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REPRESENTING THE CONDITION OF CONCRETE THROUGH IN-SITU TESTING : A REVIEW

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Abstract: *A structure should meet the necessity of serviceability, sustainability, safety and durability for a long-standing operation. The performance of a structure deteriorates with the passage of time. This deterioration is governed by environmental conditions, age of material and variation in working load. These failure causes loss of life and financial trouble. The several important structures, like bridges, nuclear plants require regular inspection and testing with consistent technologies. In the last years, failure of concrete structures focus researchers reliability of concrete structures.*
Keywords: *Concrete; Condition; Deterioration; Performance; In-situ testing.*

1. Introduction

The load bearing capacity of structures goes on reducing with time because of many factors such as harsh environmental exposure and deformation caused by unpredictable external loads. Henceforth to estimate the condition, deterioration in basic characteristics and remaining life, various advanced techniques were developed. Several in-situ and laboratory methods are available to determine the several parameters significant for the performance of concrete structures. In addition to these testing methods several analytical methods like Finite Element Analysis, Finite Difference Method, Artificial Neural Network and MATLAB are also available for developing the mathematical models for predicting the life and condition of concrete. In most of the cases it has been observed that correlation of these two techniques provides more significant results. In the present research, several studies performed by other researchers are reviewed in order to provide the information about condition assessment techniques.

Physical and chemical damage results in the decrease in performance with time, physical damage occurs due to fire, abrasion or expansion and contraction stresses while chemical damage occurs due to harsh environment. Structural design of concrete structures traditionally focuses over the compressive strength and construction. Which results in failure concrete as shown in figure -1.

Figure-1. Concrete failure with time

2. Brief review of the work already done in this field

1. **Sandeep Kumar et al. (2019)** provides the recent advances and researches about non-destructive testing

(NDT) methods for defect characterization in engineering materials and composites. The paper covers the review on the capabilities of NDT applications such as Visual Testing (VT), Ultrasonic Testing (UT), Thermograph, Radiographic Testing (RT), Electromagnetic Testing (ET), Acoustic Emission (AE) and stereography testing with respect to advantages and disadvantages of these methods. Further methods are classified on basis of their intrinsic characteristics and their applications.

2. **Amini et al. (2016)** developed models for predicting the compressive strength of concrete, without considering the past maintenance record of building. Performed ultrasonic pulse velocity (UPV) and rebound hammer (RH) tests over several cylindrical samples of concrete.
3. Several destructive and non-destructive tests were conducted by **Pucinotti (2015)** on a significant historic building in Reggio Calabria. It has been observed from results that due change in the in-situ mechanical properties of the concrete; it is needed to calibrate the strength determined by non-destructive testing of concrete.
4. An experimental study has been conducted by **Malek and Kaouther (2014)** for assessing the compressive strength of concrete through destructive and non-destructive testing 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.
5. The compressive strength of several concrete mixes produced using lightweight aggregate has been evaluated using the non-destructive ultrasonic pulse velocity method by **Bogas et al. (2013).** In this study, almost 84 separate compositions have been tested after 3 and 180 days of curing, compressive strengths of these samples is ranging about 30 to 80 MPa.
6. In an experimental study performed by **Jain et al. (2013)** evaluated the effects of concrete ingredients, proportion of concrete mix, and variables related to workmanship on the Rebound Number and Ultrasonic Pulse Velocity of concrete. In this study, combined use of both the NDT techniques had been determined.
7. **Hajjeh (2012)** performed several destructive and non-destructive tests several laboratory casted concrete cubes. Regression investigation is carried out and several relationships were determined and correlated between non-destructive testing method which is Schmidt rebound hammer test and concrete destructive compression test. Schmidt hammer has been applied in both vertical and horizontal positions. The standard concrete cubes had been made with a range of mix proportions that yielded standard cubes crushing strengths.
8. **Hannachi & Guetteche (2012)** used rebound hammer and ultrasonic pulse velocity methods to determine the concrete quality through regression analysis models between compressive strength of in situ concrete on existing structure and the non-destructive tests values. The combined method has been used and equations are derived using statistical analysis to estimate compressive strength of concrete on site. The reliability of the technique for prediction of the strength has been discussed for a case study.
9. According to **Lawson et al. (2011),** ultrasonic pulse velocity is the most accepted non-destructive techniques conducted worldwide to assess the concrete properties. After performing the testing, the relationship among the NDT results and the compressive strength of concrete has been investigated. The UPV measurement and compressive strength tests were carried out at the concrete age of 2, 7, 15 and 28 days. The UPV and the compressive strength of concrete increase with age, but the growth rate varies with mixture proportion. A relationship curve is drawn between UPV and compressive strength for concrete having different w/c from 0.35 to 0.7.

3. Noteworthy contribution in the field of proposed work

3.1 Experimental Section

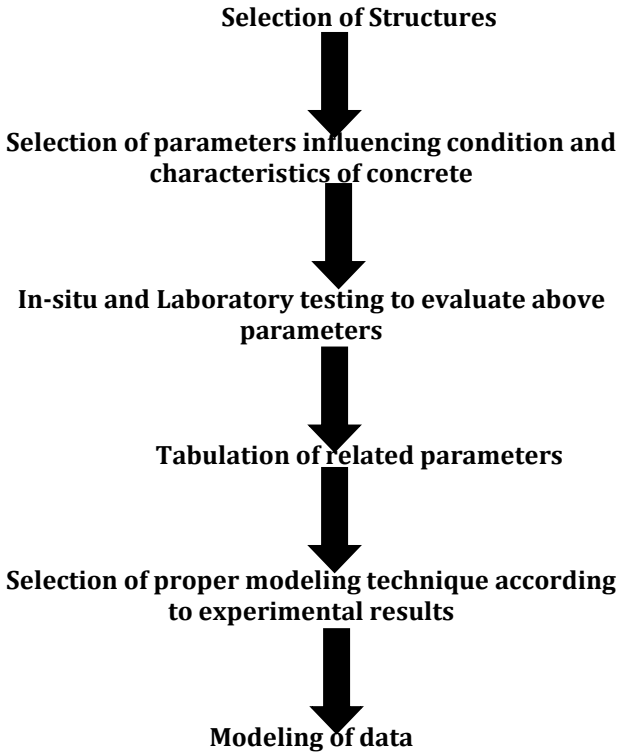
Standard methods for in–situ testing and monitoring of concrete structures have been developed. The required field data with respect to various parameters have been collected. Parameters required to be tested in laboratory have been identified and collected. The models based on such field data have been developed. However, most of the works have been done in European countries Japan and few other countries little work has been done in India.

The local model for Indian climatic conditions and structures constructed by local contractors using their thumb rules is needed. Moreover, effect of characteristics of fresh concrete over the future performance of concrete structures is needed.

4. Proposed Methodology during the tenure of the research work

In this research, data on different parameters from existing building and laboratory concrete around Bhopal and other cities in M.P. have to be collected. The Mathematical

modeling for predicting condition and characteristics has to be performed. The following flowchart describes the methodology to be adopted in the present research.



5. Discussion and Conclusions

- Systematic methodology for in-situ and laboratory evaluation of existing building structures.
- A methodology to determine the characteristics of fresh and hardened concrete.
- Effect of characteristics of fresh concrete on the performance of hardened concrete.
- Relationship between different parameters of existing structures and condition of the structure.
- A model to forecast and determine the long-term performance of concrete structures.

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