Retrofitting Of RCC Piles By Using Basalt Fiber Reinforced Polymer (BFRP) Composite, Part: 1 Review Papers On RCC Structures And Piles Retrofitting Works.

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Abstract: Retrofitting works are immensely essential for deteriorated and damaged structures in Engineering and Medical fields, in order to keep, or return to, the originality for safe guarding the structures and consumers. In this paper, different types of methods of retrofitting review notes are given based on the experimental, numerical and analytical methods results on strengthening the Reinforced cement concrete (RCC) structures including RCC piles. Soil-pile interaction on axial load, lateral load reviews are also presented. This review paper is prepared to find out the performance of basalt fibre reinforced polymer (BFRP) composite retrofitted reinforced cement concrete single end bearing piles.

Index Terms: Retrofitting, Pile, axial load, lateral load, RCC, interaction, basalt fibre, polymer composites.

1 INTRODUCTION

In general, retrofitting is a part of Civil, Mechanical Engineering and Medical field. In civil engineering field, to set right the deteriorated, damaged, corroded and aged RCC structures, masonry structures and steel structures by means of repairing, retrofitting, rehabilitating, strengthening processes based on the damage conditions of the structures and up gradation to higher seismic zones are required. Different methods are being adapted for retrofitting and repairing works. Retrofitting refers to endowing the structures with a service level higher than that initially planned by modifying the structures, not necessary damage area. Retrofitting increases the service life and level of structures. Retrofitting works are done by various methods like jacketing, sealing, stitching, overlaying, wrapping, coating, re-baring, NSM system etc., This review paper was prepared to find out the performance of BFRP retrofitted reinforced cement concrete piles under the axial, lateral and impact loads and skin friction.

2. OBJECTIVES

The objectives of this paper are (1) to use the Basalt fibre reinforced polymer composite (BFRP) wrapping methods in RCC piles strengthening works (2) to find out the performance of single end bearing RCC piles under the axial, lateral and impact load (3) to compare the load carrying capacity of the pile by IS 2911 - part1 (sec 2) with Broms method and (4) to find out the performance of BFRP wrapped RCC pile towards skin friction.

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3. Literature Reviews

Terzaghi (1955) describes elaborately about the modulus of sub-grade reaction, k, which is a non intrinsic physical parameter of the soil but is found to be inversely proportional to the width of the foundation. It was noted that the value of k can be affected by the area of foundation base. But in many circumstances this effect can be ignored considerably. By substituting the relationship that is formed between the contact pressure and its corresponding displacement, the basic equations of the theories of sub-grade reaction can be arrived. Prakash (1962) carried out the lateral load tests with the help of aluminium pipes that are 12.7 mm in outer diameter, in dense sand as model pile groups. In order to describe about the various effects of cyclic loading, pile spacing and driving, various tests were conducted. From this study, it was clearly shown that the resistance given by sum of the individual piles at a spacing less than eight times the diameter of the pile in the direction of the load or less than three times the diameter of the pile normal to the loading direction is greater than that of the piles that are installed in groups. The laboratory data that was so obtained was compared with that of the field tests having results of comparable status. Broms (1964a, 1964b) considered the yielding of the soil along the length of the pile and considered two modes of failure. By these considerations, he made successful solutions to have ultimate resistance of the piles in lateral direction by assuming the lateral soil pressure distribution and also the problem's statics. He stated that the failure occurs in the piles only after the formation of one or two plastic hinges. Also, as the pile-soil system is in plastic state, the ultimate strength of the pile soil system is mobilized in case of clays because of its plastic nature. These developments were mainly based on the earth pressure distribution in the cohesive soil in the form of rectangular shape and also due to other earth concepts. This correlates with the suggestion made by Hansen (1961). But for cohesionless soils, the total earth pressure and the passive earth pressure formed at the front of the pile were found to be greater than that of the Rankine's passive earth pressure. Mori (1964) assumed the soil reaction-deflection relationship in order to give solutions for the laterally loaded piles by sorting in form of two layered soil medium. In this method of approaching the soil reaction-deflection relationship, for the lower elastic zone, constant values of subgrade reaction were taken and for top plastic zone, the plastic resistance of the soil was taken. Murthy (1971) established several relationships between the characteristic load deformation of single vertical piles and batter piles based upon the different load test carried on instrumental model piles. The relationship thus formed was found to be analogous with the pile batter that was given by Matlock and Reese (1960). Poulos(1971) gave the elastic solution for the laterally loaded piles. Based upon the Mindlin's equation, various factors were developed with the use of additional displacements and rotations which are mainly caused due to the interaction between the adjacent piles. Poulos had also developed a chart for finding the interaction factors for both fixed and free headed piles that are subjected to horizontal loads and moments. Reese et al (1974) had undergone the full scale lateral load tests on pipe piles that were installed in cohesionless sandy soils. The diameter of the pipe pile installed was about 24 inches. Through this paper they also made some analysis of the results obtained from the tests. Also a simplified method for finding the family nature of the p-y curves based upon the soil properties and the dimensions of the pile. The results that are obtained from this method are compared with that of the experimental results and found to have good agreement. Reese and Welch (1975) performed lateral load tests in a full-scale over a shaft that was driven into the stiff clay stratum. Various instrumental setups were connected with the shafts in order to measure the deflections and bending moments of the piles. Using these setups, the results were found in such a way that the maximum moment was a non-linear function of load. Also, based on the results it was so clear that the depth to the point of maximum moment increases with the increase in the intensity of the load. Poulos and Davies (1980) used yield factors to modify the elastic solutions that will lead to non-linearity. This study implies that the modulus of the subgrade reaction will account for the non-linearity of the soil. Randolph (1981) through his paper presented briefly about the behaviour of flexible piles under lateral loading using algebraic expressions. These algebraic expressions were expressed in terms of the soil properties. These expressions were derived mainly from the results that are obtained from the finite element analysis that is made for finding the response of the laterally loaded cylindrical piles which are inserted in elastic soils like clays that contains varying stiffness with the increasing depth. Finally the interaction factors between the neighbour piles are obtained from the finite element analysis in the laterally loaded piles. Thus these expressions could be extended to use from a single pile to a pile group. Hariharan and Kumarasamy (1982) computed the grouping effect of the piles using load and displacements as two multipliers to the p-y curve of single pile. By normalizing the stresses and deformations that are formed on the horizontal layer due to the lateral movement of the piles, the multipliers were computed. This assumption was sufficient for accurate designing of piles. The computations of the equations were done using the elastic continuum methods. For varying piles in a group, an average multiplier is used in order to avoid the complexity by using different multipliers for different piles. Budhu and Davies (1987) gave the numerical way of analysis for the single laterally loaded piles that are placed in cohesion less soils. The soil yielding was also taken into account. Parametric studies