A State-Of-The-Art Review on Seismic Retrofitting And Performance Enhancement of Reinforced Concrete Structures

Sankalp Khare[1], Prof. Girish Savai[2]
[2]Assist prof
[1, 2]V.M. Institute of Technology, Nagpur

Abstract- *Earthquake around the world is 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.*

Keywords: Shear wall, reinforced concrete, Seismic Retrofitting, Retrofitted, Bonding and beam-column.

I. 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)

1.1Seismic Retrofitting of Concrete Structures:

Definition: It is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes.

The retrofit techniques are also applicable for other natural hazards such as tropical cyclones, tornadoes, and severe winds from thunderstorms.

1.2 Need for Seismic Retrofitting:

- To ensure the safety and security of a building, employees, structure functionality, machinery and inventory
- Essential to reduce hazard and losses from non-structural elements.
- predominantly concerned with structural improvement to reduce seismic hazard.
- Important buildings must be strengthened whose services are assumed to be essential just after an earthquake like hospitals.

1.3 Problems faced by Structural Engineers are:

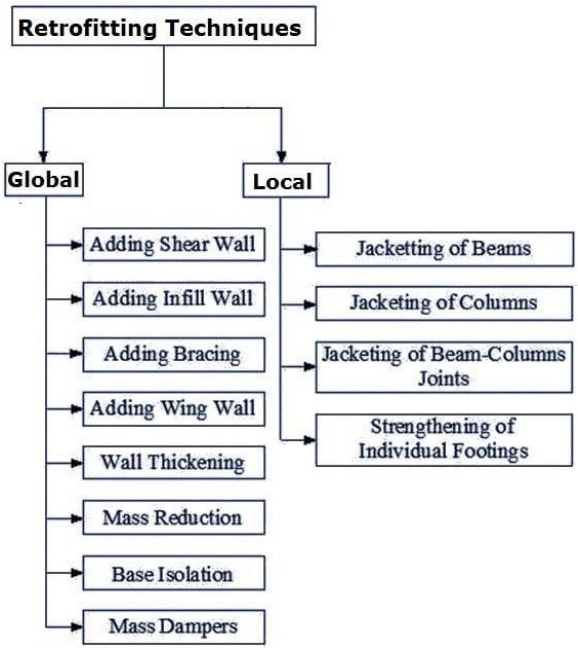
Lack of standards for retrofitting methods – Effectiveness of each methods varies a lot depending upon parameters like type of structures, material condition, amount of damage etc.,

1.4 Basic Concept of Retrofitting:

The aim is at:

- Upgradation of lateral strength of the structure
- Increase in the ductility of the structure
- Increase in strength and ductility

II. CLASSIFICATION OF RETROFITTING TECHNIQUES



2.1 Adding New Shear Walls:

- Frequently used for retrofitting of non ductile reinforced concrete frame buildings.
- The added elements can be either cast?in?place or precast concrete elements.
- New elements preferably be placed at the exterior of the building.
- Not preferred in the interior of the structure to avoid interior mouldings.

2.2 Adding Steel Bracings

- An effective solution when large openings are required.
- Potential advantages due to higher strength and stiffness, opening for natural light can be provided, amount of work is less since foundation cost may be minimized and adds much less weight to the existing structure.

2.3 Jacketing (Local Retrofitting Technique):

This is the most popular method for strengthening of building columns.

Types of Jacketing:

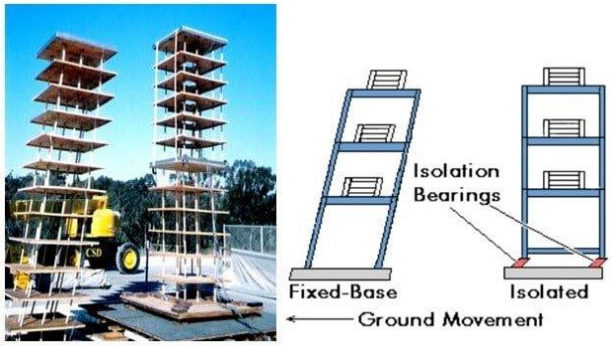
1. 1.Steel jacket,
2. Reinforced Concrete jacket,
3. Fibre Reinforced Polymer Composite (FRPC) jacket

