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# Structural health monitoring and its remedies

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**Abstract -** *Over the last 50 years, a number of catastrophic bridge failures have called attention to the disrepair of national infrastructure systems and the need for structural health monitoring. For example, the I-35W Bridge in Minneapolis, Minnesota, catastrophically failed on August 1, 2007 without warning. In recent years, the bridge was rated as "structurally deficient" after annual inspections revealed corrosion, poor welding details, fatigue cracking in steel members and dysfunctional bearings considering the catastrophe of the I-35W Mississippi River. While no conclusions can yet be drawn as to the cause of the bridge's catastrophic failure. it is critical to implement a system to monitor the health of bridges and report when and where maintenance operations are needed. Therefore, it is important to have a systematic approach to monitor the health of a bridge. Bridge Structural Health Monitoring (SHM) has rapidly become one of the main interests in civil engineering field. Inexpensive and efficient SHM method utilizing.*

***Keywords****- Structural health monitering,remote sensor,provide remedies*

## I. INTRODUCTION

Structural health monitoring has attracted much attention in both research and development in recent years. This reflects continuous deterioration conditions of important civil infrastructures, especially long-span bridges. Among them, many were built in the 1950s with a 40- to- 50-year designed life span. The collapses and failures of these deficient structures cause increasing concern about structural integrity, durability and reliability, i.e. the health of a structure throughout the world. Currently, there are no foot proof measures for structural safety. A structure is tested for deteriorations and damages only after signs that result from fault accumulations are severe and obvious enough. When the necessity of such tests becomes obvious, damages have already exacerbated the system's reliability in many cases and some structures are even on the verge of collapse. In general, a typical SHM system includes three major components: a sensor system, a data processing system (including data acquisition, transmission and storage), and a health evaluation system (including diagnostic algorithms and information management).

***Photo 1British era Mumbai- Goa Bridge***

***Photo 2 Failure of British era Mumbai- Goa Bridge***

**Components of SHM Systems**

- As mentioned previously, structural health monitoring refers to subjecting the structure to static or dynamic excitations, continuous or periodic monitoring of the structure's response using sensors that are either embedded in or attached to the structure. New advances in sensor and information technologies and the widely use of Internet is making SHM a promising technology for better management of civil infrastructures. There have been many case studies worldwide in the past decade. While the specific details of each SHM system can vary substantially, SHM basically involves sensor and data acquisition, data transfer and communication, data analysis and interpretation, and data management.
- Communication of data;
- Data processing;
- Storage of processed data;
- Identification and interpretation); and
- Retrieval of information as required.
- Improved maintenance and management strategies for better allocation of resources

## II. LITERATURE REVIEW

**Hong-Nan Li [et al](2004)** This paper presents an overview of current research and development in the field of structural health monitoring with Civil Engineering applications. Specifically, this paper reviews fibre optical sensor health monitoring in various key civil structures including buildings, piles, bridges, pipelines, tunnels, and dams.

**Ka-Veng Yuena(2005)**
A Bayesian probabilistic approach is presented for smart structures monitoring (damage detection) based on the pattern matching approach utilizing dynamic data. Artificial neural networks (ANNs) are employed as tools for matching the "damage patterns" for the purpose of detecting damage locations and estimating their severity.

**Mehdi Modares [etal] (2013)**
Because of the unpredictable nature of mechanical and environmental loads, steel bridges do not necessarily behave as anticipated in design. Moreover, such loads cause the deterioration of the bridge with respect to time.

**Patel S G1 (2015)**
Vibration testing of bridges can give very helpful information based on the behavior and performance during its service life. Ongoing researches are carried out based on the vibration based assessment of the bridge structure to evaluate the structural condition and overall integrity.

## III. OBJECTIVES

- Identification of most useful data and information to be collected.
- Identification of the types of structures/parts of structures where enhanced monitoring is needed and most promising.
- Deployment of the most promising technologies as demonstrations.

- Evaluation of current visual methods and recommendation of improvements.
- Optimize SHM methodology or risk management, life extension of aged structure,
- Identification of the types of structures/parts of structures where enhanced monitoring is needed.
- Deployment of the most promising technologies as demonstrations.
- Evaluation of current visual methods and recommendation of improvements.