were made using DPILES, a computer program for analysis. The analysis procedure takes the gapping in tensile zone, bearing failure in compressive zone, and the interface slip into the account of the analysis. From the results obtained from this analysis it was clear that the main reason for the displacements, rotations, and bending moments of laterally loaded piles is the yielding of soil. Meyerhof et al (1988) explained about the ultimate lateral resistance and the lateral deflections of single piles and small group piles with varying material properties under the influence of horizontal loads and the working loads. By using this method, the wide variation in the stiffness that causes impact on the ultimate lateral resistance and the displacements can be defined easily. Based upon the results obtained various simple expressions were suggested to find the effective depths, moments and displacements of both the laterally loaded free headed and fixed headed piles. Duncan et al. (1994) gave a new method of analysis much simpler than that of p-y analyses to define the nonlinear characteristics of both the laterally loaded piles and the drilled shafts. The analysis is based on the relationship made between dimensionless variables. This method of analysis is known as Characteristic load Method (CLM). The values of the deflections and the bending moments obtained from the analysis by CLM method is found to be quite similar with that of the field tests. Bransby (1996) studied about the deformation of the soil around the laterally displaced piles in case of un drained soil using two dimensional finite element analyses. For design of passive loading the load transfer curves are applicable and not for the active lateral loading of the pile. This study brought out the major differences between the curves for shear deformation and sub-grade reaction. Gandhi and Selvam (1997) made some investigations through the experiments done using fixed headed aluminium pipe piles that are driven into sand stratum having 60% relative density. The characteristic comparison between the bored piles and driven piles quantifies the effect of pile driving. For single bored piles, single driven piles and pile group, the lateral displacement curves were plotted to compare the results. Based upon the spacing and diameter ratios, the group effect was clearly studied. Finally through this study, the variation of the efficiency of the piles with the increase in pile spacing was found out. Mezazigh and Levacher (1998) through their studied about the effect of location of the single aluminium piles on both the horizontal and sloping ground. In the sloping ground, the experiments were conducted by varying the distance of the pile from the crest of slope. Using the centrifuge test on single piles, the effect of the distance to the slope, slope angle and soil properties were investigated. Curves such as bending moment curves, deflection curves, and derived P-Y curves were made and comparisons between the piles in horizontal ground and sloping ground was made. For slope of 1 in 2, the limiting distance over which the influence of the slope was taken as 8 times the diameter of the piles and in case of 3 in 2 slopes, it was taken as 12 times the diameter of the pile. The conclusion was made to use the co-efficient to the reference piles in practice. Narasimha Rao et al. (1998) described about the experiments carried out using aluminium and steel model pile groups that are embedded in soft marine clayey bed at varying depths. The study was carried to find the parameters that are influencing the characteristics of the laterally loaded pile groups such as flexural rigidity, embedment length of the pile and the arrangement of the piles with respect to the loading direction. The study also included the effect of pile arrangement on overall capacity by using finite element analysis. Two assumptions were made in the analysis that the soil was considered a linear elastic medium and the pile cap was considered a thin plate connecting the pile heads and the entire pile is considered a shear beam. Zhang et al. (1999) conducted the finite element analysis using FLPLIER code to determine the response of the single piles and pile groups for lateral effects. The pile groups that were included in the analysis were 3 x 3 to 7 x 3. Back analyses were made to determine the soil parameters that are used to find the lateral response of the single piles as well as group piles. Finally it was concluded from the analysis that the numerical code FLPIER could be used for finding the response of single piles and pile groups. Ashour and Norris (2000) conducted experiments to study the factors that influence the final p-y curve such as pile bending stiffness, cross-section of the pile, embedment depth of the pile and the head condition of the pile. These influences were tested with the use of Strain Wedge Model Formulation (SW). Using this SW model analysis, the response of the laterally loaded piles can be determined and the results are found to be in analogous with the field tests that are conducted in clayey, sandy and layered soils. This system was found to be more effective as it gives the effects of changes in soil properties and the material properties of the piles. De Sousa (2000) had undergone two different model approaches to determine the load-displacement curves of pile groups by assuming the soil to be a linear elastic-plastic and elastic non-linear. By assuming the soil as elastic non-linear, the analyses were made to obtain the importance of the boundary conditions of both the pile groups and single piles. In the linear elastic-plastic method, the main focus was to determine the group efficiency of the pile group. Load-displacement curves were plotted for a pile group using the models that are calibrated using the results of full-scale single pile tests. Ng and Zhang (2001) conducted tests to study the effects of laterally loaded sleeved piles and slope stability of the pile groups. Strength reduction technique is used for evaluating the stability of the slopes. Based upon the numerical analyses the factor of safety for both instability initiation and global failure of slope were identified. The causes for the slope failure were also investigated. From this analysis it was concluded that for increasing the local stability of the slope in case of shallow depths by reducing the stresses using sleeving technique. Rollins and Sparks (2002) made investigations on the tests conducted in a group of composite piles which contains steel pipe piles and concrete pile cap that was held fixed. This composite pile was driven in saturated low-plasticity soils especially silts and clay. Beneath the backside of the cap, gravel backfill was provided to form a cushion. Investigations were made to draw curves like average lateral deflection vs. depth curve and bending moment vs. depth. Comparison between the various methods for the calculation of base internal friction, pile-soil-pile interaction and passive pressure were also made. Kim et al. (2004) enlisted the results obtained from monotonic lateral loading in the single piles that are installed in Nak –Dong River, South Korea. An equivalent prototype model of the pile in a scale of 1:34 was made using hollow stainless steel pipe. The experimental tests were carried out in a layered soil stratum containing 50% and 73% relative densities by inserting the pile to an embedment of about 30 times the diameter of the pile. Based on the experimental results, effects of various factors such as relative density, pile head restraint condition and the method of installation of pile on the p-y curves were determined. Kumar and Lalvani (2004) describes about their investigation on lateral load test carried out using six drilled piles that are installed in medium-dense sands. Also various approaches were compared. The responses of the shafts were measured and it was found that the response obtained from the K_{bmax} approach was similar to the measured response than the p-y curve approach. Ilyas et al. (2004) made experiments in order to find the behaviour of the laterally loaded pile groups in case of normally consolidated and over consolidated clays. The tests were conducted using single piles and group piles with the spacing of the piles about 3 to 5 times the width of the pile. From these tests various effects such as lateral load-pile head displacement, bending moment profile and load experienced by single piles along with the pile shaft were clearly displayed. Test data also gave the shadowing effect phenomenon and pile-soil-pile interaction for pile groups. Ghosh Roy et al. (2004) investigated about the lateral load response of the pile group using centrifuge model in loose sand stratum. In these