UTILIZATION OF E-WASTE IN ROAD POTHOLES

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Abstract—Electronic waste is serious pollution problems to the humans and the environment. The disposal of E-waste is becoming a challenging problem. For solving the disposal of large amount of E-waste material, reuse of E-waste in road potholes as filler material is considered as the most feasible application. 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. Due to increase in cost of boulders (aggregate), labors and bitumen it has forced the civil engineers to find out suitable alternatives to it. E-waste is used as one such alternative as road filling material. Owing to scarcity of natural materials as well as considering the economic factor in road patch work so the E-waste as an alternative was attempted in pothole with the mixture of waste foundry sand, cement, course aggregate, chemicals. The work was conducted on practical pothole. Finally the mechanical properties and durability of these mixture specimens were obtained. The test results showed that a significant improvement in compressive strength, weather resistance, impact resistance and less water absorption was achieved in the E-waste road pothole filler mixture and hence can be used effectively in pothole filling. The reuse of E-waste results in waste reduction and resources conservation as well as safe disposal of E-waste.

Keywords- E-waste, Durability, Compressive strength, less water absorption, safe disposal.

INTRODUCTION

1.1 Many roads agencies have been experiencing 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 in the present scenario, no construction activity can be imagined without using cement. It is the most widely used building material in construction industry. The main reason behind its popularity is its strength and durability. Today, the world is advancing too fast and our environment is changing progressively.

1.2 Attention is being focused on the environment and safeguarding of natural resources and recycling of wastes materials. One of the new waste materials used in the concrete industry is E-waste. For solving the disposal of large amount of E-waste material, reuse of E-waste in concrete industry is considered as the most feasible application. E-waste is one of the fastest growing waste streams in the world. 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 in crushers mixed with the mix of cement, aggregate, waste foundry sand and chemicals.

1.3 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 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 tonnes) of e-wastes are 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 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. In 2005, the Central Pollution Control Board (CPCB) estimated India's e-waste at 1.47 lakh tonnes or 0.573 MT per day. 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 tonnes by end 2009. The CPCB has estimated that it will exceed the 8 lakh tonnes or 0.8 MT mark by 2012.

1.4 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, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat and Nagpur.

1.5 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 economic returns may be possible. The possible use of these materials should be developed for the patch work of low volume roads in different parts of our country.

I. METHOD & MATERIALS USED

A. Materials used:

The most commonly available Portland cement of 43 grade was selected for the investigation. The cement used was dry, powdery and free from lumps. All possible contact with moisture was avoided while storing cement. The concrete mix was prepared using locally available river sand. Ordinary crushed stone with size 10-20mm was used as coarse aggregate in mixes. They generally possess all the essential qualities of a good stone showing very high crushing strength, low absorption value and least porosity. In general, water fit for drinking is suitable for mixing. Impurities in the water may affect setting time, strength, shrinkage, weathering resistance, etc so to deal with this the use of admixtures is done. Hence locally available purified drinking water was used for the work. E-waste was collected locally from a PCB cutting unit in the form of long chips. Copper strips present at the bottom of PCB were removed manually and then pcb were crushed in the form of powder upto 75 micron to 90 micron in size. Specific gravity and water absorption were tested for E-waste and the results are given below.

B) Concrete mix:

The mix was designated with the M20 grade of concrete and the type of fine aggregate used. IS method of concrete mix was used to achieve a mix with cube strength of 20 Mpa. Mix proportions were arrived and E-waste and waste foundry sand was added to the concrete mix with a w/c ratio 0.5. The percentage of E-waste and waste foundry sand was added with respect to the volume of cement. That is E-waste 30% and waste foundry sand 30% of the total volume of cement. Control mix concrete and modified concrete with E-waste and waste foundry sand are presented in Table 1.

