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‘STRUCTURAL REPAIR, RETROFITTING AND ADDITION OF TWO FLOORS FOR EXISTING RCC STRUCTURES’

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Abstract: The National Institute of Occupational Health (NIOH) in India is conducting a structural audit on a residential RCC building in Raigad, India. The building, constructed about a decade ago, is visually distressed due to aging and various factors such as natural calamities, faulty construction, and aging of the structure. The audit was conducted using visual inspection and non-destructive tests (NDT), including rebound hammer tests, ultra-sonic pulse velocity tests, corrosion tests, carbonation tests, and rebar locator tests.

The structural audit revealed that the structures were affected by distress, with cracks and damage not being assessed. This led to corrosion in the reinforcement of the structures, which was found to be 30% distressed. The audit recommended retrofitting, and based on the report NIOH, proposed additions and alterations to the existing structures. The building's structural stability was assessed and potential additions and alterations were proposed.

Comparitive analysis on Etab between rising two floors in RCC building structure with the help of retrofitting techniques specifically for column and foundation.

IndexTerms – Retrofitting,Retrofitting,RCC building analysis

I. INTRODUCTION

The National Institute of Occupational Health (NIOH) in India is conducting a structural audit of a residential and commercial building in Raigad, India. The building, which was constructed about 10 years ago, is in distress due to various factors such as natural calamities, faulty construction and aging. The audit was conducted using visual inspection and non-destructive testing (NDT), including rebound hammer test, ultrasonic pulse velocity test, corrosion test, carbonization test and rebar locator test.

A structural audit revealed that the structures were affected by tension, leading to increased corrosion of the reinforcements. The audit recommended retrofitting, a technique for retrofitting existing structures to withstand seismic forces. Retrofitting can be beneficial in situations where a complete replacement of the structure may have disadvantages such as high material and labor costs and a stronger environmental impact.

The audit included visual survey, non-destructive testing, repair philosophy and static analysis. The client proposed to continue to use both buildings and carry out additions and modifications. The problem statement was that the structures were subjected to cracks and damage that were not assessed and ignored, which increased the corrosion of the reinforcing bars. To resolve the issue, the client inspected and performed NDT at the specified locations.

Proposed findings include evaluating the quality of the concrete for the lower floor, performing corrosion and carbonation tests, designing the structure for additional loads, excavating and removing soil fill, strengthening the footings, and performing structural repairs using polymer and anti-corrosion treatment of the columns. A literature review was also conducted to further understand the stated issue.

II. Retrofitting

Retrofitting holds a crucial role in civil engineering as it involves the enhancement and modernization of existing structures and infrastructure to meet contemporary standards and challenges. In the field of civil engineering, retrofitting is essential for addressing the limitations of aging structures and adapting to evolving needs and technological advancements The integration of advanced technologies into existing structures is a primary focus of retrofitting. This includes upgrading construction materials, incorporating smart monitoring systems, and reinforcing structures to improve resilience. For example, retrofitting bridges with modern materials and monitoring technologies enhances their load-bearing capacity and safety, ensuring they meet current standards. Challenges in retrofitting include integration complexities and budget constraints. The process requires careful coordination to seamlessly introduce new technologies into existing structures, and financial limitations may impact the scope of retrofitting projects. Despite these challenges, the benefits of retrofitting are significant, offering increased safety, improved performance, and prolonged lifespan for structures. Beyond structural enhancements, retrofitting in civil engineering also contributes to environmental sustainability. Energy-efficient upgrades, such as improved insulation and smart building systems, reduce the environmental impact of existing structures. As cities aim for greater sustainability, retrofitting municipal buildings with eco-friendly technologies becomes a strategic approach to minimize energy consumption and carbon footprint In essence, retrofitting in civil engineering is a dynamic and necessary process that aligns infrastructure with modern demands. By addressing the limitations of aging structures, integrating advanced technologies, and promoting sustainability, retrofitting ensures that existing infrastructure remains resilient, safe, and adaptable to the challenges of the future.

