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Strengthening of Conventional Beams Using Fibre Reinforced Polymer Composite: An Literature Review

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ABSTRACT

Traditionally used material is well known, concrete; it is having advantages such as it is economic, long lasting and its sustainability. It is easy to apply and having great compressive strength. In present time the civilization depends upon the available ranges of concrete or reinforced concrete (RC) structures, ranging from domestic structures to heavy structures. The paper studied literature review for use of fiber reinforced polymer (FRP) composites for increasing service load requirements. FRP is studied for variety of applications with concrete to form a concrete composite. The paper focuses on variety of problems which can be solved with FRP composites such as: load variations, FRP plate thickness variation, FRP material variation, etc.

Key words: Composite beam, Fiber reinforced polymer, Glass fiber reinforced polymer Fiber Plate, Fiber lamination, Fiber powder, Finite element Analysis.

Literature Survey

K.B.Parikh, N.S.Patel, 2016, Analytical study carried out by different author using FEM based software they found ultimate capacity of beam increased noticeably. Analytical investigation of reinforced concrete (RC) beam with FRP were carried out by number of investigator they all studied on different aspect, some of those worked on single layer or double layer of FRP , some of those worked on different pattern and thickness of FRP and then compared stress, strain and deflection with control specimen. For precise result by finite element method use fine mashing and appropriate material property. Bond behaviour between steel-concrete and concrete-FRP sheets/plate must be specify for accurate and realistic results.

T.Subramani , J.Jayalakshmi, 2015, The finite element program ANSYS has been used to study the Strengthened behaviour of a beam. Several investigators carried out experimental and/ or theoretical investigations on concrete beams and columns retrofitted with glass fibre reinforced polymer composites in order to study their effectiveness. The analysis has been carried out for the comparison and the study of effect of GFRP. The beams modelled in ANSYS for the various conditions.

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Subrata Chandra Das, Md. Enamul Haque Nizam, 2014, There is a growing concern with worldwide deterioration of traditional materials such as concrete, steel, and timber. Recently, attention has shifted to the use of fiber reinforced polymer composites (FRPs) as alternative materials. As FRPs are non-corrosive, high strength and modulus values compared to their density, light weight, acceptable deformability, tailored design and excellent formability enable the fabrication of new elements and the structural rehabilitation of the existing parts made of traditional materials. Furthermore, the resistance of FRP materials to corrosion means that they can be used to replace steel and reinforced concrete in situations when they would be exposed to corrosion. This paper is a review of the application of FRPs in civil engineering. Firstly, the paper will elucidate the basic information about FRP composites, including the definition, description of the components such as fibers and matrices. Then it pointed some fabrication processes, mechanical properties. Finally, it will focus on the application of FRP in civil engineering.

P. Jayajothi, 2013, Author carried out study on four beams model, from those two were control beams and remained was strengthened with CFRP. Author obtained load deflection relationship until failure and crack pattern by ANSYS and that result compared with experimental results available in literature. Author observed numerical result seen good agreement with experimental results.

Yusof Ahmad, 2013, This research was conducted to investigate the ductility behavior of timber beams strengthened with CFRP (carbon fiber reinforced polymer) plates. The surface to be bonded was spiked by punching small holes of 2 mm in diameter with 10 mm spacing. The aim is to increase bonding capacity by having small studs. The results showed that the ductility was increased as the percentage of CFRP increased.

Murali G. and Pannirselvam N, 2011, Several researches have been carried out on reinforced concrete beams strengthened with fibre reinforced polymer composites. A few works has been focused on strengthening of rectangular beams with different type and different thicknesses of fibre reinforced polymer. This paper reviews 12 articles on fibre reinforced polymer strengthened reinforced concrete beams. Finally, this paper attempts to address an important practical issue that is encountered in strengthening of beams with different type and different thicknesses of fibre reinforced polymer laminate. This paper also proposes a simple method of applying fibre reinforced polymer for strengthening the beam with different fibre reinforced polymer types with different thicknesses.

