REVIEW OF BEHAVIORAL STUDY OF STRUCTURAL ELEMENTS THROUGH DIFFERENT DESTRUCTIVE AND NON-DESTRUCTIVE TESTINGS

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Abstract

The current paper reviews different results for the techniques of condition assessment on the real structure as well as different elements. Also comparison between different techniques has been taken into account for better precision and accuracy in the results. More than one tests are taken into account for different parameters calculation.

Keywords: *Condition assessment, destructive and non-destructive tests*

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1. INTRODUCTION

Condition Assessment is a term that describes the systematic and step by step evaluation of existing condition of any structures that may vary in terms of their age design, construction methods and materials. It is an important part of Structural Health Monitoring. Also structural Health Monitoring, it simply states the procedure of implementing a damage detection and characterization strategy for Civil engineering structures like a Buildings, Bridges, tunnels, Dams and reservoirs etc. Process of applying a damage identification strategy for aerospace, civil and mechanical engineering infrastructure is alluded to as structural health monitoring (SHM).

Here damage is defined as changes to the material or geometric properties of these systems, including changes to the boundary conditions and framework integration, which antagonistically influence the framework's execution. Structural health monitoring (SHM) in broad-spectrum is a procedure targeted at providing precise and opportunate information about the condition and performance of a Structure. There can be two kind of process, either short term (e.g. Repairs efficacy) or long term (monitoring parameters continuously or periodically) process. Due to new materials and technology are revealed, buildings get higher, bridges get lengthier spans and designs of structure become more ambitious, but multifaceted. In assessment of these is an augmented requirement to offering both the costs savings with regard maintenance and a securer environment for by counteracting structural failures. India is being a developing country has picked up the structural developments counting the new technologies. India has a rich culture and recorded foundation which is extremely decently reflected in the changed measure of chronicled structures. These structures are exceptionally well constructed and have withstood the rest of time. However because of their recorded significance, it gets to be critical to evaluate wellbeing state of these structures, so that suitable steps can be taken before it is too late that they fully deteriorate.

Condition assessment are extremely important for the RCC structure such as dams, bridges or Critical buildings or Long lifeline structures such as Hospital, School buildings, Power plants, etc and buildings with great public meeting like Government administrative buildings, sports arenas, stadiums, which could damage to great amount of people at time and are something to be taken care on a regular basis, if they bear any damage due to any disaster, either manmade or natural. To keep a high level of structural security in facet of durability, corrosion, electrical resistivity, cracking, deflection etc and outcome of the infrastructure in each country, a competent system for early and regular structural valuation is straightaway a requirement. The quality guarantee during and after the construction of new structures and subsequently reconstruction processes and the categorization of material properties and damage as a function of time and environmental impacts is more and more becoming a serious alarm. Non-destructive testing (NDT) methods is having a huge potential to be part of such a system. NDT methods in common are broadly used in several industry branches. Aircrafts, chemical plants, electronic devices, commercial buildings, bridges, nuclear facilities and other safety critical installations are tested consistently with fast and dependable testing technologies. An assortment of advanced NDT methods are existing for metallic or composite materials.

In recent years advanced various NDT techniques are used for healthiness assessment of existing structures, have become obtainable to concrete structures but not follow in regular basis assessments or estimation of any structures. So that the objective of this project to find out the existing condition of the structure by various NDT methods and Visual inspection it's applicability, performance,

availability, and restriction of NDT on structure. Even the other aspect of the research dynamic analysis focuses on the defects observed due to vibrations on the structures such that before any calamity lives can be saved. These research efforts try to be useful to our society and save and secure the long life span structures like bridges, hospital, School, government buildings, commercial buildings etc.

