

# **Effect of Polypropylene Fibers on Abrasion Resistance and Flexural Strength for Interlocking Paver Block**

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**ABSTRACT:** The presently paver block is used in various applications like in street road and other construction places. Also we can say that it is partial replacement of concrete pavement. Paver block has low cost maintenance and easily replace with a newer one at the time of breakage. For improving Abrasion Resistance and Flexural Strength of paver block this study is necessary. In this study addition of polypropylene fibers in paver block to show the change in the Abrasion Resistance and Flexural Strength of paver blocks with compare to standard paver block and reduces the maintenance cost of paver block. Also it's helpful to improve the life span of paver block. In this paper represent the results of the concrete paver block with the mix proportion of 1:3 (Cement: dolomite powder) and polypropylene fibre with the different percentage rate in the top layer of paver block and 1:1:2:3.75 (Cement: Fine aggregate: Semi Grit: Quarry dust) in the bottom layer of paver block. In only both layers contain the polypropylene fiber (PPF) of 0.1%, 0.2%, 0.3%, 0.4%, and 0.5% in each mixes proportion by weight. Both tests were determined at 28 days. Test results indicate that by the addition of PPF by 0.3% and 0.4% it gives good results for abrasion resistance and flexural strength at 28 days respectively. The paper also shows the cost comparison per block for the each mix proportion.

**KEY WORDS:** Abrasion resistance, Flexural strength, Polypropylene Fiber, Paver Block, Cost

## **I INTRODUCTION**

Interlocking Pavers are the modern day solution for low cost outdoor application. Paver block is solid, unreinforced pre-cast cement concrete paving units used in the surface course of pavement. They are high strength concrete precast

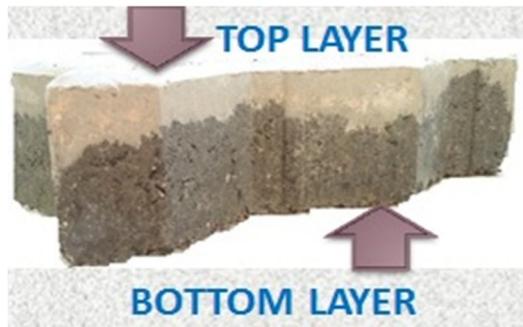
elements in various shapes, sizes and colours to suit the imagination of landscape architects & nature's essence. By improving its abrasion resistance and flexural strength it can be used in heavy traffic area and give surface resistance for higher life. Interlocking pavers are manufactured concrete 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.

The objectives of the present study are:

- To study the effect on the properties of paver block by adding the different percentage of polypropylene fibres.
- To study the effect on abrasion resistance and Flexural Strength by adding polypropylene fibre in paver blocks.
- To increase the life span of paver block.

## **II DESIGN MIX MATERIALS**

In paver block different types of material are used. In top layer cement, dolomite powder and pigment are used and in bottom layer cement, fine aggregate, semi grit, quarry dust is used. And in both layer polypropylene fibres are used in different percentage.



**Figure 1: layer distribution of paver block**

### Polypropylene Fibre

Polypropylene fiber is used in the construction industry as a secondary reinforcement which arrests cracks, increases strength and resistance to impact/abrasion & greatly improves quality of construction. 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.



**Figure 2: Polypropylene Fiber**

Source: <http://www.google.co.in/images>

**TABLE 1  
PROPERTIES OF POLYPROPYLENE  
FIBRE**

No	PROPERTY	VALUE
1	Cross Section	Triangular
2	Diameter	0.03-0.04 mm
3	Cut Length	6 & 12 mm
4	Elongation	>100 %
5	Moisture Flat	<1 %
6	Melting Point	150-160 °C
7	Specific Gravity	0.9 Cc/gm
8	Tensile Strength	140-690 N/mm <sup>2</sup>
9	Elastic Modulus	3450-4825 N/mm <sup>2</sup>

Source: Aditya Gupta, "Buildtech- A Perspective by Reliance Industries Limited", Technical Textile Summit 2010, New Delhi

### Experimental Materials



1. Cement, 2. Quarry Dust, 3. Dolomite powder, 4. Polypropylene fibre, 5. Sand, 6. Semi Grit

### Figure 3: Experimental Material

Source: Jay Maharaj Tiles, Kanjari, Anand

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.

Fine aggregate is a naturally occurring granular material composed of finely divided rock and mineral particles. Those fractions from 4.75 mm to 150 microns are termed as fine aggregate.

