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RESEARCH ARTICLE

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USE OF ELECTRONIC WASTE AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE IN CONCRETE

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ABSTRACT

Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling or disposal are also considered as e-waste. Informal processing of electronic waste in developing countries may cause serious health and pollution problems, as these countries have limited regulatory oversight of e-waste processing. Solid waste management is one of the major environmental concerns in our country now a days. The present study covers the use or recycled-wastes as replacement of coarse aggregates in concrete. The main aim of the study is to investigate the change in mechanical properties of concrete with the addition of e-wastes in concrete. It is found that the use of e-waste aggregates results in the formation of light weight concrete. In this research article Coarse aggregate is partially replaced by electronic waste from 0% to 30% Then in these mix 10%, 20% and 30% of fly ash is also added by partial replacement of cement. Various test like Specific Gravity Test, fineness modulus, Bulking of Sand, Water absorption Test, Aggregate Crushing Value, Aggregate Impact Test and aggregate abrasion value, slump cone test, compressive strength test is also performed on concrete ingredient and concrete.

Key Words: Electronic waste, Natural Aggregate, Concrete.

I. INTRODUCTION

Research concerning the use of by-products to augment the properties of concrete has been going on for many years. In the recent decades, the efforts have been made to use industry by-products such as fly ash, silica fume, ground granulated blast furnace slag(GGBS), glass cullet, etc., in civil constructions. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products.

One of the new waste materials used in the concrete industry is recycled electronic waste. For solving the disposal of large amount of recycled electronic waste material, reuse of electronic waste in concrete industry is considered as the most feasible application. Recycled electronic waste can be used as coarse aggregate in concrete. However, it is important to underline that re-using of wastes is not yet economically advantageous, due to the high costs of transport and its effect on the total costs of production. Moreover, it is important not to neglect to their costs, directly referable to the kind of wastes, due, in particular, to the need of measuring gas

emission, during firing, and the presence of toxic and polluting elements.

The processing of electronic waste in developing countries causes serious health and pollution problems due to the fact that electronic equipment contains serious contaminants such as lead, cadmium, Beryllium etc. This paper deals with the non hazardous and inert components of Ewaste generated out of Obsolete Computers, TV Cabins, Refrigerator, Mobile phones and washing Machine etc. Postconsumer components of above mentioned appliance have traditionally been disposed off either in domestic refuse, which ends up in landfill, were collected in designated collection spots for reuse/ recycling. The major objective of this task is to reduce as for as possible the accumulation of used and discarded electronic and electrical equipments and transfer waste into socially and industrially beneficial raw material using simple, low cost and environmental friendly technology. In this project Coarse aggregate is partially replaced by electronic waste upto 5%,10%,15%,20%, 25% and 35%. Then in these mix 10%, 20% and 30% of fly ash is also added by partial replacement of cement and all these mixes are checked for its compressive strength.

II. Methodology

For the this research project ordinary Portland cement of grade 43, natural sand from narmada is used as fine aggregate, natural crushed aggregate is used as a coarse aggregate and crushed plastic waste of which is passed from 20 mm sieve and retained on 4.75 mm sieve is employed in this research project.

As per IS 10262:2009 mix design is done. 28 mix prepared which contain 0% to 30% electronic waste as partial replacement to coarse aggregate along with this 10% to 30%fly ash as a partial replacement of fine aggregate. Once design of mix has been prepared then 150*150*150mm cubes is casted for these mixes, 9 cubes for each mix is casted which is going to tested after 7,14 and 28 days of curing i.e. total 252 cubes is casted.

III. Experimental Program

Considering the research objectives, laboratory works need to be executed to get the data and information related to the project. The data are the reference of research experiment that has to be answered. To determine the property of the material along with their behavior some test is performed on the materials as well as concrete. on various material Specific Gravity Test, fineness modulus, Bulking of Sand, Water absorption Test, Aggregate Crushing Value, Aggregate Impact Test and aggregate abrasion value. On fresh concrete slump cone test is performed to check workability of concrete and on hardened concrete i.e 150mm concrete cubes compressive strength test is performed after 7, 14 and 28 days of curing.

IV. Result and Discussion

Series of test were carried out on material, green & hardened concrete to obtain the workability strength characteristics of Electronic waste for potential application as structural concrete. The results for material test on, water absorption test, specific gravity test, aggregate crushing value test, aggregate impact value test are given and discussed below.

