Studies on stress-strain behaviour of fibre reinforced self-compacting concrete in confined state

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Abstract. In the present study, the stress-stain behaviour of self-compacting concrete (SCC) and fibre reinforced self-compacting concrete (FRSCC) were taken up. The stress-stain behaviour was studied for the SCC and FRSCC mixes in unconfined and confined states. The confinement was given in the form of steel hoops in the cylinders, 3 hoops (0.8%), 4 hoops (1.1%), 5 hoops (1.3%) and 6 hoops (1.6%). The addition of fibres along with confinement of FRSCC with steel hoops enhanced the compressive strength, indicating further confinement effect in the FRSCC. It is observed that the addition of fibres is helpful in lower confinements only. Beyond 1.1% confinement, the addition of any type of fibres doesn’t show any effect on compressive strengths. From the stress-stain behaviour of all types of FRSCC, it is concluded that the ultimate load-carrying capacity and strains at peak stresses are more in SFRSCC and HFRSCC for mixes up to 1.1% confinement. The addition of fibres to SCC has increased the ductility in both confined and unconfined states.

1 Introduction

Self-Compacting concrete, originally developed in Japan has given answers to many mechanical and durability problems and enhanced the strength and durability characteristics of concrete. Introduction of fibres in SCC has further improved its characteristics like crack, resistance, plasticity, impact resistance, durability etc., The Studies on Stress-Strain behaviour of concrete are essential in determining the parameters like energy absorption, toughness, plasticity index and they are very useful in design of structures using such concretes. Further modelling the stress-strain behaviour helps in predicating their behaviour.

2 Methodology

In this phase of investigations, the stress-stain behaviour of self-compacting concrete (SCC) and fibre reinforced self-compacting concrete (FRSCC) were taken up. The stress-stain behaviour was studied for the SCC and FRSCC mixes in unconfined and confined states. The confinement was given in the form of steel hoops in the cylinders, 3 hoops (0.8%), 4 hoops (1.1%), 5 hoops (1.3%) and 6 hoops (1.6%) as shown in Fig 1. The tests were carried out on the standard cylindrical specimens of diameter 150mm and height 300mm. After casting, the cylinders were capped with cement mortar and cured for a period of 28 days in curing tanks. The specimens were then taken out and made surface dry. The samples were placed in a microprocessor strain controlled universal testing machine of 1000 kN capacity and tested under uni-axial compression as per IS 516:1959. The stress-strain behaviour as obtained was plotted.

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Fig.1. Cylinders with different Confinements
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### Table 2. Stress-strain values of plain self-compacting concrete (PSCC) mixes made with PF=1.12 and s/a=0.53 in confined state

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### Table 3. Stress-strain values of plain self-compacting concrete (PSCC) mixes made with PF=1.14 and s/a=0.57 in confined state

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https://doi.org/10.1051/e3sconf/202130901054
Table 4. Stress-strain values of glass fibre reinforced self-compacting concrete (GFRSCC) mixes made with PF=1.12 and s/a=0.53 in confined state

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Table 7. Stress-strain values of steel fibre reinforced self-compacting concrete (SFRSCC) mixes made with PF=1.14 and s/a=0.57 in confined state

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Table 8. Stress-strain values of hybrid fibre reinforced self-compacting concrete (SFRSCC) mixes made with PF=1.12 and s/a=0.53 in confined state
Table 9. Peak stress and strain at peak stress values of fibre reinforced self-compacting concrete mixes made with PF=1.12 and s/a=0.53 in unconfined and confined state

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Peak stress (MPa)</th>
<th>Strain at peak stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF=1.12 and s/a=0.53</td>
<td>M30PSCC-C0</td>
<td>38.31</td>
<td>0.0026</td>
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<tr>
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<td>42.48</td>
<td>0.0030</td>
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<td>M30PSCC-C4</td>
<td>44.91</td>
<td>0.0033</td>
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<td>M30PSCC-C5</td>
<td>47.06</td>
<td>0.0037</td>
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<td>M30PSCC-C6</td>
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<td>0.0044</td>
</tr>
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<td>PF=1.12 and s/a=0.53</td>
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<td>M30GFRSCC-C5</td>
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<td>0.0039</td>
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<tr>
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<td>M30GFRSCC-C6</td>
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<tr>
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<td>M30SFRSCC-C6</td>
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<tr>
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<td>M30HFRSCC-C6</td>
<td>62.33</td>
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Table 9. Peak stress and strain at peak stress values of fibre reinforced self-compacting concrete mixes made with PF=1.14 and s/a=0.57 in unconfined and confined state

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Peak stress (MPa)</th>
<th>Strain at peak stress</th>
</tr>
</thead>
<tbody>
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<td>M30PSCC-C4</td>
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<td>0.0030</td>
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<td>M30GFRSCC-C6</td>
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<td>M30HFRSCC-C6</td>
<td>61.56</td>
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3 Conclusions

1. The addition of fibres along with confinement of FRSCC with steel hoops enhanced the compressive strength, indicating further confinement effect in the FRSCC.
2. It is observed that the addition of fibres is helpful in lower confinements only. Beyond 1.1% confinement, the addition of any type of fibres doesn’t show any effect on compressive strengths.
3. From the stress-strain behaviour of all types of FRSCC, it is concluded that the ultimate load-carrying capacity and strains at peak stresses are more in SFRSCC and HFRSCC for mixes up to 1.1% confinement.
4. The addition of fibres to SCC has increased the ductility in both confined and unconfined states.

References