

AN EXPERIMENTAL STUDY ON E-WASTE CONCRETE WITH FLY-ASH

¹Patel Dhairya

M.tech, student Civil Engineering(structure),
Sankalchand Patel engineering college, Visnagar, Gujarat, India

²Ashutosh Patel

Assistant professor Civil Engineering(structure),
Sankalchand Patel engineering college, Visnagar, Gujarat, India

Abstract : A substantial growth in the consumption of electronic equipments is observed all over the world in twenty-first century, which has led to huge quantities of e-waste. Today in current situation, the production of electrical and electronic devices is the fastest growing sector worldwide. E-waste, e-scrap or Waste Electrical and Electronic Equipment (WEEE) depict loosely discarded, obsolete or broken electrical or electronic devices. Utilization of E-waste in concrete is an alternative solution to administer the growing quantity of the E-waste. This report illustrates the efforts to utilize e-plastic as filler material in concrete with or without the help of admixture. The fresh and hardened properties of concrete with E-waste plastic such as slump, compacting factor, compressive strength at 7 & 28 days, split tensile strength at 7 & 28 days, water absorption, sulphate attack, chloride attack, bond test and chemical analysis were found experimentally. Three Series of mixes, Mix 1, Mix 2 and Mix 3 were prepared with varying percentage of waste E-plastic filler material content(0, 5, 10, 15, 20%) and varying percentage of admixture(0, 10, 20%). It was observed that the slump was slightly decreased with increasing the E-waste plastic quantity. The compressive and splitting tensile strength were reduced with increase in E-plastic. Significant improvement in strength was found in the compressive strength of concrete with the presence of waste E-plastic as filler material and fly ash as 10% weight replacement to cement in concrete. Water absorption, sulphate attack & chloride attack result also improved by adding fly ash. Bond test results also decrease with increase e-plastic. It could also improved by using fly ash. Chemical analysis of e-plastic concrete gave satisfactory result.

Index Terms –E-waste, Compressive strength, Flexural strength, Tensile Strength

I. INTRODUCTION

During the last few years, there is an increasing acknowledgment of our impact on the environment due to our lifestyle, while the need to adopt a more sustainable approach concerning our consumption habits emerges as of particular significance. Conservation of waste materials and by products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in concrete and other construction materials, it helps in reducing the cost of concrete manufacturing, but also has several indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects. Electronic waste consists of discarded old computers, TVs, mobile phones and washing machine, refrigerators, radios – basically any electrical or electronic appliance that has reached its end of life. Several tonnes of E-waste need to be disposed per year. Waste generated from the waste electronic equipments is a major problem for disposal. 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.

II. LITERATURE REVIEW

- Lakshmi R, Negan S has studied Experimental study on utilization of e-waste particles as coarse aggregate in concrete with a different percentage replacement. Result shows E waste can be disposed by using as construction materials, Compressive strength and spilt tensile strength of concrete containing e- waste isretained little less with compared to conventional concrete.It has been concluded 20% E waste aggregate can be replace as coarse aggregate inconcrete without any long-term detrimental effects and acceptable strength development properties.

- KaliyavaradhanSenthil, Kaliyamoorthy Baskar has studied An experimental study in that course aggregate was replaced with different percentages of E-plastic by volume. And result shows E plastic can be used to replace coarse aggregates in a concrete by volume (10, 20, 30,40, 50 %).It is recommended that up to 30 % replacement by volume can be done; up to this limit, the characteristic strength of M25 concrete was achieved.The recycling of electronic plastic waste to produce new materials, such as cement concrete composites, appears as one of the subtle solutions for disposing of electronic plastic waste, instead of combustion and land filling.

• Iftekar Gull, M. Balasubramanian, K.S.Anandh, K.Vetrive, studied to optimize the benefits of using elastic waste in the fibre form in concrete. E-plastic waste (insulation wires) is shredded into fibres of specific size (3cm, 4cm, 5cm) and shape. Several design concrete mixes with different percentages of waste plastic fibres for three aspect ratios, are casted into desire shape and size as per requirement of tests and cured for 7,14,28 days. And results shows Slump is 17 mm and compacting factor test result is 0.9. It has been confirmed that no major changes are found in compressive strength of concrete with the presence of E plastic. When 1% of e-plastic for 5 cm is added, compressive strength gets reduced by 2.59% compared to conventional concrete. With addition of e-plastic – 4cm and 3cm the comp. strength gets increased up to maximum of 5.9% and 10.6% respectively compared to conventional concrete.