2. LITERATURE REVIEW

Mohammadreza Hamidian, M. M. Arabnejad Khanouki, Ali Shariati, Hamid Sinaei, Karim Nouri and Ali Toghroli made their research in structural health supervising with the help of ultrasonic pulse velocity and rebound hammer techniques. Studies were carried out in two phases by designing various mix proportions for concrete cubes in laboratory and also testing of the columns, beams and slabs of an existing building using one of concrete mix properties for accurate comparison. Tests on cube specimens were made of concrete cube with 150 × 150 × 150 mm dimensions. For having different mix design of concrete, concrete mix proportion was made. The materials used for the mix were river sand, OPC cement, crusher broken granite coarse gathers of 10 and 20 mm size, super plasticizer of poly carboxyl (PC) based for water reducing of concrete mix. The NDT tests were carried out according to ASTM (ASTM C: 597). The age of 7, 28 and 90 days for concrete cubes were chosen by compressive testing machine, SRH and UPV. These time periods were chosen since the UPV and SRH tests were unaffected between 3 days to 3 months.

Correlation of Rebound Hammer vs UPV:

Even though SRH contributes the compressive strength but UPV benefits to decide the density, uniformity and modulus of elasticity of the concrete structures which are the factors for permanency of the structures and also foretelling the provision life of the structures but compressive strength is one of the constraint which always has a prime importance for determining the quality of the structure (Aydin and Saribiyik, 2010; Oz and Turkmen, 2010). SRH gives the surface hardness in turn being associted to the compressive strength by the finest fitted curve equation as given in the digital rebound hammer instrument but this curve needs to be identical as local conditions. As SRH is very much convenient for determining the compressive strength, a correlation with UPV will be all that much supportive for making the institutionalization of both NDT systems for better precision. In Figure 3, a correlation is shown, between compressive strength by SRH and UPV where a best fitted or we can say finest fitted curve is drawn to show the relation between these two values. There is no much variety in the best fitted linear curve which demonstrates that for the same UPV reading, there is a extensive variation of compressive strengths which may be false. Hence, result of SRH cannot be dependable only. It has to be auxilary verified with UPV which contributes the actual quality of the concrete.

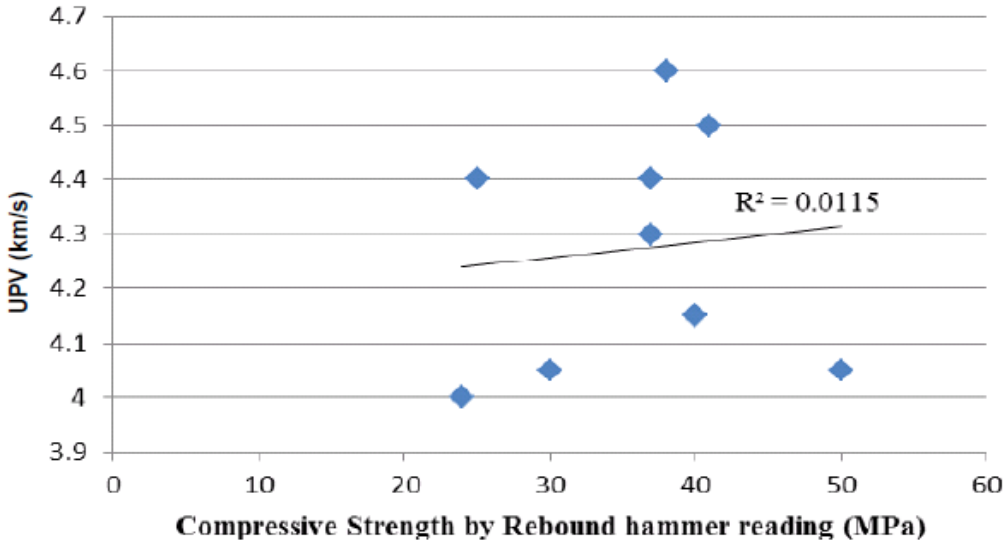

Fig. 1 Correlation curve between UPV, SRH and actual compressive strength.

By having the experimental study, it is shown that a good correlation exists between compressive strength, Schmidt Rebound Hammer and 'ultrasonic pulse velocity'. The Schmidt Rebound Hammer offers a cheap, simple and fast method of achieving concrete strength with accuracy of ±15 to ±20%. The 'ultrasonic pulse velocity method' is a impeccable instrument for launching whether concrete is undeviating. It can be utilized on both existing structures and those under development. These relations permit the potency of structural concrete to be forecasted within ±20% in this case. The technique can be protracted to test prevailing structures by captivating direct measurements on concrete elements. The methods presented are simple, fast, trustworthy and includes varied ranges of concrete strengths and these techniques can be simply applied to concrete varieties as well as prevailing concrete structures.