## IV. INFORMATION OF BRIDGE USED FOR STUDY PURPOSE

1. Name of bridge: Ozar Bridge
2. Location of bridge: Pune
3. Length of bridge: 107m
4. Type of bridge: RCC
5. Study of part: beam, Pier
6. Short span: 21.4m
7. Pier: 4
8. Work started date:9/2/1977
9. Work completed date: 9/2/1979
10. Age of bridge: 37 yrs.
11. Test conducted on Pier: Rebound hammer
12. Test to be conducted on bridge: Remote Sensor Testing using Vibration sensor

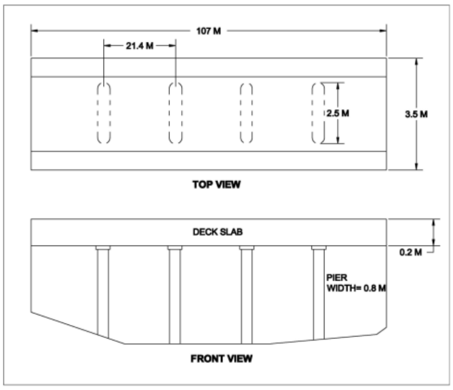



***Fig. 1 AutoCAD Drawing***

***A Vibration Analysis (FFT)***

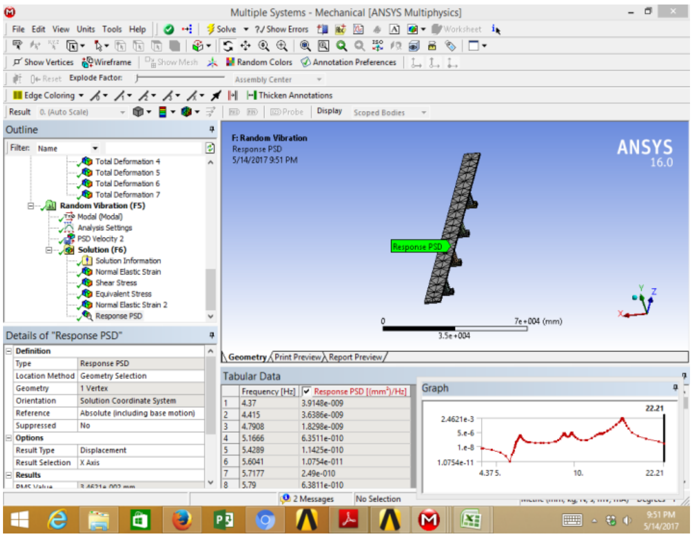
In this project we find out the current condition of bridge using Fast Fourier Transform (FFT) which is mechanical device, using FFT we find out the vibration of bridge over a moving load. Vibration testing readings are as follows for higher moving load and lower moving load for edges and middle of bridge are as follows.

Following are the FFT test readings of Ozar Bridge

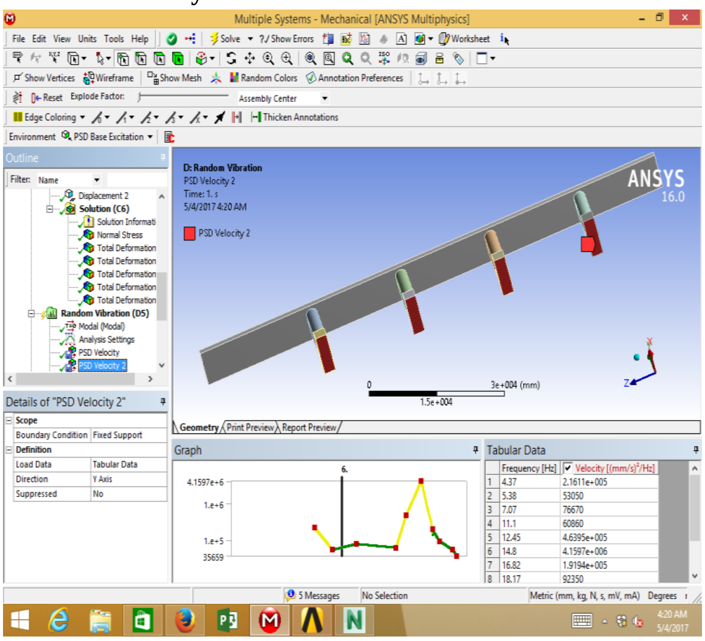
| **Higher load** | | | |
|---|---|---|---|
| Sr. No. | SIDE | Amplitude | Frequency |
| 1 | Left | 900.8 | 13.12 |
| 2 | | 827.67 | 4.71 |
| 3 | | 575.84 | 14.13 |
| 4 | | 207.16 | 11.78 |
| 5 | | 90.43 | 55.85 |
| 6 | | 83.09 | 19.18 |
| 7 | | 72.62 | 10.77 |
| 8 | | 60.75 | 23.89 |
| 9 | | 28.86 | 20.86 |
| 10 | | 26.43 | 22.21 |

| | | | |
|---|---|---|---|
| 11 | | 1013.3 | 11.44 |
| 12 | | 875.8 | 5.05 |
| 13 | | 627.34 | 13.12 |
| 14 | | 506.1 | 13.79 |
| 15 | Right | 330.35 | 8.41 |
| 16 | | 283.68 | 9.42 |
| 17 | | 273.44 | 25.91 |
| 18 | | 196.01 | 17.5 |
| 19 | | 184.68 | 20.19 |
| 12 | | 169.63 | 46.43 |