• Francesco D'Alessandro, Francesco Asdrubali, Giorgio Baldinelli, An experimental investigation of a sustainable light weight concrete containing polymers derived from the recycling of the sheets of electric wires. After the removal of the copper, the plastic insulating sheet is ground into small size granules. Chemical and physical properties of plastic granules are investigated and their applicability in concrete. Measurements of dynamic stiffness, impact sound pressure reduction and thermal conductivity are studied for thermal and acoustic insulating lightweight screeds to be applied above the concrete structural slabs in floors. And results shows The chemical analysis performed on the loose granules with a gas chromatograph detected the emission of VOC, however when the polymers are trapped inside the concrete the emission of VOC will be reasonably lower and Additional analyses are required. The performed investigations show that it is possible to use residual polymeric waste in a new product showing promising acoustic and thermal performance if compared with common light weight screeds.

• Suchithra S1, Manoj Kumar2, Indu V.S3 shows an experimental study on replacement of coarse aggregate by using E-waste in concrete. Results shows the addition of E-waste shows increase in compressive strength up to 15% replacement. Increase in split tensile strength is almost insignificant whereas gain in flexural tensile strength having occurred even up to 15% replacement. E-waste seems to have a more pronounced effect on flexural strength than split tensile strength. The use of E-waste in concrete is possible to improve its mechanical properties and can be one of the economical ways for their disposal in environment friendly manner. From the durability study the sulphate attack and chloride attack, which does not affect the strength of concrete and optimum mix is more durable than control mix it can be used in marine condition.

III. AIMS AND OBJECTIVE

- To propose a methodology to utilize the plastic components of E-waste which is crushed and ground to the particle size for the effective usage as filler material in concrete.
- To investigate the impact of the presence of waste E-plastic with admixture on the properties of fresh and hardened concrete.
- To explore the influence of waste E-plastic filler material with or without admixture on the durability parameters of concrete and making light weight concrete.
- To establish an environmentally sound recycling system for waste E-plastic to arrive at inherently sustainable solutions for E-waste management

IV. MATERIAL AND METHODOLOGY

A. Cement

The ordinary Portland cement 53 grade was used in this investigation. The various physical properties of the cement were tested as per IS 4031:1988. The test results are tabulated in Table

Physical properties	Observations
Specific gravity	3.12
Soundness	1.05 mm
Standard Consistency	33%
Initial setting time	35 min
Final setting time	225 min
Compressive strength	54.54 N/mm ²

B. Sand.

Properties	Fine aggregate
Zone	Zone- II
Fineness modulus	2.82
Specific gravity	2.5
Absorption (%)	1.50
Bulk Density (Kg/m ³)	1753
Silt Content (%)	1.20

C. Fly ash

Constituent	Test Method	Percentage
Silica	IS-1727	67.60

Alumina	IS-1727	11.30
Iron Oxide	IS-4031	1.15
Calcium Oxide	IS-1727	0.50
Magnesium Oxide	IS-1727	0.10
Sodium Oxide	IS-4032	0.035
Sulphur Trioxide	IS-1727	0.06
Titanium oxide	IS-4031	NIL
Potassium Trioxide	IS-4032	0.005

D. Coarse aggregate

Properties	Coarse Aggregate
Fineness modulus	3.2
Specific gravity	2.65
Absorption (%)	0.68
Bulk Density (Kg/m ³)	1741
Free Surface Moisture (%)	1

E. Waste E-plastic Particles

Properties	E-plastic particle
Fineness modulus	6.67
Specific gravity	1.04
Absorption (%)	<0.2
Crushing value	<2%
Impact Value	<2%

F. Water

- Water is an important ingredient of concrete as it actually participates in the chemical reaction with 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.

V. MIX PROPORTION

Mix design was carried out for M20 grade of concrete by IS 10262:2009 procedures, yielded a mix proportion of 1:1.54:2.76 with a water-cement ratio of 0.45. Three Series of mixes, Mix 1, Mix 2 and Mix 3 were prepared with varying percentage of waste E-plastic filler material content and varying percentage of admixture. The filler material was used as weight percentage of coarse aggregate to keep the constant mix proportion.

