Advanced Retrofitting Techniques for Reinforced Concrete Structures: A State of an Art Technical Review

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Abstract:

Any technology or material has its limitations and new technologies have been invented and utilized over the ages to meet the new requirements. A large number of seismically prone reinforced concrete structures are not able to withstand earthquakes in accordance with the current provisions for coal. Moreover, the seismic Due to a design deficiency, construction deficiency, additional loads, and behavior of existing buildings is affected Additional demand for performance, etc. Recent earthquakes have clearly shown an urgent need for improvement and strengthen those structures that are seismically deficient. The upgrade is one of the best options for making an existing one inadequate construction safe from future likely earthquakes or other environmental forces. The refurbishment reduces Vulnerability of structural damage in the near future of seismic activity. It aims to consolidate a structure Comply with the requirements of current seismic design codes. A considerable amount of research has been carried out develop various enhancement and rehabilitation techniques to improve seismic performance in recent years of structures. Of structures. This article aims to provide an overview of various innovative and cost-effective techniques Retrofit for reinforcement of damaged structures. Seismic construction protection is a concept based on requirements aimed at improving the performance of any structure Future earthquakes. Future earthquakes. Earthquakes of various magnitudes have taken place in India recently, causing extensive Life and property damage. Some materials and techniques recently developed can play an important role in the structural repairs. Seismic reinforcement, whether damaged or undamaged, of existing buildings. The main concern of a structural engineer must restore the structures as fast as possible successfully. Choice of the right materials, the techniques and procedures for the repair of a certain structure were a major challenge. Innovative Structural repair techniques have numerous advantages over conventional techniques. Some guidelines for the present paper discussed the selection of materials for repair work, e.g. steel, reinforced fiber polymers. The choice of materials and techniques to use depends on many aspects from various perspectives prospectivei.e. Requirement and available financial resources, applicability and appropriateness of materials Repair of structures damaged. Use of standard and innovative repair materials, suitable technology, manufacturing, Conservation and preservation according to project objectives and Building renovation can include a range of different technical considerations such as fire safety, geotechnical safety Weathering and water infiltration, hazards and remedies, structural performance in earthquakes and wind loads.

KEYWORDS: retrofitting, treatments, rehabilitation, cracks, corrosion, preventive measures, epoxy, rehabilitation. Grouts, reinforced polymer fiber jackets, steel jackets, beam jackets.

Introduction

The process of applying measures to maintain the existing form, integrity and materials of a historic building is defined as the preservation. Rehabilitation refers to the process of creating a new property application through repair, Changes and additions to preserve the historical, cultural or architectural values that transmit them.Restauration is the process of restoring a property accurately as it existed at a certain time. The rebuilding is described as an act in which a property is replicated at a certain time. The provisions on rehabilitation need to select the rehabilitation goals and acquire current building information beforehand Design for rehabilitation.

The current status of the existing retrofitting method is selectedthe structure and its performance are known and the structure performance after refurbishment is required. The factors in selecting the method, the effectiveness of the various retrofitting methods with respect should be considered for the necessary improvements in performance, viability of retrofitting work performance, impact of Refurbishment work on the environment, maintenance ease after refurbishment, economy and other factors. Structural refurbishment is done to improve survival functionality. There are different types of applications Bridges, buildings and industrial structures, urban transport structures, land-keeping structures and maritime structures.

II. TYPES OF RETROFITTING OF CONCRETE MEMEBRS

A variety of retrofitting techniques are used, namely global and local techniques for retrofitting the existing structure. Parametric analysis was performed to achieve the most viable solution, taking into account different parameters like nodal displacement, drifting stowage and base shear. Retrofitting Classification Techniques:

Towards New Shear Walls Adding:

Towards Adding Steel Bracings.

Towards jacketing (Local Retrofits):

Toward base insulation (or seismic insulation): Base insulation

Mass Reduction Retrofitting Technique:

THE WALL Thickening Retrofitting Technique:

• Method of construction continuous fiber strengthened plate bonding: bonding continuous fiber reinforced plates with the Existing structure surface to restore or enhance load carrying capacity Continuous platform enhanced fiber construction method:

Jacketing with reinforced fiber plates the existing structure periphery to restore or improve load carrying capacity and deformation characteristics Prestressed concrete jacketing method of construction: prestressing wires and prestressing stranded steel wires Instead of lateral ties around the periphery and using mortar and concrete to bind existing member sections To strengthen the structure.· Prestressing construction method for the introduction: use of internal cables for existing concrete membersPrestressing and restoring or enhancing members' load carrying capacity.· Method of repair: to replace some or all existing concrete members with new ones by using the Precast members or on-site concreting for restoring or improving load carrying capacity.

