International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

Condition Assessment and Structure Analysis of Administrative Building in Engineering College, Nagpur

Shubham.P.Ghutke[1], Dr.D.P.Mase[2], Dr, V.G. Meshram[3]

[1]Shubham.P.Ghutke Department of Civil Engineering Yeshwantrao Chavan College of Engineering Nagpur, India
[2]Dr. Dilip Mase Chartered Engineer, P.T.MASE & ASSOCIATES Nagpur, India
[3]Dr .V. G.Meshram Department of Civil Engineering Yeshwantrao Chavan College of Engineering Nagpur, India

---

Abstract - *Structure is a assembly of members that transfer superimposed load to the sub substructure. We often see many old structures in our surrounding that are 30 years old or even more. In order to ensure serviceability and safety of such structures nondestructive tests are carried out. Nondestructive testing gives us idea of present condition of structure. Basic principle of nondestructive testing is to evaluate the strength of member in a structure without any destruction in the structure so that structure can be serviceable to the client.*

In this paper condition assessment of a college building located in Nagpur city is carried out. In this case Nondestructive as well as Destructive test had been carried out. Results of these test have been included in this paper. Here we tried to investigate the strength of the columns, with NDT and structure is analyzed on the staad pro v8i software. Condition assessment was done to ensure the stability of the structure as the management wants to construct one more floor on the existing structure. Columns that fail during analysis of the structure are recommended for jacketing and design of jacketing is also included in the study.

Nondestructive testing method such as Rebound Hammer Test, Ultrasonic pulse velocity (UPV)test, ph test, Half-cell potentiometer test have been carried out, and Destructive test-core cutting test was also carried out.

***Key Words*: Strength, Non-destructive Testing, Destructive test.**

1. INTRODUCTION

Non-Destructive Testing (NDT) is a technique that is widely practiced to evaluate present strength of a structure without destroying any member within the structure. Any kind of damage in a structure can affect present as well as future performance of structure, therefore, it's necessary to examine the structure from time to time to ensure the safety of lives. Non-destructive testing helps in mapping the defects without damaging or destroying the member in a structural. These audit highlights the high-risk area that has to be repaired immediately.

As per the municipal corporation, structures with age between 10 to 30 years audit has to be done after every 5 years and structure more than 30 year of age audit has to be done after every 3 years.

1.1 Objective of the Case Study

Administrative department building of engineering college in Nagpur is the proposed structure of which condition assessment is to be carried out.

Existing structure was constructed in year 1983.

Management wants to extent one more floor on the existing structure, hence the condition assessment of existing structure is carried out, to ensure strength of structure.

2. METHODOLOGY

2.1 Rebound Hammer Test

Rebound hammer test gives the compressive strength of the concrete. Rebound hammer is held perpendicular to the testing surface. When the hammer is pushed in the direction of the surface the main spring is stretched when the body is pushed to the limit the latch is automatically released and the energy of spring pushes the hammer mass towards the plunger tip. The mass rebounds after the impact with the plunger rod.

These rebound distances is measured on the scale and is termed as rebound number. This rebound no gives probable compressive strength by using standard graph.

The device measures the rebound value R which have a specific relation between this value and the hardness and strength of concrete. The direction of hammer with the surface can be horizontal, vertically upward or vertically downward. As per IS:13311 Part-2, the accuracy of prediction of concrete strength in a structure by rebound hammer test is found to be +/-25%.

