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Experimental Investigation on Partial Replacement of E-Waste as Coarse aggregate in Concrete

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Abstract:
The rate of E-waste generation is increasing day by day in the modern world. 80 to 85% of different electronic items wastes disposed of in landfills or incinerators which can include or discharge certain lethal gases into air, may influence environment and human health conditions. The extraordinary measure of lead in e-waste alone causes harm in the vision, blood and kidneys of person. Just 12.5% of e-waste is right now reused. Most ideal approach to dispose e-waste is to use it as partial replacement for coarse aggregate in concrete which is eco-friendly measure. It helps to eliminate the concrete materials deficiency problem which is currently going on in construction industry and it also reduces the cost of concrete. Concrete mixes with different percentages of E-waste were casted. It has been decided to make three different types of conventional specimens with partial replacement of E-waste on a percentage of 10%, 20%, and 30% to coarse aggregate in M25 grade of concrete with water cement ratio of 0.45. Conventional specimens are also prepared for same grade of concrete. The mechanical properties of the concrete specimens were compared and studied.

Keywords: E-waste, Compressive strength, Split tensile strength, Specific gravity, Pollution.

1. INTRODUCTION

E-waste describes as loosely thrown-out, not needed any more, no longer useful/no longer used, broken, electrical or electronic devices. Fast technology change, low initial cost has resulted in a fast growing of electronic waste around the globe. Several tons of E-waste need to be disposed per year.

Traditional place where garbage and trash is dumped method is not a related to surrounding conditions or the health of the Earth friendly solution and the disposal process is also very complicated. How to reuse the non-disposable E-waste becomes an important research topic. The processing of electronic waste causes serious health and pollution Problems due to electronic equipment contains serious contaminants such as lead, Cadmium, Beryllium, Poisonous metal, Mercury, Nickel, Silver, Zinc. 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. Because of increment in cost of typical coarse aggregate it has constrained the civil engineers to discover appropriate other options to replace it. E-waste can be utilized as one such option for coarse aggregate. Owing to shortage of coarse aggregate for the planning of solid, incomplete supplanting of E-waste with coarse aggregate was tried. The work was conducted on M25 mix ratio. The replacement of coarse aggregate with E-waste in the range of 0%, 10%, 20%, and 30%.

At last the mechanical properties and durability of these concrete specimens were compared with conventional concrete specimens. The comparative study and tests outcomes demonstrated that a huge change in compressive strength was accomplished in the E-waste concrete and can be utilized adequately in concrete.

Figure.1. E-Waste

2. SCOPE OF RESEARCH

The scope of this experimental research is to address the possible solutions to two important and burning issues. They are harmless way of e-waste disposal and alternative solution for aggregate scarcity. Following points will portrait the need of this experimental research. They are

- New waste management method choices are expected to redirect End-Of-Life (EOL) gadgets from landfills and burning.
- The reuse of E-waste results in waste reduction and results in useful things/valuable supplies also protecting from harm.
- Increasing pollution and the need for places for process such as incineration and landfills is a major problem to our environment. Incineration is the process of burning of the electronic wastes and converting them into ashes which makes it simple to dispose them, but it leads to air pollution due to uncontrolled burning of wastes which consists of toxic components poses serious threats to environment.
- One of the goal of this project to dispose e-waste as far as possible and turn them into socially and industrially helpful raw material using simple, low cost and Eco-friendly technology.
- Running out of coarse aggregate availability and its price hiking further intensifies the need for alternative material to be find out with abundant in nature as well as economical.

3. METHODOLOGY

The research work was done before starting the work by reviewing the previous research topics papers published. The materials used are ordinary Portland cement of grade 43, natural sand is used as fine aggregate, natural crushed aggregate is used as a coarse aggregate and crushed & shredded e-waste of which is passed from 20 mm sieve and retained on 4.75 mm sieve is employed in this research project. The materials nature was tested by conducting tests namely specific gravity test, water absorption test, Impact value test. As per IS 10262:2009 mix design is done. Mix prepared which contain 0% to 30% electronic waste as partial replacement to coarse aggregate along with natural coarse aggregate with water cement ratio of 0.45 which is determined by conducting slump cone test for fresh concretes of every proportion of e-waste replaced specimens. Once design mix has been prepared, then 150X150X150mm cubes and 150X300 mm cylinders was prepared and casted for these mixes which is going to tested after 7,14 and 28 days of curing i.e. total of 36 cubes and 18 cylinders is casted and tested as per IS: 516-1959.

