1. Project Reference Number: 46S_MTech_029

2. Project Title: An experimental study on the structural performance of full scale RC beams strengthened for shear only using NSM - GFRP strips.

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7. Keywords: NSM, Shear strengthening, GFRP Strips

8. Introduction

Strengthening a structure could be the result of seismic zone upgradation, or change in occupancy, or amendment in local regulation, or rectification of faulty construction work or restoring a deteriorated structural element. Augmenting the load carrying capacity of a structure through conventional methods is a tedious and expensive affair. Hence, approaches chosen to tackle the problems encountered involves jacketing or externally bonded reinforcement (EBR). However, if the soffit of the beam is inaccessible due to the presence of wall underneath the beam, enhancing the strength through shear strengthening becomes essential. EBR is ineffective when strengthened only on the sides of the beam without flexural strengthening. Hence, near surface mounted (NSM) – GFRP strips will do the job of strengthening [**Rashmi et al. 2023**]. Earlier studies carried out with NSM-GFRP strips as the shear strengthening element were limited to small scale beams and the strips were oriented at 45° and 90°. The strength enhancement to the tune of 93.5% and 73.3% was observed for strips oriented at 45° with a spacing of 60mm and 100mm respectively, when compared with the un-strengthened beams. 48% and 59.5% was the increase in ultimate shear force resisting capacity for strips oriented at 90° and spaced at 54mm and 90mm respectively, in comparison with un-strengthened beams [**Rashmi et al 2021**]. In another study carried out with strips oriented at 60° and 75° the increase in strength with respect to the un-strengthened beams were observed to be 73.3% and 60% for 60° strip orientation and strip spacing of 80mm and 50mm respectively. However, 40% and 33.33% was the ultimate shear strength enhancement for strip orientation of 75° and strip spacing of 100mm and 60mm respectively [**Rashmi et al 2022**]. This study aims to study the effectiveness of shear strengthening of full scale beams with GFRP strips oriented at 45° and spaced at 150mm interval.

9. Objectives

- To study and compare the structural behaviour of a full scale RC beam strengthened with NSM GFRP strips oriented at 45° with that of control beam.
- To study the effect of scale on the structural performance of strengthened RC beams in comparison with earlier research carried out on small scale RC beams.

10. Methodology

10.1 Materials

Beams of size 3000mm length, 150mm wide and 175mm deep were casted using M20 grade concrete and Fe550 grade steel. GFRP strips were the strengthening element used in this experiment. 18 GFRP strips oriented at 45° to the beam axis were inserted on each face of the beam. The beams were designed to be tested as simply supported using a reaction frame as shown in Fig. 1. In order to assess the variation in load carrying capacity of the strengthened beam, control beam having same dimensions and physical properties were casted sans strengthening. The reinforcement details of the beam is shown in Fig.2.

