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A Review Paper on Importance of SHM System in India

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Abstract: ***India being the home of rich historical background inherits varied amount of historical structures like Taj Mahal (one of the seven wonders), Red fort, Temples etc. Due to their historical importance, it becomes very important to assess health condition of these structures and take the required measures to improve their life. Buildings like stadiums, sports arenas, malls, lifeline structures like hospitals, public buildings which could cause harm to large number of people at a time and are something to be taken care on a regular basis. India also has various ambitious, complex, and critical structure, like nuclear plants, Dams, bridges and tunnels should be mandated with monitoring as their failure cause more losses than any other. Structural health monitoring will help us to achieve increased durability and health of structure, reduced maintenance and improved safety. Health monitoring of civil infrastructures consists of determining by measured parameter, the location and severity of damage in structures and inform us before it became to late. The main goal of SHM is to detect the damage based on the measurement by various types of sensors, locate the geometric position of the damage and quantify the damage so that we can take the necessary action timely and improve the life of the structure.***

Keywords: Bridge, Structural Health Monitoring (SHM), sensors, data management system, instrumentation scheme, Performance parameters

I. INTRODUCTION

Civil structures are universal in every society, irrespective of culture, religion, geographical location and economical development. It is difficult to imagine a society without buildings, roads, rails, bridges, tunnels, dams and power plants. Structures affect human, social, ecological, economical, cultural and aesthetic aspects of societies and associated activities contribute considerably to the gross internal product. Therefore good design, quality construction as well as durable and safe exploitation of civil structures are goals of structural engineering. The most safe and durable structures are usually structures that are well managed. Measurement and monitoring often have essential roles in management activities. The data resulting from the monitoring program is used to optimize the operation, maintenance, repair and replacing of the structure based on reliable and objective data. Detection of ongoing damage can be used to detect deviations from the design performance. Monitoring data can be integrated in structural management systems and increase the quality of decisions by providing reliable and unbiased information.

The Structural Health monitoring is process similar to the process of diagnosis of human body to identify the pain and illness experienced by human body and how it is cured. In SHM we can treat the any structure as patient and the structural engineers as the doctors and to use some of the diagnostic techniques in order to identify the problem at very early stage so here comes the SHM into picture. SHM provide important information about structural performance with the warning in real time. It also include a wide range of sensors and wireless communication. The goal of SHM is to detect, locate and quantify the damage. If we detect, locate and quantify the damage we can predict the critical condition of the bridge structure. SHM system includes array of different sensors like acoustic, wind speed, temperature, strain gauge etc. deployed at different critical positions in the bridge element.

II. ADVANTAGES OF SHM SYSTEM

A. Prediction and monitor of damage progression.
B. Improve life of a structure and accordingly we take action for the same.
C. To reduce the operating costs of inspections and maintenance
D. To reduce the overall life costs of bridges by applying the improved lifetime prediction models already from the design stage.
E. Determining and evaluating the serviceability, the reliability of the structure, and the remaining functionality in terms of durability
F. Permanent monitoring ensures safer environment for by diagnosis the damage at the right time so that preventing structural failures.

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G. Helps to improve and enlarge the knowledge concerning structural behaviour and makes an accurate calibration of numerical models possible.
H. Many structures are in much better conditions than expected. In these cases, monitoring allows to increase the safety margins without any intervention on the structure
I. A small investment at the beginning of a project can lead to considerable savings by eliminating or reducing over- designed structural elements because Monitoring reveals hidden resources.
J. Enhance the ability for engineers to predict and avoid the great costs associated with a bridge failure.

III. OBJECTIVE OF SHM

The principal objectives of the structural health monitoring are:
A. To monitor the structural behaviour,
B. To monitor the in-situ behaviour of a structure
C. accurately and efficiently
D. To assess structure's performance under various service
E. loads,
F. To detect damage or deterioration and
G. To determine health or condition of the structure.

IV. USE OF INFORMATION OBTAINED FROM SHM

A. To plan and design maintenance.
B. To enhance the safety
C. To reduce ambiguity and
D. To expand the knowledge concerning the structure being monitored
E. The information can then be incorporated into structure maintenance and management strategies, and improved design guidelines.
F. safety measures can be considered in time,
G. Intervention on the structure can be performed immediately
H. The data resulting from the monitoring program is used to optimize the operation, maintenance, repair and replacing of the structure based on reliable and objective data
I. Monitoring data can be integrated in structural management systems and increase the quality of decisions by providing
J. reliable and unbiased information.

V. DESIGN AND IMPLEMENTATION OF THE SHM SYSTEM

A. Study the bridge structures and identify suitable location for suitable sensor.
B. Equipping of bridges with a sensor system.
C. Collecting data on characteristics parameters for most important degradation prosses.
D. Processing and analysis of the physical, chemical and dynamic parameters.
E. The establishment with an alert protocol issuing a warning signal when the monitored parameters values are exceeds a critical level alert.

