International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Email:editorijoer@gmail.com http://www.ijoer.in

Vol.4., Issue.2., 2016
(Mar-Apr)

RESEARCH ARTICLE

ISSN: 2321-7758

USE OF ELECTRONIC WASTE AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE AND LIME AS A PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

ER.K.JEGAN MOHAN[1], A.ARTHI[2], R.LAVANYA[2], M.NAFEESA[2], A.UMACHITHRA[2]

[1]Head of The Department,[2]Student

Department of Civil Engineering, Sree Krishna College of Engineering

ABSTRACT

Electronic waste or e-waste describes discarded electrical or electronic devices. Used electronics which are destined for reuse, recycling or disposal are also considered as e-waste. Utilization of waste material and by products is a partial solution to environmental and ecological problems. The present study covers the use or recycled-wastes as replacement of coarse aggregates in concrete. The main aim of the study is to investigate the change in mechanical properties of concrete with the addition of e-wastes in concrete. It is found that the use of e-waste aggregates results in the formation of light weight concrete. In this research article Coarse aggregate is partially replaced by electronic waste from 0% to 30% Then in these mix 10%, 20% and 30% of lime is also added by partial replacement of cement. Various test like Specific Gravity Test, fineness modulus, Bulking of Sand, Water absorption Test, Aggregate Crushing Value, Aggregate Impact Test and aggregate abrasion value, slump cone test, compressive strength test is also performed on concrete ingredient and concrete.

Key Words: Electronic waste, Natural Aggregate, Concrete.

ER.K.JEGAN MOHAN

A.ARTHI

R.LAVANYA

M.NAFEESA

A.UMACHITHRA

INTRODUCTION

Research concerning the use of by-products to augment the properties of concrete has been going on for many years. E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Rapid technology change ,low initial cost have resulted in a fast growing surplus of electronic waste around the globe .Several tonnes of E waste need to be disposed per year.. How to reuse the non disposable E waste becomes an important research topic.. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products.

METERIALS

Concrete is the most widely man made in the construction world. It's following materials.

1. Cement
2. Lime

3. Aggregate
4. Water
5. E- Waste

Cement

Cement is well known building materials it has occupied in indispensable place in construction works. The cement used in all mixtures was commercially available Ultratech 53 grade Ordinary Portland Cement conforming to IS 12269-1987 was used in this study. The specific gravity of cement was 3.15. Most of the cement concrete work in building construction is done with ordinary Portland Cement at present . Special verities of cement such as :

- Ordinary Portland Cement
- Pozzolana Cement
- Rapid Hardening Cement
- High Alumina Cement
- Sulphate Resistance Cement
- Quick Setting Cement
- White Cement
- Acid resistance Cement
- Low heat Portland cement
- Expansive cement
- Colour Cement
- Oil well cement
- Masonry cement
- Hydrophobic cement

Physical Characteristics of Cement :

- The cement colour Should be Uniform
- Cement Should be free from Lumps
- The total sulphur content of cement should not be greater than 2.78 %
- The weight of insoluble residue in cement should not be greater than 1.5 %.
- The Initial setting time of Cement should not be less than 30 minutes and final setting time should be 24 Hours.
- The expansion of cement should not be greater than 10 mm when soundness test is conducted.

Lime :

- Lime used in Concrete is produced from calcium Carbonates in the form Lime stone, sea shells, coral, kanker etc., The burning of limestone to produce lime mortars, renders, plasters and lime wash is an ancient practice. Most pre-nineteenth-century buildings in Wales were built and decorated using these products. Although, their use
- gradually declined following the patenting of Portland cement in 1824,
- they still have many advantages.
- They are porous allowing water to be absorbed from the surrounding materials, thus protecting them from the harmful effects of frost and hygroscopic salts.
- They help to control condensation and damp by allowing the building to breathe.
- They are relatively flexible and can accommodate a certain amount of movement in the structure, which hard and brittle cement mixes cannot.
- When small cracks do occur they can self-heal when exposed to air or when given a coat of lime wash.
- They have a soft, natural appearance that it well suited to the character of historic buildings.
- Their manufacture is considered to be less damaging to the environment than their modern counterparts.

