CONDITION ASSESSMENT OF CONCRETE WITH NDT – CASE STUDY

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Abstract

The concrete evaluation is necessary for the proper diagnosis of successful rehabilitation work. The paper present case study include the use of various Non Destructive Test (NDT), to evaluate the concrete quality of building age was 8 years. NDT used such as Ultrasonic pulse velocity, half cell potential, carbonation depth, rebar locator, cover meter and core sampling. Initially, the structure deteriorates due to cyclic temperature variations, physical causes and aggressive chemical attack due to the environment. Later on, if not paid due attention, these deteriorate rapidly and fail to meet the functional requirement for its designed service life.

The building structure can be investigated by using a visual observation, non destructive evaluation technique (NDE) and laboratory and field test performing scientific analysis, planning and documentation is more useful for classification and category of distress. The research paper also focus on standard testing procedure of NDT and sequence of operation for obtaining accuracy as well as the problems created during the testing and the limitations of the tests are considered.

Keywords: *Carbonation Depth, Core test, Half Cell Potential Test, Ultrasonic Pulse Velocity*

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1. INTRODUCTION

The testing of hardened concrete needs felt for last three to four decades. For assessment the integrity of old or new concrete and reinforcement, Non destructive testing is one of the most powerful and reliable tools. The essence of conducting non destructive test for condition assessment of the RCC structures has grown considerably in recent times, due to increase in number of structures, showing signs of distress.

The standard life of RCC frame structure is considered to be 60 - 80 years. But it has been reported that, many of the buildings completing just 20 - 25 years of their life, if one visits the chemical plant buildings, the RCC structures are in distressed condition within a span of only 7 to 10 years. The severe exposure condition is the main reason for this deterioration.

The Non Destructive Testing is being fast, easy to use at site and relatively less expensive can be used for

a. Test actual structure instead of representative cube sample.
b. Test any number of points and any locations
c. Assess the structure for various distressed conditions
d. Damage assessment due to fire, chemical attack, impact, age etc.
e. Detect cracks, voids, fractures, honeycombs and week locations
f. Monitor progressive changes in the properties of concrete, reinforcement etc.
g. Assess overall stability of the structure
h. Scanning for reinforcement location, stress locations.

2. METHDOLOGY

2.1 Core Test

Principle: - In this method concrete cores of sizes ranging from 20 mm to 150 mm in diameter and 50 mm to 500 mm long are drilled out by diamond cutters. The recommended diameters are 100 to 150 mm, but if the drill depth is insufficient as in of case slabs, then smaller diameters may be used but not less than three times nominal aggregate size. The core diameter to length ratio shall be normally between 1.0 to 2.0 Reinforcement shall be avoided in the core. At least three cores shall be tested for acceptable accuracy. These cylindrical concrete cores are then made smooth at both ends by capping of the faces shall be done. The specimen shall be cured in water for 48 hours before testing. IS - 516 suggest a multiplying factor of 1.25 for converting cylindrical strength to equivalent cube strength.

Methodology: - The chart shows the operation carried out in core test in sequentially at site.

