Incorporation of Electronic Waste in Industry Concrete as Partial Replacement of Coarse Aggregate

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Abstract

At present demand of infrastructure is increasing day by day. The basic fundamental component for construction of any infrastructure is concrete. Concrete which is widely used in the building materials is popular for its strength and durability. The ratio of demand vs supply of material is increase rapidly. Thus, to overcome the demand of natural material such as aggregate and cement, it is necessary to find alternative of these materials. On the other hand, electronic waste generation is also an emerging issue posing serious problems to the environment. Generation of e-waste is very serious issue in the world. In year 2017 produce near about 79000 MT of electronic scrap in India. Disposal of e-waste is a typical task faced in many regions across the globe. Our aim is solving the disposal of large amount of electronic scrap, partial use in concrete industry is considered as the most feasible application. The e-waste like non-metallic part is PCB (printed circuit board) plate can be recovered and can be used as an ingredient in concrete. So, we can use this e-waste to achieve desire concrete terms of their properties.
Keyword- E-Waste, Compressive Strength, Workability Parameters, Disposal, PCB, Landfill, Toxic Chemicals

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I. INTRODUCTION

We can not imagine civil engineering structures without concrete. Concrete is the second most essential material consumed after water. For many years, efforts have been made to use industrial by products such as fly ash, silica fumes, ground granulated blast furnace slag, etc. as admixture in concrete construction. The extraction of natural resources for construction materials creates environmental problems, and therefore, attention is being focused on the environment and safeguarding of natural resources and recycling of waste materials.

A. Gaps in the Current Scenario
1) Shortage of river sand,
2) Skyrocketing cost of construction materials,
3) Increasing environmental concerns, and
4) Adaptation of unscrupulous particles.

B. Therefore, A Substitute is required with
1) Similar grain size,
2) Similar mechanical properties,
3) Workable,
4) Cost-effective,
5) No effect on cement chemistry

C. Objectives
- To study the physical properties of e -waste.
- To study the physical properties of coarse aggregate.
- To investigate the strength of concrete with replacement of e waste as coarse aggregate.
- To perform the cost benefit analysis between conventional and E concrete.
- To reduce the demand of natural sources used in concrete.

Electronic waste is one of the new waste materials that are emerging in the sssconcrete industry. Disposal of large amount of E-waste material and reusing of E-waste material can be reused in the concrete industry where it also solves the disposal problem. Hence, the recycling and refusing of E-waste in the concrete is considered as the most feasible application. E-waste is a serious pollution problem for humans and also the environment. Therefore, some options are needed to be a loosely discarded surplus,

broken, electrical and electronic appliance. Rapid technology change and low initial cost gave resulted in a fast-growing surplus of E-waste around the globe.

D. Source of E-waste
- IT and Telecom equipment
- Large household appliances
- Small household appliances
- Consumer and lighting equipment
- Electrical and electronic tools
- Toys and sports equipment
- Medical devices
- Monitoring and control instruments

II. COMPOSITION OF ELECTRONIC WASTE

Most hazardous toxic materials present in E-waste are silica -28%, lead, barium-22%, Cadmium-20%, aluminium-13%, ferrous-20%.

III. METHODOLOGY OF E-WASTE DISPOSAL

There are some of the methods for the disposal of E-waste:
- Landfill
- Incineration
- Reuse
- Recycling

A. Landfill
Landfill is a technique where trenches are made on the surface. Soil is excavated from the trenches and waste materials are buried in it, and it is covered with clay which acts as thick impervious layer. It is done for the collection and transferring of an E-waste to treatment plants.

B. Incineration
It is a controlled way of disposing of E-waste and involves a complete combustion process. In this technique, the waste materials are burned in specially designed incinerators at a high temperature of 900o C-1000oC. This E-waste disposal method is advantageous where it reduces the volume of waste to a greater extent and the energy obtained is also utilized.

C. Acid Baths
This method involves the process of soaking the E-waste to concentrate of sulphuric, hydrochloric and nitric acid solution. This helps to free the metals from electronic pathways.

