

RCC STRUCTURE WITH THE HELP OF NON DESTRUCTIVE TESTING AND RETROFITTING TECHNIQUES

¹Akshay K. Doble, ²Dr. Prashant Y. Pawade, ³Dr. Rashmi Bharatey

¹Research Scholar, ²Professor, ³Assistant Professor

¹Department of Civil Engineering,

¹G.H.Raisoni College of Engineering, Nagpur, (Maharashtra), INDIA

Abstract : Non-destructive evaluation of existing structures is an important part and an active area of research in the civil engineering industry. Whenever a modification to a structure or its use is proposed the process begins with an evaluation of the current situation. Testing on concrete is essential because evaluating its quality is to ensure that it is of sufficient strength and durability to stand for years to come. NDT helps us monitor the health of concrete and it is very much needed to check the concrete structure. Generally, due to aging, weathering effects, overload, chemical attacks, temperature variations, the structure deteriorates and fails to provide hassle-free service throughout its life, with or without little maintenance, hence its life is shortened.

This paper is a case study of various NDTs carried out on an residential building that was 30 years old and located in nearby chemical plants. Various NDT techniques have been used, such as ultrasonic pulse speed testing, carbonation testing, rebound hammer testing, and half-cell potential testing to reach the quality of the structure. These tests were performed to find voids and cracks in structural elements. The carbonation depth was checked to ensure that the cover is less than concrete or not to ensure that the reinforcement does not corrode. Finally, based on the results, structural elements requiring repair were identified.

Keywords - Non Destructive Test, Rebound Hammer Test, Ultrasonic Pulse Velocity, Carbonation Test, Half Cell Potential Test, Concrete Cover Meter Test.

I. INTRODUCTION

NDT is a strategy for surveying basic trustworthiness without breaking a sweat of utilization. It is conceivable to analyze as well as measure materials or structures without harming their surface, item uprightness, and future utility. The field of NDT is an expansive, interdisciplinary field in seeing that basic segments and frameworks dependably play out their work. NDT is routinely applied in ventures where the disappointment of a part can cause genuine budgetary misfortunes. The utilization of NDT to portray solid quality in India has been expanding in late 2-3 decades. The standard existence of a structure is 60-70 years, yet it is presently essentially decreased because of ill-advised development strategies, material quality, basic dangers. The RCC structure is inclined to different impacts happening on it during its life cycle. They can be ordered into three fundamental gatherings:

- The body
- Organic and
- Chemical impacts.

Ice activity is the most serious type of physical harm brought about by strong disintegration. Bit by bit, the water put in the pores freezes at low temperatures and regularly opens the solid to very high weights (up to 220 MPa). In establishment designing, hurtful ice action is forestalled by the correct determination of establishment profundity, rock layer development, legitimate seepage, and satisfactory wet and water protection of the establishment.

Different types of physical disintegration of concrete and solid structures are identified with cracks because of shrinkage, temperature changes and different warm extensions, for example, rock and concrete stone. Likewise, the solid bearing limit ought to be alluded to as cyclic stacking and the emptying and other harm of the structure causing breaking. Preparing for the impacts of pivot.

The harming instruments portrayed as a rule assault concrete quickly subterranean level, and relying upon the stature of the water vessels, it is seldom in excess of 50 cm. Natural impacts incorporate vegetation, with existing breaks extending as the tree root framework grows.

Concoction impacts that cause strong disintegration are normally the aftereffect of synthetic responses of the composite air and forceful mixes from parts of the concrete stone. Their hurtful impacts can prompt strong consumption. The accompanying sort of consumption must happen

Alluded here:

- Salt climate,
- Carbonation,
- Leaching hurting

At the point when a strong structure is exposed to compound responses, its dependability is influenced. Synthetic concoctions can cause solids, volume changes and decay structure. The life of the structure is decreased and this prompts disappointment of the structures. The various kinds of synthetic assaults and their impacts on solid structures are given beneath.

- Sulfate assault
- Chloride assault
- Alkaline blended response
- Carbonation
- Acid assault

In the wake of knowing the evaluation and age of the solid, NDT encourages us to build up the accompanying:

- Symmetry of Concrete.
- Concrete Cracks, voids, and different imperfections
- Changes in concrete after some time
- Proper fix technique if legitimate outcomes incite questions on strong quality
- Damage brought about by fire, substance assault, and so forth.

