EXPERIMENTAL INVESTIGATION ON UTILISATION OF E-WASTE AS PARTIAL REPLACEMENT OF FINE AGGREGATES IN CONCRETE

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Abstract-*This paper is focused to improve strength and durability properties of concrete with E-waste as fine aggregate. This also aims to design a green concrete with E-waste. It reduces the demand of new resources and cuts down the cost and effort of transport and production. This study ensures that reusing of E-waste as fine aggregate substitutes in concrete gives a good approach to reduce cost of materials and solve solid waste problems posed by E-waste. The workability of E-waste concrete mix increases with increase in percentage of e-waste in concrete. The results were same as the conventional concrete up to 12% replacement for fine aggregate replacements. E-plastic waste as Fine aggregates showed good usability than as coarse aggregates due to the bonding problem of e-plastic coarse aggregates and segregation of concrete.*

Keywords: electronic waste, recycle,cement solidification,repalcement of aggregate.

1 INTRODUCTION

E-waste describes discarded electrical or electronic devices. Used electronic which are destined for reuse, resale, salvage, recycling, disposal are also considered e-waste. Electronic waste may be defined as discarded computers, office electronic equipment, mobile phones, television. An estimated 50 million tons of E-waste are produced each year. The United States is a world leader in producing e-waste, tossing away about 3 million tons each year. China already produces about 2.3 million tons domestically. The Environmental Protection Agency estimates that only 15 to 20% of e-waste is recycled, the rest of these electronics go directly into landfills and incinerators.

Concrete is widely used in construction activities which is a mixture of binding material, fine aggregate, coarse aggregate and water. Non-recycling and non-biodegradable waste materials are great threats to environment causing serious pollution problems. Efforts has been made for partial replacement of fine and coarse aggregate of concrete with e-waste. Use of these materials in concrete helps in reduction of construction cost also protects the environment from pollution as much as possible. Other benefits of this project is reduction in landfill, energy savings, utilising of the materials at its most. So here we are using e-waste as alternative for aggregate which comes under safe disposal of e-waste that means economical as well as prevention of pollution.

1.2 DEMAND FOR AGGREGATE

The global market for construction aggregates is expected to increase 5.2percent per year through 2015 to 51.7 billion metric tons in 2019. Recent studies analyze the 40.2 billion metric tons world construction aggregate industry. Sand and gravel are now the most extracted materials in the world, exceeding fossil fuels and biomass. Sand is a key ingredient for concrete, roads, glass and electronics. Massive amounts of sand are mined for land reclamation projects, shale gas extraction and beach re nourishment programs. Recent floods in India, Nepal, and Bangladesh will add to growing global demand for sand.

1.3 E-WASTE

Electronic Waste, also recognized as E-Waste, is a combination of used or unwanted electronic products that have exceeded their shelf life. E-waste describes discarded electrical or electronic devices. Used electronic which are destined for reuse, resale, salvage, recycling, disposal are also considered e-waste. Electronic waste may be defined as discarded computers, office electronic equipment, mobile phones, televisions, refrigerators. An estimated 50 million tons of E-waste are produced each year. The United States is a world leader in producing e-waste, tossing away about 3 million tons each year. China already produces about 2.3 million tons domestically. The Environmental Protection Agency estimates that only 15 to 20% of e-waste is recycled, the rest of these electronics go directly into landfills and incinerators.

1.4 IMPACTS OF E-WASTE

Electronic waste currently constitutes 2 to 5% of US municipal solid waste stream. Carnegie mellon university has detected that there are 70 million computers in our landfills. The average computer screen has 5 to 8 pounds or more of led representing 40% of all the led in US landfills. All these toxins are persistent bio accumulative toxins (BPTs) that create environmental and health risk. When computers are incinerate, put in landfills, or melted down. When computers monitors and other electronic are burned they create cancer-producing dioxins which are released into air we breathe. If electronics are thrown in landfills, these toxics may leads into ground water and affect local resources.

1.5 E-WASTE DISPOSAL

Mobiles, monitors, CPU, FLOPPY DRIVES, laptop, keyboard, cables and connecting wires can be reutilized with the help of recycling process. It involves dismantling of the electronic device, separation of the parts having hazards substance like CART, printed circuit board etc., and the recovery of the precious metals like copper, gold, or lead can be done with the help of the efficient a powerful e-waste recycler. The most crucial think here is choosing the right kind of recycler that does not break laws and handle the e-waste in the ecofriendly manner.

1.6 OBJECTIVES

- The main objective of this project is to investigate the strength of concrete with replacement of e-waste as fine aggregate.
- And to perform the cost benefit analysis between conventional and E-concrete.
- To effectively dispose e-waste considering environmental aspects. To make the structure economical.
- To reduce the landfill.

1.7 MATERIALS AND METHODS

INGREDIENTS:

The various ingredients of plain cement concrete are enumerated and discussed below:

1. Cement
2. Fine aggregate (sand & E-WASTE)
3. Coarse aggregate
4. Water

CEMENT:

Cement is used as binding materials in the concrete required for different engineering works where strength and durability are of significant importance.

The cement used should be as fresh as possible and should satisfy the latest specifications of Indian standard code.

SAND:

It consists of small angular or rounded grains of silica (sio_2) and is formed by decomposition of sand stone under the effects of weathering agencies. It may be either natural sand (river sand, sea sand) or artificial sand (prepared by crushing stones, gravels to powder form). It fills the voids present in the coarse aggregate. It assists in hardening of cement by allowing water to penetrate. It minimizes shrinkage and cracking of concrete. It prepares concrete economically, of any required strength, by varying its proportions.

