Effective Utilization of E-Waste in Concrete

Sidharthan K. V[1], Shameem V. S[1], Sayid Noufal P. S[1], Mohammed Kunhi M. K[1], Shaiju P[1], Dona Chacko[2]

[1]*Btech Students,* [2]*Assistant Professor, Department of Civil engineering, Eranad Knowledge City Technical Campus, Manjeri, Malappuram, Kerala, India*

Abstract- *E-waste is the rapidly increasing waste as the use of electronics by human are increasing in every hour. Electronic waste or E-waste describes discarded electrical or electronic devices. Used electronic devices which cannot be destined reuse, recycle, resale and disposal. A huge amount of earth space has been occupied by the earth space. E-waste is the less recycled waste material and the large produced waste material. Increased use of electronic waste in developing countries including our country may cause serious health and pollution problems. 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 (treated or crushed) in certain percentages in M25 concrete and their properties are tested. By using E-waste in concrete, we are not only reducing the waste effectively from the earth but also decrease the use of sustainable construction materials that will lead to an economic construction. The review also includes research work that has been carried out to understand the effects on compressive strength and split tensile strength characteristics.*

Keywords:*Concrete, E-waste, Compressive strength, Tensional strength, split tensile strength .*

I.INTRODUCTION

Industrialization and urbanization had made tremendous changes all over the world. Industrial revolution followed by the advances in information technology during the last century has radically changed people's lifestyle. Although this development has helped the human race, mismanagement has led to new problems of contamination and pollution. In the recent years there has been growing concern about the negative impact of industries and its products. The technical skill acquiredduring the last century has posed a new challenge in the management of wastes[1].

Electronic waste or E-waste is the discarded electrical or electronic devices. Used electronic devices which cannot be reused, recycled, resale and disposal. Increased use of electronic waste in developing countries including our country may cause serious health and pollution problems.Aggregates in concrete are replaced partially by crushed or treated E-waste. E-waste is added to the concrete to about 0% ,5%, 10 %, etc and their properties are tested in the laboratory[2,4,6].

Using E-waste in concrete, we are not only reducing the waste effectively from the earth but also decrease the use of sustainable construction materials that will lead to an economic construction[4].

II.MATERIALS

A. *Cement*

A cement is abinder, a substance used for construction thatsets, hardens and adheres to othermaterials, binding them together. Cements used in construction are usuallyinorganic, oftenlimeorcalcium silicatebased, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water Ordinary Portland cement of grade 53 is used in this project.

TableI: Physical Properties of Cement

Property	Value
Specific Gravity	2.810
Bulk Density	1.710
Void Ratio	0.47
porosity	31.7%

B. *Fine Aggregate*

Fine aggregate used for this project is river sand or M sand (depending on availability and cost) of size less than 4.75 mm [3].

Property	Value
Specific Gravity	2.650
Bulk Density	1.75
Void Ratio	0.505
Porosity	33.59
Sieve Analysis	Zone 1

C. Coarse Aggregate

Aggregates of size greater than 4.75 mm are termed as coarse aggregates. Crushed stone and natural gravel are common materials used as coarse aggregate for concrete[2,3,5].

TableIII: Physical Properties of Coarse Aggregate

Property	Value
Specific Gravity	3.050
Fineness	2%
Consistency	26%
Initial setting Time	34 min

D. E-waste

Electronic waste or e-waste describes discarded electrical orelectronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered E-waste. Here we are using Printed Circuit Boards (PCB) which is one of the main component of all electronic devices and are easily available [4,7,10].

III.CONCRETE MIX DESIGN

Concrete mix design is the process of finding right proportions of cement, sand and aggregates for concrete to achieve target strength in structures. The concrete mix design is done as per Indian Standard Method (IS 10262-2009). The obtained mix proportions are [8]:

Ordinary cement concrete with 0 % E-waste

Cement: Fine Aggregate: Coarse Aggregate = 1:1.56:2.58:0.45

Water cement ratio =0.45

IV.EXPERIMENTAL SETUP

A. *Compressive Strength*

Compressive strength at 3days,7days,28 days are tested on 150 x 150 x 150 mm cubes.The test specimens were immersed in water in curing tanks after 24 hours of casting for 3days, 7days,28days.The test was conducted according to the Indian Standard IS. Three specimens were tested each time and the average of the value is taken[3,4,6].

Percentage of e-waste (%)	Curing (days)	Load (kN)	Compressive strength (N/mm^2)
0	3	340	15.11
	7	500	22.22
	28	630	28.00
5	3	360	16.00
	7	540	24.00
	28	650	28.88
10	3	390	17.33
	7	560	24.887
	28	700	31.11
15	3	410	18.22
	7	600	26.66
	28	710	31.55
20	3	370	16.44
	7	490	21.77
	28	630	28.00

Table IV: Compressive Strength Results

A. *Split Tensile*

Split Tensile strength at 3days,7days,28 days are tested on cylinder of 300mm length and 150mm diameter. The test specimens were immersed in water in curing tanks after 24 hours of casting for 3days, 7days, 28days.The test was conducted according to the Indian Standard IS. Three specimens were tested each time and the average of the value is taken [4,5,6].