II. METHODOLOGY

2.1 Ultrasonic Pulse Velocity Test

Principle: - Each material has a particular ultrasonic speed that can be gotten by testing those materials in the research facility or field. Ultrasonic pulses travel quickly in thick materials and gradually in splits or voids. The instrument takes a shot at the standard of intersection the high-recurrence sound waves through the solid body and estimating the time taken. The separation of the wave length isolated by time gives the speed of the waves through the strong part being tried. Contingent upon the speed, the nature of the solid can be evaluated concerning consistency. The solid surface completely cleaned and dried. The gadget is adjusted before perusing. A coupling medium, for example, grease is applied to the test and readings are taken for the pulse speed in space. The rectification factor is applied to the nearness of steel any place essential.

Procedure: -

1. Survey single-sided, twofold sided, and so forth on auxiliary components
2. Clean the solid surface altogether (with or without mortar)
3. Grease the strong surface to be tried
4. Press the probe on the outside of the basic component to evacuate air holes
5. Note the separation between the two probe
6. Peruse the time it takes for the ultrasonic pulse to move starting with one probe then onto the next.
7. Figure the good ways every once in a while ($V = L/T$)
8. Rehash the test on the same number of zones of the component as vital
9. Test on various individuals from the structure

Factors Affecting:-

1. Readings are taken with or without mortar
2. New /old structure
3. Single-sided or twofold sided
4. Grade of Concrete
5. New + Old Content (Jacketed Columns)

Understanding the Result: -

1. The evaluated quality is +/- 15% or more than the real quality
2. Key tests can be performed on chosen tests of the components, if fundamental, to guarantee the after effects of the tests
3. IS Code 13311 (Part 1):1992, gives the velocity
4. Be that as it may, the code didn't portray the UPV regarding quality. Thusly, IS code reviewing should just be taken as a rule

2.2 Carbonation test: -

Principle: - Carbonation happens because of joined activity because of the decline in environmental CO₂ dampness and alkalinity levels of cement. Concrete is a permeable material that experiences the carbonation procedure with maturing. As a defensive front of completely solid carbonate, rust arrives at steel fortification, quickly quickening the erosion procedure in steel. The shading change of the solid to pink shows that the solid is healthy, while if there is no shading change, it is recommended that the solid is influenced via carbon dioxide.

Procedure: -

1. Recognize test areas
2. Drill gaps with an electric drill machine to arrive at the steel reinforcement
3. Expel the residue with an artificially glamorize or brush
4. Dissolve 1 g of phenolphthalein in 90 cc of ethanol and add 1% phenolphthalein solution for 100 cc by adding refined water to the opening.
5. Use litmus and notice the shading change
6. To decide the profundity of profile carbonation

Factors Affecting: -

1. The pore arrangement of solidified concrete
2. Relative Humidity (for Ca (OH) disintegration)
3. Concentration of CO₂

Understanding the Result: -

1. The rate may change contingent upon the advancement of carbonation in concrete (chemical attack, strategy for setting concrete, the evenness of concrete, and so on.) at a pace of 1 mm for every year.
2. Carbonation is a property that prompts disintegration of installed reinforcement
3. The carbonation test shows us the profundity of carbonation.
4. In result of the outcomes, we can distinguish whether the secured concrete is healthy or not.
5. In the event that the secured concrete is totally carbonated, for example carbonation fortification has been reached, it is prudent to remove the covered concrete

2.3 Half Cell Potential Test: -

Principle: - This gadget is utilized down the middle cell potential testing to quantify the electrical potential among support and the outside of the solid to survey the chance of consumption activity. The fortification of steel and the electrical movement of the solid are viewed as half of the feeble battery cell, going about as the steel anode and the solid electrolyte.

A large portion of the cell is named on the grounds that the cell is viewed as fortified steel and the encompassing cement. The electrical capability of the support has been contrasted and some standard terminals. One finish of the wire is joined to steel fortification and the opposite end is associated with the standard cathode and the readings are seen on the voltmeter.

