Comparative study of Engineered Cementitious Composites & Self compacting Engineered Cementitious Composites on Response under Impact Loading

Patel U. R.¹, Rathod J. D.², Chauhan D. K.³

¹,³ Assistant Professor, SVBIT, Vasan, G’nar, Gujarat
²Professor, M.S. University, Baroda, Gujarat

¹umangpatel_13486@yahoo.co.in
²jdrathod@msu.ac.in
³digskc@gmail.com

Abstract— Fibre Reinforced concrete (FRC) can be categorized into conventional Fiber Reinforced Cementitious Composite (FRCC) and High Performance Fiber Reinforced Cementitious Composite (HPFRCC). FRCC shows a tension softening behaviour after first cracking, whereas HPFRCC develops multiple cracking and a strain hardening behaviour. Compared to plain concrete and conventional FRCC, HPFRCC shows a significant improvement in ductility. By tailoring some of the properties in cementitious composites a new type of HPFRCC known as Engineered Cementitious Composites (ECC) has been developed. For better understanding the properties of this promising material, a significant amount of research effort has been focused on workability of the composite.

In the present work, the role of Self Compacting ECC (SCECC) for the Impact Purpose and also the role of water in material characterization of ECC is critically examined. To obtain cost effective product, water: cement percentage are varied for finding out better proportion for workability, while keeping the Recron 3S fiber volume fraction as 1%, Super plasticizer (Glenium Sky 777) as 4% and water: cement ratio fixed out as 0.45. Small cylinder for the impact test are carried out.

Keywords— Self compacting ECC, Impact Strength, Workability, Composition, Response of SCECC & ECC

I. SELF COMPACTING ECC

Poor performance of reinforced concrete to impact load and lack of energy absorption capacity is responsible for its limited use in some potential applications and significant amount of infrastructure repair. Impact strength of a material is characterized by a large amount of external energy suddenly being applied to a structure or to a structural element. Impact resistance is the most enhanced mechanical property of the composite when addition of fibres is done.

II. IMPACT STRENGTH

The impact strength of cement based composites is generally tested by preparing relatively small specimens and the following equipments or standard methods are in common use:

- Hydraulic Testing Machines with rate upto 103 MPa/s.
- Hopkinson Bar method with rate of loading upto 4 x 106 MPa/s.
- Rotating hammer method with impact velocity upto 30 m/s.
- Charpy Hammer with special equipment for loading upto 8 x 102 MPa/s.
- Falling weight (drop test) method as indicated in ASTM publications for a rate of loading upto 104 MPa.

The “repeated impact”, drop weight test yields the number of blows necessary to cause prescribed level of distress in the test specimen. This is the simplest and realistic test method of all and can be used to compare the relative performance of different matrices.

It may be noted here that impact strength is measured by the number of blows exerted on a tested specimen before it fails to exhibit rebound, i.e. when it becomes a composition of separate parts rather than a solid body. As there are neither standardized specimens nor universally agreed methods of testing, all published results have a relative and conventional value.

III. SAMPLE PREPARATION

In the preparation of samples for impact test, cylindrical moulds of 150 mm diameter and 300 mm length are used. Three specimens each of SCECC are prepared to study the impact resistance of matrices.
Cylindrical specimens are cured for 28 days. Specimens are cut on the concrete cutter machine keeping height of 64 mm after 28 days of curing. Then samples are coated with white wash in order to see the crack formation at the top during the impact loading.

### IV. COMPOSITION

In SCECC the 300μ sand, Glenium sky 777 super plasticizer [4%], W/C Ratio 0.45, C/S Ratio 1:1.5 Recron 3s Fibre [1%], were used.

While in ECC 300μ sand, super plasticizer [1%], W/C Ratio 0.35, C/S Ratio 1:0.5 Recron 3s Fibre [4%] were used.

### V. RESPONSE OF SCECC & ECC

After preparing sample for the test it is kept in the casing provided at the bottom of impact machine as shown in Fig.1.

![Fig. 1](image-url)

Impact loading is applied on the specimen with the hammer of 4.54 Kg by releasing it from a height of 457 mm to hit the specimen as specified in ASTM D 698 or ASTM D 1557. Blows are applied till the first crack appears at the top of the specimen. Number of blows required to produce first visible crack on top is then noted. These blows are compared with ECC results in Table 12.1 for SCECC Effect.

<table>
<thead>
<tr>
<th>Type</th>
<th>Sample No.</th>
<th>No. of Blows</th>
<th>Average No. of Blows</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCECC</td>
<td>1</td>
<td>65</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>ECC</td>
<td>1</td>
<td>222</td>
<td>297</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>370</td>
<td></td>
</tr>
</tbody>
</table>

### VI. CONCLUSION

- Number of blows required to cause first visible crack on the surface of specimens were recorded and indicated in Table 1. SCECC showed poor performance compare to ECC.

- Large depression is observed at the centre of the specimen where ball was kept due to impact load which is reflected. Here the Impact strength of ECC can be seen in Fig. 2(A).

- ECC is taken as reference for comparison with SCECC. Impact strength of ECC is 297 blows. Where SCECC indicated strength of 59 blows.

- In ECC 4% fibre and 0.35 W/C Ratio used, while in SCECC 1% fibre and 0.45 W/C Ratio used, so SCECC also give good strength in Impact Loading.

- In SCECC we try to impact the specimen from first crack to the failure of the specimens so there were more than one crack shown in. Fig 2(B), obviously first crack strength can be counted.
FIG. 2(A)

FIG. 2(B)

References:-


