Incorporation of E-Waste in Concrete as Replacement for Coarse Aggregate for Strength and Workability Parameters

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Abstract— Concrete which is widely used building material is popular due to its strength and durability.On the other hand due to the advancement of world the production of E -waste is progressing day by day especially in developing countries like India which poses serious problems due to slow degradation .The objective of the present work is to estimate the effective incorporation of E-waste in concrete there by partial replacement of coarse aggregate in ranges of 0%, 5%, 10%, 15%, 20%, 30%.This also involves in testing of specimens for parameters such as strength and workability by tests such as Compression, flexural strength and slump cone test for varied proportions of E-waste in the grade of M30 grade of conventional concrete there by evaluating the strength parameters which is vital for concrete in construction industry.This project encourages the Idea of reusing E-waste in construction there by reducing the quantity of E-waste that is disposed to reduce the burden on landfill disposing.The results indicated that Comparing slump value for W/C ratio, e-plastic waste concrete had a higher workability than conventional concrete; it saves cost of admixture moreover the strength variation is less for 7, 14, 28 days results when compared

Keywords: E-Waste, Partial replacement, Coarse aggregate, Strength Parameters, Workability Parameters

I.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 wastes streams in the world. in developed countries, previously it was about 1% of total solid waste generation and currently it grows to 2% by 210. in developing countries, it ranges 0.01% to 1% of the total municipal solid waste generation.

This report deals with the non hazardous and inert elements of waste generated out of Obsolete Computers, TV Cabins, Refrigerator, Mobile telephones and washing Machine and so on Post consumer 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 aim of this undertaking is to reduce as for as possible the accumulation of use and discarded electronic and electrical equipment sand transfer the waste into socially and industrially beneficial raw material using simple, low cost environmental friendly technology.

II.MATERIALS

E-WASTE

The e-waste used for this work is from local vendor, Tamilnadu region. The e-waste are readily available in the electronic shops. uniform length of e-waste is obtained by using tile cutting machine. Salient physical and mechanical properties of e-waste is determined in their natural form. Specific gravity and density of e-waste were determined by pycnometer. The e-waste is selected from tv's computers , etc. the physical properties was given by the manufacture.

Fig 1. E-waste.

WATER

Water is an important gradient of concrete as it actively participates in the chemical reaction with the cement. Since it helps to form the strength giving cement gel,the quantity and quality of water is required to be looked into very carefully. Portable water is generally considered as satisfactory. In the present, tap water is used for both mixing and curing.

Aggregate

Aggregate are much cheaper than cement and maximum economy is obtained by using much aggregate as possible in concrete. Its use also considerably improves both the volume, stability and the durability of the resulting concrete. The physical characteristic and in some cases its chemical composition affect to varying states.

The properties of the aggregate known to have significant effect on concrete behavior are its strength, deformation, durability, toughness, hardness, volume change, porosity, relative density and chemical reactivity.

The grading of aggregate defines the proportion of particles of different size in the aggregate. The size in the aggregate particles normally used in concrete varies from 37.5 to 0.15mm. IS1542 places aggregate into two main categories i.e. fine aggregate(commonly refer as sand)containing particles majority smaller than 5mm and coarse aggregate containing particles larger than5mm. Sieving analysis is used for determining the particle size distribution.

Fig 2. Aggregates

CONCRETE:

Concrete is a man-made composite with major constituent of which is natural aggregate i.e. sand and gravel, cement and water and admixture if required. Concrete development has evolved over long period of time. It's defined by properties in its fresh and hardened state, though fresh concrete is a prerequisite of hardened concrete. The binding media bind aggregate together to form a hard composite substance. Concrete properties typically depend on mix ratio of its constituent.

Fig 3. Concrete

COMPRESSIVE STRENGTH OF CONCRETE

In the study of strength of materials, the compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Some material fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structures.

By definition, the ultimate compressive strength of material is that the value of uniaxial compressive strength reached when the materials fail completely. The compressive strength usually obtained experimentally by means of compressive test. The apparatus used for this experiment is same that used in tensile strength. However, rather than applying a uniaxial tensile load, a uniaxial compressive load is applied.

APPLICATIONS OF E-WASTE

1. The concrete embedded with E-Plastic can be used as a light weight material for constructing structures like storage room , office chamber , also for the load bearing structure etc
2. The E-Plastic concrete can be successfully used as a pavement material in areas of low traffic like parking pavements in various school , colleges , hospital etc
3. Also can be used to construct paver blocks , concrete bricks , kerbs ,etc
4. Abrasive strength of E-Plastic material is very high , hence , can be used in construction works of gutter , manhole , manhole cover , pipes of low pressure flow , etc
5. Impact strength is very good thereby can be used in workshop and colleges as a pedestal for machine to absorb shock caused by impact .