III. PRINCIPLES OF RETROFITTING DESIGNS

The principles of building retrofitting are — reinforcement of members versus structural system reinforcement. Members who do not meet safety requirements should be strengthened, but the reinforcement of the whole often is a mistake

The structural system is overlooked. Strengthening the relationship between members is very important for structural integrity.

Local reinforcement versus global reinforcement. Local strengthening of a single member is possible

- Only if the reinforcement does not affect the entire system's structural performance.
- Temporary reinforcement versus permanent reinforcement. Temporary standards and requirements
- Reinforcement may be less than for permanent reinforcement.
- Special earthquake-resistant strengthening considerations.
- Use of new earthquake technologies.

IV. SELECTION OF THE PROPER RETROFITTING MEASURE

Proper studies of the existing structure using different analytical tools must be conducted in order to recognize the weak areas within the structure before retrofitting. It also helps to choose an appropriate retrofit measure to be taken in economic and security aspects.

Structures in the sensitive acceleration region and velocity area of the spectrum may require Different measures for retrofitting. The retrofitting option appropriate for one structure can prove inefficient for another Different dynamic structure behavior.

Furthermore, after refurbishment the rigidity of a structure can increase significantly, thereby increasing demand for load. Structure rather than retrofitting. The increase in rigidity depends also on the type of retrofit measure out. Conventional refit measures such as jacketing of steel/concrete and the inclusion of new walls will increase the structure aresignificantly rigid; thus, its dynamic behavior is altered. This re-analysis of the upgraded the structure is to be implemented. Modern techniques for jacketing, such as reinforced fiber polymer (FRP), can be implemented

The best way to build structural capacity without altering rigidity. In addition to increasing the structural stiffness, the conventional retrofitting method could have a major impact Develop new load paths which may lead to load concentration at ground level. This occurs in Frame structures in reinforced concrete (RC) where the inclusion of concrete shear walls between the columns is carried out Out as a measure of retrofitting. In this way, the existing base of the adjacent columns will probably be stressed. The proper retrofitting technique shall be chosen by analyzing the existing structure in detailed-analysis incl. Re-design of the structure may be necessary after retrofitting measures are introduced, so seismic retrofitting goals are me

V. RETROFITTING OF DESIGN PRINCIPLES

Design principles shall follow several factors, even in case of retrofitting, as in case of new constructions. For example, to take full advantage of the potential ductility of retrofitted RC members, flexure is desirable instead of shear and should govern ultimate strength. Shear failure is catastrophic and does not occur before notice

Distress. Most RC columns and beams have been found to be poor in shear strength and need of strengthening. Shear deficiencies occur because of several reasons, such as insufficient shear strengthening or reduction in shear Corrosion-related steel areas, increased service load; older codes design principles and construction defects. Shear, bending, axial and ductile capacity should be improved as far as possible in case of retrofitting. Of the structural and structural components as a whole. Most existing practices appear to be enhanced Containment of axial, shear and ductile behavior, which mainly increases structural members. Increased flexure Capacity can also be achieved if proper details and design principles are applied.

In reinforced concrete constructions, there are three basic types of structural deficiency. These are deficiencies in design, detail and construction:

VI. GENERAL DEFICIENCIES IN REINFORCED CONCRETE (RC) STRUCTURES

Deficiencies in design Include· Lack of lateral load resistance (e.g. lack of shear walls or special moment-resistant) frames) os Redundancy deficiency (alternative loading paths) of the structural system (that is, sparse beams and columns or inappropriately placed to trigger a total structural collapse in case of damage to only a few members)

• Irregularities in plan or elevation (e.g., plan L or T – plan shaped, or vertical reversals)

The presence of soft or weak floors, especially in the floor, such as in the case of large first floors.

Door and window openings

Presence of short columns that usually fail in a catastrophic pattern

· Presence of surpluses

· Strong-beam Weal-column joints, i.e. cases in which the beams are stronger than the columns with which they are linked.

The problem is that such connections tend to suffer damage in columns instead of beams, and since

Floors over the column answer more on the column than on the beam; column damage can be more disastrous

Beam damage.

Include key detail deficiencies the insufficient transverse reinforcement bars these are the smaller reinforcement bars perpendicular to the beams and columns axis. Transvers Strengthening offers resistance to shear forces and imparts concrete confines within. This confining increases ultimate concrete strength and allows for more damage without a beam or column unfortunately, failing. Wide spacing of transverse bars close to beam-column joints is particularly important. Specific provisions for narrower transverse reinforcement distances are provided by modern design codes.