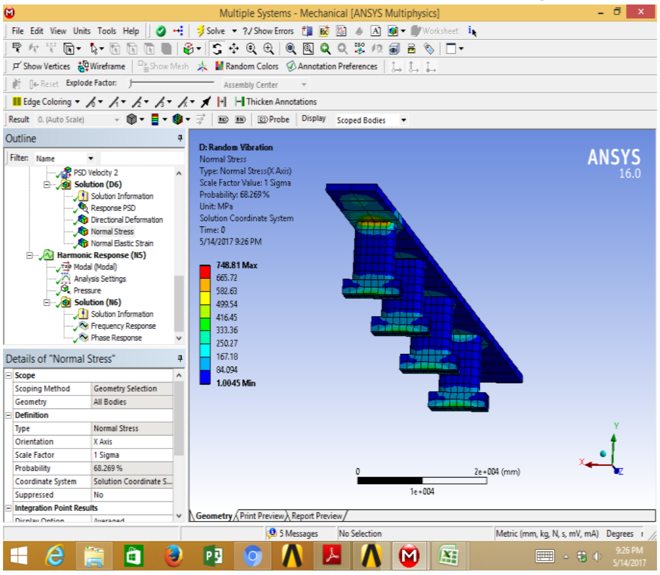
**Ansys Analysis 1 Random Vibration**



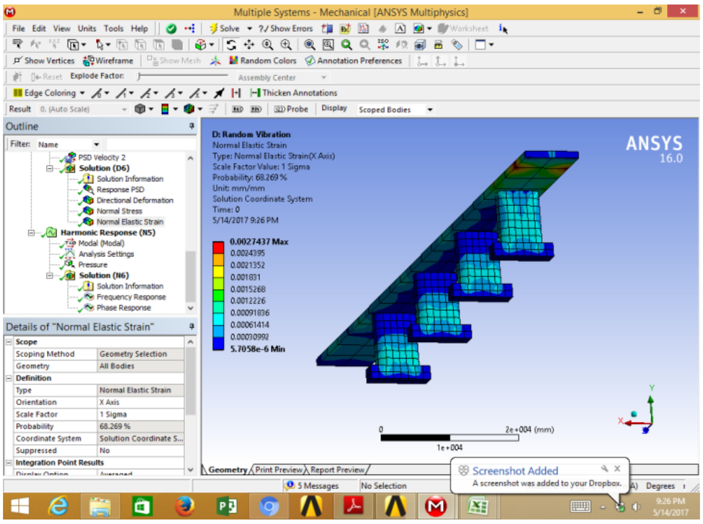

**Ansys Analysis 2 Random vibration velocity**



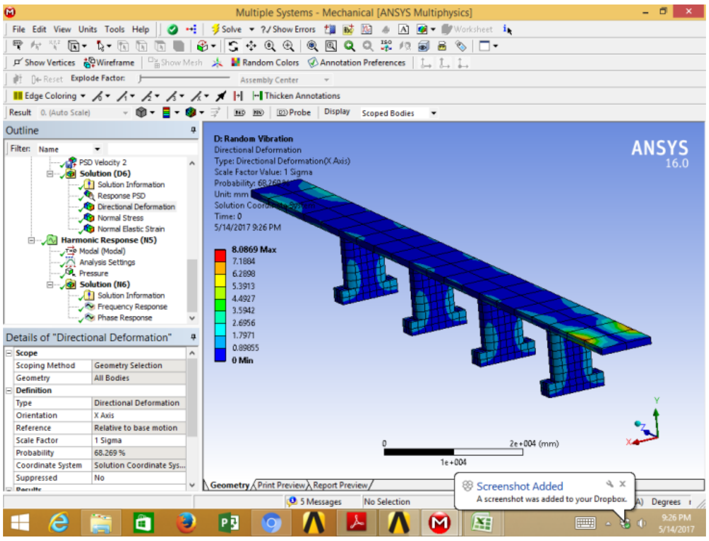
### Ansys Analysis 3 Random Vibration-Normal Stresses develop due to moving load



