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Construction Quality Monitoring By Deploying Digital Rebound Hammer and Ultrasonic Pulse Velocity Methods – A Case Study of Indore Region

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ABSTRACT

Nondestructive testing (NDT) is a widely accepted process for determining the characteristics of the objects and also for inspecting and testing of the materials. Initial inspection of the materials is required for carrying out the NDT test. As other tests are destructive in nature such tests can be performed over a limited samples. These tests are performed at a site located in Indore which is situated in the Central Part of India. In this paper, an attempt has been made to compare the test results obtained by performing both Non destructive test (NDT) methodsnamely Rebound Hammer Test and Ultrasonic Pulse Velocity Test. The results thus obtained after conducting both the tests are compared and based on the test result it can be concluded that ……..…..

Keywords

NDT, Rebound Hammer, Ultra Sonic Pulse Velocity

INTRODUCTION:

Testing of materials is an integral part of Civil Engineering which involves testing of different materials related to construction of structures, roads, dams and various other critical and non-critical structures. Various tests that are performed on the materials specifically to be used for the road construction or construction of columns for multistoried building are Tensile, Ductility, Impact, Hardness and Non Destructive Tests (NDT) such as Rebound Hammer and Ultra Sonic Pulse Tests. All tests if carried out as per the IS Codal Provisions will give correct value but might impair the properties of the materials and also might damage or destroy the samples used for testing. But in certain conditions and applications, it is very evident and important to retain theengineering properties maintaining the quality standards for the prevention of failure of the structures. Such tests maintaining the quality an standards can be carried out Non Destructive test (NDT) methods. Such methods do not destroy the surface, texture and the integrity of the structure as a whole.

VARIOUS TYPES OF NDT:

Depending on the site, location and the material various types of NDT are performed for different applications. Some of the various types of NDT performed for various specifications are mentioned below:

- Radiographic Testing
- Ultrasonic Testing
- Liquid Penetrant Testing
- Visual testing
- Magnetic Particle testing
- Vibration Analysis

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USES OF NDT:

Non Destructive Techniques are performed to determine the integrity of a material, component or structure or to quantatively measure the characteristics of an object. The advantages and specific applicability of the tests are elaborated in various others reference materials but to name a few

- Flaw Detection and Evaluation
- Leak Detection
- Location Determination
- Dimensional Measurements
- Structure and Microstructure Characterization
- Estimation of Mechanical and Physical Properties
- Stress (Strain) and Dynamic Response Measurements
- Material Sorting and Chemical Composition Determination

Civil Engineering Department of AITR, Indore was requested to carry out NDT tests to check the Strength and quality of concrete in, Columns and foundation of building under construction. The Rebound Hammer and Ultra Sonic Pulse Velocity (UPV) tests were conducted in the presence of technical persons of the client.

SITE LOCATION:

As Indore has recently been chosen as one of the top cities for Swach Bharat Abhiyaan and also for upgrading it and developing it as a Smart City, major emphasis is on the Infrastructure Development and the makeover of the entire city and surrounding area. Indore is also coming up as a commercial capital and educational hub in the central region. In this study, the tests are performed for RCC Footings for the newly constructed Modern Institute of Medical Sciences at Kanadiya Road in Indore

REBOUND HAMMER TEST:

Rebound Hammer Tests is one of the popular surface hardness method used to estimate either existing strength of concrete or for comparing concrete quality. This is conducted around all the points of observation on all accessible faces of the structural element. Concrete surfaces are thoroughly cleaned before taking any measurement.

The rebound number are influenced by a number of factors like type of cement and aggregate, surface condition and moisture content, age of concrete and extent of carbonation of concrete. This testing method is suitable only for close textured concrete.

All correlations assume full compaction, as the strength of partially compacted concrete bears no unique relationship to rebound numbers. Trowel led and floated surfaces are harder than molded surfaces and tend to overestimate the strength of concrete.

The rebound number method provides a convenient and rapid indication of the compressive strength of concrete by means of establishing a suitable correlation between the rebound index and the compressive strength of concrete. The number increases as the strength increases.

It is also to be noted that rebound indices are indicative of compressive strength of concrete to a limited depth from the surface. If the concrete in a particular member has internal micro cracking, flows or heterogeneity across the cross section, rebound hammer indices will not indicate the same.

As such the estimation of strength of concrete by rebound hammer method cannot be held to be very accurate and probable accuracy of prediction of compressive strength is + 15%. If the relationship between rebound index and compressive strength can be checked by test on concrete samples made with the same ingredient and mixed proportion, then the accuracy of results and confidence thereon are greatly increased.

Interpretation of Test Results:

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Average Rebound Number	Quality of Concrete
>40	Very Good Hard Layer
30 to 40	Good Layer
20 to 30	Fair
< 20	Poor Concrete
0	Delaminated

ULTRASONIC PULSE VELOCITY

Ultrasonic Pulse Velocity is a versatile and most reliable method of testing to assess the existing strength of hardened concrete, porosity, voids, width of cracks, depth of cracks, inclination of cracks etc. Smoothness of contact surface under test effects the measurement of ultrasonic pulse velocity. For most concrete surfaces the finish is usually sufficient smooth to ensure good acoustical contact by the use of a coupling medium and by pressing the transducers against the concrete surface. When the concrete surface is rough and uneven, it is necessary to smooth the surface to make the pulse velocity measurement possible or it will give wrong values.The ultrasonic pulse velocity of concrete is mainly related to its identity and modulus of elasticity, this in turn depends upon the materials and mixed proportions used in making concrete and as well as the method of placing, compaction and curing of concrete.

