"COST ANALYSIS BETWEEN ELECTRONIC WASTE CONCRETE AND CONVENSIONAL COCNRETE"

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ABSTRACT

Electronic garbage is a growing concern that poses major environmental and human health risks. whose disposal is evolving into a difficult issue. The reuse of E-waste material in the concrete industry is thought to be the most practical application for addressing the disposal of vast amounts of E-waste material. The cost of typical coarse and fine aggregate has increased, forcing civil engineers to look for suitable substitutes. One such substitute for both coarse aggregate and fine aggregate is e-waste. Due to the lack of coarse aggregate needed to prepare concrete, an attempt was made to partially substitute E-waste with coarse. M30 grade mix was used for the project. The proportion of coarse aggregate replaced by E-waste in the range of 0%, 3%, 6%, 9%,12%, 15% and 18%. Electronic waste can also help to partially reduce the problem of rising construction material cost in this study save the material cost 2.35% 1m^3 as compare to control mix.

Key words: - E- waste, Mix Design, Cost analysis, conventional concrete, E –waste concrete.

INTRODUCTION

Electronic garbage, sometimes known as e-waste, refers to outdated electrical or electronic equipment. E-waste includes used electronics that are intended for recycling through material recovery, refurbishment, reuse, resale, or disposal. E-waste processing done informally in developing nations can have a negative impact on human health and pollute the environment.

Lead, cadmium, beryllium, and brominated flame retardants are just a few of the potentially hazardous compounds found in electronic trash components like CPUs. The health of workers and the communities they live in may be significantly at risk during the recycling and disposal of e-waste.

When an electronic product is discarded after reaching the end of its useful life, it produces "e-waste" or electronic garbage. E-waste is produced in enormous quantities as a result of the quick advancement of technology and our consumer-driven culture.

E-waste is a

Table 1 Yearly electronic waste generated

Year	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
E-waste Generated	18.2 Mt	23.6 Mt	30.6 Mt	35.3 Mt	42.8 Mt	57.4 Mt	59.4Mt

OBJECTIVE OF THE STUDY:

- To reduce the amount of construction cost by using certain electronic waste product

LITERATURE REVIEW

Mona Brahmacharimayum et al (2019) being examined Concrete is a commonly used composite material in the building industry made of fine aggregate, coarse aggregate, cement, and water with or without additives. However, as the creation of concrete requires a lot of energy, efforts have been undertaken to find substitutes for its traditional constituents. With an estimated growth rate ranging from 3% to 5% annually, electronic waste (or "E-wastes") is one of the fastest increasing categories of waste in the world. Old computers, TVs, refrigerators, and other electrical devices that have reached the end of their useful lives are considered e-waste. E-waste's impact on the environment and ecology may be somewhat mitigated by using it in concrete. Additionally, it will assist in the disposal of E-waste and lower landfill costs.

Suchithra et al (2015) I studied Electronic garbage is a growing concern that poses major environmental and human health risks. whose disposal is evolving into a difficult issue. The reuse of E-waste material in the concrete industry is thought to be the most practical application for addressing the disposal of vast amounts of E-waste material. The cost of typical coarse aggregate has increased, which has compelled civil engineers to look for appropriate substitutes. One such substitute for coarse aggregate is e-waste. Due to the lack of coarse aggregate needed to prepare concrete, an attempt was made to partially substitute E-waste with coarse aggregate. The M20 grade mix was used for the project. A replacement of 0%, 5%, 10%, or more of the coarse aggregate with E-waste

MATERIALS AND METHODS

The materials those were used in our thesis work are as follows:-

- Binding material i.e. Cement
- Fine aggregate (Sand)
- Coarse aggregate
- Electronic waste
- Potable water

Mix Design of M30 Grade of concrete IS 10262-2019

Step-1 Target Mean Strength

$F_{ck} = f_{ck} + 1.65S$

OR

$F_{ck} = f_{ck} + X$

Where

F_{ck}= Target mean compressive strength at 28Day

$f_{ck} =$ Charestetic compressive strength at 28 day

S= Standard deviation

X = Factor based on the grade of concrete

Target Mean Strength

$F_{ck} = f_{ck} + 1.65S$

So here $f_{ck} = 30$ N/mm^2

S= 5

The standard deviation value (SD) is taken from, Table 2 of IS:10262-2019 for **up-to M30 grade**

$F_{ck} = 30+1.65*5$

$F_{ck} = 38.5\ N/mm^2$

Now we have calculated an other formula

Value of X taken form IS10262-2019 table no 1 and page no2

X=6.5

Then

$F_{ck} = 30+6.5$

$F_{ck} = 36.5\ N/mm^2$

For design purpose always consider higher value of both

Hence,

$F_{ck} = 38.5\ N/mm^2$

Step-2 Selection of water cement ratio

Water cement ratio can be established by relationship fron the grape provide IS 10262-2019 figure no 1 and page no 4

Now consider water cement ratio is 0.43

But according to IS456-2000 maximum water cement ratio is For M30 grade concrete is 0.45

But in our mix design we have calculated 0.43 hence ok.