Dr Anthony Nkem Ede, 2011, The fibre reinforced polymer [or fibre reinforced plastics (FRP)] composites is one of the innovative technologies that continues to win the attention of engineers in the recent times. The existence of deficient reinforced concrete structures in Nigeria is worrisome and has contributed to the numerous cases of building collapse with the disastrous consequences of deaths and economic waste. As Nigeria strives to improve

standards on every side as to meet up with the Millennium Developmental Goals (MDGs), efforts must be geared towards reducing deaths in the country, especially in the building sector. For this, the need for researches into innovative methods of repairs and restoration remains very vital in the life of Nigeria. This article explores the potentials of externally bounded FRP composites and how it can be gainfully applied in Nigeria to strengthen our deficient RC structures and help the building industry to reduce the perennial and embarrassing cases of structural collapse. Results of laboratory tests were used to confirme the potentials of FRP composites in strengthening damaged beams.

Ancy Joseph, et al., 2011, An analytical and experimental study has been carried out to investigate the behavior of concrete beams strengthened with Fiber-Reinforced Polymer (FRP) unidirectional laminates under loading. The finite element program ABAQUS has been used to study the linear behaviour of a beam.

N. Pannirselvam Et Al., 2009, Strengthening of structures using Fibre Reinforced Polymer (FRP) shows better promise for extending the life span of structures. The advantages of using FRP include light weight, ease of installation, minimal labour costs and site constraints, high strength-to-weight and durability. The objective of this work is to evaluate the structural behaviour of reinforced concrete beams with externally bonded FRP reinforcement. Beams bonded with four different types of Glass Fibre Reinforced Polymer (GFRP) having 3.50 mm thickness were used. Totally five rectangular beams of 3 m length were cast. One beam was used as reference beam and the remaining beams were provided with GFRP laminates on their soffit. The variable considered for the study is type of GFRP laminate. The study parameters of this investigation included first crack load, yield load, ultimate load, first crack deflection, yield deflection, ultimate deflection, crack width, deflection ductility, energy ductility, deflection ductility ratios and energy ductility ratios of the test beams. The performance of FRP plated beams was compared with that of unplated beam. The test results showed that the beams strengthened with GFRP laminates exhibited better performance.

M. Dawood and S. Rizkalla, 2008, This paper summarizes the results of a comprehensive research program conducted to develop a strengthening and repair system for steel bridges and structures using carbon fiber reinforced polymers (CFRP). The research program was completed in five phases. This paper presents the development of a high modulus CFRP system for strengthening steel bridges and structures. The experimental and analytical results demonstrate that the proposed system can be effectively used to enhance the serviceability and ultimate strength of steel beams.

Ming-Hung Hsu (2006), The finite element models based on the widely used package ABAQUS are employed in simulating the behaviour of reinforced concrete beams strengthened by externally bonded glass fiber reinforced polymer. The numerical results of four-point bending test of reinforced concrete beams strengthened by externally bonded glass

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fiber reinforced plastic plates in comparing with the experimental results show satisfactory agreement. The results indicate that the flexure strength of reinforced concrete beams can be significantly increased by externally bonded glass fiber reinforced plastic plates.

Ahmed Khalifa et al., 2000, This study presents the shear performance and the modes of failure of reinforced concrete (RC) beams strengthened with externally bonded carbon fiber reinforced polymer (CFRP) wraps. The experimental program consisted of testing twenty-seven, full-scale, RC beams. The variables investigated in this research study included steel stirrups (i.e., beams with and without steel stirrups), shear span-to depth ratio (i.e., a/d ratio 3 versus 4), CFRP amount and distribution (i.e., continuous wrap versus strips), bonded surface (i.e., lateral sides versus U-wrap), fiber orientation (i.e., 900/00 fiber combination versus 900 direction), and end anchor (i.e., U-wrap with and without end anchor). As part of the research program, the experimental study examined the effectiveness of CFRP reinforcement in enhancing the shear capacity of RC beams in negative and positive moment regions, and for beams with rectangular and T-cross section. The experimental results indicated that the contribution of externally bonded CFRP to the shear capacity is significant and dependent upon the variable investigated.

CONCLUSION

Rehabilitation by FRP has proven itself to be a better feasible option than other methods. So the future prospects for the utilization of FRP in Civil engineering infrastructure are good. Researchers around the world are now looking at the new and innovative ways of utilization of the same. The behaviour of concrete beams strengthened with FRP unidirectional composite laminates have been studied. FRP inserted beams found better than other conventional beams. Deflections in the beams retrofitted with FRP are less than conventional beams.

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