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"TO DETERMINE THE STRENGTH OF EXISTING STRUCTURE THROUGH NDT TESTING METHODS"

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Abstract: *The estimation of physical properties of concrete can be carried out by sevral methods; destructive and non-destructive. The crushing of the samples is the usual destructive test to find the concrete strength. The rebound hammer test and the ultrasonic instrument are used in the field of non-destructive tests to find respectively the compression strength and the ultrasonic pulse velocity in the concrete. Generally all the structures are constructed of R.C.C and even though it is a very good construction material, but once set it is very difficult to increase its strength. The performance of building reduces in terms of safety level, strength due to the variety of situations such as deterioration of concrete, unskilled work, alteration of building units, greater loads due to extension of structure etc. These structures perform normally during their entire life span but at the end of design period of structure, the structure will not be capable to take the existing loads and obviously it will not be possible to take the extra loads on it. So in this project we perform NDT test on existing structure by using rebound hammer and ultra-sonic pulse velocity method to determine the existing strength of structure*

Keywords': NDT, UPV, destructive, deterioration.

INTRODUCTION

Non - destructive testing (NDT) is defined as the determination of the mechanical condition of an object without affecting that objects ability. NDT methods have been in use since 4 decades, and in this period, the development has taken place to such an extent that it are now considered as a powerful method for determining concrete structures with regard to their strength, durability and quality

Non-destructive tests of concrete are a method to obtain the compressive strength and other properties of concrete from the present structures. This test gives immediate results and actual strength and properties of concrete structure. Non-destructive testing are defined as the course of inspecting, testing, or assessing materials, components or assemblies without destroying the serviceability of the system.

The objective of NDT is to evaluate the quality of materials, components without affecting the ability to perform their intended functions. Non-destructiveness ought not to be confused with non-invasiveness. Testing methods that do not affect the future usefulness of a part is considered to be non-destructive even if they consist of invasive actions. R.C.C Buildings can be made to undergo three various types of R's namely Repair, Rehabilitation and Retrofitting. Repair is partial improvement of the deteriorate strength of a building after an earthquake. Rehabilitations are a functional improvement, wherein the aims are to achieve the original strength of a building after an earthquake happen. Retrofitting means structural strengthening and improve the performance of deficient structural elements of a building to a original performance level whether or not an earthquake has occurred.

The Non Destructive Testing of concrete is a great technical and useful importance. These techniques have been grown during recent years especially in the case of finding the quality of structure. The main aims of non-destructive testing methods are to avoid the concrete damage or the performance of building structural components. Additionally, their usage is simple and quick. Test results are available on the site and the possibility of concrete testing in structures is demanding in which the cores cannot be drilled and the use of less expensive instruments. The Schmidt rebound hammer and the ultrasonic pulse velocity tests, are useful non-destructive tests, which are so useful recently and they are useful when a relation can be developed between hammer or ultrasonic pulse velocity readings and the compressive strength of the same concrete. This non-destructive calculation method has proved to be of real importance in all constructions serving the purpose of testing and as an effective tool for checking quality of concrete in concrete structures. However, the calibration curve supplied by the equipment do not needs much confidence because of using many cubic samples and standard mixture for producing this curve.

1.2 METHODS OF NDT

The different non-destructive methods of testing concrete are as following:

1. Surface hardness tests

2. Rebound test.

3. Ultrasonic test.

4. Penetration and pull out tests

5. Dynamic or vibration tests

6. Combined methods

7. Radioactive and nuclear methods

8. Magnetic and electrical methods.

9. Acoustic emission techniques

The generally used non-destructive tests are the Rebound hammer tests and Ultrasonic pulse velocity test. So the methods used in this work are rebound hammer test and ultrasonic pulse velocity test.

The main objectives of NDT are to assess one or more of in situ strength properties i.e. density, durability, and moisture content. NDT is the only way to calculate the depth of cracks and to determining whether any structural damage has occurred. Structural health monitoring by NDT like rebound hammer and UPV becomes generally useful for the prediction of the service life of structure

METHODOLOGY

Non - destructive testing are defined as the determination of the mechanical condition of an structure without affecting that objects ability. NDT methods have been in use since 4 decades, and in this time period, the development has to be taken place to such an extent that it is now considered as a excellent method for evaluating existing concrete structures with regard to their strength, durability and quality.

