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Condition Estimation through UPV

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Abstract - *One of the most common and effective non-destructive methods for determining the characteristics of concrete in constructions is testing ultrasonic pulse velocity (UPV). In addition to crushing power, other uncontrolled aspects like weather conditions or exposure are equally important for the service life of buildings. Failure of concrete structures created an unsettling scenario for researchers who were focused on the durability impacting parameters. In order to design, repair, and replace structures, it is crucial to evaluate the current state of reinforced concrete structures.*

Key Words: Compressive strength, Durability, Service life, Non destructive testing, rebar's, UPV Test, Nuclear Facilities, pulse velocity, depassivation time

1. INTRODUCTION

Determination of the present condition of concrete requires different actions such as highly skilled visual inspection for monitoring the cracks, finding pattern of cracks, investigating causes of cracks, finding corrosion activity under the concrete near rebar's, investing other properties which influences the durability of concrete.

In addition to these techniques, a number of destructive and non-destructive techniques are available to evaluate the state of structures while they are still in place. The UPV test is one of the most widely used non-destructive methods for evaluating the concrete qualities of buildings. Although the UPV test is pretty straightforward and simple to use, interpreting the test findings is quite challenging since UPV scores are affected by a variety of circumstances.

2. NON-DESTRUCTIVE TESTING

Non-destructive testing (NDT) is a technique for determining inadvertently the many characteristics of hardened concrete, such as strength, durability, and other elastic qualities, without stressing the specimen until it breaks. These techniques are based on the idea that only a small number of physical and chemical characteristics of a material may be connected to the strength and other characteristics of the concrete. These techniques have a high chance to be used in such a technology. There are many cutting-edge NDT techniques available for researching and assessing the various criteria.

In many different industrial areas, NDT techniques are widely employed. With the help of quick and trustworthy testing techniques, aircraft, chemical plants, electronic equipment, nuclear facilities, and additional protection important assets are periodically tested. For metallic or composite materials, a number of advanced NDT techniques are available.

The term "quality control technique" refers to non-destructive testing (NDT). Without causing harm to the substance being tested, it may be utilised to find information about a system, component, or material's qualities. Infrared radiation, radiography, ultrasound, x-rays, and many more methods are used in non-destructive testing to examine the material's characteristics, structural faults, and other types of material defects. The procedures used in NDT testing are often simple, quick processes that don't need a lot of waiting and computations. These methods might be used in high-risk locations including gas and oil pipelines, nuclear and seashore buildings, and coastal environments. Since they may be used to regulate production procedures, guarantee product integrity, cut production costs, and maintain the material quality standard, non-destructive tests are seen to be highly beneficial. Here are some examples of non-destructive testing techniques from a wide range available: Ultrasonic Testing, Laser Testing Methods, and Ground Penetrating Radar (UT). Compared to other non-destructive procedures, the ultrasonic pulse velocity technique is the most convenient and takes least time to use. It also has the lowest cost of usage.

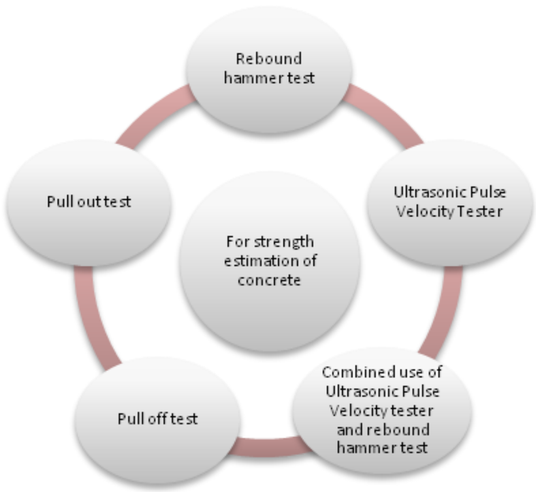

Figure 1-Various NDT methods

3. WATER TO CEMENT RATIO OF CONCRETE

A concrete mix's water-cement ratio is determined by comparing the weights of the cement and water. A concrete mix that has a w/c ratio of 0.2 adds 20 lbs. of water for every 100 lbs. of cement. The two elements that are most responsible for holding the components of the concrete mixture together are water and cement. The w/c of a concrete mix and the strength of the concrete have a connection. The strength of concrete would be stronger when the mix design has a lower w/c. And the reason for this is because adding water would result in a diluted paste that is prone to breaking and shrinking, which is why the concrete would be seen as being weaker. The weight of the aggregate will force the extra water out of the newly laid concrete when it has a high water-to-cement ratio. It would extend to the surface when there is a significant quantity of extra water. As a consequence, the tiny flaws in the concrete might enable water to seep in and cause microcracks. One of the key elements that may greatly affect the characteristics of concrete is the quantity of water used in the mix design.

