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STRUCTURAL HEALTH MONITORING IN CIVIL ENGINEERING

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Abstract – *There is a phenomenal rise in construction activities in the field of civil engineering in the recent years. Major structures like buildings, bridges, dams and large trusses in industrial areas are subjected to severe loading and their performance is likely to change with time. It is therefore, necessary to check the performance of a structure through continuous monitoring by help of structural health monitoring. Structural Health Monitoring is a very multidisciplinary field, where a number of different skills (seismology, electronic and civil engineering, computer science) and institutions can work together in order to increase performance and reliability of such systems, whose promising perspectives seem to be almost clearly stated. The life of any structure can be increased by proper monitoring. This paper summarizes in brief the basic need of doing structural health monitoring in civil engineering.*

Key Words: *Structural Health Monitoring (SHM), deterioration, damage, maintenance, Wireless Sensor Networks, automated operational modal analysis*

1. INTRODUCTION

Observation of structural behavior is a very old discipline that has accompanied theoretical developments in structural mechanics since its origins (Benvenuto 1991), providing basic knowledge of physical phenomena and verification of computational procedures. However, in the last twenty years this discipline has also taken different roles, gradually becoming the basic tool for facing the so-called time-dependent safety problem (Mori and Ellingwood 1993) in civil engineering practice.

Structural health monitoring and damage identification are assuming larger and larger importance in civil engineering. Structural Health Monitoring (SHM) is defined as the use of in-situ, non-destructive sensing and analysis of structural characteristics in order to identify if a damage has occurred, define its location and estimate its severity, evaluate its consequences on the residual life of the structure.

Another important use of health monitoring is to estimate the service condition and the remaining service life of the structure. Recorded data for strain on supporting members of a bridge can be used to obtain vehicle weight (weigh-in-motion), vehicle count, environmental conditions such as wind load and temperature variations. These data in turn can be used to help estimate the structure's safety and reliability.

Knowing the integrity of the structure in terms of its age and usage, and its level of safety to withstand infrequent but high forces such as overweight loads, earthquakes, and fatigue is important and necessary. Because every year, India loses an average of 2,658 people to different kinds of structural collapses; that is around 7 deaths a day. 2011 saw the highest fatalities in ten years, 3161 deaths. Every year, India loses an average of 2,658 people to different kinds of structural collapses; that is around 7 deaths a day. 2011 saw the highest fatalities in ten years,3161 deaths.

2. LITERATURE REVIEW

Structural health monitoring is at the forefront of structural and materials research. Structural health monitoring systems enable inspectors and engineers to gather material data of structures and structural elements used for analysis. Ultrasonic can be applied to structural monitoring programs to obtain such data, which would be especially valuable since the wave properties could be used to obtain material properties.

These techniques are relatively quick, easy to use, and cheap and give a general indication of the required properties of the structures.

This approach may be used to assess the uniformity and relative quality of the concrete, to indicate the presence of voids and cracks, and to evaluate the effectiveness of crack repairs. It may also be used to indicate changes in the properties of concrete, and in the survey of structures, to estimate the severity of deterioration or cracking. Decreases in ultrasonic waves speeds over time can reveal the onset of damage before visible deficiencies become

evident. This allows inspectors and engineers to implement repair recommendations before minor deficiencies become safety hazards.

3. METHODOLOGY

STRUCTURAL HEALTH MONITORING

Structural health monitoring (SHM) is a process in which certain strategies are implemented for determining the presence, location and severity of damages and the remaining life of structure after the occurrence of damage. Damage identification is the basic objective of SHM.

There are mainly four levels in damage identification:

Level 1: Determination that damage is present in the structure

Level 2: Level 1 plus determination of the geometric location of the damage.

Level 3: Level 2 plus quantification of the severity of the damage

Level 4: Level 3 plus prediction of the remaining service life of the structure

SHM TECHNIQUES

Now-a-days visual inspection by trained personnel had been the most common tool to identify the external signs of damage in buildings, bridge and industrial structures. The gross assessment of the damage location is made, localized techniques such as acoustic, ultrasonic, radiography, eddy currents, thermal, magnetic field or electro-magnetic impedance can be used for a more refined assessment of the damage location and severity. In some cases, test samples may be extracted from the structure and examined in the laboratory. Some critical parts of the structure may not be accessible or may need removal of finishes. This procedure of health monitoring can therefore be very tedious and expensive. The visual inspection is dependent, to large extent, on the experience of the inspector. The idea of smart structures was thought to be an alternative to the visual inspection methods. Because of their inherent „smartness", the smart materials (such as piezoelectric material, shape memory alloys, fibre optic materials) exhibit high sensitivity to any change in environment.

SENSORS FOR HEALTH MONITORING

Some of the senses are given below

1. Micro-electromechanical System (MEMS)- Device for accelerometers and other applications
2. Nuclear Magnetic Resonance (NMR)- to detect chloride ions
3. LIDAR files- to capture 3D position of objects
4. Strain gauge- It converts force, pressure, tension, weight etc. into change in electrical resistance which can then measure

These new sensors typically target the monitoring of one specific type of damage; for example, concrete cracking, cable breakage, steel reinforcement corrosion, and delamination or debonding. Another robust technique is the use of X-ray and Gamma ray to get visual images of the interior of structures such as steel cables and slabs. Acoustic approaches such as acoustic emissions, ultrasonic measurement, impact-echo and tap tests are well proven technologies that are used to evaluate local conditions of the infrastructure. Wired sensors have limited application because they usually need to be installed during construction. The wiring can also be a problem as wires get in the way of the function of the structure and limit the number of sensors that can be deployed. Wireless sensors are meant to eliminate these problems. Wireless sensors used so far are mostly powered by batteries. The batteries may be supplied by solar power.

Need of Structural Health Monitoring

SHM helps to decide the present condition of structure or damage to structure if any and subsequently the type of maintenance can be decided. By the continuous observation the appropriate maintenance can be carried out to increase the life of structure and subsequently the sudden failure. By proper SHM, the number of catastrophic events can be decreased, which will be helpful for economy of the country and also for psychology of human beings. It may possible that a new constructed structure may not be performing well with respect to design parameters, either due to inferior material or faulty construction. This can be ensured by proper health monitoring.

4. RESULTS AND DISCUSSIONS

Structural Health Monitoring is very important but in this fields we didn't see much more researches. Some critical parts of the structure may not be accessible or may need removal of finishes. Visual inspection of structures is totally depends on the experience of inspector. Use of Wireless sensors are better than wired sensors. These sensors can be run on batteries or solar power and it also gives real data in SHM except some technical errors.

5. CONCLUSION

Health monitoring of structures is becoming more and more important: its ultimate target is the ability to monitor the structure throughout its working life in order to reduce maintenance requirements and subsequent downtime. Currently, visual inspection is the standard method used for health assessment of structures, along with non-destructive evaluation techniques. The result of visual survey prompt us to conclude the distress is wide spread and is an ongoing process and so needs to be stopped at this stage so as to avoid complete collapse of the structure.

This paper has summarized the main need of SHM technology to constantly monitor the structure to prevent it from failure and ultimately the effect on the economy of country. Some aspects related to the implementation of an integrated SHM system covering several structures on a wide territory has been analyzed. So overall the SHM is now became most important by considering the economy of country and increase the service life of structure by constantly monitoring it.

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