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Partial replacement of coarse aggregate using E-waste

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Abstract

Due to the increase in urbanization need for construction plays an important role in the day to day activities. This results in the need for the material of which coarse aggregate is one of the main construction material. Infrastructure development results in the exhaust of coarse aggregate. Electronic waste (E-waste) is found to be a better alternative material for replacing coarse aggregate. Using E-waste in Concrete, compressive strength can be increased up to a certain percentage of addition and also helps us for disposing of E-waste safely.

Keywords — *Electronic waste, compressive strength, safe environmental disposal etc.,*

I. INTRODUCTION

Every year Electronic waste generated in India was about 50 million tonnes. Proper measures have to be taken to dispose of this large amount of generated Electronic waste without causing any hazards to the environment. Many types of research are being carried out for saving natural resource materials without exhausting. Strength properties of E-waste are almost similar to coarse aggregate, and also compressive strength can be increased to limited addition of percentages. Also, various types of poisonous liquids are present in E-waste, which in turn left to landfill affects soil nature and causes decrement of nutrients in the soil leading to land poisoning In this experimental study is carried out in determining the optimum percentage of the addition of E-waste in Concrete for 7 days, 14 days & 28 days.

II. LITERATURE REVIEW

Sagar R. Raut et al. concluded in their paper "Experimental Study on Utilization of E-Waste in Cement Concrete" that up to 15% of replacement of E-waste can be carried out successfully to improve compressive strength in concrete cubes.

K. Alagusankareswari et al., inferred in the paper "An Experimental Study on E-Waste Concrete" that 10% addition of E-waste results in better compressive strength comparing to 20% and 30%

Manikandan.M et al., in the paper "Experimental Study on E-Waste Concrete and Comparing with Conventional Concrete" concluded that E-Waste gives better compressive strength at 15% of replacement to coarse aggregate.

Ankur Gupta et al., in the paper "A Review Paper on Use of E-Waste in Concrete", concluded that E-waste is potentially a better material for concrete addition.

Md. Masuduzzaman at al., "Utilization of E-waste in Concrete and its Environmental Impact - A Review" concluded that E-waste increases the durable property of Concrete in all ways.

III. METHODOLOGY

E-waste collected from various industries and broken down into sizes of the coarse aggregate of about 20 mm and various tests are conducted along with conventional concrete materials. Cubes of size 150mm x 150mm x 150mm are cast. After the required curing period compressive test for 7 days, 14 days and 28 days was determined.

A. MIX DESIGN

Using IS 10262:2009 concrete mix designs are calculated. Stipulations of mix proportioning data's are tabulated in Table 1

Table.1 STIPULATION FOR MIX PROPORTIONING

Description	Value
Grade designation	M25
Type of cement	OPC 53 grade
Maximum nominal size of aggregate	20mm
Minimum cement content	300 Kg/m³
Maximum water-cement ratio	0.50
Workability	49mm(Slump)
Exposure condition	Moderate

B. MATERIALS TEST DATA

For sieve analysis of fine aggregate conforming to grading zone I of table 383-1970. Water absorption, crushing value and fineness modulus test for E-Waste

is conducted the same as followed for coarse aggregates.

E-waste collected from electronic industries, as shown in figure 1 is checked for moisture content in the laboratory, and the various test is conducted according to codal provisions.

Fig 1: E-wastes

Various laboratory tests are conducted for materials used in Concrete, and the test values are tabulated in table 2. Test conducted in the laboratory with proper inspection and also a non-violation of Indian standard codebooks.

Table.2 MATERIALS TEST DATA

Test	values
Cement used	OPC 53 grade
The specific gravity of cement	3.42
The specific gravity of fine aggregate	2.63
The specific gravity of coarse aggregate	2.7
Water absorption coarse aggregate	0.5%
Water absorption fine aggregate	0.1%
Water absorption of E-waste	0.15
Crushing value of E-waste	2.5
Fineness of E-waste	2.32
The specific gravity of E-waste	1.4

Following are the volumes of materials to be used for casting.

Cement = 394 Kg / m³
Water = 197 Kg / m³
Fine aggregate = 796Kg / m³
Coarse aggregate = 1040Kg / m³
Water – cement ratio = 0.50

C. SPECIMEN CASTING & CURING

Totally 15 cubes of 150mm size are cast for conventional, 5%, 10%, 15% and 20% of E-waste replacement as shown in figure 2.