Procedure: -

1. Recognize test areas
2. Drill gaps with an electric drill machine to arrive at the steel reinforcement bars
3. Introduce electrical contacts for reinforcement
4. Measure the voltage in millivolts on the solid surface at a few purposes of the part
5. Test on various individuals from the structure

Factors Affecting: -

1. Dampness
2. Surface condition
3. Erosion breaking point of support
4. The nature of covered concrete

Understanding the result: -

1. The half-cell potential test gives the chance of erosion and not real consumption. For better understanding, IS has grouped it as 3%, 10%, half, and 90% likelihood.
2. In any case, it ought to be noticed that the likelihood of half or 90% erosion doesn't demonstrate that the width of the implanted steel is diminished by half or 90%, separately. It basically alludes to the chance of corrosion action happening at that area.

2.4 Rebound Hammer Test

Principle: - When the rebound hammer is pushed on the outside of the solid, the spring-controlled mass is delivered with a consistent power to hit the solid surface for return. Is identified with the surface hardness and subsequently the compressive quality of the rebound of concrete. The rebound worth is perused from graduation and is assigned as a rebound number. The compressive quality can be perused straightforwardly from the chart given on the hammer's body.

Procedure: -

1. Spotless and dry the surface
2. On the off chance that the surface isn't smooth, rub it with a processor wheel or stone
3. The effect point must be chosen and it must be at least 20 mm from the edge
4. The rebound hammer ought to be at right points to the outside of the solid part
5. At that point the plunger is squeezed against the surface and the rebound number is seen
6. So also, a few readings are taken around the purpose of effect and the normal is noted.

Factors Affecting: -

1. Type of concrete
2. Surface condition
3. The dampness substance of concrete
4. Carbonation of strong surface
5. Sort of treatment and age of concrete
6. Angle of inclination

III. RESULT AND DISCUSSION

Type of Structure: RCC

Age of Structure: 30 years

Table -1: Results for Ultrasonic Pulse Velocity Test

Total No of Readings Taken		50
No. of Columns Tested		10
Pulse velocity in KM/sec (Direct Method)	Concrete Quality	no. of readings
Above 4.5	Excellent	0
3.5-4.5	Good	10
3.0-3.5	Medium	10
Below 3.0	Doubtful	30

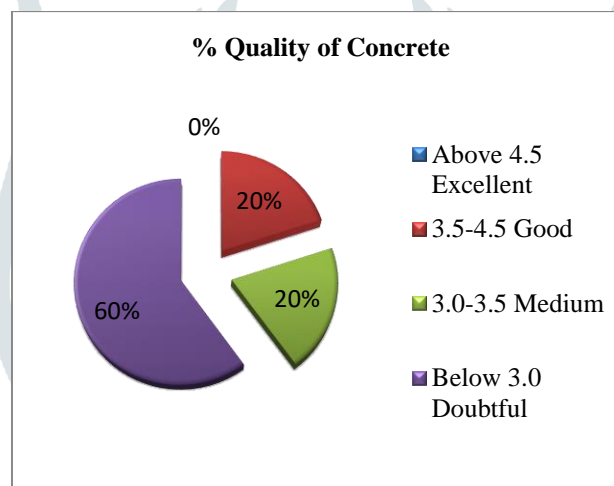


Fig 1:- Pie Diagram of Results for Ultrasonic Pulse Velocity Test

Table -2: Results for Half Cell Potential Test

Total No. Of Readings taken		30
No. Of Column Tested		10
Range	Probability of Corrosion	No. Of Readings
Over-200mv	10%	0
-200mv to -350mv	50%	05
Below -350mv	90%	25

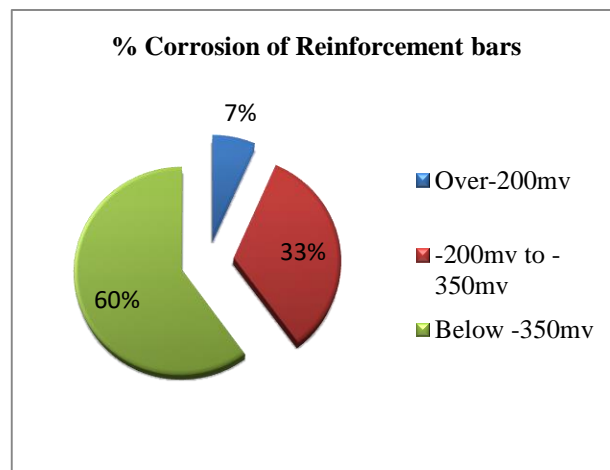


Fig 2:- Pie Diagram of Results for Half Cell Potential Test

Table -3: Results for Carbonation Test

Total No. of Reading Taken	10
No. of Column Tested	10
Carbonation Depth	No. of Reading
0-20	00
21-40	03
41-60	07

