Application Of Retro-Fitting in Old Houses

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***Abstract*:** As buildings age, they often experience deterioration in structural integrity, which can lead to safety concerns and a decline in functionality. This is especially true for old houses, where construction techniques and materials may no longer meet modern standards. Retrofitting, a process that involves the strengthening or modification of existing structures, provides a viable solution to extend the life of these buildings. By incorporating modern materials such as steel components and advanced construction techniques, retrofitting enhances the durability, energy efficiency, and overall safety of old houses. This process not only preserves the historical value of the buildings but also ensures they meet contemporary performance requirements, including resistance to seismic activity, weathering, and other environmental stresses. This study aims to explore the various aspects of retrofitting in old houses, focusing on the technical, economic, and environmental factors involved. The research will examine different retrofitting techniques, their application in varying structural contexts, and the associated benefits and challenges. In addition, the study will assess case studies where retrofitting has been successfully implemented, highlighting best practices and the importance of tailoring solutions to specific structural conditions. Ultimately, this research seeks to demonstrate how retrofitting can be an effective and sustainable approach for restoring and enhancing the performance of aging residential structures.

***Index Terms*:** Structural integrity, Retrofitting, Architectural heritage, Sustainable urban growth.

I. INTRODUCTION:

RETRO-FITTING is the process of integrating new technology into an antiquated system. The procedure of adding certain new features that weren't there before is called retrofit [23]. In the building business, retrofitting is the process of reinforcing already-existing structures to increase their seismic resistance [20]. Retrofitting is a cost-effective strategy to extend the life of an existing structure as opposed to rebuilding it [1]. Due to societal investments in housing, infrastructure, and other systems prior to the significant changes predicted by climate change, retrofitting is also a crucial component of both mitigation and adaptation to climate change [15].

I.S. 800 – 2007 Clause 2.2.4.1 states that a structural steel's physical characteristics, regardless of grade, might be interpreted as: (a) Mass, p = 7850 kg/m; (b) Elastic modulus, E = 2.0 x 10s N/mm2 (MPa); (c) p = 0.3 for the Poisson ratio; (d) Rigidity modulus, G = 0.769 x 10s N/mm^2 (MPa); (e) Thermal expansion coefficient cx. = 12 x 10' /"c

I.S. 1346 – 1991 Clause 7.2 states that masonry and Concrete Roofs, Flat Roofs should be sloped to allow water to flow away and prevent ponding, which is the best technique to prevent water stagnation. There should be a minimum slope of 1 in 100. The preliminary work outlined in IS 3067: 1988 must be finished before the waterproofing system is applied, and the cement or lime work must be given time to set and dry fully. The roof's surface, as well as the area of the parapet, gutters, drain mouths, etc., where the waterproofing treatment is to be applied, must be wire-brushed and dusted to remove any foreign objects, such as dust, moss, or fungus.

I.S. 13935 – 2009 Clause 7 states that evaluating the Damageability of Existing Masonry Structures
The following factors will primarily determine the potential degree of damage to an existing masonry building during an earthquake: a) the earthquake's likely maximum intensity; b) the building's typology; c) its configuration; and d) the building's quality of construction and ongoing maintenance.
In addition to the aforementioned considerations, a significance factor of 1.5 in accordance with IS 1893 (Part 1) has been taken into account by increasing the earthquake intensity in order to estimate damageability. Further steps can be planned based on the building's evaluated damageability.

Clause 9 Buildings can increase their lateral strength by strengthening and stiffening their existing individual walls, whether or not they are fractured. Three methods can be used to do this: a) Grouting, b) Adding vertical reinforced concrete covers to the wall's two sides, and c) prestressing the wall.

Clause 13.1 Unsymmetrical structures that could cause hazardous torsional effects during earthquakes can have their centres of masses and stiffness coincident by dividing the building into separate symmetric units or by adding new vertical resisting components like reinforced concrete or new masonry walls, which can be inserted externally as buttresses or internally as shear walls. In order to provide transverse supports for the longitudinal walls of long barrack-style buildings used for a variety of functions, including dormitories and schools, a cross wall must be inserted.

II. NEED OF RETRO-FITTING IN OLD HOUSES:

Retrofitting may be necessary for any of the following reasons:

1. Not code-designed building [2].
2. Updates to the code and design methodology thereafter subsequent seismic zone upgrading [8].
3. Age and deterioration of strength [12].
4. Alterations to the current framework [11].

In India, non-engineered constructions consisting of brick masonry walls, stone walls, and earthen walls

comprise over 85% of all buildings. These structures are more exposed.

Figure – 2: Brick Work Damage

III. GOALS OF RETRO-FITTING:

The goals of Retro-fitting are:

- To make the structure more rigid and strong at the sides [13]
- To improve ductility with the goal of avoiding brittle failure modes [4].
- To improve a building's members' continuity and integral action [6].
- To get rid of or lessen the impact of anomalies [5].
- To improve the lateral load resisting system's redundancy. By doing this, the chance of a progressive collapse is eliminated [7].

