REVIEW PAPER ON SEISMIC RETROFITTING OF STRUCTURES

Kirtika Gupta[1] , Abhishek Kumar[2], Mohd. Afaque Khan[3]

[1]Post Graduate Student, Structural Engineering, Babu Banarasi Das University, Lucknow, Uttar Pradesh, India.
[2] Head of Dept, Dept. of Civil Engg. BBDNIIT , Lucknow, Uttar Pradesh, India.
[3]Assistant Professor, Dept. of Civil Engg. Babu Banarasi Das University, Lucknow, Uttar Pradesh, India

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Abstract – *Earthquake around the world are single-handedly responsible for the destruction to life and property in large numbers. In order to mitigate such hazards, it is important to incorporate norms that will enhance the seismic performance of structures. This paper represents the change of Reinforced concrete structural components which are found to exhibit distress because of earthquake loading . Such unserviceable structures require immediate attention. And it was done by using the shear wall mechanism in the software .It can be used as a seismic retrofitting technique because it can be applied quickly to the surface of the damaged element without the requirement of any special bonding material and also it requires less skilled labor, as compared to other retrofitting solutions presently existing. It was determined that load carrying capacity for beam-column joint retrofitted with shear wall is increased. In this paper we use analytical approach. In this we use stadd pro v8i software.*

Key Words: *Shear wall, reinforced concrete, Seismic Retrofitting, Retrofitted, Bonding and beam-column, stadd prov8i.*

1. Introduction

Seismic retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes. This goal maybe achieved by adopting one of the following strategies like By reducing the seismic demands on members and the structures as a whole, By increasing the member capacities Stiffness, strength and ductility are the basic seismic response parameters taken into consideration while retrofitting. However, the choice of the technique to be applied depends on locally available materials and technologies, cost considerations, duration of the works and architectural, functional and aesthetic considerations/restrictions. Seismic retrofitting schemes can be either global or local, based on how many members of the structures they are used for. Global (Structural level) Retrofit methods include conventional methods (increase seismic resistance of existing structures) or non-conventional methods (reduction of seismic demand)

Jacketing construction is the most preferred method of retrofitting that can be applied by the following techniques:

1. Confinement with fibre reinforced polymers such as aramid fibres, carbon fibres and glass fiber reinforced composite.
2. Confinement with external steel caging techniques.
3. Confinement with ferrocement.

In comparison to the above, retrofitting Shear wall techniques have opened new possibilities of effective structural upgradation.

2. Literature Review

Yogendra Singh (2003)1 large number of existing buildings in India is severely deficient against earthquake forces and the number of such buildings is growing very rapidly. This has been highlighted in the past earthquake. Retrofitting of any existing building is a complex task and requires skill, retrofitting of RC buildings is particularly challenging due to complex behavior of the RC composite material. The behavior of the buildings during earthquake depends not only on the size of the members and amount of reinforcement, but to a great extent on the placing and detailing of the reinforcement. The construction practices in India result in severe construction defects, which make the task of retrofitting even more difficult. Step to step procedure given below-

- Setting of goals and performance level of building and estimation of seismic hazard.
- Systematic visual inspection and study of available drawing and documents.
- In situ investigation for strength and degradation of material and preparation of as built drawing.
- Identify deficiencies and scheme for detailed investigation.
- Detailed evaluation of strength, ductility, deterioration.
- Design of Retrofitting scheme based on evaluated deficiencies.
- Evaluation of Retrofitted building.

Sudhir k. Jain(2002)2 In this paper the Concept of pushover analysis that is becoming a famous tool in the profession for design of new structure, seismic evaluation of existing buildings and developing appropriate strategy for seismic retrofitting of structure. It is shown how this Analytical technique can be useful in deciding seismic retrofitting strategy and techniques.

Lakshmanan D(2006)3 In this Pushover analysis of the structures done by SAP 2000.Sap 2000 evaluating the various repair strategies for improvement of the seismic performance of RC structures are given. The behaviors of repaired beams of beam column joints are discussed. It is observed that inherent deficiencies in the detailing of the beam-column joints get reflect even after repair, though the performance factors indicate significant improvement. Two of the logical extensions show that the repair would not be as effective in these cases.

