Use of Non-Chloride Accelerator with E-Waste as Partial Replacement of Coarse Aggregate in Concrete

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Abstract—In present scenario, there is a huge demand of making concrete which gain their full strength prior to the maturity period, so that the concrete structure can be made available for use in a time less than as compared to the normal concrete structure. In addition to this the use of waste material in concrete is one of the most attractive options to make it economical and environmental friendly. Research work conducted on the concrete made using triethanolamine (TEA) as an accelerator to achieve early strength of concrete, with the partial replacement of coarse aggregate in different percentage by electronic plastic waste to make concrete eco-friendly with low cost is being presented in this paper. Concrete mixture M25 is designed as per the guidelines of IS 10262:2009; Forty eight cubes are casted and tested for compressive strength after curing period of 3, 7, 14 and 28 days. The best results are obtained with 0.25 % triethanolamine (by weight of cement) and 4 % E-waste as a replacement of coarse aggregate and it can be concluded that up to replacement of 6 % of coarse aggregate the E-waste can be used effectively with triethanolamine.

Key words: Accelerator, Compressive Strength, Early Strength, Electronic Waste, Environmental Friendly

I. INTRODUCTION

Rapid changes in technology, changes in media, falling prices, and planned obsolescence have resulted in a fast-growing surplus of electronic waste around the globe. Now E-plastic waste is one of the fastest growing waste streams in the world; the disposal of E-waste is a major problem, also the use of recycled plastic in the manufacturing of new plastic consumes great energy, as well as cause wear and tear on machinery. The use of E-waste plastic cement concrete aggregate has been focused in this investigation as a feasible solution to the problem of recycling costs and high disposal costs. Millions of tonnes of electronic waste from outdated computers and other electronic articles are being generated every year. E-waste contains so many substances and chemicals creating serious human health and environment problems if not handled properly. E-waste also includes many toxic substances that are heavy metals like lead, cadmium, mercury, arsenic, selenium, chromium etc. Since E-waste has adverse effect on health, it has to be utilized in some manner to make it environment friendly, and hence the production of concrete by using E-waste was one of the best solutions. Addition of E-waste with fly ash in the mix considerably improves strength index of concrete. The strength development of fly ash based E-plastic concrete in early days found to be less but 28 days compressive and split tensile strength has proven results in comparison with controlled concrete up to 25% e plastic replacement [4]. Also the property of concrete can be altered by using admixtures. Admixture is the material which is added to concrete with a view of getting desired properties. Accelerator is one type of admixture which increase rate of hydration of the hydraulic cement and thus shortens the time of setting, and increases the rate of strength development. Calcium chloride (CaCl2) is the most efficient and least expensive accelerator and was very popular but is corrosive to reinforcement bars so its use is not recommended and in many countries is actually prohibited. Therefore research has been focused on developing non-chloride accelerator, the combination of calcium nitrate with either triethanolamine or triisopropanolamine resulted in their joining effects with time, translated by a reduction in the initial and final setting times and a strength enhancement at all ages of the cement pastes, particularly at early ages [1].

A. Objective of Study:
- To use the Electronic waste in different percentage as a replacement of coarse aggregate to decrease their hazardous effect on environment.
- To use triethanolamine (TEA) for attaining early strength of concrete.
- To evaluate the compressive strength of concrete made using triethanolamine as an accelerator with partial replacement of coarse aggregate by E-waste.

II. MATERIAL AND TESTING

A. Materials:
Portland Pozzolana Cement Grade 43 conforming to IS 1489 (Part 1) is used. It is tested as per Indian standard specification. Locally available natural sand conforms to grading zone II as per IS: 383 - 1970 is used as fine aggregate. Crushed stone with maximum 20 mm graded aggregates (nominal size) conforming to Table 2 of IS: 383-1970 is used. Triethanolamine is used as an accelerator. Physical properties of cement, fine aggregate, coarse aggregate and Triethanolamine are given in Table 1.