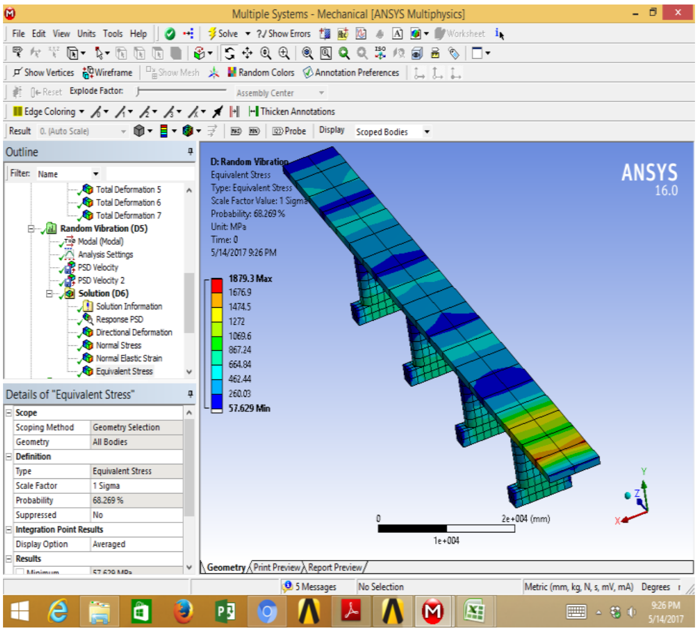

### Ansys Analysis 4 Random Vibration-Normal Elastic strain




### Ansys Analysis 5 Random Vibration-Directional Deformation



**Ansys Analysis 6 Random Vibration-Equivalent stress**



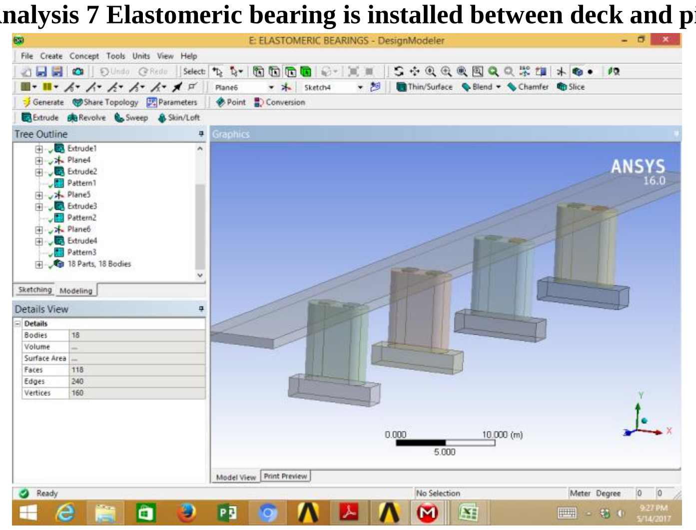

## *C. Elastomeric Bearing*

A laminated elastomeric bearing is an elastomeric rubber block reinforced with steel plates vulcanised when built. This bearing is the connection between a structure and its support, and should make the following possible through elastic deformation:

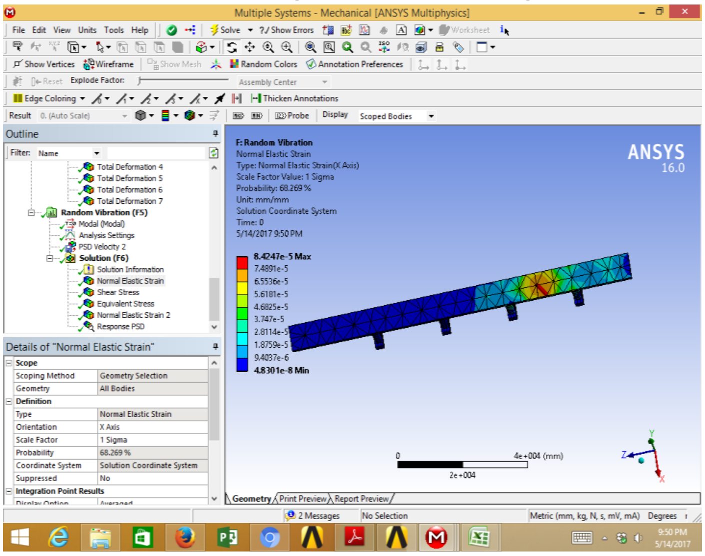
- Transmission of normal forces
- Horizontal movements
- Rotation of the structure in any direction
  Transmission of horizontal forces, within defined limits

