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Experimental Investigation on Conventional Concrete by partially replacing e-Waste as A Coarse Aggregate

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Abstract: -- **The problem of e-waste has become an immediate and long term concern as its unregulated accumulation and recycling can lead to major environmental problems endangering human health. Central Pollution Control Board (CPCB) estimated India's e-waste as 1.47 lakh tones. Efforts have been made in the concrete industry to use non-biodegradable components of E-waste as a partial replacement of the coarse or fine aggregates. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. It could be worth experimenting to use E-plastic in concrete to overcome the dual issue of shortage of raw material and safe disposal of leftover plastic to environment. An experimental study is made on the utilization of E-waste particles as coarse aggregates in concrete with percentage replacement ranging from 0 % to 20% on the strength criteria of M25 Concrete. Compressive strength, Tensile strength and Flexural strength of Concrete with and without E-waste as aggregates are carried out. The feasibility of utilizing E-plastic particles as partial replacement of coarse aggregate is experimentally investigated.**

Keywords - **Coarse aggregates, E-plastic, Flexural strength, Split tensile.**

I. INTRODUCTION

The electrical and electronic waste (e-waste) is one of the fastest growing waste streams in the world. The increasing "market penetration" in developing countries, "replacement market" in developed countries and "high obsolescence rate" make e-waste as one of the fastest growing waste streams. Environmental issues and trade associated with e-waste at local and international level has driven many countries to introduce interventions. E-waste or electronic waste, broadly describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. It is also called as 'Waste Electrical and Electronic Equipment'(WEEE).The composition of e-waste is diverse and falls under 'hazardous' and 'non-hazardous' categories. Iron and steel constitute about 50% of the waste, followed by plastics (21%), non-ferrous metals (13%) and other constituents. Obsolete computers pose the most significant environmental and health hazard among the e-wastes. In 2005,Central Pollution Control Board (CPCB) estimated India's e-waste as 1.47 lakh tons or 0.573 MT per day. A report of the United Nations predicted that by 2020, e-waste from old computers would jump by 400 per cent on 2007 levels in China and by 500 per cent in India. Additionally, e-waste from discarded mobile phones would be about seven times higher than 2007 levels and, in India, 18 times higher by 2020. Short product life span coupled with exponential increase at an average 15% per year will result in doubling of the volume of e-waste. Utilization of waste materials and byproducts is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. It could be worth experimenting to use non recyclable plastic in concrete to overcome the dual issue of shortage of raw material and safe disposal of leftover plastic to environment. Plastics are widely used for domestic, industrial and commercial purposes throughout the world. Plastics are normally stable and not biodegradable. So, their disposal is a problem. Research works are going on in making use of plastics wastes effectively as additives in plain and reinforced concrete mixes for variety of purposes.

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II.OBJECTIVES OF THIS STUDY

Efforts have been made in the concrete industry to use non-biodegradable components of E-waste as a partial replacement of the coarse or fine aggregates. The objective of this project is to find

1.The feasibility of utilizing E-plastic particles as partial replacement of coarse aggregate.
2.To solve solid waste problems posed by E-waste.
3.For Environmentally Sound Management of E-waste.
4.To produce light weight aggregate concrete.

III. EXPERIMENTAL DETAILS

In this experimental study, electronic plastics mainly from computer is made into chips and used. The cement used in the concrete mix design was Portland Pozzolana cement (fly ash based) conforming to IS 1489 (Part I)-1991. The coarse and fine aggregates are conforming to IS 2386 (Part I- IV) -1963. Tap water free from impurities is used for cast and curing the concrete specimens. The mixed E-plastic waste is used as a partial replacement for coarse aggregate. The fineness modulus and specific gravity for E-plastic waste were 6.6 and 1.072 respectively.The aggregate impact value and crushing value were less than 2%. A sample of mixed E-plastic is shown in Figure 1.The design reference mix of 1: 1.28 : 2.81 with a w/c ratio of 0.45. E-waste plastic was used to replace 2.5%, 5%,10%, 7.5%, 15% and 20% of crushed aggregate by volume to produce six additional mixtures.