ULTRASONIC PULSE VELOCITY METHOD

UPV is the important NDT method used for testing of existing concrete structure. These methods are popular now a day in all over world. This method involves a calculate of travel time over a known path length pulse of ultrasonic compression waves. The pulses are generated by use of pulse generator circuit. The pulse generator circuit consists of electronic circuit for generating pulses and a transducer. The pulses are entering into concrete by a piezoelectric transducer and in same way transducer acts a receiver to monitor the surface vibration cause by the arriving the pulse. A timing circuit is used to calculate the time for the pulse to travel from the transmitting to receiving transducers. The pulse velocity can be calculated by path length between the transducer divided by time of travel gives the average velocity of wave. The pulse velocity is calculated by the equation.

$$\text{Pulse Velocity} = \frac{Path}{Transit} \frac{Length}{Time}$$

Generally, the higher the pulse velocity, the higher will be the quality and durability of concrete and lower quality concrete is by lower velocity.

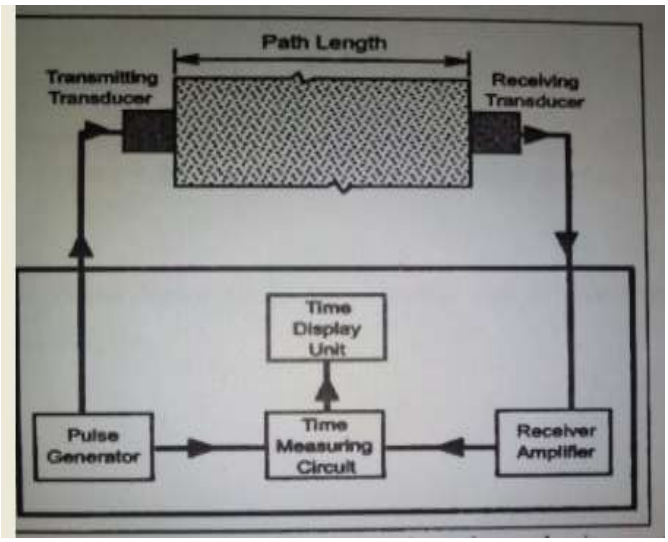

Figure 1 Schematic representation of ultrasonic pulse velocity method

Table Quality of concrete as per IS 13311(part I) 1992

S.N	Ultrasonic pulse velocity (km/sec)	Quality of concrete
1	Above 4.5 km/sec	Excellent
2	3.5 to 4.5 km/sec	Good
3	3 to 3.5 km/sec	Medium
4	Below 3 km/sec	Doubtful

TEST EQUIPMENTS

The UPV instruments include a transducer, a receiver and an indicator for determining the time of travel from the transducer to the receiver. Ultrasonic pulse uses fast potential changes to generate vibration that leads to its basic frequency. The transducer is securely attached to

concrete surface to vibrate the concrete. The pulses go through the concrete and reach the receiver.

The pulse velocity can be calculated from the following equation:

V=L/T

Where, V = pulse velocity (km/s),

L = path length (cm),

T = transit time (μs).

The velocity of sound in a concrete is correlated to the concrete modulus of elasticity:

$V=\sqrt{E/p}$

Where, E = modulus of elasticity,

ρ=density of the concrete.

The transducer fined the pulses which reach first and it is usually the leading edge of the longitudinal vibration.

The positions of pulse velocity determinaton are categorized in three category

1: Direct transmission

2: Semi-direct transmission

3: Indirect or surface transmission

SCHMIDT'S REBOUND HAMMER TEST:

Schmidt's rebound hammer developed in 1948 by a Ernst Schmidt a Swiss engineer for testing concrete, based upon rebound principle when a hammer strikes concrete. The degree of rebound is a detection of hardness of concrete. It consists of a spring control hammer that slides on a plunger within a tubular housing.. The body of the instrument is then pushed towards the concrete surface which extend the spring attached to the hammer and body. When pushed to the limit, the grab is released and the hammer is push towards the concrete by combination of gravity and spring forces. After then hammer strikes up to the shoulder of plunger and it rebounds. The rebound distance travelled by a spring control mass is called the rebound number and it is calculated on a scale which is attached to a rider. This test can be conducted horizontally, vertically or at any intermediate angle. After finding rebound number, the calibration chart is used which shows the relationship between compressive strength and rebound number.

