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CONDITIONAL ASSESSMENT OF A STRUCTURE USING DIFFERENT NON-DESTRUCTIVE TEST METHODS

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ABSTRACT: Non-Destructive Testing(NDT) is one of the most majority dominant task of well preservation and detection of the construction structural.NDT techniques putup to the destruction liberality worn in the procedure as good as numerous further operations along with preservative schemes of construction. The ensuring learn is concentrating on survey is dominant category of NDT Techniques ;the visual and further ones, which establish extensive relevancy in factual and practical read now a days. The wrapper talk about the sort out the majority wide relevant techniques; namely optical trial, ultrasonic trial, Rebound hammer, carbonation test and Half-cell potential trial. Apart from the fundamental idea trials utilize these techniques, their capable principles in different practicle and professional separations are widely debated. The inspection as the group of the NDT techniques produced in the wrapper would be supports in nomination of comparable categories in detection of different methods of structure and flaws and injury happening in these shape.

KEYWORDS:

Optical NDT methods, Non-Destructive experiment, experiment of structure, Injury recognition.

I. INTRODUCTION

A reference has been made from M/s. Vijayawada Tollway Pvt.Ltd., Vijayawada for assessing the condition of the bridge (Road Over Bridge) LHS at Ch.406+300 in Guntur Bypass in Chilakaluripet-Vijayawada project stretch.

As a part of inspection, the key issues were noted for the ROB and the necessary non-destructive experiment like Rebound Hammer experiment, Ultrasonic Pulse Velocity experiment(UPV), Half-Cell Potential, Carbonation experiment were conducted to the structural components of the bridge so as to assess the strength. In presence of all the concerned officials from the NHAI, Railway and the IJM, the NDT was conducted on 09.10.2018.

OBJECTIVE:

A lot of NDT techniques are potential of pointing flaws and explaining the characteristics of the flaws such as Dimensions (size, shape, and orientation).The motive of NDT is to examine a elements in secure, authentic, and price productive way in the absence of leads to harm to the apparatus or conclusion plant functioning.

SCOPE:

*The future of NDT is firmly connects to activity promote excessive perfection, little mistakes and consequently an accelerate prospect of spotting.

*To assist in product development and to monitor, improve or control manufacturing process.

OBSERVATIONS:

1. For the reinforcement which is exposed near girder ends, the stirrups got completely corroded
2. It is observed that the diameter of the main rebars are also decreased due to corrosion effect
3. The plate bearings are severely corroded

As per the observations, the corrosion of the reinforcement is "Transient to Final Phase"

Concrete spalling, reinforcement exposed at ends of girder

Distressed earthquake arrester

Distressed earthquake arrester

LITERATURE REVIEW:

[1]Almir and Protasio(2000) [13] used NDT methods to determine the compressive strength of concrete relationship between the measured mechanical or physical properties and the strength and also presented the validity of pull off, pin penetration, and UPV for assessing the concrete strength.

[2]Amini and Tehrani(2011) [7] designed experimentally four sets of exposure conditions,weight and compressive strength of the samples had been measured before and after the freeze thaw cycles,and the results were analyzed.

[3]Amleh and Mirza (2004) [17] performed concrete cover test, Half cell Potential, corrosion rate,electrical resistivity,chloride content at steel level (%), steel bar mass loss (%), absorption, pulse velocity, compressive strength,carbonation depth, petrographic examination, and permeability test.

[4]Bhadauria and Gupta (2007) [16] presented case study of deteriorated water tanks situated in the semitropical region of India.

[5]Capacity of structures. Sanayei et al.(2012) [6] performed static truck load test on a newly constructed bridge,to capture the response of bridge when a truck traveled across it.

[6]Chen et al.(1995) [14] presented findings of research on fiber optic bragg gratings as stress/strain sensors for monitoring the critical sections of composite beams.Combining the results.

[7]Dias and Jayanandana (2003) [18] used non-destructive techinques of visual inspection, perusal of drawings, ultrasonic pulse velocity measurements,cover-meter surveys, and core testing for the condition assessment; parameters required for evaluating the durability had been identified as (1) depth of carbonation; (2) cover to reinforcement; (3) chloride content; and (4) sulfate content.

[8]Loizos and Papavasiliou(2006) [8] performed a comprehensive monitoring and data analysis research study ny using Falling Weight Deflectometer(FWD) for in situ evaluation of recycled pavements.

Magnetic concrete cover meters are widely used to estimate the cover to steel bars.

[9]Malavar et al.(2003) [11] used pull off tests to evaluate effects of temperature,moisture,and chloride content on CFRP adhesion.

