Journal of Engineering Sciences

Vol 11, Issue 8, August/2020

ISSN NO:0377-9254

STRUCTURAL HEALTH MONITORING OF WATER TANK BY NDT MECHANISM

ShwetaWalun[1] , HemantDahake[2]

[1]PG Student, Department of civil engineering, G.H. Raisoni University, Amravati, Maharashtra, India

[2] Assistant Professor, Department of Civil Engineering, G.H. Raisoni University Amravati, India, Maharashtra, India

***Abstract*— Because of gigantic need by the general population, water must be put away and provided by their necessities. Water request isn't consistent for the duration of the day. It vacillates hour to hour. So as to gracefully consistent measure of water, we have to store water. So to satisfy the open water need, water tanks should be developed, these tanks are structured according to Seems to be: 3370 for example Code of training for solid structures for capacity of fluids. BIS executed the reconsidered variant of IS 3370 (section 1& 2) after quite a while from its 1965 form in year 2009. Directly huge number of overhead water tanks is utilized to disperse the water for open utility. The vast majority of the water tanks were structured according to old IS Code: 3370-1965 without considering seismic tremor powers. Structures are congregations of burden conveying individuals prepared to do securely moving the superimposed burdens to the establishments. Their principle and most cared for property is the quality of the material that they are made of. Concrete, as we as a whole know, is an essential material utilized for development purposes. Subsequently, quality of cement utilized, is required to be 'known' before beginning with any sort of examination. In the ongoing past, different strategies and methods, called as Non-Destructive Evaluation (NDE) procedures. The idea of Non-Destructive Testing (NDT) is to acquire material properties of set up examples without the annihilation of the example nor the structure from which it is taken. In any case, one issue that has been pervasive inside the solid business for quite a long time is that the genuine properties of a set up example have never been tried without leaving a specific level of harm on the structure. For most cast set up solid structures, development particulars necessitate that test chambers be thrown for 28-day quality assurance. Typically, delegate test examples are thrown from a similar solid blend as the bigger auxiliary components. Shockingly, test examples are not a definite portrayal of in-situ concrete, and might be influenced by varieties in example type, size, and restoring methods. The point of the task was to get the for damaging and Non Destructive Testing Equipment's viz., the Rebound Hammer and Ultrasonic heartbeat Velocity Tester and so on and to contemplate the impact of fortification on the got outcomes. These dangerous and Non Destructive Instruments were then used to test the sections, bars and pieces and tank of water tank. The utilization of the consolidated techniques produces results that falsehood near the genuine qualities when contrasted and different strategies. The technique can be stretched out to test existing structures by taking direct estimations on solid component**

***Keywords*— Retrofitting, Non-destructive testing, Rebound Hammer, UPV, rebar locator, micro-concrete, RC Jacketing**

1. INTRODUCTON

Water tanks are utilized to store water. Cost, shape, size and building materials utilized for developing water tanks are affected by the limit of water tank. State of the water tank is a significant structure parameter since nature and force of stresses depend on the state of the water tank. When all is said in done, for a given limit, roundabout shape is favoured in light of the fact that burdens are uniform and lower contrasted with different shapes. Lesser anxieties infer, lower amounts of material required for development which cuts down the development cost of water tanks.

Water tank is one such water tank which has roundabout shape with a circular top and tapered chunk with round arch at the base. In this sort of water tank, the internal powers originating from the cone shaped chunk balance the outward powers

originating from the base arch which result less weight on the solid base piece of the water tank.

1.1 Introduction

Because of lesser burdens, the thickness of the solid base chunk decreases and diminishing the measure of cement required which has direct impact on the expense of the water tank. To keep an elevated level of basic security, solidness and execution of the foundation in every nation, a productive framework for ahead of schedule and customary basic appraisal is direly required. The quality affirmation during and after the development of new structures and after reproduction forms and the characterisation of material properties and harm as a component of time and ecological impacts is increasingly turning into a genuine concern. Non-destructive testing (NDT) strategies have a huge potential to be a piece of such a framework. NDT techniques as a rule are generally utilized in a few industry branches. Airplanes, atomic offices, compound plants, electronic gadgets and other security basic establishments are tried normally with quick and dependable testing advances. An assortment of cutting edge NDT strategies are accessible for metallic or composite materials. As of late, creative NDT strategies, which can be utilized for the evaluation of existing structures, have opened up for solid structures, yet are as yet not set up for ordinary investigations. Hence, the goal of this undertaking is to examine the pertinence, execution, accessibility, multifaceted nature and limitations of NDT. The motivation behind setting up standard methods for non-dangerous testing (NDT) of solid structures is to qualify and measure the material properties of in-situ concrete without rudely inspecting the material properties. There are numerous procedures that are as of now being research for the NDT of materials today. This section centres around the NDT techniques pertinent for the review and observing of solid materials.

