Experimental Investigation On Partial Replacement Of PCB And Plastic Waste As Coarse Aggregate

(Construction Materials)

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***Abstract*— Electronic waste or e-waste defines rejected electrical or electronic devices. Electronic waste is an emerging concern posing serious contamination problems to the human and the environment. E-waste disposal is a typical task for whole over the world. E-waste is the problem with which every country is dealing right now. Because there is no method for the disposal of e-waste and with the growth in the consumption of electronic goods this problem is getting bigger and bigger. The most effective way of the disposal of e-waste is through landfill and this method require large land mass which is very difficult to find in these days. So this is a very good concept of using e-waste as an ingredient in concrete by partial replacement of aggregate.**

One of the effective method to remove e-waste is to use it for construction purposes. Aggregates in concrete are partially replaced by e-waste in certain percentages in M30 concrete and their properties are tested. The present study is focused replacing conventional coarse aggregate ranging from 0 to 12.5 with PCB and e-waste plastic.

Keywords- Concrete, E-waste, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Electronic waste or e-waste describes discarded electrical or electronics devices. Used electronics which are destined for refurbishment, reuse, resale, salvage, recycling through material recovery, or disposal are also considered e-waste. E-waste is particularly dangerous due to toxic chemicals that naturally leach from the metals inside when buried. As mentioned, electronic waste contains toxic components that are dangerous to human health, such as mercury, lead, cadmium, polybrominated flame retardants, barium and lithium. The negative health effects of these toxins on humans include brain, heart, liver, kidney and skeletal system damage. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution. The Global E-waste Monitor 2020 report found that the world dumped a record 53.6 million tonnes of e-waste last year. Just 17.4% of it was recycled, meaning that an estimated $57 billion worth of gold, silver, platinum and other high value, recoverable materials used as components were mostly dumped or burned rather than being collected for treatment and reuse. Report says that even countries with a formal e-waste management system in place are confronted with relatively low collection and recycling rates. China, with 10.1 million tonnes was the biggest contributor to e-waste, and the United States was second with 6.9 million tonnes. India, with 3.2 million tonnes, was third. Together these three countries accounted for nearly 38% of the world's e-waste last year. The new report also predicts global e-waste discarded products with a battery or plug-will reach 74 million tonnes by 2030, almost a doubling of e-waste in just 16 years. Potential use of e-waste in concrete –using e-waste as a replacement material for coarse and fine aggregate is analysed in this report.

Santhanam Needhidasan et al.2019 Studied the use of E-Waste plastic as coarse aggregate in concrete with manufacture sand. The study is focused on partial replacement of conventional coarse aggregate by 0 to 12.5% with E-Waste for M20 grade concrete.10% replacement shows better result. So they concluded that the optimum %is 10[1]. Sidharthan K.V et.al.2018 studied effective utilization of E-waste in concrete.The study is focused on the properties of concrete with partial replacement of coarse aggregate with e-waste .M25 concrete with % replacement of 0 to 20 is done. 15% is obtained as the optimum %.Beyond 15% the strength starts decreasing[2]. Jafar Ali.M et.al2018 partial replacement of E-Waste as coarse aggregate in concrete. In this study they made 3 different types of conventional specimen with partial replacement of e-waste on a% of 10%,20%,30% to coarse aggregate in M25 grade concrete .20% is obtained as optimum % beyond 20% replacement the strength noticeably decreased[3].Paneer Selvam N et al.2016 studied recycle of E-Waste in concrete. This study is focused on partial replacement of coarse aggregate by 10%, 20%, 30%with E-Waste for M20 grade concrete. It is concluded that 20% of coarse aggregate can be replaced with E-Waste[4].Vivek S Damal et al. studied the utilization of electronic waste plastic

in concrete. The study is focused on the properties of concrete with partial replacement of coarse aggregate with E-Waste. Percentage replacement of 7.5%, 15%, 21.5% was done. Optimum percentage was observed as 7.5%.

II. OBJECTIVES

To compare the compressive strength of nominal concrete and concrete made by partial replacement of coarse aggregate with PCB and E-Waste plastics.

III. MATERIALS

Cement: OPC grade53 cement was used for the the experimental works as per IS 12269-2013. As per the indian standards the initial and final setting time are 30 minutes and 10 hours respectively. The following Table1 represents the test conducted on cement as per IS standards.

TABLE 1 TEST ON CEMENT

S. no	Name of test	Value
1	Specific gravity	3.1
2	Initial setting time	30 min
3	Final setting time	8 hrs

Fine aggregate: The aggregate was chosen with respect to SP 21:2005 and the testing was done as per IS 2386(part 1)-1963.Fine aggregate have a size less than 4.75mm with a specific gravity of 2.3 g/cm^3

Coarse aggregate: Coarse aggregate chosen was in the size range of 4.75 mm to 20mm. It had a specific gravity of 2.6 g/cm^3

E-Waste: We use printed circuit board (PCB) and e-waste plastic for this study. We collected e-waste from nearby electronic shop. The collected e-waste is then cutted into required size. Specific gravity of e-waste is 1.8 g/cm^3

