International Journal of Emerging Trends in Engineering and Basic Sciences (IJEEBS)
ISSN (Online) 2349-6967
Volume 7, Special Issue 4 (July-August 2020), PP. 134-144

STRUCTURAL AUDIT OF 40 YEARS OLD BUILDING

Jayesh Kamwani, Divya Dhomane, Anurag Falnikar, K. R. Bele
Department of Civil Engineering, Priyadarshini J.L. College of Engineering, Nandanvan, Nagpur, India.

ABSTRACT: It is difficult for the engineers to overcome the need for develop the infrastructure. Due to this quality of construction is compromised to large extent. That is why now-a-days testing and quality checkup are important at several stages during the life span of the structure. Existing structure is situated at Nagpur, Maharashtra which was constructed in 1978. It is multi storeyed building Lal Imaarat 02 (G+3) RCC framed structure which is used for accommodation to the police constables. The methodology we adopted Ultrasonic Pulse Velocity test for analyzing homogeneity of concrete, presence of cracks, voids and other imperfection. The Rebound Hammer test is for analyzing compressible strength. The Cover Meter Test for locating and detecting bar location and spacing. Half Cell tests are used for calculating corrosion level of reinforcement. Carbonation Test for knowing the availability of carbonation in concrete. From all the tests it is recommended that the existing structure is needed to repair and retrofitting immediately.

KEYWORDS: Condition Assessment, NDT mring, Priyadarshini J.L. College of Engineering, Nandanvan, Nagpur, India.

I. INTRODUCTION

The property maintenance and repair of the civil infrastructure plays a crucial role for increasing the life span of building. The quality checkup and review are important at several stages during life of the building. Structural Audit is the first step for repair of the building. Structural Audit helps to correctly identify parts or section of the building that may need of immediate repair, renovation or replacement. Structural Audit is government mandated for the building between the age of 15 to 30 years the Structural Audit must be conducted once in 5 years and if the age of building is above 30 years then the Structural Audit must be conducted once in 3 years. If the building is in working condition, then also there are certain chances of some defects which can be recognized with the help of Structural Audit.

The existing structure is situated at Police line Takli, Nagpur, Maharashtra. The building is (G+3) RCC framed structure which was constructed in 1978. The building is used for the accommodation of police constables of nearby areas.

The main objective of the paper is to adopt Ultrasonic Pulse Velocity Test, Rebound Hammer Test, Cover Meter Test, analyzing depth of Carbonation, Half-cell Test including Visual observations to analysis the distressed in building such as RCC structure damages, cracks, spalling, seepages, vegetation, settlement, atmospheric reactions

Fig. 1.1 Lal Imaarat 02

II. METHODOLOGY

Structural audit can be done by two methods:-

1. Visual Inspection
2. Ultrasonic pulse velocity test
3. Rebound hammer test
4. Half-cell test
5. Cover meter test
6. ph depth of carbonation

1. Visual Inspection:

Visual inspection is one of the most versatile and powerful of the NDT methods, and it is typically one of the first steps in the evaluation of the concrete structure. Visual inspection can provide a wealth of information that may lead to positive identification of the causes of observed distressed. Visual inspection has the obvious limitations that only visual surface can be inspected. Internal defects go unnoticed. For this reason a visual inspection is usually supplemented by one or more of the other NDT methods. In visual inspection we have checked the building thoroughly which damages we have observed manually. We have mostly found out excess cover, seepage, bad quality of work, improper mixing, cracks, vegetation, etc.

Fig. 2.1.1 Reinforcement exposed in Lintel

Fig.2.1.2. Cracks in Columns

Fig.2.1.3. Seepage in walls

Fig. 2.1.4. Vegetation in Building

Fig. 2.1.5 Crack in beam

Fig. 2.1.6 Seepage and vegetation on wall

2. Ultrasonic Pulse Velocity test:

The objectives of Ultrasonic Pulse Velocity method are the homogeneity of concrete, presence of cracks, voids and other imperfections, changes in the structure of the concrete which may occur with time. Qualitative assessment of strength of concrete, its gradation in different location of structural members.