To guarantee sufficient stability against toppling and slipping [9].

Figure - 3: Application of Steel Bars in old wall restoration

IV. RETRO-FITTING IN PRACTICAL POINT OF VIEW:

An opportunity to improve the energy efficiency of commercial building assets for their continued life is provided by retrofitting existing structures. Retrofitting older commercial buildings with changes that could increase energy efficiency or lower energy demand is a common practice. Furthermore, retrofits are sometimes utilized as a good opportunity to add distributed generation to a structure. Energy-efficiency retrofits can help a property stand out from the competition, draw in tenants, and lower operating expenses—especially in older structures.

Figure – 4: Retro Fitting work at Site

V. ROAD MAP TO RETROFITTING:

Enhancing the structure's performance, adding load-bearing capacity, or extending its service life are the main goals of retrofitting or repair work. Any retrofitting project would make sense if it took into account both the symptoms and the primary cause of the deterioration [10]. If the underlying source of the problems is not properly understood and only the symptoms are treated, it becomes difficult to identify concealed deficiencies beneath the completed work [21]. It is said that we should prevent having to fix the retrofitting work, thus we must take the actions listed below to that end.

- Drawing and specification preparation.
- Assessment of Condition, Materials and repair techniques selection.
- Identifying the primary source of the degradation.
- Procedure of execution.
- After the retrofitting project is finished, maintenance.
- Suitable quality assurance procedures.

VI. DISSCUSSION OF SOME PRACTICAL RETRO-FITTING METHODS:

Supporting of Old Rolled Steel Joist (R S J) Or Wooden Beam Supported Roof to Protect the Decayed Portion:

Designation	Wt. /mtr. (kg/m)	Sectional Area (cm^2)	Depth of Section (D)	Width of flange (b_f) (mm)	Thickness of flange (t_f) (mm)	Thickness of Web (t_w) (mm)
ISMB 200	25.4	32.33	200	100	10.8	5.7
ISMB 250	37.3	47.55	250	125	12.5	6.9

Table: 1

Firstly, the old Rolled Steel Joist (R S J) or wooden beam to be propped properly. Then cut a hole to the wall of depth 250 mm and width as per size of the existing old Rolled Steel Joist (R S J) or wooden beam with workable space to the supporting wall where injury to be cured. A cut Rolled Steel Joist or CONCRETE BLOCK to be placed to hole. When using rolled steel joist, the member should have a length of 500mm where 250mm will be placed inside the cut hole in the wall and left over portion will be projected outwards.

(*Make sure to paint Red Lead or Resin Based paint to prevent rusting; whenever using the Rolled Steel Joist for supporting.)

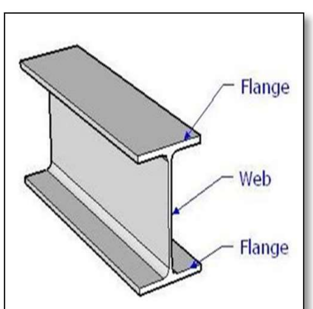

Figure – 5: 3D Section of Rolled Steel Joist

Figure – 6: Old Joist Supported Roof

A cement concrete of ratio of 1: 1.5: 3 is to be applied while placing the R S J or CONCRETE BLOCK under the pre fixed (old) Rolled Steel Joist or Wooden Beam and cure it properly. After complete curing, the props to be removed and make the floor free.

Figure – 7: Supporting the old joist roof with I section joist

I - Section Details for Working:

Designation	Radii of Gyration		Section Modulus (Z_{ez}) (cm)	Plastic modulus (Z_{pz}) (cm)	Shape Factor (Z_{pz}/Z_{ez})
	r_x	r_y			
ISMB200	8.32	2.15	223.5	253.86	1.1358
ISMB 250	10.39	2.65	410.5	465.71	1.1345

Table: 2

Brick Work Stitching:

When vertical cracks develop to the brick walls, stitching of brick is very useful process for mending it. In this process, PLAIN CEMENT CONCRETE blocks are made of size 250 mm x 50 mm x 50mm previously as per required number and to be cured properly. Horizontal chease to be cut of size 260 mm x 60 mm in staggered way.

The casted blocks then to be placed at an interval of 250 mm from down to up with sand cement mortar 4:1 ratio and cure it. Thereafter plastering to be done to the stitched wall.