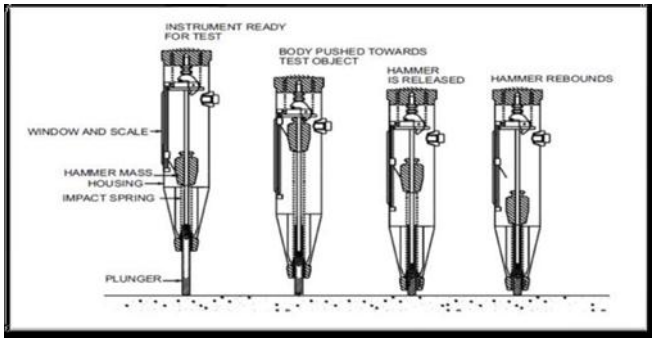

Fig-1: Rebound hammer

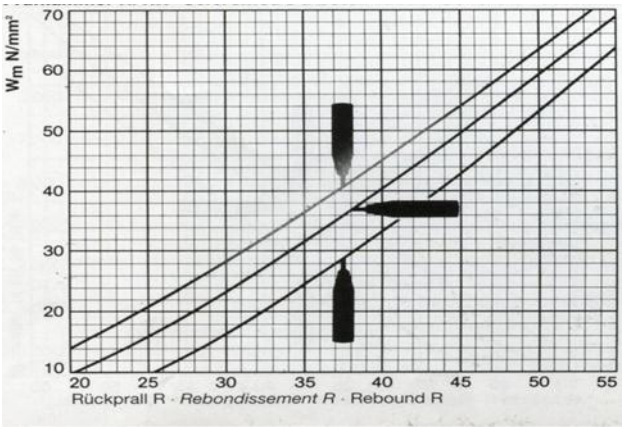

Fig-2: Rebound graph

Table -1: Rebound criteria for quality of concrete grading

Average Rebound	Quality of Concrete
>40	Very Good hard layer
30-40	Good
20-30	Fair
<20	Poor concrete
0	Delaminated

2.2 Ultrasonic Pulse Velocity Test

Ultrasonic Pulse Velocity Test is conducted to evaluate the quality of concrete, and to detect the presence of cracks, voids and other imperfections in structure.

This is one of the most commonly used test methods in which the ultrasonic pulses generated by electro- acoustical transducer are transmitted through the concrete & received by receiver on the other end. The time taken by the pulse to travel through concrete is measured on the devise itself. The distance between first and second prob is called the pathlength. The ratio of path length to transit time gives the velocity. The ultrasonic pulse velocity is influenced by path length, lateral dimension of specimen tested, presence of reinforcing steel, and moisture content of the concrete.

The various method of performing ultrasonic pulse velocity through concrete are

- Direct Transmission (Cross Probing).
- Semi-Direct Transmission.
- Indirect Transmission (Surface Probing)

The instrument used for testing is Canopus CUTE 103

Table -2: Velocity Criteria for Quality of Concrete Grading

Pulse Velocity	Quality of Concrete
Above 4.5 Km/Sec	Excellent
3.5 - 4.5 Km/Sec	Good
3.0 - 3.5 Km/Sec	Satisfactory
Below 3.0 Km/Sec	Doubtful

Fig-3: Ultrasonic Testing Machine Canopus

Fig-4: Ultrasonic Pulse Velocity Test Machine

2.3 Half Cell Potentiometer Test

Half-cell test is used determine the probability of corrosion associated with steel in concrete. The apparatus given by ASTM C876 which include copper or Copper Sulphate electrode or silver or silver chloride electrode for half-cell test.

Half-cell makes electrical contact with concrete by means of porous plug and sponge. One end of wire is connected to steel reinforcement after it's cleaned and other end is connected to standard electrode and readings are noted as seen on voltmeter. More negative value indicated the higher is the bar corroded.

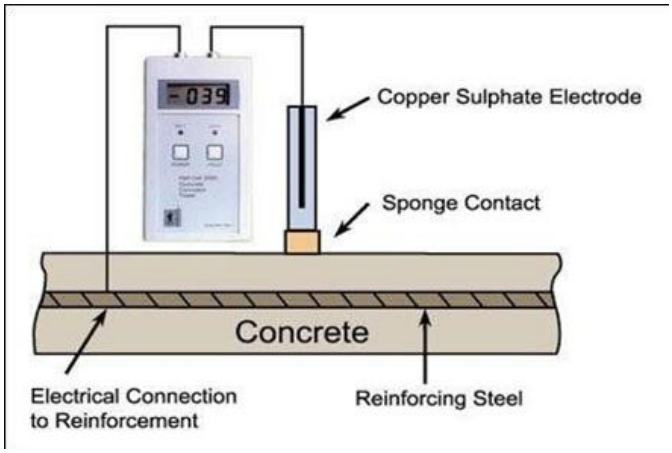

Fig-5: Schematic View of Half Cell Potentiometer

Table -3: Corrosion condition of Reinforcing Bar

Copper / Copper Sulphate	Corrosion Condition
> -200 mV	Low (10% chances)
-200 to -350 mV	Intermediate
< -350 mV	High (<90 %)
< -500 mV	Severe Corrosion

2.4 PH test

These tests is carried out to evaluate the PH of concrete sample Collected from the member. When ph value is less than 9 the Sample becomes acidic which indicates that the passivity of the steel is lost. The level at which the ph of concrete is above 9 indicates alkalinity to provide passivity to steel.

