Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 04, April -2018

# Rehabilitation of RCC frame Building: Case Study of School Building AT Bhimora

Ankur M Goyal[1], Tejpal Goda[2], Siddharth Shah[3]

[1]Department of Civil Engineering, Marwadi University
[2]Department of Civil Engineering, Marwadi University
[3]Department of Civil Engineering, Marwadi University

**Abstract** - *the purpose of rehabilitation is providing the deteriorated strength of existing structural member. The present study is focused on the rehabilitation of an existing school building, finding deficiencies, providing appropriate rehabilitation and obtaining performance of a rehabilitated RCC Building. Various Structural health evaluation techniques e.g. rebound hammer test and Ultrasonic pulse wave test can be performed as a part of the primary inspection of the building. It helps to ensure the deficient structural members. Other aims of this work to understanding various structural damages and their remedial measures of that deterioration. As per the recent strength of member's suitable method will be suggested for the various deteriorated structural member. After identifying the structural member, suitable rehabilitation method will be adopted.*

***Keywords****: structural evaluation, Building, Rehabilitation, Structural deterioration, NDT Testing, RCC structure*

## I. INTRODUCTION

As the time passes strength of concrete will be reduced due to corrosion, carbonation, alkali acid attack, earthquake, and different environmental condition. The structure can be deteriorated due to various reasons like quality of concrete ingredient, poor workmanship, poor maintenance, structural design problems, various loadings acting on the structure. For structural strength improvement, it is essential to get an idea about the reasons of distress. According to this reasons and amount of deterioration most appropriate strength improvement technique will be adopted. To overcome this damages, repair, rehabilitation and retrofitting are the different methods for structural health improvement.

Present work is focused on rehabilitation of RCC frame building. For finding current condition of the concrete and recent strength of concrete Non Destructive test is conducted. As par the results of NDT testing and visual inspection of building appropriate rehabilitation method will be adopted for the various deterioration of the building.

## II. CONCEPTS OF REPAIR, REHABILITATION, AND RETROFITTING

**A. Repair:** This is a process to regain the architectural shape of building to resume the functioning of building as it functions at the time of construction. Repair does not affect structural strength but the only improvement in the outer surface of building member. For achieving the goals of repairing, it is essential to consider the several factors distressing the building member.

**B. Rehabilitation:** Structural rehabilitation is to upgrading deteriorated strength of building member up to its original strength. It is found in study almost in all cases structural strength improvement by rehabilitation is always cheaper than the demolishing and construction of new building of same attributes.

**C. Retrofitting:** Retrofitting is the process in which structure is newly designed for the new purpose. It is necessary to improve the performance of structure due to deterioration or which have crossed their estimated lifespan. Retrofitting is also termed as reconstruction.

