Rational Study of Beam Strengthening with FRP: An Overview

Anurag Chaturvedi[1] Mukh Raj Yadav[2]
[1]Department of Civil Engineering [2]Department of Electrical Engineering
[1,2]Madan Mohan Malaviya University of Technology Gorakhpur India

Abstract— The above entitled paper show the survey of expository and numerical investigation of flexural and shear execution of beam strengthening or retrofitted beam with fiber reinforced polymer (FRP). Presently a day examiner incline toward numerical and systematic study to minimize error which can't decrease in experimental study, consequently numerical study is more solid than experimental study and analytical study less time expending than experimental as yet having great concurrence with experimental study. Almost overall software available in market are basically based on finite element method (FEM) such as ABAQUS, ANSYS and ATENA 3D. Analytical study completed by various writer utilizing FEM based software they discovered an extreme improvement in ultimate capacity of beam diagnostic examination of reinforced concrete (RC) beam with FRP were completed by number of agent they all concentrated on various angle, some of those pointed towards single layer or two fold layer of FRP, some of those dealt with various arrangement and thickness of FRP and after that analyzed stress, deflection and strain with control specimen. Finite element method utilizes fine mashing and fitting material property to obtain definite result. Bond conduct between steel-concrete and cement FRP plate/ sheets must be indicated for precise and sensible results.

Key words: Retrofitting, Strengthening, Repair, Beam, FEM [Finite Element Method], FRP [Fiber Reinforced Polymer], ANSYS Software

I. INTRODUCTION

One of the more adequate way to retrofit Reinforce concrete beam with FRP [Fiber reinforced polymer].FRP is popular due to its light weight, corrosion free, low material cost, ease of utilization. Number of FRP accessible off for sale such as KFRP (Kevlar Fiber Strengthened Polymer), CFRP (Carbon Fiber Reinforced Polymer) and GFRP (Glass Fiber Reinforced Polymer). FRP are accessible in three frame, for example, plates, sheets and bars. Shear strength as well as flexure strength are broadly expanded by use of FRP. FRP sheets/plate adhesively clung to the base face of just simply supported beam for increment in flexure strength and clung to the side face of the beam for gain in shear strength. Definitely bending moment most noteworthy in center of the beam so for gain in flexural strength FRP applied at the center of the beam however in real practice the FRP sheets apply all through beam to abstain from debonding of sheets. FRP generally acknowledged in light of the fact because of low cost, high strength, corrosion resistance and high fatigue resistance. GFRP are generally acknowledged for their shabby rate over carbon fiber composites still CFRP utilized were firmness, strength, and flexibility were vital. To comprehend the conduct of FRP in beam analyst conveyed out trial with analytical, experimental and numerical study. At the same time a percentage of the specialist concentrated on perceive and comprehend the failure modes that reinforced concrete beams retrofitted with FRP. The principle failure modes experimentally identified that there was shear failure and flexure of concrete and debonding of FRP. FRP may be used in two manner if used for application in structure. First ways we can use FRP as a plate or sheet which is to strengthen damaged structural member with FRP"s utilization. Strengthening and retrofitting the structural part, for example, column, beam and slab with outer use of FRP are an one of the compelling strategy use over a world. Utilization FRP as a bars in reinforced concrete member rather than steel bar is the second way.

II. LITERATURE REVIEW

Ramesh Kumar U More [1] et al— explored on flexural conduct of Kevlar fiber (Aramid fiber) reinforced polymer (AFRP) utilized for strengthening reinforced concrete (RC) beam of M25. Analyst took the size of beam 100 x 150 x 1200 mm and was reinforced by Kevlar fiber polymer sheets. Analyst took the size of beam 100 x 150 x 1200 mm and was strengthened by Kevlar fiber polymer sheets. Writer Used ANSYS (Structural Analysis Software) for approval of Experimental work and they discovered great understanding between experimental and analytical result. Writer concentrated on effect of strengthening on load carrying capacity and impact of damage degree. They just worked on flexural behaviour as beams were wrapped with AFRP sheets in single layer and twofold layers along the full length of beam at the base face. Writer finished up from results that the ultimate load carrying capacity for 0% damage degree beams were enhanced after strengthened with single layer and twofold layer of 100 mm width AFRP strip was 27.59% and 49.27% respectively contrasted with controlled beam, ultimate load carrying capacity were increased with increased in layer of AFRP strip, with increased in degree of damage, deflection at ultimate load was observed to be applying so as to diminish AFRP strip and 0%, 70%, and 80% damaged degree beams showed higher performance in terms of load carrying capacity, while 90% and 100% damage degree beams did not show considerable increase in load carrying capacity.