Short length of overlap with split joints

These are places where one of the longitudinal reinforcement bars says a column ends and overlap. With a second that goes further along the column, as in the lower part of the column. If there is too little overlap,

Force cannot be appropriately transferred in one bar to the next, resulting in a generally unforeseen weakness.

Column point.

Building deficiencies Include

Adverse conditions such as those mentioned above may be further exacerbated by building defects, such as low buildings. Quality manufacturing, the use of lower materials and deviations from structural drawings and specifications Phase of construction.

VII. SPECIAL CONSIDERATIONS FOR EARTHQUAKE SAFETY

During earthquakes the acceleration on the top floors of the structured load wall buildings would be higher. As a result, top level wall panels are highly vulnerable, both outside of the plane and inside the plane. Also, the compressive stress on top floors in brick masonry would be minimal due to the dead burden from the top floors. Thus the shear strength of such masonry walls on the upper floors was lower than in the lower stories. Upper floor in earthquakes Failures in a load-bearing wall system are more likely so retrofitting measures in the upper part are carried out much more detailed floors.

The weakening concentrations of stress in such window / door openings corners may take place without lintel / sill bands, and failure is more likely to be initiated at these locations. Also out of – the loading of the plane can cause serious damage and even collapse because of insufficient rigidity in such walls? To

Strengthening such wall panels could be replaced by solid walls or steel bands, channels can be replaced by window opening be provided from both sides of the wall throughout the periphery of openings. Likewise, horizontal bands of the sill and lintel mesh on both sides could be supplied accordingly. The thickness of the wall. These actions would greatly improve the performance of brick walls and of the entire structure the performance of the structure in masonry structures should also be checked for development Aircraft shear stresses that may occur during an earthquake loading and appropriate jacket measurement shall be used to reinforce it as required.

VIII. RETROFITTING OF CONCRETE MEMBERS

- Long-lasting fiber Continuous plate bonding method: Bonding the existing structure onto the surface of continuously fiber bonding plates to restore or improve load transport capacity.
- The method of reinforced platform jacketing: continuous fiber reinforced plates around
- Existing structure periphery to restore or improve load-carrying capacity and deformation features
- TREE Method of construction of pre-stressed concrete jacketing: Pre-stress wires and pre-stress stranded steel
- wires on the periphery of existing member sections and using mortar and concrete to
- Bind them to strengthen the structure.
- Pre-stressing construction introduction method: internal cables to be provided for existing concrete members
- Pre-stressing and re-establishing or improving members' carrying capacity.
- Method of repair: to replace some or all existing concrete members with new ones by using the
- Precast members or load-carrying concreting on site for restoration or improvement.

INNOVATIVE TECHNOLOGIES FOR HISTORIC PRESERVATIONS

Preserving heritage architecture is a cultural objective that communities and nations are rigorously pursuing in order to promote their history, culture and aesthesia. Structures built by traditional methods in the remote past have over time been affected by extreme load events such as earthquakes.

Periods. Retrofitting is a technological and scientific approach based on recent developments, where modern methods and construction materials are used for repairing and reinforcing historical structures. The use of reinforced concrete is suggested in the form of cast-in walls, jackets or straps;

Strengthened laminates for walls and slabs strengthening. Innovative use of materials like form memory alloys, self-compaction Also suggested are concrete or thin lead layers. Methods for moderating the are given special attention Follow-up of destructive earthquakes. Seismic energy absorption equipment and base insulation are two effective means of protecting against future seismic events, although many have been met with their application inpractice, technical challenges. Modern materials and equipment offer a wide range of refurbishments to improve structural system behavior, global Strength, and stiffness or seismic hazards mitigation. Some of the common retrofitting techniques are listed below:

Post-stressing

One of the potentially efficient retrofit options for reinforced concrete or masonry buildings is the post-tensioning (Fig1). Masonry's compressive strength is relatively large, but the strength is only low. Therefore, it is the most effective in carrying loads of gravity. Induced tensile stresses usually exceed pressure and reinforcement to provide the necessary strength and ductility, must be added.

Figure No. 1 External Post Tensioning

Figure No. 2 External Post Tensioning to restore or increase capacity

Wraps Composite

Composite wraps or carbon fiber jackets are used for reinforcing and adding ductility to reinforced concrete and maceration components without any penetration. Composite wraps on reinforced concrete columns are most effective Additional containment provided.

Figure No. 3Carbon FRP fiber installation

Figure No. 4FRP Composite Strengthening services Concrete solutions

Micro-piles

Micro piles are used in foundation rehabilitation projects and seismic upgrades to improve the ultimate capacity of the foundation and reduce deflecting of the foundation.

