Health Monitoring System for RCC Structure- A Review.

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Abstract - Health Monitoring for civil structures is becoming increasingly popular in India and worldwide also because of the opportunities that it offers within the fields of construction management and maintenance. Reduction of inspection costs, research, with the likelihood to raised understand the behavior of structures response and of evolution of damage, in order that it's possible to supply post-earthquake scenarios and support rescue operations, are the most advantages associated with the implementation of such techniques. For the right management of infrastructure, their condition and serviceability should be regularly monitored. Structural health monitoring may be a technique want to determine strain, stress, etc., at critical members. The concept of nondestructive testing (NDT) is to get material properties of existing structure without the destruction of the specimen nor the structure from which it is taken. However, one problem that has been prevalent within the concrete industry for years is that truth properties of an in-place specimen haven't been tested without leaving a particular degree of injury on the structure. It detects the damage to extend the performance or lifetime of a structure. The target of this paper is to offer a review on Structural health monitoring in several countries everywhere the planet and therefore the reason these techniques shall be adopted in our country.

Key Words: Health Monitoring for civil structures, structures response, non-destructive testing, lifetime of a structure,

1.INTRODUCTION

To keep a high level of safety, durability and performance of the infrastructure in each country, an efficient system for structural assessment is required. The standard assurance during and after the development of recent structures and after reconstruction processes and environmental influences is more and more becoming a significant concern. Non-destructive testing (NDT) methods have an outsized potential to be a part of such a system. NDT methods generally are widely utilized in several industrial branches. In recent years, innovative NDT methods, which may be used for the assessment of existing structures, became available for concrete structures, but are still not established for normal inspections. Therefore, the target of this project is to review the applicability, performance, complexity and restrictions of NDT. The purpose of building standard procedures for nondestructive testing (NDT) of concrete structures is to qualify and quantify the properties of concrete without intrusively examining the properties. There are many techniques that are currently being research for the NDT today. This paper focuses on the NDT methods relevant for the inspection and monitoring of concrete structures which are existing.

2. Role of NDT's

Nondestructive techniques are used to evaluating and assisting the condition of structure, by applying some indirect assessment of concrete properties. These techniques have been improved in last few years and the best part of NDT's is that they avoid concrete damage for evaluation. Several researchers perform NDT tests to examine the condition of concrete structures. Methods range from very simple tests to technically advanced tests depending on the purpose.

3. Literature Review

Mhammadreza Hamidian (2020)

In this research paper authors used Rebound hammer test and Ultrasonic pulse velocity test on specimen and existing structure and got compressive strength of concrete and comparison together with actual compressive strength obtain from CT machine. The structural health monitoring by NDT methods comprised of UPV and RSH (Schmidt Rebound Hammer) were administered in laboratory and site. The experimental investigation using NDT methods showed that a decent correlation exists between compressive strength, SRH and UPV. The SRH offers method of achieving concrete strength with approx. ±15 to ±20 parent and therefore the UPV method may be a great and perfect instrument for both existing structures and people under construction with approx. within ±20%.[1]

McCann and Forde (2001)

According to this paper five major factors that need to be considered in NDT survey are required depth of penetration, required vertical and lateral resolution, contrast in physical

properties between target and its surrounding, signal to noise ratio for the physical properties between the target and its surroundings, and historical information concerning the methods used in the construction of the structure.[2]

Ehiorobo J.O (2013)

In this paper authors administered structural monitoring, periodic measurement of displacements, strains, stresses and damage evaluation (e.g., crack width) and vibration characteristics and mainly visual inspection of the structure. To detect the varied crakes and also measuring the width of cracks, to point out the layout of that structures. In this paper also using various non-destructive test to detect the cracks and to evaluate the existing condition of the structure. The cracks within the building vary in breadth from 0.75mm to 31.50mm. and some of the cracks along the wall are more than 25mm, it means that the building's stability is already being impaired.[3]

D. Goyal, B. S. Pabla (2015)

The environment of machining operations may change unknowingly and implementing a well consulted SHM is in dire state to heighten structural safety, reduce maintenance cost and avoiding human and economic losses. SHM may be a continuous and an autonomous tool for measuring the varied parameters (i.e. vibration, performance, bearing temperature.) to diagnose the real time condition of the distinct components of the structural and mechanical systems which is very useful for improving structural models. Signal processing techniques includes statistical statistic models, Fourier transform, short time Fourier transform, Cohen's class, wavelet transform, Hilbert–Huang transform whereas data interpretation includes artificial neural networks, symbolic logic, support vector machine, Bayesian classifiers, Vibration measurement, reliable and non-destructive technique to monitor the condition of the machine during starting, shutdowns and general operations Vibration sensors are considered as the heart of modern computerized SHM systems. The various vibration transducers used are: -1. Displacement transducers (Vibrometer/proximity probes), 2. Velocity transducers (Velometer), 3. Accelerometers, 4. Laser Doppler Vibrometers