Fig 1: concrete with e-waste

Fig 2: casting of samples

IV. TESTS ON CONCRETE

Compressive strength test

Cubical specimens of size 150mm were cast for conducting compressive strength test for each mix. The Compressive strength test was carried as per IS: 516-1979. This test was carried at the end of 7 and 28 days of curing. The compressive strength of any mix was taken as the average strength of three cubes.

Tab 1: Compressive Strength Results

% Replacement	Compressive Strength (28^{th} day strength N/mm^2)	
	without bonding agent	with bonding agent
0%(conventional concrete)	25.63	
2.5%	21.88	23.12
5%	19.61	20.33
7.5%	18.25	20.5
10%	17.24	19.97
15%	15.21	17.57
20%	14.67	16.19

Split tensile strength test

The tensile strength of the resultant mix is judged in terms of Split tensile strength. For this, cylindrical specimens of size 150 mm dia × 300 mm height were cast. The test was carried at the end of 28 days of curing and the average of three samples was taken as the representative split tensile strength of the mix.

%	Split tensile strength (28^{th} day

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Replacement	strength N/mm^2)	
	without bonding agent	with bonding agent
0%(conventional concrete)	2.98	
2.5%	2.49	2.799
5%	2.44	2.76
7.5%	2.29	2.43
10%	2.1	2.35
15%	1.81	1.83
20%	1.32	1.75

Flexural strength test

Flexural strength, also known as modulus of rupture, bend strength, or fracture strength is defined as a material's ability to resist deformation under load. The standard size of the specimens are 15×15×70cm.The specimen for flexural strength was prepared for which the compressive strength and split tensile strength are maximum among the following mix of replacement of coarse aggregate with e-waste , 0%,5% ,10%, 15% and 20% from these mixes 15 % replacement gives the maximum compressive strength and split tensile strength. So the specimen for flexural strength was prepared for 5%,10% replacement of coarse aggregate with e-waste.

Tab 3: Flexural Strength Test Results

S.no	Beam	Flexural strength N/mm^2 (without bonding agent)	Flexural strength N/mm^2 (with bonding agent)
1.	Conventional B1	4.1	-
2.	B2	3.8	4.3
3.	B3	3.5	4.07

B1 - 0% replacement
B2 – 2.5% replacement
B3 - 5% replacement

V. RESULTS

The variation of the compressive strength with the percentage replacement is shown in Figure 3. At each percentage replacement, the compressive strength of concrete increased as the concrete aged. At all ages, the compressive strength of concrete reduced as the percentage replacement increased. Strength depends to a large extent on good bond between the cement paste and the aggregates.

