Flexural Behaviour of Prefabricated Cage Reinforced Composite Beams

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Abstract— A member composed of two or more dissimilar materials joined together to act as a unit, in this a new reinforcement to be used to reinforced concrete members. This new reinforcement is patent pending and is developed and evaluated in this research. The proposed reinforcement, termed pre-fabricated Cage System (PCS), functions as both the longitudinal and transverse reinforcement connected and working compositely with the surrounding concrete to resist applied loads. Pre-fabricated cage reinforcement is fabricated by angle sections. The confinement provided by the pre-fabricated beams effectively improves the flexural strength and deformation characteristics of pre-fabricated cage. Various methods could be used to fabricate the cage reinforcement such as punching, cutting methods, welding and casting. Pre-fabricated cage reinforcement is pre-fabricated off-site and then placed. It can eliminating the time consuming and costly labor associated with cutting, bending, and tying steel bars in construction. Pre-fabricated cage reinforcement can be used to reinforce almost any kind of concrete member which involves reinforcement and concrete.

Key words: Prefabricated Cage System (PCS), Angle Sections, Composite Beam, Welded Wire Fabric System

I. INTRODUCTION

Reinforced concrete (RC) has been used in construction of different structures for centuries. Reinforced concrete is defined as concrete which is a mixture of cement, sand, gravel, water, and some optional other admixtures, combined with a reinforcement system, which is usually steel. Concrete is strong in compression but weak in tension, therefore may result in cracking and failure under large tensile stresses. Steel has high tensile capacity and can be used in areas with high tensile stresses to compensate for the low tensile strength.

It is, therefore, reinforced by placing steel bars in the tensile zone of the concrete beam so that the compressive bending stress is carried by concrete and strength of concrete, tensile bending stress is carried entirely by steel reinforcing bars.

A. Objective

It is proposed to provide deformed and pre-fabricated welded steel reinforcement angles are used as reinforcement.
1) To investigate the flexural behaviour, ultimate strength, deflection of beams.
2) To eliminates some of the possible weaknesses and detailing problems inherent in traditional RC construction.
3) To reduce the labour cost for fabrication of reinforcing steel bar cage including cutting, bending, and tying bars in RC construction.
4) Comparison of conventional rebar beam with PCS beams like vertical stirrups, diagonal stirrups, 3D-truss by experimentally and using ABAQUS.

B. Advantages of PCS Beams

1) The concrete and steel is utilized effectively.
2) More economical steel section is used in composite construction than conventional non-composite construction for the same span and loading.
3) Depth and weight of steel beam required is reduced. So, the construction depth also reduces increasing the headroom of the building.
4) Composite beams have higher stiffness, thus it has less deflection that steel beams.
5) Composite construction is faster because of using rolled steel and pre-fabricated components than cast-in-situ concrete.

II. DIFFERENT SYSTEM OF CAGING

1) PCS Vertical stirrups
2) PCS Inclined stirrups
3) PCS 3D-Truss as given in Table1.

<table>
<thead>
<tr>
<th>Beam</th>
<th>D (m)</th>
<th>B (m)</th>
<th>Length (mm)</th>
<th>Yield strength of steel (N/m²)</th>
<th>Grade of concrete</th>
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<tbody>
<tr>
<td>A1</td>
<td>150</td>
<td>100</td>
<td>1100</td>
<td>500</td>
<td>M30</td>
</tr>
<tr>
<td>B2</td>
<td>150</td>
<td>100</td>
<td>1100</td>
<td>250</td>
<td>M30</td>
</tr>
<tr>
<td>C1</td>
<td>150</td>
<td>100</td>
<td>1100</td>
<td>250</td>
<td>M30</td>
</tr>
<tr>
<td>D1</td>
<td>150</td>
<td>100</td>
<td>1100</td>
<td>500</td>
<td>M30</td>
</tr>
</tbody>
</table>

Table 1: Different System of Caging

III. WELDING OF REINFORCEMENTS (PCS)

A. Prefabricated Cage using Angle Sections

Fig. 1: Welding of Reinforcements (PCS)

Fig. 2: Prefabricated Cage using Angle Sections
B. Need for Alternative Reinforcement

The complimentary characteristics of steel and concrete have made these two materials an excellent combination in structural members for more than a century. Properties of steel such as high tensile strength, high ductility, and availability in conjunction with concrete’s strengths including high compressive strength, formability, high temperature and fire resistance, and low cost, makes the combination of these two materials a logical choice for structural members. Traditional rebar reinforced concrete, concrete-filled tubular (CFT) systems, steel-concrete composite sections, and welded wire steel-concrete composite sections, and welded wire volumetric transverse reinforcement ratios, close spacing. Overlapping of hoops, and long column tie end-hooks. An alternative to the rebar transverse reinforcement may be to use welded reinforcement grid, prefabricated to the required size, arrangement, and volumetric ratio of transverse reinforcement. Welded reinforcement grids can offer easy cage assembly, dimensional accuracy, proper support of longitudinal reinforcement, and reduced amount of used materials by eliminating laps at tie ends and bend extensions. Furthermore, using layers of closely spaced grids in the cross-sectional plane will improve the confinement of the concrete core.

IV. Mix Design

The mix design was arrived M30 grade of concrete as per IS: 10262-2009. The proportion found from mix design was 1:1.54:2.64:0.45 (Cement: Fine Aggregate: Coarse Aggregate: Water) with a cement content of 438.13 kg/m3.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Materials</th>
<th>Weight kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cement</td>
<td>438.13</td>
</tr>
<tr>
<td>2</td>
<td>Fine Aggregate</td>
<td>747.25</td>
</tr>
<tr>
<td>3</td>
<td>Coarse Aggregate</td>
<td>1034.95</td>
</tr>
<tr>
<td>4</td>
<td>Water</td>
<td>197</td>
</tr>
<tr>
<td>5</td>
<td>Water Cement Ratio</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Table 1: Mix proportion for 1m³ of concrete

V. Cross Sections of Beams

VI. Casting and Testing of Beams

Concrete is mixed manually with the proper mix proportion. Oil is applied on all the sides of the mould to aid in easier demoulding. Care is taken to see that the concrete is properly placed beneath and also on the sides of the mould. The concrete is compacted fully with the help of tamping rod and trowel. The concrete is mixed initially and placed immediately inside the mould before the initial setting starts. Loading arrangement for testing of beam was shown in Fig. 2.

VII. Flexural Test Results

The concrete beam of 100x150x1100mm size was cast for finding the load deflection behaviour of the beam. The prepared beam was cured in water for 28 days. The cured specimens were taken out and dried. After drying, the specimen is loaded using universal testing machine with a dial gauge kept below the beam at the centre of the beam to measure the deflection readings. The load deflection behaviour is shown in Fig. 3. The cracks in the failure specimens was shown in Fig. 4.
VIII. CONCLUSION

- An experimental study on behaviour of RC and PCS beam has been presented in this thesis.
- M30 grade concrete was designed using IS: 10262:2009 code provisions.
- The strength properties of concrete has been determined as per IS code provisions.
- A RC beam was cast and tested under two point loading.
- The ultimate load carrying capacity of beam is found by 68kN.
- The ultimate deflection of beam at ultimate load was 2.5mm.
- The theoretical load carrying capacity of RC beam was calculated as 52.5kN.
- Compared to rebar reinforcement the PCS beam shows the greater flexural strength.

REFERENCES