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Experimental Investigation on Foundry Sand Paver Block with addition of Polyethylene Terephthalate Fibre

M.Suriya[1], V.Sabarinathan[2], S.Rajeshkumar[3], M.Sivakumar[4], M.Yeswanth[5]

[1234](UG students, Civil engineering department, Nandha Engineering College, Tamilnadu, INDIA)

[5](Assistant Professor, Civil engineering department, Nandha Engineering College, Tamilnadu, INDIA)

Abstract: In this experimental investigation compressive strength and water absorption of paver block were evaluated by replacing portion of M-Sand with the Foundry Sand. Polyethylene Terephthalate fibers were also incorporated along with the Foundry Sand to further enhance the mechanical properties. The different proportions of Polyethylene Terephthalate fiber starting from 0.4% by weight of materials. 10% to 30% by weight of M-Sand was replaced with the Foundry Sand. From the test results obtained the optimum Polyethylene Terephthalate fiber and Foundry Sand content from test results was found to be 0.5% and 25% by weight respectively.

Keywords: Compressive Strength, Foundry sand, Polyethylene Terephthalate fibers, Water Absorption, Paver Block.

I. INTRODUCTION

Concrete is a mixture of cement, water and aggregates, with or without admixture. Consequently, pavements in which non-interlocking blocks are used are designed as concrete block pavement. The concrete paver blocks laid on a thin, compacted bedding material which is constructed over a properly profiled base course and is bounded by edge restrains/kerb stones. Many number of such applications for light, medium, heavy and very heavy traffic conditions are currently in practice around the world. The recommended dimensions and thickness of paver block shall be 50mm and maximum 120mm. In this project the paver block designed medium traffic category for recommended grade designation is M_{40} and recommended minimum paver block thickness is 60mm. Concrete block paving is versatile, attractive, functional and cost effective and requires little or no maintenance if correctly manufactured and lay. Recently in concrete paver block fibres are introduced to increases strength, durability and reduction in cracks. Instead of using fiber used in paver block to increases the properties of paver block. The concrete paver block maintenance is low and economic when compared with other pavements. Foundry Sand consists primarily of clean, uniformly sized, high- quality silica sand or lake sand that bounded to from mold for ferrous (iron and steel) and nonferrous (copper, aluminum, brass) metal castings. Foundry Sand is used as a direct replacement of M-Sand. Replacement levels for Foundry Sand vary from 10% to 30%.

1.1 Literature Review

Dixit N. Patel Jayeshkumar, R. Pitroda (2016) Foundries for the metal-casting industry generate by-products such

as used foundry sand. Applications of foundry sand, which is technically, sound, environmentally safe for sustainable development. In this study, partially replacement of M-sand in paver block by used foundry sand for determining the change in the compressive strength of paver blocks and cost of paver block. Partial replacement of M-sand in bottom layer in different percentage as like 10%, 20%, 30%, 40% and 50%. The compressive strength, flexural strength has been determined at the end of 7, 14 and 28 days and water absorption test has been determined at 28 days. The paper also shows the cost comparison per block for the paver block mix proportion.

Kewal (2015) discussed that the partially replacement of fine aggregate in Geopolymer paver block by used foundry sand for determining the change in the compressive strength of paver blocks and cost of paver block. Partial replacement of fine aggregate in different percentage as like 0%, 20%, 40%, 60%, 80% and 100%. The compressive strength has been determined at the end of 7, 14 and 28 days and water absorption test has been determined at 28 days. The Compressive strength of Geopolymer Paver Block was found to be decreasing with replacement of foundry sand. Up to 60% replacement of fine sand by foundry sand gives slightly high compressive strength was found to be optimum.

Madam Mohan Reddy, K, Ajitha .B, and Bhavani .R (2016) The concrete consist of cement, sand, Aggregate and water. Out of which the aggregate percentage is 60 to 70 % in concrete and from the above observation, it is computed to use the 20% Recycled plastic aggregate in concrete which does not affect the properties of concrete. From the above observation it is possible to use the plastic in concrete mix up to 20 % weight of coarse aggregate. Looking in to above aspect we come to the conclusion that plastic can be in cement concrete mix increase the % in plastic to increase the strength of concrete.

II. MATERIAL PROPERTIES

2.1 Cement

Cement is a binding material in concrete which binds the other material to forms a compact mass. In this project work, OPC 53 grade cement is used for experimental study.