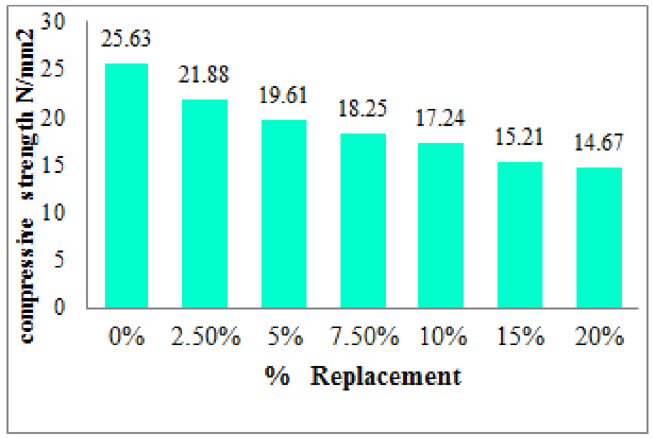

Figure 3: Variation of Compressive Strength without bonding agent

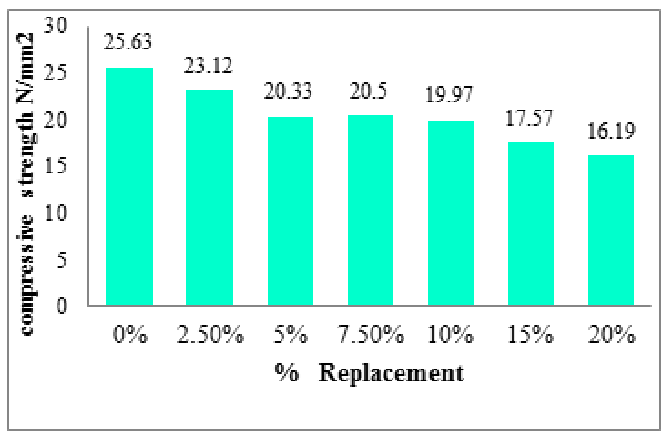

Figure 4: Variation of Compressive Strength with bonding agent

The splitting tensile strength decreased with the increase in mixed E- waste aggregates percentage. The results of split tensile strength test are shown in Figure 4. The splitting tensile

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strength was found to decrease by 44% for 20% compared to control concrete.

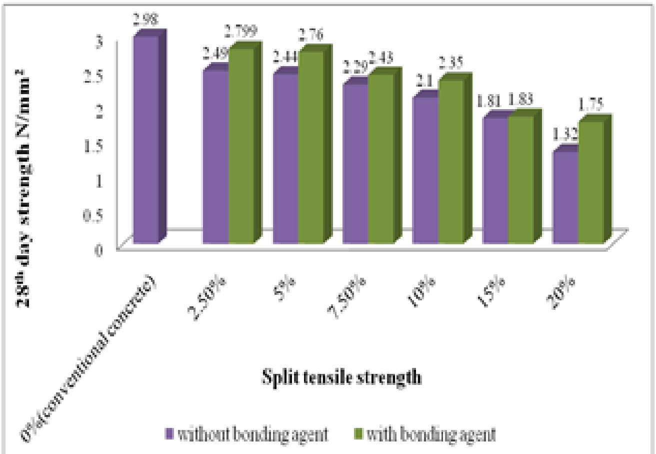

Fig. 5: Split tensile strength versus Percentage of E-waste

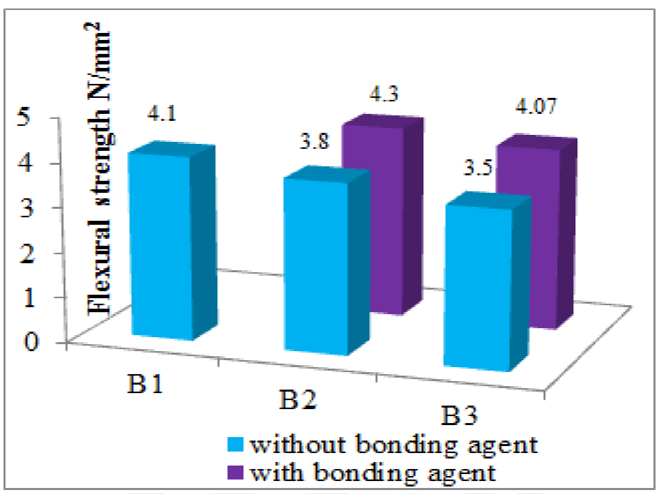

Fig 6: Flexural strength results

V. CONCLUSION

E-waste can be used to replace certain percentage of the coarse aggregates by weight in a concrete mixture. Mixed E-waste in concrete mixture resulted in lower compressive, flexural and splitting tensile strengths, because of E-plastic aggregates have flaky shape and surface texture is smooth. The strength characteristics of concrete with e- plastic and bonding agent is higher than e- plastic concrete without bonding agent. This type concrete can be used where strength is not the prime requirement like partition wall, lightweight roof, etc. The use of mixed E- waste in concrete will add extra aggregate resource to the construction industry and it will be the one of the possible electronic waste disposal method.

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