

## Health Monitoring of Structures by Using Non Destructive Testing Methods

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**ABSTRACT:** Health monitoring of structures (HMS) are used to maintain healthy of the structure. Health monitoring of structures are especially used in Civil, Structural, Constructional and Geotechnical engineering and it is used for Large structures , long span Bridges and Nuclear reactors etc. SHM aims assess to behaviour of structure and evaluate the performance of the materials. Health monitoring structures consists of sensors, wireless technology, transmission of data, electrical power, and Internet connection. In sensors, there are various types of there. In this smart sensors are the best and easy to use and it gives better performance than others. It is the effective method to know the health monitoring of structure by using NDT methods. There are different types of Non Destructive Testing methods are used to evaluating the strength and performance of the concrete structures also determine whether the cracks are present or not. If present , type of cracks, size of the cracks, length of the cracks and severity of cracks are determined.

In this paper, to attempt the knowledge of health monitoring structures by Non destructive testing methods.

**KEYWORDS:** Electronic system, Sensors, Structural assessment, structural monitoring and structural control, Non Destructive Methods.

### I. INTRODUCTION

SHM is used for non destructive sensing and helps in analysing of both structural characteristics and structural responses which helps in identifying the changes that lead to damage of the structure.

The main reason is use of health monitoring of structures is to detecting & monitoring of structural integrity and to prevent the failure and breakdown or collapse of the structure by using Non Destructive tools to evaluate present condition and existing condition of the structure and also determine Performance of the structure. There are various types of NDT methods are used for the structures to evaluate the condition. Nowadays,

sensors are widely used based on the requirements of the health monitoring of structural system. so, in order to provide structural safety, durability, integrity for all the infrastructures structural health monitoring (SHM) comes into existence. Wherever it offers a great need for evaluation regarding safety and restoration of structure and reduces the cause for the damage. It involves the integration of sensors, possibility of small materials, data transmission etc.

Inspections are carried out to evaluate the present condition of structure. these inspection are carried out for every once in a year and should visit all the structural sites at periodical intervals of time. if there occur damage between the inspection carried out, the level of inspection should be more than with in a very short time period. The damage that occurred has to be corrected either by rehabilitation or replacement.

After inspection , Testing of the structure can be done with respect to loads for estimating the properties of structure for prediction of load bearing capacity. Monitoring refers to the type of physical phenomenon which is monitored by sensors. it helps in evaluation of damage and even in health management of structure. After finally determine the strength & serviceability of the structure.

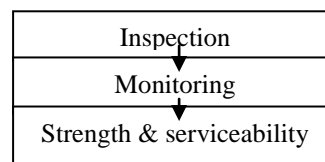


Fig.1. Flow chart of Process of SHM

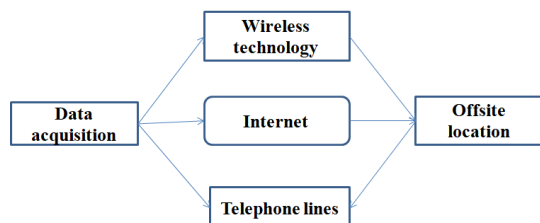
### II. LITERATURE REVIEW

SHM is a electronic system which inspects, tests load and monitors the structure is known as structural health monitoring (SHM).

#### Applications of SHM

1. High rise buildings

2. Long span of bridges
3. Dams
4. Nuclear power stations
5. Offshore platform



**Fig.2. Components of SHM**

### SCOPE and OBJECTIVES of SHM

The priority and applications of SHM is depending upon type of structure and economic considerations applications in Structural Engineering. Condition of the structure and utility of the structure are also most important.

there are 3 Important objectives in SHM, they are as follows

1. Structural Assessment: It deals with actual condition of structure and load carrying capacity of structural system.
2. Structural Monitoring: It deals with supervision of structure using sensors to maintain functional utility of structure.
3. Structural Control: It deals with control of damage response and behaviour of structure under environmental loads.

### Advantages of SHM

1. Damage of structure identified at early stage.
2. It gives strength and serviceability conditions for a structure.
3. Inpection and repairs done very quickly.
4. It is used to know the insitu behaviour conditions of concrete structures.
5. Wireless communication system.
6. It helps in management of repair works.

### Dis Advantages of SHM

1. Costly
2. Complex Handling
3. CPU required

### III. METHODOLOGY

There are three major components for evaluation of structural health monitoring. they are as follows

1. Non destructive inspection (NDI)
2. Non destructive tests (NDT)
3. Non destructive evaluation (NDE)

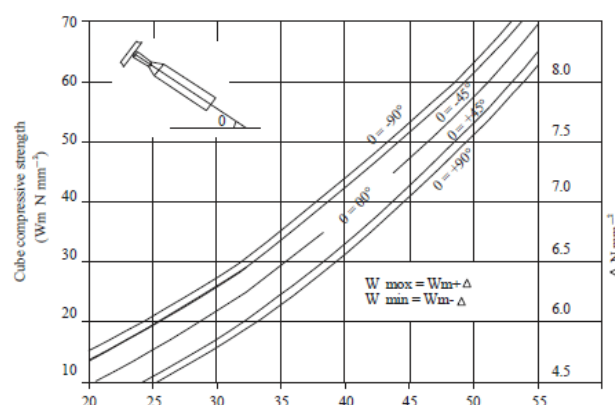
These are used to detect the failures or damages to the structural system. The most important Reasons for the structural health monitoring is

