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Utilization of Alternative Materials in Manufacturing of Paver Blocks

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Abstract – *The aim of this project is to replace cement with plastic waste in the plastic paver blocks and to reduce the cost of paver block when compared to that of the conventional concrete paver blocks. At present nearly 60 lakhs tones of plastic waste is produced in India per year. The degradation rate of plastic is a very slow process. Hence the project is helpful in reducing plastic waste in a useful way. In this project we have used plastic waste in different proportions with M Sand, Iron Ore Tailings, Coarse Aggregate and Ceramic Waste. The paver blocks were prepared and tested and results were discussed.*

Key Words: Plastic Paver Blocks, Plastic waste, M Sand, Iron Ore Tailings, Ceramic Waste.

1.INTRODUCTION

Paver block paving is versatile, aesthetically attractive, functional and cost effective and requires little or no maintenance if correctly manufactured and laid. Most concrete block paving constructed in India has also performed satisfactorily but two main area of concern are occasional failure due to excessive surface wear, and variability in the strength of paver block. Natural resources are depleting worldwide and at the same time the generated wastes from the industry and residential area are increasing substantially. The sustainable development for construction involves the use of Non-conventional and innovative materials, and recycling of waste materials in order to compensate the lack of natural resources and to find alternative ways for conserving the environment.

Plastic waste used in this work was brought from the surrounding areas. Currently about 60 lakh tonnes of plastic waste is dumped in India every year. The dumped waste pollutes the environment. As a result, it affects both human beings and animals in one or the other ways. Hence it is necessary to dispose the plastic waste properly as per the government regulations. The replacement of plastic waste for cement provides potential environmental as well as economical benefits.

Following are some literature reviews on various national and international papers on Paver Block and improvement on the paver block characteristic by adding various waste material into paver block.

Zainab Z. Ismail et al. (2007) [1] to determine the feasibility of reusing plastic sand as partial replacement of fine aggregate in concrete.

R L Ramesh et al (2009) [2] used waste plastic of low density poly ethylene as replacement to coarse aggregate.

Praveen Mathew et al. (2013) [3] investigated the suitability of recycled plastic as partial replacement to coarse aggregate in concrete mix.

Raghatate Atul M. (2014) [4] Investigated the tensile strength of concrete by adding up to 0.8% of plastic bag pieces in the concrete mix.

Youcef Ghernouti et al. (2017) [5] to determine the amount of Fine aggregate in the mix proportion of concrete to be replaced with plastic bag waste sand at 10%, 20%, 30% and 40%.

2. EXPERIMENTAL PROCEDURE

2.1 Properties of materials

Plastic waste (HDPE)

Plastic waste used in making paver block was collected from the surrounding locality LDPE is indicated by resin number 4. It includes plastic bags. The plastic bag used is of about 50 microns. The basic properties are provided below.

Table -1: properties of HDPE

SL NO.	PARTICULARS	VALUE
1.	Melting Point	150˚c
2.	Thermal Coefficient of Expansion	100-200x10^{-6}
3.	Density	940 kg/m^3

Coarse Aggregate

Locally available coarse aggregates were used in this work. Aggregates passing through 12mm sieve and retained on 4.75mm sieve were sieved and tested as per Indian standard specification IS:383-1970.

Table -2: physical properties of coarse aggregates

Sl no.	Particulars	Value
1.	Specific gravity	2.67
2.	Water absorption	0.6%
3.	Flakiness index	4.21%
4.	Elongation index	0
5.	Impact value	23.36%
6.	Abrasion value	40%

Ceramic waste

The principle waste coming from the ceramic industry is the ceramic waste. The disposal of these waste requires large area. It is very difficult to find a use of ceramic waste produced.

Table 3- Physical properties of Ceramic Waste

Sl. No.	Particulars	Value
1.	Specific Gravity	2.62
2.	Fineness modulus	2.60

Iron Ore Tailings

Tailings are the materials left over, after the process of separating the valuable fraction from the worthless fraction of an ore. Tests on Iron Ore Tailings procured from Kudremukh, Lakya Dam site were conducted.

Table 4- Physical Properties of Iron Ore Tailings

Sl no	Particulars	Value
1	Specific gravity	3.50
2	Fineness modulus	1.05

M Sand

Sand is a granular material composed of finely divided rock and mineral particles. The properties of sand were determined by conducting test as per IS:2386 The results indicate that the sand conforms to zone II of IS:383-1970.

