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UTILIZATION OF PLASTIC AND CERAMIC WASTE IN PAVER BLOCK

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Abstract: Nowadays Plastic waste is the global issue. Study estimated that India generates 9.46 million tonnes of plastic waste annually. It is hazardous for not only human begins but also for the animals and environment as well. This paper deals with the utilization of plastic waste as a replacement to cement. On the other hand, for the construction industry the demand of river sand is increasing day by day and there is decrease in its availability, so there is an immediate need for finding suitable alternatives which can replace sand partially or at a high proportion. Utilization of Ceramic waste is one of the active research area that encompass the effectiveness of replacement in all the aspects of construction materials.

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 also has performed satisfactorily, but two main areas of concern are occasional failure due to excessive surface wear and variability in the strength of block. It is very essential to develop eco-friendly concrete from plastic waste as well as ceramic waste. This paper deals with the partial replacement of cement by waste plastic and sand by using ceramic waste. In order to analyze changes in properties of the samples of paver were cast with 5%, 10%, 15%, 20% replacement of cement using plastic waste and with constant 10% replacement of sand using ceramic waste and tested for different periods of curing like 7 days, 14 days and 28 days.

Index Terms: **Plastic waste, Ceramic Waste, Eco-friendly Construction.**

INTRODUCTION

Plastic waste used in this work was brought from the surrounding areas. Currently, about 9.46 million tonnes of plastic waste dumped in India in a year. The dumped waste pollutes the surrounding environment. As the result it affects both human beings and animals in direct and indirect ways. Hence, it necessary to dispose the plastic waste properly as per the regulations provided by our government. The replacement of plastic waste for cement provides potential environmental. The global production of ceramic waste powder (CWP), which is produced during the final polishing process of ceramic tiles, exceeds 22 billion tons. The disposal of CWP in landfills will cause significant environmental problems (i.e., soil, air and groundwater pollution)