tests, the bending moment distribution and lateral displacement of both single piles and group piles were determined. p-y curves were drawn for two pile group spacing and compared with the single piles to find the effects of group interaction. Ahmet PAMUK et al (2004) in the paper "Retrofitting of Pile Foundation Systems against Liquefaction" described about the various physical modelling tests that were conducted to find about the fundamentals of lateral spreading of pile-soil interaction. The paper shows the effective testing of the pile group foundations under the severe effects that are caused mainly due to the non-liquefiable shallow soil layer. The tests were conducted with two dynamic centrifuge experiments. Model piles and an inclined laminar box were used to find out the feasibility of the retrofitting method that are used to reduce the bending moments in the pile group foundations. The results from the tests showed an effective reduction in the bending moments in the piles for about 60-70% by the use of retrofitting techniques that were more simple and easy to make. It also stated that the simplicity of this retrofitting technique can be used for multilayered soil with non-liquefiable shallow layers and for new foundation systems. Martin and Chen (2005) made investigations to find the response of piles in embankment slopes that are enhanced by the presence of water or presence of weak soil layer under the earth fill using a program named $FLAC^{3D}$ (Fast Lagrangian Analysis of Continua in 3 – Dimensions). This study mainly emphasizes the response of the pile caused by the lateral displacement and not the effect of vertical loading and inertial forces. Parameters such as pile group effect, stiffness of the piles and effect of soil strength reduction were taken into account. Johnson et al. (2006) with the help of Finite Element Modelling (FEM-3D) investigated about the effects of the shape of pile, dimensions of the pile, loading and also the properties of the soil for both circular and square piles. Electronic deep foundation load test database developed by Federal Highway Administration in USA was used to make the numerical analysis of the data. These numerical data were compared with the results obtained from field Standard Penetration Test. Based upon this study, design charts were created to make the designing with the shape factors simple. From this study, it was concluded that the lateral bearing capacity of the pile depends mainly on the cross-section of the pile in both the cases. Georgiadis and Georgiadis (2007) investigated about the effects of the sloping angle of the ground on the behavior of the pile in sloping stratum of clay and sandy soil. The investigation was carried out using 3D Finite Element Analysis and compared with the investigations by the conventional p-y curve method and various aspects that cause the slope inclination were also examined. Haldar and Babu (2008) comprehended about the tests on the laterally loaded piles that are embedded in undrained clay stratum to determine the lateral load carrying capacity. The analyses were made using random field theory and the undrained shear strength of the soil is considered as a random variable. Using the Cholesky decomposition technique the modelling of the soil was done in 2-D. Various investigations are carried out to determine the effect of the variance and spatial correlation length of the soil's undrained shear strength on the lateral load carrying capacity of the piles. Probabilistic framework was made to examine the ultimate lateral capacity using this study. Muthukkumaran et al (2008) investigated about various factors that affect the capacity of the piles by experimental proceedings under surcharge loading. The factors include slope angle, lateral deflection, lateral soil resistance, etc. Ahmadi and Amhari (2009) analysed about the effect of the laterally loaded piles in clay. A three dimensional model was created to investigate about this effect. Two case studies, one in soft clay and other in stiff clay were made to study the effects with comparisons. In order to investigate about the effect of anisotropy nature of the soil over the piles, pile head load-deflection curve were plotted and compared with the field results. The effect of anisotropy was found to be higher in case of stiff clay than the soft clay. p-y curve was drawn from the FE model and the curve is compared with the graph developed by Matlock et al. From this comparison, it was so clear that there was good similarity with the hyperbolic curves at the initial stage and Matlock's curve at the ultimate stage. B. Purushotham Reddy et al (2009) presents the paper "Retrofitting of RC piles using GFRP composites" with finite element analysis result comparison to study about the behaviour nature of retrofitted RC piles that are strengthened with the help of Glass Fibre Reinforced Polymer (GFRP) composites. The analysis was carried out using commercial software ANSYS. In order to study the behaviour under various loadings, there were totally eight RC pile specimens casted with same reinforcement details. Four specimens were used as control specimens and the remaining four specimens were made to retrofit with Glass Fibre Reinforced Polymer. The loading effect was made and the corresponding deflection and strain are obtained and compared with experimental plots. The conclusions were made from the result from finite element modelling. 43% of increase in axial compression is obtained for the retrofitted specimen. Lateral load capacity of the retrofitted specimens is found to be relatively higher than that of the control piles. Picher et al (1996) gave about the effect of the orientation of the confining fibres in concrete cylinders wrapped with carbon fibre reinforced polymer (CFRP). Investigations were made using 27 short columns with fibre orientation in square prisms, circular cylinders and rectangular prisms. This test showed that the properties such as compressive strength and ductility can be improved with the CFRP wrapping. CFRP wrapping can lead to increase in the compressive strength about 20% in case of square piles. Also from this test, it depicts that the increase in the angle of orientation decreases the axial stiffness and cause no effect in the axial ductility. Miyauchi (1997) made experiments to find the strengthening of columns with the carbon fibre sheets (CFS) by uni-axial compression. Various factors that affect the strength such as cube strength of concrete, dimensions of the columns, and number of CFS layers were also taken into account. It was found that the increase in the number of layers of CFS will lead to the proportional increase in the compressive strength. The strain at maximum stress increases exponentially with the number of CFS layers. A stress-strain curve was drawn based on the results and was found to be in parabolic shape. Also the effects of earthquake on the CFS strengthened piers of bridges were examined. Finally, from the results it was proved that the strengthening of piers with two layers of CFS can make the pier to withstand intensity similar to the Southern Hyogo Prefecture earthquake. Watanabe et al (1997) examined about the confinement effect of retrofitting of FRP sheets on the strength and ductility properties of the cylinders subjected to uni-axial compression. Both experimental and analytical investigations were carried out. Experiments were carried out using concrete cylinders retrofitted with FRP sheets of size 100 mm diameter and 200 mm height. The FRP types that are used include carbon fibre reinforced plastic (CFRP) and aramid fibre reinforced plastic (AFRP). A maximum of 4 layers of FRP sheets were used in the specimen. A clear relationship between the confinement effect and Young's modulus were made. It was found that the number of layers proportionally increases the compressive strength of the concrete. Julio F. Davalos et al (1997) presented in his paper "Analytical and Experimental Study of lateral and Distortional Buckling of FRP Wide-Flange Beams" about the evaluation of the flexure, torsion and lateral buckling of wide-flange beams that were made of fibre-reinforced plastic (FRP) composites. The evaluations were made by both analytical and experimental findings. The potential energy equations were obtained from the principles of non-linear elastic theory. Tests were done in two FRP WF beams that consist of similar geometrical properties but varying architectural properties. For calculating the buckling, flexural and torsional responses of the beam, the tests were conducted under mid span concentrated loads. LVDTs are used to determine the rotation of the cross-sections and also the critical buckling loads. Finally through the results obtained, it was found that