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Condition Assessment of RCC ESR Using NDT Methods

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Abstract- Abstract: Concrete is considered as a durable material but it is still potentially vulnerable to deterioration, unless certain precautions are taken. Life enhancement of distressed concrete structures depend on number of factors such as design, detailing, materials used in the original construction, quality control, environment as well as periodic inspection and regular maintenance. The assessment of concrete structures consists of not only evaluation of the present condition but also prediction of the cause of deterioration and its residual life. Hence, it is essential to have accurate assessment of physical, chemical and electro-chemical properties to enhance the existing life of the structure. If the cause of deterioration is predicted and a proper assessment of the structure is made, it may be economically feasible to repair the distressed structure and prolong its life. The estimation of mechanical properties of concrete can be carried out by several methods namely destructive and non-destructive. In this context, the crushing of the samples is the usual destructive test to determine the concrete strength. The rebound hammer test is used in the field of non-destructive tests to determine respectively .The result obtained from the given data, exact assessment will be found out of the given water tank.

Keyword Concrete, Condition assessment, Carbonation, Corrosion, Service life;

1. Introduction

Deteriorating infrastructure continues to be a growing concern. Accurate information on the condition of concrete in a existing structure is critical to evalaluate its safety and serviceability. This information is required by decision makers to determine if repair or replacement is necessary and to select optimum repair techniques where conditions require. (ACI Committee 207). Assessment of quality of concrete is necessary to ensure that the quality of execution is satisfactory and also to identify any deficiencies so that they can be rectified. This can be achieved only by conducting some in-situ tests on the structures besides visual inspection. These tests have been developed with a primary objective of evaluating the condition of in- situ concrete quickly. The in-situ tests are either non-destructive or partially destructive [1, 2]. Rebound hammer test, Cover survey, Carbonation test, pH test and chloride contein test are mostly used for the assessment of existing concrete structures [3, 4]. It is important to note that almost all the NDT methods indirectly estimate the concrete strength and strength obtained by these methods, in most of the cases, is comparable. Even then, no single method can be said to be fully reliable and therefore, more than one method should be used and results should be correlated [1]. Non-destructive testing technologies are evolving and research continues to enhance existing methods and develop new methods. The paper present is intended to provide an overview of the principles of various NDT methods being used in practice, and to summarize their applications and limitations. The emphasis is placed on methods that have been applied to measure physical properties other than the strength of concrete in structures, to detect flaws or discontinuities and to provide data for condition evaluation [3]. This paper discusses the assessment of old overhead Reinforced Cement Concrete (RCC) reservoirs as a case study useing NDT methods. The main aim of the paper is to highlight the importance and significance of different test methods employed to assess the present condition of RCC structures. This paper also presents the rational and systematic approach for the interpretation of test results for arriving at an economical repair procedure and rehabilitation measures. Necessary repair measures are suggested to enhance the service life of the structure.

1.1Typical Condition Deterioration Curve :

The simple and more advanced approaches to condition assessment allow the development of predictive decay curves for assets as shown in Fig.1. The slight improvement in condition at the start of an asset's lifecycle reflects the normal improvement in performance after a short teething period [11].

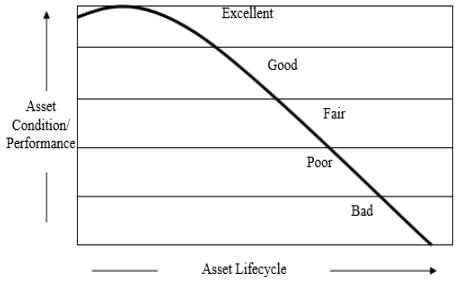

Figure 1: Typical Condition Deterioration Curve [11]

This paper describes the systematic visual inspection of various RCC ESR's in Amravati region along with photographs and interpretation of results of various non-destructive tests such as rebound hammer. Chemical tests of concrete samples were carried out to determine the pH, carbonation and chloride content of concrete. This paper also presents and describes detailed investigation of RCC ESRs at Amravati region. Tests were carried out at columns, beams, dome periphery, and dome slab of RCC ESR's. The results of carbonation, pH and chloride content were presented in tabular form. Data interpretation was carried out in accordance with various reference codes.