Semi grit is the heavier sand than normal sand and is very versatile sand used for many different tasks and jobs. Semi Grit is also ideal for building and it is one of the building sands that building companies use, mainly as bedding material for paving. The size of the semi grit is less than 9.5 mm.

Quarry Rock Dust can be defined as residue, tailing or other non-volatile waste material after the extraction and processing of rocks to form fine particles less than 4.75mm.

Dolomite is one mineral with specific gravity of 2.84 to 2.86. The main use of dolomite is to impart the particular red or yellow colour to the surface of paver blocks. Dolomite is mixed with cement and colour in a mixer drum and is rotated for a fixed period of time to get a proper mixture. It is then put in the mould initially to impart the colour of the blocks.

**III DESIGN MIX METHODOLOGY**

**TABLE 2  
MIX DESIGN PROPORTION FOR TOP LAYER**

S	C	D. P.	P
TOP LAYER	50 Kg	150 Kg	4 Kg
RATIO	1	3	0.08

S=sample, C=cement, D.P.=dolomite powder, P=pigment

By using this standard mix (M20) we can cast the top layer of 260 blocks.

**TABLE 3  
MIX DESIGN PROPORTION FOR BOTTOM LAYER**

S	C	SA	S.G.	Q. D.
BOTTOM LAYER	50 Kg	50 Kg	100 Kg	175 Kg
RATIO	1	1	2	3.50

S=sample, C=cement, SA=sand, S. G. = semi grit, Q.D.=quarry dust

By using this standard mix (M20) we can cast the bottom layer of 160 blocks.

**TABLE 4  
ADDITION OF POLYPROPYLENE FIBRE IN STANDARD CONCRETE PAVER BLOCK**

SR. NO.	TYPES OF PAVER BLOCK	DESCRIPTION OF CONCRETE PAVER BLOCK
1	A1	Standard
2	B1	Standard+ 0.1% PPF
3	B2	Standard+ 0.2% PPF
4	B3	Standard+ 0.3% PPF
5	B4	Standard+ 0.4% PPF
6	B5	Standard+ 0.5% PPF

PPF: Polypropylene Fibre

**IV EXPERIMENTAL METHODOLOGY**

**Testing Methodology**

Paver block concrete contains cement, fine aggregate, semi grit and quarry dust in bottom layer of paver block and in the top layer of paver block only mixture of cement, dolomite powder and pigment is used. In the both layer polypropylene fibre is to be added with the 0.1%, 0.2%, 0.3%,

0.4% and 0.5% by weight of the concrete paver block. For Abrasion Resistance Test and Flexural Test there were four numbers of paver block has been casted. At the time of casting water added only for the wet purpose of the mix. After about 24 h the specimens were placed at safe place and water curing was continued till the respective specimens were tested after 28 days for both tests.

**ABRASION RESISTANCE TEST (IS 1237:1980)**

The objective of the abrasion test is to screen out products that might cause excessive wear to the pumps at air tanker bases due to their abrasiveness. The abrasion resistance of concrete pavements is a surface property that is mainly dependent on the quality of the surface layer characteristics. The top 3-5 mm is the most important part of the abrasion resistance of the concrete product.

Sample size with 70.6 x 70.6 mm surface, properly dries in oven at temperature of 1100C was placed on disc rotating at 30 rpm with constant load of 300N and 20 gram abrasive powder uniformly spread over disc at end of predefined constant revolution 22 and repeated for total 220 revolutions with 9 breaks. The wear shall be determined from the difference in readings obtained by the measuring instrument before and after the abrasion of the specimen. The value shall be checked up with the average loss in thickness of the specimen obtained by the following formula.

$$T = ((W1-W2)*V1)/(W1*A)$$

Where, t = average loss in thickness in mm,  
 W1 = initial mass of the specimen in gm.  
 W2 = final mass of the abraded specimen in gm.  
 V1 = initial volume of the specimen in mm<sup>3</sup>  
 A = surface area of the specimen in mm<sup>2</sup>



**Figure 4: Setup of Abrasion Resistance test**

**FLEXURAL STRENGTH TEST  
(IS 15658:2006)**

Flexural strength test of concrete paver block specimens was determined at 28 days of age. For that age four specimens were tested. The load was applied from the middle of the specimen. The flexural strength of the specimens was calculated according to the formula:

$$F_b = 3 * P * L / (B * D^2)$$

- F<sub>b</sub> = flexural strength, in N/mm<sup>2</sup>;
- P = maximum load in N;
- L = distance between central lines of supporting rollers, in mm;
- B = average width of the block, measured from both faces of the specimen, in mm;
- D = average thickness, measured from both ends of the fracture line, in mm.

