# E-WASTE DISPOSAL MANAGEMENT USING IN CONCRETE

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***Abstract*— The disposal of electronic waste is an issue imposing serious pollution problems to the human life and the environment. For solving the disposal issues of large amount of E-waste material, utilizing the E-waste as a construction material is considered as the most feasible application. The cost of normal coarse aggregate is increasing day by day, has forced the civil engineers to find out suitable alternatives for the coarse aggregate. E-waste is used as one of the alternative for coarse aggregate. The replacement of coarse aggregate with E-waste in the range of 0%, 5%, 10%, 15% in M25 grade concrete. Finally, the mechanical properties such as compressive strength, split tensile strength and flexural strength of the concrete specimens obtained from the addition of these materials is compared with conventional concrete. The test results showed that a significant improvement in compressive strength was achieved in the E-waste concrete compared to conventional concrete The reuse of E-waste results in waste reduction, controls pollution and resources conservation.***

***Keywords*— E-waste, Compressive strength, Split tensile strength, Flexural strength, Workability .***

## I. INTRODUCTION

Latest innovations in science and technology have changed the lifestyle of common man. Much electronic equipment that was beyond reach earlier is now available at affordable prices. On one hand this development has made life easy for all but on the other hand it has encouraged use and throws mentality. Nowadays people prefer to buy a new appliance rather than taking the pains to get the older one repaired. Such a trend not only leads to increase in volume of electrical and electronic waste but also poses serious threat to public health and environment. E-waste is growing exponentially in recent years because the markets for these products are also growing rapidly. The US-EPA has estimated an increase of 5 to 10% in the generation of e-waste each year globally of which only 5% is being recovered Thereby the amount of e-waste that needs to be disposed off in an environmental friendly manner is increasing day by day. The fraction including iron, copper, aluminium, gold and other metals in e-waste is over 60%, while plastics account for about 30% and the hazardous pollutants comprise only about 2.70% .

Concrete is the most widely used building material in construction industry. The main reason behind its popularity is its high strength and durability. Today, the world is advancing too fast and our environment is changing progressively. 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. In developed countries, previously it was about 1% of total solid waste generation and currently it grows to 2% by 210. In developing countries, it ranges 0.01% to 1% of the total municipal solid waste generation.

E-waste is an emerging issue posing serious pollution problems to the human and the environment options need to be considered especially on recycling concepts. E- Waste describes loosely discarded surplus, obsolete, broken, electrical or electronic devices. Rapid technology change, low initial cost has resulted in a fast growing surplus of electronic waste around the globe. Several tonnes of E-waste need to be disposed per year. E-waste contains numerous types of substances and chemicals creating serious human health and environment problems if not handled properly. E-waste or Electronic waste describes discarded electrical or electronic devices. Used electronic which are destined for reuse, resale, salvage, recycling or disposal are also considered as E-waste. Old electronic equipment that becomes junk could turn out to be positively harmful for the environment if not taken care properly. Over the years there have been significant rise in the number of people that use electronic equipment like mobile phones, computers and smart phones. In the past few years, india has emerged as one of the primary contributors of E-waste in the world. The main reason for this is because of the technology boom which the nation is currently undergoing. The main source for E-waste in india is public and private sector institutions which contribute to around 70% of the total E-waste. Household waste is relatively small and accounts for just above 15%. We are only recycling 4% of it. Today, it has become a real challenge as to how to dispose electronic products without causing any damage to the environment. 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. Now a day’s use of concrete is very large so availability of natural material is reduced and there is no material to fulfill the requirement of industries. Thus the use of E-waste materials in concrete not only helps in getting them utilized but also to reduce the cost of construction materials.