1.2 Classifications of Water Tanks

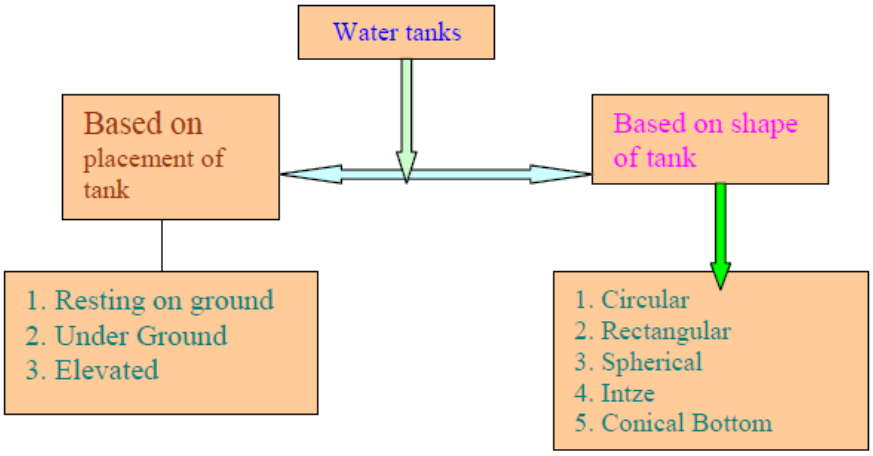

Fig -1 Classification of water tank

1.3 Aim

1. The aim of the project was to obtain the Calibration Graphs for destructive and Non Destructive Testing Equipment's viz., the Rebound Hammer and Ultrasonic pulse Velocity Tester etc and to study the effect of reinforcement on the obtained results. These destructive and Non Destructive Instruments were then used to test the columns, beams and slabs and tank of water tank
2. The aim is to advance the theory and application of structural health monitoring systems and methodologies in civil engineering infrastructure as a service to engineering profession and society members at large
3. By increasing the approximate expertise and knowledge of SHM the society can provide advice and counsel to the private sector, government, ensures of civil structures and universities on all the matter dealing with SHM.

1.4 Structural Health Monitoring

Structural health checking is at the front line of basic and materials inquire about. Structural health

checking frameworks empower overseers and specialists to assemble material information of structures and basic components utilized for investigation. Ultrasonic can be applied to basic checking projects to get such information, which would be particularly important since the wave properties could be utilized to acquire material properties. This testing approach might be utilized to survey the consistency and relative nature of the solid, to demonstrate the nearness of voids and splits, and to assess the viability of break fixes. It might likewise be utilized to show changes in the properties of cement, and in the overview of structures, to assess the seriousness of decay or breaking. Diminishes in ultrasonic wave's rates after some time can uncover the beginning of harm before obvious inadequacies become apparent. This permits auditors and architects to execute fix suggestions before minor lacks become security dangers.

1.5 Structural Health Monitoring utilizing Non-Destructive Testing

The nature of new solid structures is subject to numerous components, for example, sort of concrete, kind of totals, water concrete proportion, relieving, ecological conditions and so forth. Other than this, the control practiced during development likewise contributes a ton to accomplish the ideal quality. The current arrangement of checking droop and testing blocks, to evaluate the quality of cement, in structure under development, are not adequate as the real quality of the structure rely upon numerous different factors, for example, appropriate compaction, powerful restoring too. Thinking about the above prerequisites, need of testing of solidified cement in new structures just as old structures, is there to evaluate the genuine state of structures. Non-Destructive Testing (NDT) methods can be utilized adequately for examination and assessing the genuine state of the structures. These procedures are moderately snappy, simple to utilize, and modest and give a general sign of the necessary property of the solid. This methodology will empower us to discover suspected zones, accordingly diminishing the time and cost of inspecting an enormous mass of cement. The decision of a specific NDT technique relies on the property of cement to be watched, for example, quality, consumption, break observing and so on.

The ensuing testing of structure will to a great extent rely on the after effect of primer testing finished with the suitable NDT method .The NDT being quick, simple to use at site and generally more affordable can be utilized for

1. Assessing the structure for different troubled conditions
2. Damage because of fire, substance assault, sway, age and so on.
3. Detecting breaks, voids, cracks, honeycombs and frail areas
4. Assessing the real state of fortification

A large number of NDT techniques utilized for solid testing have their source to the testing of progressively homogeneous, metallic framework. These strategies have a sound logical premise, yet heterogeneity of solid makes translation of results fairly troublesome. There could be numerous parameters, for example, materials, blend, workmanship and condition, which impact the consequence of estimations. In addition the test gauges some other property of cement (for example hardness) yet the outcomes are deciphered to evaluate the diverse property of the solid for example (quality). Subsequently, understanding of the outcome is significant and a troublesome activity where speculation is unimaginable. Despite the fact that administrators can complete the test yet understanding of results must be left to specialists having experience and information on utilization of such non-ruinous tests.

1.6 Strength determination by NDE methods:

Quality assurance of cement is significant on the grounds that its flexible conduct and administration conduct can be anticipated from its quality attributes. The ordinary NDE techniques normally measure certain properties of cement from which a gauge of its quality and different attributes can be made. Thus, they don't straightforwardly invigorate the outright estimations of.

1.7 Damage detection by NDE methods:

Worldwide procedures: These methods depend on worldwide basic reaction for harm distinguishing proof. Their principle downside is that since they depend on worldwide reaction, they are not touchy to confined harms. Along these lines, it is conceivable that a few harms which might be

available at different areas remain un-took note. Nearby strategies: These procedures utilize confined basic investigation, for harm identification. Their primary downside is that extras like tests and apparatuses are required to be genuinely hauled around the test structure for information recording. Along these lines, it no longer stays independent use of the strategy. These procedures are regularly applied at not many chose areas, by the impulses/experience of the designer combined with visual assessment. Subsequently, irregularity creeps into the subsequent information.