MIX	TYPE	DESCRIPTION
MIX 1	JC1	NORMAL CONCRETE
	EC1	E-PLASTIC WITH 5% COARSE AGGREGATE REPLACEMENT
	EC2	E-PLASTIC WITH 10% COARSE AGGREGATE REPLACEMENT
	EC3	E-PLASTIC WITH 15% COARSE AGGREGATE REPLACEMENT
	EC4	E-PLASTIC WITH 20% COARSE AGGREGATE REPLACEMENT
MIX 2	JC2	NORMAL CONCRETE + FLY ASH WITH 10% CEMENT REPLACEMENT
	ECFC1	E-PLASTIC WITH 5% COARSE AGGREGATE REPLACEMENT + FLY ASH WITH 10% CEMENT REPLACEMENT
	ECFC2	E-PLASTIC WITH 10% COARSE AGGREGATE REPLACEMENT + FLY ASH WITH 10% CEMENT REPLACEMENT
	ECFC3	E-PLASTIC WITH 15% COARSE AGGREGATE REPLACEMENT + FLY ASH WITH 10% CEMENT REPLACEMENT
	ECFC4	E-PLASTIC WITH 20% COARSE AGGREGATE REPLACEMENT + FLY ASH WITH 10% CEMENT REPLACEMENT

MIX 3	JC3	NORMAL CONCRETE + FLY ASH WITH 20% CEMENT REPLACEMENT
	ECFC11	E-PLASTIC WITH 5% COARSE AGGREGATEREPLACEMENT + FLY ASH WITH 20% CEMENT REPLACEMENT
	ECFC22	E-PLASTIC WITH 10% COARSE AGGREGATEREPLACEMENT + FLY ASH WITH 20% CEMENTREPLACEMENT
	ECFC33	E-PLASTIC WITH 15% COARSE AGGREGATEREPLACEMENT + FLY ASH WITH 20% CEMENT REPLACEMENT
	ECFC44	E-PLASTIC WITH 20% COARSE AGGREGATE REPLACEMENT + FLY ASH WITH 20% CEMENT REPLACEMENT

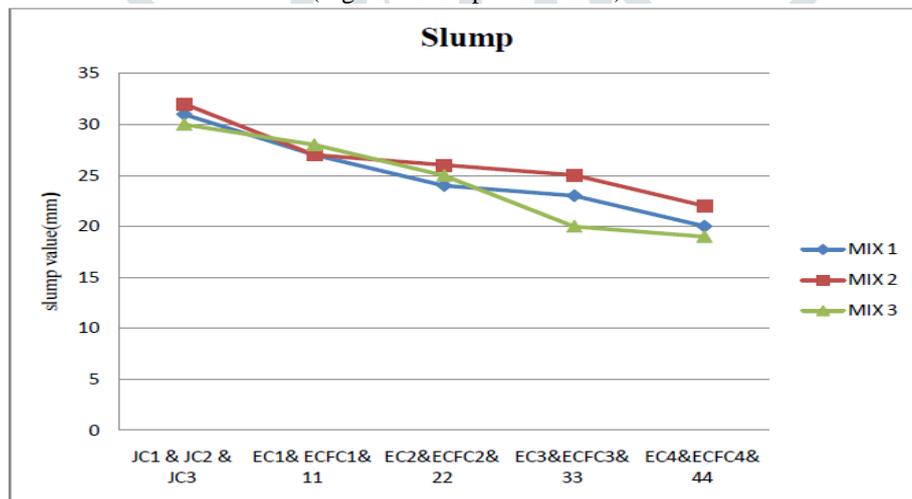
VI. TEST RESULTS

The testing will be done as per I.S Specifications.

- Slump test
- Compaction Factor Test
- Compression Tests
- Split Tensile Tests

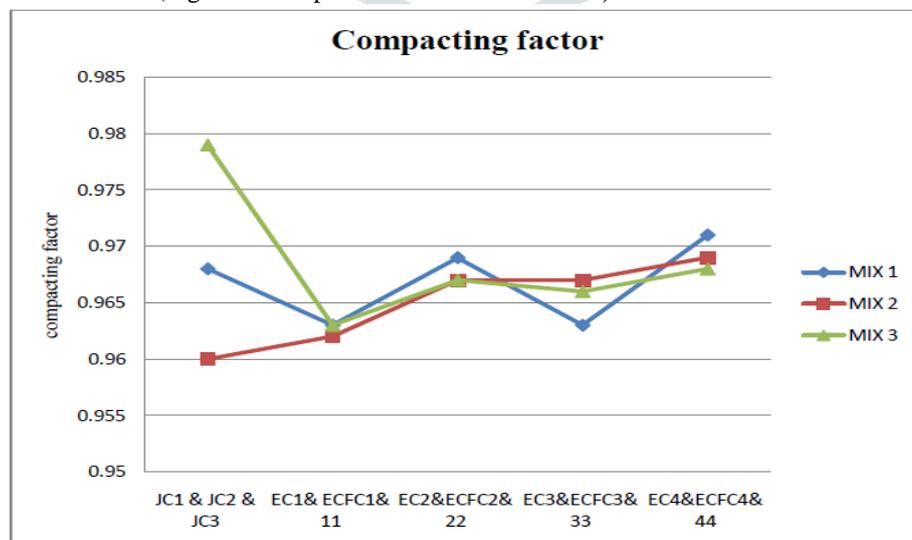
a) Slump Test

(Figure 1 Slump Test Result)



