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# Experimental Study on Effective Utilization of E-Waste in Concrete

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**ABSTRACT**: Electronic waste or E-waste is waste electronic and electrical equipment is an emerging issue posing serious pollution problems to the human and the environment. New effective waste management options need to be considered especially on recycling concepts. Now-a-days, the disposal of electronic waste becomes a tedious process as it is a non-degradable material. So by using those electronic wastes in concrete, we can achieve more strength and also it is economic in construction. This paper presents the results of an investigation to study the performance of concrete prepared with E-waste as a partial replacement of coarse aggregate.

**KEYWORDS**: Cement, Coarse aggregate, Fine aggregate, E-waste, Compressive strength, Split tensile strength and flexural strength.

# I. INTRODUCTION

The generation of E-waste is the fastest growing area and the disposal poses a major problem in the related neighbourhood. The use of recycled plastic in the manufacturing of new plastic consumes considerable energy, raw material use and wear and tear on machinery. The use of recycled materials in construction applications is among the most attractive option because of the large quality demand, low quality requirements and widespread extent of construction. The use of E-waste plastic cement concrete aggregate has been focused in this investigation as a viable solution to the problem of recycling costs and high disposal costs. The various possibilities of recycling the plastics such as coke oven process, Thermal recycling, Mechanical recycling etc. The major challenge for the plastic waste recycling is the need for a continuous and stable supply of materials to be recycled and lack of cost effective technologies for recycling.

Several research works carried out to examine the possibility of reusing waste recycled glass in concrete and construction applications as an alternative solution to the growing quantity of waste recycled glass.

E-waste describes discarded computers, circuit boards, transistors, TV, broken electrical and electronic devices as shown in fig.1. Rapid technology change, low initial cost has resulted in a fast growing surplus of electronic waste around the globe. E-waste is one of the fastest growing waste streams in the world. In developed countries, previously, it was about 1% of total solid waste generation and currently it grows to 3% by 2015. In developing countries, it ranges 0.01% to 3% of the total municipal solid waste generation. Several tones of E-waste need to be disposed every year. Traditional landfill or stockpile method is not environmental friendly solution and the disposal process is also very difficult.

Looking to the global issue of environmental pollution by E-waste, research efforts have been focused on consuming this waste on massive scale in efficient and environmental friendly manner. Researchers plan to use E-waste in form of concrete ingredient as the concrete is second most sought material by human beings after water. E-waste in concrete will not only be its safe disposal method but adding admixtures may also improve the concrete properties like compressive, tensile and flexural strength.

The main aim of this paper is to have an experimental study on effective utilization of E-waste as 10%, 20% and 30% partial replacement of coarse aggregate in concrete. By this project it helps us to know the detail works that are to



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be carried out for the concrete construction at particular place with the partial replacement of coarse aggregate by Ewaste. The results of the studies will include the workability and characteristic strength of E-waste concrete.

Fig.1 shows the view of Electronic wastes or E-waste (a) Electronic chip boards (b) Chip removed electronicboards (c) Crushed electronic waste



(a)

**II. EXPERIMENTAL INVESTIGATION** 

# Materials used and its Properties

The materials used for this study were initially tested. The test was carried out for different materials such as aggregates and cement and their results were listed in tables.

# Cement

Portland Pozzolana Cement (PPC) is manufactured by the intergrinding of OPC clinker with 10 to 25 per cent of pozzolanic material (as per the latest amendment, it is 15 to 35%). The pozzolanic materials generally used for manufacture of PPC are Calcined clay (IS 1489 Part 2 of 1991) or Fly ash (IS 1489 Part 1 of 1991). Portland Pozzolanacement of 53 grade confirming to IS 1489 was used in the present study. The properties of cement are shown in Table 1.

	Table 1 Properties of Cement		
Sl.No.	Property	Result	
1	Standard consistency	26%	
2	Initial setting time	40 minutes	
3	Final setting time	8 hours	
4	Specific Gravity	3.187	

# **Coarse Aggregate**

Crushed aggregate confirming to IS 2386(Part I)-1963 was used. Aggregates of size 20mm has been selected for the study. The properties of the coarse aggregate are shown in Table 2.

Table 2 Properties	of Coarse	Aggregate
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Sl.No.	Property	Result
1	Fineness Modulus	2.88%
2	Aggregate crushing value	24.46%
3	Aggregate Impact value	26%
4	Aggregate abrasion value	25%



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5	Water absorption value	2% 6.75%	
6	Flakiness index		
7	Elongation index	51.05%	

#### **Fine Aggregate**

Natural sand with fraction passing through 4.75mm and retained on 600 micron sieve is used and will be tested as per IS 2386(Part I)-1963. The properties of the fine aggregate are shown in Table 3.

