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A Review Study on Partial Replacement of Coarse Aggregate using E-Waste in Concrete

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Abstract - *E-waste is the fastest growing waste with an annual growth of 3 to 4% in the world and it is estimated that this will be increasing approximately to 60 million tons per annum by 2025. It comprises of different materials and chemicals such as lead, cadmium, mercury, beryllium, and plastics including polychlorinated biphenyls, poly vinyl chloride, and polystyrene, many of which are toxic and are likely to create serious problems for the environment and human health if not handled properly. Globally this problem has taken major part of total solid waste amount. Rectifying this waste is still questionable because we cannot burn it easily; landfill is also harmful for this waste and dumping into sea with affect aquatic life. So it is a matter of finding a best solution for it so that we can use this waste in different work. This research is about reducing the generated E-waste from environment by adding it into M25 Concrete and hence testing for workability, compressive strength, tensile strength and flexural strength. Reuse of e-waste materials not only helps in getting them utilized in concrete and other construction materials, it helps in reducing the cost of concrete manufacturing but mainly protecting the environment from possible pollution effects. The present study is focused on replacing conventional coarse aggregate with e-waste materials for different grade concrete using manufacturing sand. It has been found that the compressive strength, flexural strength and split tensile strength of concrete replacing e-waste is high compared to conventional concrete.*

Key Words: **E-waste, compressive strength, tensile strength, flexural strength, concrete.**

1. INTRODUCTION

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. Modern world is witnessing the difficulty of managing the e-waste coming out of so many sources, mostly from IT Companies, educational institutes in the form of PCs and other electronic things. There are lots of attempts which are been made to reduce and manage e-waste by digging in a non-important land and dumping in the sea. But, yet the problem exists. Scientists and engineers are trying hard to come up with new technologies that can overcome the problem of recycling some E-waste percentage, but still it is a very difficult task. So coming up with an idea of manufacturing of E-Concrete, in this concrete we used different percentage of e-waste, reduced the effects of emitted bad radiations by it and used the same as an ingredient for manufacture of concrete. By doing so, we are not only decreasing the space required for disposing of e-wastes, but also decreasing the amount of electronic-waste by using some percentage of it for constructive purposes until it is tested and proved un harmful for the human beings and the environment. Mixing of fine aggregates (sand), coarse aggregate, binding material (cement) with water prepares concrete. It is widely used in today's construction works due to its good compressive strength.

According to the Hazardous Wastes (for Management and Handling the E-waste) Rules, 2003, e-waste is explained as "Waste or discarded Electronic and Electrical Equipments which includes all of its components and sub-assemblies. Electronic waste, explained as E-waste, consists of used out of order old computers, TVs, refrigerators, radios –basically any electronic or electrical appliance that has reached its end of life. Utilization of waste materials and by products is a partial solution to environmental and ecological problems. Use of these materials not only helps in getting them utilized in cement, concrete and other construction materials, it helps in reducing the cost of cement and concrete manufacturing, but also has numerous indirect benefits such as reduction in landfill cost, saving in energy, and protecting the environment from possible pollution effects.

In the past few years, India has emerged as one of the primary contributors of E-waste in the world. 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 more than 5,00,000 tons approximately and it expected to grow at a much higher rate of 10 – 15%. At last the mechanical properties and durability of these concrete specimens were compared with conventional concrete specimens. The comparative study and tests outcomes demonstrated that a huge change in compressive strength was accomplished in the E-waste concrete and can be utilized adequately in concrete.

1.1 Materials used

Cement: - Cement is a binding material used for construction. The ordinary Portland cement of 43 grades confirming to IS 12269-1987 was used.

Fine Aggregates: - Locally available sand passed through 4.75 mm IS sieve was used as fine aggregate. Before using it, the sand was well cleaned, sieved and washed to eliminate impurities.

Coarse Aggregate: - Coarse Aggregate was in the form of irregular broken stones or naturally occurring rounded gravel. The size of aggregate range from 20 mm to 4.75 mm was used as course aggregate which was obtained from local quarry conforming to IS: 383-1970.

Water: - Potable water was used for mixing and curing of concrete specimens throughout the research mentioned in IS 456-2000.

E-waste: - E-waste refers to electronic equipments nearing the end of their useful life. E-wastes from Electronic Products such as laptops, TVs, computers, refrigerators, etc. were crushed and used in the place of coarse aggregate.

2. LITERATURE REVIEW

Lakshmi.R, Nagan.Sre (2010) reported that e-waste can be used by crushing and grounding to the particle size. The divided particle size was assumed to be between 1.18mm – 2.36mm. The compressive strength of the mix was reported to get reduced as the percentage of the e-waste increases. In this paper an experimental study is made on the utilization of E-waste and plastic waste particles as aggregates in mortar cubes with a percentage replacement ranging from 0% to 8%. E-waste particles were rubbed against each other to form an irregular shape of the particle by mutual friction and to develop roughness on the surface of the grinded particle. Compressive strength with and without E-waste and plastic waste as aggregates was observed which exhibits a good strength gain [1].

