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Experimental Investigation on Self Compacting Concrete with Non Destructive Techniques

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ABSTRACT

Non-Destructive Testing (NDT) methods are especially valuable when assessing the quality of concrete at a young age as they can reduce inspection time and costs. His national study focused on the potential use of NDT in quality assurance (QA) of concrete recommends the introduction and/or use of test methods with low test variability. The purpose of this study, therefore, is to build on such recommendations and to develop a specific, well-developed and mature he It was to evaluate the response of the NDT method. Given his extensive knowledge and experience evaluating concrete using such methods over the years, his NDT method is reviewed below. Ultrasonic Pulse Velocity (UPV). resonance frequency analysis (RFA); and rebound hammer. Here we focus on his NDT results for self-compacting concrete cubes at 7, 14 and 28 days. The results were satisfactory as the surface became harder as the number of days increased and we also saw an increase in uniformity and density during the UPV test.

KEY WORDS: Self compacting concrete, Rebound Number, Ultra sonic pulse velocity

1. INTRODUCTION

Concrete structures often need to be tested after the concrete has cured to determine if the structure is suitable for its intended use. Ideally, such tests should be performed without damaging the concrete. Tests available for concrete testing range from completely non-destructive tests that do not damage concrete, to tests that slightly damage the concrete surface, core tests, tear tests, and tear tests that require surface repair after testing. There are various types of tests, including partial destructive tests. The range of properties that can be evaluated by non-destructive and semi-destructive tests is very wide and includes basic parameters such as density, elastic modulus, strength, surface hardness, surface absorption, position, size and spacing of reinforcing surfaces. In some cases, the ability to detect blowholes, cracks and delamination also verifies build quality and structural integrity. Non-destructive testing can be applied to both old and new structures. For new construction, the primary use may be for quality control, or for answering questions about the quality of materials or construction. Inspection of existing structures typically involves assessing structural integrity or adequacy. In either case, using only destructive testing, such as removing the core for compression testing, can be misleading as the cost of coring and testing means that only a relatively small number of tests can be performed on large structures. there is. In such situations, non-destructive testing can be used as a prelude to subsequent coring.

1.2 Basic methods for NDT of concrete structures

The following methods, with some typical applications, have been used for the NDT of concrete

• Visual inspection, a crucial step before doing any envisioned non-destructive test. An expert civil or structural engineer may be able to determine the potential cause(s) of damage to a concrete structure and, thus, determine which of the different NDT techniques could be most beneficial for any future examination of the issue.

• The half-cell electrical potential method, which assesses the potential for corrosion of concrete reinforcement bars.

• The Schmidt/rebound hammer test, which measures the concrete's surface hardness.

• The carbonation depth measurement test, which assesses if moisture has accumulated beneath the reinforcing bars, where corrosion may be taking place.

• Permeability test, which gauges the rate at which water permeates concrete.

• Penetration resistance or Windsor probe test, which is used to gauge the concrete's surface hardness and, consequently, the strength of the surface and nearby layers.

• Covermeter testing, which determines the depth to which steel reinforcing bars extend below the surface of the concrete as well as, potentially, their diameter.

• Radiographic testing, which is used to find concrete voids and determine where stress channels are located.

• Ultrasonic pulse velocity testing, which is primarily used to gauge the concrete's compressive strength by determining the concrete's sound velocity.

• Acoustic techniques that use an instrumented hammer to provide both sound transmission and echo.

1.3 SELF COMPACTING CONCRETE

Self-compacting concrete (SCC) is a mix of fluid concrete that has the ability to compact on its own. SCC can be put in difficult circumstances and in places where the reinforcement is congested because to its exceptionally fluid nature. The usage of SCC can also help to lessen workplace hearing damage brought on by concrete vibration. Because of SCC, the time required to install considerable portions is greatly reduced. Since SCC is defined by how concrete performs when it is still in the fresh stage, fluidity is essential in establishing whether or not concrete meets the criteria for SCC.

2. LITERATURE REVIEW

The electrical characteristics of concrete structures are used by several NDT techniques to evaluate the state of the structures. In order to identify ungrouted cells in concrete block masonry projects, El-Dakhakhni et al. (2010) [48] devised a method based on local dielectric permittivity. This method has been utilised to produce coplanar capacitance sensors with high sensitivity to identify construction flaws. In situ NDE techniques, such as radiography, ultrasonic testing, and infrared thermography, were provided by Nassr and El-Dakhakhni (2009) [49] employing Coplanar Capacitance Sensors (CCSs) to detect variations in material dielectric for damage detection in FRP-strengthened concrete structures. The interpretation of electrical conductivity measurements in concrete to determine water penetration was covered by Rajabipour et al. (2005) [50]. Using a nondestructive evaluation method called time, Liu et al. Time domain reflectometry (TDR), a nondestructive evaluation method created by Liu et al. in 2002 [51], can be used to locate and assess the degree of corrosion on embedded or encased steel rebar and cables.

