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"RETROFITTING OF EXISTING STRUCTURE"

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Abstract: *Retrofitting is a technique to improve the structural capacities including the strength, stiffness, ductility, stability of a building that is found to be deficient. It can effectively improve the performance of a building. Then the number of floors will be increase to 1 numbers above the top floor of existing building so that the building becomes G+4 floors. Because of increment of floors the load on the building will be increase so the existing columns may fail in design the failure of columns may be maximum in bottom storey, so how many number of columns fail the same will rectified by Reinforced Concrete jacketing technique, because of jacketing the column strength will be In the software each failed column will be modeled and the increased area of reinforced column can able to take an increased load so the building can raise to the above mentioned floors. Hence columns can be strengthened to carry the increased load safely. Also we repair cracks on surface of elements and walls.*

Keywords: *NDT Test, Concreting, Jacketing, Retrofitting*

1. INTRODUCTION

General

R.C.C. structure of G+3 building audited an 16/10/2022 at Bhiwandi to enlist the life of structure and to increase storeys of building by 1 floor. The building occupied with shops as commercial use at ground floor and 1st and 3nd floor is used as residential. The structure is having life of 9 years old and existing plan is of G+3. Now we are working to increase the load capacity of existing building from G+3 to G+4.

Fiber Reinforced Polymer (FRP)

A composite is generally defined as a multiphase system that consists of at least two different groups of materials which are chemically and physically distinct and separated by interfaces. It consists of one or more discontinuous phases embedded in a continuous phase. The discontinuous and continuous phases are termed as reinforcement and matrix respectively. The type and geometry of reinforcement provides strength to the matrix and the resultant composite develops properties such as high strength, stiffness, tough ness and the like which are better than the individual constituents.

Figure 1.2 FRP Bars

Figure 1.1 FRP with Reinforcement Column

Auditing

The word Audit is derived from the Latin word audile, which means to hear. Originally, it was customary for person responsible for maintenance of accounts go to some impartial and experienced persons, ordinarily judges who used to hear these accounts and express their opinion about their correctness or otherwise such persons were known as "Auditors". Thus the term auditors mean literally hearer i.e., one who hears and is used ever since the days when public accounts were accepted and approved on the basis of hearing the accounts read. Auditing is an important professional task carrying heavy responsibility and calling for commensurate skill and judgment. Keeping in view the definitions of various authors we may define the word “Auditing” as is an examination of the accounting books and the relative documentary evidence so that an auditor may be able to find out the accuracy of figures and may be able to make report on the balance sheet and other financial statements that have been prepare from there.

Figure 1.3 Half Cell Potential Test

Figure 1.4 Schmidt Rebound Hammer Test

Jacketing

Jacketing is a method of structural retrofitting and strengthening It is used to increase bearing load capacity following a modification of the structural design or to restore structural design integrity due to a failure in the structural member. This technique is used on vertical surfaces such as walls, columns and other combinations such as beam sides and bottoms. It consists of added concrete with longitudinal and transverse reinforcement around the existing column. Jacketing is the process whereby a section of an existing structural member is restored to original dimensions or increased in size by encasement using suitable materials. A steel reinforcement cage or composite material wrap can be constructed around the damaged section onto which shotcrete or cast-in-place concrete is placed. Jacketing is particularly used for the repair of deteriorated

columns, piers, and piles and may easily be employed in underwater applications. The method is applicable for protecting concrete, steel, and timber sections against further deterioration and for strengthening. Jacketing improves axial and shear strength of columns and a major strengthening of the foundation may be avoided