VI. LITERATURE REVIEW

Cristian-Claudiu Comisu, Nicolae Taranu, Gheorghita Boaca, Maria-Cristina Scutaru have suggested to developed an integrated monitoring system for durability assessment of bridges and they found out that the system must interface and integrate the actual practice mainly based on visual inspections and combine the response of a number of different reliable sensors, installed on the structure to monitor the progress of damage, with enhanced realistic deterioration models. According to them the system and the sensors were developed to cover the parameters for the most important deterioration mechanisms: corrosion of reinforcement in bridges, carbonation of concrete, freeze-thaw cycles, alkali-silica reaction and mechanical damage, as well as the changes in the structures behavior and safety: static deformation, strains; crack widths and vibrations (frequencies, amplitudes, accelerations and vibration modes).The use of permanent monitoring systems has several advantages once the system is installed: (i) to reduce the operating costs of inspections and maintenance by 25%, and the traffic-related costs by 30 % by reducing the number and extent of site inspections and (ii) to reduce the overall life costs of bridges by 10 % by applying the improved lifetime prediction models already from the design stage.

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Prateek Roshan, Akshay Kumar, Devyani Tewatia and Shilpa Pal have found in their study that ageing phenomenon of concrete is very challenging to predict and this can lead to mishaps and damages. Reinforced concrete structures in critical places like nuclear plants make them so imperative that we have to be sure that they are in good condition. India as a developing country needs to be more aware and cautious about its Infrastructure. A major event can lead to irreversible losses and hence should be well informed in time. Lifeline structures like hospitals and important bridges and tunnels should be mandated with monitoring as their failure cause more losses than any other. According to them Structural Health Monitoring is a vital need for all structures to keep a check on their performance and life span. It gives a means to overcome these shortcomings with minimal damage and loss. It has proved to be effective and has a great potential for gaining confidence over the structures we are making so that development happens faster and with accurate results.

By Gajanan M. Sabnis, Yogesh Singh, Abhay Bambole, Gopal Rai have established the need of SHM by giving us strong reasons for it to become a integral part of a structure. India as a developing country needs to be more aware and cautious about its Infrastructure. A major event can cause irreversible losses and hence should be well informed in time. There are many important structures where instrumentation is already being used in India like the dams, whose various parameters have to be looked upon, but these are not being done effectively and can be better with new technologies. Structural health monitoring economically is also light and is only 0.5% to 3% one time cost of total structures cost and 2% to 5% for monitoring structure over 10 years. It is done with some structures in India but have to be focused more on. Structural. It has proved to be effective and fruitful in many countries, now being practices often, and has a great potential and usefulness for India for gaining confidence over the structures we are making so that development happens faster and with accurate results.

Branko Glišiæ, Daniele Inaudi and Samuel Vurpillot are suggested that the concrete is non-homogeneous material, containing inclusions (aggregate) and discontinuities (cracks) it is recommended to use long-gage sensors for its structural monitoring. Since the concrete is subjected to dramatic dimensional and structural changes during hydration process, it is recommended to embed the sensors. It is not enough to use appropriate equipment for monitoring, but it is also necessary to employ good monitoring strategy. What topology of sensor will be used for monitoring depends on type of the structure and of expected loads. Good monitoring strategy can provide excellent results with relatively limited budget. Benefits of structural monitoring of concrete structures during different periods of the structure life are presented and illustrated by results obtained using the SOFO system. Knowledge provided by structural monitoring helped understanding the real behaviour of the structures.

Raghavendra Rajendran in his report on Bridge Failures Case Studies in India The above-mentioned principle cause of failures is the primary cause of a Bridge failures, but there are the results of the two subcategories namely enabling and triggering causes. concurrently. Enabling and triggering causes are the means by which a bridge can fail, where enabling causes are generally internal to the bridge structure and triggering causes are external to the bridge; for an example enabling cause and a triggering cause could be inspection errors and tornado damage respectively. These causes can create a situation, where a total collapse or a partial collapse is probable; a total collapse is the situation where the traffic is no longer serviceable. Bridge Scour is one of the major failures of about 60 percent of total failure. Most of the bridge scour failure due to inadequate maintenances and complied database is listed in table. Second most failures occur during construction process due to improper management and in construction sequence and poor communication. In this work we discussed about this kind of failures in the section buckling failures.

Keith R. Lane, James M. Sime This work has involved both strain measurements and vibration behavior. Both short and long term studies have been conducted. Short term monitoring studies have typically been based on strain monitoring, with some effort to integrate vibration information with the strain data. These studies have generated data for the evaluation of specific members or connections and have provided information needed for the determination of the overall bridge performance. Long term monitoring has involved the use of accelerometers to determine vibration information, both to evaluate the causes of what was perceived as excessive vibrations and to evaluate the overall structural integrity.