Purpose for jacketing:

- To increase concrete confinement
- To increase shear strength
- To increase flexural strength

2.4 Base Isolation (or Seismic Isolation):

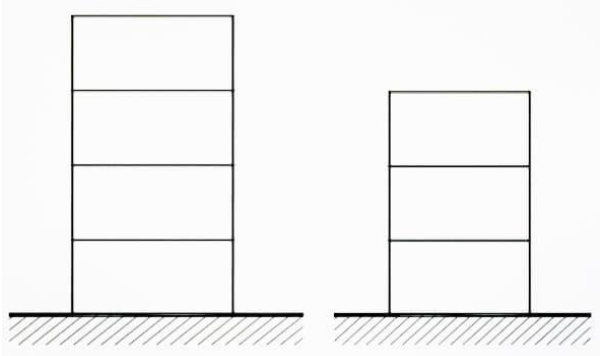
Isolation of superstructure from the foundation is known as base isolation. It is the most powerful tool for passive structural vibration control technique.



(a) (b)

2.5 Mass Reduction Technique of Retrofitting:

This may be achieved, for instance, by removal of one or more storey's as shown in Figure. In this case it is evident that the removal of the mass will lead to a decrease in the period, which will lead to an increase in the required strength.



Seismic Retrofitting by Mass reduction (removal of Storey)

2.6 Wall Thickening Technique of Retrofitting:

The existing walls of a building are added certain thickness by adding bricks, concrete and steel aligned at certain places as reinforcement, such that the weight of wall increases and it can bear more vertical and horizontal loads,

and also its designed under special conditions that the transverse loads does not cause sudden failure of the wall.

III. INDIAN STANDARD CODES FOR EARTHQUAKE DESIGN OF STRUCTURES

- IS: 1893-2002 (part-1) Criteria for Earthquake Resistant Design of Structures (Part 1 : General Provision and Buildings) – Code of Practice
- IS: 4326-1993 Earthquake Resistant Design and Construction of Buildings – Code of Practice
- IS: 13920-1993 Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces – Code of Practice
- IS: 13935-1993 Repair and Seismic Strengthening of Buildings – Guidelines
- IS: 13828-1993 Improving Earthquake Resistance of Low Strength Masonry Buildings – Guidelines
- IS: 13827-1993 Improving Earthquake Resistance of Earthen Buildings – Guidelines

Previous studies Carried out (Brief Overview of past research)

Dr. Gopal L. Rai,

In this paper, different strengthening techniques for R.C columns are studied. Methods studied are concrete jacketing, steel jacketing, precast concrete jacketing, external prestressing and FRP wrapping. Concrete jacketing involves addition of thick layer of reinforced concrete in the form of a jacket, using longitudinal reinforcement and transverse ties. Additional concrete and reinforcement contribute to strength increase.

Pravin S Waghmare,

In this paper, different jacketing methods are mentioned. Jacketing methods described for strengthening of column to improve the performance of R.C.C building. Jacketing is the most popularly used method for strengthening of building columns. The most common types of jackets are steel jacket, reinforced concrete jacket, fiber reinforced polymer, composite jacket, jacket with high tension materials carbon fibre, glass fiber.

Bhavar Dadasaheb O, Dhake Pravin chandra D, Ogale Ramesh A,

This paper has focused on strengthening the existing R.C.C building. In this paper, an old R.C.C building is strengthened to overcome the future disorders or inconvenience. A health building in the heart of Nashik city is strengthened to overcome the future disorders from the physical and experimental investigation, it was concluded that the building either should be demolished or at least should be retrofitted with suitable techniques to increase is sevice life.

