MODELLING ANALYSIS AND RETROFITTING OF FLANGED BEAMS WITH GFRP CONFINEMENT

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Abstract: *In order to improve the quality of the reinforced concrete structure it is better to repair or upgrade the structure by retrofitting. Retrofitting is one of the best options to make an existing inadequate building safe against future probable earthquake or other environmental forces. Retrofitting is the modification of existing structure to make them more resistance to seismic action, motion of ground and failure of soil due to earthquake or other natural calamities such as tornadoes cyclones and winds with high velocity caused by thunder storm, snow fall, hailstorms, etc. The analyses is done to investigate the improvements in the structural behavior of the RC flanged beams retrofitted with types of FRP such as glass fibers And Steel Plates. The project aims in the performance of 3D RC Flanged beam, With different types of retrofitting in shear deficient beams using Ansys (Structural static) software. And the results are compared.*

KEY WORDS: *GFRP, T BEAMS, RETROFITTING*

1 .INTRODUCTION

One High strength non-metallic fibers, such as carbon, glass and aramid fibers, encapsulated in a polymer matrix in the form of wires, bars, strands or grids have shown great potentials as reinforcement for concrete, particularly where durability is of main concern. It is commonly known as fiber reinforced polymer or, in short, FRP. Despite being a recent development, numerous investigations have already been reported in the literature on various aspects of its structural use. Fiber-reinforced polymers (FRP) have been used for structural reinforcement materials and also for bridge construction materials such as bridge decks and materials.

2. GFRP

Fiber Reinforced Polymer (FRP) materials are well recognized as a vital constituent of the modern concrete structures. The superiority of the FRP materials, in comparison with other conventional building materials like timber, steel and reinforced concrete, lies in its improved structural performance, in terms of stability, stiffness, strength (including improved resistance to fatigue loading) and durability Other factors include convenience in mass production with high quality control and relative economy. The most commonly used fibers in the production of FRP are glass, carbon and aramid. These fibers are usually bonded together with the help of such binding agents as resins and cements and are used to produce rods, strands, sheets, mats and pultruded profiles. These find very large application in load bearing structures, repair and rehabilitation of existing structures.

The properties of gfrp are shown in Table 1.

Table-1: Properties of GFRP

Material	Tensile Strength (MPa)	Tensile Modulus (GPa)	Laminate Thickness (mm)
Glass Fiber	3240	72.4	0.36
Epoxy resin	72.4	3.18	-
GFRP	575	26.1	1.3

2.1 Why GFRP?

GFRP has a very high strength to weight ratio. And Lightweight, Low weights of 2 to 4 lbs. per square foot means faster installation, less structural framing, and lower shipping costs and is good Resistance towards salt water, chemicals, and the environment - unaffected by acid rain, salts, and most chemicals and Seamless Construction, Domes and cupolas are resined together to form a one-piece, watertight structure. These are Able to Mold Complex Shapes Virtually any shape or form can be molded. And is Low Maintenance Research shows no loss of laminate properties after 30 years. They have Durability Stromberg GFRP stood up to category 5 hurricane Floyd with no damage, while nearby structures were destroyed.

Table-2: Properties of concrete

Description	**M 20 grade (m)**
Design Mix Ratio	1:1.76:3.14
W/C Ratio	0.45
Average Compressive Strength of Concrete Cubes	28.75

(MPa)	
Modulus of Elasticity (MPa)	26575

Table-3: Properties of Steel

Properties	Steel (Fe)
Yield strength (MPa)	490
Longitudinal elastic modulus (GPa)	218
Compressive strength (MPa)	572
Strain	0.014
Poisson's ratio	0.26

3 .Modelling And Analysis in Ansys:

ANSYS structural analysis software enables us to solve complex structural engineering problems and make better, faster design decisions. With the finite element analysis (FEA) solvers available in the suite, we can customize and automate solutions for your structural mechanics problems and parameterize them to analyze multiple design scenarios. We can also connect easily to other physics analysis tools for even greater fidelity. ANSYS structural analysis software is used throughout the industry to enable engineers to optimize their product designs and reduce the costs of physical testing.