III. Fieldwork

The preliminary investigation revealed several structural problems in the G+4 building: improper concrete cover and exposed steel reinforcement, structural cracks at the beam columns, damaged concrete cover at the beam bases, debonding, hollow sound beards, signs of leakage, and corroded steel. Externally, major structural cracks were noted on the columns, and interior observations revealed improper concrete cover and exposed steel reinforcement on the undersides of the slabs. Severe leakage and plant growth were also noted at the stilt level. The first floor exhibited structural cracks, areas of debonding concrete and moisture stains on the interior walls.

Polymer coatings such as IPN are applied to concrete surfaces to prevent the infiltration of air and harmful elements into the structure. Common guidelines include removing unsafe concrete, de-rusting steel, restoring rebar with anchors, applying a bond/binder coat, stitching techniques, injecting cement slurry or epoxy resin and applying a protective coating. A study in Mumbai, India, found extensive cracking and spalling in sunshades, chajjas, stairs and beams.

IV. Visual survey

The structure of a reinforced concrete frame (RCC) building was examined for defects such as cracks and seepage points. Observations were recorded on observation sheets and focused on de-lamination, crack patterns and crack patterns on beams, columns and slabs. Tapping was also carried out on each section to assess the condition of the components. Four NDT tests were performed on selected columns, beams and slabs to determine the strength of the RCC truss.

The rebound hammer test measures the surface strength of the RCC section by analysing the force on the shaft and its rebound. The ultrasonic pulse velocity (UPV) method is used to test the integrity and depth of defects in the RCC section. The equipment was calibrated before and after the test to ensure accuracy.

The corrosion test checks the probability of corrosion in the RCC section and determines the extent of steel corrosion. The carbonation test estimates the depth of carbonation in the RCC section by spraying phenolphthalein on the exposed concrete and observing the change in colour profile.
The Rebar Locator Test is used to determine the diameter of the rebar and the spacing of the main holes and stirrups to determine the exact use of the steel in new structures and to gather information for construction drawings..

V. Need of Retrofitting

Seismic performance for the existing structure which has undergone distress can be enhanced through proper use of retrofitting. The need of Retrofitting is mentioned below:

- To improve the performance of the building which was distressed, retrofitting wa carried out.
- Deficiencies in design or construction

- The structure which underwent dynamic force due to earthquake where distress is observed that structure needs to be strengthened
- Due to deterioration and pacing of the structures, the capacity of the building to
- resist earthquakes reduce greatly
- Increasing the ductility (Energy absorption) and damping (Energy dissipation)
- Buildings those are expanded and renovated.

VI. Column Jacketing

a) Supports:

The RC members should be properly supported before chipping the spalled/loose concrete. The props provided shall be adequate to provide sufficient structural support to the load carrying members

b) Surface Preparation of concrete:

All the spalled cracked concrete or any other pre-applied mortar shall be removed by chipping to expose the reinforcing bars. The concrete shall be chipped to a minimum depth of 10mm behind the reinforcing bars. The areas to be repaired shall be profiled to get rectangular or square shape with an inward tapering edge.

c) Surface preparation of reinforcement:

The exposed reinforcing bars should be cleaned thoroughly to remove all traces of rust, scales, etc., by using wire brush, emery paper etc. The lateral ties/stirrups shall also be cleaned in the same way. After removal of corroded portion, the diameter of the reinforcement shall be checked and compared with the drawings.

d) Application of two coats of IPNet-RB anticorrosive epoxy coating on steel rebar's:

Application of primer shall be followed with application of two coats of IPNet-RB) anticorrosive epoxy coating for bar protection against future corrosion. Coating is for old as well as newly provided steel. The polymer used is IPNet - RB.

Technical data of IPNet - RB:

Base: Epoxy/ Phenolic. Appearance: Yellow. Mix proportion by weight: 1: 1 (Base: Curing agent).