Lokesh V, B. Shivakumara Swamy, S.Vijaya has contributed their working for checking the soundness of RC structures with the help of NDT approach. In their approach three different methods have been taken into consideration. The purpose of a non destructive test is to acquire an approximation of properties of material by quantifying some particular quantities which are empirically associated to it. To make strength approximation, it is essential to discern the relationship between the outcome of the non destructive test and strength of material. The precision of interpretation of outcomes relies directly on the correlation between strength of material and measured quantity. Hence, the user of NDT should have a perceptive of what amount is measured by the test and how this amount is identified with the quality of material. Test routines go generally in unwavering quality and unpredictability. Thus, suitable experience is essential in determination of the correct tests and revises elucidation.

In the present paper, healthiness assessment methods such as A) Rebar locator test B) Carbonation test and C) Half- cell potential test are closely dissected to discover some basic aspects of R. C. structure health monitoring.

2.1 Profometer/Rebar Locator:

It is used for sensing location and size of the reinforcement and the concrete cover. This instrument is otherwise called rebar locator. The technique is in light of estimation of the change in electromagnetic field caused by the steel embedded in the concrete. It is covered by BS 4408:1969-Part1. The device is a convenient and helpful instrument, regularly used to spot the fortification, with an electronic showcase. The strategy is quick and gives truly exact results if the support is not intensely congested. The supplies is light and a solitary individual can perform the test.

2.2 Carbonation Test

Carbonation test was done on RC individuals at irregular utilizing phenolphthalein indicator as a part of 0.1 N methyl liquor answers for evaluate the degree of carbonation in spread concrete. Carbonation of concrete happens when the carbon dioxide, in the atmosphere in the presence of moisture, responds with hydrated bond minerals to create carbonates, e.g. calcium carbonate. The carbonation procedure is likewise called depassivation. Carbonation infiltrates beneath the uncovered surface of concrete to a great degree gradually. The time needed for carbonation can be assessed knowing the concrete review and utilizing the following equation:

$$t= (d/k)^2$$

2.3 Half-Cell Potential:

Electrochemical Half-cell Potentiometer test gives a quantitative appraisal of fortification corrosion more than a wide territory without the need of real evacuation of the concrete cover. The technique identifies the probability of corrosion of steel however can't demonstrate the rate of corrosion. Qualification can be made in the middle of corroded and non-corroded areas by making estimations over the entire surface. Corrosion analyzer is in light of electro-concoction methodology to recognize corrosion in the support bars of structure. Amid dynamic corrosion, the steel-concrete framework in the strengthened concrete component speaks to shortcircuited galvanic cell, with the eroding territory of the fortification bar going about as the anode, the passive surface as the cathode and concrete as electrolyte. The abundance electrons produced amid corrosion move through the concrete in the middle of anodic and cathodic destinations, producing current which is joined by an electric potential field encompassing the eroding bar. equipotential lines intersect the surface of the concrete and the potential at any point can be measured using the half potential method.

Francesco NUCERA and Raffaele PUCINOTTI have contributed their work by performing destructive as well as non-destructive testing on an RC structure. The structure assessed by them is actually The National Museum of Reggio Calabria. The evaluation of in situ pressure quality of a reinforced concrete structure assumes a key part in the assessment of its wellbeing. The investigation of an "ancient" structure is fascinating in light of the fact that gives data about materials and innovations accessible at the time of generation and the information of the primary physical properties of concrete and its condition of preservation. The portrayal of the materials used amid the development of "ancient" or authentic structures, aftereffects of principal significance when the structural safety or the seismic damageability evaluation are lead in a reinforced concrete (RC) building where the desolates of time don't assent a right assessment of the mechanical attributes of the materials. Additionally, these structures have frequently awesome recorded significance. For them it is advantageous to point of confinement the quantity of destructive testing (cores).The utilization of non-destructive techniques is for the most part legitimate just if a dependable connection for a specific kind of concrete is created preceding the assessment of the subject quality concrete. In this paper, the criteria and the outcomes concerning a non-destructive examinations led in situ on a critical authentic building, i.e. the Museum of Magna Graecia in Reggio Calabria, are introduced.

