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Strength Characteristics of Concrete Containing E-Waste

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Abstract — In this project deals with the non-biodegradable components of E waste as a partial replacement of aggregates. An experimental study is made on the use of E- waste particles as coarse aggregates in concrete with a percentage replacement ranging from 0 % to 30% on the strength criteria of M25 Concrete. Compressive strength, Tensile strength and Flexural strength of Concrete with and without E-waste as aggregates was observed which exhibits a good strength gain.

Keywords — Compressive strength, E-waste, M25.

I. INTRODUCTION

E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Rapid technology change ,low initial cost have resulted in a fast growing surplus of electronic waste around the globe .Several tonnes of E waste need to be disposed per year. Traditional landfill or stockpile method is not an environmental friendly solution and the disposal process is also very difficult to meet EPA regulations. How to reuse the non-disposable E waste becomes an important research topic.

However, technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment). According to the OECD any appliance using an electronic power supply that has reached its End of life would come under WEEE. E -plastic 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.

The e waste inventory based on this obsolescence rate and installed base in India for the year 2005 has been estimated to be 146180.00 tones. This is expected to exceed 8, 00,000 tonnes by 2012. In India, e- waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e- waste handling infra-structure has developed mainly based on a long tradition of waste recycling. Sixty-five cities in India generate more than 60% of the total e waste generated in India. Ten states generate 70% of the total e-waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in India. Among top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. There are two small WEEE/E-waste dismantling facilities are functioning in Chennai and Bangalore. There is no large scale organized e-waste recycling facility in India and the entire recycling exists in un- organized sector. Ahamed et.al [1] reported waste glass can be used by grinding it into a fine glass powder (GLP) for incorporation into concrete as a pozzalanic material. It under goes beneficial pozzalanic reactions in the concrete and could replace up to 30% cement in some concrete mixes with satisfactory strength development.

II. RECYCLING OF E - WASTE

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 E-waste 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. Iron and Steel are the most common materials found in electrical and electronic equipments and amounts to nearly half of the total weight of WEEE. Plastic are the second largest component by weight representing nearly 21 % of WEEE.

Chen [3] reported the scope for utilization of waste glass in concrete in several forms, including fine aggregate and coarse aggregate. Reindl [2] suggested the applications of glass cullets as concrete aggregate, Road construction aggregate and building applications (Bricks, Tiles, Wall panels etc). The utilization of waste plastic components of E waste in construction applications is the major interest of the work reported here.

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III. EXPERIMENTAL DETAILS

1) Materials

The potential applications of industry by products in concrete are to be partial aggregate replacement or partial cementious materials depending on their chemical composition and grain size. Recent studies have shown that reuse of very finely grounded E-waste in concrete has economical and technical advantages for solving the disposal of large amount of e-waste, reuse in complete industry may be the most feasible application. E-waste particles can be used as coarse aggregate, fine aggregate, fine filler in concrete depending on its chemical composition and particle size.

E-Waste sources in the form of loosely discarded , surplus, obsolete ,broken, electrical or electronic devices from commercial informal recyclers have been collected which were crushed and ground to the particle size. Table 1 represents Physical properties of E waste particle and Coarse aggregate.

Table 1: Physical properties of e-waste particles and coarse aggregate

Properties	**E-waste particle**	**Coarse aggregate**
Specific gravity	1.21	2.70
Absorption (%)	<0.2	0.4
Color	White & Dark	Dark
Shape	Angular	Angular
Crushing Value	<1.78%	28.2%
Impact value	<1.82%	25.73%

The E-waste contents are calculated as weight percent of coarse aggregate in the control mix. The fineness modulus of coarse aggregate with various E-waste contents is between 1.86 and 2.78. The E- waste particles can be considered as partial coarse aggregate substitute retaining mix ratio as the same. The divided particle size is assumed to be between 1.18mm – 2.36mm. Since it possesses no cementious property, it is considered as replacement to coarse aggregate in cement concrete in various percentages.

2) Concrete Mixes

Control mix concrete and modified with various E-waste contents as listed in Table 2 are prepared. By considering the use E-waste particles in the mixes as much as possible and achieve suitable workability was attempted and strength criteria of Grade M25 concrete mix was analyzed.

Table 2: Mix Specifications

Mix specifications	Control Mix	A1	A2	A3
Proportion of E-waste	0%	4%	8%	12%

3) Tests

Compressive strength test was conducted to evaluate the strength development of concrete containing various E-waste contents at the age of 7, 14, 28 days respectively. Cylindrical specimens were also cast for finding the Tensile strength of specimens on 7, 14, 28 days for each mix specification following the standard test procedures.

Table 3: Compressive strength test results in N/mm^2

Mix Specification	Control Mix	A1	A2	A3
Proportion of E - waste	0%	4%	8%	12%
7 Days	13.74	14.19	14.24	14.58
14 Days	19.70	20.52	20.72	20.92
28 Days	26.83	27.49	27.55	27.64

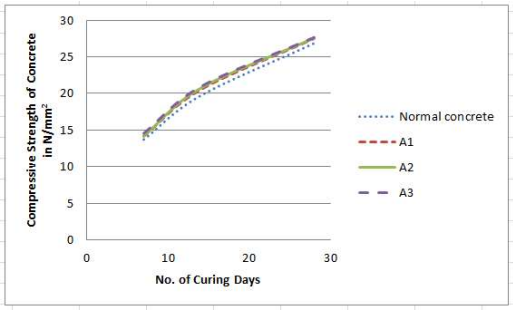

Fig: 1 Compressive Strength Test Results

Table: 4 Split Tensile Strength results in N/mm^2

Mix Specification	Control Mix	A1	A2	A3
Proportion of E - waste	0%	4%	8%	12%
7 Days	4.64	4.56	4.35	4.25
14 Days	4.98	4.82	4.72	4.55
28 Days	5.15	4.98	4.85	4.70

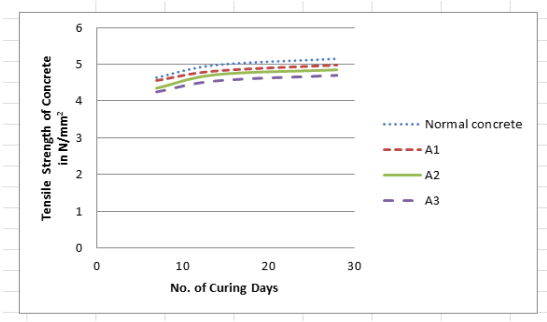

Fig: 2 Split Tensile Strength Test Results

IV. CONCLUSION

This study intended to find the effective ways to reutilize the hard plastic waste particles as concrete aggregate. Analysis of the strength characteristics of concrete containing recycled waste plastic and fly ash gave the following results.

- It is identified that e-waste can be disposed by using them as construction materials.
- Since the E-waste is not suitable to replace fine aggregate it is used to replace the coarse aggregate.
- The compressive strength and split tensile strength of concrete containing E- plastic aggregate is retained more or less in comparison with controlled concrete specimens. However strength noticeably increased when the E- plastic content was more than 4%.
- Has been concluded 12% of E-waste aggregate can be incorporated as coarse aggregate replacement in concrete without any long term detrimental effects and with acceptable strength development properties.

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