there is a successful agreement among the three analyses that were made simultaneously. Thus for calculating the flexural-torsional and buckling, the analytical solutions are found to be quite easier because of the simplified design equations. Mahmoud T. El-Mihilmyn et al (2000) via the paper "Analysis of Reinforced Concrete Beams Strengthened with FRP Laminates" showed about the strengthening of the existing smaller bridges in North America. These strengthening were based upon the use of reliable and cost-effective method of repair and strengthening. This paper mainly focuses on the use of the external bonding Fibre-reinforced polymer (FRP) laminates for the strengthening process. Analytical procedure for finding the flexural capacity of the FRP laminates was made in a simple manner. This procedure was found to be reliable and efficient for both the singly and doubly reinforced concrete sections and also for the flanged section like T-section, I-sections, etc. Design Nomographs were made to facilitate the usage of the simplified procedure for the analysis of the FRP laminates. Ductile property of the beams was well examined to find the upper and lower limits of FRP laminates that can be effectively used. Finally the results were related with the experimental results and found to have greater correlation. Thanasis C. Triantafillou et al (2000) describes in his paper "Design of Concrete

Flexural Members Strengthened in Shear with FRP" with a simple design model for the calculation of the calculation of the fibre-reinforced polymer (FRP) contribution to the shear capacity of the shear capacity of strengthened RC elements. The key element in the model is the calculation of an effective FRP strain, which is taken as the minimum of three values: maximum strain to control crack opening, strain corresponding to premature shear failure due to FRP de-bonding, and strain corresponding to shear failure combined with or followed by FRP tensile fracture. The last two strains, obtained through calibration with >75 experimental data available to date, were shown to be functions of the quantity$E_f\rho_f/f_c^{2/3}$. Finally, it was demonstrated that, when compared with two other models, the proposed model gives better agreement with most of the test results available. Tan (2001) made experiments using eight compressive members of length 1.2 m long and cross-section 115mm by 420mm. The compressive strength of concrete used is 25 MPa and 2.2% longitudinal reinforcement was included. Three specimens were reinforced with GFRP sheets and three with CFRP sheets. The remaining two specimens were used as control specimens. From the study it was observed that the columns strengthened with FRP sheets undergoes failure by de-lamination of FRP sheets before the concrete failure attains. Thus it showed that the FRP strengthening causes effective increment in both the strength and ductility of the columns. Renato Parretti and Antonio Nanni (2002) examined the effects of CFRP confinement with different fibre orientations in circular and rectangular cross-sections. It was observed that the ±45º columns possess high stiffness and ductility than the hoop direction. But this ultimate capacity of ±45º was less than that of the latter. Greater energy dissipation causes the enlargement of failure zone. Houssam Toutanji et al (2002) in his paper " Strength and Durability performance of Concrete Axially loaded members Confined with AFRP Composite sheets" clearly depicts about the performance of concrete columns externally wrapped with aramid fibre reinforced polymer(AFRP) sheets. Loading in uniaxial compression were made on the control specimens (Both Confined and unconfined). Measurement of axial load and axial and hoop strains were made in order to evaluate the various properties of the wrapped specimens. The main evaluation done in this paper is by presenting the performance of the wrapped concrete specimens in extreme environmental conditions. The specimens were exposed to wetting cycles of about 300 nos. and drying is made using salt water. Based upon the results obtained with the specimens wrapped with aramid fibres, it is so clear that there is no reduction in strength due to wet/dry exposure. But, there is reduction due to freeze/thaw action of about 7.9%. M.N.S. Hadi (2003) in his paper "Retrofitting of Shear Failed Reinforced Concrete Beams" considers the strength and load carrying capacity enhancement of reinforced concrete beams that have been tested and failed in shear. His research was carried out with a total of sixteen sheared beam specimens with a length of 1.2 m and cross-sectional area of 100 by 150 mm retrofitted by using various types of FRP and then retested. The retrofitted beam specimens were subjected to four-point static loading. The results confirm that the strengthening techniques using FRP sheets can be used to considerable increase in shear capacity, with efficiency that varies depending on the tested variables. Helical reinforcement proved a 3% of strength increment which was observed from the test results for beam that failed in bending. It indicates that the beams strengthened with CFRP display an increase in the beam's maximum flexural strength up to 31% higher compared to that of beams strengthened with E-glass. The comparison between the results of E-glass wrapped beams and that of the original beams indicates that the retrofitted beams achieve a shear capacity enhancement up to 17% compared to the original ones. The beams wrapped with E-glass failed in shear with angle of a critical inclined crack with respect to the horizontal axis which is about 45°. The results confirmed that, under the same amount and configuration, the CFRP material outperforms the E-glass material in structural externally strengthening. Claudia Pulido et al. (2003) made model analysis with two model bridges in a scale of ¼ were tested using shake tables at University of Nevada, Reno. The models were made typically as the bridges built in California. CFRP retrofitting was made at the bent and the seismic behaviours were observed. To measure the maximum strain, strain gauges were placed in the reinforcement bars. CFRP retrofitting showed effective increase in the ductility from 2 to 7. A simple stress-strain model for the confinement of concrete with FRP was evolved. The overall performance of the bent and the enhancement using FRP were measured using the analytical studies. This study emphasizes mainly on the difference between the as-built bent and the retrofitted bent. Chris P.Pantelides et al.(2004) made experiments on columns jacketed with FRP composites having circular, square, rectangular and elliptical cross-sections. FRP composites possess problem of being brittle at failure. FRP tends to increase the axial strength and the ductility of the columns. This experiment with the result recommended the usage of not less than two layers of FRP as retrofitting and the adoption of a factor of safety. It was finalized in the study that the FRP composite jacketing is more effective in case of circular columns that the square columns. Anthony J. Lamanna et al (2004) briefly explained in his paper "Flexural Strengthening of Reinforced Concrete Beams by Mechanically Attaching Fibre-Reinforced Polymer Strips" at reducing the extensive time and semiskilled labour for bonding fibre-reinforced polymer (FRP) strengthening strips to concrete structures. This study shows that beams strengthened with mechanically fastened FRP strips showed increases in yield moment over the control beams of up to 21.6% and showed increases in the ultimate moment of up to 20.1%. Based on this study it was clear that, it is possible to achieve a failure mode using the fastened method similar to that seen in a standard reinforced concrete beam. Also, fasteners in the moment span may have helped the beams achieve a higher level of strengthening. Predrilling pilot holes reduces the amount of visible initial cracking and spalling and allows greater penetration of the fasteners, resulting in better overall strengthening and ductility. The results from this test showed that the mechanical fastening method took on average 30 min to complete, compared to 4 h for the bonded method. R. Santhakumar et al (2004) via the paper "Analysis of retrofitted reinforced concrete shear beams using Carbon Fibre Composites" brought out the numerical study on the inducing of behaviour of Retrofitted concrete beams under shear. The fibre orientation of the beams were made as 45° and 90° in both the non-retrofitted RC beams that are used as control beams and RC beams that are retrofitted by the usage of Carbon Fibre Reinforced Plastic (CFRP). ANSYS software was used for the finite element analysis. The major effect of the retrofitting and non-retrofitting