TITLE: - Comparison Between Destructive and Non-Destructive Test Parameters for M30 & M40 Grade Concrete.

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COMPARISON BETWEEN DESTRUCTIVE AND NON-DESTRUCTIVE METHODS OF TESTING OF CONCRETE

Abstract: -

1. The estimation of mechanical properties of concrete can be carried out by several methods; destructive and non-destructive.

2. We will be doing the crushing of the samples that is the usual destructive test to determine the compressive strength.

3. The rebound hammer test and the ultrasonic device are used in the field of non-destructive tests to determine respectively the compression strength and the ultrasonic pulse velocity in the concrete.

4. In this work we will use two different concrete compositions (GRADE M30 & M40) to prepare P.C.C cubes by varying the water/ cement ratio and the cement dosage.

5. An experimental study will be conducted to determine the compressive strength of concrete by destructive (compression) and non-destructive (rebound hammer) tests at different ages (7, 14 and 28 days).

6. In addition, the influence of several factors on the modulus of elasticity determined by pulse velocity test will be investigated.

7. **Keywords:** Rebound hammer test, Compression test, Pulse velocity test, Destructive test, Non-destructive test.

Introduction: -

1. It is often necessary to test concrete structures after the concrete has hardened to determine whether the structure is suitable for its designed use.
2. Ideally, such testing should be done without damaging the concrete.
3. The tests available for testing concrete range from completely non-destructive tests, where there is no damage to the concrete, through those where the concrete surface is slightly damaged, to partially destructive tests, such as core tests and pull-out and pull-off tests.where the surface has to be repaired after the test.
4. The range of properties that can be assessed using non-destructive tests and partially destructive tests is quite large and includes many fundamental parameters as,
5. density, elastic modulus and strength as well as surface hardness, surface absorption, reinforcement location, size and distance from the surface.
6. The crushing of the specimens is the usualdestructive test to assess the strength of concrete.
7. Non-destructive methods like rebound hammer test and ultrasonic test do not damage buildings and allow to have an inventory of structures and conditions.
8. Non- destructive tests are widely applied to study mechanical properties and integrity of concrete structures.
9. They are simple to use and often economically advantageous. They are suitable for taking measurements on site and taking continuous measurements.
10. These non-destructive methods are usually associated with each other to improve diagnosis and reduce the number of tests.

1. Ultrasound measurements provide a simple non-destructive and inexpensive method to evaluate the elastic modulus of concrete.

2. The formulae proposed by different standards to estimate the dynamic modulus of elasticity from the resistance are very approximate.

3. The dynamic modulus of elasticity is strongly influenced by the aggregates, it cannot be determined accurately based on the strength, which depends mainly on the cement paste and the particle size.

4. For temperatures between - 10° C and + 30° C, there is an increase in the dynamic modulus of elasticity of the concrete with temperature.

5. This project will present measurements of compressive strength and dynamic modulus of elasticity determined from destructive and non-destructive tests.

6. The results obtained from non-destructive tests will be compared with destructive test results.

7. The influences of the age of the concrete, its strength and water/cement ratio on the resistance determined by rebound hammer test and compression test will be studied.

8. A simplified expression shall be proposed to estimate the rebound number from the value of dynamic modulus of elasticity determined by pulse velocity test.

TEST PROCEDURES: -

Schmidt Rebound Hammer Test: -

1. **It** is principally a surface hardness tester. It works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges.

2. There is little apparent theoretical relationship between the strength of concrete and the rebound number RN of the hammer.

3. However, within limits, empirical correlations have been established between strength properties and the RN.

4. The hammer is suitable for use both in a laboratory and in the field. The hammer can be used in the horizontal, vertically overhead or vertically downward positions as well as at any intermediate angle, provided that the hammer is perpendicular to the surface under test.

5. The position of the mass relative to the vertical, however, affects the rebound number due to the action of gravity on the mass in the hammer.

6. Thus, the RN of a floor would be expected to be smaller than that of a soffit, and inclined and vertical surfaces would yield intermediate results.

7. Although a high RN represents concrete with a higher compressive strength than concrete with a low RN.

8. This test will be performed on the specimens according to **IS 13311-2 (1992)**. Schmidt rebound hammer test gives values of RN.

9. The compressive strength of the concrete will be derived using the UNIVERSAL TESTING MACHINE at the rate of 140Kg/cm^2/min^2 according to **IS 14858 (2000)**.

