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Influences of polyester fiber on concrete paver blocks

G. Navya[1], J. Venkateswara Rao[2]
[1](P.G student, Department of civil engineering, G.M.R.I.T, India)
[2](Associate professor, Department of civil engineering, G.M.R.I.T, India)

Abstract: *In this experimental investigation the compressive strength, water absorption and flexural strength of paver blocks were determined by adding Polyester fibers in the top 20mm thickness. Polyester 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 polyester fiber by 0.4% paver block attains maximum compressive, flexural strengths and minimum water absorption at 7 and 28 days. In this investigation at 0.4% of polyester 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: *Compressive Strength, Cost, Flexural strength, Paver Block, Polyester Fiber and Water Absorption.*

I. Introduction

Concrete block paving is versatile, aesthetically attractive, functional and cost effective and requires little or no maintenance if correctly manufactured and lay. Concrete paving blocks are also utilized in a variety of commercial, municipal and industrial applications. But 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. A concrete block pavement may be preferable to conventional pavements for some specific applications. By using concrete block paver, pavement materials are not wasted and jackhammers or heavy equipment are not required. Concrete block pavement will absorb stress such as small earthquakes, freezes and thaws, and slight ground erosion by flexing.

Recently in concrete paver block fibers are introduced to increases strength, durability and reduction in crakes. By using fibers in concrete paver block it improves properties of paver block. A concrete block pavement may be preferable to conventional pavements for some specific applications. 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

Shackel, B.(1990)[1] has determined that concrete block pavement can support heavy loads similar to that of asphaltic concrete. The cost maintenance is very low when compared to other pavement. These concrete block pavement are used as an alternative pavement for heavy industrial and airport areas with several successful applications worldwide. Midrand (2001) [2] studied concrete blocks, moulds, shapes and castings during manufacturing process. Currently these concrete block paver are used for many purposes like, concrete / plaster castings, precast tiles, stones and bricks, concrete splash blocks, gutter block molds, precast concrete paver blocks etc. Aslantaş, Onur (2004) [3] has concluded that concrete blocks showed best performance at a specific water content called optimum moisture content. By testing abrasion resistance the pigments used for the upper part of the mix has an effect on the abrasion resistance. As the cement content in a mix increases to obtain higher strengths, the W/C ratio should be lowered as higher water contents cause some stability and segregation problems. Bikasha C. P.and AshokK.G(2007) [4] has conducting tests on different shapes, thickness, size gives different compressive strength and the path seems to different for different shapes. The effect of load repletion on the pavement behavior is discussed. The mechanism of load transfer, the effect bedding sand, jointing sand and edge restraints are discussed. It is found that shape, size, thickness of block have a significant influence on the behavior of concrete block pavement. Bhavin k. Kashiyani, Jayeshkumar pitroda (2013) [5] has determined that addition of polypropylene fibers only in the top layer (15 mm) of paver block for determines the change in the compressive strength of paver blocks and water absorption is observed. The maintenance cost of paver block is also very low. Dr. B .K.Shah (2013) [6] studied by addition of polypropylene fibers in paver block to show the change in the Abrasion Resistance and Flexural Strength of paver blocks when compared to standard paver

block and reduces the maintenance cost of paver block. 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. In the present investigation polyester 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 0.4% 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 both polyester 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 with a specific gravity of 2.59 was used. The size of the semi grit is less than 9.5mm with a fineness modulus of 3.14. Quarry dust particles having size less than 4.75mm with a fineness modulus of 4.26. Dolomite powder is one mineral with specific gravity of 2.84 to 2.86 were used. The polyester fibers of 8 mm length and diameter of 0.045 mm which was produced from reliance industries Ltd., Mumbai are used in the present study.

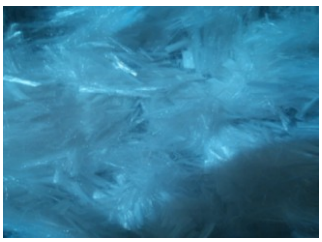

Figure 1: Polyester Fiber

Table. 2.1 Shape and Size of Paver Block

Block shape	Length(mm)	Width(mm)	Thickness(mm)
Rectangle shape	200	100	80

2.2 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.