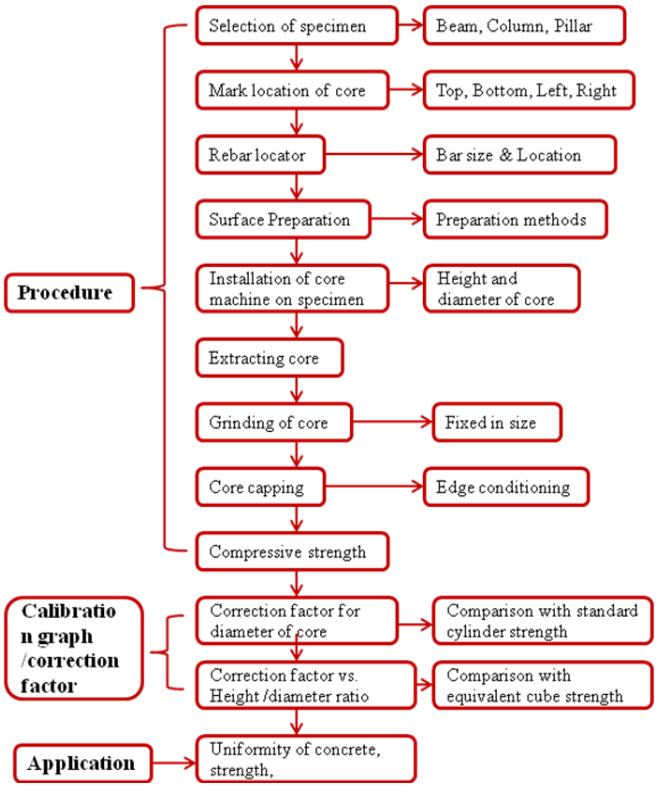

Chart -1: Process of core cutting test

1.2 Half Cell Potential

Principle: - The electrical activity of the steel reinforcement and the concrete leads them to be considered as one half of weak battery cell with the steel acting as one electrode and the concrete as the electrolyte. The electrical potential of a point on the surface of steel reinforcing bar can be measured comparing its potential with that of copper - copper sulphate reference electrode on the surface. Practically this achieved by connecting a wire from one terminal of a voltmeter to the reinforcement and another wire to the copper sulphate reference electrode.

Methodology: - The chart shows the operation carried out in half cell potential test in sequentially on specimen member.

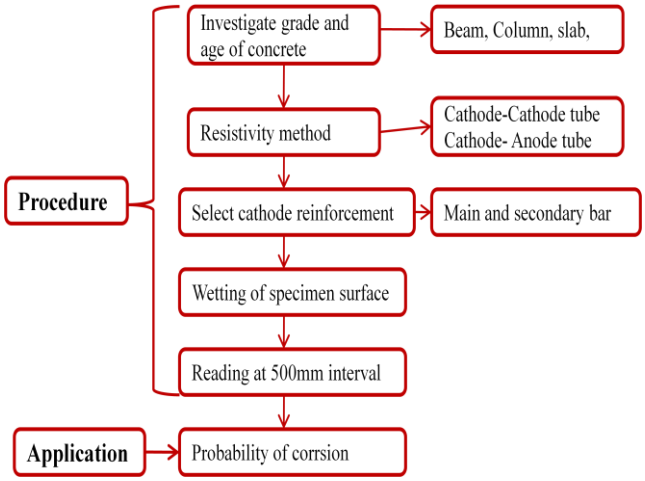

Chart -2: Process of Half cell potential test

1.3 Ultrasonic Pulse Velocity

Principle: - These transducers converts' electrical signals into mechanical vibrations (transmit mode) and mechanical vibrations into electrical signals (receive mode). Transducers with natural frequencies between 20 kHz and 200 kHz are available, but 50 kHz to 150 kHz transducers are common. This instrument basically is dependent on the Dynamic Young's Modulus, density, Poisson's ratio of the material. The transducers are placed on the smooth concrete surface to measure the time required for travel. A coupling media such as petroleum jelly, grease are applied to the surface to have good acoustical coupling. The velocity is calculated as **V = L / T** (L is the distance between two probes and T is the time required to travel the distance between two transducers)

Methodology:- The chart shows the operation carried out in ultrasonic pulse velocity test in sequentially on specimen member.

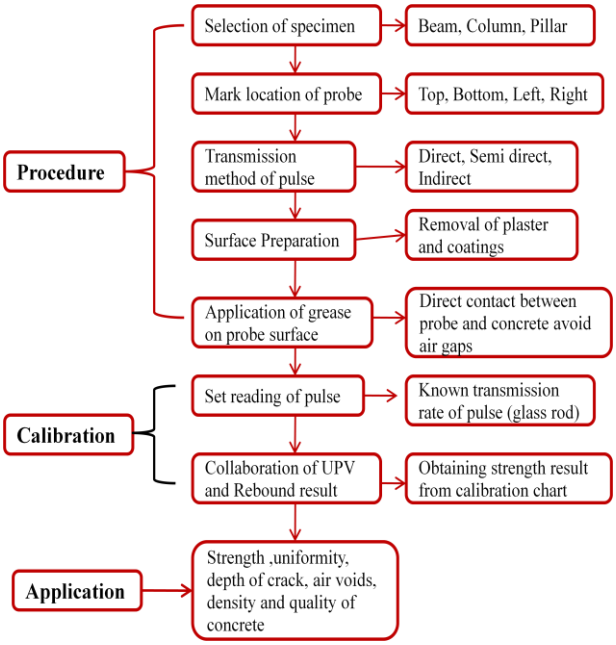

Chart -3: Process of Ultrasonic pulse velocity test

1.4 Rebar Locator & Bar Sizer

Principle: The reinforcement bar is detected by magnetizing it and inducing a circulating "eddy current" in it. After the end of the pulse, the eddy current dies away, creating a weaker magnetic field as an echo of the initial pulse. The strength of the induced field is measured by a search head as it dies away and this signal is processed to give the depth measurement.