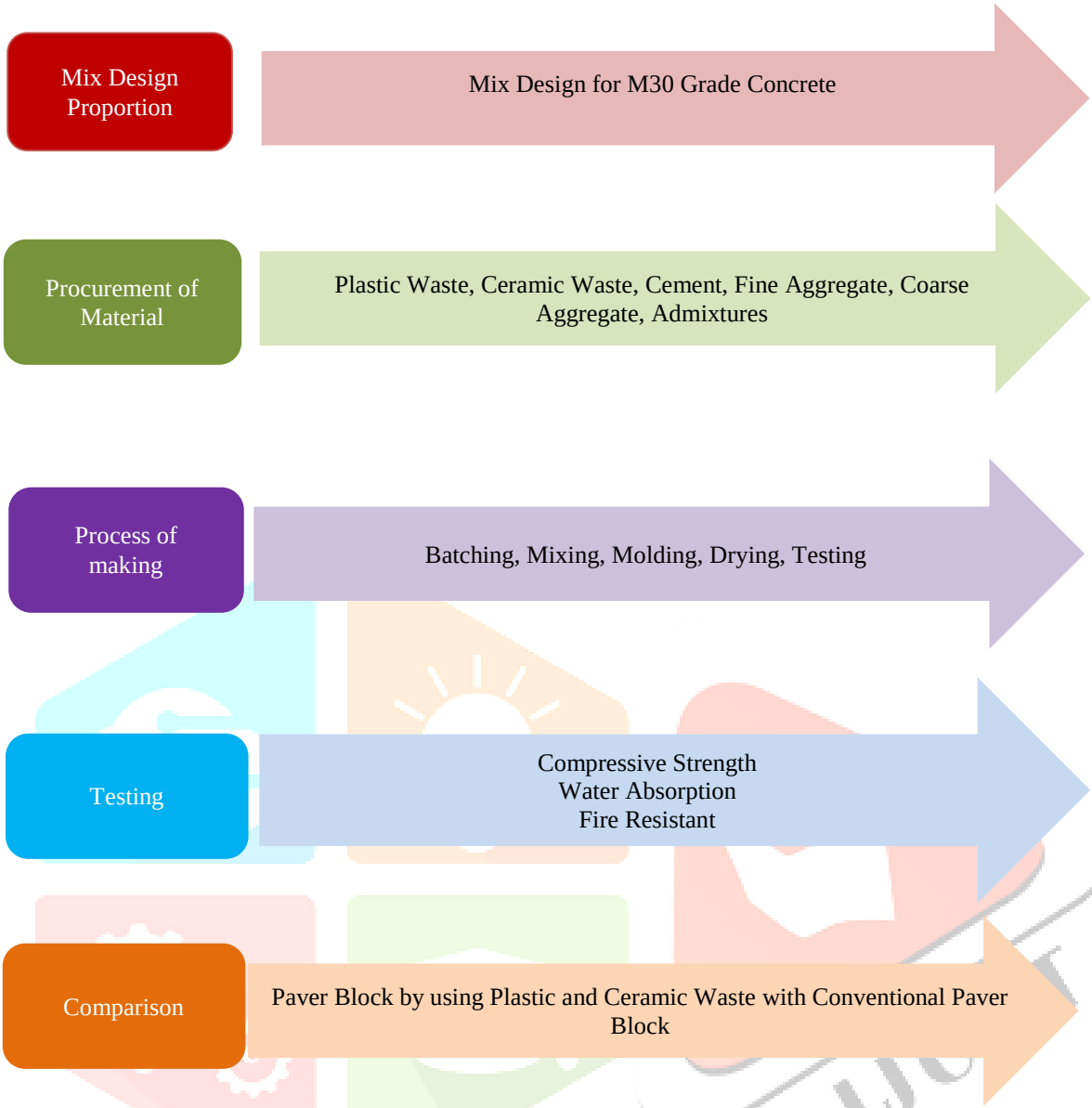
NEED OF STUDY

Burning of plastic in the open air, leads to environmental pollution due to the release of poisonous chemicals.
Due to the fact that biodegradation period of ceramic waste is very long and recycling of ceramic is big problem. Reuse of this kind of waste has advantages economic and environmental, reduction in the number of natural spaces employed as refuse dumps and a decrease in the quarrying necessary to extract conventional natural aggregates. Indirectly, all the above contributes to a better quality of life for citizens and to introduce the concept of sustainability in the construction sector.

OBJECTIVES

1. To cast paver blocks by partially replacement of cement by waste plastic and sand by ceramic waste.
2. To test waste plastic and ceramic waste paver blocks.
3. To check the cost of conventional block and waste plastic and ceramic waste paver block.
4. To compare strength parameters with conventional paver blocks

METHODOLOGY



MIX DESIGN

The concrete paste and testing specimen was mix designed in this study with help of IS 10262 (2009) for M30 concrete. The OPC was blended Plastic Waste which were used partially to replace 5, %, 10%, 15% and 20% of OPC. And also the ceramic waste replaced with 10% of weight of coarse aggregate. The plastic waste and ceramic waste is replaced by weight of OPC and weight of coarse aggregate.

PROPORTION FOR TRIAL MIX

Cement	= 394 kg/m^3	
FA	= 642.356 kg/m^3	
CA	= 1263.3557 kg/m^3	
Water	= 177.072 kg/m^3	
Admixture	= 4.728 kg/m^3	(1.2% of Cement Content)
w/c Ratio	= 0.45	

