Repair and Retrofitting of Building

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Abstract: **Many existing building do not meet the seismic strength requirements of present earth quake codes due to original structural inadequacy and material degradation due to time. The case study in this paper mainly emphasizes to identify the several problems which the building faced at the time of earthquake and to analysis the building after earthquake and to redesign the plan & structure using various kind of test, such as visual survey, field work, tapping & NDT test. The codes like IS 13311(part 1,2), IS 1893:2002, IS 456 :1978 are used. This paper gives brief idea about how the process of retrofitting & repairing is carry forwarded.**

Key words: **Repair, retrofitting, field work visual survey, tapping, NDT test.**

I. INTRODUCTION

The last two decades have seen enormous changes in natural calamities. So in order to overcome thisaction, the methods like repair and retrofitting is established on the existing structure which are affected by seismic force. Repair is the activity which depends upon identification of the root cause of the deterioration of the concrete structure. If this cause is properly identified, satisfactory repair can be done for the improvement of strength and durability, thus extending the life of structure, is not difficult to achieve. Whereas, retrofitting is any change made to an existing structure to reduce or eliminate the possibility of damage to their structure from its age, erosion, high wind, earthquake. Retrofitting increase strength and stiffness of building, reduce deformation of the building and to increase the ductility of whole structure. The analysis of retrofitting structure using modern software's such as E-TAB so as to design a best and economical structure with done by methodology. The pride of country is also depending on the historical buildings which should be care by proper repair and retrofitting of structure.

A. Site Situation: -

- The building was built in 1978. The building is situated in the campus of N.I.O.H centre, Ahmedabad.
- The structure is ground plus two floor and is R.C.C. frame structure
- Structure & leakages marks & vegetation growth was observed on ceiling, columns & beam bottom
- De- bonding concrete cover was observed on slab area at various locations.

Fig-1

B. Structural Plan: -

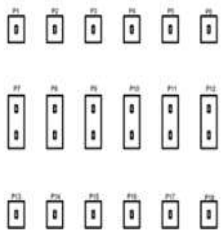


Fig-2

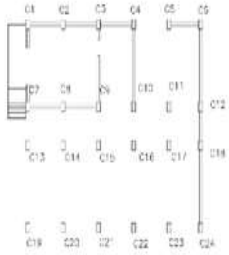
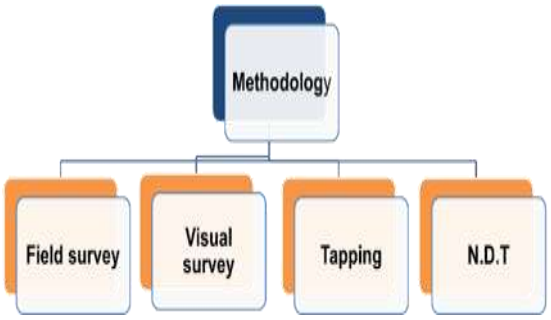


Fig-3

Fig-4

II. METHODOLOGY



A. Field work:

The work begins with the marking of the column and beam positions on the copy of drawing sheet, which was prepared for every floor. Non-destructive test in the form of rebound hammer test, ultrasonic plus velocity, corrosion test was performed.

B. Visual Survey:

Each column, beam and slab within the section was observed for a range of defects such as cracks, seepage. Basis on which survey the observation were made

1. The delamination that had taken place in the RCC walls and the RCC columns and beams.
2. II)Cracking pattern and its type whether there were separation cracks between masonry walls and the column.

C. Tapping:

Every column, beam and slab were subjected to tapping. Member in sound condition gave a clear ringing sound while, which was in stage of deterioration, gave a hollow sound. The member with hollow sound, were recorded and would be taken up for repairs.

D. N.D. T On Building:

a) Rebound Hammer Test
b) UltrasonicPulseVelocity
c) Carbonation Test
d) Corrosion Test

a) Rebound Hammer Test:

It is a surface hardness test. When a spring loaded shaft strikes a surface its rebound is a function of the hardness of surface. The force on the shaft & its rebound are developed and measured by the hammer.

The locked plunger is released by pressing gently against the hard surface and setting of the rebound number indicator on the graduated scale.

Fig-5

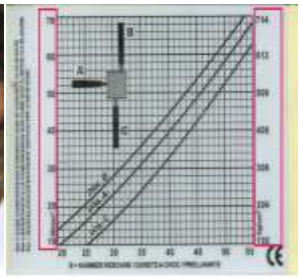


Fig-6

b) Ultrasonic Pulse Velocity Test:

Speed of sound wave varies with the density of its propagation. Concrete is a medium through which UP is made to propagate. Pulse is sent through a transmitting transducer acoustically coupled with the surface and is received by a similar transducer placed in position. The time of pulse received is measured in microsecond and displayed on lcd display of Uptight number of void is more than velocity decreases which is vice versa.

