

Need of Structural Health Monitoring

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Abstract - Prevention of the old infrastructure and maintaining the good life of new infrastructure is now most important part by considering the economy of any country. The old infrastructure can be properly maintained by monitoring it for all the time with the use of Structural Health Monitoring (SHM) Techniques and selecting the proper maintenance method by checking the damage. The life of any structure can be increased by proper monitoring. This paper summarizes in brief the basic need of doing the SHM.

Key Words: Structural Health Monitoring (SHM), deterioration, degradation, damage, maintenance.

1. INTRODUCTION

Structural Health Monitoring is a trending issue now days to check or ensure complete performance of structure. Just like human body, as the age of human body increases the deterioration starts which may include wearing of bones, decrease in capacity to carry more weight etc. Same happens with the civil structures as the structural components; which we may call as bones of building starts deteriorating because of several reasons. This deterioration affects the performance of building structure. The deterioration may be minor or major. It can be of structural component or non-structural component. This paper will try to list out the types of deterioration to the structure and the need of monitoring of those.

The deterioration of structure may be due to various factors such as change in loading conditions or change in environmental conditions. At the time of construction there is variation of strength at every section as it is highly impossible to ensure the same quality every time. However if the variation of strength is within some given limit, the structure may be said to be free from any damage. If this strength variation is increasing beyond some given limits due to the reasons like increase in loading, change of use, increase in fatigue may lead to damage of structure. If again this limit crosses certain value, it can be said that the structure has failed. Hence damage and failure are the terms with some variation to structure to structure.

1.1 Structural Health Monitoring (SHM)

To check the performance of the structure it must be observed continuously. This continuous observation will provide the data about the exact state or performance of the structure after the construction. Structural Health Monitoring is a process of determining the status of structure considering the severity of damage and its location. SHM consist measurement of response of structure to the loading on it, mostly related to finding damage location and severity. There are mainly four levels in damage identification (Rytter, 1993) –

Level 1 –Determination of any presence of damage in structure

Level 2 – Level 1 plus determining the location of damage

Level 3 – Level 2 plus calculating severity of damage

Level 4 –Level 3 plus predicting the remaining service life of structure

Typically SHM involves determining the damage location with its severity with the help of some sensors to analyze current health of the structure. It also gives the performance of structure related to environmental factors and also considers aging factor for the long term monitoring. Overall SHM gives the integrity of the structure. Structural Health Monitoring (SHM) is indeed just the combination of structural Mechanics, electronics, material science, Information and material technology.

2. Need of Structural Health Monitoring

Continuous observation of structure may help to improve the life of structure and its performance. By the continuous observation the appropriate maintenance can be carried out to increase the life of structure and subsequently the sudden failure. SHM helps to decide the present condition of structure or damage to structure if any and subsequently the type of maintenance can be decided. Economy of any country depends on transportation infrastructure like bridges, railways, roads etc. Any structural failure to these infrastructures may cause the economy damage to the nation. Considering the Indian scenario, India has lot of bridges which are constructed way back and are still in use. These bridges are now operating under increased loadings. Failure of these infrastructures may affect the gross domestic product of nation. So it is most important that these

bridges must be observed continuously with the help of some appropriate health monitoring methods. Sudden failure of any infrastructure may cause worst accident leading loss of serviceability or access. The structure is also subjected to number of natural events which may damage it. If structures are monitored continuously or periodically better understanding will be achieved of the behavior of the structure. It will be very much useful for to make improvements in the design of structure. With the use of proper SHM the number of hazardous events can be minimized and as a result the economy of country and human psychology. If the damage is detected before the failure at the very early stage, some proper measures can be taken to avoid the failure of structure. Collapse of bridge or any tall structure affects the economic growth of country.

Every structure is designed for a certain life span and it is assumed that it will perform its function throughout that life span. If proper monitoring is done then it can improve the life of structure and ultimately results in savings. This monitoring results in well serviceability of the structure also.

This above fact indicates the requirement or importance of the proper monitoring of structure to prevent the damage or failure of structure. Proper monitoring can also lead to assessment of condition of the structure related to performance. This use of automatic sensor techniques helps for proper monitoring of structure.

3. Degradation of Material

Considering Indian scenario, most of the structures in the India are build way back with the use of materials like stone masonry, concrete and steel etc. Material degradation is a key issue considering the performance of those structures. Loss of material strength or degradation leads to loss of structure and ultimately the economic loss of country. Considering the concrete structures the most important factor for the degradation of concrete structure is due to corrosion of reinforcing steel induced by the chlorides ion ingress in concrete. Other common causes of deterioration of concrete are carbonation induced corrosion, freeze-thaw attack, alkali-silica reaction and external and internal chemical attack. The development of corrosion is also depends upon the temperature and moisture content in the surrounding concrete. For steel structure the main cause of degradation is the fatigue. Fatigue may be due to moving loads or vibrations which lead to the degradation of the joints of steel structures. Corrosion and aging is also important factor of degradation for steel structure.

Corrosion and degradation of material causes reduction in resisting sections of member which in turn reduces the integrity of whole structure. Detection and presence of

these factors of degradation can be done by direct monitoring of structure.

4. Maintenance Strategies and Cost Optimization

Several maintenance and cost optimization strategies have been performed in recent years to keep the infrastructure in well performing condition. These maintenance strategies require large economic parts. Use of SHM is not a common practice in the current scenario of infrastructure management. Although in many special cases like long span bridges, tall buildings SHM system has been implemented and used for maintenance planning. Most of the maintenance approach is based on traditional method i.e. visual observation and use of NDT. There are many reasons for that. Following is the list of some reasons –

- Standards and regulations concerning infrastructure safety impose performance of traditional inspection at fixed time interval this cannot be legally avoided by the use of SHM.
- Although a consistent number of damage identification have been proposed and validated in literature, the reliability of the determination of structural condition from SHM data is still to be widely experienced.
- The sensor system always shows some malfunctions, this need redundancies at sensor installation and maintenance during operations.
- The operational life of electronics is shorter than that of any other system components and much shorter than operational life of structure this will require substitution of electronic component..
- Education on SHM system and global infrastructure monitoring approaches is still not enough diffused in civil engineering consequently the infrastructure organisation owner are less in relying on SHM.

5. CONCLUSION

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. The material degradation, damage and damage location can be observed by proper monitoring system and by this the maintenance methods can be selected to improve the performance of the structure. 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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