were clearly explained. The analytical results were compared with the load deflection plots that were made by Tom Norris, et al (1997) and found to be having good agreement with the both. The crack patterns obtained from the loading were also clearly presented. Alper ILKI1 (August - 2004) et al briefly explained in his experimental investigated report in the topic of "Seismic retrofit of non-ductile rectangular reinforced concrete columns by cfrp jacketing". In this, non-ductile rectangular columns retrofitted by carbon fibre reinforced polymer (CFRP) by jacketing method. Specimens (8 nos) are cast in low strength concrete and MS plain rods without adequate transverse reinforcement .Tested the specimens under constant axial and reversed cyclic lateral loads. The lap splice lengths of longitudinal reinforcement for four of the specimens were inadequate, while the longitudinal bars were continuous for the remaining four specimens. In each of these two groups; one specimen was tested as the reference specimen, 2 specimens were retrofitted with different thicknesses of transverse CFRP jackets, and one previously damaged specimen was retrofitted with CFRP jacket after repairing procedure. From experiment they are find out the significant ductility enhancement can be obtained for low strength brittle concrete columns retrofitted by CFRP jackets. For the specimens with inadequate lap splices, the enhancement in ductility was not as remarkable as the specimens with continuous longitudinal reinforcement. CFRP jackets improved the behaviour of strength and ductility. For specimens with continuous longitudinal reinforcement, CFRP jackets prevented premature strength loss by providing sufficient confinement that helped to prevent buckling of the longitudinal bars. For specimens with lap spliced longitudinal reinforcement, CFRP jackets limited transverse deformations, That caused significant loss in strength due to reinforcement slip in the early stages of inelastic part of the Loading for the original specimen. For both cases (either continuous or lap spliced longitudinal reinforcement) thickness of the CFRP jacket had marginal effect on the behaviour. Consequently it can be concluded that CFRP jackets of three plies were enough for the retrofit of these specimens. Pre-damage of the specimens, did not have a significant adverse effect on the performance of the retrofitted specimens. Homan and Sheikh (2005) conducted short term tests to demonstrate the effectiveness of structural upgrade by experiments and field applications. The durability of both the FRP materials and the FRP reinforced concrete were explained. Various severe environmental factors like freeze-thaw cycling, UV radiation, temperature variation, pH variations and moisture were also included in the tests. The results explained about the variations in the stress-strain characteristics and bond between concrete and FRP based on the environmental conditions. Finally it was concluded that the effect of most of the environmental conditions were minimized with the usage of FRP reinforcement. Normal FRP seemed to be affected by freeze-thaw cycling and moisture exposures but not the CFRP. CFRP was recommended for usage as it has more resistance to NaOH exposure, temperature variations and so on. J.F.Berthet et al's (2005) paper on "Compressive behaviour of concrete externally confined by composite jackets" shows the result by carbon and E-glass FRP jackets externally confined. Based upon the results, it is so clear that the ultimate strength and ductility of the specimens can be obtained by external confinement. For confined concrete, the stress-strain response is bilinear in nature. The natures of plain and confined concrete specimens are quite similar in the first linear zone. The nature of the confined concrete mainly relies on the mechanical properties of jacket in the second pseudo-plastic zone. This study imposes that the efficiency of the confinement decreases as the compressive strength of the concrete core increases. Based on the study, it is clear that there is a significant increase in ultimate strengths and strain with the enhancement of the number of composite layers and the level of confinement. Guoqiang Li et al (2005) in the paper "Effect of fibre orientation on the structural behaviour of FRP wrapped concrete cylinders" shows the experimental result that was carried out using 27 cylinders of concrete having a diameter of about 152.4 mm and a height of about 304.8mm. Among the 27 cylinders, 3 cylinders were used as control; 18 were wrapped using two layers of FRP; remaining 6 were wrapped using four layers of FRP. E-glass fibre reinforced ultraviolet (UV) curing vinyl ester was used as FRP in those experiments. Tensile strength of FRP with fibre orientations at 0°, 45°, 90° from the loading directions was experimentally determined. It is observed from the test result that the stress-strain behaviour, strength, ductility and failure mode of wrapped concrete cylinders depends on the fibre orientation and FRP wall thickness. For each wrapping systems, the failure zone are suggested to be found and also along these alignment, the fibres should be avoided. M.N.S. Hadi (2005) through his paper "Behaviour of FRP wrapped normal strength concrete columns under eccentric loading" clearly pointed out the strengthening of the eccentrically loaded columns that are presented in the structures near the openings rather than the usual strengthening of the concentrated loaded columns. This paper differs from most of the research papers through the loading type. This paper shows the result of the testing of six normal strength concrete columns under the eccentric loading. FRP wrapping were made in a large number of layers. From this paper, he concluded about the increase in the strength, ductility and energy absorption of the columns by using the FRP layer than that of the columns reinforced with steel bars. External confinement to the plain specimens showed a greater improvement in the ductility, and restraining in the volumetric strain. Tsung-Chin Hou (2005) et al in their paper on "In-situ Wireless Monitoring of Fibre Reinforced Cementitious Composite Bridge piers" insists about the usage of the High-performance Fibre Reinforced Cementitious Composites (HPFRCC) which has short fibres that undergoes strains under tension rather than compression. This paper mainly insists the use of this HPFRCC as transverse reinforcement for the seismic loadings which reduces the usage of transverse steel reinforcements. This study focused on the usage of wireless structural monitoring system for monitoring the long-term performance of the critical structural components at low-costs. This system possesses a high precision of the values of the collected data of the HPFRCC structural members subjected to reverse cyclic loading. The data obtained from this monitoring system were compared with the laboratory data. This paper provides the importance of self-assessing intelligent civil structures. Abhijit Mukherjeeet al in the paper "Recent Advances in Repair and Rehabilitation of RCC Structures with Non-metallic Fibres" showed the important development in the field of repair and rehabilitation of RCC structure till date. This paper depicts about the disadvantages of using the external reinforcements using steel plates. This paper also shows the advantages of using the Fibre Reinforced Composites (FRCs) for the purpose of repair and rehabilitation in earthquake affected structures. This paper also shows the application of the FRCs in the regions affected by the Bhuj earthquake in Gujarat. This paper mainly imposes the use of FRCs that was free from the environmental effects such as corrosion due to acids, and chemical changes due to temperature. It ensures the availability of various FRPs in India and the suitability of various FRPs in the Indian conditions checked for the Durability. Alper Ilki et al. (2006) made tests with 15 CFRP externally jacketed RC columns with less than nominal transverse reinforcement under uni-axial compression. It was found that the columns in which the external confinement made with CFRP showed larger increment in the strength and ductility. A stress-strain model was also proposed to determine the characteristics of CFRP jacketed columns. The results from the experiments and analysis were found to be in line. CFRP showed more increase in strength in case of low strength concrete. The compressive strength of normal strength concrete increases about 1.5 to 3.6 times with the usage of CFRP. Rectangular columns were characterized by more axial deformation and less strength enhancement than the circular columns jacketed externally with CFRP sheets. Giuseppe campione (2006) in his paper "Influence of FRP wrapping