Sergio F. Bren and Beth M. Macri [2] tentatively conveyed out tests on eighteen little scale reinforced concrete beam strengthened by CFRP composites. Writer intended to comprehend conduct of strengthened reinforced concrete beam under various design of CFRP. Writer utilized three distinctive kind of design, in first case lamintes were connected just to tension face of the beam, in second case joined to shear/side face of the beam and in third case laminates were joined to whole specimen. Their experiment finished up on a conclusion that composite pattern/configuration straight forwardly influence behaviour of deflection versus load and deflection of the beam were influenced by composite design.

Hsuan-The [3] Hu et al did numerical study by ABAQUS taking into account FEM (finite element method) to foresee the ultimate loading capacity of rectangular

reinforced concrete beams strengthened by FRP connected at the side face or base of those beam. Writer ended up with a result that the numerical result FRP strengthening is not viable for high reinforcement proportion as contrasted with low reinforcement proportion. Writer watched more split at the focal region of the beam with high reinforcement proportion which was reinforced with FRP at the base, and discovered nearly more crack at support area of the beam with low reinforcement proportion which was strengthened with FRP at the base. Writer seen more ultimate strength and deceased crack when FRP connected on base face of the beam.

P.Parandaman [4] et al taken a look at RC structure which is harmed amid quake and they attempted to retrofitting of that reinforced structure with fiber strengthen composite. They used CFRP, KFRP and GFRP on same size of beam and after that writer did modelling and analysis by ANSYS. Examiner's goal is to analyze execution of above three retrofitted beams with controlled beam. Writer at last summed up from the ANSYS results, deflection of the retrofitted beam with CFRP is minimized around 73% contrasted with controlled beam, deflection of the retrofitted beam with GFRP is minimized around 65% contrasted with controlled beam, deflection of the retrofitted beam with KFRP is minimized around 60% contrasted with controlled beam and carrying capacity of retrofitted beam is higher than the controlled RC beam.

C. C. Spyrakos [5] et al completed trial and explanatory examination of the viability of FRP reinforcing sheets on RC beam to improve their flexural strength and stiffness. Writer led four point bending tests on four full scale reinforced concrete beams strengthened with externally bonded FRP. Writer examined the deflection, strength and failure mode reinforced pillars in both tentatively and systematically. The structure outcomes with a result i.e. increase in strength and stiffness of beam by the use of CFRP as the result describes.

Kaushal Parikh [6] et. alcompleted experimental and explanatory examination on preloaded retrofitted beam with GFRP for improvement in flexural strength. Writer utilized new arrangement of FRP for strengthening the beam in which they were apply full length of single layer, they reduced length and width in second and third layer. Seventeen beam were considered for exploratory study, out of which two were control beams and fifteen were pre-loaded at 0%, 40%, 90% of control beam. Writer used ANTENA 3D software. Creator finished up from the logical furthermore, test results, new plan so powerful that was movement the flexural break far from the flexural locale furthermore turn out from the debonding failure. They watched deflection versus load curve that is not more than 5% fluctuated in trial and analytical results, failure mode are moreover momentous analyzed.

F.A.Fathelbab[7]et al led analytical investigation on strengthened RC simple beam with externally bonded FRP (Fiber Reinforced Polymer) sheets strategy, that is beam were stacked in flexure, shear, a mix of flexure and shear. Writer used ANSYS software. Writer examined principle parameter to control beam of diverse plans of FRP sheets in shear, flexural and mix shear & flexural. Writer compared the results and concluded that beam capacity and ductility straight forwardly relative to CFRP sheets applied on the beam but in the meantime Writer watched that the beam capacity didn't increased with increase in CFRP sheets but ductility increased.

Tarek H. Almusallam[8] et al studied on repaired or strengthened reinforced concrete specimens. Strengthening is achieved by utilization of GFRP to base face of beam. They compared flexural capacity and mid span of the strengthened beams and control beams to evaluate effectiveness of strengthening technique. Twelve beams were explored by writer and size of the beam is 150 X 200 X 2050 mm. They applied FRP on beam in three distinctive way. In the first bunch writer connected FRP at base of the beam, in second they connected FRP utilized (in U shaped sheet) and in third they then connected twofold layer of FRP at the base of the beam. To calculate central deflection they used linear variable displacement transducer (LVTD) and Amsler testing machine for application of load. Performed test on that beam lastly came to a result that flexural strength increased significantly by bonding GFRP sheets to the base face of the reinforced concrete beams and U molded port framework had significantly affected on failure mode and ultimate strength of the beam. Improvement in strength and ductility were observed by author.