Pulse Velocity = Pulse travel path / Pulse travel time

c) Carbonation Test:

It is performed to know that at which depth the carbonated zone has reached up to. When($CA(OH)_2$)calcium hydroxide is reacted with CO_2 It gives ($CA(CO)_3$)calcium carbonate. This test wad conducted by spraying phenolphthalein on the already exposed concrete and observing the change in colour.The depth of carbonation is estimated based on the change in colour profile.

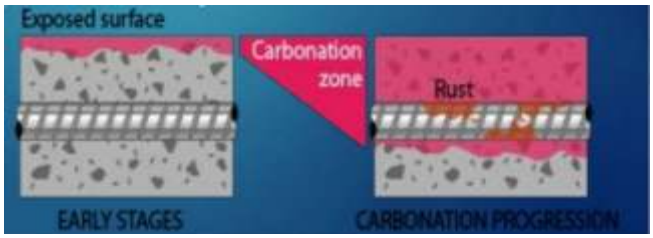


Fig 7

d) Corrosion Test:

This test is defining reinforcement corrosion presence in the existing building. This test was only carried out in the location were cracks were present in columns, slab, beams & RCC walls. This test uses hydroelectric device to find out data and thus this data are assembled by the software and contour are made by software. By this contour we determine the corrosion present in each column, beams and slabs etc. this method of determining corrosion is known as half potential test.

III. RESULTS

(1) UPV Test & Rebound Hammer Test:

RCC member columns	Ultrasonic pulse velocity test				Rebound Hammer Test			
	Velocity 1 Km/sec	Velocity 2 Km/sec	Average velocity km/sec	Method of testing	R1	R2	Average Reading	Comp. strength kg/cm^2
FOOTING								
P-1	2.0	2.2	2.1	ID	20	20	20	155
P-2	1.8	2.0	1.9	ID	18	18	18	145
P-3	1.9	2.1	2.0	ID	20	20	20	155

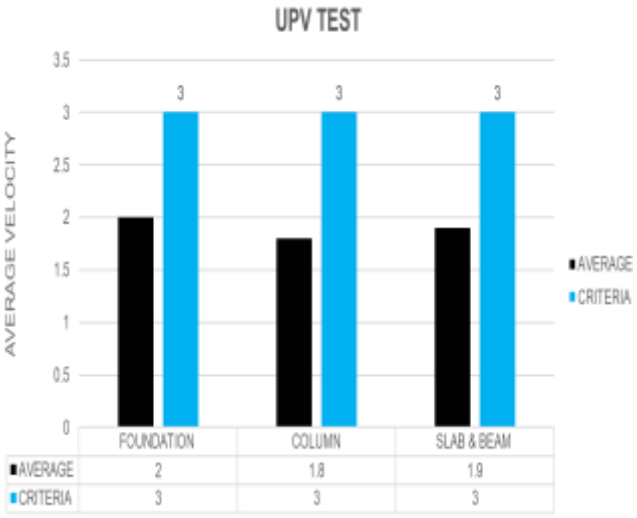
Table-1

RCC member columns	Ultrasonic pulse velocity test				Rebound Hammer Test			
	Velocity 1 Km/sec	Velocity 2 Km/sec	Average velocity km/sec	M.O.T	R1	R2	Average Reading	Comp. strength kg/cm^2
stilt floor column								
C-4	**1.8**	**2.0**	**1.9**	**ID**	**23**	**22**	**23**	**140**
C-5	**1.9**	**2.1**	**2.0**	**ID**	**22**	**22**	**23**	**140**
C-11	**1.7**	**1.9**	**1.8**	**D**	**22**	**22**	**23**	**140**
C-18	**1.8**	**2.0**	**1.9**	**ID**	**24**	**22**	**23**	**140**
C-24	**1.6**	**1.8**	**1.7**	**ID**	**23**	**25**	**24**	**160**
C-22	**1.9**	**2.1**	**2.0**	**D**	**24**	**24**	**24**	**160**
C-20	**1.6**	**1.8**	**1.7**	**D**	**22**	**22**	**23**	**140**
C-19	**1.5**	**1.7**	**1.6**	**D**	**24**	**24**	**23**	**140**
C-1	**2.0**	**2.2**	**2.1**	**ID**	**24**	**24**	**24**	**160**
C-13	**1.7**	**1.9**	**1.8**	**ID**	**24**	**26**	**24**	**160**