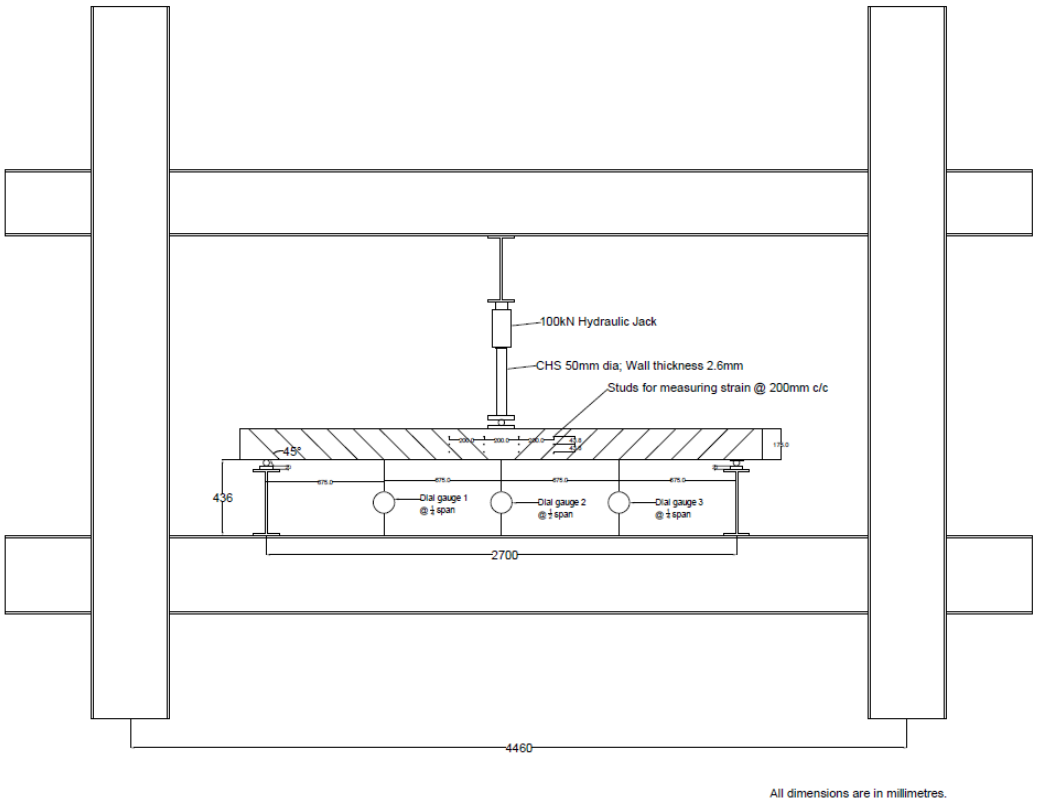


Fig. 1: Experimental setup for testing of beams

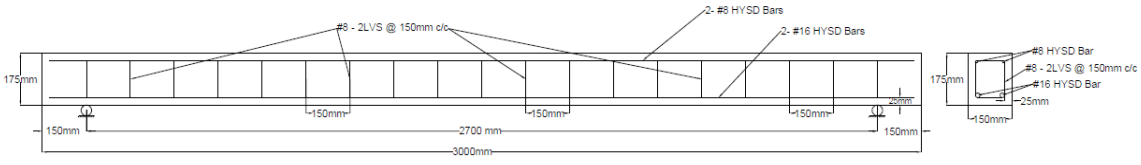
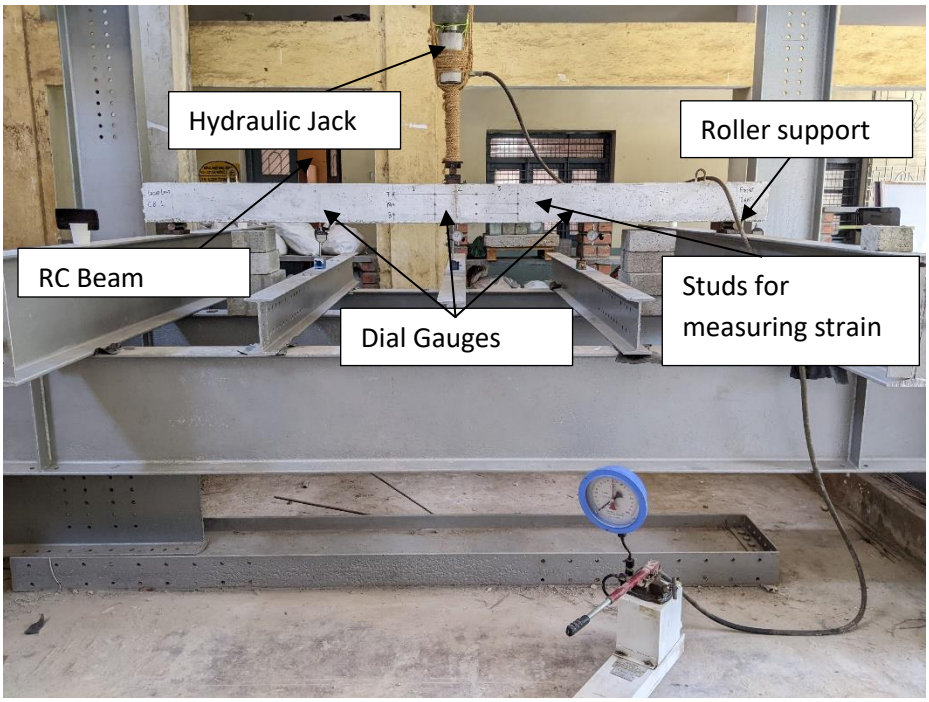


