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Sustainable Paver Block using Waste Plastic and Construction Demolition Waste

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Abstract – This study is aimed at utilizing plastic and construction demolition waste in production of convention concrete paver blocks. In India on an average 26,000 Tonnes of Plastic waste is generated per day, majority of this remains uncollected. According to the statistics, only 5% of the Construction & Demolition waste are processed. In this study an attempt has been made to use plastic waste and construction demolition waste in producing paver blocks and their behavior in compression is studied. The density test and the water absorption tests also have been performed on these paver blocks to study their suitability for the practical usage of the blocks. The study indicates that utilization of plastic waste results in reduced compressive strength and water absorption but it showed an increase in the density.

Index Terms – Paver Blocks, Construction Demolition Waste, Plastic Waste.

I. INTRODUCTION

Conventional paver block production uses cement as a binder material natural resources such as crushed stone as fine aggregates coarse aggregates which are depleting fast. In order to avoid the use of cement and natural resources we have studied using the plastic which is constantly generated as a binder and Inorganic municipal waste such as construction demolition waste and waste glass powder as fine aggregates and coarse aggregates. This will help in reducing the impacts of waste disposal on environment and wastage of land for Landfill.

Fig. 1 Plastic deposited in land and water

II. RESEARCH OBJECTIVES

- Characteristic studies of construction demolition waste used as aggregates and waste plastic as a binder in prototype paver blocks.
- Conduct the experimental studies on paver block made with waste plastic and construction demolition waste.
- Comparative studies of characteristic properties of conventional paver blocks and prototype paver block produced.
- To achieve of cost effective and good quality prototype paver block.

III. METHODOLOGY OF THE STUDY

A. Materials used

Waste plastic is collected from the nearby BBMP waste processing yard, Yelahanka, that are collected from nearby wards. The types of plastic collected are Polyethylene, i.e. waste plastic covers, wrappers, carry bags, package covers, etc. The construction and demolition waste are collected near the college. A large piece of concrete debris was broken manually into small pieces and taken for processing.
The process of recovering waste plastic and reprocessing the material involves

- Collecting
- Sorting
- Resizing/shredding
- Washing
- Drying

Design Experiment and Testing

Trial mixes
Conventional paver block is casted using conventional concrete. A Standard M20 Concrete mix proportion of 1:1:2 (Cement : Fine Aggregates : Coarse Aggregates) is used for the Conventional Concrete Paver Block.

1. **Trial mix 1**: In this proportion plastic waste is used as binder and demolition aggregates of size passing 10mm sieve and retained on 4.75 mm is mixed in three different proportions as (Plastic : coarse Aggregates) 1:5, 1:4, 1:1.33.

2. **Trial mix 2:** In this proportion plastic waste is used as binder and demolition aggregates is taken as passing 4.75mm IS sieve as fine aggregates as a filler material and aggregates passing 10 mm and retained on 4.75mm Is sieve as coarse aggregates is mixed in three different proportions. (Plastic : Fine Aggregates : Coarse Aggregates) 1:0.75:2.28, 1:1.2:2.8, 1:2:3.

B. Standard tests on materials

Table 1. Standard Material Test Values

Property	**Result**
Polyethylene (PE)	
Melting Temperature	110°C
Heat Deflection Temperature	21 – 66°C
Specific Gravity	0.92
Density	0.910 – 0.940 g/cm3
Shrink Rate	2.4 – 3.1% (0.24 – 0.31 in/in)
Tensile Strength	7 MPa
Flexural Strength	6 MPa
Water absorption	Very low
Fine Aggregates	
Specific gravity	2.44
Coarse Aggregates	
Specific gravity	2.77
Water absorption	0.8%

Aggregate Impact value	32.33%
Aggregate Crushing value	26.5%

IV. EXPERIMENTAL PROCEDURE

- Collection of ingredients to produce the target concrete mix
- Designing concrete for a target strength of M25.
- Casting of paver block of size 200 x 200 x 60 mm, for different mixes as mentioned in Table 2 and Table 3.
- In this study a total of 54 paver blocks were casted measuring size 200 x 200 x 60 mm and tested for compression, density and water absorption, after a curing period of 28 days.

Trial mix 1: In this proportion plastic waste is used as binder and demolition aggregates of size passing 10mm sieve and retained on 4.75 mm is mixed in three different proportions.