Step-3 Selection of water contain

The amount of water content needed per cubic volume of concrete must be estimated in this phase. With the nominal maximum size of coarse aggregate being 20 mm, the following chart from IS 10262:2019 can be used to determine this water content. (angular coarse aggregate).

Okay, so as you can see from the table, IS 10262 specifies that 186 kg of water are needed for 20 mm angular aggregate with a 50 mm Slump.

However, the workability requirement is 75 mm slump, and the method of putting concrete is by chute.

186 Kgs of water are currently being used for only a 50mm slump value, as the code recommends. As a result, we must make certain adjustments to account for the additional 25 mm of slump at a rate of 3%.

By the way, the formula provided by IS 10262:2019 in Clause No. 5.3 makes it simple to determine.

$$WC_{75}=186 + (75 - 50)/25*(3/100) * 186$$

$$WC_{75}= 191.58\ Kg/m^3$$

So consider of water 192 Kg/m^3

Step-4 calculation of cement

Quantity of cement = $\frac{\text{Water Contain}}{\text{Water Cenet ratio}}$

Quantity of cement = $\frac{192}{0.43}$

Quantity of cement = 447 *Kg/m^3*

Step-5 Course and fine aggregate calculation

Since 20 mm is the maximum nominal size, Table 5 of IS 10262:2019 states that the volume of coarse aggregate per unit volume of total aggregate for the various zones of fine aggregate is 0.62. The approximate values for this aggregate volume are given in Table 5 for a water-cement/water cementations materials ratio of 0.5, which may be suitably adjusted for other ratios. According to IS 10262:2019 Clause 5.5.1, "the proportion of volume of coarse aggregates to that of total aggregates is increased at the rate of 0.01 for every decrease in water cement/cementations materials ratio by 0.05 and decreased at the rate of 0.01 for every increase in water-cement ratio." Once more, in order to collect the amount of coarse aggregate, we must make some modifications to our designed water-cement ratio. The overall decrease in this ratio is = (0.50-.043) = 0.07

In the end, the modified value of coarse aggregate= (0.01 x 0.07)/0.05 = 0.014 will increase to = 0.62 + 0.014 = 0.634

So we get the value

$F_{ck=}$ 30Mpa

W/C ratio= 0.43

Water contain = 192 kg

Cement Contain= 447kg

C.A /Total aggregate=0.634

F.A/ Total aggregate= (1 – 0.634) = 0.366

Mix calculation

Mass/(Sp. Gravity of Cement * 1000) = Volume of Cement

Cement volume = 447/(2.880 * 1000) = 0.155 m3

Volume of Water = Mass/(Water's Specific Gravity * 1000)

Volume of Water = 192/(1.000 * 1000) = **0.192 m^3**

Volume of All-in-aggregate (Coarse + Fine aggregate) = (Total Concrete Volume – Air Content – Volume of Cement – Volume of water)

Volume of All-in-aggregate = (1 – 0.01 – 0.155 – 0.192) = **0.643 m^3**

Anyway, we can say that, the Total Volume of Coarse and Fine Aggregate is of fractional of 0.719 m^3 out of total $1m^3$ Concrete Volume.

There so, the **Weight of Coarse Aggregate** = (0.634 x 0.643 x 2.74 x 1000)

= **1117 Kg.**

In the Similar way, the **Weight of Fine Aggregate** = (0.366 x 0.643 x 2.65 x 1000)

= **624 Kg.**

Table 2 materials used in $1m^3$ For M30 grade of concrete

In this table show all material quantity per m^3 cement, sand, aggregate and water.

Cement	Sand	Aggregate	Water
447	624	1117	192

But in our research we replaced aggregate 0%, 2%,4%,6%,8%,10% and 12% and sand replace 0%,1%,2%,3%4%,5% and 6 % with e- waste.

So new material's quantity per $1m^3$ is

Table 3 weight of Aggregate and e-waste

In this table shown electronic waste quantity and coarse aggregate quantity.