4.1. TEST ON MATERIALS

4.1.1.Specific Gravity:

Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance.

Table.1. Specific Gravity

MATERIAL	SPECIFIC GRAVITY
CEMENT	3.15
FINE AGGREGATE	2.74
COARSE AGGREGATE	2.71
E-WASTE	1.82

4.1.2.Water Absorption Test:

For water absorption test, the aggregates are well dried and weighed. After that it is immersed in water for 24 hours. Then specimen is weighed, and water absorption value is calculated using formula and indicated here in terms of percentage.

Table.2. Water Absorption Test

AGGREGATE	WATER ABSORPTION VALUE
COARSE AGGREGATE	0.65%
FINE AGGREGATE	0.35%
E-WASTE	0.05%

4.1.3.Impact Value Test

Impact test is the good indicator of strength and durability of aggregates and it is indicated in terms of percentage.

Table.3. Impact Value Test

AGGREGATE	IMPACT VALUE
COARSE AGGREGATE	16%
E-WASTE	4 %

4.2.TEST ON FRESH CONCRETE

4.2.1.Slump Cone Test:

The slump cone test is a means of assessing the consistency of fresh concrete. It means of checking that the correct amount of water has been added to the mix.

Table.4. Slump Cone Test

SL.NO	PERCENTAGE OF E-WASTE ADDED	SLUMP VALUE	TYPE OF SLUMP
1	10%	50mm	TRUE
2	20%	53.5mm	TRUE
3	30%	56mm	TRUE

4.3.TESTS ON HARDENED CONCRETE

4.3.1.Compressive Strength Test

Compressive strength test was conducted to calculate compressive strength developed in concrete containing e-waste at the age of 7, 14, 21 days respectively. Cube moulds having size 150X150X150 mm casted for testing.

Figure.2. Compressive Strength Test.

Table.5. Compressive Strength Test

PERCENTAGE OF E-WASTE ADDED	7DAYS	14 DAYS	28 DAYS
10%	13.34	17.20	21.36
20%	16.44	19.30	23.94
30%	14.51	18.53	20.72

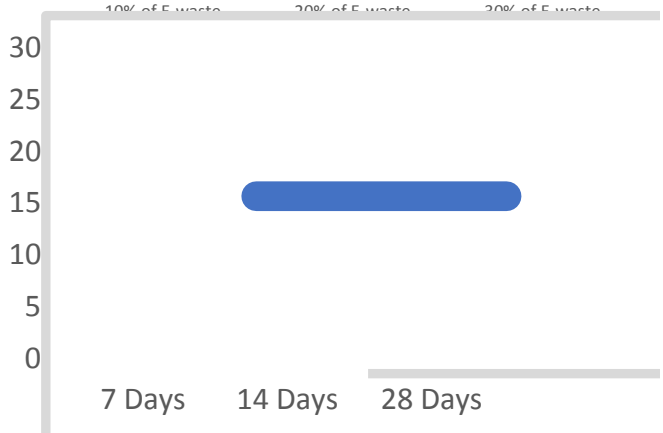

Chart.1. Graphical representation of compressive strength of concrete specimens

4.3.2.Tenile Strength Test:

The cylinders are cast using the cylinder moulds and used to determine the tensile strength of the concrete by splitting the

cylinder. The cylinders are taken out of the curing chamber and then wiped out and dried. The cylinders are placed in the testing machine and the break point load is determined.

Figure.3. Split Tensile Strength.

Table.5. Tensile Strength Test

PERCENTAGE OF E-WASTE ADDED	7DAYS	14 DAYS	28 DAYS
10%	2.12	3.24	4.61
20%	2.80	3.48	5.26
30%	2.39	3.17	4.54

Chart.2. Graphical representation of tensile strength of concrete specimens

5. CONCLUSION:

An experimental study has been done on concrete using e-waste as coarse aggregate and following points is observed from the study. They are

- 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 better equipped to replace the coarse aggregate.
- The compressive strength and split tensile strength of concrete containing e-waste aggregate can be retained as in conventional concrete specimens. However, strength noticeably decreased when the e-waste content was more than 20%.
- It can be concluded that 20% of E-waste aggregate can be replaced as coarse aggregate replacement in concrete without any long term effects and with acceptable strength development properties.

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