Figure – 4: Cracked Brick Wall

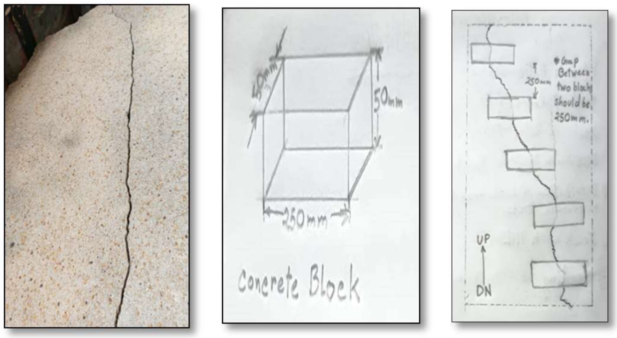

Figure – 8: Brick Work Stitching Process

Mending of Cracks on Terrace of Old Houses:

To mend the cracks on old Terrace roof, steps to be followed as under: -

- Cut a chease of width 500 mm and depth 65 mm along the cracks.
- Clean the dirt and dust from the cut chease.
- Prepare a reinforcement Mesh with 5.5 mm diameter TMT Bar @ 150 mm c/c both ways.
- Wet the surface with water and apply a paste of latex with cement and water as per product specification.
- Place the TMT Bar mesh to the chease cut portion on the roof.
- Apply cement concrete with 1: 1.5: 3 ratios with proper cover of minimum 25 mm to the bottom of the reinforcement and compact the concrete and then finish it providing required slope.
- Curing to be done for a stipulated period.
- Apply the same paste of latex with cement and water, horizontally and vertically in two course and cure it after 24 hours.

Figure – 9: Crack on roof of Old Buildings

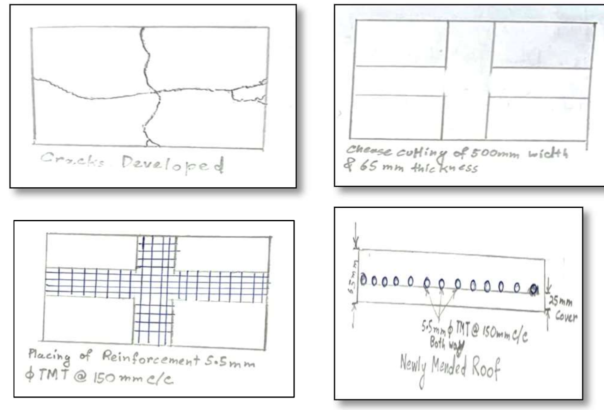

Figure – 10: Mending of Cracks on Terrace of Old Houses

Figure – 11: Final Result after crack mending

VII. CONCLUSION:

Retrofitting existing buildings is one of the most cost-effective, environmentally responsible, and proven ways to maximize energy performance [19]. It can also assist to extend the life of existing structures, particularly historical ones [21]. Retrofitting is currently spreading uncontrollably over the world as a big number of significant recorded, public, and private designs grow genuinely old and weaker with the passage of time [16]. Perhaps the best option for protecting an existing, unprotected structure from natural forces or potential threats is retrofitting [25]. The benefits of retrofitting for various factors are highlighted in the following figure. It clearly demonstrates the that retrofitting existing buildings offers numerous benefits, making it a valuable investment. The most significant advantage is lower operational costs (78%), as energy-efficient upgrades reduce maintenance and utility expenses. Improved building quality (64%) enhances durability and safety, ensuring long-term sustainability. A higher reputation (50%) attracts tenants, investors, and customers by showcasing a commitment to modernization and sustainability. Additionally, retrofitting reduces risks (29%) by minimizing structural vulnerabilities and ensuring compliance with safety standards. It also provides a better return on investment (26%) as property values increase while long-term expenses decrease. Enhanced workplace conditions lead to increased labor productivity (23%), creating a more efficient and comfortable environment. With better facilities and energy efficiency, buildings experience higher occupancy rates (19%) and a higher sale price (15%), making them more attractive to potential buyers. Lastly, better rental income (12%) results from improved living and working conditions, allowing property owners to charge higher rents. Overall, retrofitting ensures cost savings, increased value, and a more sustainable future for buildings.

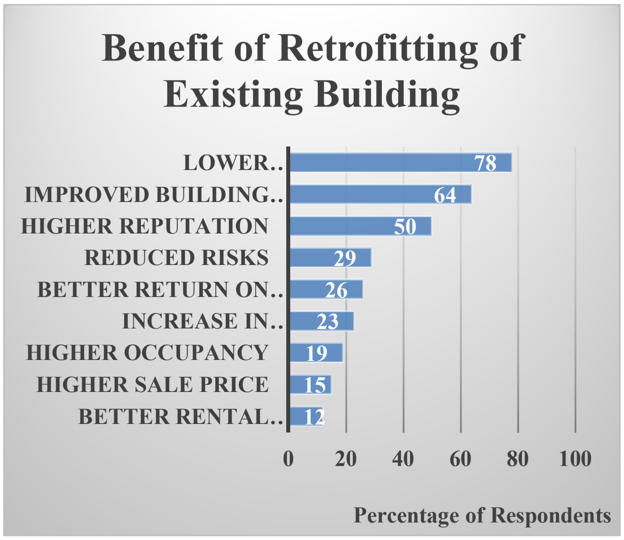

Figure – 10: Benefits of Retro Fitting

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