10. The hammer has to be used against a smooth surface. Open textured concrete cannot therefore be tested.

11. If the surface is rough, e.g., a trowelled surface, it should be rubbed smooth with a carborundum stone.

Pulse Velocity Test: -

1. The equipment consists essentially of an electrical pulse generator, a pair of transducers, an amplifier and an electronic timing device for measuring the time interval between the initiation of a pulse generated at the transmitting transducer and its arrival at the receiving Transducer.

2. The pulse velocity test will be determined using cubical specimens in accordance with the requirements of **IS 13311-1 (1992)**.

3. The device used will be an electronic tester with microprocessor in a portable case.

4. It is capable of measuring transit time over path lengths ranging from about 100 mm to the maximum thickness to be inspected to an accuracy of ±1%.

5. The transducers that will be used are in the range of 50 to 60 kHz.

6. The same face (indirect or surface transmission). Since the maximum pulse velocity is transmitted at right angles to the face of the transmitter, the direct method is the most reliable one from the point of view of transit time measurement.

7. Also, the path is clearly defined and can be measured accurately, and this approach should be used wherever possible for assessing concrete quality.

8. A pulse of longitudinal vibrations is produced by an electro-acoustical transducer, which is held in contact with one surface of the concrete under test.

9. When the pulse generated is transmitted into the concrete from the transducer using a liquid coupling material such as grease or cellulose paste, it undergoes multiple reflections at the boundaries of the different material phases within the concrete.

10. A complex system of stress waves develops, which includes both longitudinal and shear waves and propagates through the concrete. The first waves to reach the receiving transducer are the longitudinal waves, which are converted into an electrical signal by a second transducer. Timing circuits enable the transit time T of the pulse to be measured.

- Longitudinal ultrasonic pulse velocity is given by:
- **UPV = L/t** (m/s)
- Pulse velocity measurements made on concrete structures may be used by placing the two transducers on either
- - Opposite faces (direct transmission);
- - Adjacent faces (semi-direct transmission);
- Dynamic Modulus of Elasticity The relationship between the dynamic modulus of elasticity and the velocity of an ultrasonic pulse travelling in an isotropic elastic medium of infinite dimensions is given below:
- $Ed = UPV^2 . \rho . [(1 + \mu)(1 - 2\mu)/(1 - \mu)]$
- Where,
- Ed: the dynamic elastic modulus (MPa)
- μ: the dynamic Poisson's ratio
- ρ: the density (kg/m3)
- UPV: the ultrasonic pulse velocity (m/s).

Compression Test: -

- The compressive strength of cubical concrete specimens was determined by destructive testing with a compression test machine.

- Progressive loading with a rate of $140 Kg/cm^2/min^2$ will be applied to the crushing of the specimen.

- The resistance value will be read directly from the computer screen

- **Brief Summary of procedure: -**
  - We will cast 36 cubes of M30 grade and 36 cubes of M40 grade of concrete.
  - We will test 12 cubes of both grades with Ultrasonic Pulse Velocity and Rebound Hammer Test and immediately break them with Universal Testing Machine.
  - This procedure will be carried out on 3^{rd} 7^{th} and 28^{th} day after casting.
  - After testing all 72 cubes with RH Test, UPV Test and Compressive Test we will compare these results to get a co-relation factor between RN, UPV and Compressive Test to plot a graph of these values and to finally get a relative equation for NDT & DT.

Conclusions: -

- The various techniques for measuring the compressive strength and modulus of elasticity were presented from destructive and non-destructive tests on concrete specimens with different compositions.
- The following conclusions might be drawn from this study: -
- Whether the difference between the values of resistance obtained by destructive and non-destructive tests increases or decreases at the age of 28 days.
- Can we use the rebound hammer test to evaluate the compressive strength of old concrete and young concrete, and how accurate the Rebound Hammer Test results are with respect to aging of concrete.
- Does the UPV changes with the increase of W/C ratio.
- Does the UPV Changes with the age of the concrete.
- Does the dynamic modulus of elasticity determined by ultrasonic measurement changes over time of hardening of the concrete up to the age of 28 days.
- Moreover, will there be a change in the dynamic modulus of elasticity as the W/C ratio changes.
- Equation shall be proposed to estimate the relationship between RN and dynamic modulus of elasticity for the concrete for 28 days of age.

References: -

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Thank You.