

Assessment of Damaged Building by Retrofitting Techniques

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Abstract— Enormous capital venture is required in development of new venture inside time, spending plan and quality. Old structure loses its life and quality. Pulverization of old structure and afterward build new structure require more store and time. By legitimate appraisal and administration of retrofitting lessens general cost of development and increment quality and life. There is requirement for compelling administration appraisal for retrofitting of old development extend. It relies on to know reasons for crumple to be evaluated, retrofitting procedure required for the harm part. Development to be finished inside time with least cost by reinforcing old parts of structure and expanding life by retrofitting. Retrofitting of harms structures is redesigning the seismic resistance of current structures so it gets to be distinctly more secure under the event of likely future earthquake. In retrofitting, the structure must be overseen so it is with regards to its motivation of utilization and is both sheltered and sturdy, with thought given to the simplicity of retrofitting development and post retrofitting support, and in addition general economy and environment-friendliness. Rehabilitation activity incorporate evacuation and modifying of crumbled walls, grouting of splits in the auxiliary members, guniting harmed solid surfaces, treatment against corrosion, providing extra steel fortification to reestablish elasticity influenced by corrosion, underpinning of establishments etc. Retrofit particularly means to upgrade the limits of building that is observed to be lacking or defenseless. The retrofit is expected to alleviate the impact of a future seismic tremor. In the outline of retrofitting methodology, the designer must consent to the construction regulations. The outcomes created by the received retrofitting methods must satisfy the base necessities on the structures codes, for example, misshapening, specifying, quality, and so forth.

Keywords— Demolition, Retrofitting, Damage, Rehabilitation, Corrosion, Underpinning.

I. INTRODUCTION

Appraisal of existing structures is a critical theme for specialists working in development in most mechanical nations, where restoration including repairs and updating of development works speak to about portion of all development exercises.

A current structure might be subjected to the appraisal of its real unwavering quality if there should arise an occurrence of:

- a) Rehabilitation amid which new basic individuals are added to the current load conveying framework.
- b) Adequacy checking with a specific end goal to build up whether the current structure can oppose loads connected with the expected change being used of the office, operational changes or augmentation of its outline working life;
- c) Repair of a building, which has crumbled because of time ward natural impacts or which has experienced harm inadvertent activities, for instance, tremor;
- d) Doubts concerning real dependability of the structure.

For structures, retrofitting implies rolling out improvements to the frameworks inside the building or indeed, even the structure itself sooner or later after its underlying development and occupation. Normally this is finished with the desire of enhancing luxuries for the building's inhabitants and additionally enhancing the execution of the building. The improvement of new advancements imply that building retrofits can take into account critical diminishments in vitality.

II. LITERATURE SURVEY

Emlyn Witt, Irene Lill, Tiina Nuuter, 2015 The built environment must adapt to a rapidly changing context and, since buildings have relatively long lives, this must primarily be achieved through retrofitting the existing building stock rather

than by replacing it. We therefore need robust approaches to evaluating the cost-effectiveness of retrofit investments. Some guidance for performing investment appraisals of building retrofit proposals is available for specific types of retrofit, for example, the economic evaluation procedure for energy systems in buildings in the form of the EN 15459 standard. In this preliminary study, three existing evaluation methods are reviewed and compared. On this basis, recommendations for the development of a robust, general approach to the financial and economic evaluation of building retrofits are made.[3]

Minakshi V. Vaghani, Sandip A. Vasanwala, Atul K. Desai, 2014 A higher degree of damage in a building is expected during an earthquake if the seismic resistance of the building is inadequate. The decision to strengthen it before an earthquake occurs depends on the building's seismic resistance. The structural system of deficient building should be adequately strengthened in order to attain the desired level of seismic resistance. Though considerable research was carried out on performance of existing- and retrofitted- 'GLD' and 'Ductile' structures, studies on the behavior of 'Non-ductile' one, which falls between these two prominent levels of design concept, are inadequate. Indian Standard is well accepted in the larger part of South-East Asia which is a prominent seismic zone. Since most of the structures in this region are commonly built without adhering to ductile provisions, usability of the damaged structure after any earthquake is of great importance. [6]