Several scientists utilise the travel time of longitudinal waves over a certain distance to calculate the ultrasonic pulse velocity in order to evaluate the qualities of concrete. Ultrasonic guided waves were utilised by Sharma and Mukherje (2011) [36] to track the development of rebar corrosion in a chloride and oxide environment. For the corundum and bauxite-based refractory concretes, Terzic and Pavlovic (2010) [37] utilised the NDT methods Image Pro Plus (IPP) and Ultrasonic Pulse Velocity (UPV). An experimental evaluation of the concrete using a nonlinear ultrasonic testing approach was presented by Shah and Hirose in 2010 [38]. "Ervin et al" (2009) [39] developed an ultrasonic sensing network to evaluate the deterioration of reinforcement. Under accelerated uniform and localised corrosion, reinforced mortar specimens had been observed using guided ultrasonic waves. A method for NDT of urban concrete facilities utilising UPV measurements was presented by Stergiopoulou et al. (2008) [40] and applied to concrete garages. UPV has been employed as a concrete quality gauge. Using the concrete surface sonic speed, Yoshida and Irie (2006) [41] proposed a macroscopic ultrasonic approach that enables measurement of concrete thickness, fracture width, and features. When determining the degree of damage to a concrete, Dilek (2006) [42] explored the usage of pulse velocity, Young's modulus of elasticity, and air permeability of concrete. A study was carried out experimentally to determine the impacts of concrete by Abo-Quadais (2005) [43]. Measured UPV parameters include aggregate deterioration, w/c ratio, and curing time. The portable ultrasonic ND digital indicating tester was utilised as study equipment (PUNDIT). For determining the setting time of concrete, especially high-performance concrete, Lee et al. (2004) [44] used UPV techniques (HPC). Laboratory-based NDE methods based on observations of mechanical waves that move through concrete were described by Shah et al. in 2000 [45]. Measurements of the transmission of ultrasonic longitudinal wave (L-wave or P-wave) signals have been used to identify concrete damage in the form of dispersed cracking. For assessing the concrete quality of hazardous waste tanks, Davis et al. (1997) [46] proposed numerous NDE techniques, including UPV, impulse response, parallel seismic, and cross-hole sonic logging. The idea and implementation were provided by Rens and Greimann (1997) [47] use of an ultrasonic continuous spread-spectrum signal for spotting decaying infrastructure and monitoring it. Direct-sequence spread-spectrum ultrasonic evaluation (DSSSSUE), a new ultrasonic NDE technique, is currently being developed.

3. METHODOLOGY

3.1 REBOUND HAMMER

The Rebound Hammer Test gauges the elastic rebound of concrete and is mainly employed for comparative studies and concrete strength assessment. Using a concrete test hammer, the sample cubes' R rebound values were calculated. The pressure testing apparatus was then used to determine the compressive strength.

PRINCIPLE OF REBOUND HAMMER

The premise behind the rebound hammer test method is that an elastic mass' ability to rebound is dependent on how hard the concrete surface it strikes is. The spring-controlled mass in the rebound hammer bounces back when the plunger is pressed against the concrete surface. The hardness of the concrete surface affects how much the mass bounces back. As a result, the compressive strength of concrete can be connected to the rebound hammer reading and hardness of concrete. The rebound value, also known as the rebound number or rebound index, is read off along a graded scale. Direct reading of the compressive strength is possible from the graph located on the hammer's body.

Fig 3.1 Rebound Hammer

3.2 UPV TEST

The non-destructive ultrasonic pulse velocity test is used to assess the quality of the concrete at the construction site. In essence, this test measures how quickly an electronic pulse travels through concrete from a transmitting transducer to a receiving transducer.

The fundamental idea behind the ultrasonic pulse velocity test is that a solid's sound velocity depends on the square root of the relationship between its density P and its elastic modulus E. Quality and strength of a material are connected to its density and elastic qualities, respectively.

Electronic pulses typically travel between 3 and 5 km/h in speed. The electronic pulse's frequency ranges from 15 kHz to 175 kHz.