1.7 Objectives

The main objectives of study area are as follows:

1. To make a study about the analysis and design of water tanks.
2. To make a study about the guidelines for the design of liquid retaining structure according to IS Code.
3. To Study of literature to find out gap between various methods using in SHM
4. To know about the design philosophy for the safe and economical design of water tank.
5. To find Reliability of SHM in construction industry
6. In the end, the programs are validated with the results of manual calculation given in. Concrete Structure.
7. Application of SHM in construction industry with a case study.

2. REVIEW OF LITERATURE

Durgesh C. Rai and Bhumika Singh et.al , examined Reinforced solid platform (round, empty shaft type bolsters) are well known decision for raised tanks for these of Construction and the more strong structure it gives contrasted with surrounded development. In the ongoing past Indian seismic tremors, Gujarat (2001) and Jabalpur (1997), dainty shells (150 to 200 mm) of solid platforms have performed unacceptably when extraordinary many created circumferential strain Flexural splits in the platform close to the base and a couple crumbled.

Mr.A.B. Mahadik and Mr. Jaiswal et.al auxiliary architects basic division, MHW GLOBAL LIMITED wakadewadi, Maharashtra Pune. This is investigation of basic reviewing of water tank in Pune and Mumbai in different area by inspecting and utilizing Non – ruinous testing and fixes of cement.

Prof.& Advisor, Department of Civil Engineering, Amity University, Noida, UP, India, previous Chief Engineer and Jt. Chief General, (MES/MOD) et.al Rehabilitation of RCC Overhead Reservoir at Siliguri, WB, India An investigation was done in March-April 96 for an overhead tank of 50,000 gallons limit laying on organizing of 16 RCC sections propped together at various levels. The tank is situated in North Bengal.

B.H Chafekar, O.S Kadam K.B Kale, S.R Mohite ,P.A Shinde, V.P Koyle et.al contemplated that before going in insight concerning the basic review is important to think about the structure. A structure is an arrangement of interconnected components to convey stacks securely to underground earth. The wellbeing assessment of solid structure called as auxiliary review. The creator shows various strategies in paper E.g. Visual investigation, non-ruinous test.

K.R. Sonawane ,Dr .A.W .Dhawale et.al presumed that The existence pattern of building can be extensively partitioned into four stages for example engineering arranging, auxiliary plan, and development support. In a large portion of working all things considered consideration is taken in initial three cases yet upkeep is overlooked. Obliviousness to support causes extreme basic pain in working over timeframe. With respect to basic soundness of building and fix required can be done. Such an examination can be done utilizing the accompanying techniques:

a) Visual assessment

b) Non Destructive Testing.

c) Partial Destructive Testing.

Rajendra P. Srivastava et.al. - This article performs two kinds of examination utilizing Dempster-Shafer hypothesis of conviction capacities for evidential thinking. The primary investigation manages the effect of the structure of review proof on the general conviction at every factor in the system, factors being the record equalization to be examined, the related exchange streams, and the related review destinations. The subsequent investigation manages the effect of the relationship (intelligent "and" and "arithmetical relationship")

among different factors in the system on the general conviction. For our first examination, we change the evidential structure from a system to a tree and decide its effect.

Constantinos A. Balaras et.al–An aggregate of 349 private structure reviews were acted in seven European nations to gather information on the corruption of building components (compositional and establishments). The structures spread run of the mill building typologies, sizes, developments and establishments, at various conditions of decay. The information was gathered dependent on a normalized approach for building reviews. Follow up investigation uncovered the most significant impacting factors on the disintegration of existing private structures all through Europe and assessed administration lives of different structure engineering components and electromechanical establishment..

B.H Chafekaret. Al - Before going in insight regarding the basic review is important to think about the structure. A structure is an arrangement of bury associated components to convey stacks securely to underground earth. The wellbeing assessment of solid structure called as basic review. The creator shows various techniques in paper:

A.B. Mahadik et.al. – This paper arrangements to make mindfulness among the structural architects, inhabitants and proprietors of working towards the wellbeing assessment of existing solid structures called as Structural Audit. The need of basic review is for upkeep and fixes of existing structures whose life has surpassed the age of 30 years to keep away from any incidents and spare significant human life. The solid is broadly utilized as development material being cheap, simple for development, applications and in view of it high quality cost proportion. Like never before, the development business is worried about improving the social, monetary and ecological parameters of supportability. In India, from 1980 onwards the foundation business saw venturing up of open speculation and development in framework industry which brings about development of new multistories solid condos which are currently in the age of thirty or more years. There are numerous structures during this period and prior have diminished quality at the appropriate time of time on account of basic inadequacy, material disintegration, surprising over loadings or physical harm. On the off chance that, further utilization of such decayed structure is proceeded with it might jeopardize the lives of tenants and encompassing residence. There is request of suitable activities and measures for all such structure structures to improve its presentation and Re establish the ideal elements of structures which may prompts increment its useful life

Francesca Ceronia et.al - A synergic approach for the examinations of the verifiable structure exhibitions - regarding both the auxiliary conduct and the vitality exhibitions for the space warming and cooling - is introduced. The chronicled brick work building "Palazzo Bosco Lucarelli", situated in Benevento, has been picked as contextual investigation. The basic and vitality investigations are done in equal, particularly during the distinguishing proof of the structure qualities through tests and reviews in-situ. For the auxiliary investigation - past assessments on materials – some unique tests have been utilized for better surveying a numerical Finite Element model essential for the check ofthe structure wellbeing. In addition, being essential a basic restoration, additionally a vitality retrofit could be figured it out. A thorough assessment methodology - planned to ensure the important unwavering quality of numerical forecasts - is acted so as to confirm the specialized and prudent accommodation of different vitality retrofit arrangements.

