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EFFECT ON COMPRESSIVE STRENGTH AND WATER ABSORPTION OF INTERLOCKING PAVER BLOCK BY ADDITION OF POLYPROPYLENE FIBER

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ABSTRACT

The presently paver block is used in flooring versatility application and also it is used in street road and other construction places. For improving compressive strength and other parameter of paver block this study is necessary. By addition of polypropylene fibers in paver block it increases the compressive strength of paver blocks 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) 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 both layer additions of polypropylene fiber (PPF) by 0.1%, 0.2%, 0.3%, 0.4%, 0.5% in each mix proportion. The compressive strength and water absorption has been obtained with the inclusion of PPF in paver block. Test results indicate that by the addition of PPF by 0.4% it gives maximum strength at 7, 14, 28 days and minimum water absorption. The paper also shows the cost comparison for the each mix proportion.

KEYWORDS: Compressive Strength, Water Absorption, Paver Block, Polypropylene Fibre, Cost
INTRODUCTION
Interlocking Pavers are the modern day solution to the outdoor flooring versatility in applications. Paver block is solid, unreinforced pre-cast cement concrete paving units used in the surface course of pavement. They are high strength concrete mouldings in various shapes, sizes & colors to suit the imagination of landscape architects & nature's essence. Interlocking pavers are manufactured concrete product that is individually placed in a variety of patterns. They do not absorb water and can be placed so that excess water is taken away from the garden and patio area rather than over-saturating it. 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 fibre is used in the construction industry as a secondary reinforcement which arrests cracks, increases resistance to impact/abrasion & greatly improves quality of construction.

The objective of the present study is
- To study the effect on the properties of paver block by adding the different percentage of polypropylene fibers.
- To study the effect on compressive strength and water absorption by adding polypropylene fiber in paver blocks.
- To increase life span of paver block.
- To work out on useful fibers use in construction industry.

DESIGN MIX MATERIALS
In paver block different types of material is used. In top layer cement, dolomite powder and pigment is for its aesthetic purpose. In bottom layer cement, fine aggregate, semi grit, quarry dust is used.

Figure 1: layer distribution of paver block
A. 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. Cement is added to semi grit and water in the required ratio and the final mixture is thus made.

![Cement Bags](http://www.jiarm.com)

Figure 2: Cement Bags
Source: Jay Maharaj Tiles, Kanjari

B. POLYPROPYLENE FIBRE

Polypropylene fiber is used in the construction industry as a secondary reinforcement which arrests cracks, increases resistance to impact/abrasion & greatly improves quality of construction. Polypropylene is a thermoplastic polymer used in a wide variety of applications. Polypropylene fibre/filament possesses all the outstanding properties associated with the Polypropylene Polymer.

![Polypropylene Fiber](http://www.google.co.in/images)

Figure 3: Polypropylene Fiber
Source: http://www.google.co.in/images

**TABLE 1**

<table>
<thead>
<tr>
<th>PROPERTIES OF POLYPROPYLENE FIBRE</th>
</tr>
</thead>
</table>

www.jiarm.com
<table>
<thead>
<tr>
<th>No</th>
<th>PROPERTY</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cross Section</td>
<td>Triangular</td>
</tr>
<tr>
<td>2</td>
<td>Diameter</td>
<td>0.03-0.04 mm</td>
</tr>
<tr>
<td>3</td>
<td>Cut Length</td>
<td>6 &amp; 12 mm</td>
</tr>
<tr>
<td>4</td>
<td>Elongation</td>
<td>&gt;100 %</td>
</tr>
<tr>
<td>5</td>
<td>Moisture Flat</td>
<td>&lt;1 %</td>
</tr>
<tr>
<td>6</td>
<td>Melting Point</td>
<td>150-160 °C</td>
</tr>
<tr>
<td>7</td>
<td>Specific Gravity</td>
<td>0.9 Cc/gm</td>
</tr>
<tr>
<td>8</td>
<td>Tensile Strength</td>
<td>140-690 N/mm^2</td>
</tr>
<tr>
<td>9</td>
<td>Elastic Modulus</td>
<td>3450-4825 N/mm^2</td>
</tr>
</tbody>
</table>

Source: Aditya Gupta, “Build tech- A Perspective By Reliance Industries Limited”,
Technical Textile Summit 2010, New Delhi

**C. FINE AGGREGATE**

Sand 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. The river sand is used as fine aggregate conforming to the requirements of IS: 383.

