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Experimental and analytical study on torsion behavior of RC beam strengthened with GFRP laminations.

Sandeep Aghara[1], Prof.Tarak vora[2]

[1]PG Scholar, Marwadi education foundation group of institute, Rajkot.
[2]Associate Professor, Marwadi education foundation group of institute, Rajkot.

Abstract: *Fiber reinforced polymer (FRP) as an external reinforcement is used extensively to enhance the strength requirement related to flexure and shear in structural systems. But the strengthening of members subjected to torsion is yet to be explored as Torsion failure is a brittle form of failure. In present study experimental and analytical study on torsional strengthening of RC beam with GFRP lamentation. Total six rectangular beams of size 180*230 and length 1500 mm are casted. Out of six beam one beam as control beam and remaining five beams are GFRP wrapped beam at different configuration. Numerical work was carried out using non-linear finite element (FE).*

Keywords— *GFRP laminates, Torsional Strengthening.*

1. INTRODUCTION

In current practice, torsional strengthening of concrete.members is achieved by one of the following methods (1) increasing the member cross-sectional area combined with adding of transverse reinforcement, (2) using externally bonded steel plates and pressure grouting the gap between plate and concrete element, and (3) applying an axial load to the member by post-tensioning. Although these methods will continue to be used in many more instances, fiber reinforced polymer (FRP) composites provide another option for strengthening. Strengthening structural elements using .FRP enable the designer to selectively increase their ductility, flexure, and shear capacity in response to the increasing seismic and service load demand. Shear strengthening or flexural strengthening of reinforced concrete beams using composite materials were studied by several researchers and investigators at several institutions. However, studying the torsional strengthening of structural elements using ,FRP has not received much attention. The reasons For the lack of research in the area include the specialized nature of the problem and the difficulties in conducting realistic tests and representative analyses. It is also a reason that few practical structures need to be Strengthened to increase the torsional capacity under cyclic torque.

REVIEW OF LITURATURE

Ghobarah[1] et al. (2002) conducted an experimental investigation on the improvement of the torsional resistance of reinforced concrete beams using fiber-reinforced polymer (FRP) fabric. A total of 11 beams were tested. Three beams were designated as control specimens and eight beams were strengthened by FRP wrapping of different configuration and then tested. Both glass and carbon fibers were used in the torsional resistance upgrade. Different wrapping designs were evaluated. The reinforced concrete beams were subjected to pure torsional moments. The load, twist angle of the beam, and strains were recorded. Improving the torsional resistance of reinforced concrete beams using FRP was demonstrated to be viable. The effectiveness of various wrapping configurations indicated that the fully wrapped beams performed better than using strips. The 45° orientation of the fibers ensures that the material is efficiently utilized
Panchacharam and Belarbi[8] (2002) experimentally found out that externally bonded GFRP sheets can significantly increase both the cracking and the ultimate torsional capacity. The behaviour and performance of reinforced concrete member strengthened with externally bonded Glass FRP (GFRP) sheets subjected to pure torsion was presented. The variables considered in the experimental study include the fiber orientation, the number of beam faces strengthened (three or four), the effect of number of FRP plies used, and the influence of anchors in U-wrapped test beams. Experimental results reveal that externally bonded GFRP sheets can significantly increase both the cracking and the ultimate torsional capacity. Predicted strengths of the test beams using the proposed theoretical models were found to be in good agreement with the experimental results. Jing[5]et al. (2005) made an experimental investigation on the response of reinforced concrete box beam under combined actions of bending moment, shear and cyclic torque, strengthened with externally bonded carbon fiber reinforced polymer sheets. Three strengthened box beams and one reference box beam were tested. The main parameters of this experiment were the amount of CFS and the wrapping schemes. The failure shapes, torsional capacities, deformation capacities, rigidity attenuations and hysteresis behaviours of specimens were studied in detail. The experimental results indicated that the contribution of externally bonded CFS to the a seismic capacity of box beam is significant. Based on the text results and analysis, restoring force model of CFS strengthened R.C. box beam under combined actions of bending moment, shear and cyclic torque was established.

Al-Mahaidi and Hii[3](2006) focuses on the bond-behaviour of externally bonded CFRP in an overall investigation of torsional strengthening of solid and box-section reinforced concrete beams. Significant levels of debonding prior to failure by CFRP rupture were measured in experiments with photogrammetry. Numerical work was carried out using non-linear finite element (FE) modeling. Good agreement in terms of torque-twist behaviour, steel and CFRP reinforcement responses, and crack patterns was achieved. The addition of a bond-slip model between the CFRP reinforcement and concrete meant that the debonding mechanisms prior to and unique failure modes of all the specimens were modelled correctly as well. Numerical work was carried out using non-linear finite element (FE) modeling. Good agreement in terms of torque-twist behaviour, steel and CFRP reinforcement responses, and crack patterns was achieved.
Very few analytical models are available for predicting the section capacity (Ameli and Ronagh 2007; Hii and Al-Mahadi 2006; Rahal and Collins 1995). Hii and Al-Mahaidi (2007) briefly recounted the experimental work in an overall investigation of torsional strengthening of solid and box-section reinforced concrete beams with externally bonded carbon fiber-reinforced polymer (CFRP).

3 EXPERIMENTAL WORK

In experimental work total six beam casted out of six one beam as control beam and remaining five beams are strengthened by GFRP wrapping of different configuration.

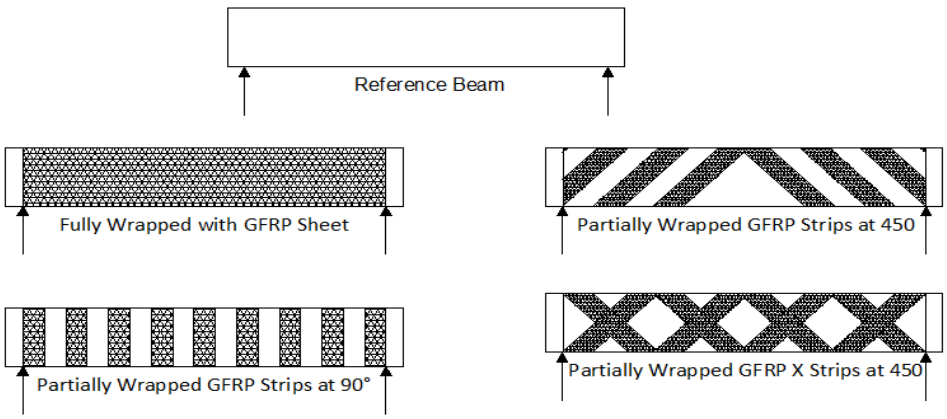
3.1 Specimen characteristics

Six Reinforced Concrete rectangular beam of cross section of 150 × 300 mm and 1200 mm long were casted by using, 3 No's-20 mm diameter reinforcing bar at bottom and 3 No's-16mm diameter bars at top 10mm stirrups at spacing 60 mm c/c.

3.2 Material property:

1].Concrete properties : All the RC beams were casted using M25 grade of concrete with 53 grade OPC cement , 20 mm maximum size of coarse aggregate and river sand having with water cement ratio of 0.45 mix proportion ratio by using I.S 10262-2009.The clear concrete cover to the outer side of stirrup was 30.

4 GFRP LAMINATES WRAPPING PATTERN



5 CONCLUSION

From experimental we conclude that wrapping pattern at 45 angel give more torsional strength than wrapping at 90 degree.

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