Mohammad Ismail et.al - The paper presents inquire about discoveries on the breaking down states of surrendered private ventures because of natural components of corruptions . Examining was produced using 200 and sixty-one relinquished lodging ventures. Basic corruptions related with the uncompleted structures were examined. Likewise, a little scope fortified solid structure was raised in an open and basically observed for deserts brought about by ecological variables of corruptions. The chose uncompleted structures were evaluated for surface salt stores, split arrangements and fortification erosion. In any case, the little scope structure was assessed for execution corruptions through dangerous and non-damaging quality tests, steel elasticity test and consumption test. Results show that there is a disturbing reduction in auxiliary uprightness and sturdiness works in surrendered fortified solid structures with time. In

the end, execution deterioration versus age diagram was produced for surveying life expectancy limit past which unsuitable mechanical properties are famous. In view of the encompassing presentation conditions, a surrendered strengthened solid structure could neglect to perform satisfactory planned quality capacities inside a time of twelve (12) years

J. Bhattacharjee et.al – The development material for the most part fortified cement is being utilized broadly for different kinds of development ventures. Be that as it may, the decay of Reinforced Concrete structures is perceived as a significant issue around the world. Aside from requiring customary upkeep, numerous structures require broad Repair, Rehabilitation &Retrofitting. Over some stretch of time, as these structures become more established, we find in them certain corruption or weakening with resultant trouble showed through breaking, parting, delaminating, consumption and so forth. Such decayed structures can be restored and retrofitted by utilizing different kinds of admixtures and present day fix materials. The paper draws out the current situation with solid structures and the significant regions where improvement is required during its administration life stage for feasible advancement and likewise the strategy for doing Repair, Rehabilitation &Retrofitting. This has been gotten subtleties in the paper alongside Case examines, where the Author of the paper was straightforwardly associated with arranging and execution of the employments.

Swapnil U Biraris et.al – Structural review is a general wellbeing and execution registration of structures .It is essential to the structure to check their security and they have no hazard. It is procedure of investigations of building And this procedure recommend a fitting fixes and retrofitting measures required for the structures to perform better in its administration life auxiliary review is a significant device for knowing the genuine wellbeing status of the old structures.

Shah I. H. et.al has stated structural review is a significant device for knowing the genuine status of the old structures. The review should feature and explore all the hazard regions, basic zones and whether the structure needs prompt consideration. On the off chance that the bldg. has changed the client, from private to business or modern, this ought to draw out the effect of such a change. This Publication gives bit by bit rules for doing auxiliary review of old structures.

Monteria. J., Pathak, N. J et.al have assessed the sufficiency of existing structures whose life has crossed the age of thirty years.

3. PROPOSED METHODOLOGY

3.1 General

To assess the consumption status in the RCC ESRs, the examination on the evaluation of erosion influenced structure of solid water tanks is completed. The examination includes visual investigation, non-ruinous test utilizing half-cell estimation, and resistivity estimation. The synthetic investigation is done to decide chloride content in the gathered solid powder test. The initial step of examination is visual assessment in visual assessment saw that splits, rust, decolouring are distinguished at different area. The half-cell potential test is done on the chose area on water tank part for discovering the likelihood of consumption. The profundity, spread and various sizes bars are estimated by the photometer. By ascertaining resistivity of cement and having current (I in ampere) going through solid we get voltage (V in volts).

An old water tank of age in the range of 30 to 40 years will be selected. The research methodology will be consist as follow

1. Performing preliminary inspection of the water tank.
2. Preparation of architectural, structural plan of the water tank.
3. Visual inspection to highlight critical area.
4. Performance of NDT tests.
5. Finding actual strength of the water tank.
6. Suggesting remedial measures

3.2 Steps to be followed in Structural Auditing

Step 1: It is imperative that we must have Architectural and Structural plans of the water tank. It will be helpful if we have detailed structural calculations including assumptions for the structural design.

Step 2: If the Architectural plans and Structural plans are not available, the same can be prepared by any Engineer.

Step 3: Inspection of the water tank - A detailed inspection of the building can reveal the Following:

1. Any settlements in the foundations.
2. Cracks in columns, beams and slabs.

3. Concrete disintegration and exposed steel reinforcements photographs can be helpful.
4. Slight tapping using hammer can reveal deterioration in concrete.
5. Corrosion in reinforcement.
6. Status of sagging, deflection, cracks.
7. Status of Architectural features viz. Chhajjas.
8. Cracks and swelling in R.C.C. members or deflection or corrosion.
9. Leakages from terrace
10. Leakages & dampness.
11. Status of repairs & last repaired.
12. What was repaired?
13. Who was the Agency?
14. How much was spent for repairs?
15. Water tank plans are available? When approved?