Aggregate :

- There are the insert materials which all bounded together by means of cement. Aggregate are classified as following:-
- Fine Aggregate
- Course Aggregate

Fine Aggregate:

- Locally available river sand passed through 4.75mm IS sieve is used as fine aggregate. Fine Aggregate may be one of the following types:-
- Natural sand
- Crushed Stone Sand.
- Crushed gravel
- Aggregate to be used for concrete cubes work should be hard durable and clean. The aggregate should be completely free from lumps of clay organic, vegetables matter and fine dust etc

Physical Properties of Fine aggregate :

- The specific gravity of sand is 2.82
- Fineness modulus of 2.5.
- Colour – Dark

- The Crushing value is 24.56 %
- Angular in Shape
- The impact Value is 26.75 %
- Absorption value is 0.3 %

Coarse aggregate:

- The Coarse aggregate are obtained from a local quarry is used. The coarse aggregate with a maximum size 20mm. Fine Aggregate may be one of the following types:-
- Crushed gravel or stone
- Uncrushed gravel or stone.
- Partially gravel or stone
- Physical Properties of Fine aggregate :
- The specific gravity of sand is 2.91
- Fineness modulus of 3.06.
- Colour – Dark
- The Crushing value is 27.2 %
- Angular in Shape
- The impact Value is 24.73 %
- Absorption value is 0.5 %

Water :

Water used for mixing and curing shall be clean and free from injurious amount of amounts of oils, acids, alkalis, salts, sugar, organic materials. Portable water is generally considered satisfactory for mixing concrete.

Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90 % of the average strength of three similar concrete cubes prepared with distilled water. The pH value of water shall not be less than 6.

COMPONENTSOF E-WASTE

E-waste has been categorized into three main categories, viz. large household appliances, IT and Telecom and consumer equipment. Refrigerator and washing machine represent large household appliances, personal computer monitor and laptop represent IT and Telecom, while television represents consumer equipment. Each of these e-waste items has been classified with respect to twenty six common components, which could be found in them. These components form the "building blocks" of each item and therefore they are readily "identifiable" and "removable". These components are

- metal,
- motor/compressor,
- cooling, plastic,
- insulation,
- glass, (Liquid Crystal Display) LCD,
- rubber, wiring/ electrical,
- transformer,
- magnetron,
- textile,
- circuit board,
- fluorescent lamp, incandescent lamp,
- heating element, thermostat,
- BFR-containing plastic, batteries,
- fluorocarbons (CFC/HCFC/HFC/HC),
- external electric cables,
- refractory ceramic fibers,

E-waste generation in India

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions. In 2006, the International Association of Electronics Recyclers (IAER) 8 projected that 3 billion electronic and electrical appliances would become WEEE (Waste Electrical and Electronic Equipment) or e-waste by 2010. That would tantamount to an average e-waste generation rate of 400 million units a year till 2010. Globally, about 20-50 MT (milliontons) of e-wastes is disposed off each year, which accounts for 5% of all municipal solid waste. Although no definite official data exist on how much waste is generated in India or how much is disposed of, there are estimations based on independent studies conducted by the NGOs or government agencies. According to the Comptroller and Auditor- General's (CAG) report, over 7.2 MT of industrial hazardous waste, 4 lakh tones of electronic waste, 1.5 MT of plastic waste, 1.7 MT of medical waste, 48 MT of municipal waste are generated in the country annually.10 In 2005, the Central Pollution Control Board (CPCB) estimated

India's e-waste at 1.47 lakh tones or 0.573 MT per day.11 A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo-"Componex Nepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tones by end 2009-12. The CPCB has estimated that it will exceed the 8 lakh tones or 0.8 MT mark by 2012-13.