techniques on the compressive behaviour of concrete prisms" elaborates the results of an experimental investigation carried on the compressive behaviour of concrete prisms using a square cross section which is externally wrapped with the help of providing carbon fibre reinforced plastic (CFRP) sheets. Effect of parameters like local reinforcement at the corners and continuous layers, etc are also analyzed. Experimental results using CFRP sheets show that increase in layers of reinforcement increases the maximum strain capacities. The theoretical results show that there is no uniform pressure distribution due to confinement along the sides of the transverse cross section. Validation of experimental data with analytical law is done finally. Stathis N. Bousias et al (2006) through the paper "Concrete or FRP Jacketing of Concrete Columns for Seismic Retrofitting" showed the various results by comparing the experimental and analytical work for jacketed concrete by means of FRP by including the short lap splices at the base of the columns. For about 45 columns were tested under the axial loading with smooth or vertical ribbed bars that are subjected to cyclic bending under varying loads. Various test parameters such as type of retrofitting, number of layers, etc were checked for the 45 columns. Pseudodynamical testing of a two-storied space frame in a scale of 0.7:1 was made before and after retrofitting of the concrete columns. The effect of the retrofitting was not found in a systematic manner. However the retrofitting of the columns with wrapping showed some increase in the cyclic deformation capacity or the rate of strength degradation which consist of either smooth bars or ribbed bars. It was also found that the energy dissipation decreases with the decrease in the lap length. Concrete wrapping is effective in case of ribbed bars. From the report, the dowels or U-bars welded with new or old corner bars tend to increase the roughness of the surfaces by means of the drift ratio of the member after the yielding of the jacketed member. Tarek H. Almusallam (2007) in his paper on "Behaviour of Normal and High-Strength concrete cylinders confined with E-glass/epoxy Composite Laminates" is aimed at knowing the characteristic behaviour of concrete cylinders with different compressive strength wrapped with E-glass/epoxy fibre reinforced polymer which were subjected to uniaxial compressive loads. 54 plain concrete cylinders were involved in this study experiment. The effectiveness of GFRP laminates if used, for confinement of concrete cylinders was observed to increase the axial and lateral strength of concrete cylinders greatly. Moreover, usage of GFRP laminates wrapping increases the ductility property in addition to the strength increment. Also, as the number of layers of confinement increases, the ductility also increases. Finally, it was found that at same level of confinement, ductility of normal strength concrete is higher than that of high strength concrete. Katarina Olivova and Juraj Billicik (2008) conducted tests with four sets of RC columns with cross-sections 250x250x1500mm. The first set is the non-strengthened control specimens and the other sets are strengthened with CFRP sheets. Foundation blocks were also connected to the individual columns. Care was taken to avoid the premature-debonding in externally bonded reinforcement. From the result, it was observed that the load-carrying capacity of the columns can be enhanced by surface mounting technique. The failure of the eccentrically loaded column occurs at the compression zone of the column. The rupturing of the FRP confining jacket occurs at the half-zone in case of confined columns. Both the confined and unconfined columns possess similar properties up to the ultimate load of unconfined column. Based on the observation on the tested specimen, it was evidenced that there is symmetrical deflection of the column and use of CFRP swipes the local buckling effect. Baris et al (2008) in his paper "Performance of FRP-Strengthened RC beams with Different Concrete Surface Profiles" had made the investigation on the effect of concrete surface roughness on the bond behaviour and general performance of FRP strengthening systems. This study included flexural testing of 26 specimens with two different carbon FRP systems and three different levels of surface roughness and also influence of six different levels of anchorage by means of U-straps was also evaluated. Additionally 10 bonds specimens were tested in direct shear. It was finally found out that Surface Roughness did not appear to have significant influence on the overall performance of the FRP strengthening system with or without adequate anchorage. It is also noticed that higher level of anchorage affected the ductility more than the strength. Specimens with seven or less straps failed by debonding of FRP. But, after those with 11 straps and continuous straps failed by rupture of FRP. Finally this study recommends CSP (Concrete Surface Profile) 2-3 as a conservative measure. Abdelhak Bousselham et al (2008) through his paper "Mechanisms of Shear Resistance of Concrete Beams Strengthened in Shear with Externally Bonded FRP" aimed to contribute to the understanding of the shear resistance mechanisms involved in RC beams strengthened in shear with externally bonded FRP. This is mainly based on results obtained from an experimental program, involving 17 tests, performed on full size T beams, and using a comprehensive and targeted engineered measuring device. This paper provides an insightful and comprehensive description of the behaviour of beams strengthened in shear with FRP under increasing loads, from the formation of the first flexural cracks to failure. The strain distribution in the transverse steel shows that the strains are much higher within 1.25d (approximately) from the face of the support. Yielding of steel is observed to occur under relatively high shear force, which means that after yielding of the stirrups and the resulting major cracking, the residual shear capacity of the RC beams becomes minimal if not negligible. It was found that the maximum strain attained by the FRP is only a fraction of the ultimate strain capacity of the FRP. M.Sarafraz1 et al (October -2008) explained his experiment study report in the journal of "FLEXURAL ENHANCEMENT OF RC COLUMNS WITH FRP". In this, Concrete column structures retrofitted by FRP composites wrapping, it is use to increase the strength, ductility and compressive strength of RC columns. RC columns are affected by axial force and moment bending, FRP wrapped RC columns no affected on tension control region .In this research paper, to enhancement flexural strength of RC columns with high and low axial steel content when retrofitted by FRP system that oriented in the direction of applied axial load. Performance analyses have been carried out on RC column strengthened with NSM systems. Near-Surface Mounted (NSM) FRP rods can increased the flexural capacity of RC column and NSM specimens utilized the CFRP reinforcement more efficiently than the externally bonded strengthening .Combination of FRP jacketing and NSM rods could be used for improving the flexural capacity of damaged or undamaged columns. J.G. teng et al(2009) in the paper " Behaviour of RC beams shear strengthened with bonded or unbonded FRP wraps" made experiments to find solution for the rupture of FRP caused by debonding of the FRP from the sides of the beam. The interaction between FRP, concrete, and internal steel stirrups were essential to have a better understanding about the shear resistance. Totally, nine beams were conducted in the testing; among the nine three were used as control specimens, three were used with bonded FRP full wraps and three were used with FRP full wraps left unbonded to the side. From the experimental verification, it was noted that last unbonded specimens got some slight increase in the shear capacities than the beams that are bonded with full wraps. FRP is found to reduce the ductility of the beams on both the cases. Larger crack was found at the ultimate state in the FRP rather than that of concrete. Ciprian Cozmanciuc et al (2009), explained on his paper of "Strengthening techniques of rc columns using fibre reinforced polymeric materials". Strengthen the rc columns with using fibre composite sheets. Fibre composite behaviour of confined concrete columns and their principal advantages of these techniques are the high strength-to-weight ratio, good fatigue properties, non-corroding characteristics of the fibre reinforced polymers (FRP), and the facility of its application. The maximum efficiency of confining systems using FRP materials .The corners this paper reveals the most utilized techniques of performing composite confining