Matej Kusar, Maruska Subic Kovac, Jana Selih, 2013 Over the past two decades, we observed the importance of the management of existing buildings is continuously increasing with time. Refurbishment of buildings requires execution of various measures that have to be carefully chosen, as selection of a set of refurbishment actions demands that the goals of contemporary sustainable development are achieved. Therefore, a rational decision model is required to select a set of refurbishment measures for a building that results in largest total benefit to cost ratio. This ratio has to be calculated on the basis of several relevant criteria. [2]

Pravin B. waghmare, 2011 Seismic protection of buildings is a need-based concept aimed to improve the performance of any structure under future earthquakes. Earthquakes of varying magnitude have occurred in the recent past in India, causing extensive damage to life and property. Some recently developed materials and techniques can play vital role in structural repairs, seismicstrengthening and retrofitting of existing buildings, whether damaged or undamaged. The primary concern of a structural engineer is to successfully restore the structures as quickly as possible.

Sandeep G. Sawant, M.B.Kumthekar, V.V.Diwan,2011 It is observed that worldwide, a great deal of research is currently being conducted concerning the use of fiber reinforced polymer wraps, laminates and sheets in the repair and strengthening of reinforced concrete members. Fiber-reinforced polymer (FRP) application is a very effective way to repair and strengthen structures that have become structurally weak over their life span. FRP repair systems provide an economically viable alternative to traditional repair systems and materials. Experimental data on load, deflection and failure modes of each of the beams were obtained. The detail procedure and application of GFRP sheets for strengthening of RC beams is also included. failure mode of the beams are investigated.[11].

Ion Nicol Robertson, Gaur Johnson, 2004 Repair, strengthening, and retrofit of reinforced and prestressed concrete members have become increasingly important issues as the World's infrastructure deteriorates with time. Buildings and bridges are often in need of repair or strengthening to accommodate larger live loads as traffic and building occupancies change. In addition, inadequate design and detailing for seismic and other severe natural events has resulted in considerable structural damage and loss of life, particularly in reinforced concrete buildings..[4]

Maria Q. Feng , Eun Y. Bahng, 1999 The damage assessment of reinforced concrete (RC) columns retrofitted by advanced composite jackets was experimentally and analytically studied. The writers built two half-scale bridge columns, wrapped them with the composite jackets, and subjected them to cyclic loading to introduce moderate and severe levels of damage to the columns. Vibration tests using a shaker were performed on these columns before and after jacketing and

under undamaged and damaged conditions. The neural network technique was effective in estimating change (representative of damage) in the stiffness based on the measured vibration characteristics.

II. ASSESSMENT OF DAMAGE AND EVALUATIONS

It is vital to survey the state of the working before any retrofit strategies are taken up. Assessment decides whether a weakened building be destroyed or retrofitted keeping in view its cost-viability and general wellbeing.

The appraisal strategy includes in two phases:

1. Visual Inspection:

- i. Gathering of data – Building information as for auxiliary and constructional drawings, helplessness, number of stories, year of development, seismicity and codes took after before and so forth.
- ii. State of the building – Identification of basic harms, for example, splitting, spalling, nature of development, sidelong load opposing framework, stack way, support, corrosion, late retrofit measures and alterations.

2. Detailed Investigation:

In the event that development drawings and auxiliary points of interest are not accessible, definite examinations must be led. Properties of materials like cement and steel can be acquired by leading non-damaging testing (NDT) in the field and research center. With the evaluation examination, wellbeing of the building can be assessed to prescribe retrofitting/fortifying measures. The evaluation give an account of visual and itemized assessment is displayed table 4 as takes after.

