION

The compressive strength of paver blocks has been increased by the addition of polypropylene fiber. The 7 days, 14 days and 28 days test will shows the compressive strength variation. The compressive strength was maximum when 0.4% of fiber is added to the paver blocks. On further increase of fiber will show the decrease in compressive strength. Flexural strength was found to be increased when 0.4% fiber is added. Further addition of fiber will decrease the flexural strength.

Water absorption was minimum for 0.4% of fiber. Further addition will increase the water absorption. It was concluded that addition of polypropylene fiber to the paver blocks will increase the compressive strength, flexural strength. It will help to reduce the maintenance cost of paver blocks and reduce the cracks, abrasion that happened in paver blocks.

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