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EXPERIMENTAL STUDY ON REPLACEMENT OF COARSE AGGREGATE BY E-WASTE IN CONCRETE

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Abstract - *Electronic waste is an emerging issue posing serious pollution problems to the human and the environment. The disposal of which is becoming a challenging problem. For solving the disposal of large amount of E-waste material, reuse of E-waste in concrete industry is considered as the most feasible application. Due to increase in cost of normal coarse aggregate it has forced the civil engineers to find out suitable alternatives to it. E-waste is used as one such alternative for coarse aggregate. Owing to scarcity of coarse aggregate for the preparation of concrete, partial replacement of E-waste with coarse aggregate was attempted. The work was conducted on M_{30} grade mix. The replacement of coarse aggregate with E-waste is in the range of 5%, 10%, and 20%. The influence of mineral admixture in strength achievement of e-waste added mix is also study in this project. Class C flyash is taken as the mineral admixture. Cement replaced by about 10% flyash in each percentage of e-waste added concrete mixes. Finally the mechanical of the concrete mix specimens obtained from the addition of these materials are compared with control concrete mix.*

***KeyWords*: E-waste, E-plastic, Environmental issues, Compressive strength, Flexural strength, Flyash**.

1. INTRODUCTION

In the present scenario, no construction activity can be imagined without using concrete. Concrete is the most widely used building material in construction industry. The main reason behind its popularity is its high strength and durability. Today, the world is advancing too fast and our environment is changing progressively. Attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. One of the new waste materials used in the concrete industry is E-waste. For solving the disposal of large amount of E-waste material, reuse of E-waste in concrete industry is considered as the most feasible application. 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 2% by 2010. In developing countries, it ranges 0.01% to 1% of the total municipal solid waste generation. Owing to the scarcity of coarse aggregate for the preparation of concrete, partial replacement of E-waste with coarse was attempted.

1.1 OBJECTIVES

The partial replacement of coarse aggregate by e-waste can be considered as a suitable waste management technique. The plastic waste accumulated by electronic waste such as computer, keyboard, Television etc. may pollute the environment. The pollution rate can minimize through the reuse of e-plastic wastes generated. The suitability of e-plastic waste to replace the coarse aggregate in higher grade concrete M_{30} is studied in this project with and without the mineral admixture(fly ash).The amount of green house gas generated by burning the e-plastic can reduce by suitable waste management techniques. The space for dumping the plastic waste is not needed by the suitable waste management.

1.2 SCOPE OF THE STUDY

The electronic wastes are accumulating on earth in day-by-day. Due the lack of suitable management techniques pollution of soil, atmosphere and water bodies rise. The chemicals from e-waste such as lead, cadmium, mercury, zinc, copper etc. are leach out and affects on human health.

Effects on human health;

- The lead and lead oxide mixed with water and the polluted water affects blood circulation, skin sensation and kidney working. It retards the brain development of children.
- Cadmium affect kidney, liver and sensational system.
- Content of mercury affects brain as well as respiratory systems.
- Burning of plastic and PVC affect birth creation capacity and affects the overall resistance capacity and overall life is shorten.

The disposal methods of e-waste are land filling, incineration, recycling, reuse etc. So we have reached to find the suitable solution for waste management. The e-plastic waste crushed into appropriate sizes and replaces the coarse aggregate in conventional concrete. Many researchers have done experiments on replacement of e-wastes such as e-plastic (computer and keyboard cabins and insulation wires) and PCB. There is an optimum percentage for replacement of the aggregate by e-waste. The strength can increase by using

mineral admixtures. The cost of construction is high due to the less availability of aggregates. The use of e-waste in concrete reduces the cost.

2. MATERIAL CHARACTERIZATION AND MIX DESIGN.

2.1 Materials

1. Cement: Ordinary Portland cement 53 grade(chettinad)
   - Specific gravity =3.15
   - Standard consistency=35%
   - Initial setting time=130 minutes
2. Coarse aggregate 12 mm size
   - Specific gravity =2.7
   - Water absorption=0.85%
3. Fine aggregate: M-sand
   - Zone-l fine aggregate
   - Specific gravity =2.6
   - Water absorption =1.5%
4. Crushed E-Plastic wastes 12mm size
5. Super plasticizer
6. Class C Flyash
7. Pure Water

Table -1: Mix proportion ratio

Cement	Fine aggregate	Coarse aggregate	Water cement ratio
1	2.09	2.11	0.4

2.2 MIX DESIGNATION

Table 2: MIX DESIGNATION

MIXDESIGNATION	DESCRIPTION
CM	Control Mix
E0	Concrete mix with addition of 0% E-waste by weight of C.A
E5	Concrete mix with addition of 5% E-waste by weight of C.A
E10	Concrete mix with addition of 10% E-waste by weight of C.A
E20	Concrete mix with addition of 20% E-waste by weight of C.A
EF0	Concrete mix with addition of 0% E-waste by weight of C.A+10% flyash
EF5	Concrete mix with addition of 5% E-waste by weight of C.A+10% flyash
EF10	Concrete mix with addition of 10% E-waste by weight of C.A+10% flyash
EF20	Concrete mix with addition of 20% E-waste by weight of C.A+10% flyash

3. TESTS ON CONCRETE

The hardened concrete properties are compressive strength and flexural strength .Both 28 days and 7 days strengths are find out.

3.1 COMPRESSIVE STRENGTH TEST

Compressive strength for 0%, 5%, 10% and 20% e-waste added concrete mix with and without flyash is finding by casting 4 cubes for each percentage.

