RESEARCH ARTICLE OPEN ACCESS

Utilization of Electronic Waste Plastic in Concrete

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Abstract
In India, bitumen pavements are commonly used for highways. Due to the increasing traffic intensity, distress such as rutting and cracking of pavements are very common in Indian roads. Under varying seasonal temperature, flexible pavements tend to become soft in summer and brittle in winter. Investigations revealed that properties of concrete can be better than bitumen roads.
But now a day's concrete roads are used commonly because concrete roads have more life span than the bitumen roads. In large cities now a day's concrete roads are used because concrete roads are more durable, strengthen and having more life span than bitumen roads. Waste plastics and E-waste (electronic waste) both by domestic and industrial sectors can be used in the production of asphalt mix. Waste plastic, mainly used for packing are made up of polyethylene, polypropylene, polystyrene. Electronic waste, abbreviated as e-waste, consists of discarded old computers, TVs, refrigerators; radios, etc are basically any electrical or electronic appliance that has reached its end of life. An experimental study is made on the utilization of E-waste particles as fine aggregates in concrete with a percentage replacement ranging from 0 % to 21.5% i.e. (7.5%, 15% and 21.5%) on the strength criteria of M30 Concrete. Compressive strength Concrete with and without E- waste plastic as aggregates was observed which exhibits a good strength. The feasibility of utilizing E-waste plastic particles as partial replacement of fine aggregate has been presented. In the present study, compressive strength was investigated for Optimum Cement Content and 7.5% E-plastic content in mix yielded stability and very good in compressive strength of 43 grade cement.
Keywords: Compressive strength, E-waste.

I. Introduction

Many roads agencies have been experience the problem of premature failure of pavements like potholes, roughness and cracks etc. which leads to poor performance of roads and its life. On the other hand, electronics waste, plastics, rubbers, etc. are increasing day by day. E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices. Waste materials like keyboards, mouse, mother boards, mobile phones, plastic bottles, polymers, cups, waste tires can be re-used by making powder or blending it with crushers and can be coated with aggregate or mixed with the concrete process. Today availability of the electronic waste is enormous, as the electronic materials have become part and parcel of daily life. The quantity of electronic waste is getting higher in our country. Several tones of E waste need to be disposed per year. If not recycled, their present disposal is either by land filling or by incineration. Both the processes have certain impart on the environment. Under these circumstances, an alternate use for the electronic waste is also needed. E plastic waste is one of the fastest growing waste streams in the world. If these materials can be suitably utilized in highway road construction, the pollution and disposal problems may be partly reduced. Keeping in mind the need for bulk use of these wastes in India, it was though expedient to test these materials and to developed significations to enhance the use of electronic wastes in road making, in which higher economy returns may be possible. The possible use of these materials should be developed for construction of low volume roads in different parts of our country.

1.1. E-waste generation in India

All over the world, the quantity of electrical and electronic waste generated each year, especially computers and televisions, has assumed alarming proportions. In 2006, the International Association of Electronics Recyclers (IAER) 8 projected that 3 billion electronic and electrical appliances would become WEEE (Waste Electrical and Electronic Equipment) or e-waste by 2010. That would tantamount to an average e-waste generation rate of 400 million units a year till 2010. Globally, about 20-50 MT (million tons) of e-wastes is disposed off each year, which accounts for 5% of all municipal solid 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 tones 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.10 In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tones or 0.573 MT per day.11 A study released by the Electronics Industry Association of India (ELCINA) at the electronics industry expo- "Componex Nepcon 2009" had estimated the total e-waste generation in India at a whopping 4.34 lakh tones by end 2009-12. The CPCB has estimated that it will exceed the 8 lakh tones or 0.8 MT mark by 2012-13. There are 10 States that contribute to 70 per cent of the total e-waste generated in the country, while 65 cities generate more than 60 per cent of the total e-waste in India