Table 2.1 Properties of Cement

Fineness value	8.5
Consistency	31%
Initial setting time	32min
Specific gravity	3.15

2.2 Water

Water conforming to the requirements of IS 456-2000 is found be satisfactory for making concrete. In the present investigation, portable drinking water available in the industrial company was used for mixing and curing the paver block.

2.3 Coarse Aggregate

Locally available crushed stone aggregates of nominal size 10mm. wherever possible size of aggregate 10mm used in the project.

Table 2.2 Properties of Coarse Aggregate

Description of test	Test result obtained	Permissible limits as per IS:383-1970
Specific gravity	2.66	Minimum 2.5
Fineness	6.13	

modulus		
Unit weight (kg/m^3)	1600	

2.4 Fine Aggregate

A concrete with better quality can be made with sand consisting of rounded grains rather than angular grains. River or pit sand must be used but not used sea sand as it contains salt and other impurities. In this study, river sand has been used as fine aggregate.

Table 2.3 Properties of Fine Aggregate

Description of test	Test result obtained	Permissible limits as per IS 383:1970
Specific gravity	2.61	Minimum 2.5
Fineness modulus	3.24	
Unit weight of sand (kg/m^3)	1600	

2.5 Foundry Sand

Foundry Sand is a byproduct of the ferrous and nonferrous metal casting industry, where sand has been used for centuries as a molding material because of its unique engineering properties. In modern foundry practice, sand is typically recycled and reuse through many production cycles. The specific gravity of Foundry Sand is 2.39 to 2.55.

Table 2.4 Properties of Foundry Sand

S.No	Description	Percentage of Content
1	CaO	0.45%
2	SiO_2	87.91%
3	AL_2O_3	4.70%
4	MgO	0.30%

2.6 Polyethylene Terephthalate fibers

Table 2.5 Polyethylene Terephthalate fibers

Specific gravity	1.35-1.45
Aspect ratio	757
Diameter	0.035mm
Density	0.90kg/Cu.m
Colour	White
Length	30mm

Fig 2.1 Polyethylene Terephthalate fibers

2.7 Slump Test

This is a test extensively used in construction site. It is very useful in detecting the variation in the uniformity of mix of given nominal proportion. It also give an idea of water cement ratio need for concrete to be used for different works.

Table 2.6 Slump Test

S.No	% Replacement of Foundry sand & Polyethylene	Slump Value (mm)

	Terephthalate fibers	
1	M	95
2	$MPT_{0.4}F_{10}$	90
3	$MPT_{0.4}F_{15}$	90
4	$MPT_{0.4}F_{20}$	85
5	$MPT_{0.4}F_{25}$	80
6	$MPT_{0.4}F_{30}$	75

2.8 Paver Block

Block paving also known as brick paving is a commonly used decorative method of creating a pavement or hardstanding.

Fig 2.2 Paver block

Table 2.7 Paver Block

Size (cm)	26.5x14.25x0.60
Mould	Rubber Mould
Patten	Zig Zag

III. MIX PROPORTION

In this study, control mix was designed as per IS 10262:2009 for M_{40} grade. Polyethylene Terephthalate fibers was initially added 0.4% by weight of concrete. Optimum Polyethylene Terephthalate fibres and Foundry sand. Foundry sand was replaced for M-sand in percentages 10 to 30. The details of the mix proportions of paver blocks were given in following table 3.1. Each mix proportion for 11 paver blocks.

Mix Proportion : 1:1.7: 2.9

Table 3.1 Mix Design

Title	Specification
Grade of Concrete	M_{40}
Type and Grade of Cement	OPC 53 Grade
Size of Coarse Aggregate	10mm
Specific Gravity of Coarse Aggregate	2.66
Specific Gravity of Fine Aggregate	2.61
W/C Ratio	0.45

Table 3.2 Mix Proportion Details

→ Materials / Mix ↓	Cement (kg)	FA (kg)	CA (kg)	Water (lit)	FS (kg)	PTF (g)
M	9.93	17.250	29.59	2.221	0	0
$MPT_{0.4}F_{10}$	9.93	15.537	29.59	2.221	1.713	44
$MPT_{0.4}F_{15}$	9.93	14.668	29.59	2.221	2.582	44
$MPT_{0.4}F_{20}$	9.93	13.008	29.59	2.221	3.450	44
$MPT_{0.4}F_{25}$	9.93	12.931	29.59	2.221	4.319	44
$MPT_{0.4}F_{30}$	9.93	12.022	29.59	2.221	5.030	44

IV. EXPERIMENTAL METHODOLOGY

4.1 Compressive strength test

Paver blocks were casted conforming to the mix proportion and recommendations laid down in IS: 15658:2006. The paver blocks were casted control mix M, and mix with $MPT_{0.4}F_{10}$, $MPT_{0.4}F_{15}$, $MPT_{0.4}F_{20}$, $MPT_{0.4}F_{25}$, $MPT_{0.4}F_{30}$. The paver blocks were cured in 7, 21and 28 days. For

determining compressive strength, paver blocks were tested in compressive testing machine. Now a result in Polyethylene Terephthalate fibers and Foundry sand was determined.