systems for reinforced concrete columns, with their advantages. They are utilized the following techniques of performing composite confining systems for reinforced concrete columns are wet lay-up method, automated method and the method based on using prefabricated elements. For developing efficient composite confining systems it is required to respect the technological steps that lead to a corresponding transfer of stresses from concrete to the composite membrane. These steps include priming of the concrete substrate, of the application surface, execution of the resin mixture, application of the composite system and of the protection layers. The confining pressure develops on a so called confined area and the size of it determines the efficiency of the confining system. The most efficient can be considered to be the columns with circular cross-section, where the confined area represents the entire transversal cross-section of the column. Yasmeen taleb obaidat et al. (2010) in his investigated about the retrofitting of a structurally damaged RC beam with CFRP using experiments. For creating proper bonding between the CFRP sheet and the concrete, epoxy adhesives were used. The tensile strength of CFRP was 1.5 to 2 times than the steel. The factors such as reinforcement percentage, position and length of CFRP sheets were taken into account. The loading was done until the loading cracks formed and the beam was retrofitted with CFRP sheets. The observation on the result showed that the usage of CFRP as retrofitting member causes restoring of strength and ductility. Also, it was found that the length of the CFRP increases the efficiency of strengthening. Sangeetha et al (2010) in the paper on "Behaviour of Glass Fibre wrapped concrete columns under uniaxial compression" shows the behaviour of the columns wrapped with GFRP under uniaxial compression. Circular columns of size 150mm diameter and 300mm height are involved in this experiment. The experiment was carried out using 42 columns. From this experiment, it was shown that there is increment in the strength and ductility with the increase in the confinement. Also, as the number of plies of GFRP increases, the compressive strength of the columns also increases. The compressive strength can also be increased with the number of days or period of curing. Promis and Ferries (2011) investigated about the usage of Carbon Fibre Reinforced Polymer (CFRP) and Kevlar Fibre Reinforced Polymer (KFRP) using six circular columns with cross-sections 240mm diameter and 950mm height. 2.5% reinforcement is provided for longitudinal. Two specimens were used as control specimens, two specimens are reinforced with CFRP and the remaining with KFRP. It was observed that the increase in the compressive load induces the slope of the performance curve of reinforced columns and declines the strengthened columns. For circular columns, the axial compressive force increases the performance as well. Due to energy dissipation effect, the strengthening using CFRP and KFRP increase the ductility and causes increase in stability against seismic loads. Tara sen(2011) in her paper "Flexural Characteristic Study of RCC Beams Retrofitted using Vinyl Ester Bonded GFRP and Epoxy Bonded GFRP" describes about the flexural characteristics of the normal RCC beams, Vinyl-Ester bonded GRFP and Epoxy bonded GFRP wrapped beams. The retrofitting of beams were made with 1.2 mm Epoxy bonded GFRP sheets and 0.9 mm Vinyl-Ester bonded GFRP sheets with the use of epoxy resins. The test was conducted using a total of 28 beams. The wrappings were made either fully or as strip for the analysis of the flexural properties. The analysis of the cracking and deflection of the sheets were made by experimental proceedings. After finding the ductility ratios of the various beams, it was clear that the ductility property of the beam can be increased considerably by the use of GFRP sheets. From this paper, it was determined that the use of full wrapped GFRP shows higher increase in the ultimate load carrying capacity than that of the strip wrapped GFRP. This report shows a cost analysis about the retrofitting and also concludes that the ultimate load carrying capacity of RCC beams can be enhanced with the use of wrapping of GFRP sheets. Also the cost of retrofitting with the use of Vinyl Ester was found as more cost efficient than that of the Epoxy Bonded GFRP sheets. Gopal rai et al (2011) in the paper "Use of FRP composite materials in seismic retrofitting of structures" showed the effectiveness of the seismic retrofitting of structures in India based upon the revised codes introduced in 2002. This paper mainly focuses on the full scale building that was tested in CPRI, Bangalore to ensure the effectiveness of the retrofit. The paper also showed the present case study of the FRP retrofitted building in New Delhi with the new codes. This paper presents the clear idea about the linear as well as non-linear analysis of the retrofitted building in CPRI, Bangalore. This paper emphasizes the care that needs to be taken in case of FRP sheets for bonding to the original structure. Mrs. Tara Sen et al (April 2011) explained in her paper of "Finite Element Simulation of Retrofitting of RCC Beam Using Coir Fibre Composite (Natural Fibre)". In this research paper, natural fibres properties and behaviour find out from concrete cubes and compare in analytically. Natural fibres have lower durability and lower strength than synthetic. Coir natural fibres recently developed fibre treatments have improved these properties considerably. Coir fibre reinforced composite is of particular interest as these composites have high impact strength besides having moderate tensile and flexural properties compared to other lignocelluloses fibres. Coir fibre suitable for Plain Concrete Block by using Coir fibre reinforced polymer. It is seen that the strengthened specimens exhibit significant increase in strength, stiffness, and stability as compared to controlled specimens. Retrofitting the RCC beam by using Coir fibre with wrapping technique around all four sides, 83.33 % load carrying capacity is increased as compared to that of the controlled specimen. By providing different percentages of Coir fibres for retrofitting, the load carrying capacity of reinforced concrete beam models can be enhanced as compared to that of the controlled specimens. The use of Coir fibres for retrofitting of reinforced concrete beams also minimizes the deflections in the beams. Depending upon the strength required for the reinforced concrete beam, the percentage of fibres, that is to be applied on to the reinforced concrete beam, can be varied so as to obtain different increments in strength. B. Abdollahi et al's paper (2012) on "SIFCON strengthening of concrete cylinders in comparison with conventional GFRP confinement method" presents the comparison of SIFCON strengthening with GFRP Confinement. Experiments are done on concrete specimens with strength ranging from 15 to 40 MPa with confinement using GFRP sheets or SIFCON jacket. From this study, it is clear that both GFRP and SIFCON confinement methods gives significant improvement in strength, energy absorption and strain of the cylinders. Moreover, for mid-strength it is found that SIFCON confinement technique is highly effective in strengthening. But, as the core concrete strength increases there is a decrease in the efficiency of GFRP wrap confining concrete columns. In stress-strain responses, GFRP confined concrete shows Bilinear forms whereas SIFCON shows Non-linear forms. Based upon the comparison, it is concluded that SIFCON confinement method can be the competitive method for the GFRP confinement techniques. Raafat El-Hacha et al(2012) in the paper "Effect of SFRP Confinement on Circular and Square Concrete Columns" reports the experimental investigations that is carried out using steel fibre reinforced polymer (SFRP) sheets as confinement for plain concrete circular and square columns. Totally, 36 circular and 36 square specimens were tested. In phase III, 12 number of SFRP wrapped square specimens were tested. The test results obtained contains the factors such as cross-sectional shape, concrete compressive strength, number of SFRP layers which affects the performance of SFRP. SFRP wraps is found to improve the axial compressive strength and ductility of both the cross-sections. It was also found that increasing in the number of SFRP layers increases the confined axial compressive strength and ductility for both the cross sections. Improving of corner radius using SFRP wrapping increases the ductility and strength of the columns. It is concluded that use of SFRP is very efficient and effective too. The only disadvantage of SFRP is that it fails suddenly due to its