In India due to its growing economy and higher consumption, it is estimated that the annual generation of E-Waste (Computers, Mobile Phone and Television only) is 4, 00,000 tons approximately and it expected to grow at a much higher rate of 10 – 15%. Mumbai generates 10, 000 tons of E-Waste, Delhi 9000 tons, Bangalore 8000 tons and Chennai 5000 – 6000 tons each year [1]. Reusing of E-Waste as coarse aggregate substitutes in concrete gives a good approach to reduce cost of materials and solve solid waste problems posed by E-Waste [2]. 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 get decreased gradually when fine aggregate are replaced beyond 15% with Electronic Waste. PCB waste and demolished waste can be utilized in concrete making and hence solve a potential disposal problem and it saves natural aggregate . E-Waste can dispose in concrete as a coarse aggregate; it can withstand the earthquake effect up to a certain level due to its flexibility in nature . The physical recycling techniques of Printed Circuit Board (PCB) effectively separate the metallic and non-metallic fractions of waste PCBs; offer the most promising gateways for the environmentally-benign recycling of this waste . Due to the heterogeneous composition and hazardous material contents, proper recycling methodology is still a challenging task. More studies are needed in the area of metal separation and recovery from PCB leach liquor. Reuse of bulky wastes is considered as the best environmental alternative for solving the problems of disposal. Recycled plastics can be used to fabricate marine construction materials that are economically competitive and environmentally superior to conventional marine construction products.

Rapid technology change ,low initial cost have resulted in a fast growing surplus of electronic waste around the globe .Several tonnes of E waste need to be disposed per year. Traditional landfill or stock pile method is not an environmental friendly solution and the disposal process is also very difficult to meet EPA regulations. How to reuse the non disposable E waste becomes an important research topic. However, technically, electronic waste is only a subset of WEEE (Waste Electrical and Electronic Equipment).According to the OECD any appliance using an electronic power supply that has reach edits End –of life would come under WEEE. E plastic waste is one of the fastest growing waste streams in the world. In developed countries, previously, it was about 1% of total solid waste generation and currently it grows to 2% by 2010. In developing countries, it ranges 0.01% to 1% of the total municipal solid waste generation.

The e-waste inventory based on this obsolescence rate and installed base in India for the year 2005 has been estimated to be 146180.00 tones. This is expected to exceed 8, 00,000 tones by 2012. In India, e-waste is mostly generated in large cities like Delhi, Mumbai and Bangalore. In these cities a complex e-waste handling infrastructure has developed mainly based on a long tradition of waste recycling. Sixty-five cities in India generate more than 60% of the total e waste generated in India. Ten states generate70% of the total e-waste generated in India. Maharashtra ranks first followed by Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Karnataka, Gujarat, Madhya Pradesh and Punjab in the list of e-waste generating states in India. Among top ten cities generating e-waste, Mumbai ranks first followed by Delhi, Bangalore, Chennai, Kolkata, Ahmadabad, Hyderabad, Pune, Surat and Nagpur. There are two small WEEE/Ewaste dismantling facilities are functioning in Chennai and Bangalore. There is no large scale organized e-waste recycling facility in India and the entire recycling exists in unorganized sector. Ahamed et.al [reported waste glass can be used by grinding it into a fine glass powder (GLP) for incorporation into concrete as a pozzalanic material. It under goes beneficial pozzalanic reactions in the concrete and could replace up to 30% cement in some concrete mixes with satisfactory strength development.

The objective of the present research work is to get the characteristics of concrete which are replaced by E-Waste as a coarse aggregate.

## II. LITERATURE REVIEW

Vivek S et al. 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. K. Alagusankareswari et al. determined that the compressive strength and split tensile strength of concrete pertaining to E-Waste aggregate is slightly lesser in comparison with control mix concrete sample. A. Dhanraj et al. focuses on the performance of M30 concrete prepared with E-plastic waste (PCB cutting waste) as part of the fine aggregate to find the thermal and ultrasonic properties. A. Arun kumar et al. focused to improve strength and durability properties of green concrete with E-waste as fine (10%, 20% and 30%) and coarse aggregates (5%, 10% and 15%) replacement in fibre reinforced green concrete with 30% of ground granulated blast furnace slag (GGBS) for the replacement of cement. The overall performance of E-waste as fine and coarse aggregates replacement in compressive strength, splitting tensile strength, flexural strength and chloride ion penetration was due to the combined pozzolanic action of GGBS, increase in the tensile behaviour due to the presence of steel fibres and good bonding of E-waste aggregates.Panneer Selvam et al. aims to minimize the dangers to human health and the environment that disposed and dismantled electronics can create. Benefits of recycling are extended when responsible recycling methods are used. Arjun R Kurup et al. deals with the study of E-Waste Fibers in the concrete to explore its effect on the concrete properties and to reduce the environmental hazards. Results reveal that the optimized percentage addition of E-Waste Fibers to the Concrete is found at 0.8%.