## III. SOURCES AND REMEDIES OF DISTRESSES

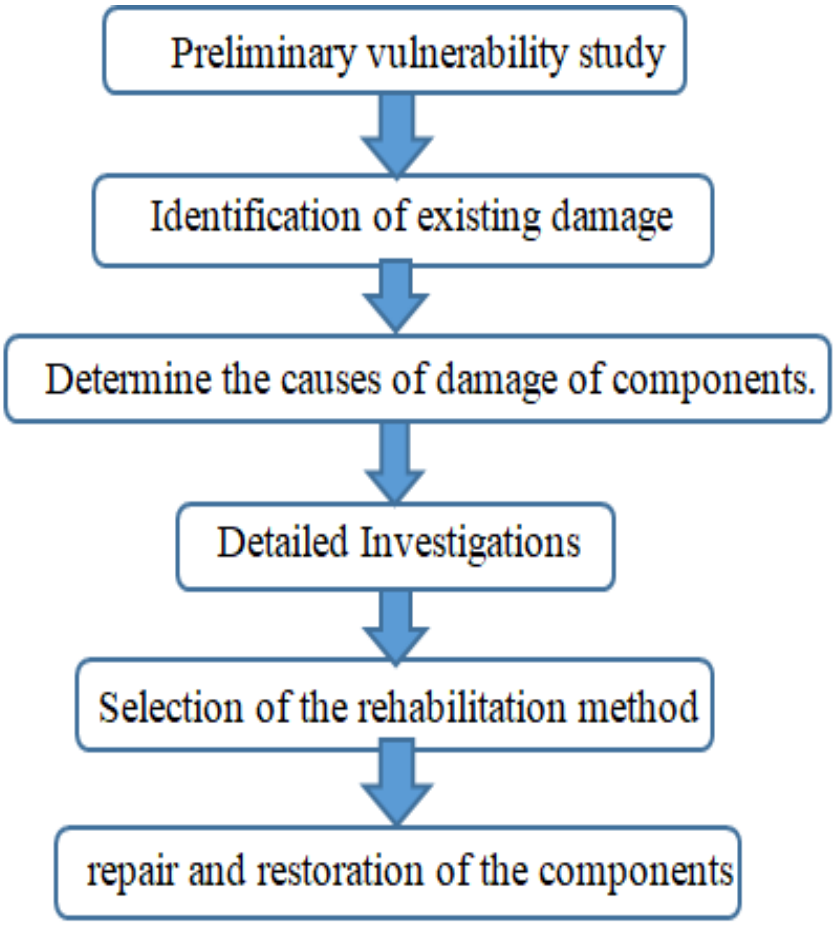
- Improper workmanship: due to not implementation of proper design specification and not followed standards while construction.
- Error in design: Error remains present in the design
- Change in design load: Excessive load then designed load acting on the structural member
- Temperature stress: According to temperature change some stresses will be generated in member

- Corrosion effect: Corrosion is root causes for so many types of deterioration.as the time passes; this will be the main problem of structure.
- Carbonation
- Weathering action: this will lead to spalling of concrete, cracks, deterioration of plaster

## IV. EVOLUTION OF STRUCTURE

Followings are the steps for evaluation of structure[4]




Non-Destructive Testing (NDT), Semi Destructive Testing and Destructive Testing are the methods used for evaluation of structure. Here Non- Destructive testing methods are used for evaluation of structural members. These non- Destructive testing methods can be used for new and old structures both. This will measure the recent strength of existing building without causing damage to the structure[5].

Some circumstances where NDT is useful, are as follows:

- Quality control of precast units or construction in situ
- Location and determination of the extent of cracks, voids, honeycombing and defects within a concrete structure
- In Determining the concrete homogeneity, possibly to use core cutting
- In Determining the position condition and alignment of reinforcement

### 4.1 Rebound hammer test:

Schmidt rebound hammer works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges [8]. There are a theoretical relationship concrete strength and rebound number of the hammer. Hence with the help of empirical correlations, one can find the strength of the concrete. This rebound hammer gives a surface hardness of concrete.