Shelf life: 1 year in a sealed container.

e) Provision of additional reinforcement:

As the diameter of reinforcing bars is reduced substantially (say >20%) additional bars shall be provided as per the design. This additional reinforcement shall be properly. anchored to the existing concrete by providing adequate shear connectors. Weld mesh may also be provided if found necessary.

f) Formwork and shuttering:

Slurry tight and strong form work shall be provided. The shuttering for encasement shall be kept ready such that the formwork shall be placed in position and fixed such that the micro concrete can be poured into the formwork within the overlay time of the bonding agent (5 hours). Adequate supports shall be provided for the formwork. Care should be taken to ensure leak proof shuttering. Under no circumstance the slurry should flow out of the shuttering during pouring of micro concrete.

g) Mixing and pouring of micro concrete:

The micro-concrete used is MONOLITH-MC. It is free-flow, shrinkage compensated, single-component micro-concrete used in high volume repairs structures. It should be mixed using the appropriate water powder ratio. The mixing shall be done mechanically and under no circumstance hand mixing shall be done. Mixing shall be carried out for 3 to minutes to ensure that homogeneous mix is obtained without any bleeding or segregation. The mixer should be poured into the formwork using a suitable funnel or through a hose pipe. The pouring operation shall be continuous, and it shall not be stopped unless the job is completed. concrete

Technical data of MONOLITH-MC: Compressive strength (1-day):10 N/mm². Compressive strength (7-day):40 N/mm². Flexural strength (28-day): 8 N/mm².Compressive strength (28-day):55 N/mm². Shelf Life: 6 months.

h) Curing:

All the repaired and encased area shall be fully cured as per standard concrete practices of IS 456:2000.

VII. Methodology

The repair of civil engineering structures involves several steps. First, damaged or loose concrete is removed with tools such as chisels and hammers until we reach solid concrete. Then we clean the surface and remove oil or other contaminants. Next, we clean the metal rods (reinforcement) that are in the concrete to remove rust. Rust can weaken the metal and cause further damage to the structure.

After cleaning, we drill holes in the concrete and insert special nozzles. We mix a material called epoxy resin and inject it into the holes under pressure. This resin fills all the cracks and gaps in the concrete. We have to keep an eye on the pressure and make sure the material gets everywhere it needs to go. Once we're done, we seal the holes and make sure there are no leaks.

To prevent future damage, we apply a substance called corrosion inhibitor to the surface. This prevents rust from forming on the metal inside the concrete. We also use polymers that act like strong adhesives to bond the new and old concrete together. This ensures that the repair remains stable.

For larger repairs, such as strengthening columns, we use a process called column encasement. This involves adding extra supports, cleaning the concrete and metal and then filling any gaps with a special type of concrete. We also wrap the structure with fibres to make it stronger.

Overall, these steps help us to repair damaged structures and make them safe for people. It's like fixing a broken toy so you can play with it again, but for buildings and bridges!

VIII. Data and Sources of Data

Structural Description	G+4 RCC Building Existing Building	G+6 RCC Building Extended Building
Material Parameters		
Grade of Concrete	M30	M45
Grade Of Steel	Fe 415	Fe 500
Structural Components		
Column Size (mm)	C230X230 C230X450 C230X520 C230X600 C300X750M20 C450X750	C230X230 C230X450 C230X520 C230X600 C300X750M20 C450X750
Beam Size (mm)	B230X600M20 B300*450 B300X450	B230X600M20 B300*450 B300X450

	B450X750	B450X750
Slabs Size (mm)	125	125
Height of structure From Ground (m)	1860	2460
Seismic Parameters		
Response Reduction Factor (R)	3	3
Importance Factor (I)	1	1
Seismic Zone Factor (Z)	0.16	0.16
Soil Type	II	II
Wind Parameters		
Terrain Category	3	3
Structure Class	A	A
Wind Speed Vb (M/S)	39	39
Topography Factor	1	1