Table 5 -Physical Properties of M Sand

Sl no.	Particulars	Value
1.	Specific gravity	2.64
2.	Fineness modulus	2.923

Cement

OPC 53 Grade cement is required to conform to BIS specification IS:12269-1987 with a designed strength for 28 days being a minimum of **53** MPa or 530 kg/sqcm is used for making M20 paver blocks. 53 Grade OPC provides high strength and durability to structures because of its optimum particle size distribution and superior crystallized structure.

Table 6- physical properties of cement

Sl no	Particulars	Value
1	Specific gravity	3.15
2	Initial setting time	35 min
3	Fineness	98%
4	Standard consistency	32%

3. MIX DESIGN and PREPARATION

3.1 MIX DESIGN OF CONVENTIONAL-CEMENT PAVER BLOCK

According to IS-15658:2006, cement paver blocks of size 200x100x60 mm are designed of M20 grade and the following mix ratio is obtained after calculation- cement: FA: CA= 1:2:4 and W/C ratio=0.62. Then four paver blocks were casted for testing at 3,7,14 and 28 days.

Fig 1: cement paver blocks preparation

3.2 MIX DESIGN OF PLASTIC PAVER BLOCKS

The various mix ratios adopted by us in this project are as follows: -

Sl no.	Composition (c)	Trial1	Trial 2	Trial 3
TYPE 1	P: Sand: CA	1:1:1	1:.75:1.25	1:1.25:.75
TYPE 2	P: Sand: IO: CA	1:-:1:1	1:.25:.75:1	1:.5:.5:1
TYPE 3	P: Sand: CW: CA	1:-:1:1	1:.25:.75:1	1:.5:.5:1
TYPE 4	P: Sand/IO/CW	1:2	-	-

Where,

P= Plastic, CA= Coarse Aggregate, IO= Iron Ore, CW= Ceramic Waste

3.3 PREPARATION OF PLASTIC PAVER BLOCKS

Plastic wastes are heated in a metal bucket at a temp of above 150˚. As a result of heating the plastic waste melt. The materials such as m sand, iron ore tailings, ceramic waste, coarse aggregates are added to it in right proportion at molten state of plastic and well mixed. The metal mould is cleaned through by using waste cloth. Now this mixture is transferred to the mould. It will be in hot condition and compact it well to reduce internal pores present in it. Then the blocks are allowed to dry for 24 hours so that they harden. After drying the paver block is removed from the moulds and ready for the use.

Fig -2: Plastic Paver blocks preparation

4. TESTS ON PAVER BLOCKS

4.1 COMPRESSIVE STRENGTH:

After the casting of paver blocks, they were placed to let them dry. Then blocks are transferred to testing. The maximum load at failure reading was taken for three samples of the same ratio. The average compressive strength is calculated by the equation Compressive strength (N/mm^2) = load (N) / cross section area of specimen (mm^2).

Table 7- COMPRESSION STRENGTH RESULT OF **CEMENT PAVER BLOCK**

Composition	3days (N/mm^2)	7days (N/mm^2)	14days (N/mm^2)	28days (N/mm^2)
1:2:4 (M20)	3.4	8.2	19.8	21.78

Fig-3: experimental setup for compression test

COMPRESSION STRENGTH RESULT OF **PLASTIC PAVER BLOCKS (PPB)-**

Table 8.1- TYPE 1-Plastic: M-sand: CA

Composition	PPB 1 (N/mm^2)	PPB 2 (N/mm^2)	PPB 3 (N/mm^2)	AVERAGE (N/mm^2)
1:1:1	12.2	12.42	12.51	12.38
1:.75:1.25	10.5	10.34	10.84	10.56
1:1.25:.75	11.74	11.91	11.34	11.66

Table 8.2- TYPE 2- Plastic: M-sand: Iron Ore: CA

Composition	PPB 1 (N/mm^2)	PPB 2 (N/mm^2)	PPB 3 (N/mm^2)	AVERAGE (N/mm^2)
1: -: 1:1	7.56	6.93	7.37	7.29
1:.25:.75:1	7.12	7.90	7.28	7.43
1:.5:.5:1	8.16	8.31	7.95	8.14

