Mechanical behaviour on Replacement of Aggregate by E-waste in Concrete

R.Abirami, Srija Juluru , D.S.Vijayan, Yalakapalli balaji ,Ananthu R S

Abstract: Concrete is a widely used material in all construction work. The aim of the project is to study the behavior of concrete with replacement of E waste. The fine aggregate and coarse aggregate are naturally available due to increase in demand it is over exploited. The waste utilization is sustainable solution to environmental problems. Waste from electric and electronic equipment is used as an E waste replacement for coarse aggregate in concrete which is used in the construction. Therefore the effects have been made to study the use of E waste components as a partial replacement of coarse aggregate in 5%, 10% and 15%. To determine the optimum percentage of E waste that can be replaced for coarse aggregate the compressive strength and split tensile strength of concrete to be studied. After determining the optimum percentage of E waste that can be replaced with coarse aggregate. The comparison of the conventional and optimum percentage of E waste replaced with concrete has been done.

Keywords :Concrete, E-waste, Construction, Compressive Strength, Split Tensile Strength, coarse aggregate, waste utilization, recycling.

I. INTRODUCTION

E-waste waste describes the most discarded electrical, or electronic devices. It has been utilized electronic that zone unit bound to be utilized, resale, rescue, use thought of as E-squander. Previous instrumentation that becomes huge junk of electrical waste would be possibly prove to be completely harmful to the human life and environment it is not taken care properly by the industry. Each and every years there are many significant rises within the various electronic materials for the people that is use electronic equipment like computers, mobile phones, television, and smart phones [1]. Within last ten years, Republic of India has emerged collectively of the first contributors of E-waste within the world. The expected reason for this Electronic E-Waste because of the technology development thought the world is presently undergoing with different research. The most supply for E-waste in Republic of India is private and public sector establishments that contribute.

To around seventieth of the complete electronic E-waste has been extracted from all software companies. We tend to be recycling 4-dimensional of it. It has become a real challenge on the way to dispose electronic merchandise, whereas, not inflicting any injury to the environment. For resolution the disposal of huge amount of E-waste material, utilize of E-waste in concrete trade is taken into account because of the most possible application. Day by day use of concrete is very huge and thus accessibility of natural material which has been reduced due to cost and there is no material to fulfill the requirement of soft skill industries. So the use of E-waste materials which has been embedded in concrete which helps and in getting them used, but collectively to reduce the price of construction materials and its products the environment.

In concrete river sand of 2.35mm sieve and 20mm of blue metal aggregate is the major content the objective of the project is use accessible E waste in concrete in replacement of coarse aggregate. Electronic waste generated is obsolete, surplus, and loosely discarded electrical broken, or electronic devices. In India, the first supply of E-waste is public and private sector institutions that lead 70th of the whole waste [2]. The calculable annual generation if electronic waste is 5, 00,000 tons. The wastes are generated from the highest cities like New Delhi, Hyderabad, Mumbai, Bangalore and Chennai were calculated to be 16,000 tons, 10,000 tons, 7,000 tons and 4,000 tons respectively [3]. However, from these sources 4-dimensional only recycling of it. The necessity for disposal of E–waste many tons each year because of its increasing manner. The efforts are created to use the elements of E–waste as a partial replacement of coarse aggregate within the field of construction.

If the E waste is to be utilized in the concrete, as a partial replacement of coarse aggregate. The optimum percentage of E waste to get replaced for fine aggregate should be well-known. So once determine the optimum proportion of E waste replacement. With the optimum percentage the rigid pavement is made and tested and to review the bonding nature of E waste with the reinforcement and cement, fine and coarse aggregate.

The main objective is
1. To confirm the ideal level of E waste that might be used in concrete
2. To confirm the characteristic compression strength and split tensile strength of the standard and E waste replaced concrete.
3. To study the behavior of rigid with optimum percentage of replacement of E waste replacement for coarse combination

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II. MATERIALS AND METHODOLOGY

A. Cement
Cement is the most important ingredient which is used to bind the material in concrete (which is having cohesive and adhesive properties). Cement is obtained by palavering clinker formed by claiming raw materials primarily comprising of liming (CaO), Silica (SiO₂), Alumina (Al₂O₃) and Ferric Oxide (Fe₂O₃) along with some minor oxides. The Various Physical Properties of Cement in Table 1

| Tests                  | Results |
|------------------------|---------|
| Specific gravity       | 3.15    |
| consistency            | 33      |
| Initial setting time   | 27 min  |
| Final setting time     | 375 min |

B. Fine aggregate.
The fine aggregate was brownish in its appearance for which the sieve analysis, specific gravity, water absorption tests were performed. The purpose of addition of river sand as fine aggregate is chiefly due to its inert nature on its addition to cement in concrete. The test results are tabulated in Table 2

| Parameters          | Fine Aggregate |
|---------------------|----------------|
| Particle shape      | Irregular      |
| Appearance          | Brownish yellow|
| Type                | River sand     |
| Specific gravity    | 2.58           |
| Water absorption %  | 1.5            |
| Fineness modulus    | 2.73           |