Among the 10 largest e-wastes generating States, Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab. Among the top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. The main sources of electronic waste in India are the government, public and private (industrial) sectors, which account for almost 70 per cent of total waste generation. The contribution of individual households is relatively small at about 15 percent, the rest being contributed by manufacturers. Though individual households are not large contributors to waste generated by computers, they consume large quantities of consumer durables and therefore, potential creators of waste. An Indian market Research Bureau (IMRB) survey of 'E-waste generation at Source' in 2009 found that out of the total e-waste volume in India, televisions and desktops including servers comprised 68 percent and 27 percent respectively. Imports and mobile phones comprised of 2 percent and 1 percent respectively.

II. Recycling of E-waste

The processing of electronic waste in developing countries causes serious health and pollution Problems due to electronic equipment contains serious contaminants such as lead, Cadmium, Beryllium, Arsenic, Mercury, Nickel, Silver, Zinc, Copper, Chrome, Cobalt etc. Pollutants or toxins in e-waste are typically concentrated in circuit boards, batteries, plastics and LCDs (liquid crystal displays). This paper deals with the non hazardous and inert components of E-waste generated out of Obsolete Computers, TV Cabins, Refrigerator, Mobile phones and washing Machine etc. Postconsumer components of above mentioned appliance have traditionally been disposed off either in domestic refuse, which ends up in landfill, were collected in designated collection spots for reuse or recycling. Iron and Steel are the most common materials found in electrical and electronic equipments and amounts to nearly half of the total weight of WEEE. Plastic are the second largest component by weight representing nearly 21 % of WEEE. The major objective of this project to reduce as far as possible the accumulation of used and discarded electronic and electrical equipments and transfer waste into socially and industrially beneficial raw material using simple, low cost and environmental friendly technology.

III. Experimental Details

3.1. Materials

Recent studies have shown that reuse of very finely grounded e-waste in concrete has economical and technical advantages for solving the disposal of large amount of e-waste, reuse in complete industry may be the most feasible application. E Waste sources available 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 as per requirement for coarse aggregate or fine aggregate. The potential applications of industry by products in concrete are to be partial aggregate replacement or partial cementious materials depending on their chemical composition and grain size. E-waste particles can be used as coarse aggregate, fine aggregate, fine filler in concrete depending on its chemical composition and particle size. Table 1 shows the physical properties of E-waste and fine aggregate.

Table 1: The physical properties of E-waste and fine aggregate.

Properties	E-waste	Fine Aggregate
Specific Gravity	1.2	2.61
Color	Brown and Dark	Dark
Crushing Value	<2%	
Shape	Round and Cylindrical	Angular
Impact Value	<2%	
Absorption	<0.2	<0.2%

3.2. Concrete Mixes

The E-waste contents are calculated on weight basis as fine aggregate in conventional mix. Assuming the use of E-waste particles as substitute of fine aggregates and remaining mix ratio as the same with conventional mix in the concrete mixes as much as possible and achieve suitable compressive strength and workability is attempted and strength criteria of

Grade M30 concrete mix is analyzed. Conventional mix concrete and various content of E-wastes (0% - 21.5%) listed in Table 2.

Table 2: Mix Specifications

Mix Specification	Conventional Mix X	X1	X2	X3
Proportion of E-waste	0%	7.5%	15%	21.5%

3.3. Tests

Compressive strength test is used to calculate the strength of concrete containing various E-waste contents at the age of 7, 14, 28 days respectively. Cube specimens are cast for finding the compressive strength of specimens on 7, 14, 28 days for each mix specification following the standard test procedures with the help of cube testing machine.

