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# Experimental Investigation on Properties Concrete Paver Block with the Inclusion of Natural Fibers

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**ABSTRACT**
In this experimental investigation the compressive strength, water absorption and flexural strength of paver blocks were determined by adding Coconut fibers in the top 20mm thickness. Coconut fibers were added in proportions of 0.1%, 0.2%, 0.3%, 0.4% and 0.5% in volume of concrete. The compressive strength, flexural strength and water absorption were determined at the end of 7 and 28 days. Test results indicate that addition of coconut fiber by 0.3% paver block attains maximum compressive strength. Test results indicate that addition of coconut fiber gradually increases flexural strengths and water absorption at 7 and 28 days. In this investigation at 0.3% of coconut fiber content effect of top layer thickness on compressive strength and flexural strength is also determined. Results show that inclusion of fibers even up to 50% of top layer thickness compressive and flexural strengths are increasing. The paper also shows the cost comparison per each block.
***Keywords*** **–** Coconut Fiber, Compressive Strength, Cost, Flexural Strength, Paver Block, Water Absorption.

## I. INTRODUCTION

Concrete fails suddenly under tension and cracks excessively when unreinforced. Steel rebar is conventionally used to reinforce concrete. But, it is very expensive. In tropical regions, natural fibers are abundantly available which when utilized will reduce the cost of reinforced concrete and improve its performance. Now-a-days concrete paver blocks are used in various applications like street road, small and medium market roads, low volume roads and other construction places. Concrete block pavement will absorb stress such as small earthquakes, freezes and thaws, and slight ground erosion by flexing.

In the recent past, there has been growing interest in studying the properties of coconut fibers. In the concrete paver block fibers are introduced to increases strength, durability and reduction in crakes. The concrete paver block maintenance is low and economic when compared with other pavements. The experimentally investigation is that compressive strength and flexural strength of concrete paver block is more by using fiber and it can be used in heavy traffic area and give surface resistance for higher life. By using fibers in concrete paver block it increases resistance to impact/abrasion & greatly improves quality of construction. Therefore, paver blocks with fibers do not easily crack, break or buckle like pouring asphalt or poured concrete.

### 1.1 Literature review

Alake, Adewale Doyinsola has determined "Strength development and crack pattern of coconut fiber reinforced concrete (CFRC)"the use of coconut fibers as reinforcement in concrete. Coconut fibers were extracted from coconut seeds and chopped into 40 mm in length. Compressive strength and modulus of rupture of CFRC specimens were determined following standard procedures at curing ages of 7, 21, 28 and 56 days. Also, crack pattern was monitored. Rao, K. M. M. has focused on Extraction and tensile properties of natural fibers. By using coconut fiber the tensile properties of concrete has been increased. Baruah, P., and Talukdar, S. has observed the compressive, flexural, tensile and shear strength of concrete with fibers of different origins. Compressive strength and modulus of rupture of CFRC specimens were determined at curing ages of 7, 21, 28 and 56 days. Also, crack pattern was monitored. Munawar, S.S., K. Umemura, and S. Kawai have determined the characterization of the morphological, physical, and mechanical properties of seven non-wood plant fibers. Ramakrishna, G. and Sundararajan, T. Studied on the durability of natural fibers and the effect of corroded fibers on the strength of mortar.

In the present investigation coconut fibers were added in the mix in different proportions varying from 0.1% to 0.5% in the volume of concrete. The influence of addition of these fibers in the top 20mm thickness was studied. By taking 0.3% as optimum dosage the influence of top layer thickness is also studied.

## II. MATERIAL SPECIFICATION

### 2.1 Materials:

In paver block different types of material are used. In top layer cement, semi grit, dolomite powder and pigment are used and in bottom layer cement, fine aggregate, quarry dust is used. Also at different

percentages coconut fiber are used. Ordinary Portland Cement (OPC) of grade 53 conforming to IS: 10262-2009 was used for the studies. Locally available fine aggregate with a maximum size of aggregate of 20mm was used. The size of the semi grit is less than 9.5mm were used. Quarry dust particles having size less than 4.75mm was used. Dolomite powder is one mineral with specific gravity of 2.84 to 2.86 were used. The coconut fibers of 6 mm length and diameter of 0.01 mm which was produced from Lofgren are used in the present study.

