Strength and Short Term Durability of Steel Waste and Polystyrene Based Concrete

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ABSTRACT
Concrete is an eminent material in the field of engineering, production of light weight material and replacement of waste in concrete is a complex task. This present work shows the results of an experimental study on various strength and durability tests on concrete containing Polystyrene as a replacement of coarse aggregate and GGBFS Was used as a partial replacer for cement to check durability properties. Durability test such as acid curing and sorptivity were studied. For this research work M20 grade is used and the tests are conducted for various proportions of Polystyrene with coarse aggregate 5%,10%,15%,20%, 25%.The obtained results were compared with those of normal concrete

Keywords---- GGBF, Materials, Polystyrene

I. INTRODUCTION
Concrete is a best heterogeneous material which has lot of advantages. Light weight aggregate posse’s different salient features such buoyancy which helps the concrete to float and dead load can be reduced. Waste material such as polystyrene and GGBFS can be effective in achieving durability properties

- Lightweight aggregates are natural and artificial
- Natural materials, like volcanic ash
- The thermal treatment of natural raw materials like clay, slate.
- Manufacture from industrial by-products such as fly ash.
- Processing of industrial by-products or slag.

The main objective of the work is
1. Studying the strength and durability of a polystyrene light weight concrete
2. Comparing a standard concrete with partial replacement of coarse aggregate in 5%, 10%, 15%, 20% and 25% by volume.
3. For durability, acid resisting and sorptivity test will be carried out
4. Over all to find the optimum mix combination

II. EXPERIMENTAL INVESTIGATION
CEMENT
Ordinary Portland cement of 53 grades was used in this work.
The cement used has been tested for various properties as per IS: 4031-1988 and found to be confirming to Indian standard code and the specific gravity was found to be 3.15

GROUND GRANULATED BLAST-FURNACE SLAG (GGBFS)
It is a by product from iron industry Investigations were carried out with 30% of GGBFS with cement.

COARSE AGGREGATE
12.5mm size aggregates are used. The specific gravity and fineness modulus are found out as per Indian Standard. The specific gravity of coarse aggregate is 2.80.

FINE AGGREGATE
Locally available sand from river of size 2.36mm confirming to IS code was used

POLYSTYRENE
Polystyrene is one of the thermoplastic polymers, size was found to be 20mm

WATER
Deleterious free water as per IS456:2000 were used

SUPERPLASTICIZER
The super plasticizer used in the casting was CONPLAST SP 430 .It complies with IS 9103 and BS 5075 part III.
III. METHODOLOGY AND MIX DESIGN

Methodology is given in the form of a flowchart in Fig 1. It clearly explains about the type and details about the experiments. Final mix design shown in Table 1

### Table 1: Final Mix Design Values

<table>
<thead>
<tr>
<th>W/C</th>
<th>Cement</th>
<th>Fine Agg</th>
<th>Coarse Agg</th>
<th>Aggregates</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.38</td>
<td>1.0</td>
<td>1.53</td>
<td>3.67</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cement (kg/cum)</th>
<th>Free Water (kg/cum)</th>
<th>Dry Coarse Aggregate (kg/cum)</th>
<th>Dry Fine Aggregate (kg/cum)</th>
<th>Admixture (kg/cum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td>144</td>
<td>--</td>
<td>--</td>
<td>20 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20 mm</td>
<td>12.5 mm</td>
<td>River sand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td>38.5%</td>
<td>31.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td>30%</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>767</td>
<td>627</td>
<td>581</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--</td>
<td>--</td>
<td>0.70%</td>
</tr>
</tbody>
</table>

Table 2 shows the notation

<table>
<thead>
<tr>
<th>NOTATION</th>
<th>% of Polystyrene Replaced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0</td>
</tr>
<tr>
<td>A</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>20</td>
</tr>
<tr>
<td>E</td>
<td>25</td>
</tr>
</tbody>
</table>

Volumetric replace of Coarse aggregate

![Flowchart showing Methodology](image-url)
Sorptivity test were conducted as per ASTM C1585 specimen size was 100mm dia and 50mm height.

Cube Compressive Strength (Acid Resistance)

Durability characteristics such as sulphate and chloride resistance were studied by making cubic specimens of 150mm size. Diluted Hydrochloric acid and diluted Sulfuric acid were used for curing along with water and 28 days acid Curing was done and compressive strength test was done. And the final results were compared with normal concrete.

IV. RESULTS AND DISCUSSION

RESISTANCE TO ACID ATTACK

Specimens with various percentage replacements were cast and cured in diluted HCL and H₂SO₄. The 28 days strength parameter shows increasing trend. Compressive strength are shown in Fig 2 and 3.

![Graph 2](image2.png)

Fig: 2 28days compressive strength results in HCL Curing

![Graph 3](image3.png)

Fig: 3 28days compressive strength results in sulphuric acid Curing
V. CONCLUSION

The following conclusions are drawn based on the findings of the tests reported here:

- Characteristics of Durability improved by adding of GGBFS, Acid resistance of Combination of polystyrene and GGBFS For 5% and 30%, 10% and 30% shows good performance. Without adding GGBFS the polystyrene based concrete are not durable
- The sorption coefficient of combination of 5% polystyrene and 30% GGBFS were found to be 1.75×10^1 mm/sec^{1/2} which indicates the permeability reduction when compared to other combination
- Using of polystyrene and GGBFS is eco friendly and cost effective
- Strength characteristics of polystyrene for 5% replacement with coarse aggregate and durability characteristics for GGBFS and polystyrene combination for 5% and 30% results were better when compared to other combination, so polystyrene and GGBFS Can be used as an alternate material.

REFERENCES