A] Destructive Testing: Cylindrical cores, specimens, were extricating from some structural component of Museum with the goal to get a more advantageous correlation curve. On the same examples, determination of the profundity of carbonation has been completed. For cores separated from inner columns the profundity of carbonation was around 2 cm, though this profundity was around 10 cm for cores extricate from outside columns.

B] Non-destructive testing: In Non-destructive part base of three methods have been shown such as surface hardness method in which rebound hammer is selected another is the Ultrasonic methods in which UPV and the combination of method which is SonReb is performed.

The result obtained by the performance is in the graphical format as follows:

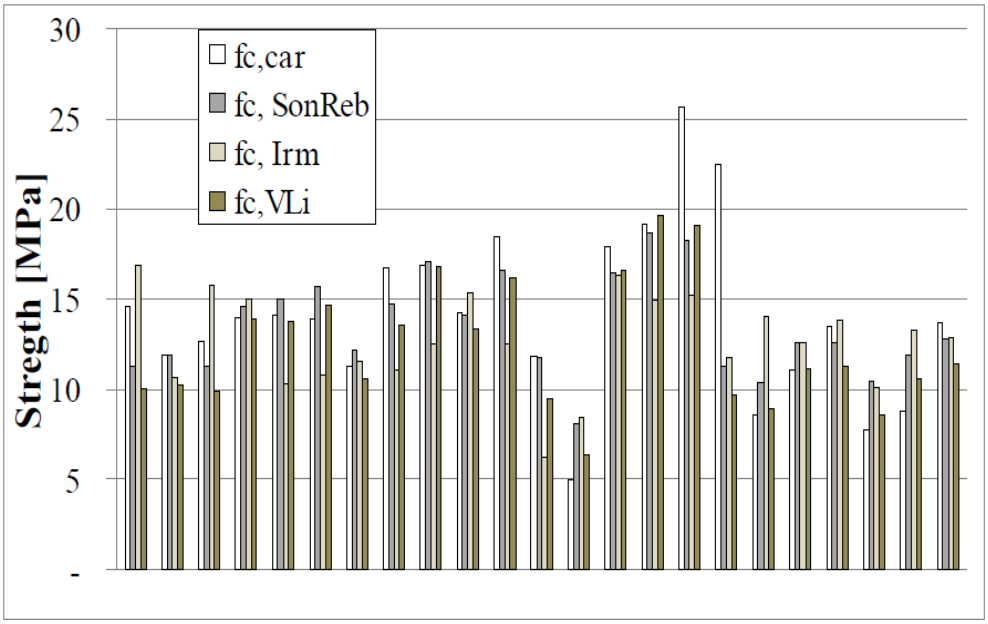

Fig.2 Comparison among different non destructive methods

The roundabout determination of the really quality of the concrete is an operation much sensitive. It must be done with the due caution from skilled laborers of merged experience. The rebound hammer system is not expected as an option for quality determination of concrete. With reference to the Ultrasonic Pulse Velocity strategy, the evaluation of the resistance of the corrupted concrete consequences of troublesome arrangement on account of the lacking sensibility of the ultrasonic speed in the field of the low quality. The utilization of the joined strategies (SonReb) expands the precision of the estimation of the in situ compressive quality.

C.K.FAIZAL contributed his work for the element examination. The enthusiasm for the capacity to screen a structure and distinguish harm at the most punctual conceivable stage is pervasive all through the civil, mechanical and aerospace engineering communities. Presence of structural harm in an engineering system prompts adjustment of the vibration modes. These changes are showed as changes in the modal parameters (natural frequencies, mode shapes and modal damping qualities), which can be gotten from aftereffects of element (vibration) testing. Changes in the modal parameters may not be the same for every mode since the progressions rely on upon the nature, area and seriousness of the harm. This impact offers the likelihood of utilizing information from element testing to identify, find and measure harm. Modal parameters can be effectively acquired from measured vibration reactions. The reactions are procured by some type of transducer, which screens the structural reaction to falsely prompted excitation strengths or surrounding powers in the administration environment. Low input energy levels are sufficient to create measurable reactions since the input energy is progressively increased.