Table 1 Visual inspection assessment report

| S.No | Structural component | Place / Position | Status/ Condition | Method of retrofit |
|------|----------------------|------------------|---|---|
| 1 | Column | Corner | Minor cracks and spalling of small portions of concrete due to corrosion of steel bars are observed | Column jacketing on four sides of existing column in cellular floor column, jacketing on two sides of middle exterior columns in other floors |
| | | Exterior/ middle | Minor cracks are observed at junction of beam – column joint | |
| | | Interior | No defects are observed | |
| 2 | Slab | Terrace | Leakage problem exists during rains, minor superficial cracks at top surface of slabs | Retrofitting is not required |
| | | Other floors | No symptoms of cracks | |
| 3 | Beams | Terrace | Minor cracks are observed at beam column joint | Beam jacketing at roof and cellar floor levels |
| | | Other floors | In cellar floors cracks are observed in beam- column joint and at middle of the beam | |
| 4 | Walls | Interior | Shear diagonal cracks are observed | In cellar floor periphery columns may be connected with R.C shear walls |
| | | Exterior | Tension and diagonal cracks are observed | |

IV. METHODOLOGY

Jacketing of Existing Beams, Columns, or Joints : R.C.C. Jacketing is the most prominently utilized for reinforcing of building sections and Shafts. The most widely recognized sorts of coats are strengthened solid coat. The fundamental reasons for jacketing are builds the part estimate essentially. This has the benefits of increment the part firmness and is helpful where twisting is to be controlled. In the event that segments in the building are observed to be slim, RC jacketing gives a superior answer for abstaining from clasping issues.

Outline for the reinforcing repair work depends on the composite activity of the old and new work. Jacketing existing pillars, sections, or joints with new fortified solid, steel, or fiber wrap overlays can be done. The new materials should be composed and developed to act compositely with the current cement. Where fortified solid coats are utilized, the plan might give specifying to upgrade flexibility.

While retrofitting segments, FRP sheets can be wrapped on the section. In sheet technique segments are wrapped by FRP sheet of certain width and with a specific cover. In tape strategy sheets are connected constantly without the need of any cover. The second technique is viable since it lessens the cost of development by sparing materials and furthermore it is

more grounded on the grounds that it does not have any joint. Propelled composite materials, for example, carbon fiber strengthened plastic (CFRP) is much more grounded and lighter than steel. The inalienable non-destructive normal for CFRP makes CFRP fortification an extremely successful other option to steel support for fortified solid structures, particularly when fortification corrosion is a principle sympathy toward the execution and solidness of the structure. Expository and exploratory outcomes have demonstrated that, wrapping basic parts, (for example, segments, shafts and dividers) with CFRP sheets make strides their quality and pliability without adding solidness to the components. Simplicity of establishment, which is like setting up backdrops, makes the utilization of CFRP sheets an exceptionally financially savvy and effective option in the seismic retrofit of existing structures.

Use of Metal Shear Panel (Steel and Aluminum):The advancement of the metal plate shear dividers conduct has prompted to an alternate grouping of these gadgets inside two primary typologies, to be specific reduced shear boards, acknowledged with either solidified plates or plates made of low-yield quality metals (LYS steel or immaculate aluminum), and slim shear boards, made of thin steel plates associated with the individuals from an encompassing steel outline by method for either welded or catapulted associations. Reduced shear boards have a decent vitality dissemination capacity, they being described by steady and huge hysteretic cycles due to the event of locking wonders in the plastic field just. Despite what might be expected, thin shear boards have a poor hysteretic conduct with professed squeezing impacts due to locking wonders happening in the versatile field.

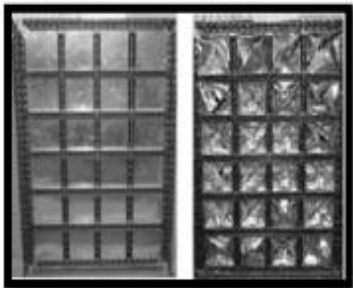


Fig.1 Aluminum shear panel



Fig.2 Steel slender shear

Steel Bracing: The primary favorable position of these techniques is that they can be effectively planned and connected utilizing customary development systems. The technique is extremely viable in decreasing the inconvenient impacts of quakes on structures (Figure 3.3). They more often than not don't require substantial obliteration or development work when utilized for seismic retrofitting. By and by, such strategies are for the most part exorbitant to execute (Cengizhan Duruca et al. 2010). This makes them unsatisfactory for customary structures. Most utilizations of RMMs are along these lines found in vital government on the other hand verifiable structures, historical centers or clinics steel connect prop retrofitting framework is designed to overhaul the execution of seismically powerless RC structures by joining the favorable circumstances what's more, dispensing with the vast majority of the detriments of traditional and current reaction change retrofitting systems for RC building.