The Ultrasonic Pulse Velocity test is assessed by measuring the velocity of an ultrasonic pulse through it. It is based on the use of equipment which includes transducers which provide and receives the ultrasonic wave. Time taken by pulse to travel from the transmitting to receiving transducer is measured by the timing circuit. Best quality of concrete is indicated by higher velocity. The pulse velocity in concrete will be represented in Km/sec. The ultrasonic pulse produced by an electro-acoustical transducer, held in contact with one surface of the concrete member under test and receiving the same by a similar transducer in contact with the surface at the end. This procedure is as per IS 13311:1992 (Part I).

Fig. 2.2.1 Ultra Sonic Pulse Velocity Apparatus

Fig. 2.2.2 Probes (Transducer) of UPV

TABLE I. VELOCITY CRITERIA FOR QUALITY OF CONCRETE GRADING

Pulse Velocity	Quality of Concrete
>4.5 Km/sec	Excellent
3.5-4.5 Km/sec	Good
3.0-3.5Km/sec	Satisfactory
<3.0 Km/sec	Doubtful

3. Rebound Hammer Test:

Rebound Hammer Test is a Non-Destructive Testing method of concrete which provide a convenient and rapid indication of the compressive strength of the concrete. When the plunger of rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such rebound depends upon the surface hardness of concrete. The surface hardness and therefore the rebound is taken to be related to compressive strength of concrete. The rebound of an elastic mass depends on the hardness of the surface against which its mass strikes. This procedure is as per IS 13311:1992(Part II).

Fig. 3.1.1 Rebound Hammer

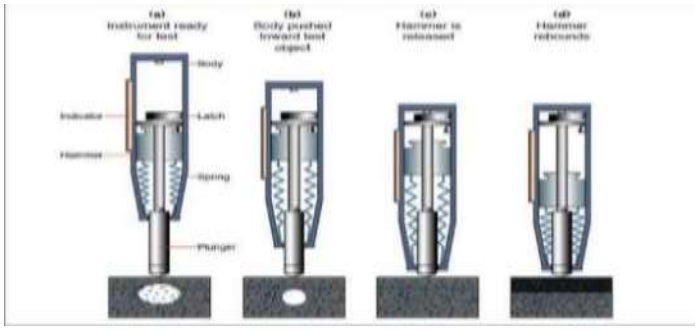

Fig. 3.1.2 Working of Rebound Hammer

(https://gharpedia.com/wp-content/uploads/2017/03/0710050002-01-Rebound-Hammer-Test-1.jpg)

TABLE II. REBOUND CRITERIA FOR QUALITY OF CONCRETE GRADING

Sr. No.	Average Rebound Number	Quality Of Concrete
1.	>40	Very Good Hard Layer
2.	30 to 40	Good Layer
3.	20 to 30	Fair
4.	<20	Poor Concrete
5.	0	Delaminated

4. Half Cell Test:

Half Cell potential test is the corrosion monitoring technique to determine the probability of corrosion with the rebar in reinforced concrete corrosion structure. The instrument measure the potential and the electrical resistance between the reinforcement and the surface to evaluate the corrosion activity. The electrical activity of the steel reinforcement and the concrete leads them to considered as one half of weak battery cell with the steel acting as one electrode and the concrete as the electrolyte.

Fig. 4.1.1 Half Cell apparatus

TABLE III. CRITERIA FOR HALF CELL TEST

Measured Potential(mv)	Probability of steel corrosion activity
>-200	Less than 10%
-200 to -350	Uncertain
<-350	More than 90%

5. Cover Meter: Cover meter is an instrument to locate rebars and measure the exact concrete cover. Rebar detectors are less sophisticated devices that can only locate metallic objects below the surface. It gives information about concrete covers and steel reinforcement in concrete using magnetic field. These meters can also be used to estimate the depth of bars if its size is known or estimate the size of the bars if the depth of cover is known. Inaccurate results may occur when the depth of concrete cover is equal to or close to the spacing of the reinforcement bars. Due to this, steel or other metals must not be present close to the area under examination. The features data storage for automatic collection of data to make rebar detection more efficient.