NDT methods used are cover meter, Phenolpthalein indicator test, Quantab test, Potentiometer Titration, Schist's hammer test, and UPV test.

Parameters measured are concrete cover, carbonation depth, chloride concentrartion, compressive strength, and so forth.

[10]Pascale et al.(2003) [12] carried out an experimental program involving both destructive and non-destructive methods applied to different concrete mixtures,with cube strength varying from 30 to 150 MPa, to define a relation between strength and parameters.

[11]Proverbio and Venturi (2005) [9] evaluated the reliability of rebound hammer test and UPV test on concrete of different composition and strength.

[12]Rens and KLim (2007) [15] inspected a steel bridge using several NDT methods such as visual inspection, hammer sounding, Schmidit hammer, and UPV testing including tomographic imaging; results of NDT had been used to determine areas, to be tested with local destructive tests such as compressive strength, chloride testing, and petrographic testing.

[13]Rens et al.(2005) [10] explained application of NDE methods for bridge inspection,which is Bridge Evaluation Using NDT(BENT).

Tests performed are pulse velocity,rebund hammer,pull out,and probe penetration,microcoring and combined methods.

TESTS:

Non-Destructive Tests (NDT)

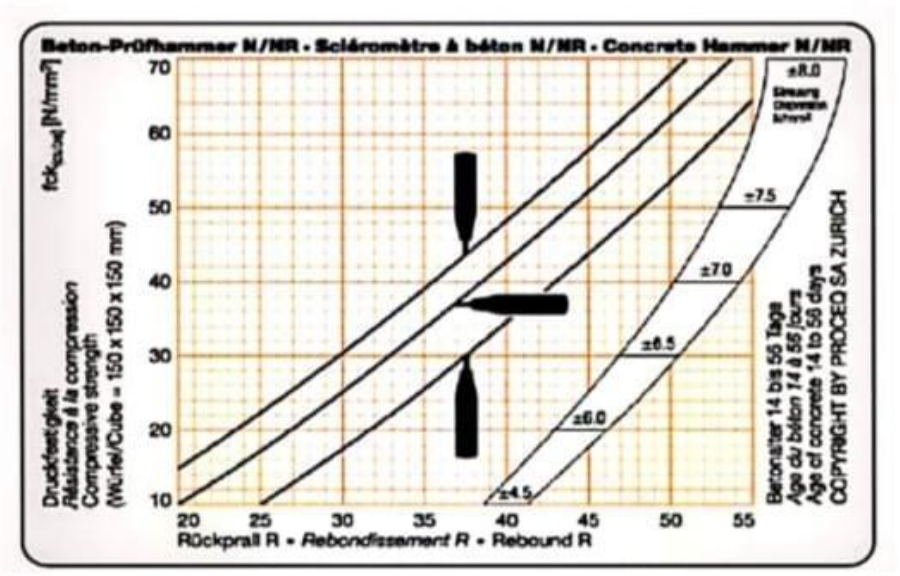
The following are the NDT tests which being conducted so as to as to appraise the state of structure.

Rebound Hammer Tests:

Rebound hammer experiment is finished to solve out the compressive strength of concrete by based on Rebound hammer experiment as per IS:13311(part 2)-1992. The primary characteristics of the Rebound hammer experiment is the rebound of flexible bunch based on stiffness of the exterior opposed to which its lump collides. When the plunges of the Rebound hammer is push opposed to the exterior of concrete; the pring-stopped lump rebounds and the stretch of similar Rebound based on the exterior stiffness of the concrete.

The exterior stiffness & the consequently the rebound is take hold of to be similar to the compressive strength of the core. The Rebound merits is noted from graduated scale and is selected as the number or rebound signal. The compressive strength can be noted from the hammer.

The typical graph for rebound hammer for the 3 directions of testing is given below:



The graph provided by the manufacturer.

Depending on the direction of testing the estimated compressive strength is calculated from the respective graph.

In case of columns and beams the testing is carried out by placing the Rebound hammer Horizontally (perpendicular to the face of concrete) and in case of slabs

(when tested from bottom) the Rebound Hammer is placed vertically upwards.