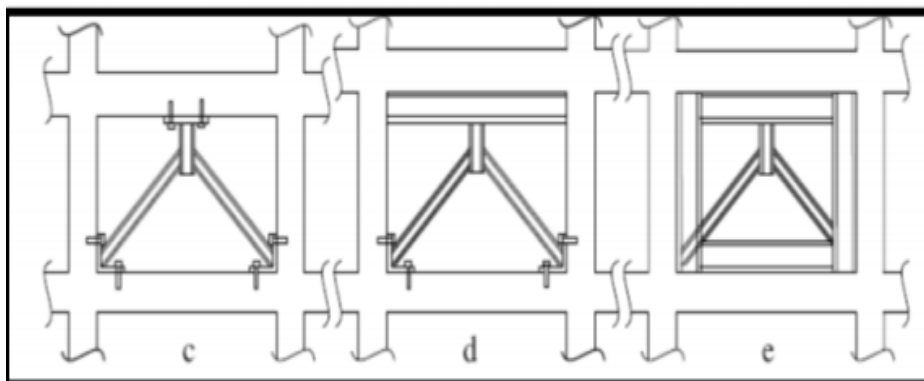


Fig.3 Configuration of steel bracing

Friction Damper: Grating damper, comprising of uncommonly covered steel plates being catapulted together, is generally part of a steel prop framework that is mounted inside a segment pillar outline. The generally utilized grating damper frameworks are as a X (grinding damper being at the center of the X) or an askew (grinding damper being along the corner to corner) inside a rectangular segment shaft outline. Such a grating damper framework is joined to the auxiliary edge through associations at the segment pillar joints. Contact damper framework's capacity is like that of a shock absorbing framework in an auto. Seismic tremors discharge vitality through ground shaking movements, which Friction dampers have vast rectangular hysteresis circles, like a perfect elasto plastic conduct, with insignificant blur more than a few cycles of inversions Pall et al., Filiatrault et al. These contact dampers are additionally minimized in plan and can be effectively covered up inside drywall allotments.



Fig.4 Friction Damper

Fiber Wrap Technique: The fiber wrap procedure, otherwise called composite fiber framework is a non-nosy auxiliary reinforcing system that builds the heap conveying limit (shear ,flexural ,compressive) and flexibility of strengthened solid individuals without bringing on any decimation or misery to the current cement.



Fig.5 Fibre wrapped technique for improving load carrying capacity of beam and column

3.5.6 Confinement of Column by inserted composite matrix : The obsessive investigation of weakness of solid structures drove towards the utilization of composite materials as support guaranteeing a reclamation of firmness and quality. Considering the high mechanical execution of composite materials consolidated with their delicacy, it gets to be distinctly wise to partner them in the organization of the solid individuals, to better oppose outside stacking. This idea has risen as a novel option for modifying as well with respect to repairs of harmed structures. The composite material is made of sap impregnated E-glass strands with thickness of 2 mm. The yield quality and the Young's modulus of versatility of the E-glass fiber gave by the producer are individually 560 MPa and 4.1 GPa. This development innovation plans to expand the part inflexibility and quality, to take into consideration bendable disappointment and to anticipate sudden disappointment

under over the top stacking. It maintains a strategic distance from additionally the issues due to interface amongst concrete and composite materials.

Base Isolation : The seismic base segregation innovation includes setting adaptable seclusion frameworks between the establishment and the superstructure. By method for their adaptability and vitality retention capacity, the confinement frameworks reflect and assimilate part of the tremor input vitality prior to this vitality is completely transmitted to the superstructure, lessening the vitality dispersal request on the superstructure. Base segregation causes the common time of the structure to increment what's more, results in expanded removals over the confinement level and diminished increasing speeds and relocations in the superstructure amid a seismic tremor. This not just gives security against fall, additionally to a great extent lessens harm, which is critical for offices that ought to remain operational after extreme seismic tremors, for example, crisis reaction focuses, doctor's facilities, and fire station.