Fig. 5.1.1 COVER METER APPARATUS

6. pH Carbonation Test:

When the carbon-dioxide in atmosphere in the presence of moisture reacts with hydrated cement, carbonation of concrete occurs. Carbonation process is also called as DE passivations. The method to establish the extent of carbonation in concrete by applying a solution of 15mg phenolphthalein and 10ml ethanol diluted in 50ml of

distilled water to a fresh fracture surface of concrete. The change of pink color of concrete indicates carbonation free concrete while the uncolored indicates carbonation. The pH of concrete lowers when the carbon dioxide in the air comes in contact with concrete, the process is called as carbonation. A standard pH meter is used to measure the pH of concrete. If pH value between 7 to 9 concrete starts to break down and pH of the concrete below 8.6 suggesting carbonation.

Fig.6.1.1 Depth of Carbonation in column

Fig. 6.1.2 Phenolphthalein indicator

TABLE IV. VELOCITY CRITERIA FOR QUALITY OF CONCRETE GRADING

Indication	pH	Remark
Pink	>9 Alkaline concrete	Non-Carbonated Concrete
Colorless	< 9 Acidic concrete	Carbonated Concrete

III. RESULT

TABLE V. ULTRASONIC PULSE VELOCITY TEST RESULT

Sr. no.	Description	No. of points	Ultrasonic Pulse Velocity (Km/sec)		
			Max	Min	Average
Ground Floor					
1.	Column	14	3.82	2.15	2.99
First Floor					
2.	Column	10	3.99	2.65	3.32
3.	Beam	2	2.89	2.81	2.85
4.	Slab	1	3.016		3.016
Second Floor					
5.	Column	6	3.52	2.4	2.96
6.	Beam	2	3.9	3.4	3.65
7.	Slab	1	2.79		2.79
Third Floor					
8.	Column	3	3.46	2.95	3.205
9.	Beam	2	2.85	2.76	2.805

TABLE VI. REBOUND HAMMER TEST RESULT

Sr. no.	Description	No. of Points	Rebound Hammer Test		
			Max.	Min.	Average
Ground Floor					
1.	Column	13	28	17	22.5
First Floor					
2.	Column	6	24	15	19.5
3.	Beam	2	24	22	23
4.	Slab	1	24		24
Second Floor					
5.	Column	6	28	17	22.5
6.	Beam	2	22	20	21
7.	Slab	1	22		22
Third Floor					
8.	Column	4	19	17	18
9.	Beam	2	22	20	21
10.	Slab	1	22		22

TABLE VII. HALF CELL TEST RESULT

SR. NO.	PARTICULARS	HALF CELL
1	Column No. A7	-334
		-402
		-416
		-418
		-388
		-423
		-448
		-395
		-370
2	Beam 01	-426
		-426
		-431
		-425
		-421
		-429
		-430
		-432
		-426

TABLE VIII. COVER METER TEST/ PERFOMETER

Sr. No.	Description	COVER METER (mm)				
1.	Column A06	25	28	31	37	46
2.	Column A08	25	40	41	36	37
3.	Column A04	17	21	27	31	26
4.	Column A02	37	41	51	57	32
5.	Column B08	36	21	27	37	31
6.	Column C02	26	24	30	34	26

TABLE IX. pHCARBONATION TEST RESULT

Sr. No.	Description	Potential (mv)		PH
		40mm	80mm	
1.	Column A06	-121	-142	8.25 to 10.75
2.	Column A08	-139	-149	9.35 to 11.35
3.	Column A04	-127	-139	10.97 to 11.99
4.	Column A02	-197	-112	8.70 to 11.51
5.	Column B08	-107	-139	9.11 to 10.77

IV. OBSERVATION

1. High vegetation at the backside of the building.
2. High seepage observed at kitchen, toilet and bathroom wall.
3. The building has many construction deficiencies.
4. High corrosion in column, beam and slab at maximum location.
5. Bad quality of material used while construction.
6. Slab leakage.