Fig 3.2UPV TEST

4. RESULTS AND DISCUSSION

From the test performed we have observed that the rebound number and ultrasonic pulse velocity test results for self-compacting concrete

4.1 REBOUND HAMMER RESULTS

Table no :4.1 Rebound hammer results

GRADE	7 DAYS	14 DAYS	28 DAYS
M20	29	31	33
M30	31	33	34
M40	38	39	40

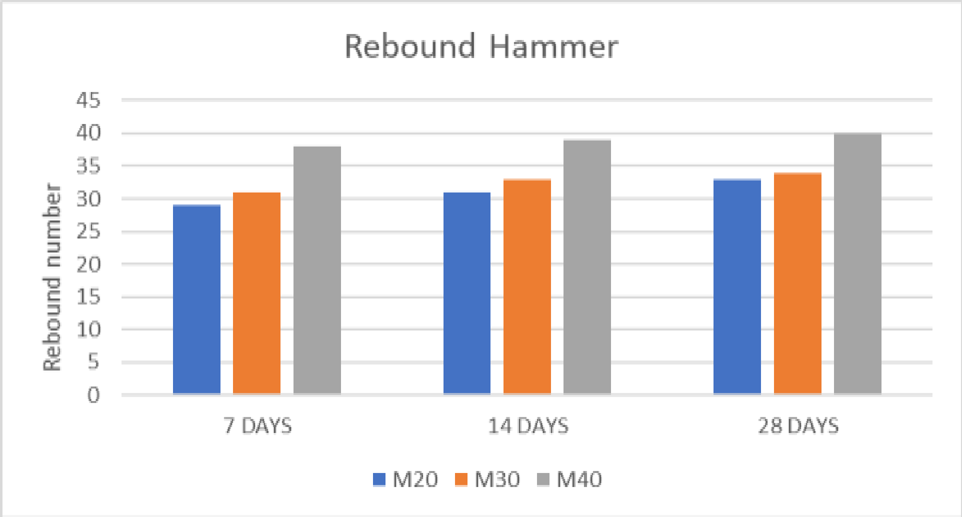

Fig 4.1 Graphical representation of rebound hammer

From the above table and graph , we have observed that the maximum rebound number is at M 40 grade after 28 days which shows highest surface strength. With the number of days increased the surface is getting harder with respective their grades.

4.2 UPV TEST RESULTS

Table No 4.2 UPV test results

GRADE	7 DAYS	14 DAYS	28 DAYS
M20	4178	4688	4702
M30	4344	4756	4862
M40	4526	4866	4926

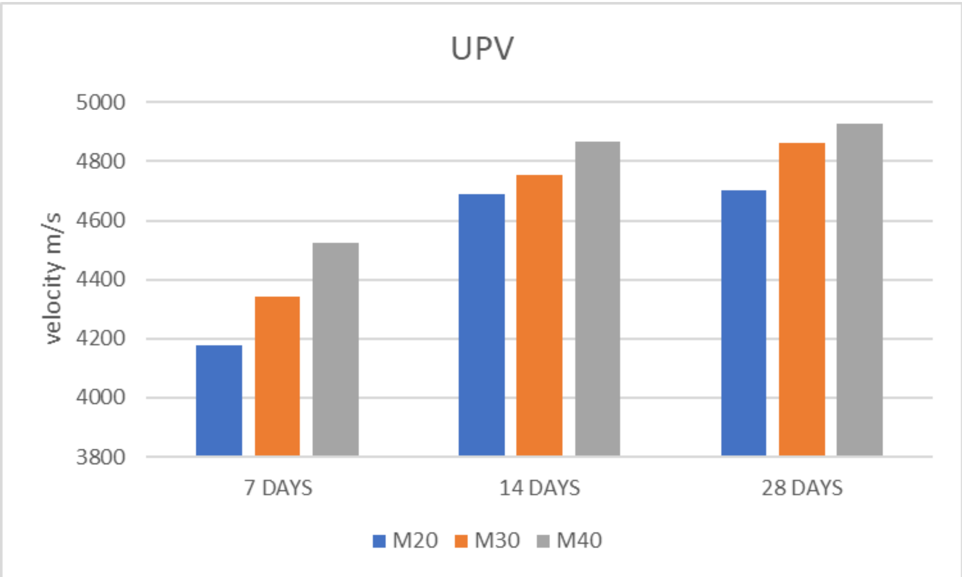

Fig 4.1 Graphical representation of UPV

From the above table and graph, we have observed that the UPV has maximum velocity for M40 grade with 4926m/sec compared to other grades. With number of curing days increases the velocity results are also proportionally increased.