Carbonation test is done to know whether there is sufficient thickness of un carbonated concrete to protect the reinforcement. But even if the carbonation is observed deeper than the reinforcement, the reinforcement will only corrode if there is enough moisture in the concrete.

2.5 Core test

Core tests involve taking the actual core samples from the structure using the diamond core cutting bits and subjecting the cores to compressive loading in the Compression Testing Machines, followed by the visual inspection.

Core tests are conducted in conformance with the guidelines laid out in IS: 456.

UPV test is also carried out on extracted core samples.

3. Test Results

3.1 Rebound hammer test results

Table -4: Rebound hammer test results

Sr. No.	No. of Points	Rebound number		
		Max	Min	Avg
First floor				
1	126	31	21	26
Ground floor				
2	36	33	22	27.5
Lower Ground floor				
3	45	32	24	28

As per Rebound Hammer Test results it is observed that maximum readings are confirming to M10 to M27 grade of concrete that indicated the poor quality of concrete.

3.2 Ultrasonic Pulse Velocity Test Results

Table -5: UPV Results

Sr. No.	No. of Points	Ultrasonic Pulse velocity Test (Km/SEC)		
		Max	Min	Avg
First floor				
1	130	4.2	2.6	3.4
Ground floor				
2	120	4.4	2.4	3.4
Lower Ground floor				
3	50	3.8	2.7	3.25

As per Ultrasonic Pulse Velocity test results it is observed that the quality of concrete is good and medium at maximum locations & doubtful at few locations. The readings are taken with direct and indirect method and as per IS 13311 (Part 1) indirect readings give less pulse velocity than direct method generally by 1Km/sec. All the readings given are factored.

3.3 Half Cell Potentiometer Test Results

Fig-6: Half Cell Potentiometer Test.

Table -6: Test Results

Sr. No.	Description	Half Cell Potentiometer Test	
		Half Cell Readings (mV)	Average (mV)
1	Ground floor	-343,-340,-349,-350,-347,-341,-342,-343,-340,-351	-344.6

As per half-cell potentiometer test on reinforcement it is observed that the readings are between -340 MV to -351MV which indicates the minor corrosion has started in reinforcement & well within the acceptable limits.

3.4 Core Test

Table -7: Core test results

Sample	Equivalent Cube Strength Mpa
Sample 1	11.47
Sample 2	13.98
Sample 3	19.95
Sample 4	14.20
Sample 5	17.64

As per core test the compressive strength of concrete ranges from M11to M20.

4. Staad Analysis

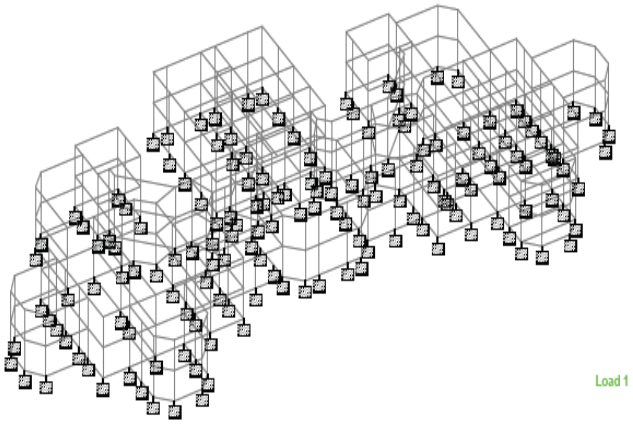

Fig-7: Existing structure model

The existing G+1 structure. This structure is analyzed considering grade of concrete M20 and grade of steel Fe415. Actual sizes of column is considered during analysis.

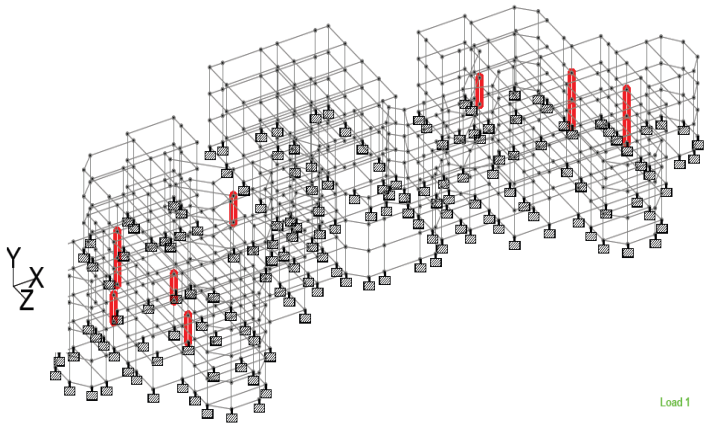

Fig-8: Highlight of columns for which reinforcement % exceeds maximum limit.