A. Test on Materials

1. Crushing Value Test

Form the result of crushing value we come to know that the Electronic waste is having more resistance to the wear and tear than the natural aggregate. Result of Crushing value test is given below in table 1

Table 1: Aggregate Crushing Value

Aggregate	Crushing Value
Natural Coarse Aggregate	14.22%
Electronic waste	2.35%

2. Impact Value Test

Impact test is the good indicator of strength and durability from the test result we can say that natural and Electronic waste are having wide difference of impact and crushing value, which again shows that aggregate of electronic waste is stronger than that of natural aggregate. Result of impact test is given below in table 2

Table 2: Aggregate Impact Value

Aggregate	Impact Value
Natural Coarse Aggregate	7.90%
Electronic waste	1.95%

3. Abrasion Value Test

Los angles abrasion test result shows that abrasion value of natural coarse aggregate is much higher than electronic waste.

Table 3: Aggregate Abrasion test

Aggregate	Impact Value
Natural Coarse Aggregate	11.90%
Electronic waste	3.57%

4. Specific Gravity Test

Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance. Result given in table 4.

Table 4: Result Specific Gravity Test

Aggregate	Specific Gravity
Natural Coarse Aggregate	2.71
Natural Fine Aggregate	2.64
Electronic waste	1.20
Cement	3.14

5. Fineness Modulus

Sieve analysis test is performed on the aggregate i.e Natural coarse aggregate, Natural fine aggregate and Electronic waste and their result given in table 5.

Table 5: Result of sieve Analysis Test Result

Aggregate	Fineness Modulus
Natural Coarse Aggregate	2.70
Natural Fine Aggregate	1.90
Electronic waste	2.50
Cement	4.3

6. Water absorption

Water absorption of is performed on the aggregate and it has find that all aggregate have water absorption below 5% and their result given in table 6.

Table 6:Result of Water Absorption Test

Aggregate	Water Absorption %
Natural Coarse Aggregate	0.60
Natural Fine Aggregate	0.30
Electronic waste	0.04

4.2.7 Bulking of Sand

Sand is used as a fine aggregate and to use sand in concrete we have to check its bulking and Bulking of sand is 30.21.

7. Combined Test Result

All material test result is combined in a table given below

Table 7: Combined Test Result

S.No.	Test	Natural Coarse aggregate	Electronic waste	Fine Aggregate	Cement
1	Water Absorption	0.60%	0.04%	0.30%	-
2	Specific gravity	2.71	1.20	2.64	3.14
3	Crushing value	14.22 %	2.35 %	-	-
4	Impact value	7.90%	1.95%	-	-
5	Abrasion value	11.90%	3.57%	-	-
6	Fineness Modulus	2.70	2.50	1.90	4.3
7	Bulking of Sand	-	-	30.21	-

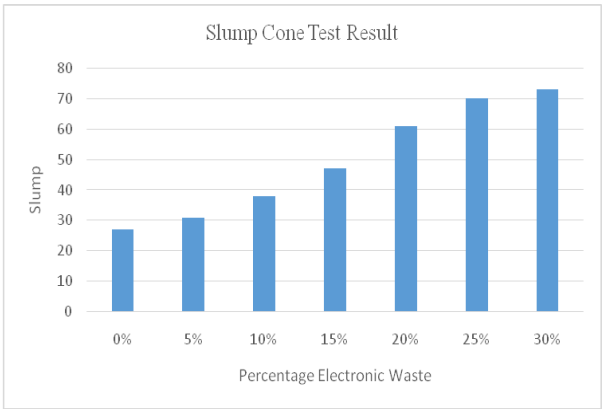
B. Slump Cone Test

The slump test indicates a decreasing trend of workability when the percentage of Electronic waste increased. Table 8 and table 9 below shows the average slump recorded during the test. Graph 1, 2, 3 and 4 below shows a graphical representation of slump height.