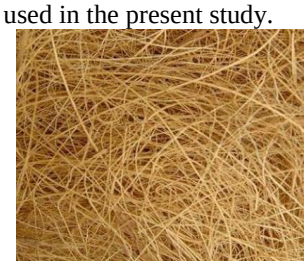

**Figure 1: Coconut Fiber**

**2.2PHYSICAL TESTS ON MATERIALS:**

**2.2.1Tests on cement:**

Fineness of the cement = 92%
Specific gravity of cement sample = 3.05
Standard consistency of cement = 27%
Initial setting time of the cement sample = 45 min
Final setting time of the cement sample = 4 hrs 42 min

**2.2.2 Tests on aggregates:**

Specific gravity of aggregate = 2.59
Water absorption of aggregate = 0.097%
Average crushing value of aggregate sample = 23.78%
Fineness Modulus = 293/100 = 2.93

**2.2.3 Test on semi grit:**

Fineness Modulus = 314.8/100 = 3.148

**2.2.4 Test on quarry dust:**

Fineness Modulus = 426.6/100 = 4.266

**2.3 Mix proportion:**

All the mixes prepared are corresponds to M-20 grade. For the design of mix IS: 10262-2009 & IS: 15658:2006 recommendations are adopted.

**Mix Design Proportion for Top Layer**

| Sample | Cement | Pigment | Semi Grit |
|---|---|---|---|
| Top Layer | 50Kg | 4Kg | 100 Kg |
| Ratio | 1 | 0.08 | 2 |

**Mix Design Proportion for Bottom Layer**

| Sample | Cement | Fine aggregate | Quarry Dust | Dolomite Powder |
|---|---|---|---|---|
| Bottom Layer | 50 Kg | 50 Kg | 175 Kg | 150Kg |
| Ratio | 1 | 1 | 3.5 | 3 |

## III. EXPERIMENTAL METHODOLOGY

Paver block concrete contains cement, fine aggregate, and quarry dust in the bottom layer of paver block and in the top layer of paver block only a mixture of cement, semi grit, dolomite powder and pigment is used. In the top layer 20 mm coconut fiber is to be added to the concrete in proportions of 0.1%, 0.2%, 0.3%, 0.4% and 0.5% by weight of the concrete. 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 and 28 days for compressive strength, flexural strength and water absorption tests.

**3.1 Test Specimen and testing procedures**

For compressive strength test, water absorption and flexural strength test paver block of dimensions 200x100x80 mm were casted. The moulds were prepared with 0%, 0.1%, 0.2%, 0.3%, 0.4% and 0.5% coconut fiber. The samples were cured in water at 7 and 28 days. For determining the compressive strength samples were tested in compressive testing machine and flexural strength test was conducted using universal testing machine. The compressive, flexural and water absorption tests are conducted as per IS: 15658:2006. In each category three cubes were tested and their average value is reported.

**Fig . No.1. Compressive strength test**


**Fig .No.2. Flexural strength test**

## IV. EXPERIMENTAL RESULT

### 4.1 Compressive strength

The compressive strength values of the standard concrete paver block & paver block with coconut fibers in top 20mm layer thickness were presented in figure.3.

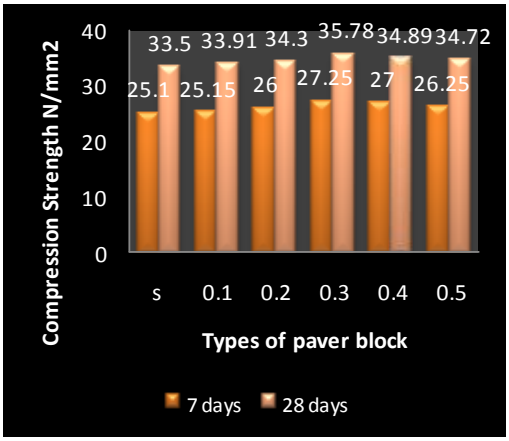


**Fig .No.3. Compressive strength at 7 & 28 days for Paver blocks without and with fibers**

From fig.3. it is observed that the compressive strength of concrete paver block is increasing with the increase in fiber content compared to standard concrete paver block at 7 and 28 days.It is observed that at 0.3% of fiber maximum strength was attained and later with increase in fiber content strengths are falling down. The increment in the compressive strength at 0.3% fiber content is 8.57% and 6.81% at the age of 7 and 28 days respectively.