Giuseppe Oliveto And Massimo Marletta (2005)4 considered the retrofitting of buildings vulnerable to earthquakes and briefly described the main traditional and innovative methods of seismic retrofitting. Among all the methods of seismic retrofitting, particular attention was devoted to the method which was based on stiffness reduction. This method was carried out in practice by application of the concept of springs in series, which lead in fact to base isolation. One of the two springs in series represented the structure and the other represented the base isolation system. The enhanced resistance of the buildings to the design earthquake clearly showed the effectiveness of the method, while a generally improved seismic performance also emerged from the application.

Abhijit mukherjee and amit r. Kalyani (2004)5 This paper introduces a method of design of structural upgradation using FRC and discusses the design of enhancement of RCC elements with FRC, a strategy of upgradation of RCC frames and use of the developed strategy of upgradation for retrofitting of RCC frames based on Capacity Spectrum Method.

Sarvesh Kumar Jain(2003)6 In this paper main focus on functioning of a building during retrofit work in a progress. Mainly we see conventional method of Retrofitting often requires restricting the use of the building during retrofit. In the paper briefly prevailing retrofit methods without affecting their daily functioning. Their some techniques used which are given below
Sheet jacketing
Strand jacketing
Panel jacketing
Dampers
Wall type viscous damper

Pranab Agarwal,Siddhartha Gupta,Ankur Kataria and Pratima Rani Bose(2003)7 Normally jacketing is provided according to experience . In this paper suggest an effective analytical procedure for the purpose of jacketing. Standard codal provision for column design has utilized to suggest a jacketing solution. The entire procedure has been supported by a C++ program which plots the interaction diagram and gives the final dimensions of the retrofitted member.

Jong-Wha Bai(2003)8 Studied the Seismic Retrofit for Reinforced Concrete Building Structures and proposed a relatively new paradigm, performance-based design, has also had an impact on seismic retrofitting and rehabilitation. This concept provides a new approach to design objectives and desired performance levels. As the performance-based design paradigm become more accepted for new structures, seismic retrofitting and rehabilitation methods have been affected by this concept. Consequently, retrofitting procedures could be selected and applied so that the performance objective of the retrofit depends upon the importance of the structure and the desired structural performance during a seismic event with a particular recurrence interval.

Abdullah and Takiguchi (2003)9 Investigated the square columns using both square and circular ferrocement simultaneously under compressive and cyclic loading. For the study three types of columns were considered Three columns, designated as CJ-AL10-6L, CJAL15- 6L, and CJ-AL20-6L were tested under different axial loads after being strengthened 13 with circular ferrocement jackets containing six layers of wire mesh. Specimen CJAL15- 6/3L, strengthened with reduced number of layers of wire mesh for the centre portion, was tested to investigate the behavior and strength of the important practical aspect of strengthening RC column with ferrocement. Two reference columns, SJ-AL15-4L and SJAL15-6L, were strengthened with square ferrocement jackets, with four and six layers of wire mesh, respectively, before tested to their failure to study the effects of different shapes of jacketing on lateral load–displacement response. Each of the reference columns was reinforced with 12 deformed D-6 bars distributed evenly around the perimeter of the column cross-section. Smooth R-2 (diameter¼2mm) bars were used as transverse reinforcement spaced at 50 mm.

Shailesh Agrawal and Ajay Chourasia (2003)10 performed the nonlinear static analysis of RC building using pushover approach before and after retrofitting. The comparison of strength parameters and pushover curve indicated that there was increase in ductility. As regards to stiffness of the building, it was seen that it remains more or less same up to linear stage, while in nonlinear stage every point increased both in capacity and the deformation after retrofitting. The strength of the building was correlated with base shear, the net enhancement in strength after retrofitting.