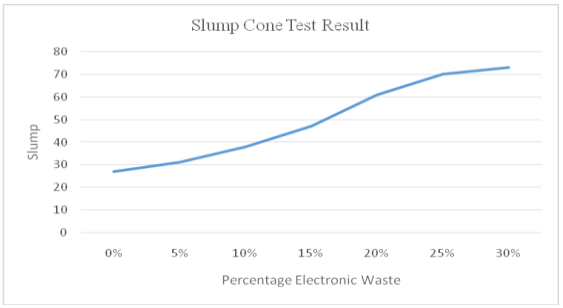
1. Electronic waste concrete

Table 8: Slump Cone test Result of electronic waste concrete

electronic waste	Slump (mm)
0%	27
5%	31
10%	38
15%	47
20%	61
25%	70
30%	73



Graph 1: Workability Test Result of Electronic waste Concrete (Line Chart)

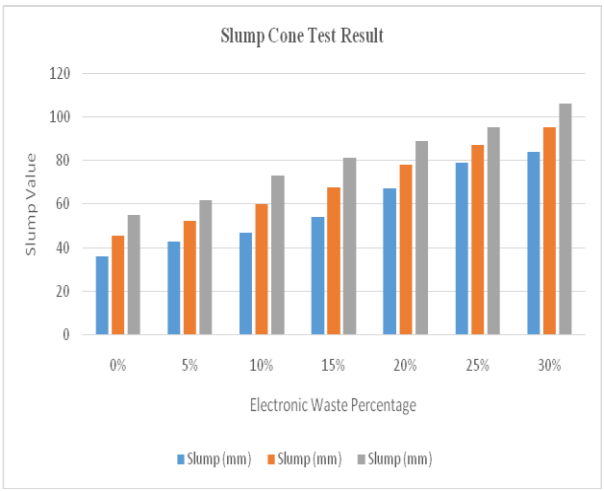


Graph 2: Workability Test Result of Electronic waste concrete (Bar Chart)

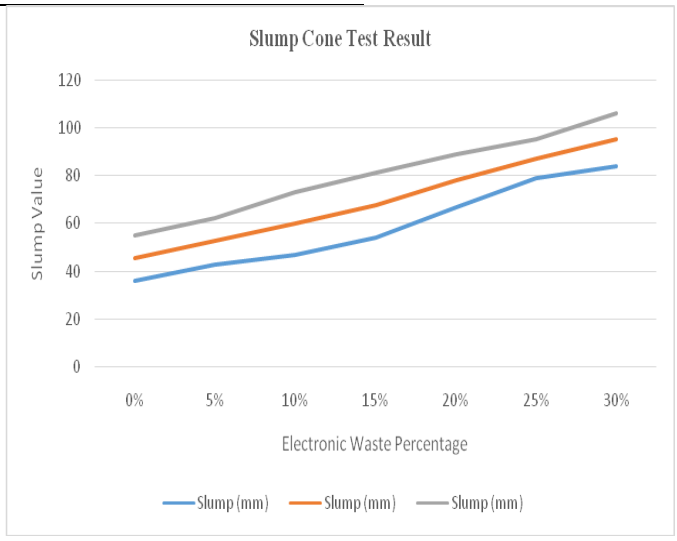
2. Electronic waste with fly ash Concrete

Table 9: Workability Test Result of Electronic waste with Fly Ash concrete

percentage electronic waste	Slump (mm)		
	Electronic waste with 10% Fly Ash	Electronic waste with 20% Fly Ash	Electronic waste with 30% Fly Ash
0%	36	46	55
5%	43	53	62
10%	47	60	73
15%	54	68	81
20%	67	78	89
25%	79	87	95
30%	84	95	106



Graph 3: Workability Test Result of Electronic waste concrete with Fly Ash (Bar Chart)



Graph 4: Workability Test Result of Electronic waste concrete with Fly Ash (Line Chart)

C. Compression Test Result and Analysis

The compression test by CTM (Compressive Testing machine) indicates an increasing trend of compressive strength with age of the concrete

specimens. However, it shows that the strength of Electronic waste specimens is lower than natural aggregate specimens

1. Compressive Strength of Electronic waste Concrete

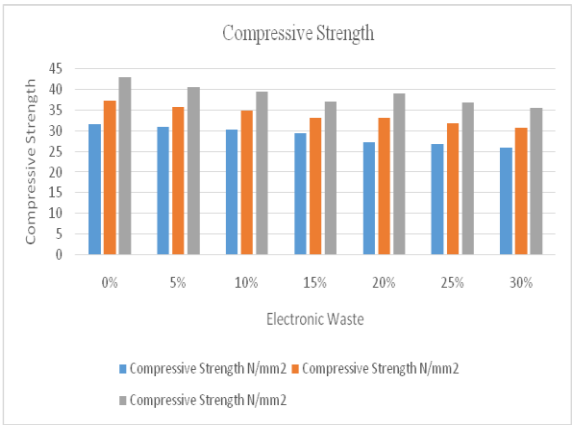
Table 10 and graph 5-6 shows compressive strength test result of concrete containing electronic waste.