Table V: Split Tensile Strength Results

Percentage of e-waste (%)	Curing (days)	Load (kN)	Tensile Strength (N/mm^2)
0	3	110	1.55
	7	130	1.83
	28	174	2.46
5	3	118	1.67
	7	136	1.92
	28	176	2.48
10	3	126	1.78
	7	138	1.95
	28	180	2.55
15	3	139	1.96
	7	163	2.30
	28	184	2.60
20	3	112	1.58
	7	129	1.82
	28	168	2.38

B. *Flexural Strength*

The flexural test measures the force required to bend a beam under mid-point loading conditions. Flexural strength at 3days,7days,28 days are tested on beam of size 500 x 100 x 100 mm. The test specimens were immersed in water in curing tanks after 24 hours of casting for 3days, 7days, 28days.The test was conducted according to the Indian Standard IS. Three specimens were tested each time and the average of the value is taken [4,5,6]

Table VI: Flexural Strength Results

Percentage of e-waste (%)	Curing (days)	Load (kN)	Flexural Strength (N/mm^2)
0	3	6	4.50
	7	6.4	4.80
	28	8.3	6.23
5	3	6.3	4.73
	7	6.6	4.95
	28	8.5	6.38
10	3	6.4	4.80
	7	6.9	5.18
	28	8.9	6.68
15	3	7	5.25
	7	7.4	5.55
	28	9.8	7.35
20	3	5.1	3.82
	7	5.5	4.12
	28	8.2	6.15

IV. RESULT ANALYSIS

The results obtained by conducting the various tests are analysed and various graphs are plotted. The graphs are plotted between strength and the percentage of E-waste added.

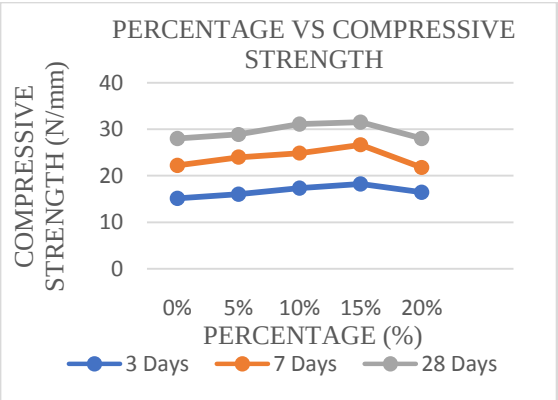

Fig 1: Effect of Change inCompressive Strength in Addition of E-waste

The graph shows the compressive strength characteristics of concrete. The strength increases for 0%-15% of E-waste and then starts decreasing for the addition of 20% of e-waste. Here the optimum point ofpercentage of E-waste is 15 %[5].

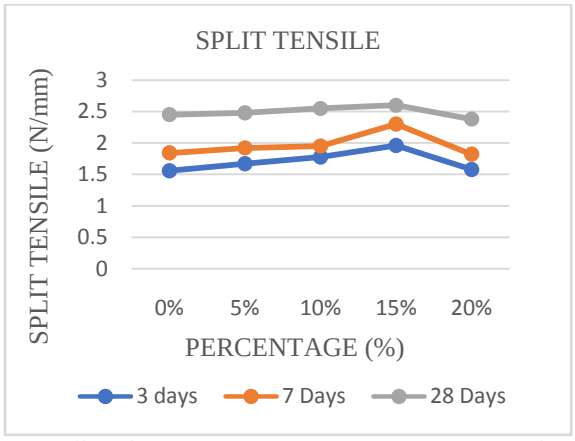

Fig 2:Effect of Change in Split Tensile Strength in Addition of E-waste

The graph shows the split tensile strength characteristics of concrete on addition of various percentage amount of E-waste. The strength increases up to 0%-15 % and then starts decreasing for 20%. So, here the optimum point of percentage of E-waste is 15% [5,6].

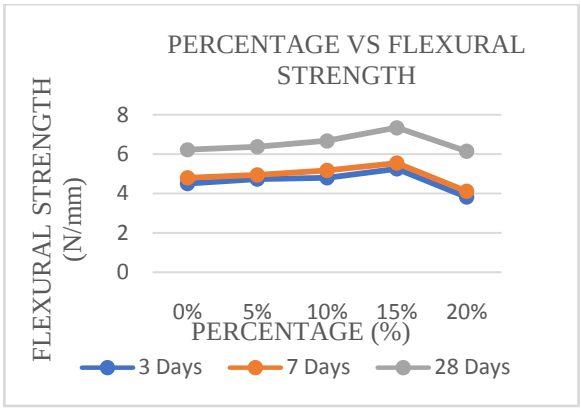

Fig 3: Effect of Change in Flexural Strength in Addition of E-waste

The graph shows the Flexural strength characteristics of concrete on addition of various percentage amount of E-waste. The strength increases up to 0%-15% and then startsdecreasing for 20%. So, here the optimum point of percentage of E-waste is 15%.

V. CONCLUSION

Based on the experimental investigation the following conclusions are drawn:

a. At 5 %,10 %,15 % replacement of aggregates by E-waste has higher strength than normal conventional concrete.

b. 15% is the optimum percentage of addition of E-waste. After 15% the strength starts decreasing.

c. Cost of construction can be reduced by replacing the construction materials by using E-waste in concrete.

d. Utilizing E-waste in concrete is one of the major process through which the E-waste can be reduced from the society.

e. Using E-waste in concrete helps in reducing and conservation of the natural aggregates.

f. E-waste in concrete is very economical and useful method of light construction works.

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