SCOPE OF UTILISATION OF E-WASTE IN CONCRETE

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ABSTRACT

Recently the electronics industry had made advancement with leaps and bounds in the production of products. The amazing developments have certainly enriched the quality of our lives.Rapid growth of technology, up gradation of technical innovations and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world, simply called as E-waste. Improper disposal of E-waste can cause serious threats to human health and environment.

Published literature shown that there is a strongly possibility of E-waste being used as substitute/ replacement of aggregate. Its use in concrete becomes more significant and important in view of the fact that sources of natural aggregates are getting depleted gradually, and it is of prime importance that substitute of aggregates be explored.

This paper presents an overview of the published literature on the use of E-waste in concrete. Effect of E-waste on the properties of concrete such as compressive strength, split tensile strength and durability are presented.

Keywords: Compressive strength,Concrete, Durability, E-waste, split tensile strength,

I. INTRODUCTION

Waste materials from other industries are being utilised in concrete productions such as fly ash, silica fume etc.The waste materials from electronics and electrical industries are divided in two categories hazardous and inert waste materials.The inert waste is also known as E-waste describes obsolete, discarded and malfunctioned electrical or electronics devices. The European Union countries have developed policies and scientific measures for recycling, reuse and disposal of such 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 tonnes 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 [9]. A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo – "ComponexNepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tonnes by end 2009 [7]. The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2012 [8]. Two small E-waste dismantling and recycling facilities are operational in Chennai and Bangalore. There is no large scale organized E-waste recycling facility in India and the entire recycling exists in unorganized sector.

1.1 Methods of disposal of E-waste

The E-waste that generated is usually disposed of in the following ways.

- *Land Fill*

A land fill is a disposal area where garbage is piled up and eventually covered with dirt and dust. Fractions of E-waste is most often dumped into landfills. Over time, the e-waste leads to certain amount of chemical and metal teaching. This can very often lead to ground water contamination.

- *Incineration*

E-waste is burnt in incineration process. Individuals in unorganized sectors carry out such operations in which release of harmful toxic gases like dioxins, which escape to the atmosphere and contaminate it.

- *Reuse*

About 3%-5% of the computers that have been discarded by their users are reused. Reuse made possible either direct second hand use or use after slight modification. Non-working old computers are repaired and resold for profit in developing countries. These older units obviously have a limited lifespan and end up as waste sooner or later in these developing countries.

- *Recycling*

In order to combat the environmental impact of improper electronic waste disposal many organizations have opted to recycle their old technology. After the possibilities of reuse have been exhausted, then the next preference lies on recycling process. Recycling means that the old raw materials are reclaimed to be made of in making new products. However, the costs of recycling are high. It is necessary to arrive at a cost effective and environmental friendly recycling process, which may be considered as the real need hour.

1.2 Scope of investigation

Increasing the need for landfills is a burden to our environment. Also with the storage of landfills capacity and an increased concern about environmental quality, diverted waste treatment methods are desired. New waste management options are needed to divert End-Of-Life (EOL) electronics from landfills and incineration. However, there are several factors to consider in the development of a successful diversion strategy. This strategy must be based on its economic, sustainability, technical feasibility and a realistic level of social support for the program.

One aspect of the strategy should include recycling and reuse of EOL electronic products in construction field.

1. Efforts have been made in construction industry to use E-waste as a partialreplacement of the coarse or fine aggregate (Chen and Hwang, 2006).

2. The successful use of other industrial by products of wastes such as fly ash andsilica fume in concrete set as good example for waste to be used in a differentway.

3. Trials are also suggesting utilizing shredded waste plastics usage in concrete as apartial replacement of the coarse aggregate.

4. Recent studies have shown that glass and plastic fractions generated from e-wastecan be used as aggregate in road constructions and building materials such as tiles and bricks (Shayan and Xu, 2006).

The current study is aimed to review the published literature on concrete with E-waste in which different proportions of E-plasticparticles are used as replacement to aggregates.