Table. 2.2 Mix Design Proportion for Top Layer

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

Table. 2.3 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 polyester 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% polyester 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. Concrete Paver Block in Oven

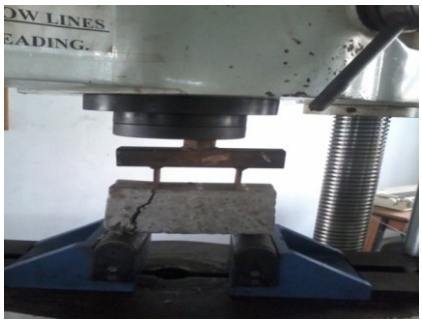

Fig .No.3. Flexural strength test

IV. Experimental Result

4.1 Compressive strength

The compressive strength values of the standard concrete paver block & paver block with polyester fibers in top 20mm layer thickness were presented in figure.4.

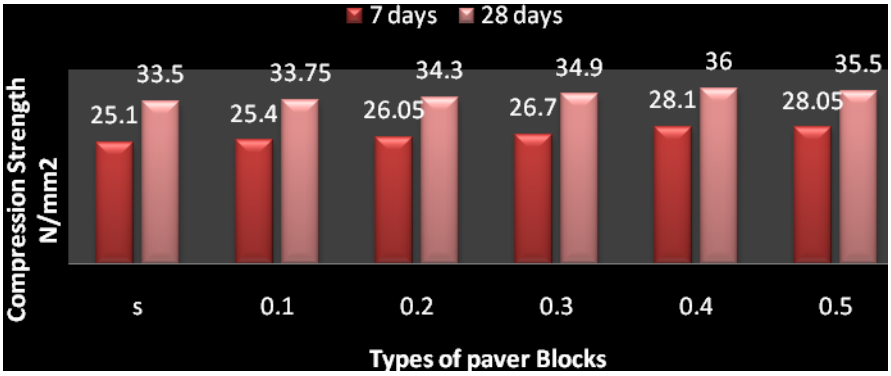

Fig .No.4. Compressive strength at 7 & 28 days for Paver blocks without and with fibers

From fig.4. 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 0.4% of fiber maximum strength was attained and later with increase in fiber content strengths are falling down. The increment in the compressive strength at 0.4% fiber content is 11.95% and 7.46% 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.5.

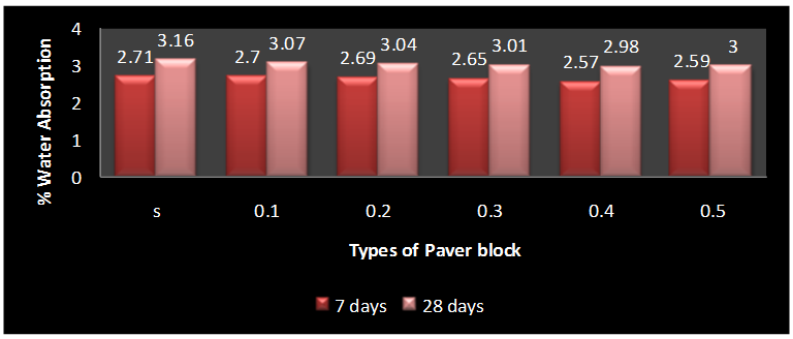

Fig .No.5. Water absorption at 7 & 28 days for Paver blocks without and with fibers

From fig.5 it is observed that the fiber content is increased from 0.1% to 0.4% water absorption is decreasing. At 0.4% polyester fibers the water absorption is found to be minmimum. Compared to the standard paver block there is a decrement of 5.16% and 5.69% at the age of 7 and 28 days respectively.

4.3 Flexural strength

The flexural strength values of the standard concrete paver block & paver block with polyester fibers in top 20mm layer thickness were presented in figure.6.

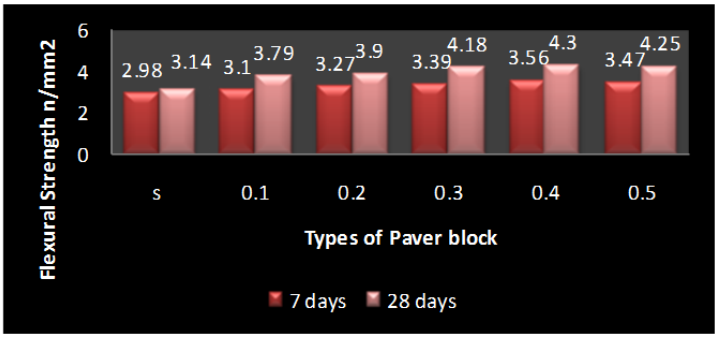

Fig .No.6. Flexural strength at 7 & 28 days for Paver blocks without and with fibers

From fig.6 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 at 0.4% of fiber maximum strength was attained. The increment in the flexural strength at 0.4% fiber content is 19.46% and 36.9% 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.7.