brittle nature which may lead to serious effects. C. Antony Jeyasehar et al (2012) in their paper on "Cyclic Behaviour of Beam Column Joint Retrofitted with SIMCON Laminates" reported about their investigation on the behaviour of the RC beam column joints under the influence of Cyclic loading. Various joints with varying shear capacity and bond of reinforcement were created with the usage of Slurry Infiltrated Mat concrete (SIMCON), a Fibre Reinforced Cementitious Composites (HPFRCCs) in different volume fraction and aspect ratios. Under controlled displacement they subjected the column to an axial force and beams to cyclic load. The characteristic behaviour of the joint was plotted as curves. Various comparisons in the energy dissipation, and other properties were made between the experimental and analytical results of the tested control as well as SIMCON retrofitted specimen. Through this paper, it was reported that the SIMCON materials can be used for retrofitting the beam column joints in seismic designs. For the case of non-ductile RC beam column joints, the energy dissipation is 28.3% whereas for ductile case it is about 31.6%. Moreover, the result from this investigation shows that the strengthened beam column joint possess increment in the strength, stiffness and composite action. V.S.R. Pavan kumar. Rayaprolu (2012) et al through the paper "Incorporation of various Seismic Retrofitting Techniques and materials for RC Framed Building Using SAP2000" gave about the various reviews carried out based on the material and techniques that are adopted for seismic retrofitting RC framed building mainly located in the seismic zone v using SAP2000 software. Based upon the reviews, the weak points were found out in various aspects in a five storied building for the proper designing and detailing of the building for the purpose of seismic retrofitting. Through this paper, the formation of the plastic hinges at various levels of the building was found to be at a peak lateral load of about 384.75 KN which starts from the beams and columns of the bottom stories followed by the upward movement. The analysis using the push over analysis showed that the retrofitting is necessary for a building after the second storey. This paper also emphasizes the use of various wrapping techniques that are weight less, cost effective and also increases the ductility property of the structure to increase the time for making the people to easily escape from the building in seismic zone v. Saadatmanesh and Ehsani (1991) conducted evaluation of the strengthening of RC beams with GFRP laminates. The GFRP laminates was proven as a better external reinforcement for strengthening of RC beams with low reinforcement ratio. The factors that affect the strengthening include selection of adhesive and concrete surface preparation. Z.P. Bazant and Y.M. Kwon experimented about the failure of both slender and normal concrete columns. The study emphasizes that the failure occurs in the column due to the result of buckling, initial compression of concrete at compression zone and initial yielding of steel at tension zone. It was proposed that the failure of the column occurs mainly due to the releasing of the bending energy at the centre or at the end. Based upon the fracture mechanism, it showed that the failure is caused by releasing of the strain energy stored in the specimen. Quantrill et al. (1996) conducted experiments with concrete prisms of compressive strength 65MPa. To test the shear pull-off, GFRP laminates were bonded with the concrete prism using 1mm thick adhesive agent. From the test results, it was noticed that the average bonding strength decreases by 10% with the increase in 1mm of the adhesive layer. The average bond strength of 1mm adhesive is 6.4MPa. The failure of the prism was formed within the concrete adjacent to the strengthened layer. Shi Zhang et al. (2000) conducted the experiments on increasing efficiency in the concrete columns with external reinforcements. For the investigation process a total of five polymer composites wrapping were casted. Furthermore, E-glass fibres and vinyl-ester resin proved to be the best cost effective system of external reinforcement. It was noted that the fibre reinforced in hoop direction showed high strengthening to the columns. For best usage, the carbon fibre hybridized with glass fibre reinforcement can be used which tends to increase the mechanical properties with reduction in cost. Antonopoulos and Triantafillou (2003) made experiments in FRP using models in a scale of 2/3 with exterior joints. The various factors that are involved are internal reinforcement, axial load, initial damage, effect of transverse beam, thickness of FRP layers, distribution of FRP, carbon and glass fibres, etc. The results proved that the flexible sheets are more effective than the strips and glass fibre sheets are effective than the carbon fibre sheets. The modal analysis showed that the least usage of FRP can also increase the shear capacity of the section at a high rate. Chris P. Pantelides et al. (2004) performed tests to differentiate between the usage of CFRP and GFRP jackets. GFRP jackets are found to be more effective in circular columns with usual concrete. The study implies on the importance of using atleast two layers of FRP composites in retrofitting. It was proved that the circular columns possess more effectiveness for FRP jacketing than that of square columns. FRP jacketing improves the ductility, strength and column axial behaviour. V.Ramakrishnan et al (2003) researched and find out the basalt fibre may to use in concrete. After investigations, the basalt fibre used in concrete for the first time in world. And also they are find out the beams reinforced with plain basalt bars failed in flexure, due to inadequate bond between the rod and the concrete. All the actual ultimate moments were much less than the calculated ultimate moments to the bar pullout failure. The beam with 3D fibres exhibited a primary failure in flexure and shear followed by a secondary failure on splitting and also ductile, micro cracks resist. Bond between all the modified basalt rebar and concrete was extremely good. Ultimate moments good compare with normal concretes. In general, the basalt fibres are suitable for use in reinforced concrete structures. B.V.Bhedasgaonkar explained in his paper of “Assessment of Damage to Framed RCC structures in Gujarat Earthquake and Retrofitting with Fibre wrapping Technique.” In this paper, detailed explanations about type of damage and how to retrofit the damages. He is also briefly noted the Fibre wrapping methodology, type of fibres, advantages of fibre reinforcements etc., Says in investigated report the fibres are have highly withstand the flexural and shear strengths. Professor Andrzej Ajdukiewicz (November 2012) et al brief explained in his research experiments in the area of “Strengthening of structures using non-metallic fabrics and mineral or mineral-polymer matrix”. In this, they are used non-metallic fibres and mineral or mineral-polymer composites matrix for efficient strengthening and repairs of damaged and corrode existing structures used with very small thickness of fibre layers. They are investigated the FRP protect the concrete from corrosion and increase the durability, And compare the following fibres composites glass, carbon, PVA and Basalt fibres. The composites with non-metallic fabrics and mineral matrix are known as Textile Reinforce Concrete (TRC). TRC is material used for rehabilitation works, light weight concrete, impregnate concrete works, Strengthening of RCC structures etc., and noted the advantage of TRC are flexibility, increase the durability, ductility, reduce the self weight of structures, improve the bonding properties. Composite that calcium silica grows from the mortar into the carbon filaments of the textile fabric. This results in a shear-resistant interlocking and anchoring of the textile fabric length is reduced roughly by 30%. An oxygen barrier at high temperature and protect fibres against oxidation in case of fire.

4. Conclusion

After studying and analysing the review papers, it is decided to study the effects of Retrofitting (Strengthening) of RCC end bearing pile with wrapping of Basalt Fibre uniaxial fabric. Retrofit (strengthen) the pile by using basalt fibre polymer composites (BFRP) focuses on finding out the pile performance under axial load, lateral load, impact load and skin friction in cohesive less soil. Because of lack of researches about retrofitting of structures using Basalt Fibre, Basalt fibre reinforced polymer (BFRP) composites for strengthening or retrofitting the pile are adapted by BFRP wrapping method to conduct research.

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