INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E - ISSN: 2454-4752 P - ISSN : 2454-4744
VOL 3 ISSUE 3 (2017) PAGES 2421 - 2425
RECEIVED : 25.04.2017 PUBLISHED : 18.05.2017
May 18, 2017

STRENGTHENING OF RC BEAMS USING FIBRE REINFORCED POLYMERS

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ABSTRACT

Infrastructure development is raising its pace. Many reinforced concrete and masonry buildings are constructed annually around the globe. With this, there are large numbers of them which deteriorate or become unsafe to use because of changes in use, changes in loading, change in design configuration, inferior building material used or natural calamities. Thus repairing and retrofitting these structures for safe usage of these structures has a great market. There are several situations in which a civil structure would require strengthening or rehabilitation due to lack of strength, stiffness, ductility and durability. Beams, columns, plates may be strengthened in flexure through the use of CFRP bonded to their tension zone using epoxy as a common adhesive. Due to several advantages of carbon fiber wrapping over conventional techniques used for structural repair and strengthening, the use of CFRP has becoming popular. The paper makes a comparative study between the load carrying capacity and ductility of an RCC beam and other beams with CFRP bonded. An experiment study is carried out to study the change in the structural behavior of R.C.C. beams wrapped with carbon fiber of different thickness, orientation and length to enhance the flexural and shear capacity of the beams along with the existing practice of doing the repair work.

Keywords: carbon fibre, epoxy, flexural, retrofitting, rehabilitation.

1. INTRODUCTION

Reinforced concrete (RC) structure using externally bonded fibre reinforced polymer (FRP) components has become a very universal practice, extensively accepted by recent design codes [1, 2]. In particular, the flexural strength of a reinforced concrete beam can be extensively increased by application of carbon (CFRP), glass (GFRP) and Aramid (AFRP) FRP plates/sheets adhesively bonded to the tension face of the beam. Glass fibre reinforced polymers sheets are being increasingly used in rehabilitation and retrofitting of concrete structures, since low cost comparison with other types of FRP fibres are generally high strength-to-weight ratio, corrosion resistance and fatigue resistance. A low weight of the fibre make it easy to handle without lifting equipment at site, negligible change of cross section, self weight and free height of a structure. Based on the chemical composition, properties and their usage glass fibres are classified as chopped strand mat, woven roving, continuous rovings, E-glass, S- glass, satin weave cloth and laminate. For structural applications, FRP is mainly used in two areas. The first area involves the use of FRP sheets/plates which is to strengthen structurally deficient structural members with external application of FRP.

Retrofitting with adhesive bonded FRP has been established around the world as an effective method applicable to many types of concrete structural elements such as columns, beams, slabs and walls. At the same time, widespread experimental, numerical and analytical research has been carried out to understand and model the structural behaviour of FRP strengthened reinforced concrete beams. For literature reviews on different aspects of FRP strengthening of reinforced concrete structures.

2. LITERATURE REVIEW

Investigation on the behavior of FRP retrofitted reinforced concrete structures has in the last decade become a very important research field. In terms of experimental application several studies were performed to study the behavior of retrofitted beams and analyzed the various parameters influencing their behavior. Triantifillou and Plevris (1991) used strain compatibility and fracture mechanics to analyze reinforced. The same assumptions as An et al. (1991) were used with the inclusion of an rectangular compression stress distribution in the concrete at failure. The applied moments that would cause each of the three failure modes were predicted. The failures were yielding of the steel reinforcement followed by CFRP rupture; yielding of the steel reinforcement followed by the crushing of the concrete compression zone; and concrete crushing before either tensile component fails. These models were compared with experimental studies and deemed creditable.

Shahawy et al.(2000)assessed the effectiveness of external reinforcement in terms of the cracking moment, maximum moment, deflection, and crack patterns. The deflection and cracking patterns showed results similar to experiments previously discussed. The deflection decreased inversely with the number of CFR Players on each beam. This, alternatively, caused the stiffness to increase.. The control had wider cracks while the repaired beams showed smaller cracks at relatively close spacing. This shows an enhanced concrete refinement due to the CFRP sheets. Almusallam in the year 2001 examined a straightforward and efficient computational analysis to predict the nominal moment carrying capacity of RC beams strengthened with external FRP laminate. They investigated the determination of the limits on the laminate thickness in order to guarantee tensile failure due to steel yielding and to avoid tensile failure due to FRP laminate rupture. They found that beam strengthened with CFRP laminate require less number of layers than those strengthened with glass FRP laminate for the same load capacity.

