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Experimental Analysis of Strength of Concrete using Destructive and Non-Destructive Testing

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Abstract: ***Properties of concrete are estimated from the various methods. The Rebound hammer test, Ultrasonic pulse velocity test are the nondestructive test used to determine the compressive strength of concrete. In this paper we have done the comparative study of ultrasonic pulse velocity test, rebound hammer test and compression testing machine test. Here we are determining the quality of concrete in structure and also assessing the quality of elements in concrete compare to other. Experimental study was done for comparative study of the result obtained from Rebound hammer test, ultrasonic pulse velocity test and compressive testing machine. The obtained results were shown in this paper.***

Keywords: Rebound hammer, ultrasonic pulse velocity, Compression testing machine, concrete compressive strength.

1. Introduction

It is very necessary to test the concrete structure after the concrete has hardened to determine whether the structure is suitable for designed use or not. Such testing should be done without causing damage to the concrete. The tests available for testing the concrete are the non-destructive test where there is no damage to the concrete. Destructive test are the test which causes damage to the concrete during inspection process. This is the main advantage of nondestructive test over the destructive test.

Non-destructive techniques are the techniques which are used to evaluate the material properties, components or entire process unit. These techniques can also be utilized to detect, characterize or measure present of damage mechanism. Many non-destructive testing are capable of locating defects and determining features of defects such as size, shape and orientation. The main purpose of non-destructive testing is to inspect a component in a safe reliable manner without causing damage.

Non-destructive test can be performed during or after manufacture, or even on equipment that is in service. During operation non-destructive test inspection can be used to assess the current damage state of equipment. The most important advantage implies by the use of non-destructive method refers to the short duration of investigation and lower cost when compared to those specific destructive test.

2. Methods used for Assessing the Compressive Strength

2.1 Ultrasonic pulse velocity Test

It is most utilized non-destructive method used to check quality of concrete and natural rock and also for the assessment of compressive strength of concrete. This test is conducted by passing a pulse of ultrasonic wave through concrete to be tested and measuring the time taken by pulse to get through concrete.

Figure 1: Ultrasonic pulse velocity testing meter

Higher the density, Elastic modulus and integrity of concrete, higher is the pulse velocity. Ultrasonic pulse velocity depends on density and elastic properties of material being used.

The correlation between ultrasonic pulse velocity and quality of concrete investigated is presented in a table shown below:

Table 1: Velocity criterion for concrete quality grading

Concrete Quality	Ultrasonic pulse velocity (m/s)
Excellent	Over 4500
Good	3500-4500
Doubtful	3000-3500
Low	2000-3000
Very Low	Under 2000

2.2 Rebound hammer test

Digital rebound hammer is advanced, completely automated system for estimating compressive strength of concrete. Its calculation memory and recording functions allow for quick, easy and accurate test results.

It measures surface hardness as well as penetration resistance of concrete. The rebound hammer measures the rebound of an anvil impacting a plunger in contact with concrete surface. It is also used for comparative testing

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referenced against a concrete with known strength or against a verified as conforming to a particular strength class.

Figure 2: Typical digital rebound hammer

2.3 Compressive testing machine

Compression testing is a very common testing method which is used to establish the compressive force or crush resistance of material and the ability of material to recover after a specified compressive force is applied and even held over a defined period of time. It is the test in which samples are tested to failure. The prepared cubes are tested in the compressive testing machine in such a way that, two opposite side of cube are compressed (top and bottom surface).The load at which cube specimen fails is noted. The compressive strength is calculated by dividing the load by area of specimen.

Figure 3: Compression testing machine

3. Experimental Work

In this work we have used M20 grade of concrete. We have casted Six numbers of concrete cubes of size (150mm*150mm*150mm).Out of which we have cured two cubes each for 7 days, 28 days and without cured. The tests were conducted on all six cubes by Rebound hammer, ultrasonic pulse velocity and compressive testing machine. The result were noted and used for discussion.

4. Result and Discussion

The compressive strength of cube calculated from Rebound Hammer, Ultrasonic Pulse velocity and Compression Testing Machine are presented in tableno.2.

