EXPERIMENTAL & ANALYTICAL STUDY ON TEE BEAMS REINFORCED CONCRETE USING FRP COMPOSITES ANALYSIS: REVIEW

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ABSTRACT
Shear collapse of reinforced concrete (RC) members is catastrophic and occurs suddenly with no advance warning of distress. In several occasions existing RC beams have been found to be deficient in shear and in need of strengthening. Conventional shear strengthening method such as external post tensioning, member enlargement along with internal transverse steel, and bonded steel plates are very costly, requiring extensive equipment, time, and significant labor. Conversely, the relatively new alternative strengthening technique using advanced composite materials, known as fiber reinforced polymer (FRP), offers significant advantages such as flexibility in design, ease of installation, reduced construction time, and improved durability.

1. INTRODUCTION
1.1 PREAMBLE

Many natural disasters, earthquake being the most affecting of all, have produced a need to increase the present safety levels in buildings. The knowledge of understanding of the earthquakes is increasing day by day and therefore the seismic demands imposed on the structures need to be revised. The design methodologies are also changing with the growing research in the area of seismic engineering. So the existing structures may not qualify to the current requirements. As the complete replacement of such deficient structures leads to incurring a huge amount of public money and time, retrofitting has become the acceptable way of improving their load carrying capacity and extending their service lives.

Retrofitting is specially used to relate to the seismic upgrade of facilities, such as in the case of the use of composite jackets for the confinement of columns. Retrofitting is making changes to an existing building to protect it from flooding or other hazards such as high winds and earthquakes.
The maintenance, rehabilitation and upgrading of structural members, is perhaps one of the most crucial problems in civil engineering applications. Moreover, a large number of structures constructed in the past using the older design codes in different parts of the world are structurally unsafe according to the new design codes. Since replacement of such deficient elements of structures incurs a huge amount of public amount and time, strengthening has become the acceptable way of improving their load carrying capacity and extending their service lives.

2. REVIEW OF LITERATURE

2.1 BRIEF REVIEW

The state of deterioration of the existing civil engineering concrete structures is one of the greatest concerns to the structural engineers worldwide. The renewal strategies applied to existing structures comprise of rehabilitation and complete replacement. The latter involves a huge expenditure and time; hence the rehabilitation is the only option available. Fiber reinforced polymers (FRP) are the promising materials in rehabilitation of the existing structures and strengthening of the new civil engineering structures.

This chapter presents a brief review of the existing literature in the area of reinforced concrete (RC) beams strengthened with epoxy-bonded FRP. The major achievements and results reported in the literature are highlighted. The review of the literature is presented in the following three groups:

Chaallal et al. (1998) investigated a comprehensive design approach for reinforced concrete flexural beams and unidirectional slabs strengthened with externally bonded fiber reinforced plastic (FRP) plates. The approach complied with the Canadian Concrete Standard. This was divided into two parts, namely flexural strengthening and shear strengthening. In the first part, analytical models were presented for two families of failure modes: classical modes such as crushing of concrete in compression and tensile failure of the laminate, and premature modes such as debonding of the plate and ripping off of the concrete cover. These models were based on the common principles of compatibility of deformations and equilibrium of forces. In the second part, design equations were derived to enable calculation of the required cross-sectional area of shear lateral FRP plates or strips for four number of plating patterns: vertical strips, inclined strips, wings, and U-sheet jackets.
Khalifa et al. (2000) studied the shear performance and the modes of failure of reinforced concrete (RC) beams strengthened with externally bonded carbon fiber reinforced polymer (CFRP) wraps experimentally. 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., 90°/0° fiber combination versus 90° direction), and end anchor (i.e., U-wrap with and without end anchor). The experimental results indicated that the contribution of externally bonded CFRP to the shear capacity is significant and dependent upon the variable investigated. For all beams, results show that an increase in shear strength of 22 to 145% was achieved.