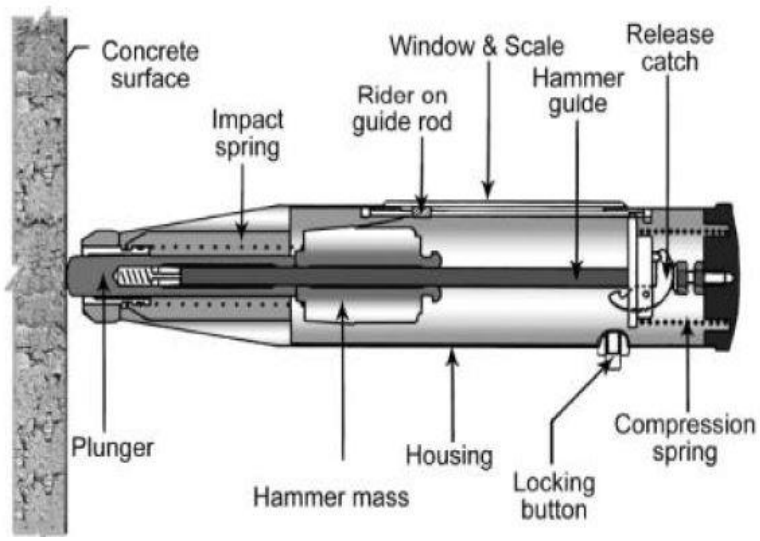



***Figure 1 Rebound Hammer Testing Apparatus***

**4.2 Ultrasonic Pulse Velocity Test:**

As testing equipment, receiver, transmitter, and source with the display are used. Transmitter propagates energy in the form of an ultrasonic pulse, travel through the concrete material and reaches to the receiver. As the energy received at receiver the uniformity of material is measured. According to the situation of concrete member, there are three methods available: Direct, Semi-direct and Indirect. To reduce reflection at the boundaries grease or cellulose paste is used as liquid coupling material. According to elastic modulus and concrete strength, ultrasonic pulse velocity is influenced. And Prediction of concrete is done according to Ultrasonic Pulse Velocity value.[9] [10]

***Figure 2 Ultra Sonic Pulse Velocity Test apparatus***

**4.3 Rebar Locator:**

Rebar locator is equipment which is to find reinforcement spacing, diameter, clear cover in concrete member. Also with the help of this rebar locator equipment, the increase in diameter of reinforcement bar can also found.

**4.4 Carbonation Test:**

Carbonation refers to a reaction between carbon dioxide and alkalis in pore solution of the cement paste. As a result, the pH of the pore solution decrease and this will also decrease the passive coating on reinforcing steel. Hence steel becomes susceptible to corrosion.

$Ca(OH)_2 + CO2 \text{ ---> } CaCO3 + H2O$

$2NaOH + CO2 \text{ ---> } Na2CO3 + H2O$

Many factors such as mixture proportion, type of cement, water cement ratio, weather condition, permeability are effect to carbonation of concrete.

## V. REPAIR APPROACH

The following approach is adopted for rehabilitation of the building.

a) Removal of deteriorated plaster /concrete.
b) Removal of corrosion on steel reinforcement by mechanical and chemical action (also provide new steel reinforcement) and further use of corrosion Inhibitor material.
c) Use of bond coat of acrylic polymer – cement mix to make the proper bond between old and new concrete or mortar.
d) Repair of RCC columns, beams, slabs by polymer modified rich mortar.
e) Jacketing of columns with rich concrete if required.
f) FRP wrapping for increase strength
g) Crack sealing in masonry walls with polymer modified rich mortar.
h) Re-plaster and acrylic paint on the exterior wall.

## VI. REPAIR PROCEDURE

The repair of the structural member was carried out as follows,

### 6.1 Removal of deteriorated plaster/ concrete

At the areas, where plaster/ concrete cover had spalled down e.g. Exterior wall, slab, soffit of the beam, column corners and loose concrete material should be removed. The beams and slabs were supported with props before removing of deteriorated concrete. Loose concrete covers at columns corners should be removed by tempering by hammer manually. All dust and loose particles resulting from such pretreatment were removed by washing with water under pressure.

### 6.2 Removal of corrosion on steel reinforcement

Corrosion on steel should be removed first by light hammering and manual chipping. If steel corroded more than the half of the diameter of the rod, then entire steel reinforcement should be replaced with new reinforcement bar of the same diameter. Then one coat of rust remover was applied all around the steel rebar. This rust remover will remove all oxide from surface chemically. Then one coat of corrosion inhibitor is used to prevent steel from further corrosion on steel.

### 6.3 Use of bond coat of acrylic polymer

All surfaces prior to application of bond coat were thoroughly inspected and made free from any deleterious materials such as oil, dust, dirt etc. Use of bond coat of acrylic polymer will make the proper bond between old concrete and new concrete.