Table 3**:** Compressive strength test results in N/mm²

Mix Specification	Conventional Mix X	X1	X2	X3
Proportion of E-waste	0%	7.5%	15%	21.5%
7 Days	36	33.18	19.9	16.39
14 Days	44.81	41.25	17.95	19.03
28 Days	47.18	44.07	24.69	22.15

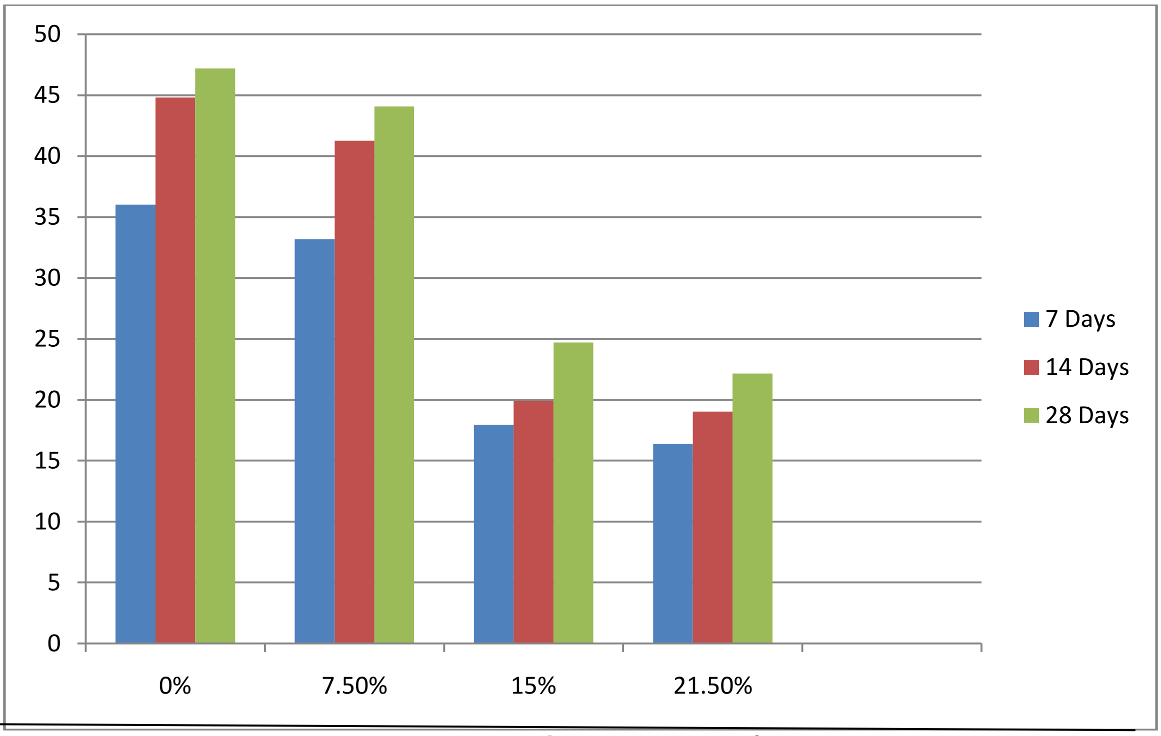

Fig. 1. Compressive strength V/S Proportion of E-waste in %

IV. Discussions

By comparing above results with conventional concrete at 28 days the compressive strength of concrete it is observed that the compressive strength of concrete is reduced by 52.98% when fine aggregate is replaced by 21.5% of E-waste. This proved that the compressive strength of concrete gets reduced when fine aggregate are replaced by E-waste. Figure 1 shows the compressive strength of E-waste plastic concrete with mixing ratio of E-waste plastic aggregate.

V. Conclusion

This study is carried out to find the effective and capable ways to utilization of the hard plastic waste particles as fine aggregate. It is also observed that the compressive strength of concrete is found to be optimum when fine aggregate is replaced by 7.5% with Electronic waste. Beyond it the compressive strength of concrete goes on decreasing. The compressive strength of concrete will gradually decrease when fine aggregate are replaced beyond 15% with Electronic waste. From this study we can use Electronic waste in to the concrete by replacing the fine aggregate. Now it is identified that the E-waste particles can be used as the construction material.

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