Table 3: Compressive strength of E-plastic added mix

Mix designation	Compressive strength (N/mm^2)	
	7 day	28 day
E0	27.55	39.11
E5	20.44	32
E10	18.66	31.55
E20	14.66	28.44

Table 4: Compressive strength of E-plastic added mix with flyash

Mix designation	Compressive strength (N/mm^2)	
	7 day	28day
EF0	28.44	41.77
EF5	22.64	33.68
EF10	21.03	33.33
EF20	18.23	31.56

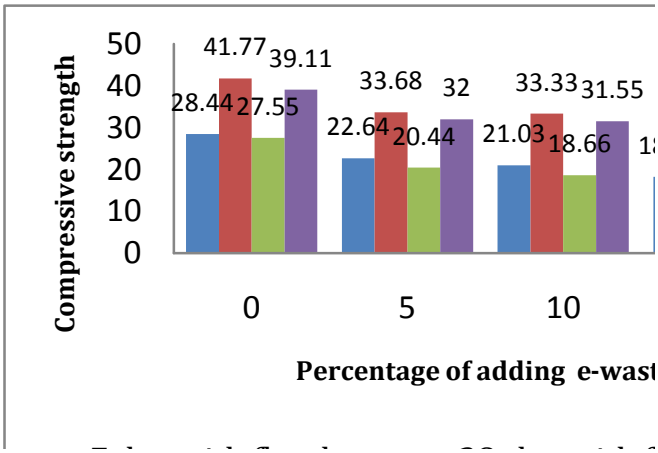

Chart 1: Variation in strength on 7 day and 28 day of various percentages of e-waste added mixes with and without flyash.

The compressive strength of e-waste added mix by replacement of coarse aggregate has less strength than the conventional mix. The addition of flyash decreases the value of strength reduction. At 5% and 10% replacement the

compressive strength of mix is larger than the characteristic compressive strength of M_{30} mix. So the 5% replacement can be considered as optimum percentage in structures where strength has less importance.

3.2 Flexural strength of E-waste added mix without flyash

Flexural strength of conventional(0%),5%,10% and 20% e-waste added concrete mixes is find out by casting beams.4 beams for each percentage is casted for 7-day and 28 day strength.

Table 5:Flexural strength of E-plastic added mix

Mixdesignation	Flexural strength (N/mm^2)	
	7 day	28 day
E0	4.58	5.40
E5	3	3.80
E10	2.50	3.13
E20	2.39	2.75

Table 6: Flexural strength of E-plastic added mix with 10% flyash

Mix designation	Flexural strength (N/mm^2)	
	7 day	28 day
EF0	5	6.75
EF5	3.25	5.28
EF10	2.75	4.75
EF20	2.66	4

The addition of 10% flyash to e-waste added concrete mix reduces the amount of percentage reduction in strength. E-waste added mixes by replacing coarse aggregate hold above 50% flexural strength of the conventional mix. The percentage reduction in flexural strength on 28 day curing is very much less. For 5% replacement of coarse aggregate by e-waste the percentage reduction in flexural strength is very much less.So it is the optimum percentage of replacement of coarse aggregate in structures where strength has less importance

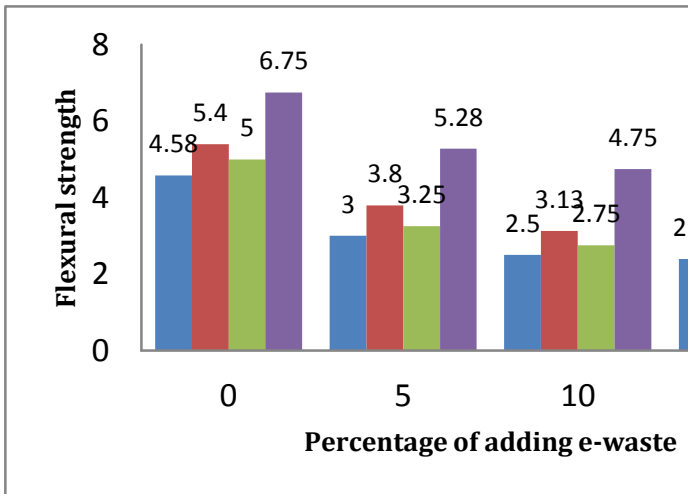

Chart 2: Variation in flexural strength on 7 and 28 day curing of various percentages of e- waste added mix with and without flyash.

4. CONCLUSIONS

- The compressive and flexural strength of M30 mix shows reduction with increasing percentage of replacement of coarse aggregate by e-waste .The percentage reduction in strength can reduce by adding 10% flyash.
- At 5% replacement with flyash, the compressive strength is 33.68 N/mm^2 and the percentage reduction in strength from conventional mix is 14%.The compressive strength value is higher than the characteristic compressive strength of M30 mix i.e., 30 N/mm^2 .
- At 5% replacement with 10% flyash the flexural strength is 5.28 N/mm^2 and percentage reduction in strength is 2% than that of conventional mix.
- Small amount of e-waste (≤5%) can be used to replace the coarse aggregate.
- E-waste added mixes can retain above 50% strength of conventional concrete mix.
- The addition of mineral admixture such as flyash increases the strength of each percentage of replacement mixes.
- Replacement of e-waste can do upto certain percentage (≤20%) in non-structural parts such as partition walls.
- The utilization of e-plastic waste to replace coarse aggregate in small amount (≤5%) is a suitable waste management technique.

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