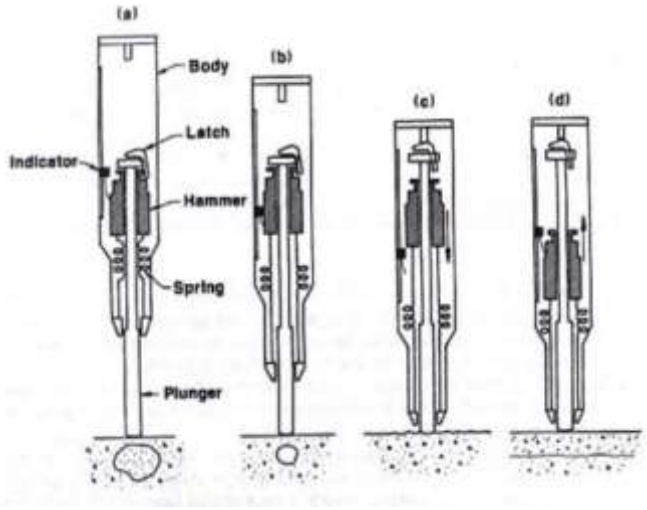

Figure 3.3 Schematic c/s of rebound hammer showing principle of operation

Assessment of Strength of Reinforcement through Ultra Sonic Pulse Velocity and Rebound hammer test

The Rebound hammer and UPV test have been used to determining the concrete quality by applying regression analysis models between compressive strength of in-situ concrete on present building and tests values. The main members of a present structure including column, beam and slab were included in the study

The Table showing result of NDT by Rebound hammer test for Ground floor.

SN	Column NO	Average Rebound Number	Compressive Strength (N/mm²)
1	C-13	29.2	22.1
2	C-8	28.4	20.6
3	C-2	29.6	22.2
4	C-10	27.6	18.8
5	C-15	28	20.2
6	C-17	29.6 22.4	22.4 22.4

The following table shows the results of NDT by Ultrasonic pulse velocity

SN	Column NO	AVERAGE VALUE OF U.P.V. km/Sec	Compressive Strength (N/mm²) fc(V)=15.533V - 34.358
1	C-13	3.61	21.71
2	C-8	3.45	19.37
3	C-2	3.40	18.45
4	C-10	3.66	22.49
5	C-17	3.35	17.80
6	C-19	3.39	18.29
7	C-22	3.41	18.45
8	C-24	3.37	17.98
9	C-23	3.55	20.78

CONCLUSIONS

1. The rebound number method appears to be more competent in finding the compression strength of concrete as compare to the ultrasonic pulse velocity method.
2. The use of combined methods produces more accurate results that are closer to the true values when compared to the use of the above methods individually. An acceptable level of precision was additionally admired for concrete strength estimation. Therefore, for engineering investigation, the resulting regression model for strength calculation could be used securely for concrete strength estimation.
3. As per the Non destructive Tests carried out on existing structure, it is found that the Ultrasonic Pulse Velocity Results with direct, semi direct and indirect methods indicates the maximum readings are below 3km/sec and in between **3.0 km/sec to 3.5km/sec**
4. As per the Ultrasonic pulse velocity test (refer to IS 13311 (Part I) 1992 "Non –Destructive Testing of concrete methods of test, Ultrasonic Pulse Velocity").It is observed that quality of concrete is **medium and doubtful.**
5. As per Rebound Hammer test (refer to IS 13311 (Part II) 1992 "Non- Destructive Testing of concrete - methods of test, Rebound Hammer") the readings of Rebound Hammer indicates the likely to compressive strength of CONCRETE IS **M18 TO M22.**

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