C. Coarse Aggregate
The aggregates provide strength to the concrete. In this research we used the aggregates having a size of 20mm. The preliminary tests were conducted and results are given in Table 3

| Tests                  | Results |
|------------------------|---------|
| Specific gravity       | 2.66    |
| Water absorption %     | 0.68    |
| Impact value           | 12.5    |
| Fineness modulus       | 2.35    |

D. E-Waste
E –waste (Printed Circuit Boards) was collected from E-Clean Enterprise, Chennai. And it crushed in numerous sizes and sieved through 10mm, and 20mm used to replace blue metal (by weight) in concrete at different rate as recorded as listed in Table 4 are taken for the experiment and fig 1 shows electronic waste used.

| Tests                  | Results |
|------------------------|---------|
| Specific gravity       | 1.26    |
| Water absorption %     | 0.35    |
| Impact value           | 10 %    |
| Fineness modulus       | 2.65    |

M25 grade was used. The mix proportion wasdesigned based on IS: 10262 guidelines [4]. The proportion mix design for M25 grade is 1:2.174:3.356:0.54.fo cement.Fine,coarse aggregate, water respectively. Here we replaced coarse aggregate with E-waste of 5, 10, and 15 of varying percentages.

III. RESULTS AND DISCUSSIONS

A. Slump Cone test
Slump test is used to work out the workability of fresh concrete. Slump test as per IS: 1199-1959 is followed [5]. The slump cone test for fresh concrete results are given in table 5

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

GGBS and Silica fume were added to concrete directly as the percentages of 0%, 5%, 10% and 15% by weight of cement.

B. Compression strength test
The specimens after curing for 7, 14, and 28 days are tested. Until specimen breaks load should be increased gradually at the rate of 145 kg/ cm² per minute. As per the results Ewaste with 10% replacement has higher strength, The results are given in Table 6 and graph plotted is given in fig 2

| Replacement Details (%) | (MPa) [14 days] | (MPa) [28 days] |
|-------------------------|-----------------|-----------------|
| Nominal-mix             | 23.5            | 28.53           |
| E Waste (5%)            | 25.0            | 30.5            |
| E Waste (10%)           | 25.9            | 32.5            |
| E Waste (15%)           | 23.5            | 28.2            |

Figure 2 : Compression strength test results
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C. Split tensile strength: To decide the concrete is very feeble in ductile on account of its weak nature and isn't relied upon to oppose the direct tension. When a tensile load is subjected, cracks will occur on the concrete. Thus to determine the tensile load, split tensile strength is conducted in a laboratory. The split tensile strength values are shown in Table 7 and comparison is displayed in Fig 3 and testing done in laboratory is shown in Fig 4.

Table 7: Results for split tensile strength

| Replacement Details (%) | 14 DAYS | 28 DAYS |
|-------------------------|---------|---------|
| Nominal Mix             | 2.12    | 2.53    |
| E Waste (5%)            | 2.29    | 2.59    |
| E Waste (10%)           | 2.35    | 2.68    |
| E Waste (15%)           | 2.25    | 2.58    |

Figure 3: Split tensile strength

Figure 4: Testing of Split tensile strength in laboratory

D. Flexural Test

Flexural strength is one measure to discover of the rigidity of the solidify concrete. It's a proportion of an unreinforced concrete beam to resist failure in bending. It is measured by loading 100 mm x 100 mm x 500 mm concrete beam as per IS456[10]. The Flexural strength values is shown in Table 8 and comparison is displayed in fig 5&6 respectively.

Table 8: - Flexural Test

| Replacement details | 7 days | 14 days | 28 days |
|---------------------|--------|---------|---------|
| Nominal Mix         | 2.59   | 2.93    | 3.22    |
| E-waste (5%)        | 2.6    | 3.25    | 3.43    |
| E-waste (10%)       | 2.74   | 3.36    | 3.62    |
| E-waste (15%)       | 2.65   | 3.21    | 3.41    |

Figure 5: Flexural Test

Figure 6: Flexural Test in laboratory

IV. CONCLUSION

- For E Waste 5%, 10% and 15% the compressive strength has increased to about 30.5 MPa, 32.5 MPa and 28.2 MPa respectively from 28.53 MPa when compared to conventional concert.
- For E Waste 5%, 10% and 15% the split tensile strength has increased to about 2.29 MPa, 2.35 MPa and 2.25 MPa respectively from 2.12 MPa when compared to conventional concert.
- For E Waste 5%, 10% and 15% the flexural tensile strength has increased to about 2.6 MPa, 2.74 MPa and 2.65 MPa respectively from 2.59 MPa when compared to conventional concert.
- The above data shows us that the 10% mixture of e-waste provides with the maximum compressive, split tensile and flexural strength that can be obtained by mixing e-waste with the concrete. Hence, we conclude that the optimum mixture that needed to be added to the concrete should be 10%, in order to achieve the high strengths.

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