Fig. 2: Reinforcement details of RC Beam

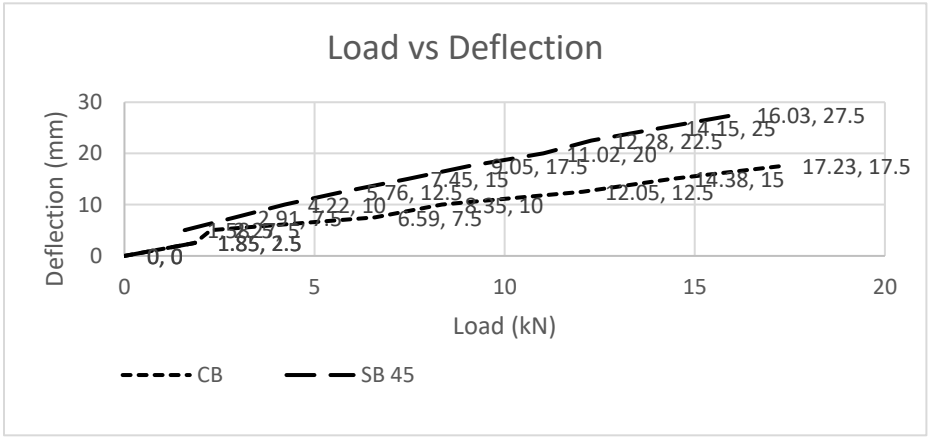
10.2 Strengthening procedure

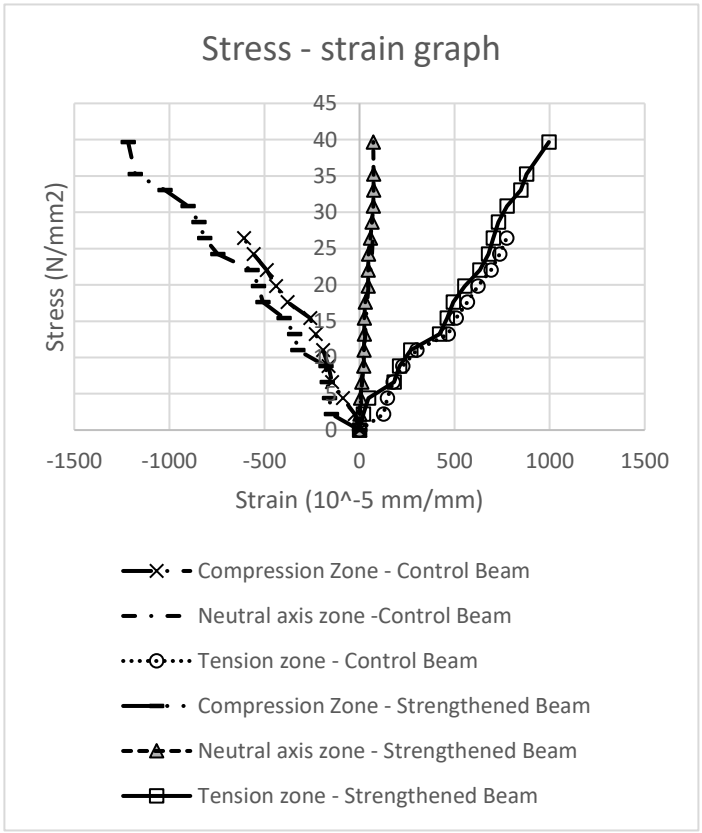
10.3 Testing procedure

Incremental load to be applied on beam using hydraulic jack of capacity 100kN until desired failure and deflections are observed in X and Y directions.



11. Results


Load vs Deflection
Deflection (mm)
Load (kN)
0, 0
1.85, 2.5
2.91, 5
4.22, 10
5.76, 12.5
6.59, 7.5
7.45, 15
8.35, 10
9.05, 17.5
11.02, 20
12.28, 22.5
12.05, 12.5
14.15, 25
14.38, 15
16.03, 27.5
17.23, 17.5
CB
SB 45


Stress - strain graph
Stress (N/mm2)
Strain (10^-5 mm/mm)
Compression Zone - Control Beam
Neutral axis zone -Control Beam
Tension zone - Control Beam
Compression Zone - Strengthened Beam
Neutral axis zone - Strengthened Beam
Tension zone - Strengthened Beam

12. Conclusions

Only preliminary results have been presented and the said work is in progress. Final conclusions can be drawn only after the study is completed in all respects.

13. Innovation in the project

Utilization of GFRP strips cut to desired shape and size from GFRP sheets and mounting them near surface (NSM) for strengthening the structural component (beam). This is a material which is widely used in aerospace and electrical industries, but scarcely used in civil engineering industry. Realizing the potential of this material in tackling problems faced by this industry can help achieve desired results without depending on virgin raw materials actually required for strengthening beams, that is, aggregates and constituent materials of cement to a great extent.

14. Scope for future work

Shall be identified after completion of the current experimental study.