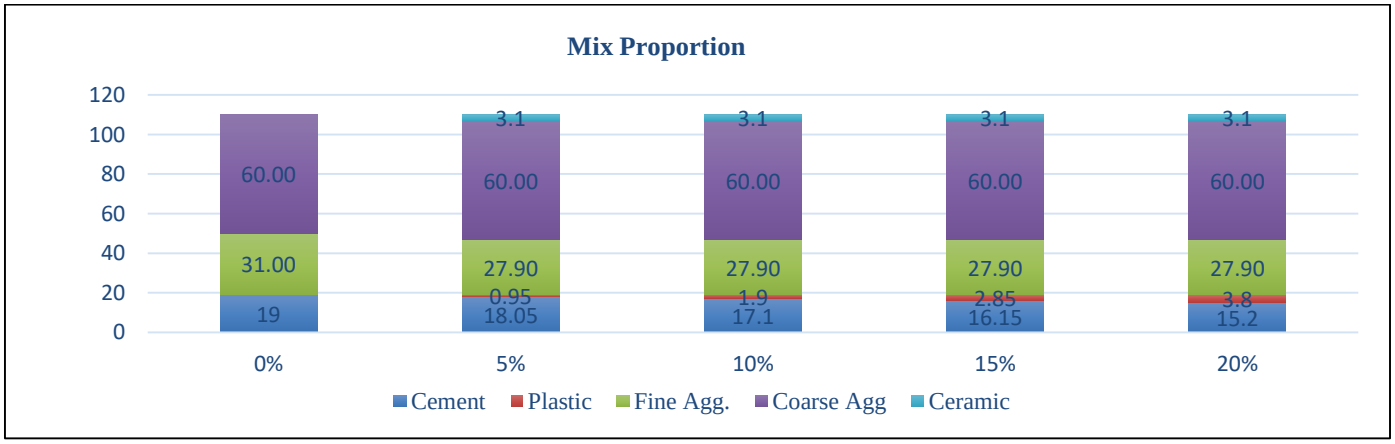
Proportions for M30 Concrete Mix Design = 1: 1.6: 3.2

RATE ANALYSIS

Cube Size	= (270 x 185 x 60) mm		
Volume of cube	= $2.997x10^{-3}$ m^3		
No. of Cubes	= 80		
Mix Proportion	= 1 : 1.6 : 3.2	- [As per concrete mix design]	
Wet Mix Volume	= 2.997 x 10^{-3} x 80	= 0.23976 m^3	
Dry Mix Volume	= 1.52 x 0.23976	= 0.3644352 m^3	
Volume of Cement	= 0.3644352/(1+ 1.6 +3.2)	= 0.062834 m^3	
No. of Cement bags	= 0.062834 /0.035	= 1.795 = 2 Bags	
Volume of Fine Aggregate	= 0.062834 x 1.6	= 0.1005344 m^3	
Volume of Coarse Aggregate	= 0.062834 x 3.2	= 0.201069 m^3	
Cement Content	= 394 x 0.23976	= 94.4654 kg	= 95 kg
F.A. Content	= 642.356 x 0.23976	= 154.0113 kg	= 155 kg
C.A. Content	= 1263.3557 x 0.23976	= 298.1069 kg	= 300kg

Mix ID	Plastic Waste (kg) and (%)	Ceramic Waste (Kg) and (%)	Weight of Cement (Kg)	Weight of Aggregate	
				Fine Aggregate (Kg)	Coarse Aggregate (Kg)
Standard	-	-	19.00	31.00	60.00
P5C10	0.95 (5%)	3.1 (10%)	18.05	27.90	60.00
P10C10	1.9 (10%)	3.1 (10%)	17.10	27.90	60.00
P15C10	2.85 (15%)	3.1 (10%)	16.15	27.90	60.00
P20C10	3.8 (20%)	3.1 (10%)	15.20	27.90	60.00
Total Quantity (kg)	**9.50**	**12.40**	**85.50**	**142.60**	**300.00**

quantity of material used



mix proportion

COST COMPARISON

Paver Block	Conventional (Rs)	P5C10 (Rs)	P10C10 (Rs)	P15C10 (Rs)	P20C10 (Rs)
Cement	133	127	120	114	107
Fine Aggregate	37	33	33	33	33
Coarse aggregate	34	34	34	34	34
Plastic Waste	-	4	8	12	16
Ceramic Waste	-	0	0	0	0
Total Cost	**204**	**197**	**195**	**193**	**190**

cost comparison of conventional paver block and paver blocks using plastic & ceramic waste

Cost Comparison for 1000 Paver Blocks

Conventional Paver Block = 204 / 16 x 1000 = 12750/- Rs
Plastic & Ceramic Waste Paver Block = 193 / 16 x 1000 =12063/- Rs
For proportion (P15C10)
Cost Comparison for 1000 Paver Block = 12750 – 12063 = 687/- Rs
The cost of paver blocks using plastic and ceramic waste is **reduced by 687/- rupees**.

TESTS

1.0 Compressive Strength Test

The test procedure followed by IS 15658: 2006 in annex D.
Strength tests are required for one or both of the following purpose.