ADVANTAGES OF E-WASTE IN CONCRETE:

1. E-Plastic concrete produce high workable concrete than conventional concrete for same W/C ratio thus reduces the high cost of admixture required to produce workable concrete
2. They have high impact strength and also good abrasion strength
3. Can be used as a substitute for high cost river sand and also reduces the problem which are been caused by E-waste material
4. The E-waste now a days is nothing but a scrap material but by using of E-pastic in concrete and remaining material like copper , gold and silver material obtained from plates can be used by Government and can help Government to make a little contribution towards the economy of the country and also reducing the problem of E-waste.
5. The Concrete with E-plastic are comparatively light in weight than the conventional one.

III.METHODOLOGY

Ordinary Portland cement (OPC) of 53 grade, locally available river sand as fine aggregate, crushed stone aggregate with a maximum particle size of 20mm as coarse aggregate, from chemical industry were collected

and portable water were used in the investigation. The details of various materials are given further in materials section.

Concrete with using has a very high workability from control sample. This result achieved from the slump test that use of e-waste will increase the workability of concrete. In terms of strength, concrete with using e-waste have higher strength at 14 days but once the concrete reached at 28 days the control mix give more higher value.

Experimental investigation of fresh mix of reinforced concrete was conducted. Compressive strength of various specimen was determined using IS 516-1959. Compressive strength was measured at 7,14 and 28 days. Specimen were cube and beam strength were taken.

GRADATION OF COARSE AGGREGATE

Coarse aggregate in concrete may contain aggregate of various sizes. This particle size distribution of coarse aggregate is known as Gradation. The sieve analysis is conducted to determine the particle size distribution.

Proper gradation of coarse aggregate is one of the important factor in producing workable concrete. Proper gradation ensures that a sample of aggregates contain all standard fractions of aggregate in required proportions such that the sample contains minimum voids. Gradation : poor graded aggregate is characterized by small variations in size. It contains aggregate particles which are almost of same size. This means that the particle packed together, leaving relatively large voids in concrete. It is also called 'uniform graded'. It is characterized by a step curve

Gap graded : gap-graded consists of aggregate particles in which some intermediate size particles are missing. A core slice of gap-graded or skip graded concrete shows a field of small sized aggregate interspersed with slightly isolated, large aggregate piece embedded in a small sized aggregate.

Fig5. Gradation

MANUFACTURING

E-waste is replaced as the coarse aggregate to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance. These improvements stems from both the mechanical improvements.

E-waste contains material both toxic and valuable. It contains lot of harmful metals and waste plastics .Processing of ewaste causes to lot of serious problems in environment. This Paper deals with plastic material generated from obsolete keyboards, monitor,cpu,etc.This E-plastic contains plasticizerbisephenol-A(orBPA), as well DEHP (diethylhexylphthalate) and DBP (Dibutyl phthalate) ,plastic compounds known as phthalates .Chlorinated plastics releases harmful chemicals into the surrounding soil, which seep into ground water or other surrounding water sources which cause serious harm to the species that drink this water, developing heart problems ,reproductive disease. Shredding and low temp melting of plastic leads to Emissions of brominated dioxins, heavy metals and hydrocarbons. Plastic is second largest component by weight in WEEE (Waste Electrical and Electronic Equipment) after electrical and electronic equipment. Objective of our task is reduce accumulation of e- plastic in environment and use of waste plastic in construction applications and making it durable.

IV.MIX DESIGN, MOULDING AND CASTING

Mix design was prepared as per the IS : 10262:2009. Detailed procedure followed for the mix design is as shown below.

DESIGN STIPULATIONS

Characteristic compressive strength required = 30Mpa in the field at 28 days

Maximum size of coarse aggregate = 20mm

Degree of workability = 60-75mm

Water cement ratio = 0.5

Type of exposure = mild

Maximum cement content = 310Kg/m3

TEST DATA FOR MATERIALS

CEMENT

Type of cement = OPC 53 grade

Specific gravity = 3.11

COARSE AGGREGATE

Specific gravity = 2.5

Water absorption = 1.123

FINE AGGREGATE

Specific gravity = 2.48

Water absorption = 5.48%

DESIGN STEPS

TARGET MEAN STRENGTH

ft = fck + 1.65 s

= 30 + 1.65*5

= 38.25N/mm2

ft = target mean strength of concrete

fck = characteristic compressive strength of concrete

t = tolerance factor =1.65

s = standard deviation = 5

STEP 2 : SELECTION OF WATER CEMENT RATIO

Maximum water cement ratio is = 0.5

Based on experience adopting W/C ratio 0.42. hence 0.42>0.5

STEP 3 : SELECTION OF WATER CONTENT

From table no 2. Max. water content is = 186 lit

To achieve slump value 75mm slump191.5lit of water is necessary

If the slump is increased 3% i.e 3/100x186+186 =191.5 lit

There is no chemical admixture hence no change in water content .so 191.5 lit is ok