IX. Results

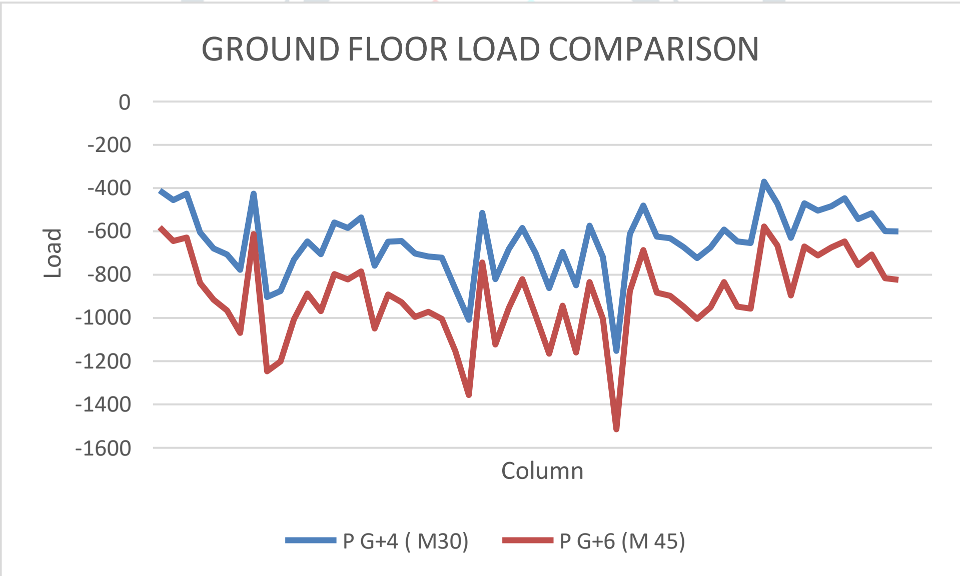

Fig 1

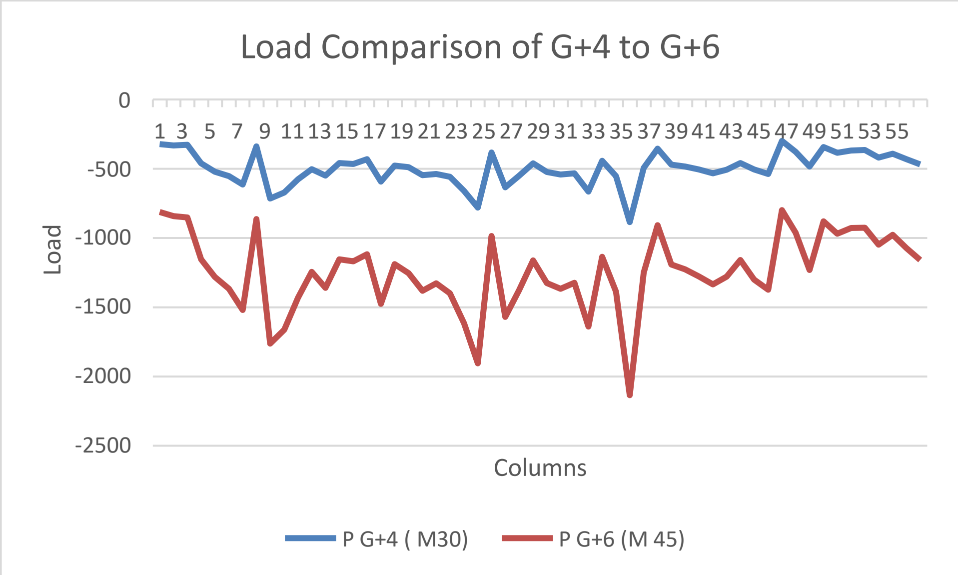

Fig 2

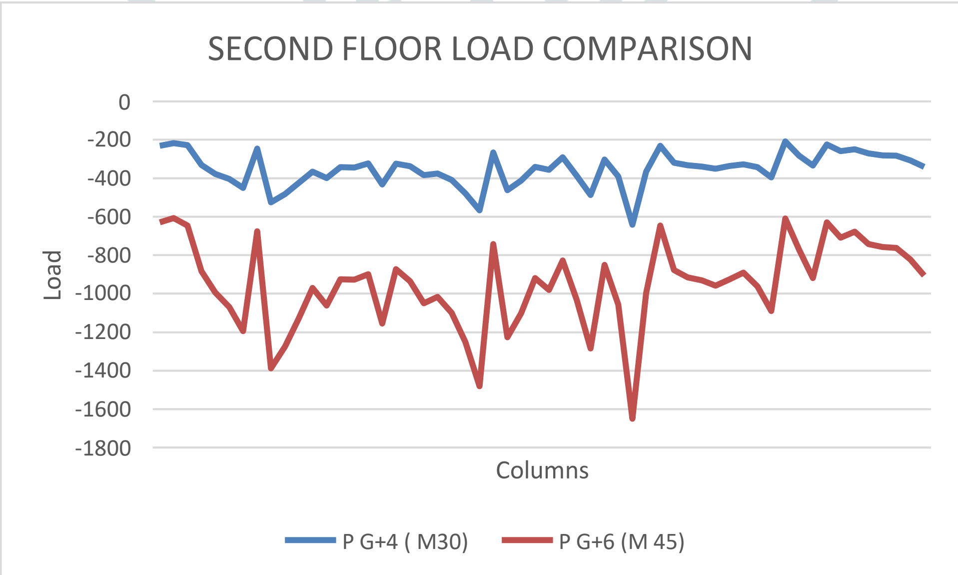

Fig 3

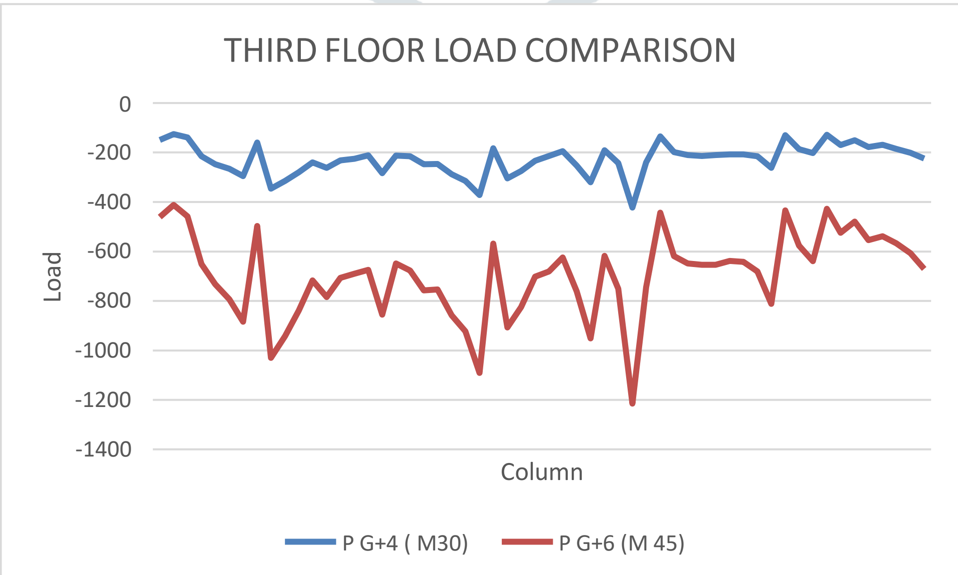

Fig 4

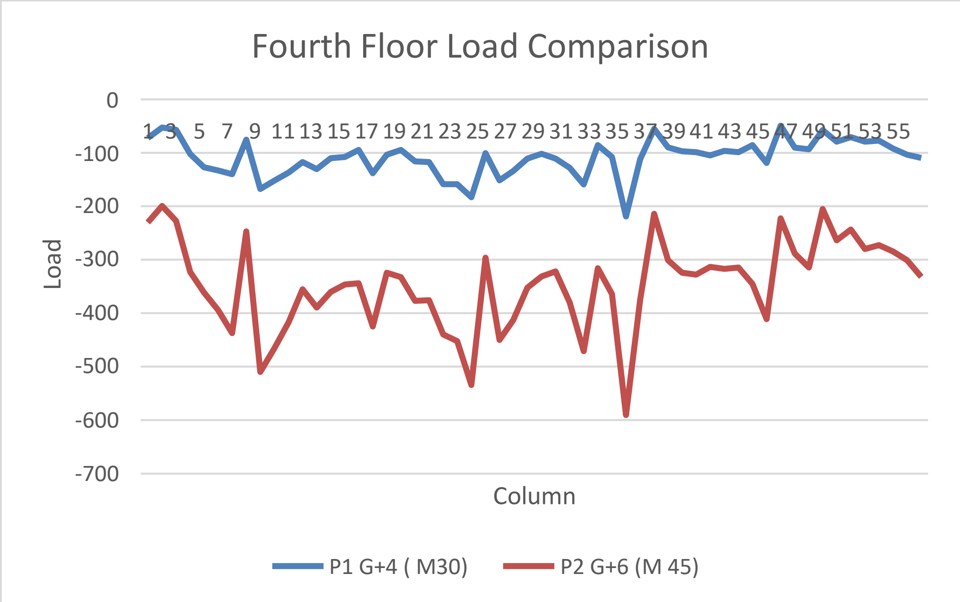

Fig 5

X. Conclusion

1. The old existing structure was designed for static load and the proposed modified RCC structure for G+4 & G+6 static analysis is carried out.

2. The sizes and depth of the foundation provided were on the lower side in all column groups with silts.

3. The grade of concrete for the existing RCC structure was M30 and upgraded to M45 for analysis purposes based on Non-Destructive test results.

4. All the brick walls (internal and external) are to be replaced with Siporex walls of not more than 150mm thick from the Stilt floor and above.

5. It can be stated that steel reinforcement provided in all column groups appears to be on the lower side.

6. After performing non-destructive tests on the existing RCC structure, it was observed that about 30% distress in the existing RCC structure.