D. Reuse
Reuse is a quite common technique where it Constitutes direct second hand use or use after slight modifications to the original functioning equipment. This includes computers, mobile phones and another electronic appliance. It is estimated that 3%-5% of the computers that have been designated surplus by their users are reused.

E. Recycling
In the recycling technique the old raw materials are recovered in making new products. However, the costs of recycling of e-waste are high. Dye to the scarcity of land, the dumping of E-waste has become a major issue and it difficult to get new dumping sites. Therefore, recycling is the best possible option for the management of electronic waste

IV. EXPERIMENTAL DETAILS

A. Materials
The potential application of industry products in concrete are to be partial aggregate replacement or partial cementations materials depending on their chemical composition and grain size. Recent studies have shown that reuse of very finely grounded e-waste in concrete has economical and technical advantage for solving the disposal of large amount of e-waste, reuse in complete industry may be the most feasible application. E-waste particles can be used as coarse aggregate, fine aggregate, fine filler in concrete depending on its chemical composition and particle size. E-waste in the form of loosely discarded, surplus, obsolete, broken,

electrical or electronic devices from commercial informal recyclers have been collected which were crushed and ground to the particle size.

	Aggregate	*Type*	
Aggregate property	*Coarse aggregate*	*Fine aggregate*	*E-waste*
Specific gravity	*2.67*	*2.64*	*1.44*
Bulk density (kg/m^3)	*1624*	*1656*	*650*
Fineness modulus	*5.6*	*3.37*	*3.08*
Water absorption (%)	*0.64*	*1.10*	*Nil*

Table 1: Physical and mechanical properties of aggregates

B. Concrete Mixes

Control mix concrete and concrete modified with various E-waste content listed in table 2 were prepared. By considering the use of E-waste in mixes as much possible was attempted and strength criteria of grade M20 concrete mix was analysed.

Mix specifications	*Conventional mix*	*Proportion 1*	*Proportion 2*	*Proportion 3*
Proportion of E-waste	*0%*	*10%*	*20%*	*30%*

Table 2: Mix specifications

V. TESTS

A. Workability Test for Different Proportions

From the below graph of slump value test, it is found that the workability decreases with the increase in the percentage of e-waste in concrete. It is due to the rough, irregular shape of e-waste aggregate as compared to the natural aggregate. These aggregates are flaky in shape and of rough texture so the internal friction is very high between these aggregate and results is reduced workability.

B. Compressive Strength Test

Out of various teat carried out on Concrete, this is the utmost important which gives an idea about various characteristics of concrete. Based on this test one judge that whether concreting has done properly on not. It was conducted to evaluate the strength development of containing various E-waste content at the age 7, 14, 28 days respectively.

Mix specifications	*Conventional mix*	*Proportion 1*	*Proportion 2*	*Proportion 3*
Proportion of E-waste	*0%*	*10%*	*20%*	*30%*
7 Days	*20.87*	*23.40*	*13.38*	*12.8*
14 Days	*34.2*	*26.7*	*15.7*	*13.9*
28 Days	*42.60*	*29.5*	*20.5*	*14.7*

Table 3: compressive strength test results in N/mm^2

VI. DISCUSSION

An analysis was made on the strength characteristics by conducting the test on e-waste concrete with E-waste and the results revelled that up to 20% replacement e-waste for coarse aggregate in concrete shows improvement in compressive strength and split tensile strength.

VII. CONCLUSION

This study intended to find the effective ways to reutilize the hard-plastic waste particles as coarse aggregates. It is also observed that the compressive strength of concrete is found to be optimum when coarse aggregate is replaced by 20% with E-waste. The following results are

1) It is identified that e-waste can be disposed by using them as construction materials.
2) Since the e-waste is not replace fine aggregate it is used to replace the coarse aggregate.
3) The compressive strength and split tensile strength of concrete containing E-waste aggregate is retained more or less in comparison with controlled concrete specimens.
4) The replacement of E-waste in concrete without any long-term detrimental effects and with acceptable strength development properties.

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