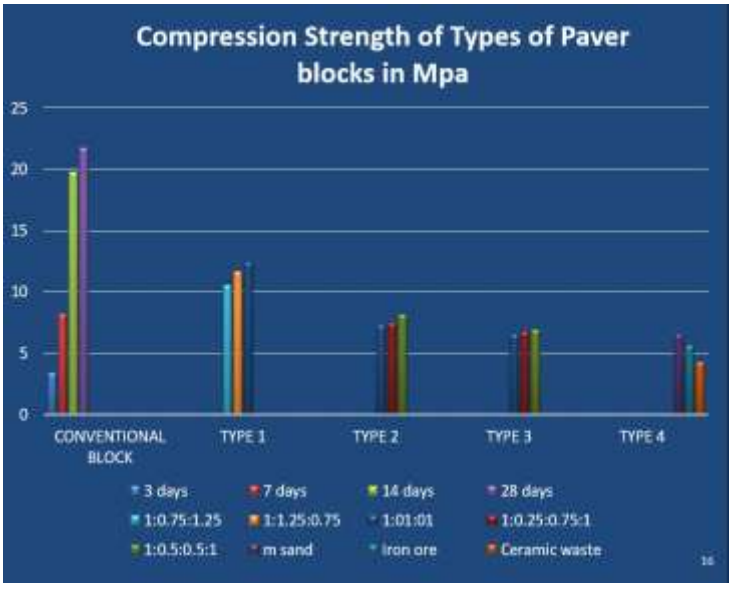
Table 8.3- Plastic: M-sand: Ceramic Waste: CA

Composition	PPB 1 (N/mm^2)	PPB 2 (N/mm^2)	PPB 3 (N/mm^2)	AVERAGE (N/mm^2)
1: -: 1:1	6.51	6.47	6.68	6.55
1:.25:.75:1	6.67	6.72	6.75	6.71
1:.5:.5:1	6.94	6.81	6.91	6.88

Table 8.4- Plastic: M-sand/ Iron Ore/ Ceramic Waste

Composition (1:2)	PPB 1 (N/mm^2)	PPB 2 (N/mm^2)	PPB 3 (N/mm^2)	AVERAGE (N/mm^2)
P: M-sand	6.78	6.23	6.54	6.52
P: Iron Ore	5.28	5.87	5.69	5.61
P: C W	4.17	4.67	3.98	4.27

Chart 1- GRAPHICAL COMPARISON OF COMPRESSION STRENGTH RESULTS



4.2 HEAT RESISTANCE TEST BY OVEN TEST-

As the paver block is made of plastic, we need to know its melting point hence oven test is performed. The paver block is kept in oven for 1hour at 50˚c, 100˚c and 150˚c and after 1 hour its condition is verified.

Table 9- OVEN TEST RESULT

TYPE OF PAVER BLOCK	TEMPERATURE (˚C)	REMARKS
TYPE 1 PPB	50	No change
	100	No change
	150	melts
TYPE 2 PPB	50	No change
	100	No change
	150	melts
TYPE 3 PPB	50	No change
	100	No change
	150	melts
TYPE 4 PPB	50	No change
	100	No change
	150	melts

4.3 WATER ABSORPTION TEST

The casted specimen was subjected to water absorption test to study the character of plastic block. After the drying period is completed, the specimen was immersed in water tank and is left for 24 hours. The blocks shall then be removed from the water and allowed to drain for 1 minute by placing them on a 10mm or coarser wire mesh, and visible surface water being removed with a damp cloth, the saturated and surface dried blocks are immediately weighed. After weighing, all the blocks shall be dried by keeping in sunlight for 24 hours. The dried paver blocks are again weighed after drying.

Table 10- WATER ABSORPTION TEST RESULTS

Sl no.	Type of block	Dry weight(gm)	Wet weight(gm)	% of water absorption
1.	TYPE 1	1820	1831	0.60
2.	TYPE 2	3721	3746	0.78
3.	TYPE 3	2350	2377	1.14
4.	TYPE 4	2216	2231	0.63

5. CONCLUSIONS

The following conclusions were drawn from the experimental investigation-

- Plastic is an innovative material for using it in construction purpose.
- Plastic paver block possess more advantages which includes resource efficiency.
- Plastic paver block is a productive way of disposal of plastic waste.
- On comparing the **compression strengths** of various types of plastic paver blocks, it was concluded that-
  1. Compression strength of TYPE 1 PPB is **60%** of conventional paver block.
  2. Compression strength of TYPE 2 PPB is **37%** of conventional paver block.
  3. Compression strength of TYPE 3 PPB is **32%** of conventional paver block.
  4. Compression strength of TYPE 4 PPB (m sand) is **30%** of conventional paver block
- After conducting the **heat resistance test**, it was concluded that all the types of PLASTIC PAVER BLOCKS showed **NO CHANGE** at **50˚c, 100˚c** but **MELTED** at **150˚c**.
- After conducting the **water absorption test**, it was concluded that **TYPE 1 PPB** absorbed **least** and **TYPE 3 PPB** absorbed **most** amount of water.
- On the basis of above results it is concluded that PPB can be used in light traffic road or footpath.
- It requires less time for manufacture.
- The cost of paver block is reduced when compared to that of concrete paver block
- Though the compressive strength is low when compared to the concrete paver block.

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