## III. MATERIAL PROPERTIES

E –waste (Printed Circuit Boards) was crushed in various sizes and sieved through 4.75mm, 10mm, and 20mm. It was used to replace coarse aggregate (by weight) in concrete at various percentages as listed in Table 1 are taken for the investigation. Concrete Grade of M20 is adopted in the present investigation. The concrete cubes of size 150x150x150 mm, cylinders of 100x200 mm size and beams of 500x100x100 mm size were cast. The cast specimens are removed after 24 hours and these are immersed in a water tank for a curing period of 28 days and are tested for Compression, Split tensile and Flexural strength test. These results are compared with conventional concrete. E waste describes loosely discarded, surplus, obsolete, broken, electrical or electronic devices.

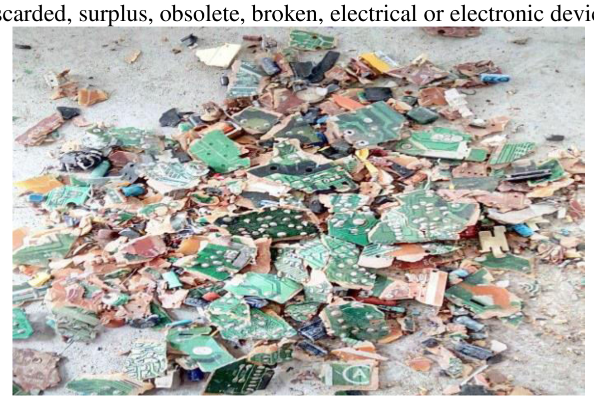

**Fig. 1 E-Waste**

**Table 1 The conventional mix proportion**

| Cement | Fine aggregate | Coarse aggregate | Water |
|---|---|---|---|
| 345 kg/m$^3$ | 750 kg/m$^3$ | 1158 kg/m$^3$ | 186 kg/m$^3$ |
| 1 | 2.174 | 3.356 | 0.54 |

## IV. RESULTS AND DISCUSSION

Workability is the capacity of being worked without extra labour and loss in strength. The strength of cement concrete entirely depends upon the correct percentage of water.

**Fig . 2 Measuring slump of concrete**

**Table 2 Slump test**

| Replacement Details (%) | Slump Value (mm) |
|---|---|
| Nominal Mix | 100 |
| E Waste (5%) | 85 |
| E Waste (10%) | 75 |
| E Waste (15%) | 70 |

The specimen is tested by compression test machine after 7 days, 14 days and 28 days curing.

**Fig 3 Compression Strength Test**

**Table 3 Compressive Strength Results**

| Replacement Details (%) | Compressive Strength ($N/mm^2$) | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| Nominal Mix | 20.7 | 23.5 | 28.53 |
| E Waste (5%) | 21.2 | 25.0 | 30.5 |
| E Waste (10%) | 21.9 | 25.9 | 32.5 |
| E Waste (15%) | 19.5 | 23.5 | 28.2 |

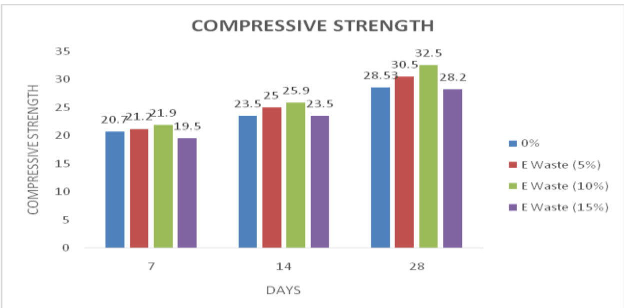


**Fig 4 Compression Strength Test Results**

**Fig 5 Split Tensile Strength Test**

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tensile due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces.

