A Review on Strengthening of High Strength Concrete With Using Fibre Wrapping System

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Abstract: FRP material is a strengthening material which is being used frequently in civil engineering. It has very fast process of strengthening for all types of buildings like hospitals, schools etc where less time is required for rehabilitation. FRP is very light in weight that is why easy to handle and corrosion less for RCC structures. Since last two decades it has been used in all types of structures for retrofitting and giving better results by comparing other methods of strengthening.
Various fibers has been utilized by scientist and engineers in recent times, as use of FRP is quite encouraging for improvement of concrete strength. The objective of this study is to analyse increase in strength of high strength concrete with the use of fiber wrapping system CFRP and GFRP in single layer and to check the strength of splitted concrete with epoxy only. The review exhibited furtherance in an increase in strength of splitted concrete with the use of epoxy alone and with the use of epoxy and wrapping of CFRP and GFRP layers.

Keywords: Concrete, strengthening methods, beam column joint, Fiber reinforced polymers (FRP), CFRP,GFRP.

I. INTRODUCTION

The use of FRP emerged as a need for improving the strength of the existing column . There are so many structures damaged due to earthquake which need proper strengthening In RC buildings. RC frames designed without seismic provisions are performing unsatisfactory structural behavior due to low ductility and lack of strength.
Portion of columns that are common to beams at their intersections are called beam column joints. As beam column joint is critical portion of any structure. RC frames designed without seismic provisions and due to inadequate shear reinforcement are often result failures/damages.

Strengthening methods

Externally bonded steel plates, concrete jackets, steel jacketing, External Post-Tensioning and wrapping FRP are commonly known as strengthening methods.

Concrete Jacketing: This method is commonly used fir strengthen of reinforced concrete columns.

Steel Jacketing and Externally Bonded Steel: Steel jacketing method is very effective to increase the shear strength as well as ductility of reinforced columns

External Post-Tensioning Method: It can be applied to reinforced and prestressed concrete members. Post-tensioning is a technique used to prestress reinforced concrete after concrete is placed the tensioning provides the structural member with an immediate and active load-carrying capacity

Fibre reinforced polymer (FRP): Fiber reinforced polymer/Plastic (FRP) is a composite material made of combining polymer matrix reinforced with fibres. FRP material is very easy to handle and use because of very light weighted material as discussed above. It is used in various forms as sheet, rods and laminates (plates). Epoxy resin is used as binding material between reinforced concrete and strengthening material FRP.

II. RESEARCH AND STUDIES ON USE OF FRP

Relevant research work and studies are reviewed here:

1. H. Saadatmanesh et al. (1994): The analytical studies performed on concrete columns strengthened with composite straps indicate that this strengthening method can be used to increase effectively the strength and ductility of seismically deficient concrete columns. The rate of increase in the ultimate axial load, ductility, and maximum moment capacity decreases for increasing concrete compressive strength. The stress-strain models for concrete confined with composite straps indicate significant increases in compressive strength and strain at failure when compared with the stress-strain behavior of unconfined concrete.

2. Amir Mirmiran. et al. (1997) This paper presents the study on Uniaxial compression tests on concrete-filled FRP tubes indicates that fiber composites are an effective means of confinement, as they significantly increase both strength and ductility of concrete. A comparison of test data with available confinement models indicates that while they produce acceptable results for steel-encased concrete, they overestimate the strength of FRP-encased concrete. This is attributed to their inability in estimating the dilatancy of confined concrete.

3. Y. Xiao et al. (2000) This paper describes axial compression test results of 27 concrete cylinders confined by carbon fiber reinforced polymer composite jackets. The experimental parameters include plain concrete compressive strength and the thickness of the composite jacket. It is found that the carbon fiber composite jacketing can significantly increase the compressive strength and ductility of concrete. The test results indicate that concrete strength and confinement modulus, defined as the ratio of transverse confinement stress and transverse strain, are the most influential factors affecting the stress-strain behavior of confined concrete.

4. E S Ju´ lio et al (2003) The objective of this paper is to review one of the most commonly used retrofitting techniques: jacketing of reinforced concrete columns . This method is evaluated according to different characteristics and, in order to help structural engineers to choose the most appropriate solutions, recommendations are given, based on published experimental research and real case studies.

5. L. Lam et al. (2004) The average hoop rupture strains measured in the FRP confined concrete cylinders are affected by at least three factors—(1) the curvature of the FRP jacket; (2) the deformation non uniformity of cracked concrete; and (3) the existence of an overlapping zone in which the measured strains are much lower than strains measured elsewhere. 2. These three factors combine to produce an average FRP hoop rupture strain in confined cylinders that is much lower than that from flat coupon tests. While the effect of curvature depends on the type of FRP, the non uniformity of the strain distribution is independent of the FRP type.

6. Tamer El Maaddawy (2009) This paper presents the results of experimental program and analytical modeling for performance evaluation of a fiber reinforced polymer. FRP wrapping system to upgrade eccentrically loaded reinforced concrete RC columns. Test results shown that full FRP wrapping resulted in about 37% enhancement in compression strength.
The compression strengths of the partially wrapped columns were on average 5% lower than those of the fully wrapped columns.

7. Riad Benzaid et al. (2010) The present article deals with the analysis of experimental results, in terms of load-carrying capacity and strain, obtained from tests on plain- and reinforced-concrete (RC) cylinders strengthened with external carbon-fiber-reinforced polymer (CFRP). Test results showed that the CFRP wrap increases the strength and ductility of plain- and RC cylinders significantly. A simple model is presented to predict the compressive strength and axial strain of FRP-confined columns.

8. K. P. Jaya (2012): This paper presents an experimental and analytical investigation conducted to assess the behaviour of beam-column wrapped with GFRP and CFRP. It is observed that the column specimens wrapped with two layers, four layers and six layers of GFRP shows 8%, 28% and 32% increase in the load carrying capacity respectively compared to the specimen without wrapping.

- The specimen jacketed with 6 layers of GFRP has the highest load carrying capacity and there is 32% increase in the strength compared with the specimen without GFRP wrapping.

9. Jun Wang et al. (2019) Syntactic foams (hollow glass macrospheres bonded with a polymer matrix) encased in glass fiber-reinforced polymer (GFRP) composite shells have the potential to enhance structural performance and energy absorption. To investigate this hypothesis, several load carrying structural columns with a GFRP composite shell encasing a syntactic foam core were designed, manufactured, and tested under axial compression, with a focus on optimal energy absorption and compressive force resistance. The structural responses of column specimens and the foam core alone were assessed via load, strain, and deflection responses. The following parameters were varied to induce different failuremodes: (1) shell thickness; (2) fiber volume percent in both the longitudinal and circumferential directions; (3) syntactic foam density; and (4) cross-shaped fiber orientation of GFRP web. Based on the experimental data, a strength prediction model was developed to predict the axial load capacity, including the buckling limits of the hollow GFRP tubes and syntactic foam columns with GFRP shells. The predictions are relatively simple and provided good accuracy when compared with the experimental data.

Ⅲ. Conclusions

This paper reviewed the concept of utilization of FRP in high strength concrete. Most of the literature cited above showed that FRP is used in normal grade concrete and limited study is done on use of epoxy for strengthening of splitted concrete. To achieve this, cylinders are prepared and wrapping of CFRP and GFRP layers is done in splitted and without splitted surface and few samples are tested alone with epoxy. This study is important because FRP is used in normal grade concrete , but there is no enough literature review related to the use of FRP in high grade concrete.

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