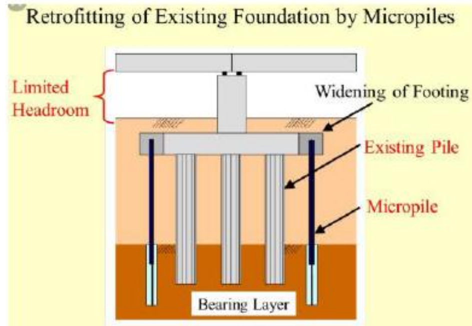

Figure No. 5Model Foundations Retrofitted

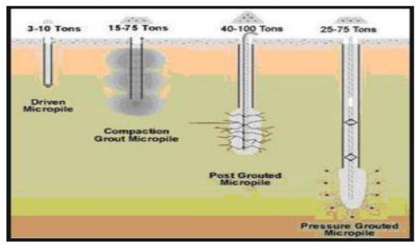

Figure No. 6Micro Pile Foundations with Micro Piles

Conclusion

This report addressed the seismic and energy retrofitting of existing Indian buildings with innovative materials and solutions. The need to renovate the old building stems from their substandard design, as shown by strong earthquakes or by high energy consumption, in terms of earthquakes resistance and thermal insulation(Heating and refreshment). This paper examined innovative methods for building retrofitting with a state –of the art review of advanced materials and solutions to enhance the efficiency of security, energy and resources the poor residential buildings of the EU. The following are the summary and main conclusions of the paper:

Before the 1970s concrete structures had to be retrofitted to withstand earthquakes. Six different retrofit methods were presented, divided into two main categories, local and global. Concrete, steel and composite to a specific member are local methods to improve their response to seismic events. All three are effective

Each one has some disadvantages: concrete is intensive to work, steel demands high maintenance throughout its life.
The structure and the composites are very costly to start up. Global methods improve the entire structure simultaneously by adding shear or using base insulation walls or steel braces. Shear wall is hard-working and costly. Steel brace can be simpler Implement some connection problems, but present them. Base isolation works well and is effective, but cannot be applied to all structures of all kinds. The method is chosen based on the building, its specific requirements and its requirements.

Custom, location, and geometry. Various methods should usually be considered and compared Best one. Best one. Hybrid methods for multiple methods should be used to provide greater flexibility in the retrofit scheme the advantages of each can be combined and implemented together. In the use of composites, an understanding of materials and design considerations is increasingly needed. For concrete component rehabilitation. Composite layers can be easily connected to concrete and can be connected. The contours of the structure must be followed closely, so that good practice of detailing is followed. To prevent premature failure followed. The development of design principles based on fracture mechanics Combined with criteria for material selection (fiber, resin, adhesive) and their shape is considered to be critical

The necessary step to the efficient and safe use of these techniques is necessary. The use of FRP has been made to repair and strengthen plain concrete and reinforced cement concrete in this study, analyzed. From this study the following conclusions can be drawn. In this paper, several techniques were examined for using the maximum efficiency of FRP such as number of FRP layer, FRP strips with and without FRP anchorage, FRP, FRP strips fully and partially contained FRP horizontal and sloping pattern bands with mechanical fasteners, near surface mounting (NSM), externally reinforced (EBR) and externally reinforced on groove (EBROG). The techniques of reinforcement increase the cargo capacity of samples and scissors produced at 45 degrees they've been restricted. The cracks were also reduced in width and length. The mechanisms used increased the ultimate load in FRP concrete beams and shifted the interface failure plane Concrete FRP interface to the specific interface. EBROG technique tested different groove sizes, results showed that the bond strength decreased with an increase in the groove dimension. These techniques have been very successful Effective on concrete flexural behavior. Flexural reactions were considerably improved and deflections were noted Reduced, too.

Risk assessment and retrofit cover almost all aspects of earthquake engineering that require close cooperation. Between disciplines, especially in the acceptable risk area. The increasing understanding of existing risk Owners' and government building creates a demand for more effective and reliable analytical methods, as well as Innovative retrofit techniques. A benchmark analysis tool is required to test and set simplified limitations Procedures not online. Small, reliable and consistent simplified processes based on linear or force are also necessary.
Considering the whole range of components and elements in existing buildings, seismically deficient, there are small cyclical test data available from which criteria of analytical acceptability can be set. A systemic programmer is required In order to fill the most important gaps. To take account of close collapse conditions, a lot of information is needed Determine elements' ability to carry gravity-load under severe deformations. The connection between local and local Further definitions are needed to prevent global failures and collapse from penalizingredundant structures Failure of one or more local components.

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