STEP 4 : CALCULATION OF CEMENT CONTENT

Water cement ratio = 0.5

= 191.5/0.5

383 kg/m2

Maximum cement content = 450 Kg/m3

Volume of coarse aggregate = 0.62

Volume of fine aggregate = 1-0.62 = 0.38

STEP 5 : MIX DESIGN CALCULATION

Volume of cement = 1m3

= 450/3.15*1/1000

= 0.142m3

Volume of water = 191/1*1/1000

= 0.191 m3

Volume of aggregate = [1-(0.142*0.191)]

= 1-0.335 =0.682m3

Mass of CA = 0.682*0.62*2.86*1000

= 1191Kg

Mass of FA = 0.682*0.38*2.63*1000

= 665.60~666Kg

STEP 6 : MIX PROPORTION

Cement = 430Kg/m3

Water =191Lit/m3

FA = 666Kg/m3

CA = 1191Kg/m3

MIX RATIO = 1: 1.53: 2.62

Table 1. Mixdesign

Water	Cement	Fine aggregate	Coarse aggregate
191	430	666	1191
0.44	1	1.53	2.62

V.RESULT AND DISCUSSION

The tests performed after casting the cubes and curing for 28 days were analysed and compared between the various percentages of mixes. The results obtained were also put into graph and were compared accordingly.

SLUMP RESULT

Table 2. Slump test results

% OF E-WASTE	SLUMP VALUE(mm)
0%	71
5%	72
10%	73
15%	73
20%	75
30%	77

COMPRESSION TEST RESULT FOR 7, 14, 28 DAYS

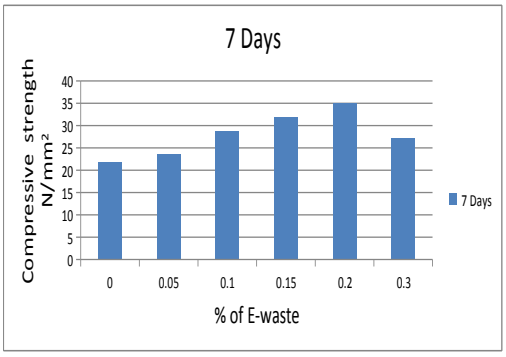

Fig 6. Variation of compressive strength for 7days

The above chart denotes the variation in compressive strength of the cubes of 150mm dimension, made up of concrete mix of M30 grade, 5%, 10%, 15%, 20%, 30% replacement respectively. The cement used is OPC 53 grade. According to design mix, the compressive strength determined to be 21.77 for nominal mix, 23.55 for 5% replacement, 28.88 for 10% replacement, 32 for 15% replacement, 35.11 for 20% replacement and 26.22 for 30% replacement.

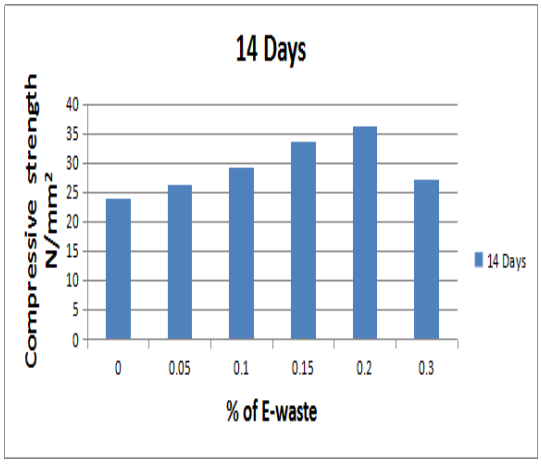

Fig 7. Variation of compressive strength for 14days

The above chart denotes the variation in compressive strength of the cubes of 150mm dimension, made up of concrete mix of M30 grade, 5%, 10%, 15%, 20%, 30% replacement respectively. The cement used is OPC 53 grade. According to design mix, the compressive strength determined to be 24 for nominal mix, 26.22 for 5% replacement, 29.33 for 10% replacement, 33.77 for 15% replacement, 36.44 for 20% replacement and 27.11 for 30% replacement.