Pantelides and Gergely (2002) presented analysis and design procedures for a CFRP composite seismic retrofit of a reinforced concrete three-column bridge bent. In situ test results showed that the seismic retrofit was successful, and the bridge bent strengthened with CFRP composite reached a displacement ductility level and doubled the hysteretic energy dissipation of the as-built bent.

Dr. Gopal Rai and Yogesh Indolia (2011) Beams, Plates and columns may be strengthened inflexure through the use of FRP composites bonded to their tension zone using epoxy as a common adhesive. The direction of fibers is kept parallel to that of high tensile stresses. Both prefabricated FRP strips, as well as sheets (wet-layup) are applied. Hence, FRP composites are finding ways to prove effective and economical at the same time. If the cost constraint is kept aside, the fiber wrapping system has been proved to be a system which has many added advantages over conventional strengthening processes.

3. RELATED RESEARCH

Investigation on the behaviour of FRP retrofitted reinforced concrete structures has in the last decade become a very important research field. In terms of experimental application several studies were performed to study the behaviour of retrofitted beams and analyzed the various parameters influencing their behaviour. On the field of strengthening structure Michael et al., 1994 experimentally investigated fourteen reinforced concrete beams. The author examined three control beams having same steel reinforcement. Houssam et al., 1997 investigated the long-term durability of concrete beams externally bonded with FRP sheets and studied the effect of harsh environmental conditions such as wet/dry cycling using salt water on the performance of FRP bonded concrete beams and on the interfacial bond between the fibre and the concrete. Four different types of FRP composite material were used: two carbons and two glasses with a thickness of 1.165, 0.118 and 1.3 mm, respectively. Kachlakeva et al., 2000 examined four full-scale reinforced concrete beams were replicated from an existing bridge. The original beams were significantly deficient in shear strength, particularly for projected increase of traffic loads. Of the four replicate beams, one served as a control beam and the remaining three beams were implemented with varying configurations of CFRP and GFRP composites to simulate the retrofit of the existing structure. CFRP unidirectional sheets were placed at the tension side of the beam to increase flexural capacity and GFRP unidirectional sheets were utilized to mitigate shear failure results from this study show that the use of FRP composites for structural strengthening provides significant static capacity increases approximately 150% when compared to unstrengthened sections. Load at first crack and post cracking stiffness of all the beams was increased mainly due to flexural CFRP. Test results recommend that beams retrofit with both GFRP and CFRP should well exceed the static demand of 658 kNm sustaining up to 868 kNm applied moment. The addition of GFRP to the side face of the beam alone for shear was sufficient to offset the lack of steel stirrups and allow conventional reinforced concrete beam failure by yielding of the tension steel. This allowed ultimate deflections to be 200% higher than the pre-existing shear deficient

Fig.1.Failure of Plain Concrete

Brena et al., 2003 experimentally carried out tests on twenty rectangular beams. Two beams were used as reference beams and eighteen beams were strengthening using carbon fibre reinforced polymer. Four composite material systems used such as two unidirection carbon fibres, woven fabric and pultruded plates were applied to the surface of the beams with four different layouts. In the first layout the CFRP composites were attached to the soffit of beams. Second layout straps were wrapped around the bottom of the cross section and extended vertically to within 75 mm of the compression face. Third layout the longitudinal composites were positioned on the sides of the beams rather than on the bottom surface. Fourth layout the longitudinal composites were positioned on the sides of the beams rather than on the bottom surface in addition with that transverse straps were used with the side application of the composites. The author concluded that the debonding is prevented by adding transverse straps alone the shear span and debonding of the longitudinal composites was delayed. The flexural capacity of reinforced concrete beams can be increased by attaching CFRP laminate than control beams.

4. RESULT ANALYSIS

From the above literature review we have observed the following results. Shear failure occurs usually without advanced warning therefore it is desirable that beam fails in flexure than in shear. Many existing reinforced concrete members are found to be deficient in shear strength and need to be repaired. These deficiencies occurs due to several reasons such as insufficient shear reinforcement or reduction in steel, due to corrosion, increased due to load and due to construction defects therefore to reduce or to minimize these deficiencies externally bonded reinforcement such as Carbon Fiber Reinforced Polymer is an excellent solution in these situation.