### 6.4 Repair of RCC columns, beams, slabs by polymer modified rich mortar

There are no codes/standards available for preparation of polymer modified mortar for rehabilitation of concrete structures. The building was originally constructed with M-20 with minimum strength requirement of 20 $N/mm^2$. So for repairing work rich polymer modified mortar have a compressive strength of minimum 25 $N/mm^2$. So that it can withstand all weathering conditions and provide proper cover to old concrete.

### 6.5 Crack sealing in masonry walls with polymer modified rich mortar

Before starting repairing treatment, it is necessary to remove loose dust, mortar, and concrete by wire brush. The plasticized expanding grout admixtures along with Styrene Butadiene Rubber (SBR) polymer was used for sealing of masonry wall cracks. The SBR and acrylic having the same specification were added to grout admixture for increasing bonding with cracked masonry inside.

### 6.6 Re-plaster and acrylic paint on an exterior wall

To prevent further deterioration and weathering effect re-plastering is used for the slab, parapet, exterior walls. For re-plastering of member rich quality cement mortar with acrylic paint is used.

## VII. REHABILITATION METHODS

### 7.1 FRP wrapping for strengthing of beam and columns

Cracks can be generated Due to design errors, overloading then design load and deterioration by weathering action. So cracks and deflection of members can be prevented by wrapping on the member. Glass fiber wrapping and carbon fiber wrapping are the methods according to the material used for wrapping. Different wrapping pattern and method is used as per the strength requirement[11].

### 7.2 Jacketing of columns with rich concrete

The main aim of Jacketing is to increase section modulus by increasing size of the element. Columns were jacketed with new rebar and jacketing with concrete is about 75mm all around to increase its strength and stiffness and to protect reinforcement from further corrosion.

## VIII. REFERENCES

[1] Varinder, K. Singh " Structural Repair, and Rehabilitation of 3 no. (G+8) Multi-Storeyed residential Building, at ONGC colony at Chandkheda, Ahmedabad, Gujrat."
[2] Anand S. Arya, Ankush Agarwal Guidelines on "Condition Assessment of Building for Repair and Upgrading." – June 2007.
[3] Jen-Chei Liu, Mou-Lin Sue and Chang-Huan Kou "Estimating the Strength of Concrete Using Surface Rebound Value and Design Parameters of Concrete Material" Tamlang Journal of Science and Engineering Vol. 12, No. 1, pp. 1-7 (2009)
[4] Swapnil U Biraris, Aishwarya G Gujrathi, Abhishek D Pakhare, Anjali N Satbhai, Pournima K Vispute "Structural Audit of Old Structures" International Journal of Engineering Trends and Technology (IJETT) – Volume- 43 Number-3 – January 2017.
[5] Nikhil L.Jagtap, Prof. P. R. Mehetre "Study on Retrofitted R.C.C. Building by Different NDT Methods" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) (May – Jun 2015)
[6] CPWD Handbook on Repair and Rehabilitation of RCC Structure, Central Public Works Department (CPWD), Government, New Delhi, 2002.
[7] Guide for Evaluation of Concrete Structure Prior to Rehabilitation (ACI 364. 1R-94(99)), By ACI Committee 364, Rehabilitation – 1999.
[8] IS 13311 (Part 2): 1992, Non-Destructive Testing of Concrete – Methods of Test, Part – 2, Rebound Hammer, Bureau of India Standards.
[9] IS 13311 (Part 1): 1992, Non-Destructive Testing of Concrete – Methods of Test, Part – 1, Ultra Sound Pulse Velocity, Bureau of India Standards.
[10] Handbook on Non-Destructive Testing of Concrete, Second Edition, Edited by V.M. Malhotra and N.J. Carino, CRC Press LLC, 2004.
[11] Giovanni Martinola , Alberto Meda , "STRENGTHENING AND REPAIR OF RC BEAMS WITH FIBER REINFORCED CONCRETE" Cement & *Concrete Composites 32 (2010) 731–739, 2010*