4. USING UPV MEASUREMENTS IN CONCRETE

Concrete is a substance that is often used in building. This finding supports research on the characteristics of concrete. Compressive strength has historically been the control parameter most commonly employed to evaluate concrete. If the concrete is not strong enough, it cannot withstand the design loads and the action of environmental agents, resulting in damages that can be expensive to fix, in short service life or, in extreme situations, in the collapse of the structure built, endangering their users. UPV measurements are theoretically better capable of performing in-depth investigations of concrete compactness and have been successfully used in real life situations by our research team to detect voids and to analyze changes in concrete type and strength, especially when combined with the extraction of core samples in order to provide a reference for analyses (Lorenzi et al., 2009). Obtaining concrete homogeneity estimates by NDT applied to the actual structure provides higher control possibilities, and this can be achieved by UPV testing. It must be mentioned that there is a relation between ultrasonic wave and concrete density and this relationship justifies the use of ultrasonic wave to evaluate concrete, despite some limitations (Popovics, 2001). UPV methods, which allow for investigating material homogeneity, may be thought of as one of the most promising NDT techniques for assessing concrete structures. Determining how a structure's qualities evolve over time might let one take complete control of it. It is possible to assess the compactness or spot heterogeneous areas within concrete structures by analyzing differences in the propagation of ultrasonic wave velocity. The test may be used to regulate the quality, identify flaws, gauge the thickness of various materials' component layers, or specify the kind of concrete (ASTM E 114-95, 1995). The Brazilian Standard NBR 8802 specifies a few steps to be taken while conducting the tests in order to employ the UPV in concrete. Common applications of UPV include assessing the homogeneity of the concrete, identifying internal flaws, determining the depth of flaws, calculating the compressive strength and deformation module, and tracking changes in concrete properties over time (NBR 8802, 1994). When analyses are properly performed, it is possible to make a reliable diagnosis on the state of repair of concrete structures. Lorenzi and Silva Filho (2003) point out that the UPV has been increasingly employed in the diagnosis of structures, as it allows to material characterization and integrity checking, as well as to measure their physical properties by monitoring the velocity of wave propagation through the material. Additionally, the tests may be used to investigate the relationship between compressive strength and concrete characteristics. The primary goal is to investigate how the relationship between compressive strength and material density, which affects ultrasonic velocity waves, may be understood. However, one drawback of the method is that it depends on a number of variables, like concrete age, aggregate type and percentage, carbonation depth, etc., to determine the link between UPV and compressive strength values. In addition, the assessment of UPV is a highly specialized and difficult task that calls for meticulous data gathering and qualified analysis. It's really intriguing to consider if compressive strength, the primary structural parameter, may be estimated from an NDT test. Consequently, there has been a rise in interest in developing helpful correlations between UPV and compressive test findings. The ability of UPV to conduct tests in the same location as those previously conducted, allowing for time-related differences to be effectively taken into account, is a crucial consideration (LORENZI, 2009).

3. LITERATURE REVIEW

For the purpose of evaluating the state of RC structures, many researches used various NDT tools. There has been an experimental investigation.

Malek and Kaouther (2014) for measuring concrete's compressive strength using destructive and non-destructive methods at 7, 14, and 28 days. For destructive testing compression test and for non destructive testing rebound hammer tests have been conducted. Effect of several parameters on the modulus of elasticity has been investigated through pulse velocity test. These parameters are the age of concrete and the water/ cement ratio. [1]

Bogas et al. (2013) Utilizing a non-destructive ultrasonic pulse velocity approach, the compressive strength of different concrete mixtures made with lightweight aggregate has been assessed. After 3 and 180 days of curing, about 84 different compositions have been examined in this research; the compressive strengths of these samples range from 30 to 80 MPa.[2]

Jain et al. (2013) The Rebound Number and Ultrasonic Pulse Velocity of concrete were examined experimentally to determine the impacts of the materials in concrete, the percentage of the concrete mix, and workmanship-related factors. It had been established in this investigation that both NDT methods could be used together. [3]

Singh and Kotiyal (2013) A correlation between the strength measured experimentally and the strength predicted by the model has been shown. NDTs are those that may be used to determine strength without causing any damage to the building. In this study, an artificial neural network is used to anticipate concrete's compressive strength. In order to create equations for various models, the predicted strength was compared to the concrete's actual compressive strength, which was obtained via experimentation. Additionally, a relationship between the two NDT approaches has been constructed for the regression analysis computation of strength.[4]

Shariati et al. (2011) Through the use of DT and NDT, a relationship between the compressive strength of a structure has been demonstrated. The NDT testing was conducted to evaluate the eminence of the concrete structure, and the correlation between test results and the actual in-place value of the structure's crushing strength was carried out using the regression analysis approach. Beams, columns, and slabs are the structural members that are being tested. To identify any differences between the two outcomes, the resulting results are contrasted with the test values. The final result demonstrates that the Rebound Hammer test is more effective. However, combining the findings of the two NDT tests yields more trustworthy outcomes. [5]

Cheung et al. (2009) a 2-D FE coupled model was created to assess the chloride penetration process in a variety of environments and estimate the time of corrosion onset. [6]

Liang et al. (2009) To examine the service life of RC bridges, a mathematical model based on Fick's second law of diffusion and other earlier models was suggested. The initiation time (tc), depassivation time (tp), and corrosion (propagation) time are the three phases of the corrosion process (tcorr). For the current RC bridge, the overall service life of the pier may be stated. as t = tc + tp + tcorr. [7]

Breysse (2009) using the rebound hammer, UPV, and several empirical strength-NDT, and it was determined that the model error was far lower than that resulting from measurement uncertainties, emphasising the decline in NDT measurement error. According to artificial simulations, the accuracy of NDT measurements directly affects the accuracy of evaluations for both standalone and combined NDT. [8]

Stergiopoulou et al. (2008) provided a method for performing nondestructive testing (NDT) on concrete garages in metropolitan areas utilizing UPV measurements. UPV has been used as a concrete quality gauge. [9]

4. CONCLUSION:

In-situ compressive strength of concrete components may be determined using UPV techniques, as can be shown from the literature study that was just mentioned. Additionally, it has been mentioned that the need of concrete in-situ testing has been recognized in order to identify the significance and factors affecting the behavior of existing buildings.

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