II. PROPERTIES OF HARDENED CONCRETE

2.1 Compressive strength

Chen et al (2006)**[6]**demonstrated that use of E-glass waste in concrete as fine aggregate replacement. The compressive strength of specimen with 40% E-waste glass is 17%, 27% and 43% higher than control concrete at the ages of 28, 91 and 365 days. The E-waste particles act as crack resistorsin concrete.***Lakshmi and Nagan (2011)*****[2]**utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The decrease in strength was observed at all substitution levels. At 20% replacement the highest strength reduction was observed. They also utilised 10% fly ashas mineral admixture which resulted in better compressive strength. Till 12% replacement of natural aggregates the compressive strength was better than reference concrete.***Prasanna and Rao (2014)*****[5]**investigated the use of E-waste in concrete as partial replacement of concrete.The strength loss was 33.7% when 20% of E-waste is used to replace coarse aggregate, it is reduced by 16.86% when coarse aggregate is replaced by 20 % of E- waste plus 10% Fly ash.***Arora and Dave (2013)*** **[4]**studied the low amount replacement of E-waste as fine aggregates in mortars. They concluded that 4% replacement of E-waste as fine aggregates resulted in acceptable strength gain.***Nagajothi and Felixkala (2014)*****[3]**reported that utilising E-fiber waste as additive in concrete till 2.5% resulted in almost twice compressive strength as compared to control mix. The compressive strength increased constantly with addition of E-fiber waste.

2.2 Split tensile strength

Lakshmi and Nagan (2011)**[2]** utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The decrease in strength was observed at all substitution levels. At 20% replacement the highest strength reduction was observed. They also utilised 10% fly ash as mineral admixture which resulted in better split tensile strength. Till 12% replacement of natural aggregates the split tensile strength was better than reference concrete. The utilisation of fly ash improved the split tensile strength by 50%.

III. DURABILITY PROPERTIES OF CONCRETE

3.1 Sulfate resistance

Chen et al (2006) **[6]** demonstrated that use of E-glass waste in concrete as fine aggregate replacement. The increase in E-glass content significantly decreases weight and strength loss, mostly for the specimens with lower water/cement ratio. The surface defects of tested specimens also show a qualitative evidence of sulfate attack. The positive effect of E-glass on sulfate resistance of concrete is very prominent. ***Lakshmi and Nagan (2011)*****[2]** utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. The average loss of weight and loss of compressive strength of E-plastic concrete is considerably lesser than the corresponding loss of weight and loss of compressive strength of conventional concrete. It shows that E-plastic particles in the concrete is not influenced by Sulphate.

3.2 Resistance to chloride attack

Chen et al (2006) **[6]** demonstrated that use of E-glass waste in concrete as fine aggregate replacement.It is evident that the total charge passed decrease with an increasing E-glass content. The total charge passed as reported is less than 2000 which indicates very low chloride permeability.

3.3 Permeability

Lakshmi and Nagan (2011)**[2]** utilised E-waste in concrete as coarse aggregate replacement from 0% to 24%. E-waste concrete exhibits slightly higher values than conventional concrete. This can be explained by the E-waste aggregates dispersed in concrete may comprised of inter particle voids which may be assumed to be contributed the increase in Saturated water absorption, Porosity and sorptivity as all these factors linked directly to voids in structure. However, with proper vibration mechanism the possibility of voids can be minimized.

IV. OBSERVATIONS AND CONCLUSIONS

The review of different published literature results that E-waste has potential to be utilised as lower aggregate replacement in concrete. The strength development pattern of E-waste concrete is similar to that of conventional concrete but there is decrease in strength at all the curing ages. The utilisation of mineral admixtures can be used to increase compressive strength. From the published research work it is concluded that:-

1. E-waste is the potential viable material to be used as fine aggregate to produce durable concrete.
2. Its use as fine aggregate in concrete will help in alleviating the potential problem of dwindling natural resources.
3. Its use will also help in protecting the environment surroundings.

Till date a very limited research work on E-waste as aggregate in concrete has been carried out. Therefore further investigations to study the ways in which E-waste as aggregate replacement in concrete affects the rheological properties of fresh concrete, mechanical and durability properties of hardened mass are needed.

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