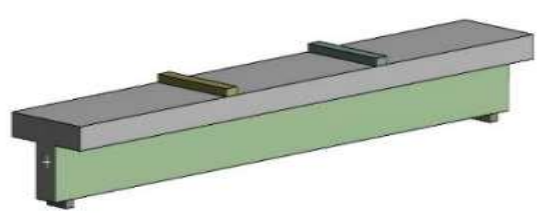

Fig-1: Model of T-Beam in ansys

3.1 Reinforcement Crossection:

Fig-2: Reinforcement of model T beam

3.1.1 Reinforcement details:

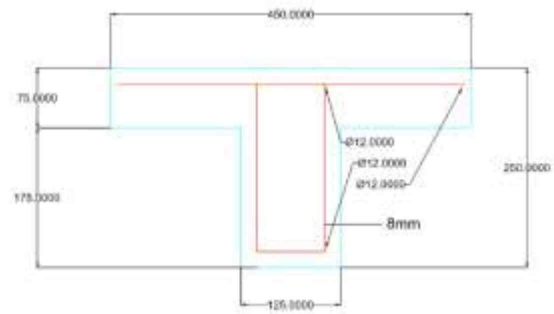

Fig-3: Reinforcement details (All dimensions are in mm)

4. Analysis results in Ansys

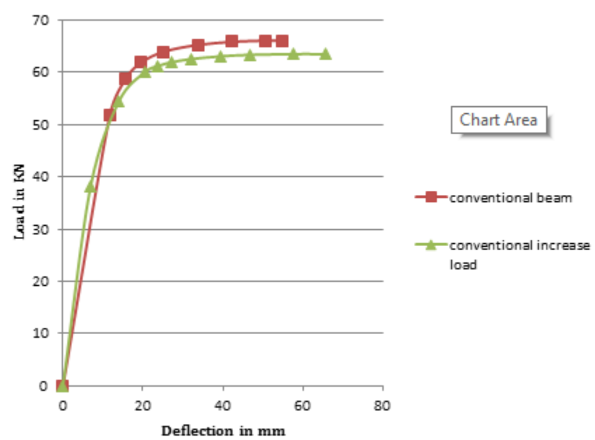

Chart-1: Load difference between normal beam and load increased beam

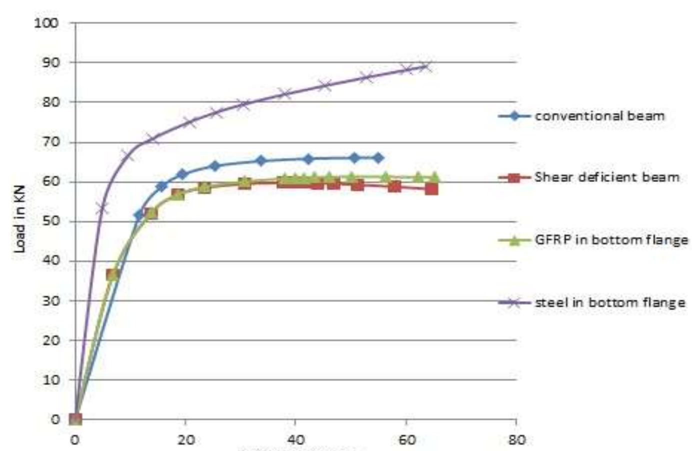

Chart-2 Load and deflection comparison between partial gfrp, steel and conventional beam

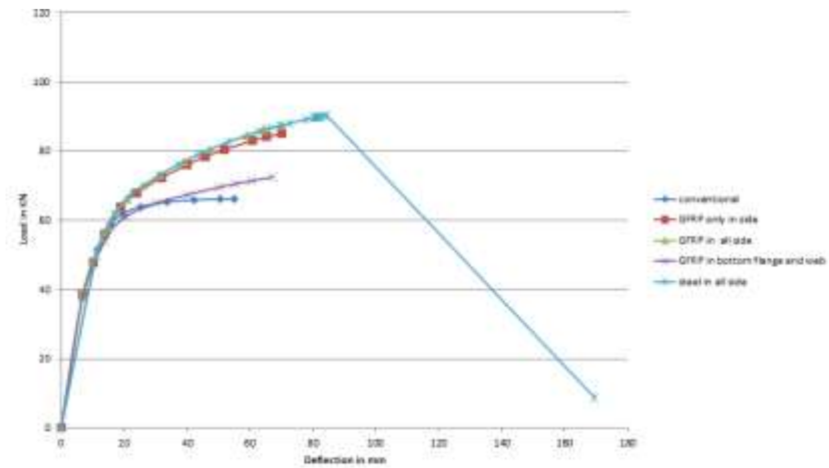

Chart-3 Load and deflection comparison between gfrp, steel and conventional beam

5. Results

Table – 4 Comparison of retrofitted shear deficient Beams

Retrofitted Beams	Ultimate deflection (mm)	Ultimate load (KN)	% increase	YD (mm)	YL (KN)	DUCLTILITY=UD/YD
Conventional Beam	39.111	59.803	-	6.846	36.452	5.7129
Steel plate in bottom flange	69.966	87.487	46.29	6.9128	38.682	10.1212
Gfrp in all side	69.233	76.151	49.06	6.8894	37.517	10.04921
Gfrp in bottom flange and web	50.09	61.301	2.504	6.8437	36.509	7.3191
Steel plate in sides only	67.134	72.449	21.14	6.8724	37.53	9.76864
Steel plate in all side	69.953	87.055	51.03	6.9139	38.528	10.1177
Gfrp in side only	100.51	89.146	27.33	11.244	49.568	8.9389
Steel plate in bottom flange and web only	84.354	90.321	45.56	11.238	49.895	7.50614

6. CONCLUSIONS

1. Retrofitting t-beam with shear deficient using gfrp wrapping all sides increases the strength of the beam by 49.06% to that of conventional beam.

