CAREER POINT UNIVERSITY HAMIRPUR

CPUH-Research Journal: **2018,** ***3(2),*** 37-39
ISSN (Online): 2455-6076
http://www.cpuh.in/academics/academic_journals.php

Utilization of Waste Printed Circuit Board As an Additive for Concrete

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ABSTRACT: Concrete a heterogeneous mix of cement, water and aggregate is the most commonly used construction material. Rapid increase of construction activities resulted in huge demand for the aggregate to be used in concrete. This has led to depletion of natural resources and adverse changes in the environment. In other hand, Electronic wastes are emerging issue posing serious pollution problems towards human and environment. E-wastes like PCBs contain approx 30% metals and 70% nonmetals. The disposal of these materials is becoming a challenging problem. For solving the disposal of large amount of E-wastes like Printed Circuit Boards (PCBs) can be utilized and can be used as a partial replacement for fine aggregate to achieve a desire concrete in terms of their properties. PCBs have very large quantity of silica in its refined form. Utilization of this E-waste in concrete will reduce the usage of conventional fine aggregate which results conservation of natural resources. In this research work mainly effects of printed circuit board on workability, setting time, and compressive strength studied. More use of these waste materials can reduce the natural resources.

Keywords: Concrete; e-waste; natural resources; printed circuit board

INTRODUCTION

Concrete is well known heterogeneous mix of cement, water and aggregates. The admixtures are added in concrete to achieve the desired properties. Fine aggregates are important constitutes of concrete. They give body to the concrete, reduce shrinkage and give economy. The stress at which the cracks develop in concrete depends largely on the properties of aggregate. Advantage of natural sand is the particle are cubical or rounded with smooth surface texture. Being cubical rounded and textured it gives good workability. Use of concrete is large so availability of natural sand are less and there is no material which plays the role of this ideal material (concrete). Hence it forms the ideal replacement of fine aggregate in concrete, which also may result in reducing the dead weight of the structure. use of E-waste particles as fine aggregates in concrete with a replacement ranging from 0 % to 30% on the strength criteria of M20 Concrete.

Figure: 1.1 A Pictorial View of waste printed circuit board (Courtesy Google)

E-wastes like PCBs contain approximately 30% metals and 70% nonmetals .The printed circuit boards (PCBs) is said to have very large quantity of silica in its refined form. Hence it forms the ideal replacement of fine aggregate in concrete, which also may result in reducing the dead weight of the structure. Millions of tons of electronic waste from obsolete computers and other electronic articles are being generated every year. E-waste contains numerous types (more than 1000 different) of substances and chemicals creating serious human health and environment problems if not handled properly. E-waste also includes many toxic substances viz heavy metals like lead, cadmium, mercury, arsenic, selenium, hexa-valent chromium etc. About 70% of the heavy metals (mercury & cadmium) in landfills come from electronic waste. Consumer electronics is the root cause for the presence of about 40% of the lead landfills. These toxins can causes brain damage, allergic reactions and cancer. E-waste also contains considerable quantities of valuable materials like gold, copper and other ordinary metals.

Literature Review

Ahirwar et al. 2016 stated that the workability of concrete increases when the percentage of E-Waste increases when the percentage of E-Waste concrete gives better results than conventional concrete. The Compressive strength of concrete decreases with increase in the percentage of E-Waste, it has been observed, when concrete is replaced by fly ash in concrete with as a coarse aggregate, its compressive strength is increased. Cement with 30% of fly ash replacement shows a better result.

Alagusankareswari et al. 2016 experimented with E-waste as a replacement material for fine aggregate. The rate of strength attainment of control mix, E10, E20, E30 was observed. The compressive strength and split tensile strength of concrete pertaining to E-Waste aggregate is slightly less in compression with the concrete sample. It can be consumed as light weight aggregate because the self-weight of the concrete decreases with the increase in percentage of E-Waste.

Suchithra et al. 2015 started that the addition of E-waste shows better compressive strength up to 15% replacement. E-Waste has more pronounced effect on the flexural strength than the split tensile strength. The result of durability study show that sulphate attack and chloride attack do not affect the strength of concrete and the optimum mix was found to be more durable than the control mix.

Lakshmi and Nagan et al. 2010 studied on the utilization of E-waste as coarse aggregate in concrete. It is experimented with replacement level of 0% to 30%, and the mechanical properties of concrete were observed and exhibited a good strength gain. The addition of fly ash in concrete mix considerably improves the strength for control mix as well as E-waste concrete.

Objective of the research: The main objective of this research paper is to utilize waste printed circuit board as an additive for concrete and to analyze various properties such as compressive strength, flexural strength and workability. Also to examine the possibility of using printed circuit board in concrete.

MATERIAL AND METHODS

In this research work various materials like cement, fine aggregate, coarse aggregate, and crushed printed circuit board used. Ordinary Portland Cement of grade 43, natural sand below 4.75 mm as a fine aggregate, natural crushed aggregate of size 10-20mm as coarse aggregate, and crushed printed board passing 20mm sieve and retained on 4.75mm used in the research work. Concrete mix prepared as per IS 456-2000. Mix is prepared with waste PCBs from 0% to 30% as replacement of fine aggregate. Total 24 cubes prepared with different proportions of PCBs. Curing is done for all the cube properly.

In order to determine the property and behavior of fine aggregate and PCBs used in the study, compression test and flexural test is being conducted on harden concrete. Waste PCBs are added in the concrete mix according to their percentage replacement, and proper mixing of material cement, sand and aggregate done using water to cement ratio of 0.5. After mixing, fresh concrete is placed into mould of size 150*150*150 mm.

Tests on harden concrete: Compressive Strength test- The compressive strength test gives one of the most critical properties of concrete. Table 1.1 shows the compressive strength test result of concrete at 7 days and 28 days. From the table it was found that with the increase in PCBs in concrete compressive strength of concrete decreases.

Table: 1.1 Compressive Strength of the Concrete

% replacement of fine aggregate	0%	10%	20%	30%
7 days	19.4	18.8	17.6	17.0
28 days	33.4	31.4	28.2	24.7

It is observed that 28^{th} day strength of control mix concrete is 33.4 N/mm^2. It gradually reduces when sand is replaced by waste PCBs. As the percentage replacement of fine aggregate by waste PCBs increases, the compressive strength decreases progressively by 31.4, 28.2, and 24.7 N/mm^2.

Flexural Test- The flexural strength of concrete is determined by the beam testing, for this standard size of 150*150*700 mm beam casted with PCBs replacement varying from 0 % to 30 %. The flexural strength is expressed modulus of rupture in MPa and it is determined by centre point loading. It is observed that the flexural strength for control mix (0 % replacement) is 5.06 N/mm^2 and it is higher than that 10% replacement, 20% replacement and 30% replacement of fine aggregate with waste PCBs.

Table: 1.2 Flexural Strength of the Concrete

% replacement of fine aggregate	0%	10%	20%	30%
Flexural Strength, N/mm^2	5.06	4.21	3.01	2.89

CONCLUSIONS

This study paper describes several experimental results we have observed that utilizing the waste printed circuit board for concrete. PCB concrete mix can be used as light weight concrete. Self weight of concrete reduces with the increase in the percentage of PCBs in concrete. Workability of the concrete with the pulverized PCB did not show appreciable changes as compared to the control mix waste PCB can be utilized in concrete making and hence solve a potential disposal problem.

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