A STUDY ON THE SEISMIC RETROFITTING OF THE STRUCTURE

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ABSTRACT

Earthquakes 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.

The overall aim of the present study is to know and understand the behavior of certain structures under seismic activity and how different parameters affect retrofitted structures. It may be achieved by adopting one of the following strategies-

- By reducing the seismic demands on members and the structures as a whole

- By increasing the member capacities.

Keywords : Seismic Retrofitting, Jacketing,

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. 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.

Retrofit strategies are different from retrofit techniques, where the former is the basic approach to achieve an overall retrofit performance objective, such as increasing strength, increasing deformability, reducing deformation demands while the latter is the technical methods to achieve that strategy. 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).

NEED FOR RETROFITTING

The need for retrofitting of buildings or structures need to be evaluated and retrofitted by :

- To ensure the safety and security of a building, structure functionality , machinery and inventory.
- Essential to reduce hazard and losses from non-structural elements.
- Predominantly concerned with structural improvement to reduce seismic hazard.
- To reduce the seismic demands on members and the structures as a whole.
- To increase the member capacities.
- The buildings whose serviceability or strength cannot meet the requirements of structural codes or regulations, due to misuse, irregular maintenance, aging of materials and structures.
- The buildings that have quality or safety problems due to design flaws or deficiency in construction quality. These problems are often met in new construction and existing buildings.
- The buildings in which structural damages are caused by disasters such as earthquakes, strong winds, fires, etc.
- Those historic buildings and memorial buildings that need to be rehabilitated and protected.
- The buildings that will be reconstructed, or have additional stories built.
- The buildings whose structural members may be changed during renovation, which may influence the performance of whole structural system.
- When the buildings are located close to the site of a deep pit foundation of a new

construction, this deep excavation may cause unequal settlement of the surrounding soil and the surrounding buildings may consequently face potential damages or risks. The assessment and retrofitting of this kind of building is also an important safety measure for the construction of the deep foundation as well as the new structure.

TYPES OF RETROFITTING

3.1 Power plant retrofit

A power plant is an industrial facility for the generation of electric power . At the center of nearly all power stations is a generator , a rotating machine that converts mechanical power into electrical power by creating relative motion between a magnetic field and a conductor.

3.2 Home energy retrofit

Home Energy Retrofit are terms with overlapping meaning for retrofits that ensure the maintenance and preservation of buildings and continued operation and maintenance of energy efficiency technologies.

3.3 Seismic Retrofit

Seismic Retrofitting is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to Earthquakes. 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.

METHODS FOR SEISMIC RETROFITTING

Retrofitting of existing structures with insufficient seismic resistance accounts for a major portion of the total cost of hazard mitigation. Thus, it is of critical importance that the structures that need seismic retrofitting are identified correctly, and an optimal retrofitting is conducted in a cost effective fashion. Once the decision is made, seismic retrofitting can be performed through several methods with various objectives such as increasing the load, deformation, and/or energy dissipation capacity of the structure Conventional as well as emerging retrofit methods are briefly presented in the following subsections.-

4.1 Global Retrofit Methods

Two approaches are used for structure level retrofitting: a) conventional methods based on increasing the seismic resistance of existing structure , and b) non-conventional methods of reduction of seismic demands

4.1.1 Conventional methods

Conventional methods of retrofitting are used to enhance the seismic resistance of existing structures by eliminating or reducing the adverse effects of design or construction. The methods include adding of shear wall, infill walls and steel braces.

4.1.1.1 *Adding new shear walls*

One of the most common methods to increase the lateral strength of the reinforced concrete buildings is to make a provision for additional shear walls . The technique of infilling/adding new shear walls is often taken as the best and simple solution for improving seismic performance. Therefore it is frequently used for retrofitting of non ductile reinforced concrete frame buildings . the added elements can be either cast–in- place or pre-cast concrete elements . new elements preferably be placed at the exterior of the building, however it may cause alteration in the appearance and window layouts . placing of shear walls in the interior of the structure is not preferred in order to avoid interior mouldings

4.1.1.2 Adding Steel Bracings

Another method of strengthing is the use of steel bracing ,which also has similar advantages .The structural details of connection between bracing and column are shown below . The installation of steel bracing members can be an effective solution when large openings are required . This scheme of the use of steel bracing has a potential advantage over other schemes for the following reasons:

-higher strength and stiffness can be proved,

-opening for natural light can be made easily ,

-amount of work is less since foundation cost may be minimized,

-the bracing system adds much less weight to the existing structure ,-most of the retrofitting work can be performed with prefabricated elements and disturbance to the occupants may minimized.

4.1.1.3 Adding Infill Walls

Strengthening of existing reinforced moment resisting frames often involves addition of infill walls . it is an effective and economical method for improving strength and reducing drift of existing frames . by proper selection of the infill masonry strength along with prevention of its premature separation from the columns , a more desirable failure mode can be achieved . anchorage of the masonry to the frame is a critical factor in determining an overall performance . with proper anchorage it should pe possible to force failure in the masonry and prevent a premature shear/flexure column failure .