7. To overcome existing RCC structure distress, repair activities like anticorrosive treatment on corroded reinforcement, application of corrosion inhibitors and polymer treatment, etc. were carried out.

8. As per the requirement of two additional floors from NIOH National Institute of Occupational Health, the feasibility of the existing structure was checked for additional floors. Thus, it was recommended to carry out strengthening of the foundation and column jacketing to accommodate the additional floor load.

REFERENCES

1. Singh Varinder K. "Structural Repair and rehabilitation 3 no. of (G+8) Multi-storied Buildings, at ONGC colony at Chandkheda, Ahmedabad, Gujarat" Procedia Engineering 51 Kesner Keith and Brown 2013.

2. D. Michael "Integration of NDT results into the evaluation of distressed structure" Page no 637-646, Forensic Engineering 2009.

3. Sioe Oey Hong and Aldrete J.Carlos "Simple method for upgrading an existing reinforced concrete structure" Page no 47 -50, Practice. Period. Struct. Des. Constr. 1996.

4. Bhattacharjee J."Repair, rehabilitation, and retrofitting of RCC for sustainable development with case study" Page no 33 -447. Civil Engineering and Urban Planning: An International Journal (CIVEJ) Vol.3, No.2, June 2016.

5. Rao SD V S N and J Vikranth "Promotion of seismic retrofitting for existing low earthquake resistance structure", Page no 1850-1855, S DVSN Rao et al Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013.

6. Hadi N. S Muhammad, and Rai Bagus Ida "Axial and Flexural Performance of Square RC Columns Wrapped with CFRP under Eccentric Loading" Page no 640-649, Journal of Composites for Construction Vol. 16, No. 6, December 1, 2012.

7. R. Heiyantuduwa, M. G. Alexander and J. R Mackechnie (2006) "Performance of a Penetrating Corrosion Inhibitor in Concrete Affected by Carbonation-Induced Corrosion" Page no 842 850, Journal Of Materials In Civil Engineering Casce/November/December 2006.

8. Cruz-Noguez A.Carlos , Lau T. David and Edward G. "Seismic Behavior of RC Shear Walls with Externally Bonded FRP Sheets: Analytical Studies" Page no 1-11, Journal O ASCE, ISSN 2014.