Fig 4.1 Compressive strength test

Table 4.1 Compressive Strength Test

Compressive Strength Test			
Mix	At 7 Days (N/mm²)	At21 Days (N/mm²)	At 28 Days (N/mm²)
M	24.57	37.86	38.51
$MPT_{0.4}F_{10}$	35.85	46.83	47.16
$MPT_{0.4}F_{15}$	29.89	37.19	40.50
$MPT_{0.4}F_{20}$	27.09	38.26	41.20
$MPT_{0.4}F_{25}$	26.93	39.65	42.52
$MPT_{0.4}F_{30}$	28.43	39.85	41.85

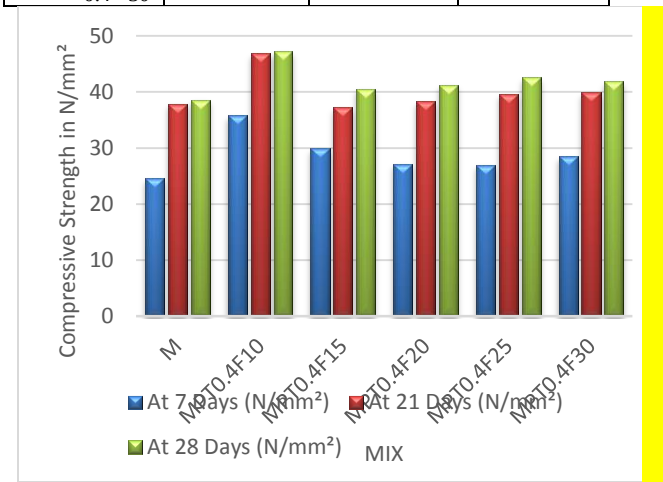

Fig 4.2 Compressive Strength Test

4.2 Water Absorption Result

The water absorption tests were conducted as per IS: 15658:2006. The water absorption values of the conventional concrete paver block & paver block with Foundry sand and Polyethylene Terephthalate fibres was determined.

The paver blocks after casting were immersed in water for 7, 21 and 28 days curing. They were weighted and this weight was noted as the wet weight of the paver block. These specimens were taken into oven dried at the temperature 100°c the mass became constant and again weighed.

Table 4.2 Water Absorption Test

Water Absorption Test			
Mix	At 7 Days	At 21 Days	At 28 Days
M	4.20	4.23	4.10
$MPT_{0.4}F_{10}$	4.10	4.10	4.15
$MPT_{0.4}F_{15}$	4.54	4.41	4.10
$MPT_{0.4}F_{20}$	4.31	4.45	4.24
$MPT_{0.4}F_{25}$	4.00	4.18	4.05
$MPT_{0.4}F_{30}$	4.31	4.45	4.25

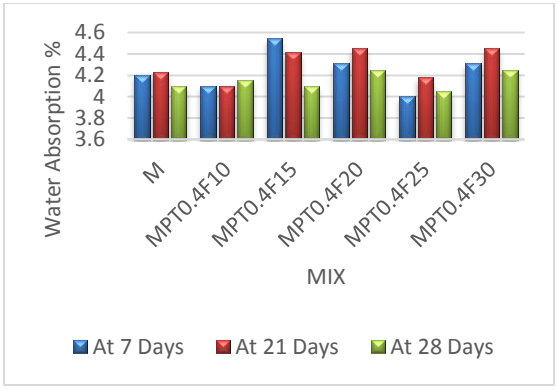

Fig 4.3 Water Absorption Test

V. RESULTS & DISCUSSION

Specific gravity of foundry sand higher than m-sand.

Based on various researches it is observed that 10% replacement generally gives maximum strength compared to conventional concrete paver block.

In concrete paver block is more economical compared to conventional concrete paver block.

Workability of the concrete paver block goes on continuously increasing in the percentage of waste foundry sand.

Compressive strength of paver block increases by foundry sand, addition polyethylene terephthalate fibers and optimum content of foundry sand and polyethylene terephthalate fibres inclusion was 10% & 0.4%.

Water absorption of concrete paver block is slightly increasing compared to conventional paver block.

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