<table>
<thead>
<tr>
<th>Physical Properties</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Consistency (%)</td>
<td>34</td>
</tr>
<tr>
<td>Specific Gravity of Cement</td>
<td>2.94</td>
</tr>
<tr>
<td>Specific Gravity of Fine Aggregate</td>
<td>2.63</td>
</tr>
<tr>
<td>Specific Gravity of Coarse Aggregate</td>
<td>2.76</td>
</tr>
<tr>
<td>Density of Triethanolamine</td>
<td>1.22 kg/l</td>
</tr>
</tbody>
</table>

Table 1: Physical Properties of Materials

B. Preparation of Specimen and Compressive Strength Testing:
Concrete cubes of size 150 mm x 150 mm x 150 mm are casted. Total Forty eight numbers of cubes are prepared, out of which twelve cubes are of controlled mix without E-plastic waste and triethanolamine (accelerator) and remaining thirty six cubes are prepared with addition of triethanolamine at 0.25 % by weight of cement and replacement of coarse aggregate by E-waste in different percentages as shown in the Table 2.
Mix | Proportion
---|---
Mix-A | Ppc + Fa + Ca
Mix-B | Ppc + Fa + Ca + 4 % E-Waste + 0.25 % Tea
Mix-C | Ppc + Fa + Ca + 6 % E-Waste + 0.25 % Tea
Mix-D | Ppc + Fa + Ca + 8 % E-Waste + 0.25 % Tea

Table 2: Concrete Mix Compositions

After casting, cubes are placed in a curing tank filled with water. Specimens were tested for compressive strength on compressive testing machine after 3, 7, 14 and 28 days of curing. Compressive strength of the above mentioned cubes were recorded and compared with the strength of control mix at the corresponding ages.

III. RESULT AND DISCUSSION
The Compressive strength of the concrete mixes as mentioned in Table-2 is calculated by casting cubes and testing them on compression testing machine at 3, 7, 14 and 28 days of curing. The compressive strength test result of Mix-B is found to be more than the nominal Mix-A at each testing day. Three day compressive strength of Mix-B is more than the seven day compressive strength of Mix-A this shows the rate of gain of early strength of Mix-B is more than that of Mix-A. Maximum increase in the strength is obtained when the test specimen is tested after seven days of curing as compared to the Mix-A. The Chart-1 below shows the comparison of the compressive strength obtained by the test specimens of Mix A and Mix B tested after 3, 7, 14 and 28 days of curing.

The compressive strength of Mix-C test specimens also found to be more than the strength of the test specimens of Mix-A. Also the early strength gain of Mix-C is greater than nominal Mix-A. The Chart 2 below shows the strength gain by Mix-A and Mix-C.

Chart 2: Strength Comparison of Mix A and Mix C
The test results of the Mix-D shows that the compressive strength is increasing when the test specimens is tested after three and seven days of curing as compared to the test results of Mix-A. The strength of Mix-D test specimens after seven days of curing, that is the specimens which are tested after fourteen and twenty-eight days of curing is found to be less than the strength of the nominal Mix-A. Hence on replacing coarse aggregate by 8% of E-waste and adding 0.25% TEA by weight of cement the compressive strength falls as shown below in Chart-3.

Chart 3: Strength Comparison of Mix A and Mix D
The strength at various days of curing is maximum for Mix-B out of all the four mixes. Strength obtained for Mix-B at fourteen day is more than the strength obtained by the Mix-A and Mix-D at twenty eight day. The test results obtained for Mix-C is also satisfactory, the rate of gain of strength of Mix-C is more than the rate of gain of strength of Mix-A and Mix-D but less than the Mix-B. Chart-4 below shows the strength obtained of all the four mixes at various days of curing.
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Chart 4: Strength Comparison of Mix A, Mix B, Mix C and Mix D

IV. CONCLUSION

Based on the experimental results the following points are summarized with respect to the use of non-chloride accelerator with E-waste as partial replacement of coarse aggregate in concrete.

1) It is clear from the study that the best results are found with 0.25 % triethanolamine (by weight of cement) and 4 % E-waste as a replacement of coarse aggregate.

2) The results obtained with 6 % replacement of coarse aggregate were also satisfactory.

3) Up to replacement of 6 % the E-waste can be used effectively with triethanolamine .

4) E-waste can be used efficiently to reduce its effect on the environment.

REFERENCES