In this model one floor is added on the given Model 1 design, Model 2 is G+2. Proposed floor is of the Grade M25 concrete and Fe500 grade steel.

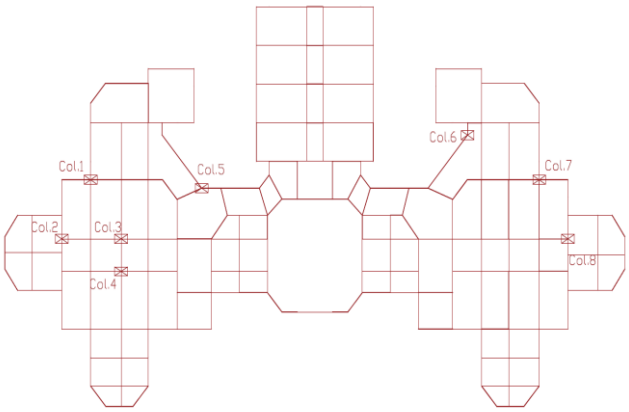

Fig-9: Layout plan for column to be jacketed

Table-8: Axial forces on column

Column	Pu in KN
Col.1	1846.403
Col.2	1213.33
Col.7	1759.027
Col.8	1067.438
Col.5	947.207
Col.6	678.858
Col.1	1846.403
Col.7	1759.027
Col.8	1067.438
Col.4	2416.548
Col.3	2156.267

5. Column Jacketing

Column jacketing design using 15988 -2013

Design of column no 8 (230x400)

Compressive strength of concrete Fck - 25 Mpa

(New)

Compressive strength of concrete Fck - 20 Mpa (old)

Yield strength of Main and secondary steel Fy – 500 KN/m^2

Pu – 1067.44 KN

Mz –197 KNm

Old dimension of column – 230x400 mm

Assume area of steel Asc = 0.8% of gross area

According to 8.5.1.2 (a) of IS 15988: 2013, Concrete strength shall be at least 5 MPa greater than the strength of the existing concrete.

* Pu = 0.4 x Fck x Ac + 0.67 x Fy x Asc

*1067.44 x 10^3 = 0.4 x 25 x Ac + 0.67 x 500 x (0.8%Ac)

*Ac = 84182.96 mm^2

According to 8.5.1.1 (e) of IS 15988:2013

* Ac = 1.5Ac'

* Ac = 1.5 x 84182.96 mm^2

* **Ac = 126274.44 mm^2**

Assume B = 300 mm therefore D = 126274.44/300 = 420.9 ≈ 450

Thickness of jacketing = [new dimension of column – old dimension of column]/2

B = [300-230]/2 = 35 mm

D = [450-400]/2 = 25 mm

According to the code, Minimum jacket thickness shall be 100 mm as per 8.5.1.2 (c) of IS 15988:2013

*Provide thickness of 125 mm

Revised size of column B = 230+125+125 = 530 ≈ 550 mm

D = 400+125+125 = 650 mm

Adapt Size = 550x650 mm

Area of steel = 0.8% x 550 x 650 **= 2860 mm^2**

But according to 8.5.1.1 (e) IS 15988:2013, As = (4/3) As'

* As = 4/3 x 2860 = 3813.34 mm^2

Assume 20 mm diameter bars

No of bars = 3813.34 / π/4 x 20^2 = 12.144 ≈ 14

Provide 14 nos of 20 mm dia main steel.

Design of lateral ties –

As per 8.5.1.2 (e) of IS15988: 2013, Minimum diameter of ties shall be 8 mm and not less than one third of the longitudinal bar diameter.

Diameter of bar =1/3 of Ø

bar =1/3 x 20 = 6.67mm ≈ 10 mm

Spacing of ties as per 8.5.1.1 (f) of IS 15988:2013- The code suggests that the spacing, of ties to be provided in the jacket in order to avoid flexural shear failure of column and also to

provide adequate confinement to the longitudinal steel along the jacket is given as:

S = fy x dh^2 / √(fck) x tj

Fy = yield strength of steel

Fck = compressive strength of concrete

dh = diameter of bar

tj = thickness of jacket

s = 500x10^2 / √25 x 125

s = 80 mm

provide 10 mm bar @ 80 mm c/c

Dowels which are epoxy grouted and bent into 90° hook shall also be employed to improve the anchorage of new concrete jacket. (Referred to IS 15988: 2013 cl. 8.5.1.1.h)

Provide 10 mm diameter shear connector @ 300 mm c/c as shown in figure below.