1.5 Rebound Hammer Test

Principle: - The principle of this method is rebound of an elastic mass depends on the hardness of the surface against which mass strikes. The plunger of hammer is pressed strongly and steadily against the concrete surface at right angles to its surface, until the spring loaded mass is

triggered from the locked position. The distance traveled by the mass as a percentage is defined as rebound number.

1.6 Carbonation Test

Principle: - Carbonation of concrete results in increase in strength and reduction in permeability. Carbonation reduces the pH level of concrete. Carbonation rate is normally high in dry weather than in moist weather. The corrosion of reinforcement will start if entire cover to the steel is carbonated, but presence of moisture and oxygen is essential.

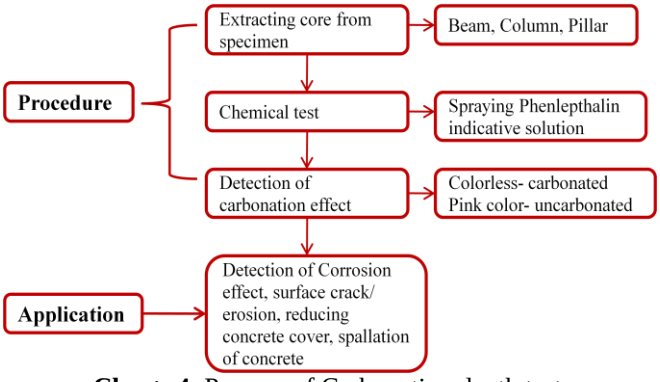

Chart -4: Process of Carbonation depth test

3. RESULT

Table -1: Half cell potential test result

Structure		RCC - G+1	
Temp. during testing		28	
Temp. corrections applied as per ASTM-C-870		5 mv	
Reinforcement connection		Reinforcement of respective member connected to voltmeter	
Type of half cell		Copper- copper sulphate solution	
spacing of readings		500	
Pre-wetting		Wetting of entire concrete surface	
Total member tested		**2 - Column**	**1 -Beam**
Total locations		6	4
Minimum half cell potential		-264	-283
Maximum half cell potential		-391	-364
Cover		40	20
% Half cell potential	< -200mv	0%	0%
	< -200mv to -350mv	60%	75%
	< -350mv to -500mv	40%	25%
	>-500mv	0%	0%

Fig: 1: Set up of half cell potential test

Table -2: Ultrasonic pulse velocity test result

Location (Column)	Temp Corrected velocity in (km/sec)	Anvil corrected avg. rebound index	Quality of concrete	Approximate of range compressive strength (N/sq.mm)		UPV method
				From	To	
Lower Basement Column (Wing-A)						
A3	4	40.05	Good	23	29	Direct
A4	4.37	44.04	Good	27	33	Direct
A5	4.105	47.85	Good	25	31	Semi Direct
A6	4.195	45.77	Good	26	32	Direct

Fig: 2: Calibration and UPV testing of beam

Table -3: Core test result

Core mark	**Column no A8**	**Column no A24**
Grade of concrete	M20	M20

Age of core sample	8 years	8 years
Core recovery Fraction/total	140-154	180-189
weight of capped core	1.57	1.59
Mean dia. of core (mm)	74.5	74.4
Mean height of core (mm)	145	145
H/D ratio	1.95	1.95
Correction factor for H/D ratio (K)	1	1
Correction factor for diameter (Cd)	1.08	1.08
True crushing load (KN)	91	115.5
Compressive strength of core cylinder (fo) (N/Sqmm)	20.9	26.5
Equivalent cube strength = (1.25*Cd*K*fo)	28.1	35.6

Fig: 3: Rebar locator and rebound hammer

4. CONCLUSIONS

In building structure it was observed that the half cell potential reading of concrete beam is 15% more than the concrete column, the reading is shift in between 200mv to 500mv. There was 50 to 75% of probability of corrosion in beam member, due to shifting towards more negative values getting chances of corrosion of reinforcement. Considering all factors including the possibility of the cover concrete, it was estimated that the concrete had an average compressive strength ranging from 20-26 MPa this strength were found to be up to 5 % lower than the minimum required as per Indian codes of practice. The present methods for ultrasonic testing of concrete require direct contact between the concrete surface and the transducers. Since the contact is not always perfect, the air trapped in between may cause variable errors in the measurements.

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