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AN EXPERIMENTAL EXPLORATION OF CONCRETE PAVEMENT USING ELECTRONIC WASTE AS A PARTIAL REPLACEMENT

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ABSTRACT

Now-a-days the production of electrical and electronic devices is the fastest growing sector worldwide. The rapid change in equipment features and capabilities reduces the life-time of consumer-oriented electronic devices. This waste stream of obsolete electronic equipment is the base for electronic waste. E-waste, e-scrap or Waste Electrical and Electronic Equipment depict loosely discarded, obsolete or broken electrical or electronic devices. This research aims to investigate the use of recycled plastic components of E-waste in concrete used in Rigid Pavements. This is an alternative solution to administer the growing quantity of the E-waste. The strength properties of specimens were observed with the use of waste plastic in various percentages (5%, 10%, 15%, 20% and 25%). The data presented in this paper showed that there is great potential for the utilization of waste E- plastic fiber in concrete which can be cost effective and Eco-friendly.

KEYWORDS: Concrete, Highway, E-waste, Recycling etc.

INTRODUCTION

E-waste, Electronic Waste or e-waste – is the term used to describe old, end-of-life electronic appliances such as computers, laptops, TVs, DVD players, mobile phones, mp3 players etc. which have been disposed off by their original users. While there is no generally accepted definition of e-waste, in most cases, e-waste comprises of relatively expensive and essentially durable products used for data processing, telecommunications or entertainment in private households and businesses. Public perception of e-waste is often restricted to a narrower sense, comprising mainly of end-of-life information- & telecommunication equipment and consumer electronics. However, technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment). According to the OECD any appliance using an electric power supply that has reached its end-of-life would come under WEEE.

Composition of E-Waste:

It contains more than 1000 different substances, which fall under "hazardous" and "non-hazardous" categories. Broadly, it consists of ferrous and nonferrous metals, plastics, glass, wood & plywood, printed circuit boards, ceramics, rubber and other items. Iron and steel constitutes about 50% of the e-waste followed by plastics (21%), non-ferrous metals (13%) and other constituents. Nonferrous metals consist of metals like copper, aluminum and precious metals ex. silver, gold, platinum, palladium etc. The presence of elements like lead, mercury, arsenic, cadmium, selenium, and hexavalent chromium and flame retardants beyond threshold quantities in e-waste classifies them as hazardous waste. Hazardous waste is that which poses substantial or potential threats to public health or the environment. A product in corporate, business establishments, government agencies and households that is ignitable, corrosive, reactive or toxic.

Electronic Waste Pollution:

E-waste is of concern largely due to the toxicity of some of the substances if processed improperly. Informal processing of electronic waste in developing countries causes serious health and pollution problems. The toxicity is due to lead, mercury, cadmium and a number of other substances. A typical computer monitor may contain more than 6% lead by weight. Up to thirty-eight separate chemical elements are incorporated into e-waste items. The lack of sustainability of discarded electronics and computer technology is another reason for the need to recycle.

SAMPLE PREPARATION

In case of sampling the procedure used is very handy and simple. For concreting partial replacement with sand is done. Replacement with sand in the form of percentage is done. Replacement of 5%, 10%, 15% is done with tests on concrete. Approximate mix Design or Volumetric Design has been conducted. Use of 15cm x 15cm x 15cm cube is adopted for conducting compressive strength of cubes.

Table 1 - Material Details

MATERIAL	SPECIFICATION
Cement	ACC concrete plus cement of 53 grade
Sand	Tapi river sand
Aggregate	Aggregate passing through 12micron sieve and retaining in 10 micron
E-waste	Crushed waste passing through 4.75 micron Sieve

Curing Procedure:

The Concrete cubes were kept for curing immediately after removing from moulds in a curing tank for respective day. Markings were done to identify the content of E-waste. The temperature of the curing tank was maintained to 30°C.

Concrete Mixes:

Control mix concrete and modified with various E-waste contents as listed in Table 2 are prepared. By considering the use E-waste particles in the mixes as much as possible and achieve suitable workability was attempted and strength criteria of Grade M20 concrete mix (1:1.5:3) was analyzed.

Table 2- Control Mix

Mix Specification	Control Mix A	A1	A2	A3	A4
Proportion of E- waste	0%	5%	10%	15%	20%

Table 3 -Proportion for Three samples

Sample	Cement (Kg)	Sand (Kg)	Aggregate (Kg)	Water (Kg)	E-waste (Kg)	Total (Kg)
A1	4	5.7	12	2	0.3	24
A2	4	5.4	12	2	0.6	24
A3	4	5.1	12	2	0.9	24
A4	4	4.8	12	2	1.2	24

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TEST CONDUCTED ON CONCRETE:

1. **SLUMP CONE TEST:** A slump test is a method used to determine the consistency of concrete. The consistency, or stiffness, indicates how much water has been used in the mix. The stiffness of the concrete mix should be matched to the requirements for the finished product quality.