E-waste resembles to be coarse aggregate and holds the good property in strength-related concepts. According to workability point of view, the addition of E-waste in Concrete gives designed workability values, and it does not affect the flow of concrete ingredients in any means.

Fig 1: Casting of Cubes

After the removal of specimens from the mould, it is placed in the curing tank for completion of the hydration process as shown in figure 3

Fig 2: Curing of Cubes

D. TESTING OF CUBES

Casted cubes are tested in compression testing machine, as shown in figure 3, after achieving respective days of curing.

Fig 3: Compression test on Cubes

The values of compressive strength for conventional Concrete along with 5%, 10%, 15% and 20% of E-waste replacement are tabulated in table 3, 4 & 5.

Table.3 compressive strength of cube for 7 days

Specimen details	Max.load (kN)	Comp.strength (N/mm^2)	Average (N/mm^2)
Conventional 0% Replacement	260	11.55	11.84
	272	12.08	
	268	11.91	
5% E-Waste Replacement	279	12.4	12.56
	281	12.48	
	288	12.8	
10% E-Waste Replacement	310	13.77	14.15
	318	14.13	
	328	14.57	
15% E-Waste Replacement	390	17.33	17.38
	386	17.15	
	398	17.68	
20% E-Waste Replacement	288	12.8	13.44
	312	13.86	
	308	13.68	

Table.4 compressive strength of cube for 14 days

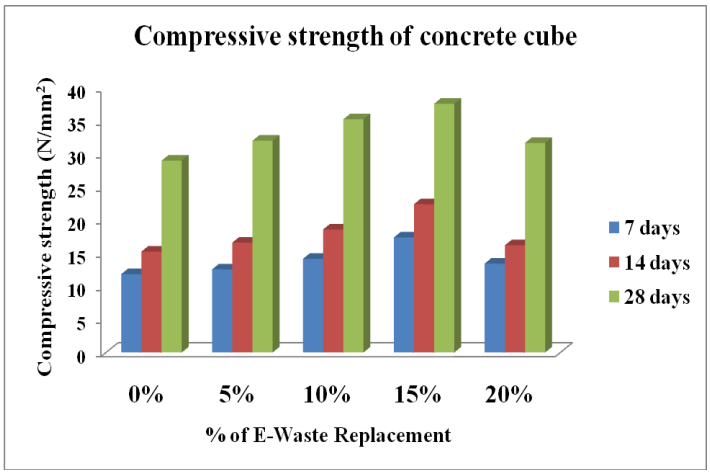
Specimen details	Max.load (kN)	Comp.strength (N/mm^2)	Average (N/mm^2)
Conventional 0% Replacement	330	14.66	15.25
	348	15.46	
	352	15.64	
5% E-Waste Replacement	368	16.35	16.61
	372	16.53	
	382	16.97	
10% E-Waste Replacement	410	18.22	18.60
	418	18.57	
	428	19.02	
15% E-Waste Replacement	492	21.86	22.42
	502	22.31	
	520	23.11	
20% E-Waste Replacement	384	17.06	16.2
	348	15.46	
	362	16.08	

Table.5 compressive strength of cube for 28 days

Specimen details	Max.load (kN)	Comp.strength (N/mm^2)	Average (N/mm^2)
Conventional 0% Replacement	640	28.44	29
	660	29.33	
	658	29.24	
5% E-Waste Replacement	710	31.55	32.02
	732	32.53	
	720	32	
10% E-Waste Replacement	790	35.11	35.25
	802	35.64	
	788	35.02	
15% E-Waste Replacement	848	37.68	37.62
	838	37.24	
	854	37.95	
20% E-Waste Replacement	710	31.55	31.69
	722	32.08	
	708	31.46	

E. COMPARISON OF RESULTS

Compression test values obtained from the tables mentioned above are plotted in chart 1 as shown below



IV. CONCLUSIONS

From the above-plotted result values, the following points are concluded,

- Greater compressive strength is achieved when E-waste is replaced by 15%
- Workability of Concrete is found to be same as the addition of aggregate
- Addition of E-waste in Concrete reduces the self-weight of conventional Concrete and can be utilized for constructing lightweight structures.
- May be at higher risk of conducting electricity since E-waste particles contain permits electricity to pass-through
- E-waste is found to be a better replacement for coarse aggregate, thereby by saving earth's natural resource.

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