Figure 1.5 Jacketing on existing column

Figure 1.6 Jacketing on existing structure

2. EXAMPLES FROM THE LITERATURE

Sr. No	Author Name	Conclusion
1	Pranay Ranjan et al	The author explained the befits of FRP and SFRC over the RC Jacketing and Retrofitting by reducing dead space.
2	Mohmmad R. Irshidat et al	- On heating of RC and CFRP beams on high temperature 5000 K to 6000 K and results shows that ultimate load carrying capacities and stiffness of CFRP enhanced by 75% of unheated beam
3	Yu Fei Wu, et al	The research shown comparison of RC with FRP which is more effective to prevent buckling, increase ductility in plastic hinge zone of beam and column.
4	Y. Xiao	The process and types of retrofitting explained in the literature. For retrofitting and repairing reinforced concrete columns were investigated at the University of Southern California (Xiao et al. 1997, 1999; Ma and Xiao 1999).
5	Marston NJ	GFRP, CFRP, BFRP, are most desirable in repair/retrofit if structural elements such as beam column and slabs, which requires a high increase in strength, toughness, energy absorption, fatigue and ductility ratio, etc.
6	[Varalakshmi V et.al (2014)	As per IS 875(Part I & II)-1987 Live and Dead load and HYSD bars i.e. Fe 415 are used as per IS 1986- 1985 used for calculation
7	A.B. Mahadik et.al. (2014)	Importance of Structural Audit, life of structure as per audit report.

		And reason of earlier failure of structure
8	Mohammad Ismail (6) (2016)	Environmental factors affecting life of structure like degradation, surface salt deposits, crack formations and reinforcement corrosion etc.
9	Saiesh.L.Naik et.al., Volume: 04 Issue: 05, May(2017)	Importance of NDT test during Structural Audit. NDT method helps is testing integrity of concrete or structural member through outs its lifespan.
10	Nicholas Lawler and Maria Anna Polak	The process of FRP shear bolts for punching shear of reinforced concrete slabs. This technology is used to protect previously built reinforced concrete slab against brittle punching shear failure

3. THEORETICAL BACKGROUND

Purpose of Structural Audit

- To save human life and buildings
- To understand the condition of building
- To find critical areas to repair immediately
- To comply with statutory requirements

Visual Inspection:

The first stage of a structural audit consists of a visual inspection that should lead to the identification of defects, material degradation, deformation of any sections or interior components. If alterations, additions or replacements are needed, they should be identified during the visual inspection too. All the elements of the building are examined, including but not limited to, columns, beams, slabs, balconies, false ceilings, roofs, parapets, railings, rooms, bathrooms, kitchens, lofts, mezzanine floors, stairways, water tanks, storage, plumbing lines, drainage lines. These inspections are carried out in order to ascertain cracks/deflections in retaining walls, leakages, and concrete durability. Dampness in the walls is also inspected along with varying loads on the structure that may have occurred. Additionally, soil bearing capacity is determined through pit trials or from soil data of the vicinity.

Figure 3.1 Slab reinforcement exposure

Figure 3.2 Beam steel exposure

The above figure (a) and (b) shown corrosion in reinforcement due seepage from toilets and poor quality of material.

Analysis Report

- Recommendations for repairs based on the assessment of deterioration, breakage, and faulty materials.
- Retrofitting and restoration measures to bring the damaged components up to the required standard.
- Strengthening the current components of the building to make it more resistant to collapse and increase its load bearing capacity.
- The consultant provides the cost of labour, materials, equipment and overall services to the society in the audit report, and offers expertise on future maintenance and cost-effective measures to slow down future deterioration.

Following are the steps for repairs / Strengthening Methodology:

1. Removal of cover concrete
2. Treatment to the parent concrete
3. Treatment to the corroded steel reinforcement with supplement if required
4. Repair of cracks with suitable grouting materials
5. Building up of stable micro concrete

Instruments Adopted

TABLE 1. Instrument Adopted

Instrument	Significance of the test	Test method reference.
Pulse Velocity Meter	To Assess homogeneity of concrete	IS 516 PART 5
Schmidt Rebound	Compressive strength at surface	IS 13311 Part-2
Half Cell Potentiometer	To assess corrosion activity	ASTM-C-876 2015
Carbonation Test	To assess the depth of carbonation in cover concrete	BS:1881- Part 201-1986
Rebar Locator	To locate rebar before extracting concrete core	BS 1881 part 204

From above table as the different IS code different NDT test are required for auditing.