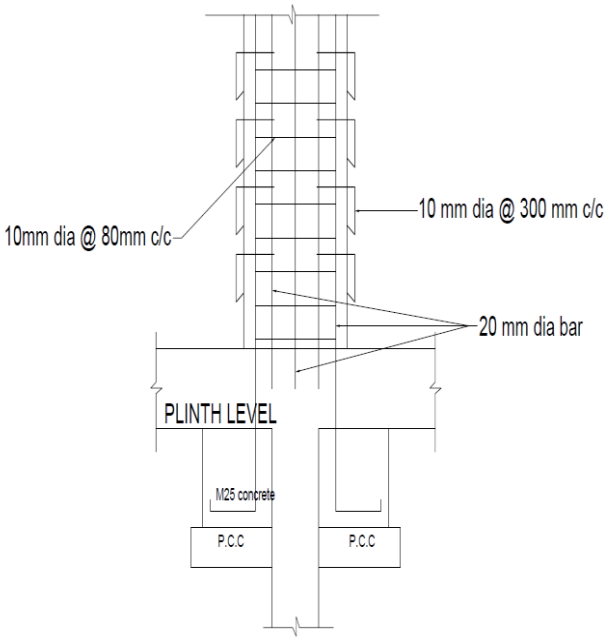

Fig-10: RCC column jacketing details

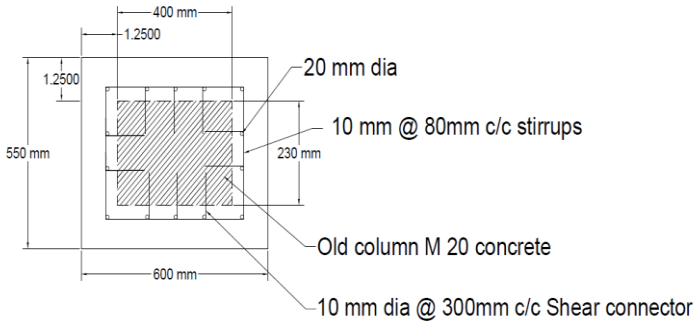

Fig-11: cross section of column

6. CONCLUSIONS

In this paper various Tests have been performed on existing structure such as Rebound Hammer Test, Ultrasonic Pulse Velocity Test, Half-cell Potentiometer Test, Ph and carbonation test and core test. After interpretation of all the test result. It is observed that the quality of concrete is good and medium at maximum locations & doubtful at few locations.

As per the Rebound Hammer test Ref. IS 13311 (part II) 1992. The maximum readings are confirming to M10 to M27 grade concrete.

Construction of second floor with jacketing of the columns from the foundation is recommended.

ACKNOWLEDGEMENT

I would like to thanks to Pofessor V. G.Meshram and Dr. Dilip.P.Mase, Director, P.T. Mase & Associates to give me this opportunity to work for this project and technical support on “Non Destructive Testing of college building ".

REFERENCES

[1] Preethi Venkatesh, Mallika Alapati, ‘Condition Assessment of Existing Concrete Building Using Non-Destructive Testing Methods for Effective Repair and Restoration-A Case Study’. 27 October 2017.Civil Engineering journal.

[2] Saiesh.L.Naik , Basavraj Saunshi ‘Structural Audit Of Rcc Building’ Volume: 04 Issue: 05 | May -2017,Irjet.

[3] IS 15988-2013, Seismic evaluation and strengthening of existing reinforced concrete building – guidelines.

[4] IS 13311:1992 (Part 2); ''Indian Standard code of practice for Non Destructive Testing of Concrete-Method of test ''(Rebound Hammer).

[5] IS 13311:1992 (Part 2); ''Indian Standard code of practice for Non Destructive Testing of Concrete-Method of test ''(Rebound Hammer).

[6] Dipali M. Kukade, Apoorva Kitey, Dr. Dilip P.Mase," Non Destructive Testing of Old R.C.C. Framed Structure", International Research Journal of Engineering and Technology (IRJET) Volume: 06 Issue: 04 | Apr 2019