Recycling of E-waste

The processing of electronic waste in developing countries causes serious health and pollution Problems due to electronic equipment contains serious contaminants such as lead, Cadmium, Beryllium, Arsenic, Mercury, Nickel, Silver, Zinc, Copper , Chrome, Cobalt etc. Pollutants or toxins in e-waste are typically concentrated in circuit boards, batteries, plastics and LCDs (liquid crystal displays). This paper deals with the non hazardous and inert components of E-waste generated out of Obsolete Computers, TV Cabins, Refrigerator, Mobile phones and washing Machine etc. Postconsumer 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 or recycling. Iron and Steel are the most common materials found in electrical and electronic equipments and amounts to nearly half of the total weight of WEEE. The major objective of this project to reduce as far as possible the accumulation of used and discarded electronic and electrical equipments and transfer waste into socially and industrially beneficial raw material using simple, low cost and environmental friendly technology.

Methodology

For the this research project ordinary Portland cement of grade 43, natural sand from Narmada is used as fine aggregate, natural crushed aggregate is used as a coarse aggregate and crushed plastic waste of which is passed from 20 mm sieve and retained on 4.75 mm sieve is employed in this research project. As per IS 10262:2009 mix design is done. 28 mix prepared which contain 0% to 30% electronic waste as partial replacement to coarse aggregate along with this 10% to 30%fly ash as a partial replacement of fine aggregate. Once design of mix has been prepared then 150*150*150mm cubes is casted for these mixes, 9 cubes for each mix is casted which is going to tested after 7,14 and 28 days of curing i.e. total 252 cubes is casted.

Experimental Program

Considering the research objectives, laboratory works need to be executed to get the data and information related to the project. The data are the reference of research experiment that has to be answered. To determine the property of the material along with their behavior some test is performed on the materials as well as concrete. on various material Specific Gravity Test, fineness modulus, Bulking of Sand, Water absorption Test, Aggregate Crushing Value, Aggregate Impact Test and aggregate abrasion value. On fresh concrete slump cone test is performed to check workability of concrete and on hardened concrete i.e 150mm concrete cubes compressive strength test is performed after 7, 14 and 28 days of curing.

Result and Discussion

Series of test were carried out on material, green & hardened concrete to obtain the workability strength characteristics of Electronic waste for potential application as structural concrete. The results for material test on, water absorption test, specific gravity test, aggregate crushing value test, aggregate impact value test are given and discussed below.

A. Test on Materials

1. Crushing Value Test

Form the result of crushing value we come to know that the Electronic waste is having more resistance to the wear and tear than the natural aggregate. Result of Crushing value test is given below in table 1

Aggregate	Crushing Value
Natural Coarse Aggregate	13.20%
Electronic waste	2.12 %

2. Impact Value Test

Impact test is the good indicator of strength and durability from the test result we can say that natural and Electronic waste are

having wide difference of impact and crushing value, which again shows that aggregate of electronic

waste is stronger than that of natural aggregate. Result of impact test is given below in table 2

Aggregate	Impact Value
Natural Coarse Aggregate	7.20%
Electronic waste	1.65 %

3. Abrasion Value Test

Los angles abrasion test result shows that abrasion value of natural coarse aggregate is much higher than electronic waste.

Aggregate	Impact Value
Natural Coarse Aggregate	10.75 %
Electronic waste	3.72 %

4. Specific Gravity Test

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

Aggregate	Specific Gravity
Natural Coarse Aggregate	2.68 %
Natural Fine Aggregate	2.58 %
Electronic waste	1.20 %
Cement	3.14 %

5. Fineness Modulus

Sieve analysis test is performed on the aggregate i.e., Natural coarse aggregate, Natural fine aggregate and Electronic waste.

Aggregate	Fineness Modulus
Natural Coarse Aggregate	2.50 %
Natural Fine Aggregate	1.60 %
Electronic waste	2.30 %
Cement	4.20 %

6. Water absorption

Water absorption of is performed on the aggregate and it has find that all aggregate have water absorption below 5% and their result given in table 6.