2. Retrofitting t-beam with shear deficient using gfrp wrapping in sides only increases the strength of the beam by 27.33% to that of conventional beam.

3. Retrofitting t-beam with shear deficient using gfrp in bottom web and flange only increases the strength of the beam by 2.504% to that of conventional beam.

4. Retrofitting t-beam with shear deficient using steel plate in bottom web and flange only increases the strength of the beam by 45.56% to that of conventional beam.

5. Retrofitting t-beam with shear deficient using steel plate in side only increases the strength of the beam by 21.14% to that of conventional beam.

6. Retrofitting t-beam with shear deficient using steel plate in bottom flange only increases the strength of the beam by 46.29% to that of conventional beam.

7. Retrofitting t-beam with shear deficient using steel plate in all side increases the strength of the beam by 51.03% to that of conventional beam.

REFERENCES

[1] Hussain M., Sharif A. Basunbul IA, Baluch M.H. and Al-Sulaimani G.J.(1995). "Flexural behavior of precracked reinforced concrete beams strengthened externally by steel plates." ACI Structural, 92, 14-22.

[2] Jones R., Swamy R.N. and Charif A. (1988). "Plate separation and anchorage of reinforced concrete beams strengthened by epoxy bonded steel plates." Structural Engineer, 66(5), 85-94.

[3] L'Hermite R. and Bresson J. (1967). "Concrete reinforced with glued plates." RILEM International Symposium, Synthetic Resins in Building Construction, Paris, 175-203.

[4] Oehlers D.J. (1992). "Reinforced concrete beams with plates glued to their soffits", Journal of Structural Engineering, ASCE, 118, 2023-2038.

[5] Sevuk, F. (2000). "Yapı hasarları ve hasarların iyiletirilmesi üzerine bir inceleme." Doktora tezi, YTÜ Fen Bilimleri Enstitüsü, Istanbul.

[6] Swamy R.N., Jones R. and Ang T.H. (1982). "Under and over reinforced concrete beams with glued steel plates." Int. J. Cement Composites Lightweight Concrete, 4, 19-32.

[7] Swamy R.N., Jones R. and Charif A. (1989). "The effect of external plate reinforcement on the strengthening of structurally damaged RC beams." Structural Engineer, 67(3), 45-56

[8] M. A. Shahawy, M. Arockiasamy, T. Beitelman, R. Sowrirajan "Reinforced concrete rectangular beams strengthened with CFRP laminates" Composites: Part B 27B (1996) 225-233.

[9] Victor N. Kaliakin, Michael J. Chajes and Ted F. Januszka "Analysis of concrete beams reinforced with externally bonded woven composite fabrics" Composites: Part B 27B (1996) 235-244.

[10] Koji Takeda, Yoshiyuki Mitsui, Kiyoshi Murakami, Hiromichi Sakai and Moriyasu Nakamura "Flexural behaviour of reinforced concrete beams strengthened with carbon fibre sheets" Composites Part A 27A (1996) 981-987.

[11] G. Spadea, F. Bencardino and R. N. Swamy "Structural Behavior of Composite RC Beams with Externally Bonded CFRP" Journal of Composites for Construction Vol. 2, No. 3. August, 1998. 132-137.

[12] Ahmed Khalifa, William J. Gold, Antonio Nanni, and Abdel Aziz M.I. "Contribution of externally bonded FRP to shear capacity of RC flexural members" Journal of Composites for Construction, Vol. 2. No. 4, November, 1998. 195-202.

[13] N. F. Grace, G. A. Sayed, A. K. Soliman and K. R. Saleh "Strengthening Reinforced Concrete Beams Using Fiber Reinforced Polymer (FRP) Laminates" ACI Structural Journal/September-October 1999. 865-875.

[14] Taljsten and L. Elfgren "Strengthening concrete beams for shear using CFRP- materials: evaluation of different application methods" Composites: Part B 31 (2000) 87-96.

[15] Ahmed Khalifa, Antonio Nanni "Improving shear capacity of existing RC T-section beams using CFRP composites" Cement & Concrete Composites 22 (2000) 165174