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REVIEW ARTICLE

RE-CYCLE OF E-WASTE IN CONCRETE BY PARTIAL REPLACEMENT OF COARSE AGGREGATE

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ABSTRACT

A solution for reducing the amount of generated electronic waste in India has become one of a major issue. Globally this problem has taken major part of total solid waste amount. Rectifying this waste is still questionable because we cannot burn it easily, landfill is also harmful for this waste and dumping into sea with affect aquatic life. So it is a matter of finding a best solution for it so that we can use this waste in different work. This research is about reducing the generated E-waste from environment by adding it into M25 Concrete and hence testing for workability and compressive strength. This study helps in optimizing the generated amount of E-waste and its scope in construction industry. This experimental research adds 0, 4, 8, 12, 16, and 20 % of E-waste by weight in M25 concrete and hence tests it for workability and compressive strength.

KEYWORDS

M25, E-waste, workability, compressive strength, dumping, landfill

1. INTRODUCTION

Modern world is witnessing the difficulty of managing the e-waste coming out of so many sources, mostly from IT Companies, educational institutes in the form of PCs and other electronic things. There are lots of attempts which are been made to reduce and manage e-waste by digging in a non-important land and dumping in the sea. But, yet the problem exist. Scientists and engineers are trying hard to come up with new technologies that can overcome the problem of recycling some E-waste percentage, but still it is a very difficult task. So coming up with an idea of manufacturing of E-Concrete, in this concrete we used different percentage of e-waste, reduced the effects of emitted bad radiations by it and used the same as an ingredient for manufacture of concrete (in M25). By doing so, we are not only decreasing the space required for disposing of e-wastes, but also decreasing the amount of electronic-waste by using some percentage of it for constructive purposes until it is tested and proved unharmful for the human beings and the environment.

Mixing of fine aggregates (sand), coarse aggregate, binding material (cement), admixtures (gypsum, calcium chloride etc.) with water prepares concrete. It is widely used in today's construction works due to its good compressive strength.

The name E-waste can be used for electronic products for which "useful life" is finished. According to the Hazardous Wastes (for Management and Handling the E-waste) Rules, 2003, e-waste is explained as "Waste or discarded Electronic and Electrical Equipments which includes all of its components and sub-assemblies.

Electronic waste, explained as E-waste, consists of used out of order old computers, TVs, refrigerators, radios –basically any electronic or electrical appliance that has reached its end of life. By estimation 50 million tons of E-waste is produced every year worldwide. The total E-waste generated in India is about 1, 46,180 tons per year. The environmental protection agency estimated that only 15-20% of Electronic-waste is recycled, the remaining of these electronics gone directly into landfills and burning incinerators. The processing of electronic waste in developing countries causes serious health and pollution problems because of the fact that electronic devices contains bad contaminants like lead, mercury, cadmium, Beryllium etc.

The use of these materials in concrete come from the environmental constraints in the safe disposal of these products. Use of E-waste materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has number of indirect advantages like reduction in landfilling cost, conservation of energy, and protecting the environment from many possible pollutions effect.

Figure 1: Scenario of E-waste

1.1 Research Objectives

The main objectives of this research are following:
(i) To calculate the strength of concrete by partially replacing the coarse aggregates with 25 mm pieces of E-waste.
(ii) To find out the use of disposed E-waste as construction material as coarse aggregate in concrete.
(iii) To reduce the amount of toxic substances produced by certain waste electronic product.
(iv) To develop and improve the technology for e-waste management.