Summary: Due to evolution and recent development in sensors, signal processing methods, and powerful computers, SHM is paramount for the area of research in engineering structures. This paper reviewed an overview of the various vibration measurement methods and signal processing techniques used in SHM.[4]

Alfredo Güemes (2020)

In this paper, various sensors are used for the purpose of detection structural health of a building. Installing the permanent sensor on a structure. A network of sensors, permanently attached to the structure. Sensors are establishing the main difference from conventional non-destructive testing (NDT) procedures, and is essential for performing automated inspections. The high number of sensors continuously produces a large amount of data to be processed in real-time. Algorithms that compare stored data from the pristine structure with recently acquired data, after correcting for environmental factors, to calculate a damage index and to inform about damage existence, localization, and type. Conventional NDT procedures like ultrasonics, X-rays, or thermography, among others, have as their main objective the detection of cracks and discontinuities inside materials or at their surfaces for quality control of newly manufactured components and quality assurance during service. Classification is based on the physical characteristics like continuous mechanics, elastic waves, fluid dynamics and electricity and magnetism and different techniques as well as sensors are used.[5]

K. L. Rens (1997)

The traditional method of evaluating the quality of concrete in civil structures is to test specimens casted simultaneously for compressive, flexural, and tensile strengths; these methods have several disadvantages such as results are not predicted immediately, concrete in specimens may differ from actual structure, and strength properties of a concrete specimens depend on its size and shape; and therefore, to overcome above limitations several NDT methods have been developed. NDT methods depend on the fact that certain physical and chemical properties of concrete can be related to strength and durability of structures. These methods have been used for more than three decades for evaluating the condition of a structure; now in the present century NDT has become more sophisticated, as it has developed from a hammer to Impact Echo and Impulse response.[6]

Shekhar Verma, Dr Vijay Ray (2017)

If we see today the country is developing through by the infrastructure so it's crucial part of country's earning in finance in this sector as our lives depend on them. The regular handling of structure their fitness and utility should be regularly observed. Structural health Monitoring is a technique used to determine strain, stress, displacement etc., at critical members and some of the dynamic parameters like natural frequency, damping and models shapes with their time variations. It detects the damage to increase the performance or life of a structure. Structures have a certain age and after that their strength starts diminish, but everyone is so busy with the new that they leave the old. The countries around the world are using different methods of seismic designing such as base isolation, damping, active vibration control techniques etc.

RUSSIA-monitoring of vintage bridge –The bridge was constructed in 1936-37 over Moskova river in Moscow next to Kremlin. It is a Reinforced Concrete arched box girder bridge. It was declared a heritage building as it is more than 70 years old. The main Purpose was to continuously monitor temperature and average strain along horizontal and vertical directions. And the Results are Settlement of an abutment producing cracking of the stone lining and structural element. Another was chloride penetration into the structure leading to reinforcement corrosion.

DUBAI- monitoring of world's tallest building BURJ KHALIFA TOWER -Construction period - 2004-2010, Temporary real time monitoring - After earthquake in Iran on 9th sept,2008. Permanent full-scale real-time monitoring - After earthquake in Iran on 20th July, 2010. There is a GPS

system installed at level 160 M3 to capture the building displacement, 23 sonometer's at all terrace and setback levels to measure wind speed and directions, A weather station at level 160M3 to measure wind speed and direction, relative humidity and temperature, there are sensors to capture building frequencies, damping ratio at low amplitude due to both wind and seismic events, Time history are also recorded at the base of the tower due to seismic events.

SINGAPORE REPUBLIC PLAZA –It was completed in 1995 and the dynamic response monitoring was done from 1996 to 2005. It is a 280 m office tower with 65 stores in Singapore. Stress call and SGs were installed in a concrete shear core and in the concrete within the steel columns. Fundamental translational frequencies were tracked by free vibration measurements during the latter part of the construction and beyond. Revealed distribution of structural dead load and how the load distribution changed over time. [7]

N. K. Dhapekar (2013)

India-Monitoring Of Heritage Temple -Bhand Deval Temple in Arang tahsil Raipur district, Chhattisgarh. It is a heritage temple which was built in 9th century AD under the ruler of Haihaya dynasty. The monitoring technique adopted is Rapid visual screening in which damageability grading system is used. Identity the primary structural lateral load resisting system. Identity building attribute that modifies the seismic performance expected for this lateral load resisting system along with nonstructural component. [8]

Nicolas E Cortez (2012)

In this paper, a new method to detect damage in structures based on the electromechanical impedance principle. The identification of damage is performed by simply comparing the variations of root mean square voltage from response signals of piezoelectric transducers. A low-cost prototype based on microcontroller and digital synthesizer was built, and experiments were carried out on an aluminum structure and excellent results have been obtained.