![Figure 4: fine aggregate](source)

Source: Jay Maharaj Tiles, Kanjari

**D. SEMI GRIT**

Semi grit is heavier sand than normal sand and is very versatile sand used for many different tasks and jobs. Semi grit is ideal for water logged areas or finely brushing beneath flag stones during flag laying. It 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 < 9.5 mm.
E. QUARRY DUST

Quarry Rock Dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm. Usually, Quarry Rock Dust is used in large scale as a surface finishing material in the highways and also used for manufacturing of hollow blocks and lightweight concrete prefabricated Elements.

F. DOLOMITE POWDER

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. Dolomite may be locally available or may be sometimes transported and it is cheap too.

![Dolomite Powder](http://www.ksmicrons.com/dolomite-powder.htm)

**Figure 7: Dolomite Powder**

Source: [http://www.ksmicrons.com/dolomite-powder.htm](http://www.ksmicrons.com/dolomite-powder.htm)

**DESIGN MIX METHODOLOGY**

**Concrete mix composition**

**TABLE 2**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>CEMENT</th>
<th>DOLOMITE POWDER</th>
<th>PIGMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOP LAYER</td>
<td>50 Kg</td>
<td>150 Kg</td>
<td>4 Kg</td>
</tr>
<tr>
<td>RATIO</td>
<td>1</td>
<td>3</td>
<td>0.08</td>
</tr>
</tbody>
</table>

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

**TABLE 3**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>CEMENT</th>
<th>SAND</th>
<th>SEMI GRIT</th>
<th>QUARRY DUST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTTOM LAYER</td>
<td>50 Kg</td>
<td>50 Kg</td>
<td>100 Kg</td>
<td>175 Kg</td>
</tr>
<tr>
<td>RATIO</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3.50</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>CONCRETE TYPE</th>
<th>DESCRIPTION OF CONCRETE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>Standard</td>
</tr>
<tr>
<td>2</td>
<td>B1</td>
<td>Standard+ 0.1% PPF</td>
</tr>
<tr>
<td>3</td>
<td>B2</td>
<td>Standard+ 0.2% PPF</td>
</tr>
<tr>
<td>4</td>
<td>B3</td>
<td>Standard+ 0.3% PPF</td>
</tr>
<tr>
<td>5</td>
<td>B4</td>
<td>Standard+ 0.4% PPF</td>
</tr>
<tr>
<td>6</td>
<td>B5</td>
<td>Standard+ 0.5% PPF</td>
</tr>
</tbody>
</table>

PPF: POLYPROPYLENE FIBRE

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 concrete paver block. For compression test there were four numbers of paver block has been casted and for water absorption three blocks were 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 7, 14 and 28 days for compressive strength and water absorption tests.

A. COMPRESSIVE STRENGTH TEST

Compressive strength tests were performed on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The block has been stored for 24 ± 4 h in water maintained at a temperature of 20 ± 5°C. The bearing plates of the testing machine shall be wiped clean. The specimens are aligned with those of the bearing plates. The load would be applied without shock and increased continuously at a rate of 15 ± 3 N/mm²/min until no greater load can be sustained by the specimen or delimitation occurs. The maximum loads applied to the specimen were noted.
B. WATER ABSORPTION TEST

The cubes after casting were immersed in water for 28 days curing. They were then weighted and this weight was noted as the wet weight of the paver block. These specimens were then oven dried at the temperature 110°C until the mass became constant and again weighed. This weight was noted as the dry weight of the paver block. % Water Absorption = [(WW – DW) / DW] x 100 Where, WW = Wet Weight of paver block, DW = Dry Weight of paver block.

TEST RESULTS

TABLE 5

COMPRESSIVE STRENGTH OF CONCRETE PAVER BLOCK (N/mm²) AT 7, 14 & 28 DAYS

<table>
<thead>
<tr>
<th>Types Of Paver Block</th>
<th>Average Ultimate Compressive Strength of cement concrete (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 DAYS</td>
</tr>
<tr>
<td>A1</td>
<td>21.86</td>
</tr>
<tr>
<td>B1</td>
<td>24.23</td>
</tr>
<tr>
<td>B2</td>
<td>25.05</td>
</tr>
<tr>
<td>B3</td>
<td>28.56</td>
</tr>
<tr>
<td>B4</td>
<td>29.90</td>
</tr>
<tr>
<td>B5</td>
<td>29.28</td>
</tr>
</tbody>
</table>
Figure 9: Compressive Strength of Concrete (N/Mm$^2$) At 7, 14 & 28 Days