### 4.2 Water absorption

The water absorption values of the concrete paver blocks at the age of 7 and 28 days are determined and the results were presented in figure.4.

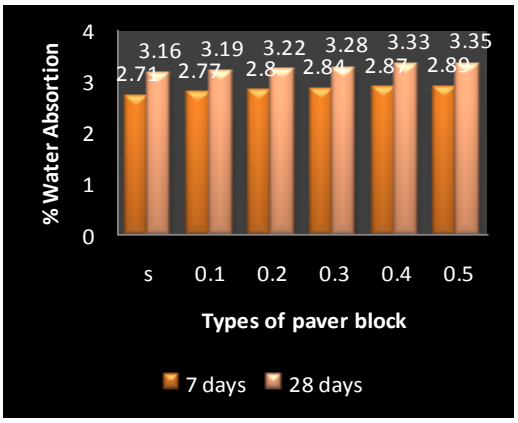


**Fig .No.4. Water absorption at 7 & 28 days for Paver blocks without and with fibers**

From fig.4 it is observed that the fiber content is increased from 0.1% to 0.5% water absorption is increasing. Compared to the standard paver block there is a increment of 6.64% and 6.01% at the age of 7 and 28 days respectively. But according to IS 15658:2006 the water absorption for concrete paver block is 7%.

### 4.3 Flexural strength

The flexural strength values of the standard concrete paver block & paver block with coconut fibers in top 20mm layer thickness were presented in figure.5.

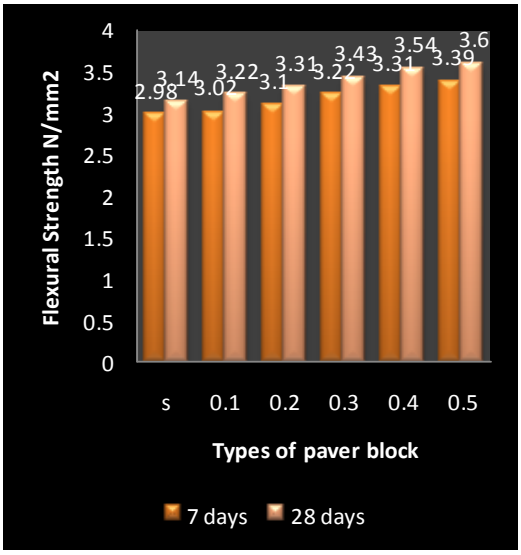


**Fig .No.5. Flexural strength at 7 & 28 days for Paver blocks without and with fibers**

From fig.5 it is observed that the flexural strength of concrete paver block is increasing with the increase in fiber content compared to standard

concrete paver block at 7 and 28 days.It is observed that increasing fiber concent increases strength of paver blocks. The increment in the flexural strength at 0.5% fiber content is 13.76% and 14.65% at the age of 7 and 28 days respectively.

**4.4 Compressive strength**

The compressive strength values of standard concrete paver block and paver block on changing the top layer thickness with fibers are as shown in figure.6.

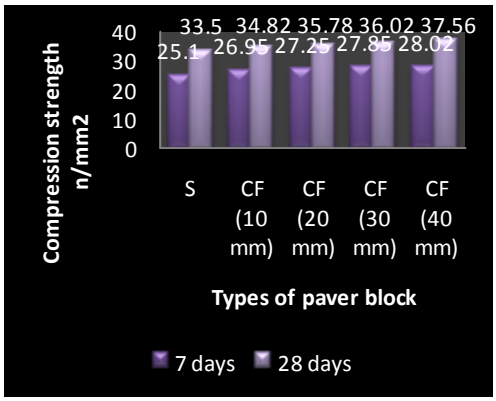


**Fig .No.6. Compressive strength of paver block at 0.3% fiber by changing top layer thickness**

From fig.6 it is observed that the compressive strength of concrete paver block with 0.3% coconut fibers is increasing by increasing the thickness of the top layer. The increment in the compressive strength by changing top layer 40mm is 11.63% and 12.11% compared to standard concrete paver block at the age of 7 and 28 days respectively.