Table 2. Trial Mix 1

Mix Proportion	Plastic : Coarse Aggregates
1	1 : 5
2	1 : 5
3	1 : 3.33

Trial mix 2: In this proportion plastic waste is used as binder and demolition aggregates is taken as passing 4.75mm IS sieve as fine aggregates as a filler material and aggregates passing 10 mm and retained on 4.75mm Is sieve as coarse aggregates is mixed in three different proportions.

Table 3. Trial Mix 2

Mix Proportion	Plastic : Fine Aggregates : Coarse Aggregates
1	1 : 0.75 : 2.28
2	1 : 1.2 : 2.8
3	1 : 2 : 3

Fig. 2 Casted Concrete Paver Block

V. RESULTS AND DISCUSSIONS

A. Compressive strength:

By observing the above results and graph 1, it is seen that the strength of the paver block is reduced gradually with the gradual increase in the quantity of plastic proportion. These results show that as the cementitious materials present in the paver blocks reduces the load bearing capacity of the plastic paver blocks also reduces.

Table 4. Compression test on Paver Blocks

Sl. No.	Proportion of Paver Block Plastic: Aggregates	Size of Paver Block	Load (N)	Surface Area (mm^2)	Strength (MPa)
1.	1:5	75 x 75 x 75	23.40×10^3	5625	4.16
2.	1:4	75 x 75 x 75	21.66×10^3	5625	3.85
3.	1:3.33	75 x 75 x 75	15.36×10^3	5625	2.73
4.	1:2.85	75 x 75 x 75	13.78×10^3	5625	2.45

Fig 3. Compression test on Plastic Paver Block

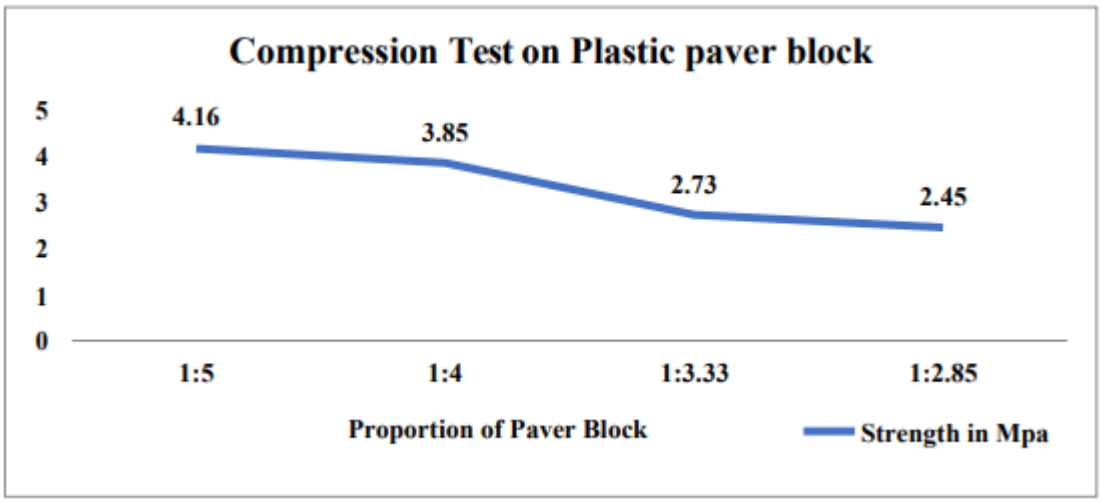

Fig. 4 Compression test on Plastic Paver Block

B. Density:

By observing the results from the table and graph 2, it has showed that the density of the plastic paver blocks increases as the quantity of the materials increases gradually in different proportions.

Table 5. Density test on Paver Blocks

Sl. No.	Proportion of Paver Block Plastic : Aggregates	Weight of Paver block (Kg)	Volume of Paver Block (m^3)	Density of Paver Block (Kg/m^3)
1.	1:5	0.456	0.00034	1341.18
2.	1:4	0.473	0.00034	1391.18
3.	1:3.33	0.498	0.00034	1464.71
4.	1:2.85	0.521	0.00034	1532.35