4.3 RELATIONSHIP BETWEEN REBOUND NUMBER AND UPV

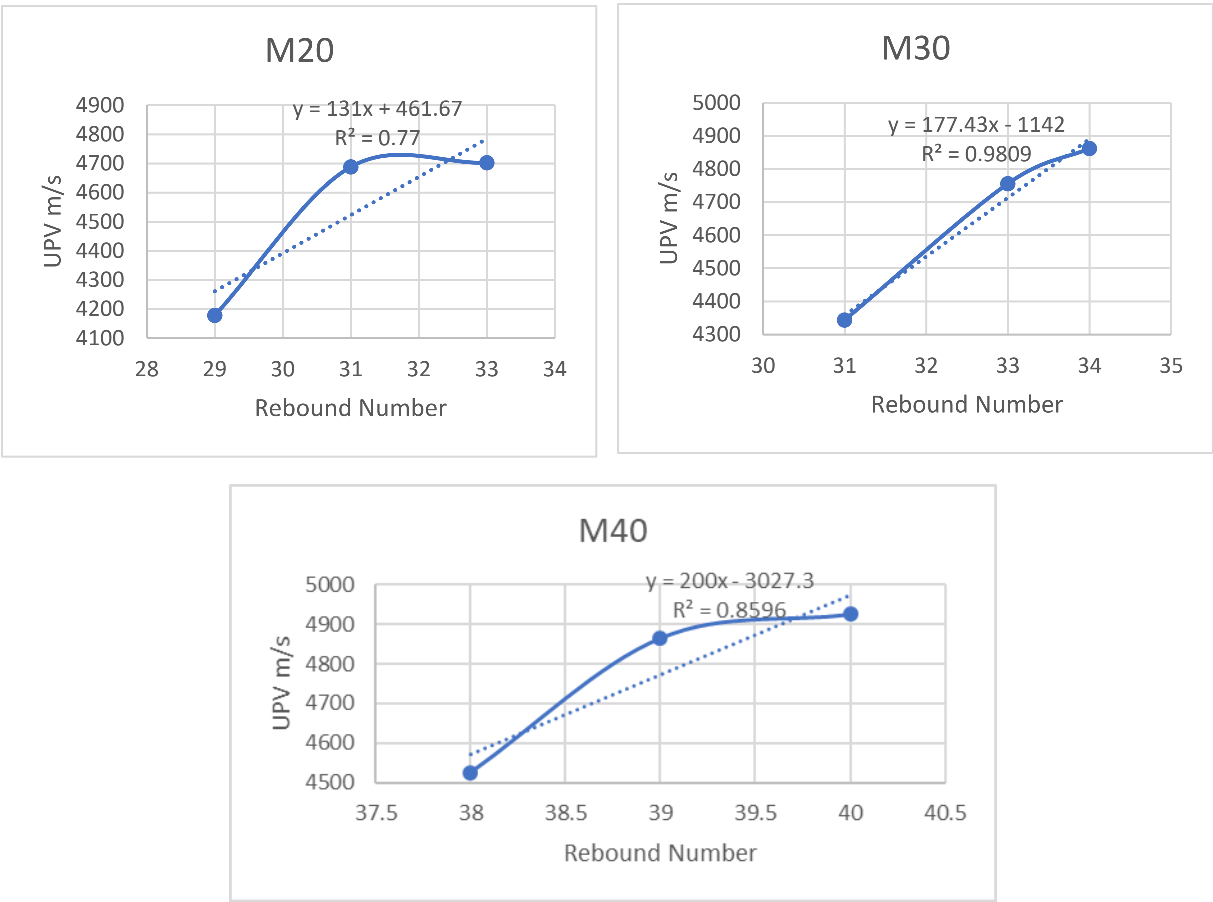

Fig 4.3 Graphical representation of the corelation Between UPV and Rebound Number

From the above correlation graphs we got the linear regression line which shows positive results satisfactory

5. CONCLUSIONS

- By performing the NDT test we have figured out the best results for the self-compacting concrete.
- Based on these test results we can conclude that any destructive test performed on the Self compacting concrete will produce satisfactory results.
- From the Rebound test results we can conclude that the surface of the concrete will be hardened which shows best results.
- From the UPV test results we can mention that the concrete will possess uniform homogeneity and more density because the range of velocity is above 4000m/s which is satisfactory.
- We have plotted a correlation between UPV and Rebound number which shows the positive trend line and we observed that the R^2 value is above 0.75 for all the grade of concrete which is satisfactory
- Individually M30 grade of concrete has achieved good relation when compared to other grades of concrete.

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