2. LITERATURE REVIEW

Electronic wastes can be the reason of very large environmental damage due to the utilization of toxic materials in the manufacture of electronic commodities. E- waste contains very toxic substances like Lead and Cadmium in circuit boards, next lead oxide and Cadmium in monitor Cathode Ray Tubes (CRTs), next Mercury in daily use switches and flat screen monitors, next Cadmium in computer batteries, next polychlorinated biphenyls (PCBs) in used time consumed capacitors and transformers and in last brominated flame retardants on printed circuit boards, plastic casings, cables and polyvinyl chloride (PVC) cable insulation which releases high amount of toxic dioxins and furans when burned to retrieve Copper compound from the wires [1]. The rapid increase of information technology all over the world coupled with the need and availability of new designs and technologies in the electronic sector which is reasoning the early decrement of many electronic items used around the world today [2]. Till 2006, the production according to world of E-waste was estimated at twenty to fifty million tonnes in average year, also including 1 to 3% of the global municipal waste production of 1636 million tonnes per year [3]. UNEP (2010) listed the equipment-wise E-waste generation in the country as over 100,000 tonnes from refrigerators, 275,000 tonnes from TVs, 56,300 tonnes from personal computers, 4700 tonnes from printers and 1700 tonnes from mobile phones. A study limited to an examination of computers, mobile phones and televisions reckoned that 3, 82,979 tonnes of E-waste were generated in 2007, 50,000 (approximately 13%) of which were imported illegally [4]. As we all know the world's fastest growing country in economy is India. Although, the Indian market's penetration for durability of consumer is substantially leser than that of developed countries, the size of India's market in absolute terms is larger than that of many high-income countries [5]. According to UNEP, 2005; Greenpeace International, (2005) around 21,00,000 to 51,00,000 tons of e-waste produced annually around the globe and this number is very huge as well approximate as there is no clear cut method or technology to measure the actual quantity of waste produce and discarded. Further author said the percentage of e-waste of that of solid waste is around [6]. In […] ETC 2010-11 in a statement, the International Association of Electronics Recyclers predictable that according to existing development & slumping trends the all personal and public electronics instruments will find its way to landfills is approximately three billion. Interpretation of current financial drift, budding nations are also going to pour more and more electronic waste into the existing amount [7].

2.1 A Review of E-Waste Generation in India

Actual and reliable data on the generation, both domestic and import of E-waste, is not currently available in India. Several studies have been conducted by various agencies to devise an inventory of E-waste in the country. All these studies are based on the technique of model of obsolescence of electronic products that needs to be validated with the field data. The preliminary estimates carried out by National WEEE task force in 2005 suggest that total E-waste or WEEE generation in India is approximately 146,000 tonnes per year. Again, a survey conducted by the Central Pollution Control Board (CPCB) during 2005, estimated that 1.347 lakh MT of E-waste was generated in the country in the year 2005, which is expected to increase to about 8.0 lakh MT by 2012 (ibid). A more recent study by GTZ (Deutsche Gesellschaft fur Technische Zusammenarbeit)-MAIT (2007) had put a much higher number of E-waste generated in India (ibid). UNEP (2010) listed the equipment-wise E-waste generation in the country as over 100,000 tonnes from refrigerators, 275,000 tonnes from TVs, 56,300 tonnes from personal computers, 4700 tonnes from printers and 1700 tonnes from mobile phones. A study limited to an examination of computers, mobile phones and televisions reckoned that 382979 tonnes of E-waste were generated in 2007, 50,000 (approximately 13%) of which were imported illegally [8]. However, a major loophole in the data of most of the studies related to E-waste generation is that it only includes equipment generated nationally. The import of the E-waste (both legal and illegal) which are substantial in emerging economies like India and China, were not considered. A scholar touched that from 1998 to 2002, there was a 53.1% growth in the sales of domestic household appliances, both large and small [9]. A scholar estimated that the E-waste processed in 2007 consisted of 12000 000 kg of computers and 7000 000 kg of televisions. As stated by a researcher, the report by Toxics Link, a New Delhi based NGO, estimated that in India business and individual households make approximately 1.38 million personal computers obsolete every year [10]. A scholar has said that the amount of electronic items (ex. computers, washing machines, mobile phones, printers and TVs) placed in the market in 2007 was approximately estimated to be 823.6 K tonnes. But in the same year of 2007, the estimated domestic increase for computers, printers, washing machines, mobile phones, and TVs was 439 K tonnes [11].