M C Griffith And A V Pinto(2000)11 have investigated the specific details of a 4-storey, 3-bay reinforced concrete frame test structure with unreinforced brick masonry (URM) infill walls are described along with estimates of its likely weaknesses with regard to seismic loading. The concrete frame is shown to be essentially a “weak-column strong-beam frame” which is likely to exhibit poor post yield hysteretic behavior. Based on the results of an extensive literature review, the building is expected to have maximum lateral deformation capacities corresponding to about 2% lateral drift. The unreinforced masonry infill walls are likely to begin cracking at much smaller lateral drifts, of the order of 0.3%, and to completely lose their load carrying ability by drifts of between 1% and 2%.

Amlan K.Sengupta, V.T.Badri Narayan and A.Ashokan(2003)12
In this paper aim to evolve methodologies to assess the seismic vulnerability of reinforced concrete three-ten storey residential and commercial building.
Use of local Retrofit Strategies they are given heare Steel Jacketing ,Steel Plating, Use of FRP bars Addition of Concrete ,Concrete Jacketing It is imperative to have seismic evaluations of a building both for the existing and retrofitted conditions.

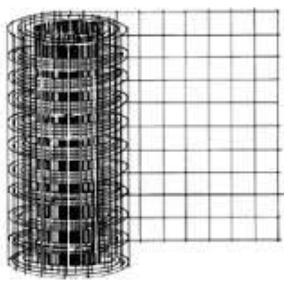
N.M.Bhandari and A.K. Dwivedi (2003)13 In this paper Some materials are described like Epoxy, Steel, Mortar, Quick setting cement mortar, F RP. Some techniques also describe like Shortcrete Jacketing, Mechanical anchorage Inserting new walls, strengthening of existingwall, Masonry arches, Random rubble Masonry

Kondraivendhan and Pradhan (2009) [14], Studied effect of ferrocement confinement on behavior of concrete. The effect of different grades of concrete confined with ferrocement was studied by keeping all other parameters constant. In this investigation, concrete mixes had been chosen over a wide range of grades of concrete, namely M25, M30, M35, M40, M45, M50 and M55. The M25, M30, M35, M40, M45, M50 and M55 have a characteristic compressive strength of 25N/mm2 , 30 N/mm2 , 35 N/mm2 , 40 N/mm2 , 45 N/mm2 , 50 N/mm2 and 55 N/mm2 , respectively. A total of 42 cylindrical specimens (21 each for controlled and confined specimens) with a diameter of 150 mm and a height of 900 mm, three replicates for each grade of concrete, were cast. Column specimens of size 150mm x 900mm with different grade of plain cement concrete were casted and then confined with ferrocement. It was found that with the increase in compressive strength of the concrete significantly improved in lower grades of concrete such as M25 which showed 78% increase as compared to higher grade of concrete M55 which resulted in an increase of 45.3%.

Turgay et. Al. (2010) [15] studied the effect and failure mechanisms of large-scale square/ rectangular columns wrapped with fiber reinforced polymer (FRP). The experimental research program studied the performance of large-scale square RC columns wrapped with carbon fiber reinforced polymer (CFRP) sheets. Moreover, the research was mainly focused on the investigation of the total effect of longitudinal and transverse reinforcement and FRP jackets on the behavior of concentrically loaded columns. A total of 20 large-scale RC columns were fabricated and tested to failure under axial loading in the structural laboratory.
Three types of columns were primarily considered: unwrapped, fully wrapped, and partially wrapped. Five different test series were conducted: unwrapped (C1); partially wrapped (C2); fully wrapped (C3); partially wrapped with two-layers (C4); and fully wrapped with two-14 layers (C5). The dimensions of all the columns were 200 x 200 mm square section and 1000 mm in height. Each column was tested under uniaxial compression using a testing machine with a capacity of 2000 kn.
The standard cylinder compressive strength of concrete mix are 18.08 mpa and 19.36 mpa 28 days and 60 days, respectively. All the specimens were subjected to monotonically increasing compression up to the fracture. Fully wrapped specimens with a slenderness ratio of 5:1 fractured at the top or bottom quarters whereas the partially wrapped columns show failure at the ends of confined regions. The partial wrapping with one-layer of CFRP results an increase in ductility and this is much more pronounced for RC columns with eight longitudinal bars. Finally, for all RC columns fully wrapped with one layer of CFRP, transverse reinforcement with a diameter of 12 mm clearly enhances the beneficial effect of CFRP on ductility.