A.K.singh, Dr. R.S jangid,Dr. gopal l. rai,

This paper describes the intensive retrofitting of an existing RCC framed structure. The building is a RCC framed structure owned by a nationalized bank and is more than 30 years old. The building was examined for its current structural condition and to suggest the remedial measures. The strategy adopted was aiming to recover the original performance, for which the damaged or deteriorated portion of the structure was to be repaired or replaced with new elements or new material.

Abdullah and Takiguchi (2003)

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.

V. CONCLUSION – SEISMIC RETROFITTING TECHNIQUES FOR CONCRETE STRUCTURES

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. following is the conclusion as per literature

The rebound number method appears to be more competent in forecasting the compression strength of concrete compare than the ultrasonic pulse velocity method. However, the development of calibration curves to conform both the Schmidt Rebound Hammer (SRH) and the UPV testing techniques for usual concrete mixes showed that the use of these two methods individually is not appropriate to predict an accurate estimation for concrete strength. The use of the Schmidt Rebound Hammer (SRH) test for strength estimation

of in situ concrete alone is not recommended unless using an available specific calibration

The project study deals with strengthening and enhancement of performance of existing structure so that structure can perform well when subjected to additional loads over it. The present work deals with NDT on existing structural elements/determination of load and moment carrying capacity of structural elements before and after extension, method applied for strengthening of structure ,design of the existing structural elements such as R.C.C beams and columns according to the load carrying capacity required.

- Seismic Retrofitting is a suitable technology for protection of a variety of structures.
- It has matured in the recent years to a highly reliable technology.
- But, the expertise needed is not available in the basic level.
- The main challenge is to achieve a desired performance level at a minimum cost, which can be achieved through a detailed nonlinear analysis.
- Optimization techniques are needed to know the most efficient retrofit for a particular structure.
- Proper Design Codes are needed to be published as code of practice for professionals related to this field.

REFERENCES

[1] Agarwal, P. and Shrikhande, M., 2006, *Earthquake Resistant Design of Structures*, 2nd Edition, Prentice-Hall of India Private Limited, New Delhi.

[2] Cardone, D. and Dolce, M., 2003, *Seismic Protection of Light Secondary Systems through Different Base Isolation Systems*, Journal of Earthquake Engineering, 7 (2), 223-250.

[3] Constantinou, M.C., Symans, M.D., Tsopelas, P., and Taylor, D.P., 1993, *Fluid Viscous Dampers in Applications of Seismic Energy Dissipation and Seismic Isolation*, ATC-17-1, Applied Technology Council, San Francisco.

[4] EERI, 1999, *Lessons Learnt Over Time – Learning from Earthquakes Series: Volume II Innovative Recovery in India*, Earthquake Engineering

[5] Research Institute, Oakland (CA), USA.Murty, C.V.R., 2004, *IITK-BMTPC Earthquake Tip*, New Delhi.

[6] Sudhir K. Jain, Srikant T, (2002), analysis for seismic retrofitting of buildings, The Indian concrete journal, pp 479-484.

[7] Lakshmanan D, (2006), seismic evaluation of retrofitting of building and Structures, ISET journal of earthquake technology, 43(1-2), pp 31-48.

[8] Giusepe Oliveto, Massimo Marleta, (2005), seismic retrofitting of reinforced concrete buildings using traditional and innovative techniques, ISET journal of earthquake technology, 42(2-3), pp 21-46.

[9] Mahdi shariati, Nor Hafizah ramli-sulong, Mohammad Mehdi Arabnejad k.h, Payam shafigh and Hamid sinaei, "Assessing the strength of reinforced concrete structures through ultrasonic pulse velocity and Schmidt rebound hammer tests", Scientific research and essays vol.6 (1)-2011.

[10] Dr. Gopal L. Rai, "Different strengthening techniques for R.C columns", R and M international pvt. Ltd.

[11] Pravin S Waghmare, "Jacketing technique for retrofitting of structures", International journal of advanced engineering research and studies, Vol. I, Issue: 15-2011