Sahu G, Garg R, Goel R, Goyal J, Jangpangi L and Lakshmy P according to them due to instrumentation and monitoring, it has now become possible to asses some salient structural effects in structure which are relevant in monitoring their long term performance. The performance monitoring on long term basis provides information in terms of structural parameters regarding the effects of any distress, in the structure during its service life. The data collection during monitoring would help in identifying the causes of such a distress and facilitate adoption of timely and appropriate remedial measures to avoid aggravation of distress in the structure. Thus instrumentation provides a scientific tool in the health assessment of structures.

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VII. CONCLUSION

Many structures are in much better conditions than expected. In these cases, monitoring allows to increase the safety margins without any intervention on the structure. Taking advantage of better material properties, over-design and synergetic effects, it is possible to extend the lifetime or load-bearing capacity of structures. A small investment at the beginning of a project can lead to considerable savings by eliminating or reducing over- designed structural elements.

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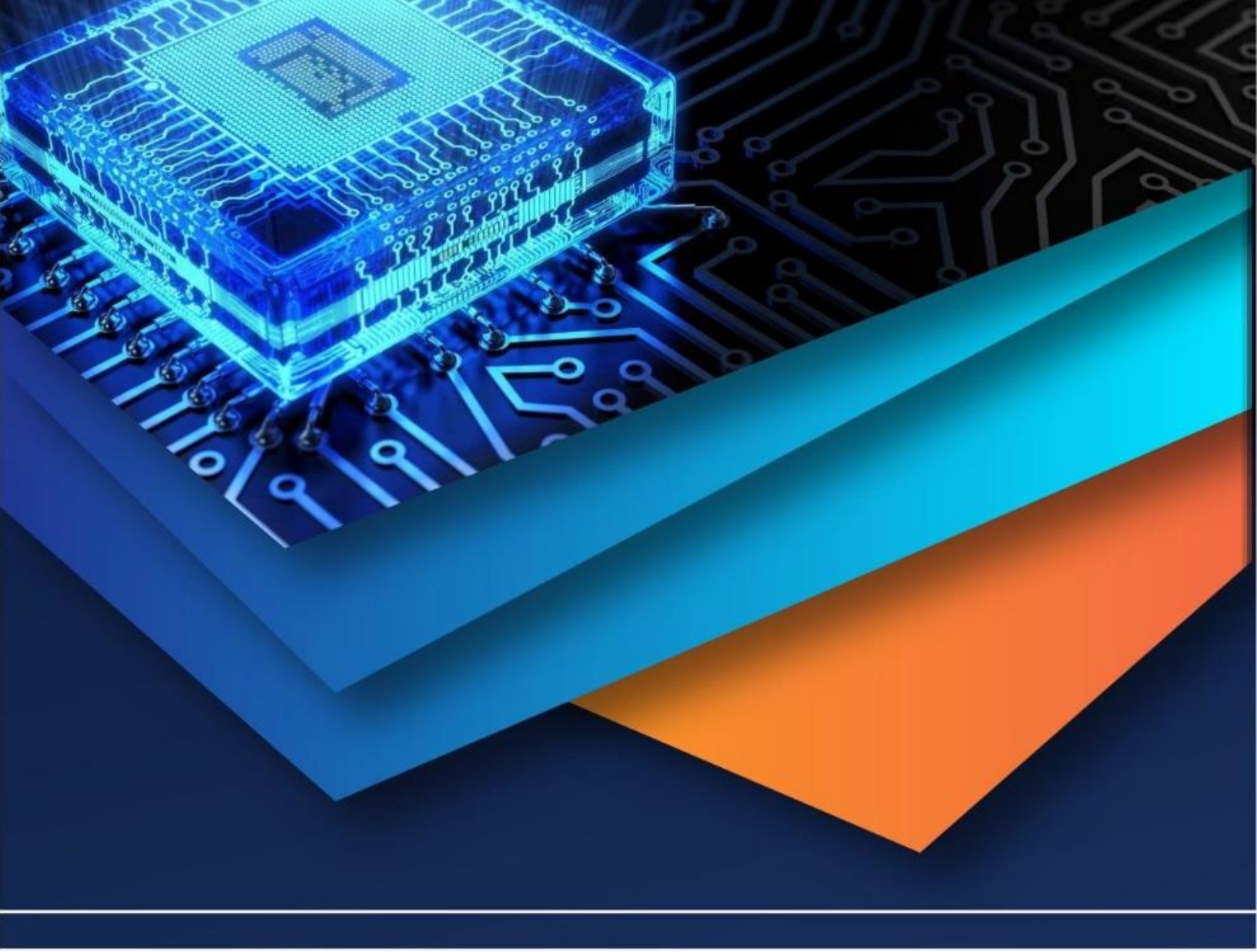

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