Xiong et. Al. (2011) [16] studied the load carrying capacity and ductility of circular concrete columns confined by ferrocement including steel bars (FS) where they are proposed to increase the compressive strength along with the ductility. The behavior of the ferrocement strengthened columns was compared with the bar mat-mortar (BS) and fibre reinforced polymer (FRP) wrapped columns under uniaxial compression. The dimensions of the concrete cylindrical columns were, 105 mm (dia) x 450mm and 150 mm (dia) x 450mm. After wet-curing (24 hrs), the samples were transferred to curing room for 27 days. The specimens with 105 mm (dia) were confined with FS or BS whereas 150mm (dia) with FRP. The comparative analyses of these samples show that the compressive strength of FS columns was enhanced by 30% than that of BS columns. Due to ferrocement caging along with steel bars specimens showed higher ductility, compressive strength and energy absorbing capacity than BS or FRP strengthened circular columns.

Mourad and Shannag (2012) [17]studied the column specimens for the ultimate load capacity and stressed samples confined with ferrocement using welded wire mesh as the confining material.


Welded wire mesh.

In case of pre-stressed specimens, the results showed that the confining increased the load carrying capacity to 33%.

Ductility of the specimens also increased. In case of stressed samples to a value of 60% and 80% of the ultimate load capacity, the confinement enhanced the ultimate load capacity to 28% and 15% respectively. With the confinement the column specimens failed in a ductile manner as compared to brittle failure of the control specimens

3. CONCLUSIONS

In summary, a comprehensive literature review was performed in order to gain a better insight into the key issues relevant to seismic retrofit of concrete frame buildings. Many guidelines are reviewed regarding seismic rehabilitation of school, office, hospital and apartment buildings. Some of the researchers discussed the various seismic retrofitting and strengthening methods for existing building. The following methods are carried out by most of the researchers which are concrete jacketing of columns of ground floor, brick masonry infill in the ground floor, X and V bracing, shear wall, FRP of beams and columns. All these topics require further research, and it is essential for seismic retrofitting of reinforced concrete structures. By the help of software and analytical method we find a great result.

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BIOGRAPHIES

Miss. Kirtika Gupta was born in 1992 in Kanpur Uttar Pradesh. He received his Bachelor of Technology degree in Civil Engineering from Uttar Pradesh Technical University, lucknow, in 2014. He is right now pursuing his Master of Technology in Structural Engineering from Babu Banarasi Das University, Lucknow. Email:kirtikagupta687@gmail.com

Mr. Abhishek Kumar was born in 1986 in Patna city. He received his Bachelor of Technology degree in Civil Engineering from school of Engineering (Cochin University of Science and Technology) ,Konchi, Kerala in 2009 ". In 2011 he received his Master's degree in Structural Engineering from MNNIT, Allahabad. He joined Babu Banarasi Das University, Lucknow in 2011 as a faculty where he works as Assistant Professor in Civil Engineering department with a total of 6 years of experience . Presently he is working as Head of Department of Civil Engineering at BBDNIIT Lucknow from july 2017.

Mr. Mohd. Afaque Khan was born in 1982 in Gonda city. He received his Bachelor of Technology degree in Civil Engineering from ZHCET, AMU, Aligarh in 2009. In 2012 he received his Master's degree in Structural Engineering from ZHCET, AMU, Aligarh. He joined Babu Banarasi Das University, Lucknow in 2012 as a faculty. He worked as a Head of Department in Babu Banarsi Das Engineering College and he is now Assistant Professor in Civil Engineering department with a total of 5 years of experience.