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Vol. 5, Issue 10, October 2016

Evaluation of Structural Concrete Durability of Overhead Tank of Various Age Constructed in Bhopal Region

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ABSTRACT: The failure of overhead concrete water structures alarmed researchers to focus on the durability and reliability of these structures. Over the age of the structure conditions are sometime typical and these structures collapsed unexpectedly even before reaching the design age. Therefore, effective methods for monitoring the condition and evaluating the deterioration level are required. This leads to the development of several destructive and non-destructive test methods. Rebound hammer and Ultrasonic pulse velocity test over any concrete structure reflects its conditions. Several physical and chemical properties of Overhead structures significantly influence the condition and hence enforce to evaluate the condition of overhead water retaining concrete structures by measuring UPV and compressive strength is significant for planning maintenances, durability and replacement of structures. In the present research study different water tanks are identified andselected according to their ages which are located in the city of Bhopal. The Research isaimed to evaluate the concrete durability of overhead tanks. Field test are carried out on selected twenty structures. The data obtained are analysed and presented the outcomes andfindings of the research study. This research study and findings are useful for Engineers andauthorities for proper planning and maintaining these structures in years to come.

KEYWORDS: Durability, compressive strength, Overhead structures, Non Destructive test.

I. INTRODUCTION

Structural health evaluation is at the forefront of structural and material research. Structural health evaluation systems enable Engineers to gather data of structures and structural elements used for analysis. Evaluation can be very beneficial for the recognition of potential damages to structures and to identify the causes of their probability. The structural damages are of many types, the cracks are considered more important damage in the structure as it reduces the life and strength durability of the structure. The causes of cracks are several, but the use of high early strength cement and concrete mixtures to support the high speed of novel construction has emerged as the most predominant factor to minimize cracks in modern concrete structures at an early age. Structure that is in use for which it is intended to, shows some structural disorder, may be evaluated for its quality, structural integrity and in place concrete compressive strength.

Any premature deterioration in the overhead water retaining structures, which are built with codal provisions and standards has drawn serious attention to the Engineers and Researchers to assess the durability of the structures.

Standing structure is not easy to evaluate by conventional methods adopted to evaluate structural integrity and in place concrete compressive strength same as testing standard specimens up to failure. Hence for overhead structures,



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standing decades together, an efficient system evaluation of structure for in place strength is persistently required. Non Destructive Testing has the potential of becoming an effective tool for quality assessment and damage evaluation.

Non Destructive techniques are useful for evaluating the conditions of the structure by performing indirect assessment of concrete properties. The standard procedure for non-destructive testing of overhead water retaining structures is to qualify and quantify the material properties of in-situ concrete without intrusive checking of the material properties. These methods are significant for the inspection and monitoring of concrete materials.

Deterioration of the overhead structure can take place due to the several factors during its proposed life cycle. Deterioration or failure can take place before the estimated life cycle of the structure in the different circumstances, predominantly harsh in hot and dry regions where lofty temperature, humidity and salinity exists. The life span of the structure without significant maintenance depends upon the embedded reinforcement and cover surrounded by the reinforcement.

In the city of Bhopal about hundreds of the Overhead tanks are in use since last 40-50 years. These Overhead Tanks are of different ages and due to several reasons the structural health of these Overhead tanks are typical at any time, some are near to achieve their life span and some are yet to give life to the serviceability. Many new Overhead tanks with latest design and emerging materials are being constructed under JNNURM. In view of Evaluation of Structural durability of selected Overhead tanks, the research is conceived or planned.

This Research emphasis on overhead tanks of the various age constructed in Bhopal region to assess the durability of the overhead structure .Design values and the net present values of structural concrete overhead tanks constructed in Bhopal region is being compare. The Research Study is also intended to study the behaviour of strength on various age of the structure. Research work will be beneficial for the consultancies and the agencies for designing the overhead structures to obtain adequate strength and durability of the structure, to plan for maintenance and for sustaining the life of Overhead tanks.

II. RELATED WORK

Kondapalli (2015)[1] Analysed a 5 storey Educational structure with NDT technique which was Usha Rama college of Engineering and Technology with an age of 8 years. Premature Deterioration were observed resulting a need for regular monitoring and maintainance.725 columns were assessed with WTC model H concrete Rebound hammer. Compressive strength for small column vary from 20 to 45 N/mm², whereas for large column it varies from 20 to 50 N/mm². Average compressive strength evaluated for small columns was 33.6 N/mm² and for large columnsit was 43.8N/mm². The outcome of the project can be used for repair and maintenance work to be carried out for the better serviceability of the structure.

Mulik and Balki(2015)[2] Research Imphasis on the mechanical properties of concrete employed in civil structures. Specimens were prepared to correlate the concrete strength obtained by combined NDT method with cubical strength extracted by destructive methods with the help of the statistical data extracted by testing specimens as per recommended procedure by IS 516:1959 and IS 13312:1992 respectively. The use of combined methods increases the accuracy of the in-situ concrete compressive strength.

Wankhade and Landage (2013)[3]Objective of the Research work is to purpose the systematic developed investigation for metrology and condition ranking mechanism based on Analytical hierarchy process(AHP). Tests were being carried out for overhead service reservoir in karad region in Maharashtra and DER rating technique is used to find out the condition ranking of the overhear service reservoir. Different Non Destructive test methods like cover depth measure, half cell potential methods, ultrasonic pulse velocity test, surface hardness test were being carried out for ranking assessment for overhead service reservoir structure.

Binda, Cardani, and Zanzi (2010)[4] Recognised a Experimental research after the floods occurred in Italy that damaged the cultural Heritage masonry buildings. The main objective of the Research was to check the influence of non destructive techniques in detecting the presence of water and the drying process. They also hold influence on the surface treatment process in their Research.