1.2 Basic methods for NDT of concrete structures: The following methods with some typical applications, have been used for the NDT of concrete [13].

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- Visual inspection, which is an essential precursor to any intended non-destructive test. An experienced civil or structural engineer may be able to establish the possible cause(s) of damage to a concrete structure and hence identify which of the various NDT methods available could be most useful for any further investigation of the problem.
- Half-cell electrical potential method, used to detect the corrosion potential of reinforcing bars in concrete.
- Schmidt/rebound hammer test, used to evaluate the surface hardness of concrete.
- Carbonation test, pH test and chloride contain test used to determine whether moisture has reached the depth of the reinforcing bars and hence corrosion may be occurring.
- Covermeter testing used to measure the distance of steel reinforcing bars beneath the surface of the concrete and also possibly to measure the diameter of the reinforcing bars.

2. Case Study

1- Condition Assessment Of RCC ESR At Kurha

2.1 Salient features

a) Period of construction : 1986-87
b) Investigation year : 2015
c) Location : At. kurha. Tah. Tivsa.
d) Owned and maintained : Grampanchayata, Kurha
e) Total period of use : 29 yrs.
f) Is water tank under use? : Yes
g) Capacity : 1,25,000 liters
h) Staging height : 3.6 m
i) Column Shape : Circular
j) Number of column : 6 No's
k) Bracing levels : Three stages
l) Structure/Geometry of tank: Tank with top spherical dome, cylindrical/ vertical wall, conical dome and bottom spherical.
m) Is the tank being maintained? : Tank is being maintained regular.

- Detail drawing of RCC ESR at Kurha shown in fig.

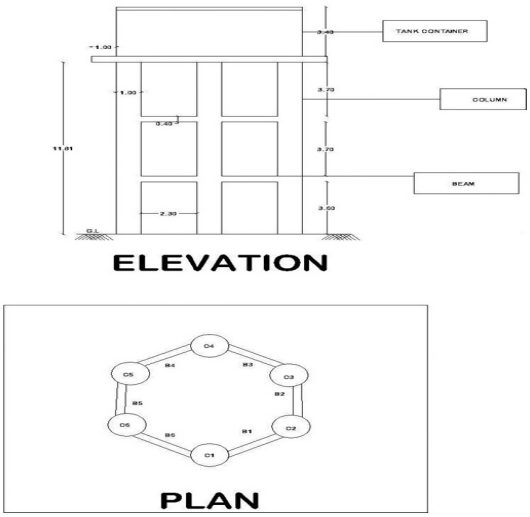

Fig2 Drawing of RCC ESR at Kurha

3. Results

3.1) Visual inspection/observation

a) Blackish patches were seen on dome periphery. Blackish pat on as shown in fig.1.2

b) Longitudinal cracks were seen on beam B2, as shown in fig.1.5.

c) Spaling of concrete observed on beam column joint as shown in fig. 1.6.

d) Craze cracks and severe spalling of concrete were seen on beam B9 and B3 as shown in fig.1.4, 1.6 respectively.

Fig3 Top spherical dome, Bottom spherical slab, Craze cracks, Longitudinal cracks, Spaling of concrete, spalling of concrete

3.2) pH test

The standard value of pH for fresh concrete is 11-13. As shown in graph (fig 1.7) the pH value of was gradually reduced to about 8.0 to 10.23 through a process called carbonation. Whereas Kurha water tank have a low pH value therefore each components carbonated and ready to receive flooring adhesive should have a pH of about 8.0. This means the surface of the concrete has had minimal moisture vapour movement.