% of e-waste	Actual Weight of Aggregate in kg as per mix design	Weight of e-waste in kg	Weight of Aggregate in kg after replacing with e-waste
0	1117	0	1117
2	1117	22.34	1094.66
4	1117	44.68	1072.32
6	1117	67.02	1049.98
8	1117	89.36	1027.64
10	1117	111.7	1005.3
12	1117	134.04	982.96

Table 4 weight of Sand and e-waste

In this table shown electronic waste quantity and fine aggregate quantity.

% of e-waste	Actual Weight of Sand in kg as per mix design	Weight of e-waste in kg	Weight of Sand in kg after replacing with e-waste
0	624	0	624
1	624	6.24	617.76
2	624	12.48	611.52
3	624	18.72	605.28
4	624	24.96	599.04
5	624	31.20	592.80
6	624	37.44	586.56

RESULTS AND DISCUSSION

The Results (or Findings) section follows the Methods and precedes the Discussion section. The Discussion section follows the Results and precedes the Conclusions and Recommendations.

COST ESTIMATION

Cost Analysis

The cost is the main important factor in any research. The invented material should be cost effective so that it can be easily adopted in modern construction industry. For construction of any project 60 % of the cost is incurred in the material. Our material in which we have used electronic waste as a partial replacement of course aggregate and fine aggregate by 0% to 12 %. and 0% to 6% In this way less aggregate will be used for every m^3 of concrete and we can save the direct material cost. The details of the cost economics of the material is described briefly in following table.

Material Rate in Bhopal 11-04-2023

Cement - 355 Per Bag

1 bag = 50kg

So rate of 1kg cement = 355/50 = 7.1Rs

Sand - 43 cu ft

1cu ft = 28.32kg

So rate of 1kg sand = 43/28.32 = 1.52 Rs

Aggregate – 25 cu ft

So rate of 1 kg aggregate = 25/28.32 = 0.88 Rs

A correct rate per unit of work or supply of work specifications such labor, materials, and equipment is determined using rate analysis. It can also be described as the analytical investigation that identifies the fundamental needs to define unit rates of work.

Table 5 Market Rate of All Material

S. No.	Material	Rate (Rs./Kg)
1	Cement	7.1
2	Fine Aggregate	1.52

3	Coarse Aggregate	0.88
4	Electronic Waste	0.2

Cost of cement per m^3 = 447*7.1 = 3173.7rs

Table 6 Cost of coarse aggregate and electronic waste

% of e-waste (1)	Weight of e-waste in kg (2)	Weight of Aggregate in kg after replacing with e-waste (3)	Cost of electronic waste in Rs (4)	Cost of coarse aggregate in Rs (5)	Total cost of coarse agg+ E waste= (4+5)
0	0	1117	0	982.96	982.96
2	22.34	1094.66	4.47	963.30	967.77
4	44.68	1072.32	8.936	943.36	952.296
6	67.02	1049.98	13.40	923.98	937.38
8	89.36	1027.64	17.87	904.32	922.19
10	111.7	1005.3	22.34	884.66	907
12	134.04	982.96	26.81	865	891.81

Table 7 Cost of fine aggregate and electronic waste

% of e-waste (1)	Weight of e-waste in kg (2)	Weight of Sand in kg after replacing with e-waste (3)	Cost of electronic waste in Rs (4)	Cost of Fine aggregate in Rs (5)	Total cost of fine agg+ E waste= (4+5)
0	0	624	0	948.48	948.48
1	6.24	617.76	1.25	939	940.25
2	12.48	611.52	2.5	929.5	932

3	18.72	605.28	3.7	920	923.7
4	24.96	599.04	5	910.54	915.54
5	31.20	592.80	6.24	901.05	907.29
6	37.44	586.56	7.5	891.57	899.07

Table 8 Total cost of materials in Rs per m^3

Electronic waste %	Cost of cement in RS	Cost of coarse agg+ electronic waste	Cost of fine agg +electronic waste	Total cost
0	3173.7	982.96	948.48	5105.14
3	3173.7	967.77	940.25	5081.72
6	3173.7	952.296	932	5057.996
9	3173.7	937.38	923.7	5034.78
12	3173.7	922.19	915.54	5011.43
15	3173.7	907	907.29	4987.99
18	3173.7	891.81	899.07	4964.58

Conclusion

From the experimental examination this exploration work can be conclude as following:-

- Since the density of concrete is reduced when e-waste is utilized in its stead, this EWC can be used to make light-weight concrete.
- One of the finest methods for disposing of e-waste is to use the EWC in conjunction with ordinary concrete.
- Up till a point, using e-waste in concrete can successfully address the issue of e-waste disposal.
- EWC can also help to partially reduce the problem of rising construction material cost. To save the material cost 2.35% $1m^3$ as compare to control mix.

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BIOGRAPHIES

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