Step: 4 Preparation of Audit Report: On the basis of inspection of water tank an Audit Report is prepared.
Step 5: Tests Recommended: It is important that various tests are carried out in the old water tank. This will give an idea about the extent of corrosion, distress and loss of strength in concrete & steel.
Step 6: Highlight the critical areas and how to go for repairs.

3.3 Case study

Elevated reinforced concrete rectangular water tanks are designed for DL, LL, and WL (using provisions of IS 875 Part III-1987) and seismic loads using IS 1893-1984. In this work find out the corrosion in the reinforcement, calculate resistivity of concrete with the help of different non-destructive tests. The tank is located in **Ambegaon (BK), Dist. Pune**. The tank is built in year 1976 and storage capacity of tank is 75,000 litres. This structure consists of 6 circular columns. The tank is owned and maintained by **Nagar Parishad Ambegaon** since from last 40 years. Staging height of water tank is 10.5 m. Structural geometry of tank is with top spherical dome, cylindrical/ vertical wall, conical dome and bottom flat with two stage bracing levels. Typical view of elevated service reservoir is as shown in figure 2.

Field work the fields have been carried out, the field work consists of visual inspection and non-destructive testing .The tests are as follows,

1. Visual observations
2. Half-cell potentiometer test
3. Resistivity meter
4. Chloride Content Test

1. Visual observations This method involves both direct and indirect visual inspection techniques, direct inspection is where the material is inspected directly by the human eye with no additional visual aids, indirect inspection may involve the use of magnifying glass, mirror etc. Flowing some observations are listed below.

a) Blackish patches were seen on dome periphery as shown in figure 3.
b) Corrosion damage of ring beam inner side of ESRs shown in figure 4.
c) Bottom reinforcement of bracings were exposed and corroded as shown in figure 5.
d) Longitudinal cracks were seen on columns as shown in figure 6.

Fig.3 Blackish patches on dome periphery

Fig.4 Corrosion damage on Ring Beam inner side

Fig.5 Bottom reinforcement exposed

Fig.6 Longitudinal cracks on column correded

3.4 Destructive testing

To confirm the honesty of a part, it is consistently conceivable to slice or area through the segments and analyse the uncovered surfaces. Segments can be pulled or focused and pressurized until inability to decide their properties of solidarity and strength. Materials can be artificially treated to decide their arrangement. These are a few types of damaging testing. Sadly this methodology of dangerous testing renders the segment pointless for its expected use as against non-ruinous testing which can be performed on the segments and machines without influencing their administration execution.

3.5 Non Destructive testing

Non-destructive testing (NDT) is a wide gathering of examination methods utilized in science and innovation industry to assess the properties of a material, part or framework without causing harm. The terms Non-damaging assessment, Non-dangerous examination and Non-ruinous assessment are likewise regularly used to depict this innovation, on the grounds that NDT doesn't for all time modify the part being investigated, it is an exceptionally important strategy that can set aside both cash and time in item assessment, investigating, and research. Basic NDT strategies

incorporate ultrasonic, attractive molecule, fluid infiltrate, radiography, remote visual examination (RVI), swirl current testing.

Non-destructive Tests:

1. Rebound Hammer Test
2. Pulse Echo Method
3. Impact Echo Method
4. Ultra Sonic Pulse Velocity Method
5. Probe Penetration Test or Windsor Probe Test
6. Ground Penetration Radar Method
7. Carbonation Test
8. Half Cell Potential Meter Test

1 Rebound Hammer Test

1. Schmidt Rebound Hammer Test is a most common non-destructive test (NDT) performed on hardened concrete.
2. Schmidt Rebound Hammer Test method is most useful in checking the uniformity of concrete in laboratory as well as in the field.
3. It works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges.
4. Theoretical relationship between the strength of concrete and the rebound number of the hammer.
5. The rebound value indicated by the hammer is related empirically to the compressive strength of concrete.
6. It is able to provide a quick estimate of the quality of concrete.
7. The Plunger is held perpendicular to the concrete surface and the body pushed towards the concrete.
8. This movement extends the spring holding the mass to the body. When the maximum extension of the spring is reached, the latch releases and the mass are pulled towards the surface by the spring.
9. The mass hits the shoulder of the plunger rod and rebounds because the rod is pushed hard against the concrete,
10. During rebound the slide indicator travels with the hammer mass and stops at the maximum distance the mass reaches after rebounding. The distance travelled by the mass. Expressed as a percentage of the extension of the spring is called rebound number.
11. The button on the side of the body is pushed to lock the plunger into the retracted position and the rebound number is read from a graduated scale is fitted on the body.

4. RESULT AND DISCUSSION

The scope of work includes following:

a) Visual inspection with photographs to assess physical condition of structural elements.
b) Carrying out various types of Non-destructive tests on structural elements.

The proposed non-destructive tests for RCC are broadly classified as:

- **Tests for strength and quality of concrete** Schmidt's Rebound Hammer test, Core Sample testing and Ultrasonic Pulse Velocity testing on representative elements/samples. Determination of cement content in the laboratory.
- **Tests for assessing the risk of corrosion** Determination of depth of concrete cover, depth Carbonation, half-cell Potential meter tests.