2.2 Import of E-Waste into India

The country has been one of the main destinations of used electrical and electronic equipment (EEE) and waste electrical and electronic equipment (WEEE) from OCED (Organisation for Economic Co-operation and Development) countries with an estimated 50 K tonnes of WEEE imported every year [12]. Same data was considered by GTZ-MAIT (2007) that estimates that around 50,000 tonnes of Electronic-waste were imported to India every year continuously. India is now becoming a large market for imported E-waste [13]. Personal computers are imported to Markets of Delhi in 2003 were nearly around 3,600, 000 kilograms per year and research studies predict that the around 50,000 to 70,000 tonnes of electronic waste are being imported annually to India. Let see one study which is only about the examination of some WEEE like computers, mobile phones and televisions from which 382,979 tonnes of electronic waste were generated in 2007, 50,000 t (which was approximately 13%) and that waste was imported illegally. Of the E-waste imported into India, it is estimated that approximately 80% is imported from the US, while the remaining 20% is predominantly imported from the EU. Nonetheless, as the import of E-waste is illegal and E-waste is often shipped via third countries, it is unrealistic to expect these statistics to be exact. All evidence on Electronic waste exported by USA to Asia shows that substantial percentages of their E-waste moves in fast manner off-shore. Whatever is not possible to recycle and reuse readily or economically is sent to markets in Asia. Report of Toxics Link (2004) states that, at the venue of recycling units in New Delhi, 70% part of the total electronic waste which is collected was actually exported to other countries or dumped in sea by developed countries [14]. Mostly all developed countries, sees it as financially profitable to export used electronic items for reuse or recycling in poor and developing countries. Reason for this is the cost of recycling of a single computer in the US is $ 20 while the same could be recycled in India for only US $ 2, a gross saving of US $ 18 if the computer is exported to India.

3. WORK METHODOLOGY

3.1 Materials

3.1.1 Cement

Ordinary Portland Cement of Grade 53 is used in this research.

3.1.2 Fine Aggregates

Medium Sand (0.25-0.5) mm size is used in this research.

3.1.3 Coarse Aggregates

20 mm angular aggregates are used

3.1.4 E-waste

(i) 25 mm pieces of E-waste
(ii) Water is used to mix all these ingredients.

3.2 Equipment

(i) As per Indian standards cube Moulds of 150mm size is used in the research.
(ii) For checking the workability slump cone of size top dia 100mm, bottom dia 200mm with 300mm height is used.
(iii) Removal of air bubbles is removed by tempering rod.
(iv) Water tank for curing of cubes is used.
(v) As concrete is strong in compression so we tested the cured cubes and hence compression testing machine is used in this research.

3.3 Properties

Table 1: Properties of ingredients

S.N.	Properties
1	M25 concrete
2	Grade 53 Portland Cement
3	Gravity of Cement = 3.15
4	Maximum size of E-waste = 25mm
5	Curing days = 7, 14, 28 days
6	Cube size = 150mmSpecific
7	Specific Gravity of E-waste = 1.1
8	Total Water absorption of E-waste = 0%

3.4 Procedure

Following steps are to be followed in research:

1. Selection of materials and equipments is done before the starting of experimental work.
2. For testing first necessary thing is mixing of suitable proportion i.e. 1:1:2 of cement, fine and coarse aggregate with 0.4 to 0.45 proportion of water to prepare wet concrete. As M25 is used in this research mix proportioning is predetermined.
3. For checking the workability of concrete slump value is tested and slump height is noted for all six type of mixture.
4. For casting of concrete cubes in mould with 0%, 4%, 8%, 12%, 16% and 20% of 20mm E-Waste chips, moulds are cleaned and checked for suitability in every aspects of experiment. Then mixed concrete is poured into moulds.
5. After setting of concrete for one day in moulds, cubes are removed with precautions so that no damage take place.
6. 54 Cubes of every type of specimen is prepared. (18 for 7 days curing, 18 for 14 days curing, 18 for 28 days curing).
7. Than all cubes are dipped into tank of water for respective days of curing.
8. After the specified curing period every specimen is tested for compression Comparison graphs are plotted.
9. Average value of 3 specimen for each type is noted into results and graph is plotted against it.