**4.5 Flexural strength**

The flexural strength values of standard concrete paver block and paver block on changing the top layer thickness with fibers are as shown in figure.7.

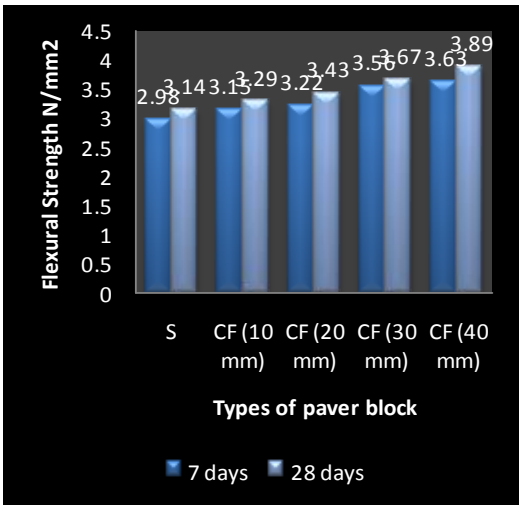


**Fig .No.7. Flexural strength of paver block at 0.3% fiber by changing top layer thickness**

From fig.7 it is observed that as the toplayer thickness is increasing the flexural strength of concrete paver block is significantly improving. The increment in the flexural strength by changing top layer 40mm is 21.81% and 23.89% compared to standard concrete paver block at the age of 7 and 28 days respectively.

## V. COST COMPRASION

**5.1 ECONOMIC FEASIBILITY**

**Table 5.1 : Cost of Materials**

| Sl. No | Materials | Rate (Kg/Rs) |
|---|---|---|
| 1 | Cement | 5.80 |
| 2 | Semi Grit | 0.60 |
| 3 | Dolomite Powder | 1.40 |
| 4 | Fine Aggregate | 0.80 |
| 5 | Quarry Dust | 0.40 |
| 6 | Coconut Fiber | 30 |

**Table 5.2 : Cost of Each Paver Block with and without Fiber**

| Sl. No | Types of Paver Blocks | Cost of Each Paver Block (RS) |
|---|---|---|
| 1 | S | 7.77 |
| 2 | CF (0.1 %) | 7.82 |
| 3 | CF (0.2 %) | 7.88 |
| 4 | CF (0.3 %) | 7.93 |
| 5 | CF (0.4 %) | 7.99 |
| 6 | CF (0.5 %) | 8.04 |

**Table 5.3: Cost of Each Paver Block by Changing Top Layer Thickness with Polyester Fiber:**

| Sl. No | Types of Paver Blocks | Cost of Each Paver Block (RS) |
|---|---|---|
| 1 | CF (10 mm) | 7.95 |
| 2 | CF (20 mm) | 7.93 |
| 3 | CF (30 mm) | 7.91 |
| 4 | CF (40 mm) | 7.89 |

## VI. CONCLUSION

From this study the following conclusion can be drawn:

1. Compressive Strength enhancement ranges from 1.22% to 6.81% when % of fiber increases from 0.1% to 0.3% when compared to the concrete paver block at 28 days.
2. As the fiber content is increased from 0.1% to 0.5% there is an increase in the water absorption from 0.95% to 6.01% compared to the concrete paver block at 28 days.
3. At the age of 28 days, there is a significant improvement in the flexural strength with the addition of fibers. The increment in the flexural strength is from 2.55% to 14.65% when % of fibers varied from 0.1% to 0.5% respectively.
4. By changing the top layer thickness from 10mm to 40mm the compressive strength increases gradually from 3.94% to 12.11% when compared to the concrete paver block at 28 days.
5. Flexural strength is significantly improving from 4.78% to 23.89% when compared to the concrete paver block at 28 days, as the top layer thickness is varied from 10mm to 40mm.
6. A small increment in cost can be observed for paver blocks with fibres in top 20mm thickness when compared to standard paver block but increases the characteristics of concrete paver block and life span of paver block and reduces the maintenance.
7. By changing the top layer thickness and using coconut fibres the properties of the paver block are improving significantly and also it is found to be economical.

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