Respective graph is used to ascertain the compressive strength of concrete

Ultrasonic Pulse Velocity Test (UPV)

Ultra-sound pulse velocity experiment are operated on Concrete structures to qualitatively access the concrete and to determine existence of any voids, cracks and other disfigurement in the concrete. In Ultra-sound testing low frequency ultra sound waves are transmitted through the concrete by the transmitter and are received at the other end by the receiver. The time taken by the pulse is measured and with the information of the thickness of concrete the instrument provides the velocity of the sound wave in KM/sec or M/sec. Based on the Pulse Velocity the quality of concrete is classified as per IS Code: 13311 (Part 1) - 1992. The classification as per IS code is as under:

Classification as per IS 13311 part 1

S.No	Pulse Velocity (M/Sec)	Concrete Quality grading
1	Above 4500	Excellent
2	3500-4500	Good
3	3000-3500	Medium
4	Below 3000	Doubtful

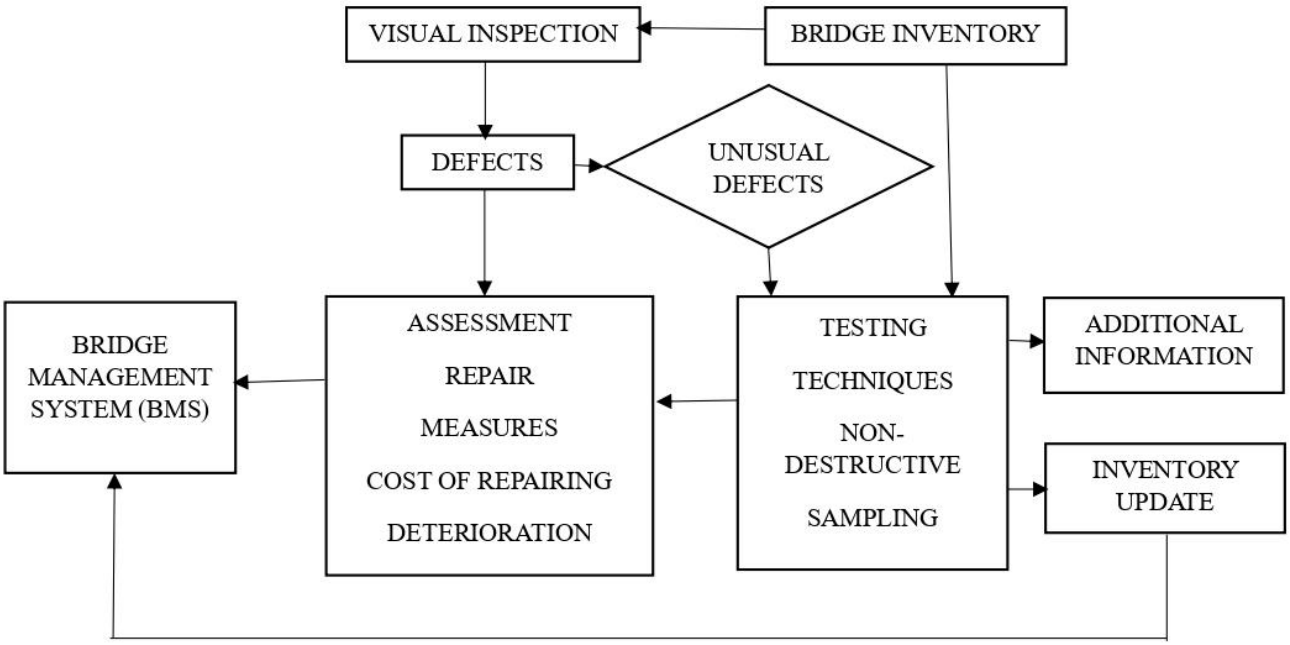
Carbonation Test:

Carbonation test is being carried to cover concrete so as to assess whether the concrete is carbonated or not. Carbonation test is conducted by application of Phenopthelene solution to ascertain the depth of carbonation in concrete. Normally the carbonation test is carried out on the freshly extracted cores and the colourless depth is measured which gives the indication of depth of carbonation in the structure.

Half Cell Potential Test:

The category of Half Cell Potential Test computation generally includes computing the capacity of an implant reinforcing rod comparative to a instance of Half Cell put on the concrete exterior. The Half-Cell is generally a copper/copper sulphate or silver/silver chloride cell but further mergings and utilised. The concrete outcomes as an electrolyte and the danger of corrosion of the reinforcement in the instant around of the experiment position would be compared Mathematically to the calculated prospective variation. In a few state of affairs, functional calculation can be occurred in the middle of two Half cells on the concrete exterior. ASTM C876-91 gives a Basic experiment category for Half-Cell Potentials of Un-finished Reinforcing Steel in concrete.