Table 3 Properties of Fine Aggregate				
Property	Result			
Fineness Modulus	2.692%			
Bulkiness of Sand	11.11%			
Specific gravity	2.44			
	Table 3 Properties of Fine Aggregate   Property   Fineness Modulus   Bulkiness of Sand   Specific gravity			

# **Mix Proportioning**

Concrete mix design for this experiment was designed as per the guidelines of Indian standards. All the samples were prepared using nominal mix. M25 grade of concrete was used for the present investigation. The table 4 shows mix proportioning of concrete.

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Water	Cement	Fine Aggregate	Coarse Aggregate			
140 litres	310 Kg/m <sup>3</sup>	$310 \text{ Kg/m}^3$	$620 \text{ Kg/m}^3$			
0.45	1	1	2			

#### **Fresh concrete**

The fresh concrete is made with the nominal mix ratio as per design standards for M25 grade concrete and the workability of the concrete were tested. The properties of fresh concrete are given in table 5.

Table 5 Properties of Fresh concrete						
Sl.No.	Property For standard concrete For E-waste concrete					
1	Slump value	50 mm	True Slump			
2	Flow value	30%	20%			
3	Compaction factor	95.88%	88.26%			

# **III.EXPERIMENTAL PROCEDURE**

The specimen of standard cube of size 15cmx15cmx15cm and standard cylinder of size 30cm height and 15cm diameter and slab of size 10cmx10cmx50cm were used to determine the compressive strength, split tensile strength and flexural strength of concrete. These specimens were tested on 7<sup>th</sup>, 14<sup>th</sup>&28<sup>th</sup>days with proportions of standard, 10%, 20% & 30% replaced E-waste concrete.

#### **Experiments Conducted**

The following experiments were conducted on the specimens casted.

- Compression test
- Split tensile test
- Flexural test

# **Compression Test**

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive



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strength. The cube specimen is of the size  $15 \times 15 \times 15$  cm were tested for compressive strength as per IS 516-1959 using a calibrated compression testing machine.

#### Split Tensile test

Split tensile strength of concrete is usually found by testing concrete cylinder of size 30cm height and 15cm diameter. The specimens were tested for its tensile strength as per IS: 516-1959 using a calibrated compression testing machine.

### **Flexural Strength Test**

Flexural strength is the one of the measure of tensile strength of concrete. It is the ability of a beam to resist failure in bending. It is measured by loading un-reinforced slab or prism of size 10cm x 10cm x 50cm. The specimens were tested for its flexural strength as per IS: 516-1959 using a calibrated flexural testing machine.

#### **IV.EXPERIMENTAL RESULTS**

The Compressive strengthtest results of the hardened concretecubes for standard, 10%, 20% & 30% E-waste concrete for 7, 14 and 28 days were given in table 6 with its graphical representation.

Table 6 Compressive strength test for concrete cubes				
	Compressive Strength (N/mm <sup>2</sup> )			
No. of Days	Standard	10% E-waste	20% E-waste	30% E-waste
7 <sup>th</sup> day	16.44	18.07	19.56	15.70
14 <sup>th</sup> day	26.00	26.96	28.74	24.44
28 <sup>th</sup> day	27.56	27.59	30.81	26.36



The Split tensile strength test results of the hardened concrete cylindersfor standard, 10%, 20% & 30% E-waste concrete for 7, 14 and 28 days were given in table 7 with its graphical representation.

Table 7 Split tensile strength test for concrete cylinders				
	Split Tensile Strength (N/mm <sup>2</sup> )			
No. of Days	Standard	10% E-waste	20% E-waste	30% E-waste
7 <sup>th</sup> day	3.18	3.50	3.82	3.37
14 <sup>th</sup> day	4.77	5.12	5.41	5.06
28 <sup>th</sup> day	6.05	6.36	6.68	6.26



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The Flexural strength test results of the hardened concrete slabsfor standard, 10%, 20% & 30% E-waste concrete for 7, 14 and 28 days were given in table 8with its graphical representation.

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	Table 8 Flexural strength test for concrete slabs				
	Flexural Strength of Slabs (N/mm <sup>2</sup> )				
No. of Days	For Standard	10% E-waste	20% E-waste	30% E-waste	
7 <sup>th</sup> day	4.00	4.00	4.20	4.00	
14 <sup>th</sup> day	4.60	4.80	5.07	4.40	
28 <sup>th</sup> day	5.20	5.40	5.50	3.63	



#### V. CONCLUSION

In this project, the Compressive strength, split tensile strength and Flexural strength have been studied for various replacements of coarse aggregate by E-waste. From the results we have chosen the optimum percentage of replacement is 20%, which gives the strength more than the conventional concrete.

It was found that the use of E-waste concrete helps in high compressive, split tensile and flexural strength with high permeability and is therefore safe compared to normal concrete construction. Based on the results of this project, it is recommended that E-waste concrete can be used for an economical construction.



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