4.1.2 Non-Conventional Methods

In recent years , several alternative approaches are being used in the retrofitting of structures. Among them , seismic base isolation and addition of supplemental device techniques are the most popular . these techniques proceed with quite a different philosophy in that sense that it is fundamentally conceived to reduce the horizontal seismic forces. The application of these techniques in retrofitting are also in infancy state ; hence , the technical literature related to their application , future performance, advantage and problems have not been thoroughly investigated . however , a brief discussion about these techniques has been made here.

4.1.2.1 Seismic Base Isolation

The seismic base isolation technology involves placing flexible isolation systems between the foundation and the superstructure. By means of their flexibility and energy absorption capability, the isolation systems reflect and absorb part of the earthquake input energy before this energy is fully transmitted to the superstructure, reducing the energy dissipation demand on the superstructure. Base isolation causes the natural period of the structure to increase and results in increased displacements across the isolation level and reduced accelerations and displacements in the superstructure during an earthquake. Base isolation can also be used in seismic retrofitting of historic structures without impairing their architectural characteristics by reducing the induced seismic forces

4.1.2.2 Supplemental Damping Devices

Use of supplemental damping may be an effective method to resist seismic force. The most commonly used approaches to add supplemental dampers to a structure are installing of viscous damper or visco-elastic damper, frictional damper, and hysteretic dampers as components of braced frames.

4.2 Local Retrofit Methods

The member-level retrofit or local retrofit approach is to upgrade the strength of the members, which are seismically deficient. This approach is more cost effective as compared to the structura level retofit. The most common method of enhancing the individual member strength is jacketing. It includes the addition of concrete, steel or fibre reinforced polymer jackets for use in confining reinforced concrete columns, beams , joints and foundation.

4.2.1 Jacketing/Confinement

Jacketing is the most popularly used methods for strenthening of building columns. The most common types of jackets are steel jacket, reinforced jacket, fibre reinforced polymer composites jacket, jacket with high tension materials like carbon fibre, glass fibre, etc. the main purposis of jacketing are:

- to increase concrete confinement by transverse fibre/reinfircement, especially for circular cross-sectional coulumns,

-to increase shear stength by transverse fibre/ reinforcement,

-to increase flexural strength by longitudinal fibre/reinforcement provided they are well anchored at critical sections. Tranverse fibre shoud be wrapped all around the entire circumference of the members possessing closed loops sufficiantly overlappped or welled in in order to increse concrete confinement and shear strength.

4.2.1.1Jacketing of columns

Jacketing of columns consists of added concrete with longitudenal and transverse reinforcement around the existing columns . this type of strengthening improves the axial and shear strength of columns while the flexural strength and column and strength of the beam column joints remain the same . it is also observed that the jacketing of columns is not successful for improving the ductility . are major advantage of column jacketing is that it improves the lateral load capacity of the builing in a reasonably uniform and distributed way and hence avoiding the concentration of stiffness as in the case of shear walls.

4.2.1.2 Reinforced concrete jacketing

Reainforcef concrete jacketing can be employed as a repair or strengthening scheme . damaged regions of the existing members should be repaired prior to their jacketing . There are two main purposes of jacketing of columns:

-increase in the shear capacity of columns in order to accomplish a strong column-weak beam design and

- to improve the columns flexural strength by the longitudinal steel of the jacket made continous through the slab system and anchored with the foundation.

4.2.1.3 Beam Jacketing

Jacketing of beams is recommended for several purposes as it gives continuity to the columns and increases the strength and stiffness of the structure . While jacketing a beam , its flexural resistance must be carefully computed to avoid the creation of a strong beam-weak column system. Jacketing of beam may be carried out under different ways , the most common are one-sided jackets or 3 and 4 sided jackets.

4.2.1.4 Beam column joint jacketing

A joint may be defined as the part of the column that is located through the depth of the beams , and which intersect that column . this critical region should have enough confinement and shear capacity. However, due to lack of space in the joint region it is difficult enough to provide an adequate confinement.

Table Comparative evaluation of the global retrofit strategies

Retrofit strategy	Merits	Demerits	Comments
Addition of infill walls	• Increases lateral stiffness of a storey • Can support vertical load if adjacent column fails	• May have premature failure due to crushing of corners or dislodging • Does not increase ductility • Increases weight	• Low cost • Low disruption • Easy to implement
Addition of shear walls, wing walls and buttress walls	• Increases lateral strength and stiffness of the building substantially • May increase ductility	• May increase design base shear • Increase in lateral resistance is concentrated near the walls • Needs adequate foundation	• Needs integration of the walls to the building • High disruption based on location, involves drilling of holes in the existing members
Addition of braces	• Increases lateral strength and stiffness of a storey substantially • Increases ductility	• Connection of braces to an existing frame can be difficult	• Passive energy dissipation devices can be incorporated to increase damping / stiffness or both
Addition of frames	• Increases lateral strength and stiffness of the building • May increase ductility	• Needs adequate foundation	• Needs integration of the frames to the building

CONCLUSION

- Seismic Retrofitting is a suitable technology for protection of a variety of structures.
- Proper Design Codes are needed to be published as code of practice for professionals related to this field.
- The retrofitting buildings vulnerable to earthquakes and briefly discuss about the different methods of seismic retrofitting..

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