- The possible achievable strength of concrete checked in controlled condition against desired strength.
- To determine the strength-age relationship of the concrete under field conditions as a control for construction operation of the work.

Compression testing is a very common testing method that is used to establish the compressive force or crush resistance of a material. Generally Three specimens of blocks are taken to laboratory for testing and tested one by one. In this test a paver block specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which block is crushed is taken into account. All three paver block specimens are tested one by one and average result is taken as paver block's compressive strength.


compressive strength test

2.0 Water Absorption Test

Water absorption test conducted for the following purpose:

- Water absorption is used to determine amount of water absorbed under specify condition.
- To determine durability property of paver block, quality and behavior of paver block in weathering.

In this test, paver blocks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then paver block is weighed in wet condition. The difference between weights is the water absorbed by the paver block. The percentage of water absorption is then calculated. The less water absorbed by the paver block the greater its quality. Good quality paver block doesn't absorb more than 5% of its own weight.

$$W \text{ percent} = \frac{Ww - Wd}{Wd} \times 100$$

water absorption test

3.0 Fire Resistance 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 2 hours in oven and after 2 hours its condition is verified.
The Plastic is highly susceptible to fire but in case of Plastic sand Paver blocks the presence of sand imparts insulation. There is no change in the structural properties of block up to 180ºC above which visible cracks are seen and the blocks deteriorate with increase in temperature.

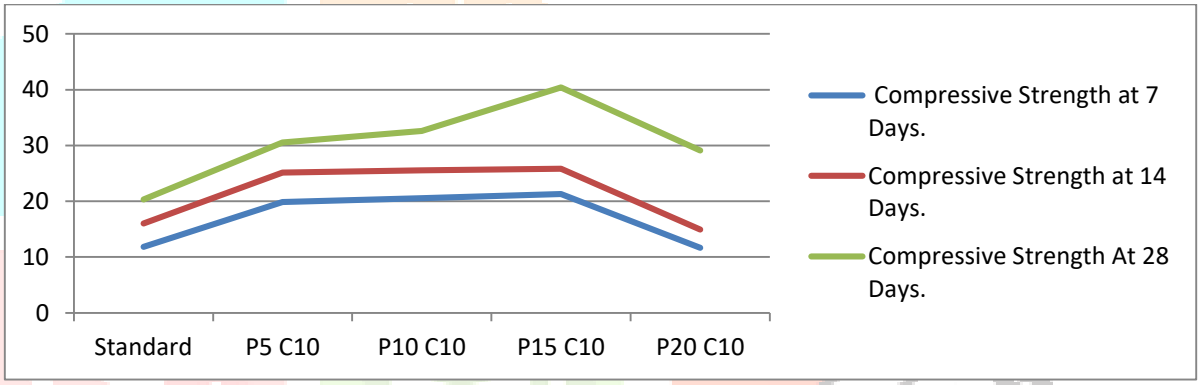
fire resistance test

TEST RESULTS

1.0 Compression Strength

These results shows compressive strength of paver block with partial replacement of plastic waste and ceramic waste with cement and coarse aggregate at 7, 14 and 28 days and there is also the comparison of compressive strength is also shown below**.**

Replacement	7 Days Comp. strength	14 Days Comp. Strength	28 Days Comp. Strength
Standard	17.715	24.000	30.435
P_5 C10	29.775	37.755	45.765
P10C10	30.795	38.355	48.885
P15C10	31.95	38.730	60.600
P20C10	17.49	22.41	43.635