Alex et al. (2001) studied experimentally the effect of shear strengthening of RC beams on the stress distribution, initial cracks, crack propagation, and ultimate strength. Five types of beams with different strengthening carbon-fiber–reinforced plastic sheets are often strengthened in flexure. The experimental results show that it is not necessary to strengthen the entire concrete beam surface. The general and regional behaviors of concrete beams with bonded carbon-fiber–reinforced plastic sheets are studied with the help of strain gauges. The appearance of the first cracks and the crack propagation in the structure up to the failure is monitored and discussed for five different strengthened beams. In particular, for one of the strengthened RC beams, the failure mode and the failure mechanism are fully analyzed.

Sheikh (2002) studied on retrofitting with fiber reinforced polymers (FRP) to strengthen and repair damaged structures, which was a relatively new technique. In an extensive research programme at the University of Toronto, application of FRP in concrete structures was being investigated for its effectiveness in enhancing structural performance both in terms of strength and ductility. The structural components tested so far include slabs, beams, columns and bridge culverts. Research on columns had particularly focused on improving their seismic resistance by confining them with FRP. All the specimens tested were considered as full-scale to two-third scale models of the
structural components generally used in practice. Results indicated that retrofitting with FRP offers an attractive alternative to the traditional techniques.

Chen and Teng (2003) carried out an investigation on the shear capacity of FRP- strengthened RC beams. These studies have established clearly that such strengthened beams fail in shear mainly in one of the two modes, i.e., FRP rupture and FRP debonding, and have led to preliminary design proposals. This study was concerned with the development of a simple, accurate and rational design proposal for the shear capacity of FRP-strengthened beams which fail by FRP debonding. This new model explicitly recognises the non-uniform stress distribution in the FRP along a shear crack as determined by the bond strength between the FRP strips and the concrete.

Sundaraja et al. have studied a number of studies on shear strengthening of RC beams using externally bonded fiber reinforced polymer sheets, the behavior of FRP strengthened beams in shear is not fully understood. The objective of this study is to clarify the role of glass fiber reinforced polymer inclined strips epoxy bonded to the beam web for shear strengthening of reinforced concrete beams. The study also aims to understand the shear contribution of concrete, shear strength due to steel bars and steel stirrups and the additional shear capacity due to glass fiber reinforced polymer strips in a RC beam. And also to study the failure modes, shear strengthening effect on ultimate force and load deflection behavior of RC beams bonded externally with GFRP inclined strips on the shear region of the beam.

Tanarslan et al. (2009) have studied an experimental investigation on T- section reinforced concrete (RC) beams strengthened with externally bonded carbon fiber-reinforced polymer (CFRP) strips. Five shear deficient specimens were strengthened with side bonded and U-jacketed CFRP strips, remaining one tested with its virgin condition without strengthening. The main objective was to analyze the behavior and failure modes of T- section RC beams strengthened in shear with externally bonded CFRP strips. According to test results premature debonding was the dominant failure mode of externally strengthened RC beams so the effect of anchorage usage on behavior and strength was also investigate.
Heyden et al. (2010) have investigated the results of an experimental study to the behavior of structurally damaged full-scale reinforced concrete beams retrofitted with CFRP laminates in shear or in flexure. The experimental results, generally, indicate that beams retrofitted in shear and flexure by using CFRP laminates are structurally efficient and are restored to stiffness and strength values nearly equal to or greater than those of the control beams. It was found that the efficiency of the strengthening technique by CFRP in flexure varied depending on the length. The main failure mode in the experimental work was plate debonding in retrofitted beams.

Panda et al. (2011) have investigated the performance of 2500mm long reinforced concrete (RC) T-beams strengthened in shear using epoxy bonded glass fiber fabric. The experimental program consisted of testing of 18 full scale simply supported RC T-beams. The experimental result indicates that RC T-beams strengthened in shear with side-bonded GFRP sheet increases the effectiveness by 12.5% to 50%.

Deifalla et al. (2012) investigated on several cases of loading and geometrical configurations, flexure beams, and girders are subjected to combined shear and torsion. Four strengthening techniques using carbon FRPs were tested. The experimental results were reported and analyzed to assess the effectiveness of the proposed strengthening techniques. An innovative strengthening technique namely the extended U-jacket showed promising results in terms of strength and ductility while being quite feasible for strengthening.

3. CONCLUSION

Study have been done through reviewed of different paper of RC beam. In this experimental investigation the shear behaviour of RC T-beams strengthened by GFRP sheets are studied.

REFERENCES


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