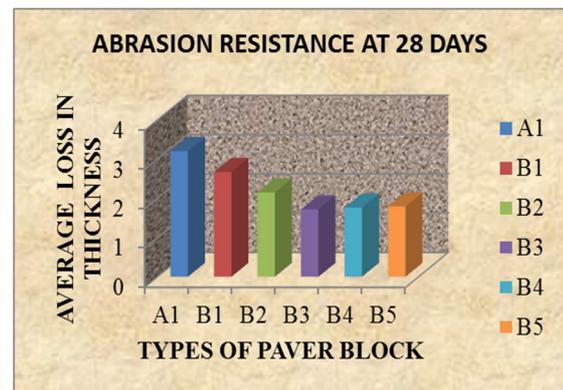


**Figure 5: Setup of Flexural test**

**V EXPERIMENTAL RESULTS**

**TABLE 5  
ABRASION RESISTANCE TEST AT 28 DAYS**

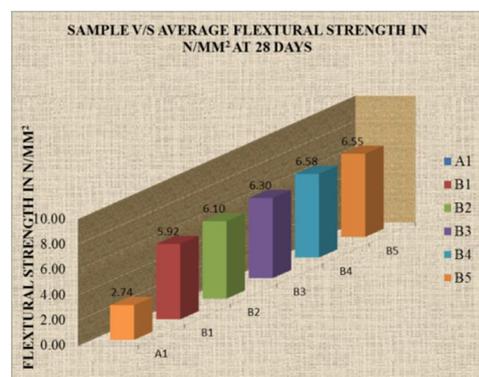
TYPES OF PAVER BLOCK	A1	B1	B2	B3	B4	B5
AVERAGE LOSS IN THICKNESS T (mm)	3.20	2.67	2.15	1.72	1.76	1.79



**Figure 6: Abrasion Resistance Test at 28 Days**

**TABLE 6  
FLEXURAL STRENGTH OF CONCRETE PAVER BLOCK AT 28 DAYS**

TYPES OF PAVER BLOCK	A1	B1	B2	B3	B4	B5
AVERAGE FLEXURAL STRENGTH IN N/mm <sup>2</sup>	2.74	5.92	6.10	6.30	6.58	6.55



**Figure 7: Flexural Test of Concrete Paver Block at 28 Days**

**VI ECONOMIC FEASIBILITY**

**TABLE 7: COST OF MATERIALS**

SR. NO.	MATERIALS	RATE (RS/KG)
1	Cement	5.80
2	Fine aggregate (Regional )	0.60
3	Semi grit (Regional )	0.40
4	Quarry dust (Regional )	0.20
5	Dolomite powder	1.40
6	Polypropylene fibre	280

**TABLE 8: DESIGN MIX PROPORTION FOR M20 GRADE CONCRETE PAVER BLOCK**

		MATERIALS										
		BOTTOM LAYER					TOP LAYER					
SR. NO.	TYPES OF PAVER BLOCK	C	F.A	S.G	Q.D	PPF	C	D	PPF	E	L	COST OF PAVER
<b>NOS. OF BLOCK</b>		160					260					
<b>1</b>	A1	50	50	100	175	0.00	50	150	0.00	0.40	1.00	5.79
<b>2</b>	B1	50	50	100	175	0.38	50	150	0.20	0.40	1.00	6.66
<b>3</b>	B2	50	50	100	175	0.75	50	150	0.40	0.40	1.00	7.54
<b>4</b>	B3	50	50	100	175	1.13	50	150	0.60	0.40	1.00	8.41
<b>5</b>	B4	50	50	100	175	1.50	50	150	0.80	0.40	1.00	9.28
<b>6</b>	B5	50	50	100	175	1.88	50	150	1.00	0.40	1.00	10.15

C: Cement, F.A: Fine Aggregate, S.G: Semi Grit, Q.D: Quarry Dust, D: Dolomite Powder, PPF: Polypropylene Fibre, E: Electricity, L: Labour Cost

**CONCLUSION**

From this study the following conclusion can be drawn:

- a) The abrasion resistance of paver block at 28 days improves the results up to 45% of paver block. In abrasion resistance minimum abrasion results obtained by adding 0.3% polypropylene fibre in paver block.
- b) Flexural strength is increased very highly up to 140% to 160% compared to flexural strength of the standard paver block. Maximum results obtain in a sample of B4 i.e. PPF has added 0.4% by weight.
- c) Cost of this type of paver block is so much higher compare to standard paver block. Cost is higher up to 20% to 80% compared with standard paver block. But overall increase the properties of paver block.

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