Table 10: Compressive Strength Test Result of Electronic waste Concrete

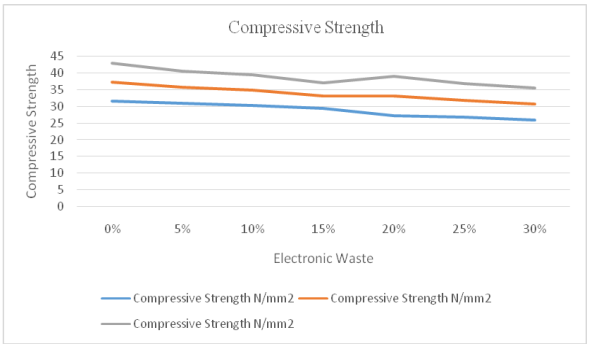
Electronic Waste	Compressive Strength N/mm^2		
	7 Days	14 Days	28 Days
0%	31.46	37.155	42.85
5%	30.91	35.71	40.51
10%	30.26	34.84	39.42
15%	29.32	33.085	36.85
20%	27.12	32.995	38.87
25%	26.78	31.775	36.77
30%	25.92	30.665	35.41

2. Compressive Strength of Concrete with Electronic waste and Fly Ash

Table 11 and graph 7-8 shows compressive strength test result of concrete containing electronic waste with fly ash.



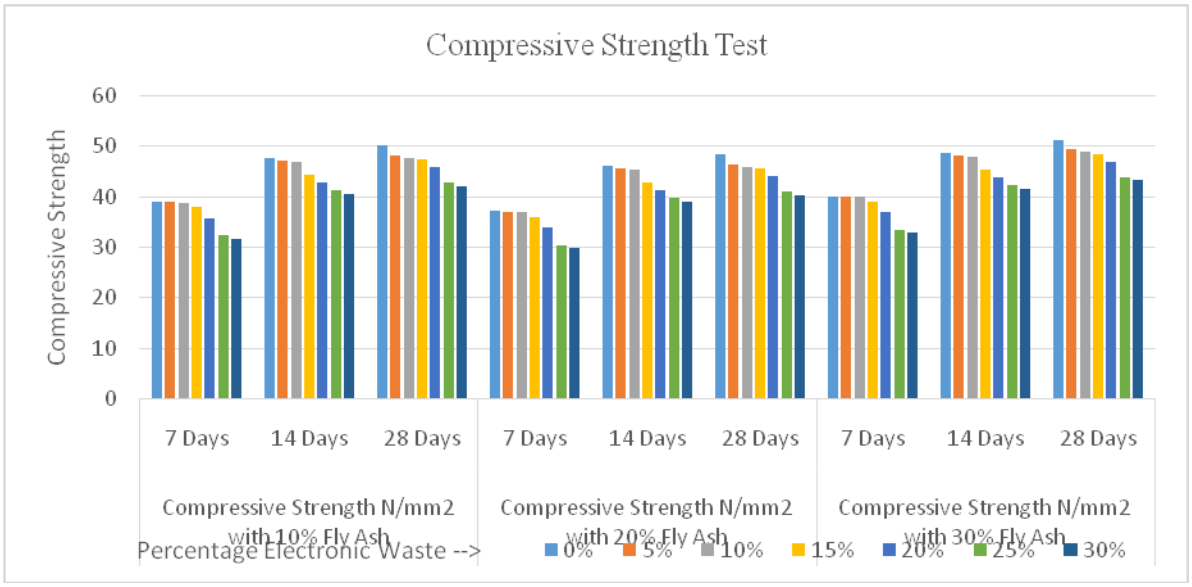
Graph 5: Compressive Strength Test Result of Electronic waste Concrete (Bar Chart)