Dr.D.L.Venkatesh babu[9] et al studied FRP beam's behaviour Writer find out bending moment, the model considers an exponential function in the stress-strain diagram of RC in both compression and tension parallel to the fiber. Writer led four point loading test to determinel oad versus displacement curve's relationship of RC beam with CFRP and GFRP sheets stuck to the tension face/base face. Writer utilized finite element techniques to see best warping style for retrofitting the deficient beam. They likewise did investigation of adequacy of CFRP/GFRP sheets in flexure strength of RC beams. From the outcomes, writer came to a conclusion that general behaviour of the finite models indicate great concurrence with trial results of beam test. Also the outcome got by writer that shows that CFRP was more proficient than GFRP in strengthening the reinforced concrete beams for shear.

III. CRITICAL REMARKS

Taking after conclusion are produced using above writing survey

1) Use of FRP on RC beam builds flexure and shear strength impressively.
2) Explanatory study in view of finite element method have a great concurrence with test study.
3) A large portion of the writer directed study on rectangle beam for shear and flexural strengthening with various kind of FRP with consistent thickness of GFRP and which are strengthened with one, two and three layer of FRP without curtailment and they discovered strength increases with increased in layer however in diminishing way.
4) Carbon reinforced polymer are more compelling in flexure and shear execution than glass fiber reinforced polymer.
5) Systematic result might be higher on the grounds that bond behaviour between FRP and concrete are not cleared.
6) The ultimate load/final load from the FEM are higher than experimental outcome but deflection vs. load behaviour is almost comparatively likewise same.

7) Toughness and ductility were increased discernibly of RC beam strengthened by FRP (Fiber Reinforced Polymer).
8) Numerical study can be utilized to foresee the conduct of retrofitted reinforced concrete beams more correctly by doling appropriate material properties and appropriate connection between concrete and FRP (Fiber Reinforced Polymer).
9) By applying proper arrangement of FRP application the performance of RC beams might increase considerably.
10) Design guidelines are not available for advancing and choosing the thickness of FRP sheets/laminate for strengthening of RC beams.
11) Strength and failure mode of RC beam are affected by anchorage length.
12) Failure mode of debonding of FRP cannot be legitimately understood in analytical study.
13) All the writer took assumed thickness of FRP particularly who did analytical study.

REFERENCES

[1] Rameshkumar U More and D.B.Kulkarni, Flexural behaviour study on RC beam with externally bonded aramid fibre reinforced polymer, International Journal of Research in Engineering and Technology Jul-2014, Volume-03, pp 316-321.
[2] Sergio F. Bren, Beth M. Macri, Effect of Carbon-Fiber-Reinforced Polymer Laminate Configuration on the Behavior of Strengthened Reinforced Concrete Beams, May-June 2004, Journal of Composites for Construction, pp 229-40.
[3] Hsuan-Teh Hu, Fu-Ming Lin and Yih-Yuan Jan, Nonlinear finite element analysis of reinforced concrete beams strengthened by fiber-reinforced plastics, 2004, Composite Structure, pp 271-81.
[4] P.Parandaman and M.Jayaraman, Finite element analysis of reinforcement concrete beam retrofitted with different fibre composites, Middle-East Journal of Scientific Research, 2014, pp 948-52.
[5] C.C. Spyrakos, I.G. Raftoyiannis, L. Credali and J. Ussia, Experimental and Analytical Study on Reinforced Concrete Beams in Bending Strengthened with FRP, 2014, The Open Construction and Building Technology Journal, pp 153-63.
[6] Kaushal Parikh and C.D.Modhera, Application of GFRP on preloaded retrofitted beam for enhancement in flexural strength, International Journal of Civil and Structural Engineering, May-2012, pp 1070-80.
[7] F.A.Fathelbab, M.S.Ramadan and A. Al-Tantawy, Finite element modelling of strengthened simple beams using FRP techniques: A parametric study, Concrete Research Letters, June-2011, Volume-2, pp 228-40.
[8] Tarek H. Almusallam and Yousef A. Al-Salloum, Ultimate strength prediction of RC beams externally strengthened by composite materials, composite engineering, Feb-2001, Part-B, pp 609-19.
[9] A.Vijayakumar, Dr.D.L.Venkatesh babu and R. Jayaprakash, Analytical study on various types of FRP beams by using AVSYS, International Journal of Engineering Research and Applications, Sep-Oct 2012, Volume-2, pp 593-98.