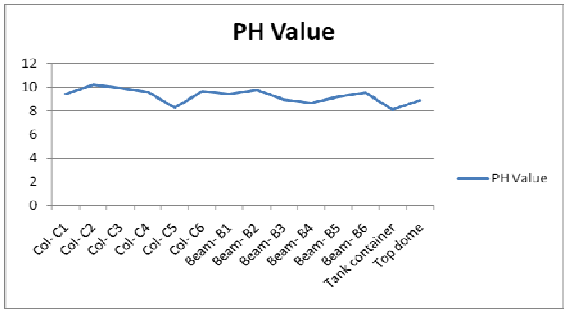

fig1.7 spalling of concrete

3.3) **Result of condition index**

Table 1 Result of condition index/condition ranking (CI) of kurha

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S.No.	Test location	Avg. comp. strengthby rebound	Avg. cover thickness by rebar	Avg. potential difference by half-cell potentiometer test	Weighting of component of water tank	Parameter (a)	Degree (Dmax)	Extent (E)	Relevancy (R)	Condition Index of each	(CIi x wi)	Condition Index of water Tank
1	Col-C1	19.00	15	-260	8	2	4	4	3	43.7	350.	
2	Col-C2	22.00	16	-170	8	2	2	2	2	87.5	700.	
3	Col-C3	19.00	22	-250	8	2	3	2	2	84.3	675.	
4	Col-C4	18.00	38	-230	8	2	4	3	3	50.7	406.	65.10
5	Col-C5	21.00	25	-430	8	2	2	2	3	71.8	575.	
6	Col-C6	22.00	-	-430	8	2	4	3	3	50.7	406.	
7	Beam-	18.00	18	-365	6	2	4	3	3	50.7	304.	
8	Beam-	19.00	50	-230	6	2	2	4	2	81.2	487.	
9	Beam-	18.00	35	-310	6	2	4	2	2	81.2	487.	
10	Beam-	19.00	61	-245	6	2	2	3	2	84.3	506.	
11	Beam-	22.00	40	-415	6	2	4	2	3	57.8	346.	
12	Beam-	18.00	36	-	6	2	3	4	3	50.7	304.	
13	Tank	19.00	24	-340	11	2	4	4	3	43.7	481.	
14	Top do	19.00	37	-320	5	2	4	2	3	57.8	289.	

From Table 3.1 condition ranking/ condition index of 65.10 it is interpreted that present condition RCC ESR at kurha is good. Degree of deterioration of this ESR is medium. Cracks, slight corrosion and spalling of concrete are the deterioration aspects observed on some components of ESR. Working function of ESR is not affected. It is recommended to repair the defected components of ESR.

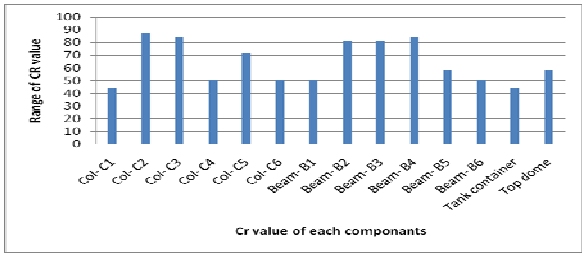

Fig 4. Cr value for each component of Structure

4. CONCLUSIONS

It has been seen that detailed visual inspection and Non Destructive Testing (NDT) plays an important role in condition assessment of RCC ESR. From visual inspection, we have observed the various damages occurred due to construction faults and because of factors affected with respect to time. This gives the information about less than average condition of the RCC ESR for further usage. The Schmidt hammer provides an inexpensive, simple and quick method of obtaining an indication of concrete strength. The Selected water tanks are nearly 30 years old, thus the strength is nearly to an average value of requirement. It is observed that the pH value of the water tank is low as compared to standard pH value. So repair measure works are required except kurha water tank. Based on the test results, it was found that the distressing of the supporting structure was mainly due to voids, honeycombing and carbonation of concrete.

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