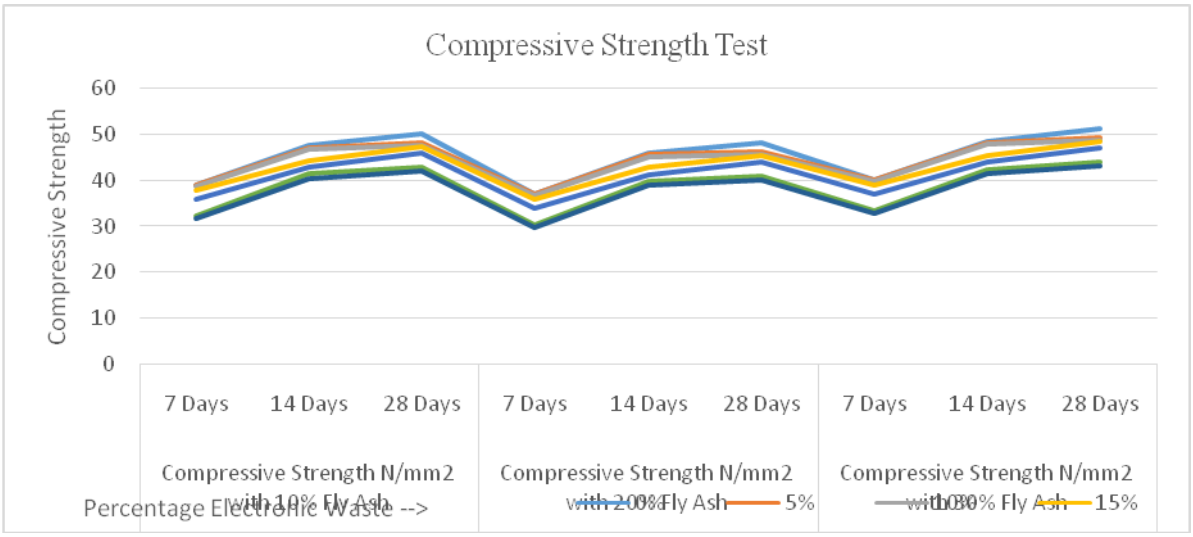
Graph 6: Compressive Strength Test Result of Electronic waste Concrete (Line Chart)

Table11: Compressive Strength Test Result of Electronic waste Concrete with Fly ash

Electronic Waste	Compressive Strength N/mm2 with 10% Fly Ash			Compressive Strength N/mm^2 with 20% Fly Ash			Compressive Strength N/mm^2 with 30% Fly Ash		
	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
0%	38.91	47.46	49.98	37.02	45.9	48.23	40.03	48.45	51.21
5%	38.78	47.05	48.02	36.89	45.49	46.27	39.9	48.04	49.25
10%	38.67	46.78	47.46	36.78	45.22	45.71	39.79	47.77	48.69
15%	37.76	44.36	47.17	35.87	42.8	45.42	38.88	45.35	48.4
20%	35.72	42.74	45.64	33.83	41.18	43.89	36.84	43.73	46.87
25%	32.24	41.27	42.61	30.35	39.71	40.86	33.36	42.26	43.84
30%	31.56	40.42	41.89	29.67	38.86	40.14	32.68	41.41	43.12



Graph 7: Compressive Strength Test Result of Electronic waste Concrete with fly ash (Bar Chart)



Graph 8: Compressive Strength Test Result of Electronic waste Concrete with fly ash (Bar Chart)

V. Conclusion

An experimental study has been done on concrete using electronic waste as coarse aggregate and also with fly ash as replacement of cement and following points is observed from the present study.

1. Workability of the concrete increases when percentage of the electronic waste increase.
2. When fly ash content added to electronic waste concrete, it has been observed that workability increased. Workability of fly ash with electronic waste concrete is even more than conventional and electronic waste concrete.
3. Compressive strength of electronic waste concrete decreases with increase in the percentage of e-waste.
4. It has been observed that when we replace cement by fly ash in concrete along with electronic waste as a coarse aggregate compressive strength increases.
5. Cement replacement of 30% by fly ash along with electronic waste gives best result.
6. Current study concluded that Electronic waste can replace coarse aggregate upto 10% or 20%.
7. Current study also concluded that electronic waste can replace coarse aggregate upto 30% in concrete when 30% fly ash is replaced by cement.

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