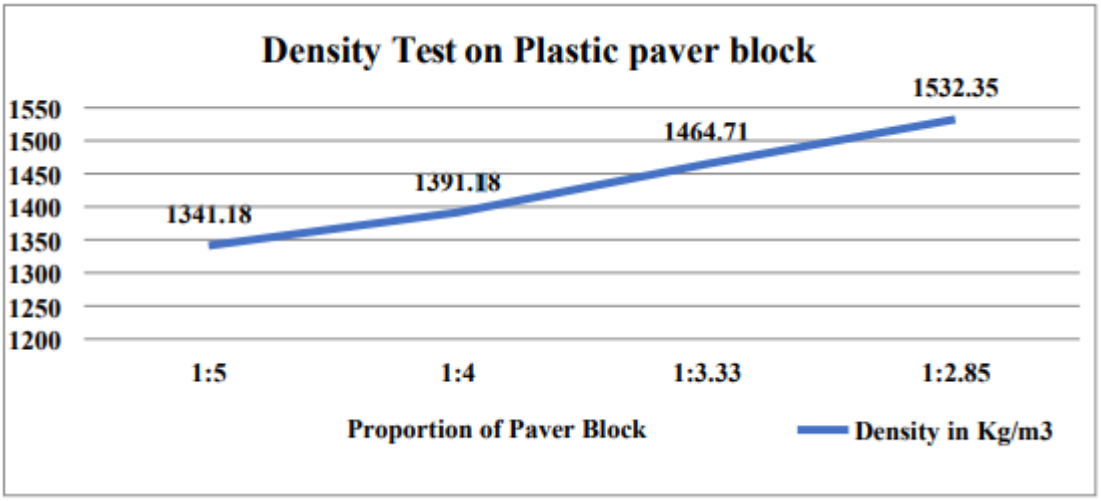

Fig. 5 Density Test on Plastic Paver Block

C. Water Absorption:

By observing the results from the table and graph 3, it isseen that as the quantity of plastic increases in the paver block the water is less observed by the blocks. As the plastic quantity in the paver blocks increases, the pores present in the paver block is filled up by the plastic. Hence, the pores are reduced and the water observing capacity in the plastic paver block is reduced.

Table 6. Water Absorption Test on Paver Blocks

Sl. No.	Proportion of Paver Block Plastic : Aggregates	Weight of Paver block before immersing in water (gms)	Weight of Paver block after 24 hrs in water (gms)	Qty of water observed by Paver Block (gms)	Percentage of Water observation (%)
1.	1:5	456	471	15	3.29
2.	1:4	473	485	12	2.54
3.	1:3.33	498	508	10	2.01
4.	1:2.85	521	529	8	1.54

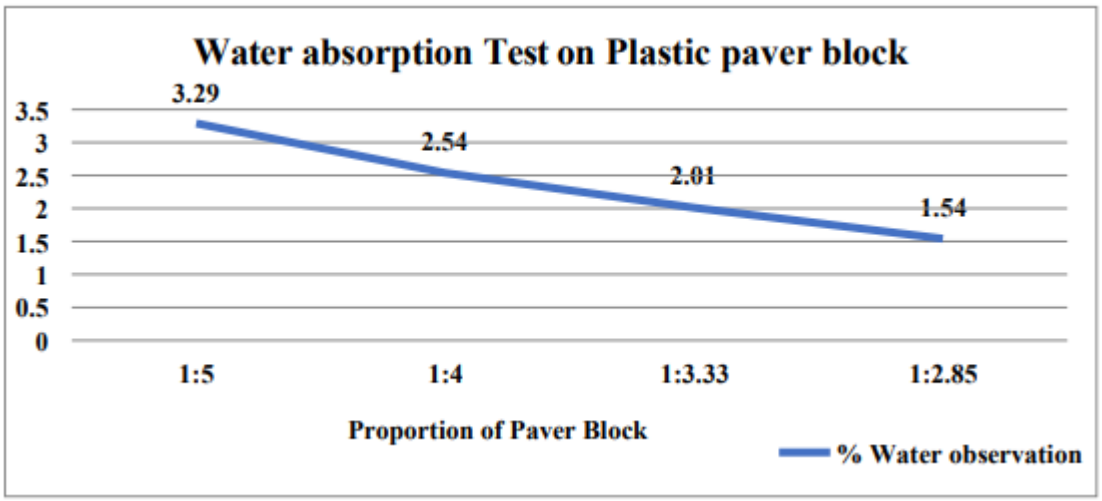

Fig. 6 Water Absorption Test on Plastic Paver Block

V. CONCLUSIONS

- Strength carrying of the plastic waste is very low that compared to the cement or any other cementitious materials.
- The compressive strength of the paver block decreases gradually as the gradual increase in the plastic proportion.
- The density of the plastic paver block increases upon increase in the quantity of the material in the proportion.
- The water absorption capacity of the paver block is less compared to the conventional paver block.
- The water absorption capacity of plastic paver block decreases as the quantity of the plastic increases.

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