P. Krishna Prasanna et al. (2014) have studied about E-Waste have been used as partially replacement to the coarse aggregate. They have made specimens by utilizing E-Waste particles as coarse aggregate in concrete with a percentage replacement from 0% to 20%. With regular interval of 5% and with addition of 10% flyash. And conventional Specimens are also prepared for M30 grade concrete without using E-Waste aggregates and tested for Compressive Strength Test and Split Tensile Strength Test. They have resulted that the strength of concrete is reduced by 33.7% when coarse aggregate is replaced by 20% of E-Waste and it is reduced by 16.86% when coarse aggregate is replaced by 20% of E-Waste plus 10% Flyash. They have also observed that the Compressive Strength of concrete is found to be optimum when coarse aggregate is replaced by 15% with E-Waste. Beyond it the Compressive Strength gets decreased. They have concluded that the use of E-Waste aggregate results in the formation of concrete which has lesser weight than that of conventional concrete. They have recommends that 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].

Siddhique et al. (2015) gave an overview on the use of E-waste as a substitute/replacement of aggregate in concrete. The effect of E-waste on the properties of concrete such as compressive strength, split tensile strength and durability were presented [3].

S.P. Kale et al. (2015) have studied about the comparison between fresh concrete materials, waste concrete materials and E-Waste concrete materials for Compressive strength, tensile strength, flexural strength and bond strength. Various mixes were prepared for carrying out the research by varying the proportions of cement, sand and aggregates. All mixes were designed for characteristic strength of M25.The Compressive strength, tensile strength, flexural strength and bond strength was tested in laboratory after 7 and 28 days. The natural coarse aggregates were replaced with 5%, 10%, 15% and 20% (by weight) crushed concrete aggregate and the natural fine aggregate were replaced with 5%, 10%, 15% and 20% (by weight) crushed PCB (Printed circuit board). The compressive strength increases with the increase in the percentage of Printed circuit board up to replacement (10%) of sand in concrete. The split tensile strength was obtained with 10% replacement of crushed PCB is greater than conventional concrete and the strength was obtained with replacement of demolished waste and demolished with admixture is near about same in conventional concrete. The flexural strength increases with the increase in the percentage of PCB up to replacement (5%) of sand in concrete. The maximum 28 days bond strength was obtained with 5% replacement of fine aggregate is greater than conventional concrete. They have concluded that PCB waste and demolished waste can be utilized in concrete making and hence solve a potential disposal problem and it saves natural aggregate. Although recycled aggregate can be applied in the high strength structure, water content in the concrete mix has to be monitored carefully due to the water absorption capacity varying quantity of recycled aggregate [4].

Suchithra et al. (2015) have conducted an experimental investigation on partial replacement of E-waste in the range of 0%, 5%, 10%, 15% and 20% with coarse aggregate on M20 grade mix. They have also conducted test for the effects of sulphate and chloride attack. Thus the addition of E-Waste shows increase in compressive strength upto 15% replacement. But the split tensile strength is almost insignificant whereas gain in flexural tensile strength have occurred even up to 15% replacements. Durability study does not affect the strength of concrete and the optimal mix

is more durable than the control mix. Thus the author concluded that it is possible to use E-waste in concrete as environment friendly manner [5].

Pravin A.Manatkar et al. (2015) have analyzed compressive strength of M20 and M25 grade of concrete by replacing coarse aggregate by adding non-metallic E-Waste in 0% to 20% (0%, 5%, 10%, 15%, 20%) They have observed that compressive strength decreases with increasing E-Waste percentage for both grades. Upto 5%, it is nearly same to normal concrete but after 15%, it reduces maximally. Upto 56% replacement of E-Waste is suitable to use up to (G+2) building construction, road construction. Up to 10% is not considerably useful for construction field because of strength decrease. E-Waste concrete block having flexibility it directly not fails during test. Firstly it compresses up to 1cm then break. It is very important at the time of earthquake it provides some time for clearance in structure. Thus they have concluded that the E-Waste can dispose in concrete as a coarse aggregate [6].

Bala subramanian et al (2016) worked on the research to analyze the concrete strength when e-waste materials is used partially with coarse aggregate in the range of 5%, 10%, 15%, 20%, 25% and 30%. Then they analyzed the results with normal concrete mix in their research. They discovered that the comp. strength, flexure strength and tensile strength have increased when coarse aggregate is replaced with e-waste by 15% and after that the strength starts decreasing. They investigated out that the concrete became more light weight and it can bear the seismic loads more efficiently as compared to normal concrete mix [7].

