AN EXPERIMENTAL STUDY ON STRUCTURAL PERFORMANCE OF RC BEAMS STRENGTHENED FOR COMBINED FLEXURE AND SHEAR BY USING NSM-GFRP STRIPS

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Introduction:

Near-surface mounted (NSM) fiber-reinforced polymer (FRP) reinforcement technique is one of the latest and most effective techniques used in strengthening the existing structural components. Existing structures demand mainly structural strengthening due to an increase in load demand, seismic retrofitting, faulty design and construction, etc. In past, many researches have been carried out by using different cross-sectional shapes and dimensions of FRP materials to strengthen for shear and flexure. After being strengthened with several types of FRPs in flexure and shear, the results showed that the load-carrying capacity of these beams was enhanced satisfactorily.

In the current work, an attempt is made to study the behaviour of RC beams strengthened for combined flexure and shear. Also, the feasibility of using GFRP (Glass fibre reinforced polymer) strips as a near-surface mounted (NSM) element to enhance the structural performance of a beam element is studied. The main objectives of the present study are:

1. To study the structural behavior of unstrengthen RC beam (control beam) with the beam strengthened using NSM-GFRP strips to enhance both shear and flexural capacity.
2. To analyse the structural performance of RC Beams strengthened using NSM-GFRP strips to enhance flexural capacity and shear capacity by orienting the strips at different angles.
3. To compare the structural behavior of RC beams strengthened using NSM-GFRP strips for combined flexure and shear with RC beams strengthened only for
   - Shear
   - Flexure

Methodology:

The methodology involves the characterization of materials by conducting basic tests on the concrete materials to design a concrete mix of M30. The under-reinforced concrete rectangular prisms of 150 x 150 x 700 mm (Fig. 1) size are considered a beam element for the experimental study. Two categories of beams, i.e., unstrengthened (control beams- CB (Fig. 2)) and beams strengthened using GFRP strips with epoxy as an adhesive are tested. To study the behaviour of beams in combined shear and flexure three point loading test is conducted. All the strengthened beams have flexural strips embedded at the soffit and the shear strips on the side faces are oriented at 45, 60, and 90 degrees. The strips of 2mm thickness and 10mm width are considered as NSM-FRP. The strengthening technique involves cutting a groove (Fig. 3) in the concrete cover at the sides and soffit of the beams which is cleaned (Fig. 4) and filled with epoxy and followed by embedding the GFRP strips in the groove filled with epoxy (Fig. 5). The groove depth of 17mm and width of 5mm were considered as per the previous studies.

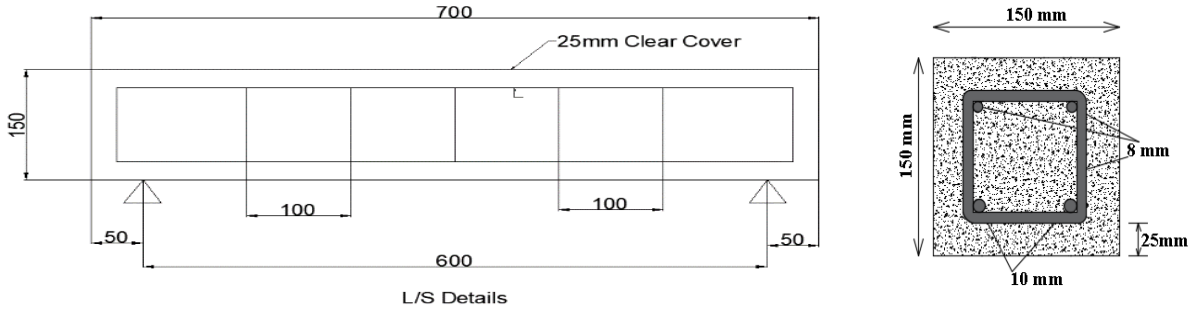

Fig. 1: Reinforcement detailing of the beams

Fig. 2: Control beam (unstrengthened beam)

Fig. 3: Groove cutting

Fig. 4: Cleaning of groove

Fig. 5: Placing of GFRP

Fig. 6: Strengthened beam

The beams are studied for the failure characteristics, i.e., yield and ultimate load-carrying capacity of these beams. Load-deflection behaviour, crack width, crack patterns and different modes of failure are studied. From the test results, it has been observed that the load-carrying capacity of the strengthened beams (Fig. 6) has increased. Also, an improvement in deflection behaviour i.e., lesser deflection, and lesser crack width compare to controlled beams. This NSM strengthening technique can be advantageous and suitably adopted to improve the load-carrying capacity of the structural beams.