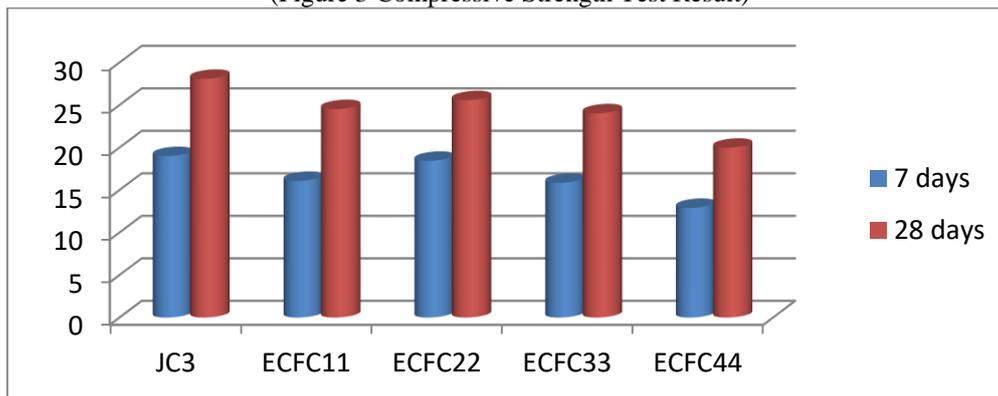
b) Compaction factor Test

(Figure 2 Compaction Factor Test Result)



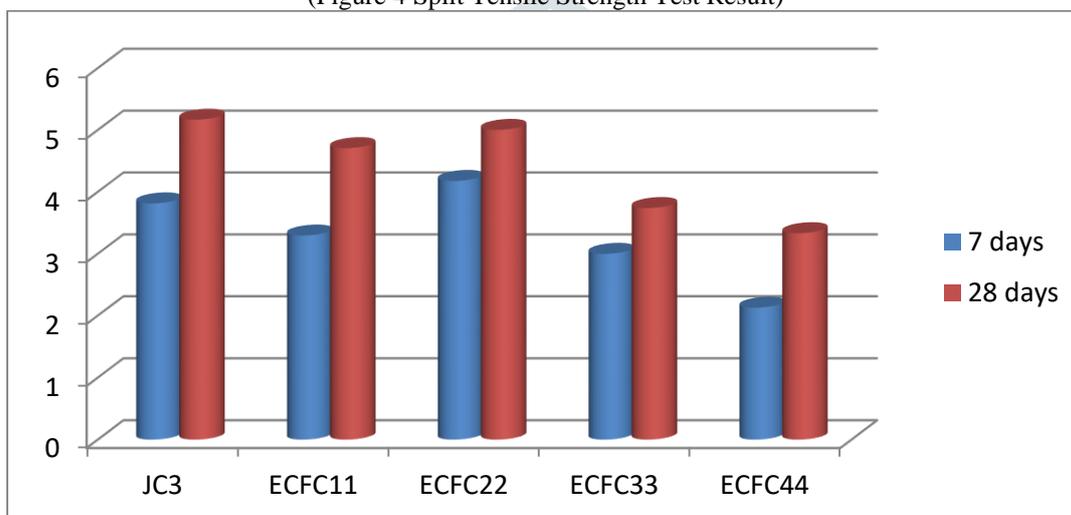
c) Compression Test Result

(Figure 3 Compressive Strength Test Result)



d) Split strength result

(Figure 4 Split Tensile Strength Test Result)



VII. CONCLUSION

- It was observed that the slump was slightly decreased with increasing the E-waste plastic quantity and compacting factor values are near to 0.97. Both can be improve by addition of fly ash.
- The compressive and splitting tensile strength were reduced with increase in E-plastic. The E-plastic aggregates have poor shape and surface texture is smooth which greatly influenced the fresh and hardened properties of concrete.
- With comparing control concrete with 5%, 10%, 15%, 20% replacement of coarse aggregate by E-plastic waste, it reduced to 11.54%, 19.63%, 27.88% & 29.74% respectively. Significant improvement in strength was found in the compressive strength of concrete with the presence of waste E-plastic as filler material and fly ash as 10% weight replacement to cement in concrete.
- Optimum content was found that 10% e-plastic and 10% fly ash as filler material in concrete gives good strength result.

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