4. METHODOLOGY

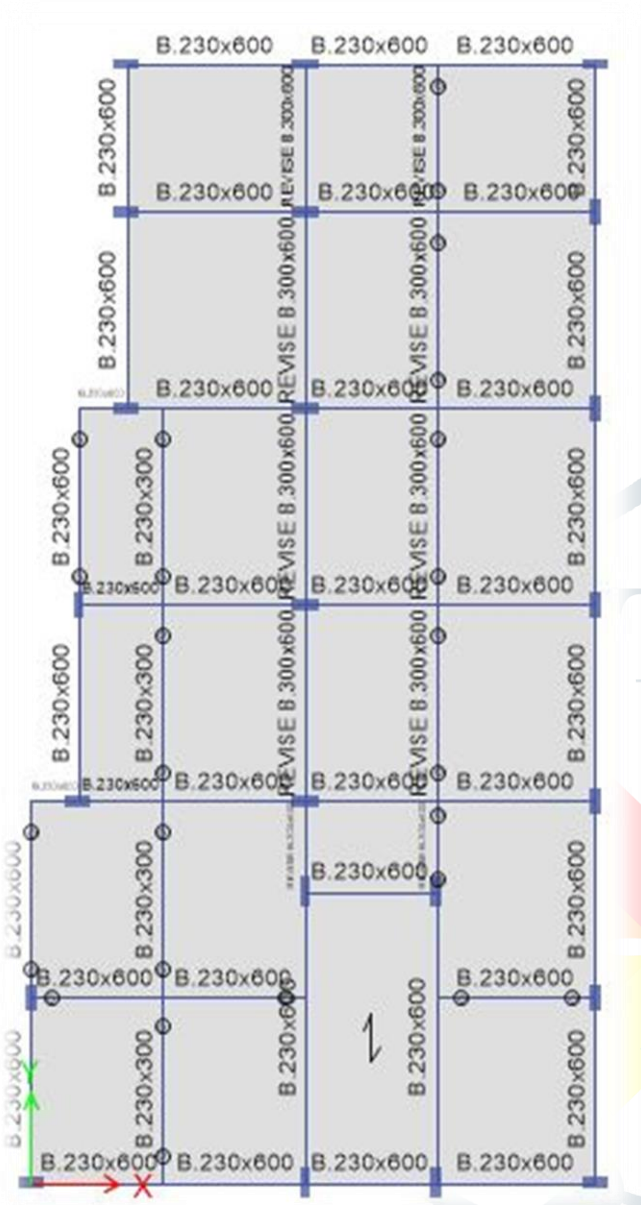

Figure 4.1 Plan View

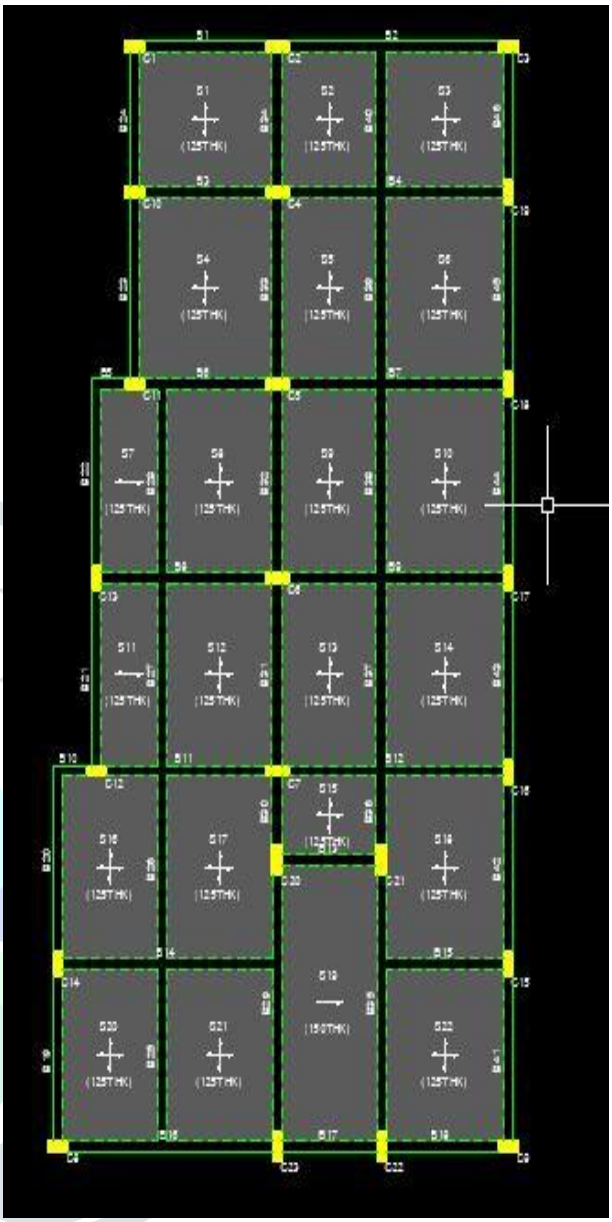

Figure 4.2 Layout of slab and beam

Design as Per IS 456:2000

Concrete frame design preference for IS 456:2000

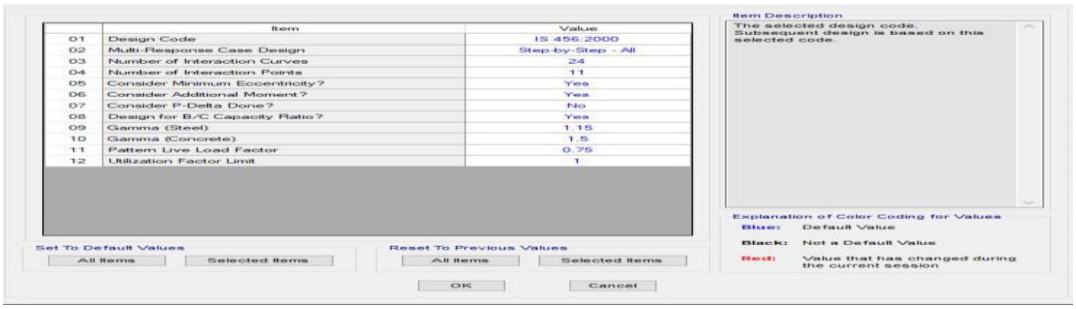

Figure 4.3 Concrete Design Data

IS Code Used

IS 456-2000
IS 15-516 (Part 5)
IS 516 (Part 5)
IS 15:13311 (Part 2 1992 reaffirmed 2008)
IS 516 (Part 5)

Overall Cost of Existing R.C.C. Structure

TABLE NO.2 Overall Cost of Existing R.C.C. Structure

Total Project Cost		
Description	Cost/Sqft.	Amount (Rupees)
Ground Floor	1220	33,34,428
1st Floor	995	27,20,596
2nd Floor	995	27,20,596
3rd Floor	995	27,20,596
Project Cost Total (Rupees)		**1,14,96,216**

Results And Recommendations

TABLE NO.3 Results And Recommendations

RESULTS AND RECOMMENDATIONS						
ELEMENTS	NAME OF TEST	UNITS	RESULT MPA	REMARK	RECOMMENDATION	MATERIAL
C1	UPV TEST	KM/S	1.18	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C1	REBOUND HAMMER	MPA	15	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C2	UPV TEST	KM/S	2.02	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C4	UPV TEST	KM/S	2.02	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-