The basic principle of the EMI technique is based on the piezoelectric effects, the property of some special materials have to convert mechanical energy into electrical energy (direct effect) and electrical energy into mechanical energy (reverse effect), changes in the mechanical impedance of the host structure caused by damage, such as cracks or corrosion, can be evaluated simply by measuring the electrical impedance of the transducer in a suitable frequency range. These systems are often prohibitive for many applications because they require data acquisition (DAQ) devices with high sampling rate, digital signal processors (DSPs), large data storage capabilities, or personal computer (PC) to process information. And Showing the defects on a Computer is automatically. [9]

DarshakKumar V. Meheta (2015)

Structural Health Monitoring means the process of implementing a damage detection and characterization for Civil engineering structures like a Buildings, Bridges, tunnels, Dams and reservoirs etc. The NDT being fast, easy to use at site and relatively less expensive can be used for,

1) Testing any number of pointes and locations,

2) Assessing the actual condition of reinforcement,

3) Main objective of assessment is to ensure that structure and its different parts do not fail under its loading condition.

4) Assessment is carried out so that its maximum resistance capacity can be observed.

5) Detecting cracks, voids, fractures, honeycombs and weak locations

6) To reduce the local damage affecting the life span of structures.

7) Scanning for reinforcement location, stress location

8) Assess overall stability of the structure.

Researchers have been done lots of work to detect distress, deterioration and existing condition of any structures like buildings, bridges, any hydraulic structure etc. by Various NDT, using sensors and Visual inspection. NDT tests such as rebound hammer, UPV and combine of Rebound hammer and UPV are most commonly used for Health monitoring of RC Structure from the literature. Structural health monitoring is an important aspect in ensuring successful performance of a structure in its given life span.

Summary: some test or methods are used for the determination of defects, like rebound hammer test, ultrasonic pulse velocity test with the help of these tests conclusion was defects are to be detects and maintenance to be done.[10]

Rainieri1, G. Fabbrocino (2008)

SHANGHAI TOWER (632m) :- The construction period was from 2008 to 2015 and the monitoring was done in 2011 to 2012. Strain sensors were installed inside the RC shear walls of inner tube and on embedded steel columns. And the results are Vertical deformation at representative location on external frame and core tube. Stress at fifth floor of a super column with and without temperature compensation. [11]

Dias and Jayanandana (2003)

In this paper they have used nondestructive techniques of visual inspection, perusal of drawings, ultrasonic pulse velocity measurements, cover-meter surveys, and core test ing for the condition assessment; parameters required for evaluating the durability had been identified as (1) depth of carbonation; (2) cover to reinforcement; (3) chloride con tent; and (4) sulfate content.[12]

Bruhwiler and Mivelaz (1999)

Highlighted the findings of two studies (i) investigated chloride ingress under given climatic conditions and in situ evaluation of concrete cover, (ii) used numerical models to investigate the effects of early age cracking and also determines preventive measures to be taken to limit the development of cracks. [13]

4. DISCUSSION

From the above literature we can clearly say that many researchers have put their efforts to study the various Non-Destructive tests on structures for concrete strength determination, concrete damage detection, to detect the corrosion in steel and also find the deflection of structure. these are all very important aspects as for the better life period of any structure.

5. CONCLUSION

According to literature review, it is obvious that the researchers have been doing a lot of work to detect distress, deterioration and existing condition of any structures like buildings, bridges, any hydraulic structure etc. by Various NDT's.

Various Non-Destructive methods which are based on different principles, have been discussed on the terms with their individual merits and limitations. It has been realized that NDT plays an important and a great role in condition evaluation of existing structures, and there has been a need for developing standards and revising specifications for performing NDT methods and for interpretation of their results.

Whatever the methods and systems that are discussed above speaks the requirement and use of expensive instruments in the detection and identification of the damage in the structures. So, there is need of cost effective and more efficient techniques for its revolutionary implementation and make the world better.

Major advantage of NDT methods has been realized as their capability to test on site. Great deal of proficiency is required for interpretation of NDT field observations and test results. NDT provides relevant data and information by revealing unknown defects, and repair or replacement of RC structures can be planned according to NDT results. Combination of different NDT methods available is a better way to assess the existing structures.

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