

Original Article

Experimental Investigation on Utilization of E-Waste in Coarse Aggregate of Paver Block Production

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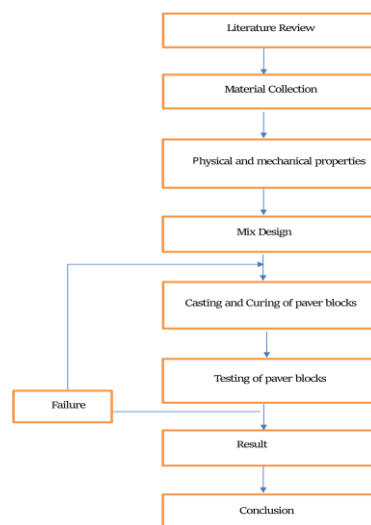
Abstract: The advent of rapid technological progress has resulted in an increase in the creation of electronic waste, which is dangerous for the environment due to its toxicity and inability to degrade. Improper disposal causes pollution of the ground, water bodies, and atmosphere. Effective waste management is vital to avoid contamination. This paper analyse the application of e-waste processed by shredding and washing as a substitute for coarse aggregate in M20 grade concrete. Paver blocks were created using a concrete mixture following the M20 ratio, but in place of conventional aggregate, 5% and 10% portions of e-waste were added. The blocks were moulded under standard laboratory conditions and tested for their compressive strength. It was established that using e-waste in the mixture decreases the unit weight of concrete and increases its resistance to impacts, making the blocks lightweight and robust under shock loads. At the same time, high substitution rates cause a reduction in compressive strength. Therefore, the optimal substitution rate has been determined, allowing for both durability and ecological benefits.

Keywords: E-waste, Coarse Aggregate, Paver Blocks, Waste Management, Eco-friendly Materials, construction materials.

I. INTRODUCTION

The progress made in the domain of science and technology has caused an unprecedented increase in the generation of electronic waste (e-waste). The waste includes used-up electronic components, which contain useful materials, but they can be harmful as well since they consist of toxins such as lead and mercury. Therefore, their disposal should be done properly as otherwise it causes pollution in the environment and poses dangers to human health. Besides, the need for natural aggregates is ever-increasing in the construction industry, resulting in wastage of resources. The current study discusses the use of processed e-waste materials in place of natural aggregates in concrete mixes of M20 grade used in paver blocks. The process involves collecting, cleaning, and processing e-waste materials to the desired size and replacing natural aggregates in M20 mixes by 5% and 10%. The concrete blocks are then made from the mix and subjected to various parameters including workability, weight, density, surface finish, and especially compressive strength test. The results reveal that though using e-waste materials decreases weight and improves some properties, it also reduces the strength. Hence, an optimum replacement level needs to be found where e-waste can be effectively used.

II. METHODOLOGY



II. EXPERIMENTAL INVESTIGATION

A. CEMENT

Cement serves as the crucial binding agent in the production of paver blocks, responsible for agglomerating the fine and coarse aggregates into a cohesive and structurally sound paving unit.

Table 1: Physical Properties of Cement

SI.NO	DESCRIPTION	VALUE
1.	Fineness	3.46%
2.	Consistency	34%
3.	Specific gravity	3.12
4.	Initial setting time	30mins
5.	Final setting time	600mins

B. FINE AGGREGATE

Fine aggregate is one of the smaller-sized aggregates used for concrete. This is made up of finer particles, either sand or crushed stone, which pass through a sieve of size 4.75mm. Fine aggregates serve to occupy the spaces between coarse aggregates and give density to the concrete. The quality of fine aggregate depends on factors such as moisture content, workability, and bonding.

TABLE 2: TESTS FOR FINE AGGREGATE

SI.NO	DESCRIPTION	VALUE
1.	Specific gravity	2.79
2.	Bulk density (loose state)	1730Kg/m ³
	Bulk density (compacted state)	1777.3Kg/m ³