Table no. 1: % of waste foundry sand and e-waste added

Mix specification	Traditional concrete	Modified concrete
Proportion of E-waste and waste foundry sand added with respect to the volume of cement	0%	30%

Figure no. 1: Modified Dry mix of e-waste concrete (source-camera)

EXPERIMENTAL PROCEDURE

For the purpose of testing specimens, various concrete specimens were prepared for different mix using rotating drum mixer. Preparation of concrete specimens aggregates, cement, E-waste, waste foundry sand and admixtures were added. After thorough mixing, water and admixtures were added and the mixing was continued until a uniform mix was obtained. The concrete was then placed in to the moulds which were Properly oiled. After placing of concrete in moulds, proper Compaction was given using the table vibrator. For compressive strength test, cubes of size

Table no. 2: properties of materials

Properties	Fine aggregate	Coarse aggregate (10-20mm)	E-waste	Cement Opc43
Specific gravity	2.69	2.56	1.9	3.15
Water absorbtion	1.2	0.05	0.2	---------
Colour	Dark	Dark	Light green	Greenish
Shape	----------	Angular	Powdered	Powdered

150mmx150mmx150mm were cast. Specimens thus prepared were de-moulded after 24 hours of casting and were kept in a curing tank for curing. For durability test, cubes of 150mmx150mmx150mm were cast for acid and Sulphate attack. The durability test was done after 28 days of water curing. The admixtures were added in mix with a view of early gain of strength so the concrete gets set quickly and hence on practical ground there will be no traffic logging problem and even strength of concrete can be maintained. The Dimensions of specimens used for the present study are listed in Table 3.

Figure no. 2: concrete cube casted with addition of e-waste and waste foundry sand (source-camera)

Table no. 3: The size of concrete cubes casted

Type of test	Size of cube
Compression test	Cube - 150 X 150 X 150 mm
Durability test	Cube - 150 X 150 X 150 mm

Water curing is the most effective method of curing. It produces the highest level of compressive strength. If a concrete is not well cured, it cannot gain the properties and durability to endure long life service. A proper curing greatly contributes to reduce the porosity and dry shrinkage of concrete and thus achieves higher strength and greater resistance to physical and chemical attacks in aggressive environments. With these results in mind, proper curing was done for specified days after the specimens are removed from the moulds.

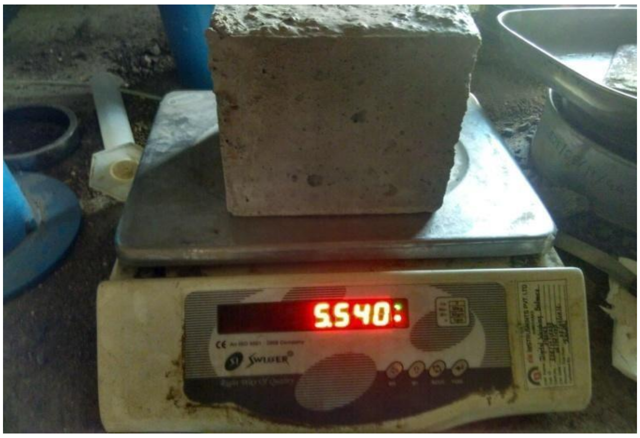


Figure no. 3: Weight of the casted specimen

A. Comparision of compressive strength:

After completing the curing period of the test specimens were kept in dry place for few hours to attaining surface dry condition. Compressive strength machine (CTM) of 2000KN capacity. Compressive strength test was carried out on 150mm x 150mm x 150mm cube specimen for which three cubes were prepared. Strength of each cube was evaluated after 7 days and 28 days. The obtained values are given in Table 4.

Figure no. 4: Compression testing on specimen

Figure no. 5: Specimen after compression testing

Figure no. 6: Readings on compression testing machine

Table no. 4: Results of compression test

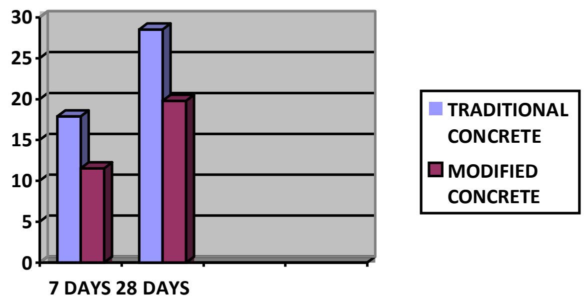
Sr. no.	Proportion of E-waste & foundry sand added	7 Days compressive strength in N/sq mm	28 Days compressive strength in N/sq mm
1.	0%	17.87	28.53
2.	30% - 30%	11.55	19.79

NOTE:- But when the test was again conducted after 90 days the compressive strength was 25.19 N/ sq mm.