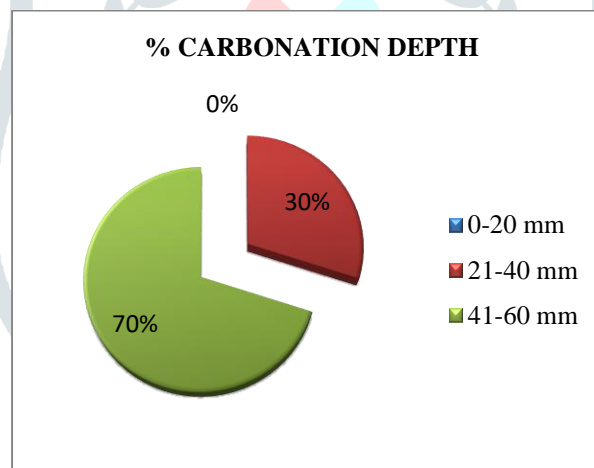


Fig 3:- Pie Diagram of Results for Carbonation test

Table -4: Results for Rebound Hammer Test

Total No. of Reading Taken	60
No. of Column Tested	10
Average	Estimated compressive strength (N/mm ²)
28.0	22

Discussion on NDT report.

The estimated compressive strength found by the rebound Hammer test appears to be greater than 22 N / mm as. IS Code 13311 Part II, 1992, noted that the deviation between the rebound Hammer test and the compressive strength found by the actual compressive strength. It can be 25%.

In most places, the depth of carbonation exceeds the thickness of the casing.

Corruption of the rebels was noticed, as cracks were visible on the surface of the columns. Also, the half-cell potential test indicates the presence of caries. The reason for this can be attributed to:

- The drain has not been provided at the end of roof sheets and now some sheets are under damaged conditions.
- Surface porosity of concrete (although the thickness of the cover is sufficient).

- The concurrency of concrete was found to be inadequate in most places. It was completely inadequate among the torn sections.
- In this process the truss appears badly deformed, a reduction in the thickness of its members will also occur.
- Crack is evident on RCC column

IV. CONCLUSION AND SUGGESTION

- The duration of the RCC beam (extended part support) should be reduced so that the opening is limited to 1.25 m or more.
- Truss and process hall roof sheets should be replaced by new trusses, parts, and sheets.
- Epoxy / Polyurathane coating will be applied to new MS trusses and purlins. This coating will act as a barrier between corrosive elements and steel.
- To facilitate removal of trusses, Some parts of the columns may also need to be demolished. Micro solids i.e. Rendroc RG / Emaco-S-346T or equivalent can be deployed.
- The symmetry of the concrete can be improved by injecting low viscosity monopoles into all columns (regardless of the results). Diameter. The hole, 120 mm deep, can be drilled at around 350–400 c / c. The height and monopole of the columns can be said to be 2–5 kg/cm of (depending on site condition) under appropriate pressure. The erosion of the rebels can be remedied by adopting the following methodology.
 - A) Cutting the affected area of concrete.
 - b) Applying 2 coats of Feovert.
 - c) Applying 2 coats of IP NET RB
 - d) Applying 1 coat of NITOBOND EP
 - E) Applying 15 mm thick polymer modified plaster with polymer modification of about 10% by wt. of cement.

The vertical part built into the free end of the chajas (about 10 cm. In height) should be removed for ease of draining rainwater. The top of the chajas should be provided with a suitable slope without increasing load on it. External grade emulsion viz. The weather shield will be applied to the entire outer surface. Next date of handling structural condition The assessment should be done after 3 years or with notable flaws, whichever occurs first.

V. FUTURE SCOPE

Structural Health Diagnosis is a significant step by step structures process to find out the quality and age of the structures. To keep away from loss of human lives and money related issues a point by point wellbeing observing instrument will be framed for each structure since everyone is one of a kind. As the Civil engineering enterprises ought to be exposed to NDT to guarantee they meet the quality necessity of clients. Subsequently in my view, in the event that we have good information and certifications like Level I, II, III in NDT we can without easy conduct the testing on the structure effectively. Note that interest for NDT will keep expanding as prerequisites for quality are expanding each day.

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