Below mentioned scope of work includes conducting various tests as suggested:

Table 1: Test and Instruments used

Sr. No.	Description of tests	Equipment used
1	Schmidt's Rebound Hammer Test	Concrete test hammer type N manufactured and supplied by PROCEQ SA ZURICH
2	Ultrasound Pulse Velocity Test	Ultrasonic Instrument TICO manufactured and supplied by PROCEQ SA ZURICH
3	Cover Meter Tests	Instrument PROFOSCOPE by PROCECQ
4	Carbonation Test	PHENOLPHTHALEIN

5	Half-Cell Potential Test	Instrument Contained copper sulphate electrode, sponger for electrode, case for connecting reinforcement with crocodile carrying case.
6	Taking Out Concrete Cores (70mm/50mm Dia.)	Core Drilling machine of make TYROLIT
C	Laboratory Test	Compressive strength and density tests.

1. Test and Observations

1.1 Visual Inspection details:

Table 2: Details of Visual Inspection: Water tank

Sr. No	Location	Name of Distress	Photos
01	Outer wall of water tank C-3 & C-4, Outer wall of water tank C-5 & C-6, Outer Slab near C-1,C-2,C-3,C-4,C-5	Patch of dampness	 Figure 1
02	nner wall of water tank above C-1, C-2	Water Seepage	 Figure 2

03	Vertical Cracks in bottom and middle parts of Column No. C-1. Horizontal cracks from bottom to top in Column No. C-2, C-3, C-4, C-5, C-6. Vertical cracks in bottom and middle parts of Column No. C-3, Beam No. B-2, B-4, B-5, B-6, B-7, B- 8, B-9, B-10, B-11	Moderate Cracks (5mm to 10mm)	 Figure 3
04	Bottom Part of Column C-1, Middle part of Column C-1, Bottom Part of Column C-2, Inner side of Beam B-2, Soffit of Beam B-8, B-3, B- 1, Patches in outer slab	Corroded Reinforcement	 Figure 4

1.2 Rebound Hammer TestResults

Table 3: Details of Rebound Hammer Test Results: Water tank

Interpretation: As Per IS:13311-Part II

→ Denotes Rebound hammer Test Conducted in Horizontal Direction
↓ Denotes Rebound hammer Test Conducted in Vertically Downward Direction
↑ Denotes Rebound hammer Test Conducted in Vertically Upward Direction

S.No.	Test Locations	*Impact Direction	Rebound No.						Average Rebound No.	Corrected Rebound No.	Observed Compressive Strength
			1	2	3	4	5	6			
	Ground										
	Columns										
1	C	→	22	24	21	20	18	20	21	21	7
2	C	→	38	40	38	42	42	38	40	40	17
3	C-3 (Core	→	36	40	35	38	39	37	38	38	16
5	B	→	28	24	26	28	24	28	26	26	10
6	B	→	22	20	18	20	18	20	20	20	6
7	B-4 (Core	→	43	44	39	43	40	41	42	42	18

8	B-5 (Core	⊢→	30	32	33	29	32	31	31	31	13

Laboratory Test Results For Compressive Strength

Table 4: Details of Laboratory Test Results: Water tank

S. No.	Sample ID	Diameter	Length	L/D RATIO	CORRECTION	MAXIMUM LOAD	CYLINDRICAL COMPRESSION	Corrected CYLINDRICAL	Equivalent	Natural	Saturated
	Ground										
	Columns										
1	C-3 (Core	67.47	134.3	1.991	0.999	39.18	11.0	10.9	**13.7**	2257	2311
2	C-4 (Core	67.56	119.1	1.763	0.974	39.20	10.9	10.6	**13.3**	2228	2292
	Be										
3	B-4 (Core	67.62	118.2	1.749	0.972	42.82	11.9	11.5	**14.5**	2187	2274
4	B-5 (Core	67.51	124.4	1.902	0.989	38.52	10.8	10.6	**13.3**	2231	2316

4.4 Test Results of Ultrasonic Velocity Tests

Table 5: Details of Ultrasonic Velocity Tests: Water tank

Interpretation: As Per IS:13311-Part I

* 'Direct': Probes Kept on Opposite Faces
* 'Semi-direct': Probes Kept on Perpendicular Faces
* Indirect': Probes Kept on Same Face

S.No	Test Location	* Method of Probing	Observed UPV	Corrected UPV (m/sec)	Inference (IS : 13311-I)
	Ground Level				
	Colum				
1	C-	Dire	46	46	Doubtful
2	C-	Dire	37	39	Doubtful
5	C-3 (Core WT-1)	Dire	347	347	Medium
7	C-4 (Core WT-2)	Dire	356	356	Good
	Beam				
13	B-	Dire	45	65	Doubtful
14	B-	Dire	22	22	Doubtful
19	B-4 (Core WT-5)	Dire	344	344	Medium
20	B-5 (Core WT-6)	Dire	346	346	Medium

4.4 Rebar locator TestResults

Table 6: Details of Rebar locator Test Results: Water tank

Interpretation : As Per IS:456 – 2000						
Note: Only 'Clear' Concrete Cover is Measured. Approximate dia. will be calculated. Accuracy of results depends on Depth, Diameter, Spacing& Positioning of Reinforcement Bars.						
S.No.	**Test Location**	**Face**	**Size**	**Reinforcement**		
				Main	**Stirrups**	**Cover**
					(mm)	**(mm)**
	Ground					
	Columns		**(Diameter)**			
1	C-		53	8X18 mmó	6 mm ó @ 220	35-
2	C-		53	8 X 20 mm ó	6 mm ó @ 225	55-
3	C-		53	8 X 20 mm ó	6 mm ó @ 220	28-
	Beam					
4	B-1(MID.)	I.Side(5	550X250	3 X 25 mm ó	10mm ó @ 325	30-
5	B-1(MID.)	Soffit(2	550X250	2 X 25 mm ó	10mm ó @ 325	20-
6	B-2(SUPP.)	OSide(5	550X250	4 X 25 mm ó	10mm ó @ 235	38-