Shoba Raj kumar et al. (2016) an experimental study was performed to find the effect of partial replacement of coarse aggregate using E-waste in M25 grade concrete. Polystyrene retained on 10mm sieve was used as E-waste material and it was replaced in the range of 10%, 15% and 20%. The compressive strength, split tensile strength and flexural strength of concrete were found. It is identified that E-waste can be effectively used as construction material. Thus they have concluded that the optimum percentage of E-Waste can be used as replacement for coarse aggregate in concrete was found to be 10% [8].

Dawande et al. (2016) studied the use of recycled E-waste material as a replacement of coarse aggregates in concrete. It was found that the use of E-waste aggregates results in the formation of light weight concrete. In this study coarse aggregate was partially replaced by E-waste material up-to 25% along with fly ash partially replacing cement in M40 grade of concrete and properties like workability, compressive strength and flexural strength were evaluated [9].

V. Rathore et al (2019) carried out investigation on M20 grade of concrete with replacement of Course aggregate with E-waste in the range of 5%, 10%, 15%, 20%, 25% and 30%. They found that compressive strength of concrete is 20.35% higher when coarse aggregate is replaced by 15% of two sizes of e-waste materials [10].

K. Hamsavathi et al (2020) Researchers used 12 mm e-waste particles as partial replacement materials for coarse aggregate in the range of 0% to 20 % in M25 grade concrete cubes. Structural behavior of the developed concrete reveals that conversion of e-waste as coarse aggregate exhibits better compression and flexural strength when compared to that of conventional material made cubes. Upon comparison of beams, they found that the load carrying capacity increased from 426 KN to 480 KN, and the compressive strength of the beam improved from 18 N/mm2 to 30 N/mm2 [11].

3. CONCLUSIONS

In the present study the influence of E-waste as a partial replacement of coarse aggregate in concrete mixture is investigated. This study was conducted to evaluate the effect of E- Waste materials used as substitutes for coarse aggregate on the main mechanical properties of concrete mixes.

- It can be concluded that those E-waste materials can be utilized in concrete mixes up to the weight percent composition of 20%.
- Addition of fly ash in the concrete mix increases the strength index of control mix as well as E-waste concrete.
- E- Waste can be disposed in concrete as a coarse aggregate.
- Concrete with E-Waste is environmentally friendly and a better solution to the E-waste problem.
- E-waste replacement with coarse aggregate gives the sustainable approach.

REFERENCES

[1]. Lakshmi.R, Nagan.S, “Studies on Concrete Containing E Plastic Waste”, International Journal of Environmental Sciences, Volume 1, No 3, 2010

[2]. P.Krishna Prasanna, M.Kanta Rao, “Strength Variations in Concrete by Using E-Waste as Coarse Aggregate”, International Journal of Education and Applied Research, Volume 4, Issue Spl 2, June 2014.

[3]. Siddhique Salman, Shakil Sikandar and Siddhiqui Mohd. Shadab, “Scope of utilization of E-waste in Concrete”, International Journal of Advance Research in Science and Engineering (IJARSE),(2015).

[4]. S.P. Kale, H.I. Pathan, "Recycling of Demolished Concrete and E-Waste", International Journal of Science and Research (IJSR)", Volume 4, Issue 1, January 2015

[5]. Pravin A. Manatkar, Ganesh P.Deshmukh, "Use of non – metallic E-Waste as a Coarse Aggregate in a Concrete" International Journal of Research in Engineering and Technology, Volume 04, Issue 03, March 2015.

[6]. Suchithra. S, Manoj Kumar. Indu V.S. "Study on Replacement of Coarse Aggregate by E-waste in Concrete" International Journal of Technical Research and Applications, Volume 3, Issue 4, (July – August 2015), 266-270

[7]. Balasubramanian B., Gopal Krishna GVT, V. Saraswathy, "Investigation on Partial Replacement of Coarse Aggregate using E-Waste in Concrete", International Journal of Earth Sciences Engineering, ISSN 0974-5904, Volume 09, No.03, P.P.285-288(2016).

[8]. Dr. D. Shoba Rajkumar, B.Nithya,"Experimental Investigation on the Strength Properties of M25 Grade Concrete with Partial Replacement of Coarse Aggregate by EWaste" International Journal of Engineering Research & Technology (IJERT), Volume 5, Issue 5, May- 2016, 305-309.

[9]. B. Dawande, D. Jain and G. Singh, "Utilization of E-waste as a partial replacement of coarse aggregate in concrete", IJRD, **3**(11), pp. 6-9 (2016).

[10]. V. Rathore and A. Rawat, "Effective utilization of electronic waste in concrete mixture as a partial replacement to coarse aggregates", AIP Conference Proceedings 2158, 020037 (2019)

[11]. Hamsavathi, K., Prakash, K. S., & Kavimani, V. (2020). Green high strength concrete containing recycled Cathode Ray Tube Panel Plastics (E-waste) as coarse aggregate in concrete beams for structural applications. Journal of Building Engineering.

BIOGRAPHIES

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