Table 2: Compressive strengths by various methods

Period of Curing (in days)	Rebound Hammer (N/mm^2)	Ultrasonic pulse velocity (N/mm^2)	Compression testing machine (N/mm^2)
7	16.5	26.89	17.33
7	20.5	27.24	19.11
28	29	30.63	20
28	33.5	27.84	24.44
No Curing	10.5	22.55	13.33
No Curing	12	21.99	8.88

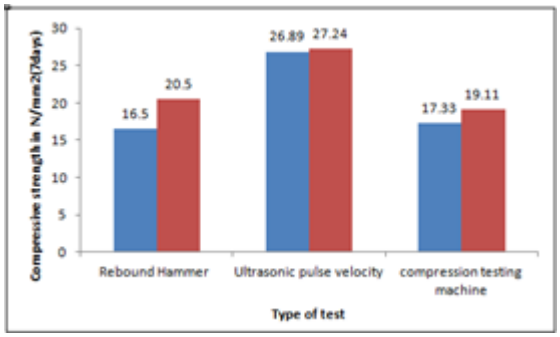

Figure 4: Graphical Representation of comparison for 7 days curing.

Fig No.4 shows the cube test result for 7 days curing for rebound hammer test, ultrasonic pulse velocity test and compression testing machine.

From graph it is clear that, results obtained from ultrasonic pulse velocity test are more than Reboundhammer test and compression testing machine.

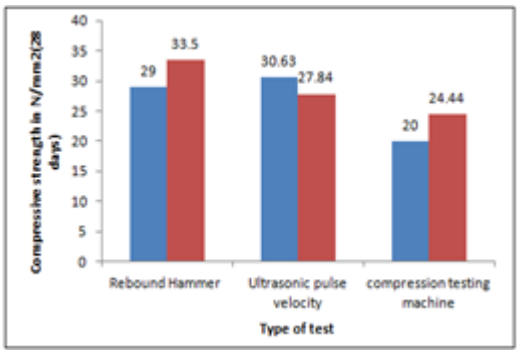

Figure 5: Graphical Representation of comparison for 28 days curing

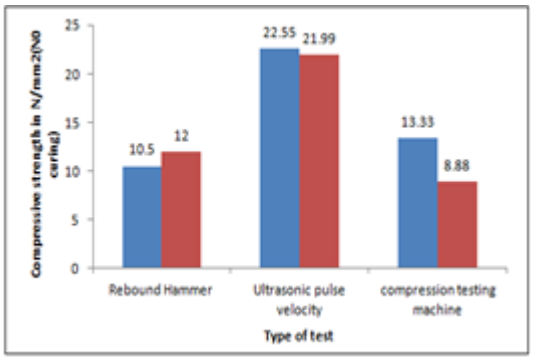

Figure 6: Graphical Representation of comparison for No curing

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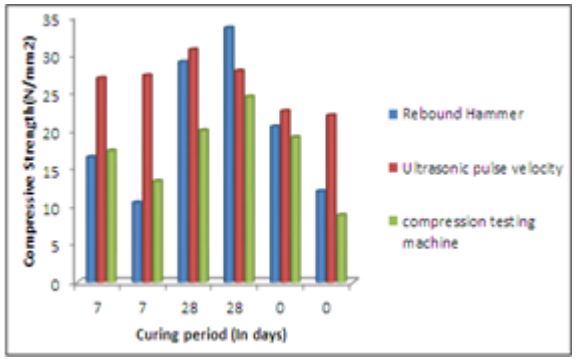

Figure 7: Combined graphical representation for comparison for 7 days curing, 28 days curing and for No curing

Above graph shows the comparison of results obtained from Rebound Hammer test, Ultrasonic Pulse velocity test and compression testing machine.

5. Conclusion

From this study, following conclusions can be drawn,

1) All the results were observed of compressive strength as per IS requirement for 7 days, 28 days.
2) Compressive Strength by ultrasonic pulse velocity test is observed higher than other rebound hammer test and compressive testing machine.
3) Compressive strengths of without cured concrete cube for 7 days were not in limit by Rebound hammer test and compressive testing machine.
4) Compressive strength by Ultrasonic pulse velocity test for all age of cube was observed very good but Compressive strength without cured cubes were noted moderate quality.

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