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III. OBJECTIVES OF THE PRESENT RESEARCH STUDY

The main objectives of the research study are as follows:

- 1. Selection of the Overhead tanks within the scope of the research for durability evaluation.
- 2. Perform Non Destructive Test on the selected Overhead tanks.
- 3. Analysis of the data of Non Destructive Test conducted.
- 4. Comparison of the concrete strength design value and present value of overhead water tanks.

IV. EXPERIMENTAL METHODOLOGY

A comprehensive test methodology has been adopted to determine the effect of durability over the age for the Overhead water tanks located in the Bhopal City. This started with the collection of data from Nagar Nigam Bhopal for the study followed by selection of non-destructive techniques to be adopted for performing the tests. The overhead water tanks of different age groups located in different regions of the City have been selected for testing. The non-destructive tests were performed on various elements of the selected structures

Structure No.	Classification	Туре	Capacity(litre)	Location	Age (years)
1.	Structure1	Column	20,00,000	ManavSanghralaya	3
2.	Structure2	Column	20,00,000	JawaharChowk	3
3.	Structure3	Column	20,00,000	Jail pahadi	3
4.	Structure4	Column	20,00,000	1100 Quarter	3
5.	Structure5	Column	20,00,000	4 Emli Tank	4
6.	Structure6	Column	22,50,000	Nehru Nagar	7
7.	Structure7	Column	1,89,000	Kotra	7
8.	Structure8	Column	22,50,000	Platinum Plaza	7
9.	Structure9	Column	1,89,000	Shabri Nagar	8
10.	Structure10	Column	22,50,000	Shayam Nagar	8
11.	Structure11	Column	7,56,000	Baghera Apartment	10
12.	Structure12	Column	3,78,000	NariyalkhedaResham Nagar	13
13.	Structure13	Column	3,78,000	Congress Nagar	14
14.	Structure14	Column	3,78,000	J.P. Nagar	14
15.	Structure15	Column	3,78,000	Arif Nagar	14
16.	Structure16	Column	1,89,000	PutliGhar	35

Table 1-Selected Data



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17.	Structure17	Shaft	7,56,000	E-6	36
18.	Structure18	Shaft	11,34,000	E-2(Arera)	36
19.	Structure19	Shaft	11,34,000	1100 Quarter	38
20.	Structure20	Shaft	7,56,000	4 emli	40

Figure 1 summarises the work done during testing of Overhead water tanks in the field.



Figure 1- Site Photographs

V. EXPERIMENTAL RESULTS

The data collected during the field testing has been analyzed taking into account various parameters in order to determine the design value and net present value, effect of age and the condition of concrete structures. In the present research, the data obtained from field has been plotted to evaluate the effect of age, compressive strength, and ultrasonic pulse velocity of structural elements. Graphs between age and UPV Condition ratings, compressive strength of Beam, Column, Top shell, Bottom Shell is been plotted.



Figure 2-U.P.V Condition Ratings



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In the figure 3 Grade comparison of beams is done to compare the design value and net present value of the beams.16 structures is been analyse for testing of the beams as an element.



Figure 3-Grade Comparison of beams

In the figure 4 Grade comparison of columns is done to compare the design value and net present value of the column.16 structures is been analyse for testing of the column as an element.



Figure 4-Grade Comparison of columns

In the figure 5 Grade comparison of Top shell is done to compare the design value and net present value of the Top shell.16 structures is been analyse for testing of the Top shell as an element.



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Figure 5-Grade comparison of Top shell

In the figure 6 Grade comparison of Top shell is done to compare the design value and net present value of the Top shell. Four structures is been analyse for testing of the Top shell as an element separately accordingly as they are shaft type overhead structures.



Figure 6-Grade comparison of Top shell

In the figure 6 Grade comparison of bottom shell is done to compare the design value and net present value of the bottom shell. Four structures is been analyse for testing of the bottom shell as an element separately accordingly as they are shaft type overhead structures.



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Figure 7-Grade comparison of Bottom Shell

VI.CONCLUSION

- 1. All 20 overhead water tanks are tested for durability and strength using rebound hammer and ultrasonic pulse velocity.
- Structure No 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16 have more than the design value of beams having average value of 51.87 N/mm².
- Structure No 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16 have more than the design value of columns having average value of 50.40 N/mm²
- Structure No 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20 have more than the design value of top shell having average value of 46.99 N/mm².
- Structure No 17, 19 have less than the design value of bottom shell having average value of 14.3 N/mm².
- Structure No 18, 20 have more than the design value of bottom shell having average value of 27.52 N/mm².
- Top shell of the structure no 19 is been collapsed therefore there is no reading of compressive strength for structure no 19.
- 2. Tests have been conducted on elements such as beam, column, top shell and bottom shell.
- Average Beam value of structures having age of 3 years is 49.05 N/mm^2 .
- Average Beam value of structures having age between 4 to 8 years is 54.46 N/mm².
- Average Beam value of structures having age between 10 to 14 years is 54.62 N/mm²
- Average Column value of structures having age of 3 years is 47.92 N/mm².
- Average Column value of structures having age between 4 to 8 years is 55.47 N/mm².
- Average Column value of structures having age between 10 to 14 years is 49.2 N/mm².
- Average value for top shell having age of 3 years is 52.15 N/mm².
- Average value for top shell having age between 4 to 8 years is 50.53 N/mm².
- Average value for top shell having age between 10 to 14 years is 53.66 N/mm².
- Average value for top shell having age between 35 to 40 years is 23.11 N/mm².
- Average value for bottom shell having age between 35 to 40 years is 30 N/mm².



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