COARSE AGGREGATE:

It acts as main filler and forms the main bulk of concrete, around the surfaces of which the binding materials adhere in the form of film. It should pass through 75mm IS sieve and entirely retained on 4.75mm IS sieve.

WATER:

It plays a vital role in mixing, laying, setting and hardening of concrete. Water influences the strength development and durability of concrete.

E-WASTE

Electronic waste may be defined as discarded computers, office electronic equipment, mobile phones, televisions, refrigerators. These electronic waste are collected and grinded as fine aggregate. And it is used as partial replacement for fine aggregate in concrete. The requirements of e-waste is similar to that of sand.

1.8 MIX DESIGN

Grade of concrete=M_{20}

Mix ratio: 1:1.5:3

size of cube=150*150*150 mm

For nominal concrete:

Cement=(1/(1+1.5+3))*(.15*.15*.15)*1.54*1440

= 1360 grams

Sand = 1.5 * 1360

= 2041 grams

Aggregate =3*1360

=4082 grams

FOR PARTIAL REPLACED CONCRETE:

FOR 4%:

e-waste=2041*0.04

=81.64 grams

sand = 2041-204.1

=1959.36 grams

FOR 8%:

e-waste =163.28grams

sand =1877.72grams

For 12%:

e-waste=244.92 grams

sand =1796.08 grams

For 16%:

e-waste=326.56 grams

sand =1714.44 grams

1.9 RESULTS AND DISCUSSION

An analysis was made on the strength characteristics by conducting the tests on e-waste Concrete with e plastic aggregate and the results revealed that up-to 12% replacement e-waste concrete is giving improvement in compressive & Tensile strength. With waste plastic content up to 12%, the addition of e plastic aggregate did not significantly affect the compressive strength and split tensile strength. However, an increase in the content of e plastic aggregate gradually enhanced 7 days, 14 days and 28 days compressive and flexural strength up to 20% replacement mixes. According to the scale days strength was observed. However 28 days results confirmed the quality criteria of e plastic concrete as good.

RESULT FOR FRESH CONCRETE TEST:

TEST	0%	4%	8%	12%	16%
SLUMP CONE TEST(in mm)	98	103	96.5	88	75
COMPACTION FACTOR TEST	93%	94.5%	95%	97.5%	98%
VEE BEE TEST(in sec)	6	2	2	1	1

7TH DAY TEST RESULTS FOR COMPRESSIVE STRENGTH: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	15.5	16	15	15.5
4%	17	17.6	16.4	17
8%	16.7	15.6	16.2	16.16
12%	15.3	13.9	14.7	15.3
16%	13.6	14.1	13.3	13.6

14TH DAY TEST RESULTS FOR COMPRESSIVE STRENGTH: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	18.96	19.37	18.8	19.02
4%	19.79	19.8	19.93	19.84
8%	19.9	18.8	19.3	19.3
12%	18.6	18.2	19	18.6
16%	17.8	18.1	18.3	18.07

28TH DAY TEST RESULTS FOR COMPRESSIVE STRENGTH: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	20	20.6	20.83	20.47
4%	21.49	22.54	21.76	21.93
8%	22.98	22.76	22.53	22.75
12%	21.68	21.30	21.43	21.4
16%	20.02	19.78	19.92	19.90

7TH DAY TEST RESULTS SPLIT TENSION TEST: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	3.36	2.92	3.43	3.23
4%	2.85	3.02	2.98	2.95
8%	2.67	2.92	259	2.72
12%	2.39	2.6	2.4	2.46
16%	2.18	2.53	2.06	2.25

14TH DAY TEST RESULTS FOR SPLIT TENSION TEST: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	4.1	4.3	4.25	4.21
4%	4.43	4.59	4.60	4.54
8%	4.6	4.73	4.98	4.77
12%	5.03	4.92	4.89	4.94
16%	4.59	4.8	4.92	4.8

28TH DAY TEST RESULTS FOR SPLIT TENSION: (in N/mm2)

% ADDED	SAMPLE1	SAMPLE2	SAMPLE3	MEAN
0%	4.83	4.7	4.9	4.81
4%	5.07	4.98	5.14	5.1
8%	5.53	5.4	5.55	5.49
12%	5.62	5.59	5.64	5.61
16%	5.44	5.61	5.39	5.48

CONCLUSION

Strength tests and durability tests were carried out on M20 grade conventional concrete and concrete with e-plastic waste as fine aggregates. The effect of physical and mechanical properties of concrete were studied. The reuse of E-waste results in waste reduction and resources conservation. This study ensures that reusing of E-waste as coarse aggregate substitutes in concrete gives a good approach to reduce cost of materials and solve solid waste problems posed by E-waste. The workability of E-waste concrete mix increases with increase in percentage of e-waste in concrete. Compressive strength of E waste concrete having 5% E-waste as a partial replacement to fine aggregates shows a significant increase in comparison to conventional concrete. Considering both strength and durability aspect it can be said that the 12% EWFA (e-waste fine aggregates) replacement satisfies to be the optimum percentage of e-waste as partial replacement in fine aggregate that can be utilized in concrete mixes.100 % replacement of natural sand was achieved by using the e-waste along with M-sand as fine aggregates for all proportions.