METHODOLOGY:



RESULTS:
UPV AND REBOUND RESULTS

S. No	Structure	location	Ultra sound pulse velocity(m/sec)	Average pulse velocity(m/sec)	Remarks (IS 13311_1)	Sl. no	REBOUND HAMMER	AVERAGE REBOUND VALUE	EQ.COMPRESSIVE STRENGTH (Mpa)
1	GIRDER-1	Location-1 (Abt-1 Slide)	3263 3266 3260	3263	MEDIUM	1 2 3 4 5 6 7 8 9	49 44 47 40 43 48 47 42 42	45	49.5
2	GIRDER-1	Location-2(Abt-1	3109 3100 3118	3109	MEDIUM	1 2 3 4 5 6 7 8 9	36 36 35 36 39 39 36 36 36	36.5	33.75
3	GIRDER-1	Location-3 (Abt-1 Side)	4400 4200 4600	4400	GOOD	1 2 3 4 5 6 7 8 9	48 49 45 45 42 42 46 46 41	44.8	48.5

CARBONATION:

Sl No	STRUCTURE	LOCATION	DEPTH OF CARBONATION (in mm)	REMARKS
1	CORE-1	ABUTMENT-1	35 mm	**Core No. 24+440 (A1)**
2	CORE-2	PIER-2	30 mm	**Core No. 24+440 (P2)**
3	CORE-3	PIER-5	28 mm	**Core No. 24+440 (P5)**
4	CORE-4	ABUTMENT-2	33mm	**Core No. 24+440 (A2)**
5	CORE-5	ABUTMENT-1	35mm	**Core No. 24+440 (A1)**
6	CORE-6	PIER-6	30 mm	**Core No. 24+440 (P6)**
7	CORE-7	PIER-4	28 mm	**Core No. 24+440 (P4)**
8	CORE-8	PIER-1	30mm	**Core No. 24+440 (P1)**
9	CORE-9	PIER-3	30mm	**Core No. 24+440 (P3)**

Half cell Readings:

Sl No	Location	Half cell reading	max -VE reading	Remarks
1	**NEAR ABUTMENT-2**	-212 -252 -236 -218 -222 -234 -246	-252.0	TRANSIENT PHASE
2	**FOR GIRDER AT SPAN-1**	-204 -182 -211 -210 -209 -248 -244	-248.0	TRANSIENT PHASE
3	**FOR GIRDER-2 AT SPAN-3**	-255 -269 -248 -239 -284 -254 -244	-284.0	TRANSIENT PHASE
4	**FOR GRIDER-3 AT SPAN-1**	-222 -208 -236 -249 -233 -249 -254	-254.0	TRANSIENT PHASE
5	**FOR DIAPHRAGM AT SPAN-3**	-218 -244 -236 -244 -238 -284 -268	-284.0	TRANSIENT PHASE
6	**PIER-2**	-284 -252 -236 -246 -222 -249 -246	-284.0	TRANSIENT PHASE
7	**PIER-5**	-219 -236 -218 -210 -224 -239	-244.0	TRANSIENT PHASE

		-244		
8	**GIRDER-1 AT SPAN-3**	-255 -269 -248 -212 -284 -254 -244	-284.0	TRANSIENT PHASE
9	**GIRDER-3 AT SPAN-3**	-284 -259 -236 -249 -274 -249 -211	-284.0	TRANSIENT PHASE
10	**FOR GIRDER AT SPAN-3**	-269 -244 -240 -209 -238 -284 -255	-284.0	TRANSIENT PHASE

CONCLUSION:

*Rebound Hammer Tests: The average test results vary from 30 to 53 MPa. These strength results are is to be compared with the grade of concrete of the structural element.
*UPV Test summary: As per the test results of UPV, it is evident that the quality of concrete for the Girders and Slab is "MEDIUM to GOOD" condition.
*Carbonation Test: Carbonation is observed in the concrete and is within cover concrete region.
*Half Cell Potential: The reinforcement near ends of girder is corroded and the bearing plates are also corroded and needs to be treated with anti-corrosive paint.

RECOMMENDATIONS:

*All the loose & spalling concrete of the girder, diaphragm and slab are to be chipped off. All the exposed reinforcement to cleaned either by way of wire brush or sand blast. Then the reinforcement to be treated with Zinc rich epoxy paint (anti-corrosive treatment).
*The spalled region of the slab to be treated with Polymer modified mortar For Girders, Diaphragm and Earthquake arresters:
*Epoxy injection grouting has to be carried to the girders
*The damaged portion needs to be treated by using high grade, non-shrink micro-concrete after providing suitable additional reinforcement & shear connectors.

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IS CODES:

* Rebound Hammer Test = IS13311(1)-1992
* IS 13311 1992. This standard covers the object ;principle, apparatus, and Test procedure of the ultrasonic pulse velocity
*Half-cell potential Text = ASTMC876-15
* Carbonation Test= IS516 (part-5 sec-III)