Polypropylene Meshing : Polypropylene coinciding utilizations normal polypropylene bundling straps (pp-groups) to shape a work which is utilized to encase workmanship dividers, forestalling both crumple and the escape of trash amid seismic tremors. PP-groups are utilized for bundling everywhere throughout the world and are accordingly shoddy what's more, promptly accessible while the retrofitting strategy itself is sufficiently straightforward to be appropriate for neighborhood manufacturers. PP coinciding has been connected in Nepal, Pakistan and all the more as of late in China.

Wire Meshing : Unreinforced stone work structures are weak in nature. To guarantee bendable basic conduct of such structures, support is given outline subtle elements particular to each building. This fortification comprises of stirred welded wire work (WWM) or TOR/MS bars that are moored to the divider and completely encased in bond mortar or smaller scale concrete. Due to the low quality of brick work, full divider jacketing from both the sides is the more powerful alternative, despite the fact that the support and wrap framework likewise works, gave these groups are firmly set to minimize neighborhood crumbling of stone work material. The work on either side of the divider is associated with steel bar connectors that go through the divider, or moored with nails.

Materials Used For Repairs ,Restoration And Retrofitting of Damaged Buildings :

Shotcrete : Shotcrete is a technique for applying a mix of sand and portland concrete which blended pneumatically and passed on in dry state to the spout of a weight firearm, where water is blended and hydration happens only before ejection. The material bonds impeccably to legitimately arranged surface of brick work and steel. In flexibility of use to bended or sporadic surfaces, its high quality after application and great physical attributes, make for a perfect intends to accomplish included auxiliary ability in dividers and different components. There are some minor confinements of freedom, thickness, bearing of utilization. Legitimately connected shotcrete is a fundamentally stable and tough development material which shows magnificent holding qualities to existing solid, shake, steel, and numerous different materials.



Fig.6 Shotcrete

Epoxy Resins: Epoxy saps are brilliant restricting operators with high rigidity. There are synthetic arrangements the syntheses of which can be changed according to necessities. The epoxy segments are blended quite recently preceding application. The item is of low consistency and can be infused in little splits as well. The higher thickness epoxy tar can

be utilized for surface covering or filling bigger splits or gaps. The epoxy blend quality is needy upon the temperature of curing (bring down quality for higher temperature) and strategy for application.



Fig.7 Epoxy Resin

Epoxy Mortar:

For bigger void spaces, it is conceivable to consolidate epoxy pitches of either low thickness or higher thickness, with sand total to shape epoxy mortar. Epoxy mortar blend has higher compressive quality, higher rigidity and a lower modulus of flexibility than Portland bond concrete. Along these lines the mortar is not a hardened material for supplanting fortified cement. It is likewise detailed that epoxy is an ignitable material. In this way it is not utilized alone.



Fig.8 Epoxy Mortar

V. EXPECTED RESULTS

- a. To increase the lateral strength and stiffness of the building.
- b. To increase the ductility in the behavior of the building. This aims to avoid the brittle modes of failure.
- c. To increase the integral action and continuity of the members in a building.
- d. To eliminate or reduce the effects of irregularities.
- e. To ensure adequate stability against overturning and sliding.

VI. CONCLUSION

Since sections are parallel to seismic tremor drives by and large, they require not to be reinforced. Be that as it may, sections and bars which were not intended for parallel burdens like seismic tremor strengths are more helpless against quake powers since shear strengths will be initiated in these components for which it was not planned. Henceforth, for the most part sections and shafts are to be retrofitted. R.C.C retrofitting system improves the hub load and minute conveying limit in section. What's more, utilization of TRF coat builds the execution levels against parallel burdens. Keeping in mind the end goal to alleviate the seismic hazard connected with the current building, the presently creating methodologies and execution of retrofit strategies are utilized to upgrade execution levels. A vital part of the generally seismic hazard is to assess and apply inventive advances with the end goal that the building can be retrofitted in a

financially savvy way. The best possible utilization of these rising advancements in building retrofit will be less nosy to building inhabitants furthermore, practical.

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