Types of Slump:

The slumped concrete takes various shapes, and according to the profile of slumped concrete, the slump is termed as;

- *Collapse Slump*
- *Shear Slump*
- True *Slump*

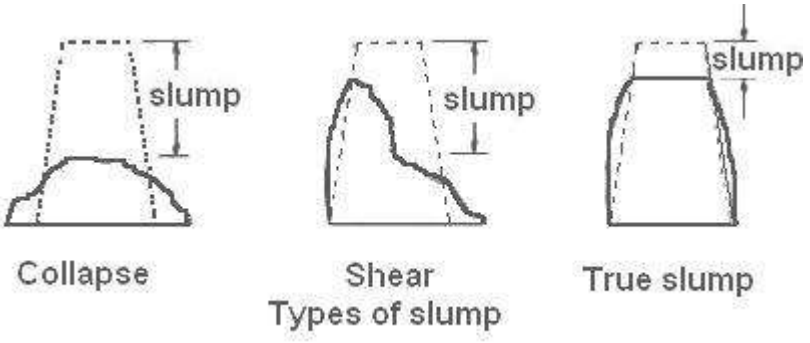

Fig. 1: Types of Slump

Applications of Slump Test:

- The slump test is used to ensure uniformity for different batches of similar concrete under field conditions and to ascertain the effects of plasticizers on their introduction.
- This test is very useful on site as a check on the day-to-day or hour- to-hour variation in the materials being fed into the mixer. An increase in slump may mean, for instance, that the moisture content of aggregate has unexpectedly increasing.
- Other cause would be a change in the grading of the aggregate, such as a deficiency of sand.
- Too high or too low a slump gives immediate warning and enables the mixer operator to remedy the situation.
- This application of slump test as well as its simplicity, is responsible for its widespread use.

Table 4: Standard values of slump cone test

Degree of workability	Slump		Compacting Factor	Use for which concrete is suitable
	Mm	In		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines.
Low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement. Roads vibrated by hand operated Machines.
Medium	50-100	2-4	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.

High	100-175	4-7	0.95	High workability concrete; for sections with congested reinforcement.

RESULTS

Table 5: Results obtained from Slump Test

SAMPLE	SLUMP VALUE
A1	25
A2	9
A3	4
A4	0

Fig. 2: Slump Cone Testing

2. **COMPRESSIVE STRENGTH TEST:** Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. Concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Table 6: Percentage Strength of Concrete at various stages

Age	Strength percent
1 day	16%
3 days	40%
7 days	65%

14 days	90%
28 days	99%

Table 7: Compressive strength of different grades of concrete

Grade of Concrete	Minimum compressive strength N/mm^2 at 7 days	Specified characteristic compressive strength (N/mm^2) at 28 days
M15	10	15
M20	13.5	20
M25	17	25
M30	20	30
M35	23.5	35
M40	27	40
M45	30	45

RESULTS

Table 8: Results obtained from Compressive Strength Test

Mix Specification	Control Mix	A1	A2	A3	A4
Proportion of E- waste	0%	5%	10%	15%	20%
7 Days	13.4	13.2	11.7	10.2	9.7
28 Days	19.7	17.5	16.2	14.3	13.6

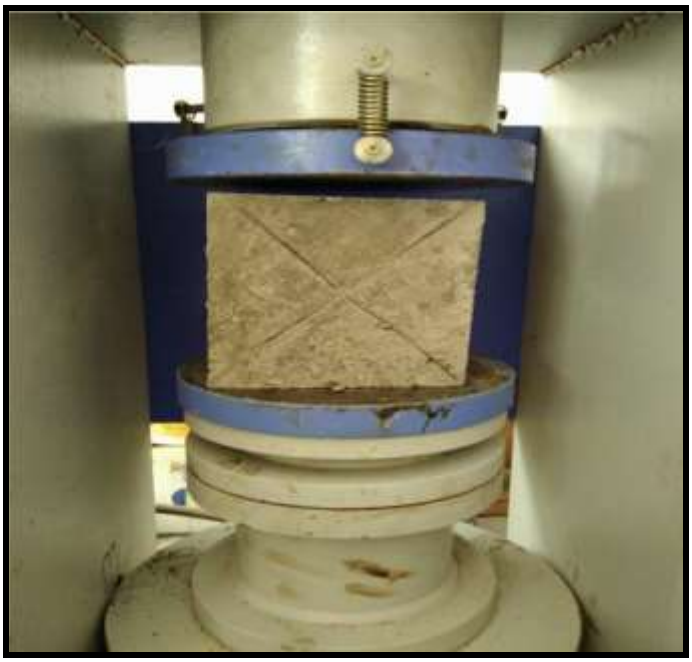

Fig. 3: Compressive Strength checking

COST ANALYSIS

Cost analysis of the any technology is the main component in the future development of that techonolgy.E-waste is a product which can be obtained without investing any money. When the metals from E-waste are removed the other parts like fiber, plastic can be used in construction purpose. The cost comparison between sand and E-waste is given in the below,

Table 6: Cost Analysis

CITY	COST OF SAND (PER KG)	COST OF E-WASTE (PER KG)
Delhi	4	Rs. 5
Mumbai	3.7	Rs. 5
Nasik	1.33	Rs. 5
Dhule	0.5	Rs. 5
Jalgaon	0.6	Rs. 5
Nagpur	2	Rs. 5
Bangalore	3	Rs. 5
Kolkata	3	Rs. 5
Chennai	2.7	Rs. 5
Ahmedabad	2	Rs. 5
Pune	2.4	Rs. 5
Shirpur	0.3	Rs. 5

Note: The processing cost for E-waste will be Rs.5 per Kg. Transportation cost for the E-waste may vary from place to place. If the crusher is available with the company the cost might get reduced.

Advantages of Using E-waste as a replacement of sand:

1) E-sand can be easily available anywhere in India after processing.

2) Black-marketing of sand will be reduced.
3) Mafia system of the sand can be reduced.
4) Load on the rivers for the sand can be minimized.
5) E-waste can be utilized.
6) Ecofriendly
7) No hazard to nature.
8) E-sand don't have problem of fluctuation in supply.
9) The scarcity of sand can be reduced.

CONCLUSON

In this Paper, the Test Conducted on Concrete were held with precision and the results for 5%, 10% sand replacement with were successful. The results indicates that, the 10% sand replacement with E-waste can be made in a concrete mix of M20 grade. This can be a best use of Electronic waste in concrete road which is Eco-friendly & uneconomical. Discarded material with such use can be advantageous for a country.

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