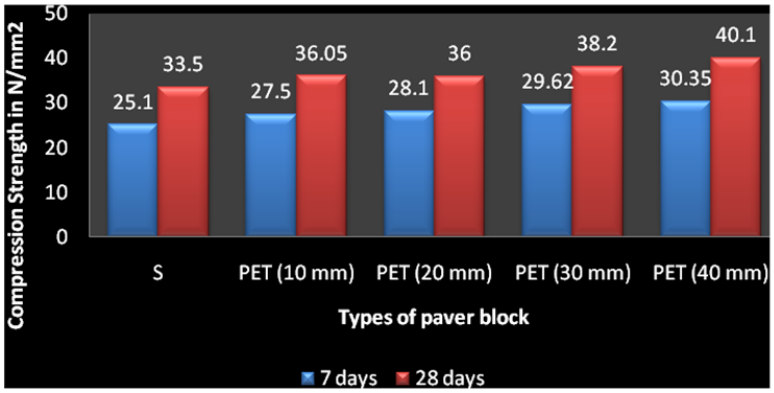

Fig .No.7. Compressive strength of paver block at 0.4% fiber by changing top layer thickness

From fig.7 it is observed that the compressive strength of concrete paver block with 0.4% polyester fibers is increasing by increasing the thickness of the top layer. The increment in the compressive strength by

changing top layer 40mm is 20.91% and 19.70% 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.8.

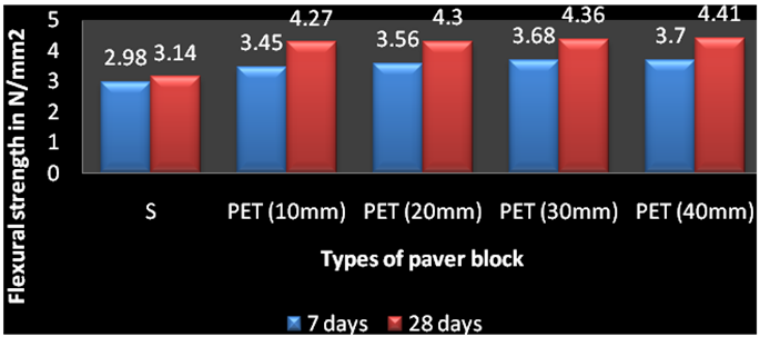

Fig .No.8. Flexural strength of paver block at 0.4% fiber by changing top layer thickness

From fig.8 it is observed that as the toplayer layer 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 24.16% and 40.44% 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	Polyester Fiber	400

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	PET (0.1 %)	8.34
3	PET (0.2 %)	8.92
4	PET (0.3 %)	9.49
5	PET (0.4 %)	10.07
6	PET (0.5 %)	10.65

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	PET (10 mm)	11.1
2	PET (20 mm)	10.07
3	PET (30 mm)	9.04
4	PET (40 mm)	8.01

VI. Conclusion

From this study the following conclusion can be drawn:

1. Compressive Strength enhancement ranges from 0.74% to 7.46% when % of fiber increases from 0.1% to 0.4% when compared to the concrete paver block at 28 days.
2. As the fiber content is increased from 0.1% to 0.4% there is an decrease in the water absorption from 2.84% to 5.69% compared to the concrete paver block at 28 days. It can be concluded that as fiber content increases paver block is becoming denser.
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 20.70% to 36.9% when % of fibers varied from 0.1% to 0.4% respectively. 0.4% is observed as the optimum value**.**
4. By changing the top layer thickness from 10mm to 40mm the compressive strength increases gradually from 4.62% to 19.70% when compared to the concrete paver block at 28 days.
5. Flexural strength is significantly improving from 35.98% to 40.44% 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 the cost of paver block decreases.

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