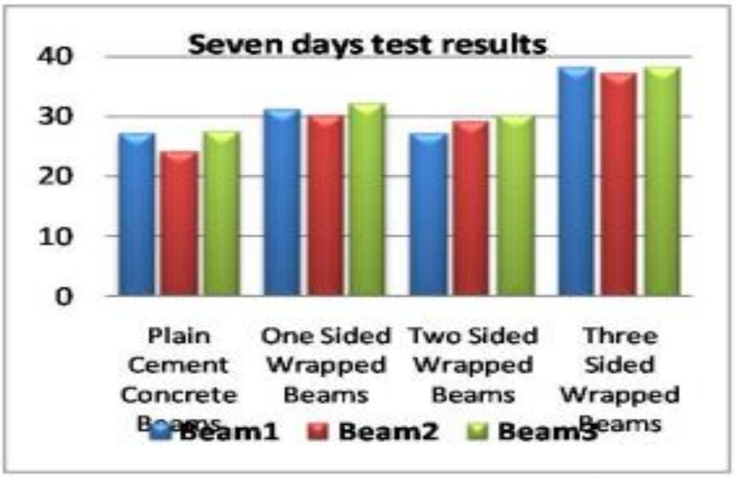

Fig.2. Result Analysis

Dr. Gopal Rai and Yogesh Indolia (2011) Beams, Plates and columns may be strengthened inflexure through the use of FRP composites bonded to their tension zone using epoxy as a common adhesive. The direction of fibers is kept parallel to that of high tensile stresses. Both prefabricated FRP strips, as well as sheets (wet-layup) are applied. Hence, FRP composites are finding ways to prove effective and economical at the same time. If the cost constraint is kept aside, the fiber wrapping system has been proved to be a system which has many added advantages over conventional strengthening processes.

CONCLUSION

From this research and from the result of this research project we can conclude that the CFRP wrapped at tension side gives better strength as compared to CFRP wrapped at two parallel sides but gives less strength as compared to CFRP wrapped at three sides. CFRP wrapped at three sides gives higher strength but as the CFRP composite is costly it increasing the cost of construction so from an economic point of consideration CFRP wrapped at tension side to the beam is desirable.

REFERENCES

[1] Jiang, H.; Desai, P.; Kumar, S.; Abhiraman, A.S.(1991) Carbon-fibers from poly(para-phenylenebenzobisthiazole) (PBZT) fibers-conversion and morphological aspects. Carbon 1991, 29,635–644

[2] Mallick, P. K(1993)., Fiber-Reinforced Composites: Materials, Manufacture, and Design, 2ndEd., Marcel Decker, Inc., 1993.

[3] Norris, T.D., Saadatmanesh, H, and Ehsani M.R.(1994). “Improving the Serviceability of Concrete Beams Using Carbon Fibre Reinforced Polymer (CFRP) sheets”, Report submitted to the Federal Highway Administration, 285p.

[4] Amir Abdelrahman and Sami H.Rizkalla(1997) ”Serviceability Concrete Beam Prestressed by Carbon Fibre Reinforced Plastic Bars”94-S42 447-457.

[5] Shahawy, M.A. and Beitelman, T. (1999), “Static and Fatigue Performance of RC Beams Strengthened with CFRP Laminates,” Journal of Composites for Construction, Vol. 125, No. 6, 1999, pp. 613-621

[6] Omar Chaallal PEAdnanAI-Saad(2000) “ Behaviour of Axially loaded short rectangular column strengthened with CFRP composite wrapping ”

[7] Dr Sujeeva Setunge(2002) Project report on “Review Of Strengthening Techniques Using Externally Bonded Fiber Reinfornced Polymer Composites” Report 2002-005-C-01.

[8] Pantelides C P and Gregley J(2002).”Carbon Fibre Reinforced Polymer Seismic Retrofit of RC Bridge Bent Design and In-situ Validation” ASCE,6(1,52-60)

[9] Jian Chen(2005) “Behaviour Of Structural Concrete Member Strenghthened by Composite Fabrics” Report

[10] Kim, I. S. (2006). Rehabilitation of Poorly Detailed RC Structures Using CFRPMaterials, Master of Science Thesis, The University of Texas at Austin, May2006.