**Table 4 Split Tensile Strength Results**

| Replacement Details (%) | Split Tensile Strength ($N/mm^2$) | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| Nominal Mix | 1.82 | 2.12 | 2.53 |
| E Waste (5%) | 1.98 | 2.29 | 2.59 |
| E Waste (10%) | 2.17 | 2.35 | 2.68 |
| E Waste (15%) | 2.05 | 2.25 | 2.58 |

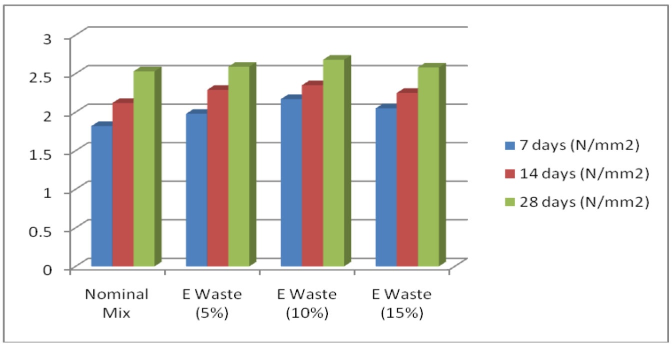


**Fig 6 Split Tensile Strength Test**

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100mm x 500mm concrete beam

**Fig 7 Flexural Strength Test**

**Table 3 Flexural Strength Results**

| Replacement Details (%) | Flexural Strength (N/mm²) | | |
|---|---|---|---|
| | 7 days | 14 days | 28 days |
| Nominal Mix | 2.69 | 2.93 | 3.22 |
| E Waste (5%) | 2.77 | 3.25 | 3.43 |
| E Waste (10%) | 3.01 | 3.36 | 3.62 |
| E Waste (15%) | 2.89 | 3.31 | 3.41 |

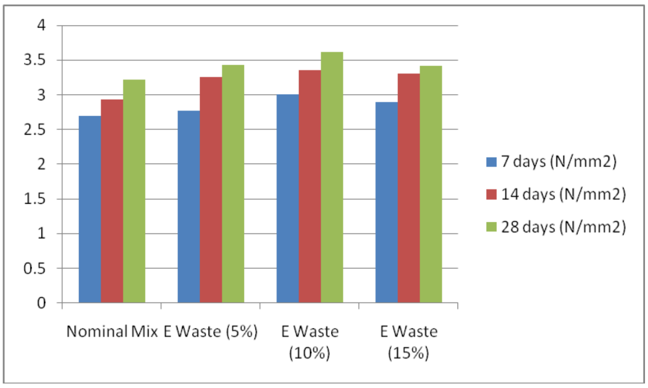


**Fig 7 Flexural Strength Test Results**

## V. CONCLUSION

Replacement of this waste in concrete will reduce the requirement for conventional fine aggregates thereby resulting in conservation of natural resources. The specific gravity of e-plastics is much less, if used in concrete, they can reduce self-weight of the mix. Introduction of plastics in concrete also make concrete ductile, hence increasing the ability of concrete to significantly deform before failure. This characteristic makes the concrete useful in situations where it will be subjected to harsh weather such as expansion and contraction or freeze and thaw.

The best way to manage increasing amount of e- waste is integration of multiple options for handling plastics from end-of-life electronics. This approach includes varying combinations of mechanical recycling, feedstock (or chemical) recycling, reuse, energy recovery, and when necessary, the safe landfilling of plastics. All these options can be viable for managing e-waste. However, the optimal combination of management options in any particular region depends on the resources, technologies and availability of materials.

The use of e-waste in concrete is relatively a new development in the world of concrete technology and lot of research is required before this material is actively used in concrete construction. The use of e-waste in concrete lowered the strength of resultant concrete. Therefore, the research must be oriented towards overcoming this drawback in use of e-plastics in concrete. More than 10% of replacement for fine aggregate is not considerably useful for construction field because of strength decrease. Similarly Split tensile strength and Flexural strength tests shows good result on 15% replacement of E-waste. From this study we can conclude that use of E-Waste in to the concrete by replacing fine aggregate is possible. Hence it solves a potential disposal problem and it saves natural aggregate. Thus, the environmental effects from industrial waste can be significantly reduced.

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