The quality of concrete in terms of uniformity, incidence or absence of internal flows, clacks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidelines given in table below which have been evolved for characterizing the quality of concrete in structures in terms of ultrasonic pulse velocity (as per IS 13311-Part I and II)

Interpretation of Test Results:

Pulse Velocity (km/sec)	Quality of Concrete
>4.0	Very Good Hard Layer
3.5- 4.0	Good Layer
3.0 – 3.5	Satisfactory
<3.0	Poor Concrete

TESTING OF STRUCTURES

Non Destructive Testing using Ultrasonic techniques was carried out for ascertaining the quality of concrete and probable range of strength of concrete. The observations by ultrasonic technique were taken by indirect and direct arrangement. The direct transmission arrangement is most satisfactory and gives results which are more reliable as compared to indirect and semi direct arrangement. The indirect and semi direct transmission gives lower values of velocity and as such suitable correction factor is applied to get the correct results as per

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IS 13311 part I clause 5.1. The velocity found out by ultrasonic method is compared with the standard results to find the satisfaction level of quality of concrete and probable strength range is obtained from the calibrated graph.

Similarly the rebound hammer test was carried out and strength is obtained by the known value of rebound number corresponding to the desired strength.

Sr. No.	Ultrasonic Pulse Velocity (m/s)	Concrete Quality Grading
1.	Above 4200	Excellent
2.	3500 to 4200	Very Good
3.	3000 to 3500	Medium
4.	Below 3000	Doubtful

RESULTS AND DISCUSSIONS

Initial Investigations and Observations:

- The concrete was casted about three months before the test were conducted.
- The concrete mix laid in the slab was of the grade M-35
- Honeycombing was observed at many locations.

The tests were performed after the above initial observations at the site and the results and values thus obtained are tabulated below:

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Table 1.1 Tests Results of Rebound Hammer and Ultrasonic Pulse Velocity

S.No.	Location	Rebound Hammer	U.P.V. (m/sec.)	Quality	Relative Compressive Strength (kg/cm^2)
1.	Grid-j2 Col-c3	17,26,21,20, 18,19,19,23, 20	D-2040, 2300,2130	Doubtful	120-150
2.	Grid-H4 Col-ST	23,16,20,19, 20,21,17,17,24	D-3180,3200	Medium	140-170
3.	Grid-H1 Col-C1	17,19,21,24, 20,21,21,20,19	2440,2700	Doubtful	120-150
4.	Grid-F2 Col-C3	26,20,28,23, 17,19,23,19,17	D-3100 3350,3260	Medium	140-170
5	Grid-R6 Col-C1	27,31,28,28,18,28,22,26,24	3400,3100	Medium	140-170
6	Grid-P12 Col-ST	22,27,24,27,25,26,30,28,25	D-3100 3370,3300	Medium	140-170
7	Grid-P8 Col-ST	17,18,20,22,15,19,18,16,22	D-2820 2370,2230	Doubtful	120-150
8	Grid-K13 Col-C1	19,23,21,25,19,23,18,19,21	2480,2400	Doubtful	120-150
9	Grid-P16 Col-ST	24,25,31,24,30,29,31,30,26	D-3110 3310	Medium	150-180
10	Grid-R18 Col-C1	28,32,33,35,29,28,29,29	3610 3920	Very Good	200-250
11	Grid-O20 Col-C3	20,21,26,19,19,26,23,20,18	D-3450 3080	Medium	150-180
12	Grid-K22 Col-C3	27,28,29,29,26,29,26,27,27	D-3680 3880	Very Good	180-225
13	Grid-I19 Col-C3	28,24,24,25,22,26,23,27	D-3220, 3190	Medium	150-180
14	Grid-F23 Col-C3	22,19,23,21,22,22,22,21,22	D-2310 2930	Doubtful	120-140
15	Grid-B19 Col-C3	27,26,23,26,26,24,26,24,28,30	D-3510 3520	Very Good	180-225
16	Grid-H24 Col-C1	22,24,22,20,20,20,20,24,24,22,23	2400,2700	Doubtful	120-140
17	Grid-H7 Col-C1	26,21,21,22,18,20,24,25,30	2550,2810	Doubtful	120-140
18	Grid-H17 Col-C1	20,23,24,24,22,27,25,27,24	2700,2700	Doubtful	120-140
19	Grid-K6 Col-ST	15,16,15,16,17	800-1000	Doubtful	100-120
20	Grid-Q6 Col-C3	22,24,21,24, 24,21,22,23, 20.	D-2020 2660,2250	Doubtful	120-140

CONCLUSIONS

The results and values obtained from both the tests were compared with the calibration chart and based on the testing results at various points, the following conclusions can be drawn:

- Both methods are quick methods to assess the quality of the material
- Higher value of the Rebound Hammer gives higher concrete strength value
- Interpretation of the average Rebound Hammer test results show that the concreteused at the site was of good quality.
- Since the testing is done mainly in the horizontal direction with the concrete mix of M35, the compressive strength as determined from the chart corresponding to the Number of rebound seems to be reflecting the same value.
- Very effective, accurate and a speedy procedure to determine the quality of material without actually damaging the structure or its property
- The quality of concrete was found to be satisfactory by both the tests.
- The present strength of concrete ranges from 12 to 18 N/mm2 at most of locations.
- The quality of concrete tested by UPV is in Poor to Medium range where the honeycombing was observed at several locations

REFERENCES

[1] Jen Chi Lu et. Al.,Estimating the strength of concrete using the Surface Rebound value and design parameters of Concrete material, , Taiwan

[2] ML Gambhir, A textbook of Concrete Technology

[3] Abrahamson, N.A. and Shedlock, K.M. (1997) Overview, Seismol.res.Lett. 68,9-23