						concerte
C4	REBOUND HAMMER	MPA	20	FAIR	Strengthening required	Durobond + Micro-Concrete
C6	UPV TEST	KM/S	2.4	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C6	REBOUND HAMMER	MPA	19	POOR	Retrofitting required	Reinforcement +Durobond + Micro-concerte
C8	UPV TEST	KM/S	2.93	POOR	Retrofitting required	Reinforcement +Durobond + Micro-concerte
C8	REBOUND HAMMER	MPA	21.5	FAIR	Strengthening required	Durobond + Micro-Concrete
C10	UPV TEST	KM/S	2.49	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C10	REBOUND HAMMER	MPA	19	FAIR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C13	UPV TEST	KM/S	3.43	DOUBTFUL	Repair required	Durobond + Ferroc Plaster
C13	REBOUND HAMMER	MPA	17	POOR	Retrofitting required	FRP +Durobond + Micro-concerte
C14	UPV TEST	KM/S	2.47	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C14	REBOUND HAMMER	MPA	17	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C17	UPV TEST	KM/S	1.91	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C17	REBOUND HAMMER	MPA	10	POOR	Retrofitting required	Reinforcement +Durobond + Micro-concerte
C18	UPV TEST	KM/S	2.42	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C18	REBOUND HAMMER	MPA	17	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C20	UPV TEST	KM/S	3.86	GOOD	Plastering required	Durobond + Ferroc Plaster
C20	REBOUND HAMMER	MPA	20	FAIR	Strengthening required	Durobond + Micro-Concrete
C22	REBOUND HAMMER	MPA	16	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C22	HCP TEST	MV	-245	DOUBTFUL	Anti-corrosion treatment and strengthening required	Durobond + Micro-Concrete

C22	CARBONATION TEST		22	46% DETERIORATION	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
C23	UPV TEST	KM/S	3.58	DOUBTFUL	Repair required	Durobond + Ferroc Plaster
C23	REBOUND HAMMER	MPA	10	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
B2	UPV TEST	KM/S	2.29	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
B2	REBOUND HAMMER	MPA	10	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
B3	UPV TEST	KM/S	1.43	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
B3	REBOUND HAMMER	MPA	10	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
S1	UPV TEST	KM/S	0.7	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
S1	REBOUND HAMMER	MPA	12	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte
S3	REBOUND HAMMER	MPA	15	POOR	Retrofitting required	FRP/Reinforcement +Durobond + Micro-concerte

Retrofitting Cost of Existing R.C.C. Structure

TABLE NO. 4 Retrofitting Cost Of Existing R.C.C. Structure

Retrofitting Cost					
	Material	Size	No's	Lump sum Amount	Total Amount
Column	Reinforcement + Durobond + Micro-Concerte	230 × 525	17	20000	340000
		230 × 600	6	25000	150000
Beam	Reinforcement + Durobond + Micro-Concerte	230 × 600	48	10000	480000
Slab	Durobond + Micro-Concrete	2733	1	150	409950
Plaster	Durobond + Ferroc Plaster	1200	1	80	96000
Total					**1475950**

4th Floor Construction Cost of Existing R.C.C. Structure

TABLE 5. 4th Floor Construction Cost of Existing R.C.C. Structure

4th Floor Extension		
Carpet Area (Sqft.)	Construction Cost (Sqft.)	Amount (Rupees)
2733	995	27,20,596
Saleable Area (Sqft.)	Sales Rate (Sqft.)	Amount (Rupees)
3826.2	2500	95,65,500
Profit		68,44,904
Cost of Retrofitting		14,75,950
Net Profit (Rupees)		**53,68,954**

5. CONCLUSION

From the above NDT results the structure life is reduced due to the corrosion in reinforcement, deterioration in concrete and cracks in plaster because of poor quality of material and execution. To increase storeys from G+3 to G+4 retrofitting with FRP/Reinforcement should be done after the working on ETABS software for load capacity.

6. FUTURE SCOPE

- With the help of SAFE software using Retrofitting foundation strengthening can be increase.
- By ETABS software using Jacketing and Retrofitting the existing structures floor can be further increase as per requirement.
- Compare the results of Destructive Test (Core cutting) and NDT Test
- Can compare the cost of demolishing and new construction of same floors with existing structure.

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