4.5 Test Results of Carbonation Tests

Table 7: Details of Carbonation Test Results: Water tank

Interpretation:				
Indicator Color: Deep Purple				
Sl. N	**Test Location**	**Depth of Carbonation**	**Minimum Concrete Cover Measured**	**Minimum Concrete Cover IS -456**
	Ground Level			
	Columns			
1	C-	49	35	40
2	C-	56	55	40
3	C-3 (Core WT-1)	37	28	40
4	C-4 (Core WT-2)	51	62	40
	Beam			
5	B-	41	30	20
6	B-	49	30	20
7	B-4 (Core WT-5)	42	26	20
8	B-5 (Core WT-6)	36	28	20

4.5 Test Results of Half-Cell Potential Tests

Table 8: Details of Half-Cell Potential Tests Results: Water tank

Interpretation: As Per ASTM:C876-1991			
By convention, potentials are considered negative when measuring the steel with respect to the electrode. The interpretation of measurements is in terms of the likelihood of corrosion.			
Sl. N	**Test Location**	**Half-cell Reading**	**Risk of corrosion**
	Ground		
	Columns		
1	C -	0.46	90
2	C -	0.42	90
3	C -	0.38	90
	Beam		
4	B -	0.32	90
5	B -	0.40	90
6	B -	0.46	90

4.6 Discussion

Repair Scheme for Column

The following repairs scheme is adopted for the correction of column:

- Propping the beams on all the sides of the columns for full vertical height. The props shall be able to take the total load coming on to the column.
- Chipping open the cover concrete until all the corroded steel rods are and cleaning of rods with brush
- Chipping the spelled surface of concrete to remove all loose materials. Then brushing it with steel wire brush to remove all loose particles. Washing the surface with potable water.
- Applying a coat of anticorrosive coating like NITO-ZINCPRIMER manufactured by M/s FOSROC or approved equivalent to all the existing reinforcement.
- Anchoring new bars by drilling holes in the tie beams for a length of 10 times the diameter of bar.(10XDia of bar)or into the pedestal. Additional bars thus introduced are bonded with the concrete using Hilti chemicals for re-barring. Tie new longitudinal bars using new column ties. The ties have to be anchored into the concrete by drilling holes in the concrete and inserting the ends of the ties into the holes. The depth of drilling shall be such that length of the ties from the centre of new longitudinal bar is 8 times the diameter of tie.
- Leak proof formwork which should not deform or leak due to pressure of concrete shall be fabricated and erected in position. The formwork should be coated with mould release agent prior to the final fixing in position. M a k i n g p roper supporting arrangements for keeping the shutter in correct line and length.
- Encasement using high slump concrete of grade M25 (minimum).It shall be ensured that clear cover to the new steel is 50mm. Curing compound is to use for curing purposes.

Repair Scheme for Beams

Basic steps involved in the repair of beams are same as that for columns except for the following point.

- Encasement is done using micro concrete of SIKA/ FOSROC or equivalent approved material with 25% aggregate (washed/cleaned) by weight of size 6.4 mm and down size. The curing has to be done immediately after stripping the formwork.

Repair Scheme for Slabs

The repair of slabs is also almost the same as that of columns and beams except for the following points:

- Propping the slab at intervals of sayabout1.5 m.

- Additional bars introduced are anchored to the beam. Additional steel shall be tied to the existing steel or anchored using anchors drilled into the slab.
- The micro concrete, with 25% aggregate of size 6.4 mm and down is poured by funnels by drilling holes of about 50 mm dia. at 2 m intervals in both directions. The curing has to be done immediately after stripping the formwork. It shall been ensured that clear cover to the new steel is 25mm.

4.7 Site photo graph

Repair Scheme for Tank Dome

1. Cracked or any surface of concrete which is prone to cracks are repaired with polymer modified mortar. After the completion of the project the NDT tests will be conducted again to ascertain the quality and strength of aspects improved in the structure