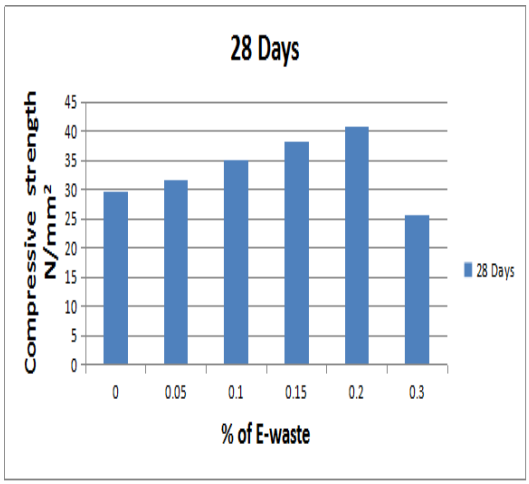

Fig 8. Variation of compressive strength for 28days

The above chart denotes the variation in compressive strength of the cubes of 150mm dimension, made up of concrete mix of M30 grade, 5%, 10%, 15%, 20%, 30% replacement respectively. The cement used is OPC 53 grade. According to design mix, the compressive strength determined to be 29.77 for nominal mix, 31.55 for 5% replacement, 35.11 for 10% replacement, 38.22

for 15% replacement, 40.88 for 20% replacement and 25.77 for 30% replacement.

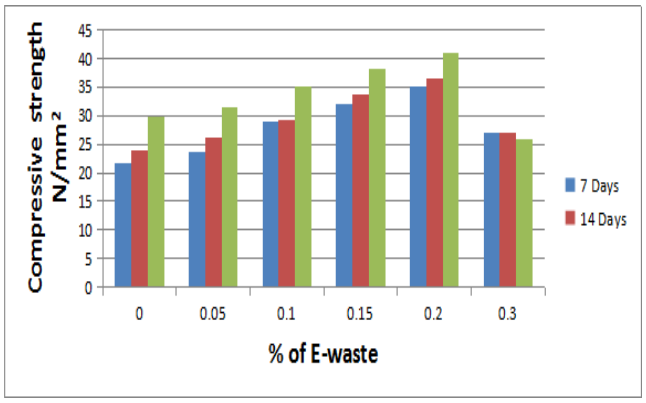

Fig 9. Compressive Strength Comparison Between 7,14,28 Days

FLEXURAL STRENGTH TEST COMPARISON FOR 7 AND 28 DAYS

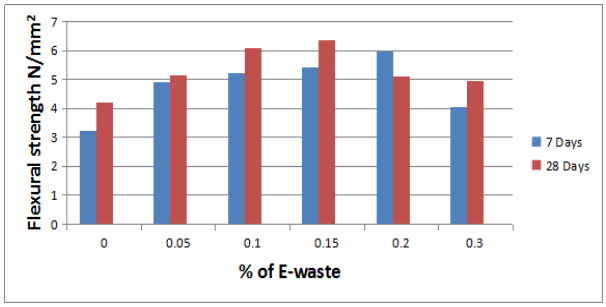

Fig 10. Flexural Strength Comparison Between 7,14,28 Days

The above chart denotes the variation in flexural strength of the beams of 500mm x100mm dimension, made up of concrete mix of M30 grade, 5%, 10%, 15%, 20%, 30% replacement respectively. The cement used is OPC 53 grade. According to design mix, the flexural strength determined to be 3.24 for nominal mix, 4.9 for 5% replacement, 5.23 for 10% replacement, 5.42 for 15% replacement, 5.96 for 20% replacement and 4.04 for 30% replacement for 7 days and

the flexural strength determined to be 4.2 for nominal mix, 5.14 for 5% replacement, 6.1 for 10% replacement, 6.38 for 15% replacement, 5.09 for 20% replacement and 4.96 for 30% replacement for 28 days.

VI.CONCLUSION

The strength of concrete with different proportions of concrete was calculated and it is clearly known increasing the percentage of addition of e-waste or decreasing the percentage of e-waste addition will not increase the strength of concrete. According to the materials and type of e-waste, the percentage of e-waste differs in increasing or decreasing the strength.

1. E-plastic waste can be disposed by using them as a construction material. This results in reduction of environmental pollution as well as reduction in burden on landfill disposing.
2. E-plastic waste can be used as a coarse aggregate as partial replacement for cement concrete, thus result in saving of natural aggregates as well as producing eco friendly structure.
3. E-plastic waste can be replaced up to 20% as a coarse aggregate.
4. For 20% replacement, comparable results are found for coarse aggregate.
5. Hardened properties of conventional concrete and e-plastic concrete are comparable with less strength variation for 7, 14, 28days results.
6. Density of e-plastic waste concrete is less as compare to conventional concrete hence light weight concrete structure can be produced.
7. Comparing slump value for W/C ratio, we concluded that e-plastic waste concrete had a higher workability than conventional concrete; it saves cost of admixture.

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