4. RESULT AND DISCUSSIONS

4.1 Slump Value

Slump values of different samples are following

Table 2: Test results for workability

Specimen	Slump in mm	Water Content	Workability
E1	127	0.45	High
E2	122	0.45	High
E3	118	0.45	High
E4	108	0.45	High
E5	102	0.45	High
E6	101	0.45	High

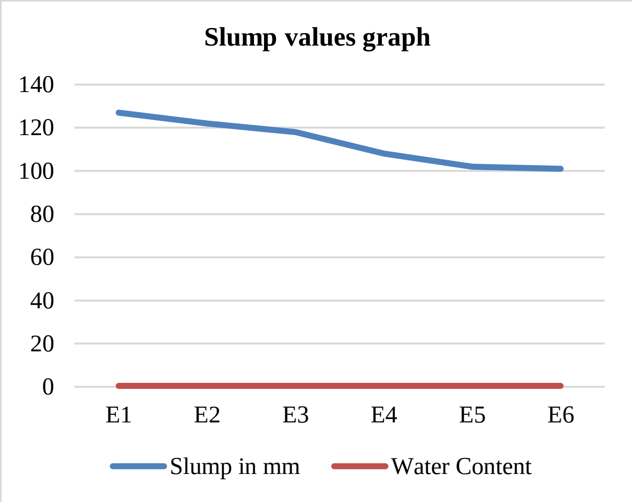

Figure 2: Slump value graph

E1= 0% E-waste, E2= 4% E-waste, E3= 8% E-waste, E4= 12% E-waste, E5= 16% E-waste, E6= 20% E-waste

4.2 Compressive Strength Test

Table 3: Test results for Compressive strength

Mix Specification	7 Days (Series 1)	14 Days (Series 2)	28 Days (Series 3)
Conventional Mix E1	14.32	18.45	25.12
E2	14.42	18.8	26.11
E3	15.22	19.24	27.32
E4	15.24	19.2	28.22
E5	14.7	19	27.1
E6	14.4	18.6	25.7

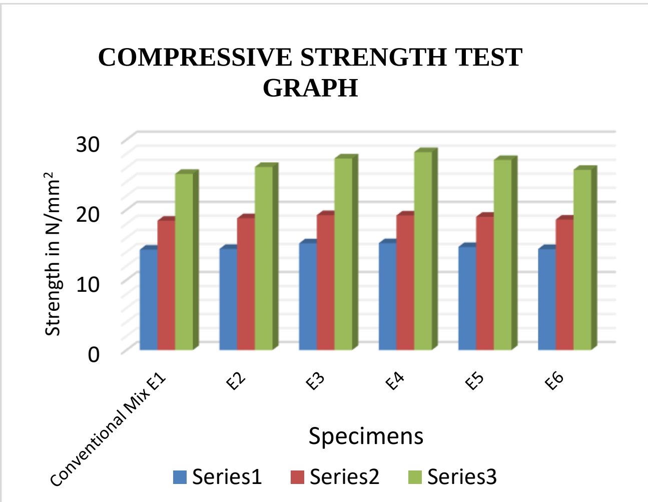

Figure 2: Compressive Strength Graph

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5. CONCLUSION

Mixing of E-waste amount of 0, 4, 8, 12, 16, and 20 in percentage in concrete concluded some points which are important to be considered for technical point of view. As the E-waste amount increases slump value is reduced and hence workability decreases. Even in max proportion of E-waste workability is high which is good for working with concrete. By adding E-waste compressive strength is changed and compressive strength of concrete increases with increase in amount of E-waste but at a certain limit after that it decreases. Graph shows the actual amount of E-waste is 12% at which compressive strength is maximum. Our research also separates the compressive strength of 7 days, 14 days and 28 days cured concrete.

6. FUTURE SCOPE

As electronic waste contains harmful metals and materials and electronic items will also be used in future, so it is necessary to reduce it in effective way. This study helps in optimizing the generated amount of E-waste and its scope in construction industry.

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