Table-2

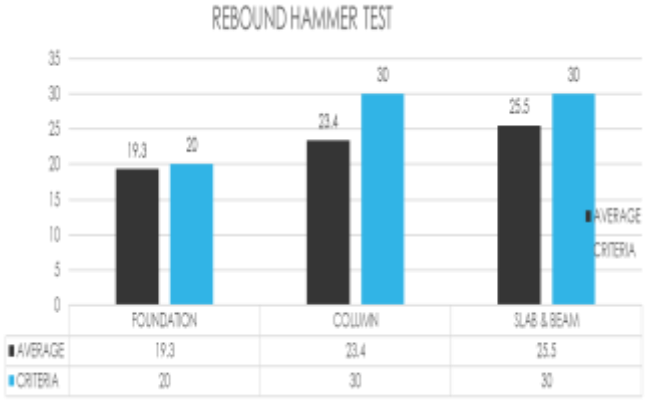
RCC member slab & beam	Ultrasonic pulse velocity test				Rebound Hammer Test			
	Velocity 1 Km/sec	Velocity 2 Km/sec	Average velocity km/sec	M.O.F	R1	R2	Average Reading	Comp. strength kg/cm^2
stilt floor slab and beam								
S-1	1.9	2.1	2.0	ID	28	26	28	140
B-1	1.8	2.0	1.9	ID	24	22	23	140
B-2	1.9	2.1	2.0	ID	26	24	25	180
B-3	1.9	2.1	2.0	ID	22	22	23	140
S-2	1.8	2.0	1.9	ID	30	28	28	140
B-4	1.6	1.8	1.7	ID	22	24	24	160

Table-3



Pulse Velocity km/sec	Quality of Concrete
Above 4.5	Excellent
3.5 to 4.5	Good
3.0 to 3.5	Medium
Below 3.0	Poor Concrete (Presence of Flaws)

Criteria for UPV test



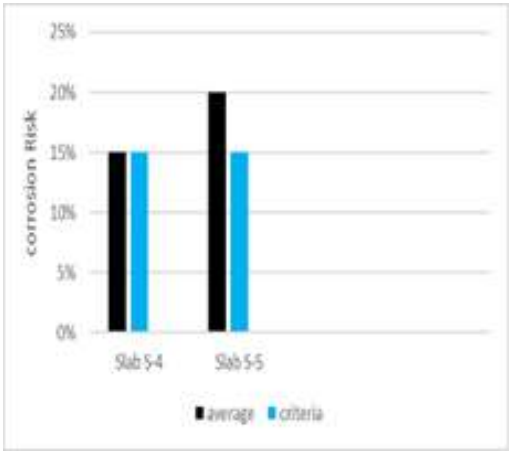
Average Rebound Number	Quality of Concrete
>40	Very Good Hard Layer
30 to 40	Good Layer
20 to 30	Fair
< 20	Poor Concrete
0	Delaminated

Criteria for rebound hammer test

(2) Carbonation Test

SR. NO	STRUCTURE & RCC MEMBER	COLOUR INDICATION	CARBONATION DEPTH IN "mm"	REMARK
GROUND FLOOR				
1.	S-4	NO COLOUR	25 MM	CARBONATION PRESENT
2.	S-5	NO COLOUR	22 MM	CARBONATION PRESENT
3.	P-1	NO COLOUR	SURFACE	CARBONATION PRESENT
4.	C-18	NO COLOUR	SURFACE	CARBONATION PRESENT
5.	C-24	NO COLOUR	SURFACE	CARBONATION PRESENT

(3) Corrosion Test:



Corrosion Risk	Potential
> 95%	More Negative than – 350mV
50%	-200 to -350mV
<15%	More positive than -200mV

Criteria for corrosion test

IV. CONCLUSION

i. Hammer Test: -The grade of concrete was found to be lower than 30(average rebound number).
ii. U.P.V Test: - The velocity was found to be 3 km/hr, due to presence of void in concrete.
iii. Corrosion Test: - Reinforcement was found about 20% at risk in column and slab of building.
iv. Carbonation Test: -The depth of carbonation was about 20-25mm in slab and whole column and footing was carbonised.

V. FUTURE SCOPE

The future scope of this work is to verify the analysis and design of existing structure based on the details and drawings as per our site visit and to check the feasibility of addition of two floors. We had carried out independent analysis of building structure using ETABS 9.5 and verified manually.

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