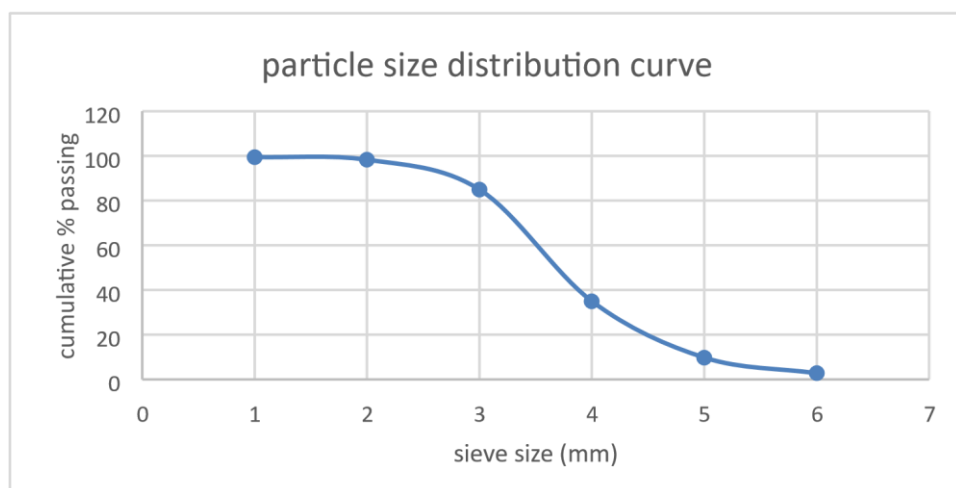


Figure 1: SIEVE ANALYSIS GRAPH FOR FINE AGGREGATE

C. COARSE AGGREGATE

Coarse aggregate is the larger sized constituent used in concrete, which could be either natural rocks or crushed rocks. The size of coarse aggregates is above 4.75 mm. The function of coarse aggregates in concrete is to provide strength, volume, and stability to concrete. Coarse aggregates form the backbone of concrete, whereas cement and fine aggregates fill the voids between coarse aggregates.

TABLE 3: TESTS FOR COARSE AGGREGATE

SI.NO	DESCRIPTION	VALUE
1.	Specific gravity	2.69
2.	Bulk density (loose state)	1511.6Kg/m ³
3.	Bulk density (compacted state)	1550.6Kg/m ³

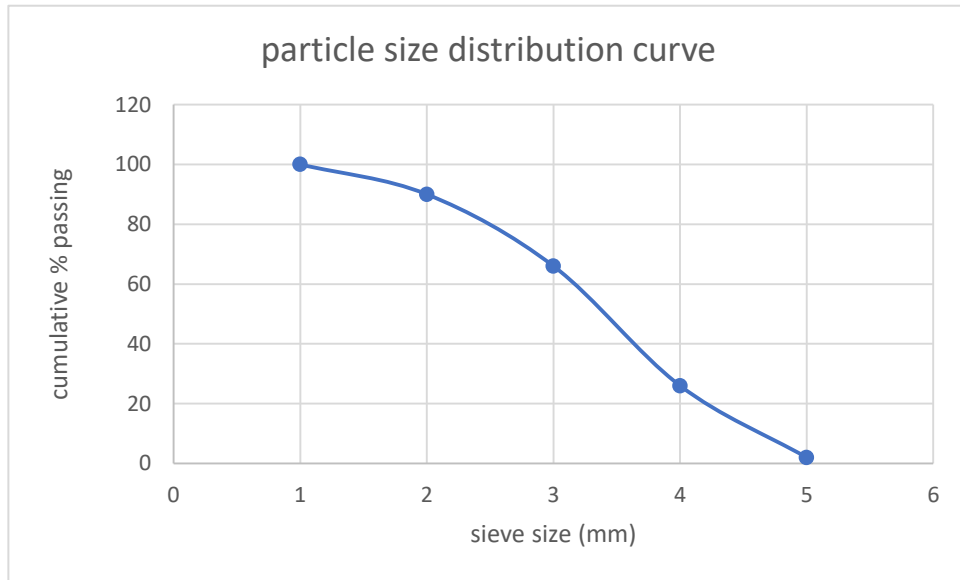


Figure 2: SIEVE ANALYSIS GRAPH FOR COARSE AGGREGATE

D. MECHANICAL PROPERTIES

After sufficient curing of both ordinary and plastic concrete block it has to be checked under compression testing machine (CTM) to know its compressive strength under gradually applied compressive force on the specimen. Noted the load at which it failed and divided it by the cross sectional area of paver block gives the compressive strength of the specimen.

The compressive strength test was conducted to evaluate the load-carrying capacity of E-plastic paver blocks. The test results indicate that the strength increases with the addition of E-waste up to an optimum level. Beyond this limit, a reduction in strength is observed due to weaker bonding between E-waste particles.