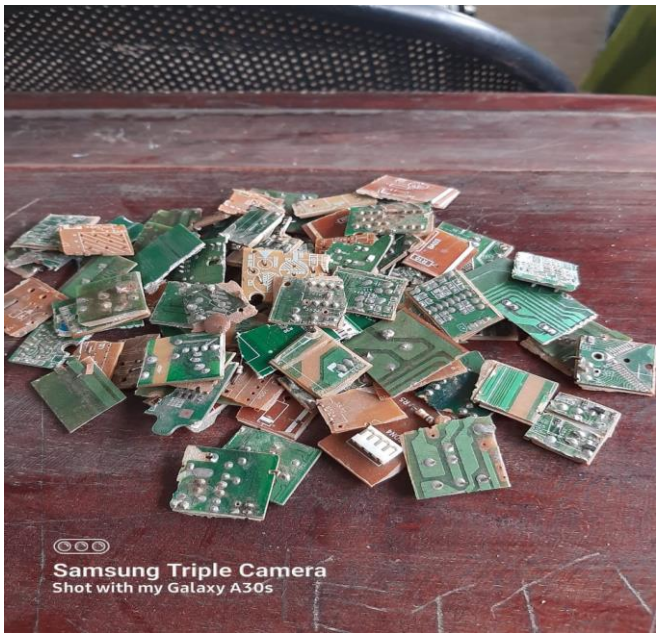

Fig 1: Crushed e-waste

Fig 2: Crushed e-waste plastic

IV. CONCRETE MIX DESIGN

Concrete mix design is the process of finding right proportion of cement, sand and aggregate for concrete to achieve target strength in structures. Concrete mix design is done as per Indian standard method(IS 10262-2009). The obtained mix proportion is 1:1.18:2.38 Adopted water cement ratio = 0.4

TABLE 2 MIX SPECIFICATION

Proportion of e-waste	Mix specification
0%	Conventional mix
5%	S1
7.5%	S2
10%	S3
12.5%	S4

V. METHODOLOGY

Ordinary Portland cement of 53 grade, fine aggregate, coarse aggregate and e-waste are used. The properties of cement, aggregate, e-waste are obtained by using standard IS methods and obtained values are considered. Required amount of e-waste are collected from near by electronic shop and cutted into required size. M30 mix with ratio 1:1.18:2.38 is adopted. Nominal concrete cubes were casted for determining compressive strength at 7 and 28 days. Concrete cubes made by partial replacement of coarse aggregate with varying percentage of E-Waste are casted and placed for curing and compressive strength of the same was determined.

Fig 3:Cube moulds for compressive strength test

Fig 4:Cube moulds for compressive strength test

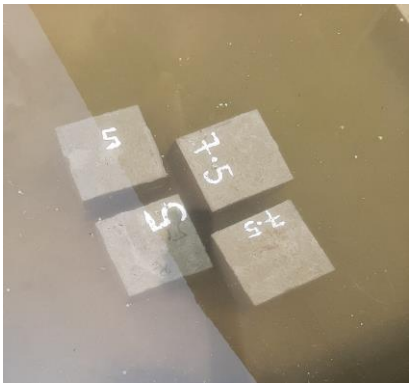

Fig 5: Cubes immersed in curing tank

VI. RESULT AND DISCUSSION

Compressive strength test

Out of various test carried out compressive strength test is most important one which gives an idea about various characteristics of concrete. Based on this test one can judge whether concrete is done properly or not. Compressive strength test was conducted to evaluate the strength of concrete cubes with varying percentage of e-waste at 7 and 28 days. Cubes of size 150×150×150mm are casted for testing.

TABLE 3 COMPRESSIVE STRENGTH TEST (7 DAYS)

S. no	Mix specimen	Load(KN)	Compressive strength(N/mm2)
1	Conventional mix	730	32.44
2	S1	750	33.33
3	S2	870	38.65
4	S3	520	23.11
5	S4	445	19.77

TABLE 4 COMPRESSIVE STRENGTH TEST (28 DAYS)

S. no	Mix specimen	Load(KN)	Compressive strength(N/mm^2)
1	Conventional mix	910	40.44
2	S1	950	42.22
3	S2	1000	44.44
4	S3	780	34.66
5	S4	650	28.88

Fig 6 :Sample cubes after demoulded

Fig 7: Compressive testing machine

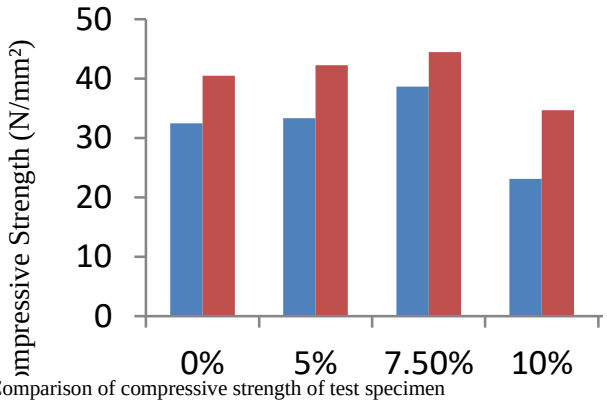

Fig8:Comparison of compressive strength of test specimen

VII. CONCLUSION

It can be concluded that E-Waste can be disposed by using them as construction material. From this study the optimum percentage of replacement of coarse aggregate with E-Waste was observed as 7.5%,beyond 7.5% compressive strength of concrete decreases.

VIII. REFERENCE

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