RESULTS:

- **Compressive Strength**

The results of compressive strength were presented in above mentioned Table. The test was carried out to obtain compressive strength of concrete at the age of 7 and 28 days. The cubes were tested using compression testing machine of capacity 2000KN. From the figure 3 the compressive strength is maximum when no addition i.e. 0% of E- waste and waste foundry sand in concrete.



Graph no. 1: Compression strength comparison of traditional and modified concrete

Rate analysis:

Rate Analysis of E Waste complex material M20 grade (approximately)			
Material	**Mass**	**Rate / kg**	**Total Amount**
Cement	**1kg**	**5 Rs**	**5 Rs**
Sand	**2kg**	**2 Rs**	**4 Rs**
Aggregate	**2kg**	**2 Rs**	**4 Rs**
WFS + E Waste	**1 + 0.5 = 1.5 kg**	**2 Rs**	**2 Rs**
Total	**6.5 kg**		**15 Rs**

- **Cost of Material Approximate : 3Rs / Kg**
- **Cost of processing : 4Rs /Kg**
- **Total cost : 10Rs /Kg (including contingencies)**

ADVANTAGES:

- It is Eco-Friendly.
- It is Economical.
- Less time is required for filling the pothole as compared to traditional way of filling.
- Less number of labors is required.
- Safe disposal of E-waste.

CONCLUSION:

- The addition of E-waste and waste foundry sand shows decrease in compressive strength when added upto 30%.
- The increase in impact resistance as E-waste gets added to it (pcbs which are made up of glass fibers and epoxy material.)
- E-waste seems to have a more pronounced effect on the water absorption.
- The use of E-waste in concrete is possible to improve its mechanical properties and can be one of the economical ways for their disposal in environment friendly manner.
- Hence safe disposal of E-waste can be achieved.
- Potholes can be repaired in more economical cost and with less numbers of labors in less time.

Figure no. 7: Actual pothole filled

Pattern of filling the road pothole is as shown below in the daigram.

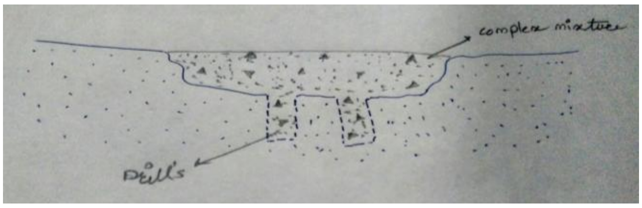


Figure no. 8: Patter of filling the pothole for its better performance

FUTURE SCOPE:

- To attempt various combinations in the mixture so as to increase the percentage of E-Waste up to 50% (presently working at 30 %) without compromising on technical stability in the product.
- Finding various ways for awareness of this topic.
- To achieve environmental credits due to safe disposal of E-Waste.
- Aiming towards Pothole free cities.
- To find out various appication of this materials.

ACHNOLOWEDGEMENT:

First and foremost, I would like to thank the Almighty god who blessed me to overcome all the obstacles I came across while proceeding with this thesis. I am deeply indebted to my thesis guides Prof. R. C. Salvi- Assistant Professor, Department of mechanical Engineering, Prof. P. N. Sonmali and Prof. R. B. Kapate Assistant Professor, Department of Civil Engineering,. vishwabharati academy's college of engineering for their sincere guidance, timely help and much appreciated correction during every step of this work. Finally, yet importantly, I would like to express my heartfelt thanks to my beloved parents for their blessings, and my friends for their help and wishes for successful completion of this thesis.

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