Fig 5 - water tank

Fig 6 water tank

Fig 7 water tank column beam

Fig 8 water tank slab

Fig 7 water tank pathology cracking

5. CONCLUSION

This undertaking was led to survey the auxiliary wellbeing of a water tank, bolstered by a non-ruinous test battle and a numerical reenactment that permitted to assess the security level and to help the meaning of the basic retrofitting and recovery needs. No significant harms were recognized in the auxiliary components assessed. In any case, breaking was seen of the top chunk that permits the penetration of water into the tank along with a lacking incline for water seepage and a raised debasement of the waterproofing film. Some non-auxiliary harms were additionally watched. The auxiliary security was commonly checked, both for vertical activities and for flat activities. The main special case is the splitting example displayed by the sections that joint the piece in its form, clarified by the powers on these components for the central mixes related with the occasional variety of temperature. A similar sort of activity likewise clarifies the splitting example saw in the spread chunk. Survey the basic wellbeing of a water tank, bolstered by a non-ruinous test crusade and a numerical reproduction that permitted to assess the security level and to help the meaning of the basic retrofitting and recovery needs. No significant harms were recognized in the auxiliary components assessed. Notwithstanding, splitting was seen of the top piece that permits the penetration of water into the tank along with a deficient slant for water waste and a raised debasement of the waterproofing layer. It varies hour to hour. So as to gracefully steady measure of water, we have to store water. So to satisfy the open water need, water tanks should be built. These tanks are planned according to Seems to be: 3370 for example Code of training for solid structures for capacity of fluids. BIS actualized the reconsidered rendition of IS 3370 (section 1& 2) after quite a while from its 1965 form in year 2009. By and by enormous number of overhead water tanks is utilized to convey the water for open utility. A large portion of the water tanks were planned according to old IS Code: 3370-1965 without considering quake powers. Structures are congregations of burden conveying individuals prepared to do securely moving the superimposed burdens to the establishments. Their primary and most cared for property is the quality of the material that they are made of. Concrete, as we as a whole

know, is a fundamental material utilized for development purposes. Subsequently, quality of cement utilized, is required to be 'known' before beginning with any sort of investigation. In the ongoing past, different strategies and methods, called as Non-Destructive Evaluation (NDE) procedures, are being utilized for Structural Health Monitoring (SHM). The idea of non-destructive testing (NDT) is to acquire material properties of set up examples without the pulverization of the example nor the structure from which it is taken. Nonetheless, one issue that has been common inside the solid business for quite a long time is that the genuine properties of a set up example have never been tried without leaving a specific level of harm on the structure. Normally, agent test examples are thrown from a similar solid blend as the bigger auxiliary components. Tragically, test examples are not an accurate portrayal of in-situ concrete, and might be influenced by varieties in example type, size, and restoring methodology. The point of the undertaking was to acquire the Calibration water tank for dangerous and Non Destructive Testing Equipment's viz., the Rebound Hammer and Ultrasonic heartbeat Velocity Tester and so forth and to consider the impact of support on the got outcomes.

REFERENCE

1. BhavarDadasaheb O, DhakePravinchandra D, Ogaleramesh A,“ Retrofitting of existing R.C.C building by method of jacketing”, International journal of research in modern engineering and emerging technology Vol 1,Issue:5-2013

2. Dr.Gopal L. Rai, “Different strenghtening techniques for R.C columns”, R and M international Pvt.Ltd.Mahdishariati, Nor Hafizahramli-sulong, Mohammad Mehdi Arabnejadk.h, Payamshafigh and Hamid Sinaei,

3. “Assessing the strength of reinforced concrete structures through ultrasonic pulse velocity and Schmidt rebound hammer tests”, Scientific research and essays Vol 1,Issue:1-2011. IS 13311(1992), “Code of practice for Non Destructive Testing of concrete – methodsof test part: 1 Ultrasonic pulse test”, Bureau of Indian standards (BIS), New Delhi.13311(1992), “Code of practice for Non Destructive Testing of concrete – methods of test part: 2 Rebound Hammer test”, Bureau of Indian standards (BIS), NewDelhi.

4. IS 1893 (2002). “Indian Standard criteria for Earthquake Resistant Design of structures part 1: General Provisions and Buildings”, Bureau of Indian standards (BIS), NewDelhi.
5. NP EN 12504-2, Testing concrete in structures. Non-destructive testing.Determination of rebound number, 2012.

6. ASTM C803/C803M, Standard Test Method for Penetration Resistance of Hardened Concrete, Book of Standards, Vol. 04.02, American Society for Testing and Materials, 2010.
7. EN 12504–1, Testing Concrete in Structures- Part 1: Cored Specimens - Taking, Examining and Testing in Compression, CEN, 2009

8. H. Rodrigues, P. Antunes, A. Costa, P. André, and H. Varum, - Chapter 5 “Dynamic measurements as support to the analysis and condition assessment of structures” - BOOK “Accelerometers: Principles, Structure and Applications” - Editors: Paulo André and HumbertoVarum, Nova Science Publishers, Inc, ISBN: 978-1- 62808-111-4.

9. P. Antunes, R. Travanca, H. Rodrigues, J. Melo, J. Jara, H. Varum, P. André, “Dynamic structural health monitoring of slender structures using optical sensors,” Sensors, vol. 12, no. 5, May 2012, pp. 6629-6644, 2012.

10. RBA, Regulamento do BetãoArmado, Decreto-lei nº 25 948, de 16 de outubro, 1935.

11. REBA, Regulamento de Estruturas de BetãoArmado, Decreto-lei nº 47 723, de 20 de maio, 1967.

12. RSA, Regulamento de Segurança e AcçõesemEstruturas de Edifícios e Pontes, Decreto-Lei nº 235/85, de 31 de Maio de 1983.

13. REBAP, Regulamento de Estruturas de BetãoArmado e PréEsforçado, Decreto-lei nº 349-C/93, de 30 de Julho de 1983.

14. EN 1998-1, Eurocode 8: Design of structures for earthquake resistance -Part 1: General rules, seismic actions and rules for buildings, CEN, 2004

15. EN 1998-5, Eurocode 8: Design of structures for earthquake resistance Part 5: Foundations, retaining structures and geotechnical aspects, CEN, 2004