1. Public safety improvement
2. To maintain serviceability requirements
3. Reduce risks
4. Reduce cost of repairs

### IV. NON DESTRUCTIVE TESTS

Non destructive testing (NDT) methods are plays an important role in quality control, detection of damages, structural health monitoring covering a wide range of structures. There are various types of NDT methods are used for the testing of concrete structures.

1. **Surface hardness tests:** Surface Hardness test is perform by pressing a special dimensional equipment and loaded into the concrete surface. it is used to evaluate state of material and measure the load bearing capacity of the concrete structures as well as estimation of concrete strength.
2. **Rebound test:** Rebound hammer test is also known as Schmidt hammer test. In this equipment a spring is present which is controlled by a mass. When plunger of rebound hammer pressed on concrete surface. Which measures the hardness of the surface. This measured value is designated as Rebound Number. There is correlation between compressive strength of concrete and rebound number.



**Fig.3. cube compressive strength**

**Table.1. Grade of the concrete surface**

Number of Rebound Hammer	Grade of the Concrete Surface
Above 40	Very Good
lessthan 40	Good
lessthan 30	Fair
Lessthan 20	Poor Concrete
0	Delaminated

**3. Ultrasonic Pulse Velocity:**

It is the most versatile Non destructive testing method. In this method ultra sonic waves are used. So, it is called as ultrasonic method. In this ultrasonic pulse velocity method the passage of waves into the concrete surface are taken into the consideration to determine the grade or quality of the concrete by knowing the pulse velocity of the concrete structures. Now a days Rebound hammer test and ultrasonic pulse velocity tests are more commonly used for the concrete surfaces. The cost of the equipment is also less compare to other equipments.

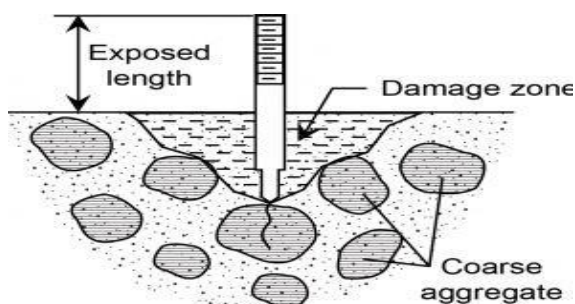
$$\text{Pulse Velocity } V = \frac{\text{Length of the structure}}{\text{time taken by pulse to go through}}$$

Velocity of pulse (km/sec)	Quality of Concrete
Greaterthan 4.5	Very good
Lessthan 4.5	Good
Lessthan 3.5	Medium
Lessthan 3.0	Weak

**Table.2. Quality of concrete**

**4. Penetration resistance test:**

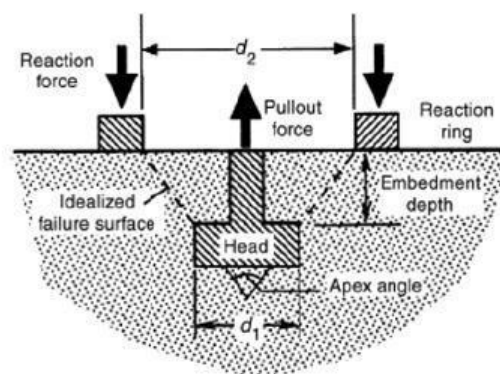
Penetration resistance test is also known as Windsor Probe test and jamesbond 007 test. In this test steel probes are used. Steel probes are fired into the concrete surface. The depth of penetration gives the strength of concrete surface and state the grade and quality of concrete surface.



**Fig.4. windsor probe test on concrete surface**

**5. Pullout test:** pullout test is used to determine the tensile strength of the concrete. Required amount of force is applied to remove the disc from the concrete surface. Amount of the force is depends on strength of the concrete surface.

$$\text{tensile strength of the concrete} = \frac{\text{force required}}{\text{area of the disc}}$$



**Fig.5. pull out test of concrete**

**V. CONCLUSION**

Non Destructive Testing methods are extensively used for Health Monitoring of structures on structural and civil engineering works. It can plays an important role in analyzing the conditions of structures. To maintain a structural integrity with improved reliability and durability. Single technology of SHM is cannot be suitable for all applications. Depends on priorities we can use type of technology and tests. Based on the experimental investigations and standard values of tests are used to know the properties of materials and behaviour of materials. It is very helpful in identifying the damage at global level. The damage on structure on whole level can be identified. Also identified type of crack and severity of cracks and damage responses to the structural system. Hence health monitoring of structures is important to prevent and mitigate the failures and damages of the structural system.

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