Figure 3: Compressive strength test

Table 4: Compressive Strength Test Result For ordinary and E-waste paver block

E-Plastic waste	Compressive strength(N/mm ²)	
	7days	28days
0%	17	29
5%	16	29
10%	15	29

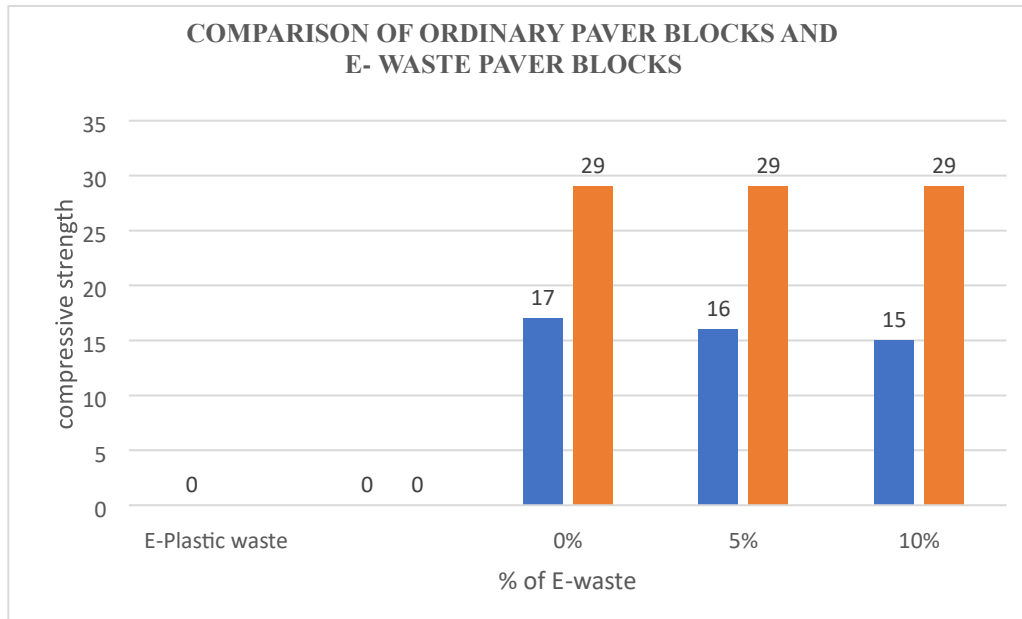


Figure 4: Bar Chart of Compressive Strength of E-Waste Content Added

From the experimental results, it is observed that the incorporation of e-plastic waste leads to a slight reduction in compressive strength at both 7 and 28 days. However, the strength values remain comparable to conventional concrete, indicating that limited use of e-plastic waste (up to 10%) can be considered feasible for sustainable construction without significant loss in performance.

IV. RESULT AND DISCUSSION

A. Compressive Strength Results

The results of compressive strength tests on the paver blocks made using E-waste as a substitute for coarse aggregate show a marginal drop in the strength with increasing percentage of E-waste. After curing for 7 days, the conventional blocks produced compressive strength values of 17 N/mm². The inclusion of 5% E-plastic as a substitute resulted in a slight drop in the strength to 16 N/mm². On the other hand, with 10% substitution, the compressive strength dropped to 15 N/mm². The same observation was evident after 28 days of curing. The blocks made by the conventional method attained 29 N/mm² of compressive strength. However, those with 5% and 10% substitutions attained strengths of 29 N/mm² and 29 N/mm² respectively. It can be observed that the inclusion of plastic waste causes a marginal drop in the strength of the blocks, but not enough to affect their functionality. This may be attributed to the relatively poor bonding ability of plastic materials with the cementitious matrix. Nevertheless, the results demonstrate that the compressive strength of the blocks remains high enough even when E-waste substitutes natural coarse aggregates.

V. CONCLUSION

E-waste could be effectively substituted for coarse aggregates in making paver blocks. The use of e-plastics at 5% and 10% substitution percentages resulted in satisfactory compressive strength. The recycling of e-waste into paver blocks would reduce environmental pollution caused by non-biodegradable waste from electronic appliances. The mixing, casting, and curing of e-waste paver blocks would result in even dispersion of e-waste materials, which would make the

block effective. E-waste paver blocks can be used in sidewalks, driveways, garden paths, parking places, and low traffic roads.

VI. REFERENCES

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