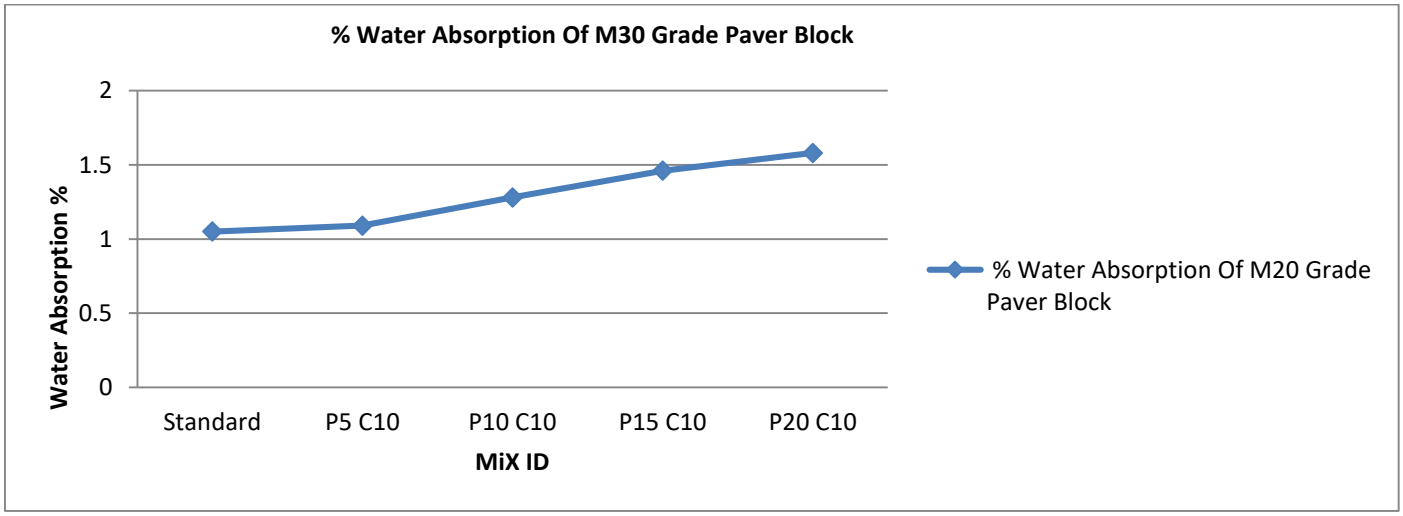


compression strength test results

2.0 Water Absorption Test

The ability of material to absorb and retain the water is known as its water absorption. It mainly depends on volume, size and shape of pores present in the material. The completely dry pavement block was weighed and immersed in clean water for 24 hours at (Ww). The block is then removed from water and then weighed (Wd).

Sr. No.	Waste Percentage	Wet Weight (Ww) in kg	Dry weight (Wd) in kg	% Water Absorption (W%)	Mean
1.	Standard	5.286	5.231	1.04	1.05%
		5.239	5.787	0.99	
		5.184	5.125	1.138	
2.	P5 C10	5.223	5.170	1.02	1.09%
		5.037	4.977	1.19	
		5.106	5.051	1.07	
3.	P10 C10	5.061	4.999	1.23	1.28%
		5.027	4.972	1.33	
		5.078	5.013	1.28	
4.	P15 C10	5.253	5.182	1.35	1.46%
		5.150	5.074	1.47	
		5.143	5.063	1.55	
5.	P20 C10	5.348	5.266	1.53	1.58%
		5.318	5.235	1.56	
		5.244	5.157	1.65	



water absorption test results

3.0 Fire Resistance Test

Mix ID	Temperature (ºC)	Original weight in Kg	Oven dry weight in Kg	Remark
P5 C10	150	5.286	5.197	Melts
P10 C10	150	5.184	5.079	Melts
P15 C10	150	5.078	4.943	Melts
P20 C10	150	5.244	5.059	Melts

fire resistance test results

CONCLUSION

Based on the results of experimental investigation, following conclusions are drawn:

1. Plastic and ceramic Paver Block achieved very early high compressive strength of 60.60 MPa.
2. The compressive strength of Plastic and Ceramic paver block was found to be increasing with replacement up to 15% Plastic and Ceramic 10% replacement gives slightly high compressive strength.
3. Complete replacement by 20% Plastic and 10% Ceramic decreasing slight compressive strength is 43.635 MPa.
4. Maximum strength of Paver block was found at 60.60 MPa at Plastic 15% and 10% Ceramic replacement which is very high, can be used for light weight traffic.
5. Water absorption of Plastic and Ceramic paver block is less than 6% which is satisfying permissible limit of IS :15658-2006.
6. The cost of paver block is reduced compare to that of concrete paver block.
7. The utilization of waste plastic and ceramic in production of paver block has productive way of disposal of plastic and ceramic waste.
8. Paver block made using plastic waste, quarry dust, coarse aggregate and ceramic waste have shown better result.

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