V. RECCOMENDATIONS

1. Seepage- Use water proofing agent and polyfied cement repair to seepage area.
2. Slab leakage- Provide water proofing treatment.
3. Vegetation- Remove vegetation and provide acid treatment to the existing areas and repair with polymer modified mortar.
4. RCC cracks- Provide epoxy or micro pile cement grouting at 150 X 150 mm c/c and repair with modified polymer mortar.
5. Wall crack- Open the cracking in weak roof and fill with crack filler and finish it with polifier modified mortar.

VI. CONCLUSION

It is observed that Ultrasonic Pulse Velocity results with direct, indirect and semi-direct method indicate that the readings are between 2.79 Km/sec to 3.65 Km/sec (refer to IS 13311(Part I):1992). The quality of concrete is medium and doubtful at maximum location.

As per Rebound Hammer test (refer to IS 13311(Part II):1992). The readings are in the range of 18 to 22. The quality of concrete is poor concrete.

As per pH carbonation of concrete corrosion of reinforcement observed at maximum location. Carbonation depth has reached up to the reinforcement level. It is observed that the pH of cover concrete is reduced but the passive layer over the reinforcement is intact.

As per the Half Cell potentiometer test on reinforcement it is observed that all the readings are range from -334 MV to -448 MV this indicates corrosion has started in reinforcement and exceed the acceptable limit.

From all the observations and results it is necessary and recommended that the existing structure is needed to be repair immediately.

VII. ACKNOWLEDGEMENTS

We would like to express our thanks of gratitude to Principal, Priyadarshini J.L College of Engineering, Nagpur, Maharashtra, India for encouragement and granting permission for this project and also to publish this project. We are also thankful to Dr .Dilip P.Mase, Director P.T Mase and Associated, Nagpur, Ashish Ganjude, Project Engineer P.T Mase and Associates Nagpur, we would also like share our gratitude to Prof K.R. Bele for here valuable guidance. The work would not have been possible without their guidance. We acknowledge the support received from the department and well-wishers.

REFERENCES

[1] Aniket Raut, Prof. N.H Pitale, Dr. Dilip P. Mase, "Structural Audit of 30 Years Old Building "International Conference on Innovation and Research in Engineering , Science and Technology (ICIRESR-19),e-ISSN: 2395-3021, p-ISSN: 2278-8719, 2019.

[2] Ashish L. Ganjude , Dr. Prashant Y. Pawade, Dr. Dilip P. Mase, "Condition Assessment of New Building" International Conference on Innovation and Research in Engineering Science and Technology (IOSRGEN), e-ISSN:2250-3021, p-ISSN:2278-8719, 2019.

[3] Saiesh L.Neik , Basavraj Saunshi , "Structural Audit of RCC Building" International Research Journal of Engineering and Technology(IRJET), Vol.04, Issue 05, e-ISSN:2395-0056, p-ISSN:2395-0072, May 2017.

[4] Swapnil U.Biraris, Aishwarya G.Gujrathi, Abhishek D.Pakhare, "Structural Audit of Old Structures" International Journal of Enginnering Trends and Technology (IJETT), Vol.43, Number 03, ISSN:2231-5381, January 2017

[5] Rushabh Karnavat, Vivek Singh, "Structural Audit: A Need of an Hour" International Journal for Scientific Research and Development (IJSRD), Vol.05, Issue 04, ISSN (online): 2321-0613, 2017.

[6] Abhinandan kale, Mahesh Gond, Pallavi Kharat "Structural Audit for an Educational Building" International Journal of Advanced Researched and Innovative Ideas in Eductation (IJARIIE), Vol.03, Issue-3 2017, ISSN(O) - 2395-4396, March 2017.

[7] Indian Standards, IS 13311:1992 (Part-I), "Non-Destructive Testing of Concrete- Methods of Tests, Ultrasonic Pulse Velocity"

[8] Indian Standards, IS 13311:1992(Part-II), "Non-Destructive Testing of Concrete- Methods of Tests, Rebound Hammer Test"