TABLE 6
WATER ABSORPTION OF CONCRETE (N/mm$^2$) AT 28 DAYS

<table>
<thead>
<tr>
<th>Type of Concrete</th>
<th>Wet Weight of Cube In Grams</th>
<th>Dry Weight of Cube In Grams</th>
<th>% Water Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>3036.00</td>
<td>2942.00</td>
<td>3.20</td>
</tr>
<tr>
<td>B1</td>
<td>3112.00</td>
<td>3021.00</td>
<td>3.01</td>
</tr>
<tr>
<td>B2</td>
<td>2993.00</td>
<td>2910.00</td>
<td>3.01</td>
</tr>
<tr>
<td>B3</td>
<td>2967.00</td>
<td>2893.00</td>
<td>2.56</td>
</tr>
<tr>
<td>B4</td>
<td>2814.00</td>
<td>2765.00</td>
<td>1.77</td>
</tr>
<tr>
<td>B5</td>
<td>2774.00</td>
<td>2722.00</td>
<td>1.91</td>
</tr>
</tbody>
</table>

Figure 10: Water Absorption of Concrete (N/mm$^2$) AT 28Days
**ECONOMIC FEASIBILITY**

**TABLE 7**

**COSTS OF MATERIALS**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Materials</th>
<th>Rate (Rs/Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cement</td>
<td>5.80</td>
</tr>
<tr>
<td>2</td>
<td>Fine aggregate (Regional)</td>
<td>0.60</td>
</tr>
<tr>
<td>3</td>
<td>Semi grit (Regional)</td>
<td>0.40</td>
</tr>
<tr>
<td>4</td>
<td>Quarry dust (Regional)</td>
<td>0.20</td>
</tr>
<tr>
<td>5</td>
<td>Dolomite powder</td>
<td>1.40</td>
</tr>
<tr>
<td>6</td>
<td>Polypropylene fibre</td>
<td>280</td>
</tr>
</tbody>
</table>

**TABLE 8**

**DESIGN MIX PROPORTION FOR M20 GRADE CONCRETE PAVER BLOCK**

<table>
<thead>
<tr>
<th>SR. NO.</th>
<th>TYP</th>
<th>BOTTOM LAYER</th>
<th>TOP LAYER</th>
<th>COST OF PAVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1</td>
<td>50 50 100 175 0.00</td>
<td>50 150 0.00 0.40 1.00</td>
<td>5.79</td>
</tr>
<tr>
<td>2</td>
<td>B1</td>
<td>50 50 100 175 0.38</td>
<td>50 150 0.20 0.40 1.00</td>
<td>6.66</td>
</tr>
<tr>
<td>3</td>
<td>B2</td>
<td>50 50 100 175 0.75</td>
<td>50 150 0.40 0.40 1.00</td>
<td>7.54</td>
</tr>
<tr>
<td>4</td>
<td>B3</td>
<td>50 50 100 175 1.13</td>
<td>50 150 0.60 0.40 1.00</td>
<td>8.41</td>
</tr>
<tr>
<td>5</td>
<td>B4</td>
<td>50 50 100 175 1.50</td>
<td>50 150 0.80 0.40 1.00</td>
<td>9.28</td>
</tr>
<tr>
<td>6</td>
<td>B5</td>
<td>50 50 100 175 1.88</td>
<td>50 150 1.00 0.40 1.00</td>
<td>10.15</td>
</tr>
</tbody>
</table>

CONCLUSION
From this study the following conclusion can be drawn:

- The results presented in this paper, indicate that the addition of a 0.4% fiber mixed in concrete paver block for compressive strength.
- By addition of polypropylene fibre it improves the strength up to 40%. And reduce the water absorption.
- It makes paver block more dense compare to standard blocks.
- By addition of paver block it also improves the other properties like abrasion resistance, durability, tensile and flexural strength of paver block.
- Cost is increase by 60% compare to standard paver block but increase the characteristics of concrete paver block and life span of paver block.

ACKNOWLEDGEMENT
The Authors thankfully acknowledge to Dr.C.L.Patel, Chairman, CharutarVidyamandal, Er.V.M.Patel, Hon.Jt. Secretary, CharutarVidyamandal, Dr. F.S.Umrigar, Principal, B.V.M. Engineering College, Mr. Jayrajhai Patel, owner of jay maharaj tiles, Kanjari, Anand, Prof. J.J.Bhavsar, Civil Engineering Department, B.V.M Engineering College, Vallabh Vidyanagar, Gujarat, India for their motivations and infrastructural support to carry out this research.

REFERENCES


[17] IRC SP: 63-2004 Guidelines for Use of Interlocking Concrete Block Pavement

[18] 2.imimg.com/data2/MW/XV/MY-/recron3s-brouchre-.pdf

[19] en.wikipedia.org/wiki/Block_paving


[21] www.krishnaprecasts.com/