Aggregate	Water Absorption %
Natural Coarse Aggregate	0.60 %
Natural Fine Aggregate	0.35 %
Electronic waste	0.04 %

7. Bulking of sand

Sand is used as a fine aggregate and to use sand in concrete we have to check its bulking and Bulking of sand is 29.30.

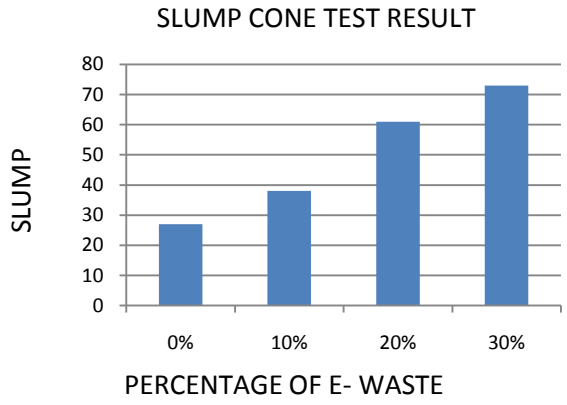
Table 7: Combined Test Result

S.No.	Test	Natural Coarse aggregate	Electronic waste	Fine Aggregate	Cement
1	Water Absorption	0.6%	0.04%	0.35%	-
2	Specific gravity	2.68%	1.2%	2.58%	3.14%
3	Crushing value	13.2%	2.12%	-	-
4	Impact value	7.2%	1.65%	-	-
5	Abrasion value	10.75%	3.72%	-	-
6	Fineness Modulus	2.5%	2.3%	1.6%	4.2%
7	Bulking of Sand	-	-	29.30	-

B. Slump Cone Test

The slump test indicates a decreasing trend of workability when the percentage of Electronic waste increased.

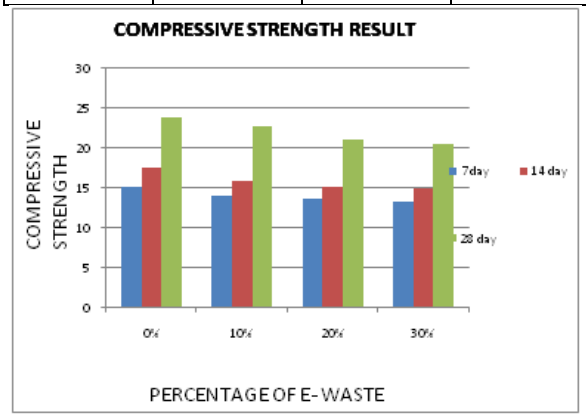
electronic waste	Slump (mm)
0%	27
10%	38
20%	61
30%	73



8. Compression Test Result and Analysis

The compression test by CTM (Compressive Testing machine) indicates an increasing trend of compressive strength with age of the concrete specimens. However, it shows that the strength of Electronic waste specimens is lower than natural aggregate specimens.

E-waste & Lime	Comp. Strength N/mm2		
	7 DAYS	14 DAYS	28 DAYS
0%	15.106	17.62	23.85
10%	14.07	15.85	22.813
20%	13.63	15.11	21.92
30%	13.33	14.96	20.58



Conclusion

An experimental study has been done on concrete using electronic waste as coarse aggregate and also with lime as replacement of cement and following points is observed from the present study.

1. Workability of the concrete increases when percentage of the electronic waste increase.
2. When lime content added to electronic waste concrete, it has been observed that workability increased. Workability of lime with electronic waste concrete is even more than conventional and electronic waste concrete.
3. Compressive strength of electronic waste concrete decreases with increase in the percentage of e-waste.
4. It has been observed that when we replace cement by lime in concrete along with electronic waste as a coarse aggregate compressive strength increases.
5. Cement replacement of 30% by lime along with electronic waste gives best result.
6. Current study concluded that Electronic waste can replace coarse aggregate upto 10% or 20%.
7. Current study also concluded that electronic waste can replace coarse aggregate upto 30% in concrete when 30% lime is replaced by cement.
8. By using of electronic waste we can reduce the construction cost by replacing electronic waste material in case of fine aggregates

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