Experimental modal examination (EMA) was utilized to distinguish the modal parameters of the structure: the full frequencies, modal damping ratios (MDR) and mode shapes. Linearity of the structural conduct is one of the essential presumptions of the technique. EMA can be utilized to screen harm. Varieties of the full frequencies and mode shapes are mostly because of changes of the worldwide and local linear firmness properties, while the varieties of the MDR's are connected with an increment of the internal energy dissemination or weakening. Mode shapes are acquired by investigation of the vibration reaction at numerous areas. Their progressions are significant pointers for harm observing, since they give local information.

In this project experimental and computational modal analysis is carried over a 2m and 4m RC beams and experimental mode shapes have obtained for a rectangular hollow cross section steel frame. The modal frequencies were calculated both experimentally using MATLAB by Frequency Response Function The modal frequencies obtained in1D and 3D differs considerably, this is due to torsion effect consideration in 3D Modal analysis, whereas in1D analysis it is not considered.

In the data acquisition process it is found that PZT yields good results in comparison to that accelerometer and electric strain gauge.

On 2m Reinforced Concrete Beam

Damage detection and condition assessment carried over the 2m beam using only modal displacements instead of curvature and it has been found that the damage location can be detected conveniently but the severity of the damage is not properly quantified.

Change in flexibility of the beam element has been found to be in close approximation to locate the damage and the intensity of the flexibility gives the severity of the damage occurred.

On 4m Reinforced Concrete Beam

In the 4m beam, the curvature of the nodes of the beam elements was used and the damage place and the rigorousness of the damage in the beam were found to be well correlated with actual observation.

Change in flexibility of the beam element under different support condition was found according to damage location which is checked through experimental pictures available**.**

On Steel Frame

The experimental mode shape found through the frequency response function and by using the ICAT modeling software under free suspended condition were not in close approximation with those of computational mode shapes obtained using ANSYS 9.0. This may due to the approximation boundary condition adopted in computational method.

3. DISCUSSION

In this study, different methods of destructive and non destructive works are observed which by using on different elements and real time structures quality results are obtained. The use of combined method of rebound hammer and ultrasonic pulse velocity demonstrates out to be good for obtaining the precise result for the soundness as well as ultrasonic parameters. Also the parameters of the reinforcement are obtained with the help of half cell potential as well as electrical resistivity. The combination of rebound hammer and UPV is termed as SonReb testing. Even the dynamic analysis of different sizing beams is done by using the software's such as mat lab and comparing it with the analysis done in the ANSYS software. The difference of percentage error between UPV and rebound hammer is 15-20 %. Destructive testing is generally not preferred too much as the aesthetics of the structure is affected. Destructive tests are used for performing carbonation tests, acid tests etc

4. CONCLUSION

The following conclusions were made from this Study:
Destructive as well as non destructive testings are performed for the condition assessment of the structure. Numbers of tests are performed for the quality results.

Single use of Rebound hammer is not appropriate as there is 15 to 20 % error in results might be obtained. Hence the use of ultrasonic with rebound hammer proves out to be effective for obtaining quality as well as precise results.

For observation of different aspects or say parameters different types of tests are performed such as for reinforcement results half cell potential as well as electrical resistivity, for soundness of concrete rebound hammer, For vibrational effects dynamic analysis are performed.

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BIOGRAPHIES

Jay Mukeshbhai Jadav was born in 1992 at Rajkot, Gujarat. He receives his Bachelor of Engineering degree in Civil Engineering from the Darshan College, Gujarat Technological University in 2013. At present he is Final year student of Master's degree in Structural engineering from Marwadi Education Foundation Group of Institutions, Gujarat Technological University

Prof. Tarak P. Vora an academician by heart with a teaching experience of thirteen years. He is pursuing his PhD in Civil Engineering from Gujarat Technological University. His area of interest is experimental stress analysis, FE Analysis, Structural Dynamics etc.