***Photo 5 Bearings with anchor plates***

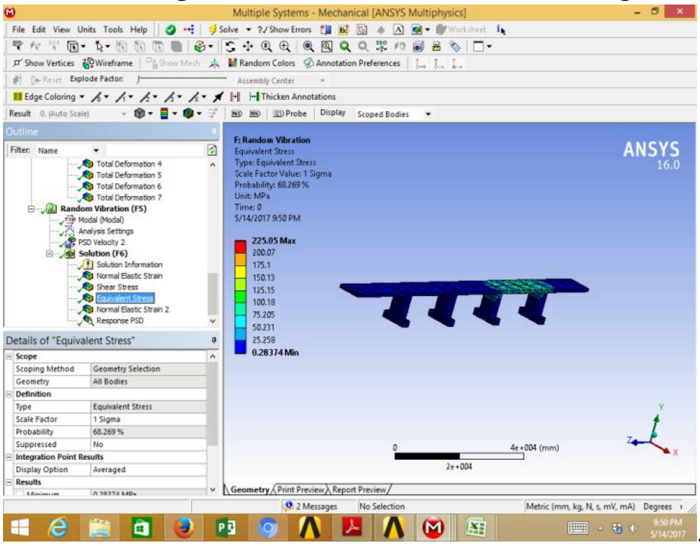
**Ansys Analysis 7 Elastomeric bearing is installed between deck and pier joint**



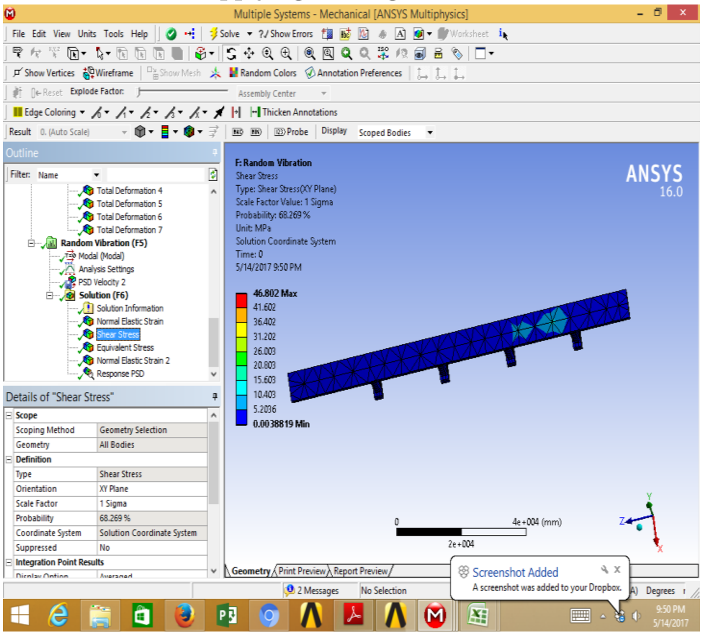
**Ansys Analysis 8 Normal elastic strain reduced using elastomeric bearing**



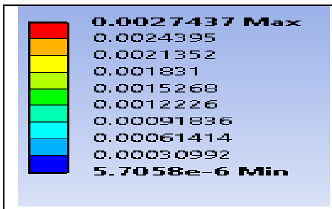

**Ansys Analysis 9 Equivalent stresses also gets reduced due to Elastomeric bearing**



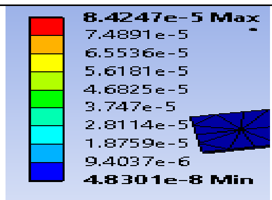

**Ansys Analysis 10 Shear stress results after applying bearing**



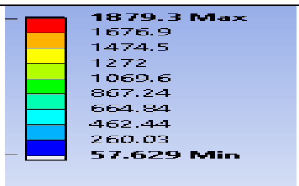
***D. Comparative analysis of bridge condition with and without Elastomeric bearing***



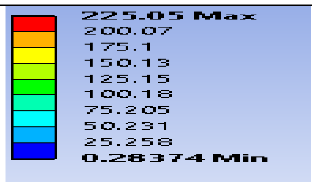
Normal elastic strain without bearing



Normal elastic strain with bearing



Equivalent stress without bearing



Equivalent stress with bearing

**Tab. 3 Comparative analysis of bridge with and without Elastomeric bearing**

| Sr. No. | Stresses without using bearing | Stresses when using bearing |
|---|---|---|
| 1 | 1879.3(Max) | 225.05(Max) |
| 2 | 1676.9 | 200.07 |
| 3 | 1474.5 | 175.1 |
| 4 | 1272 | 150.13 |
| 5 | 1069.6 | 125.15 |
| 6 | 867.24 | 100.18 |
| 7 | 664.84 | 75.205 |
| 8 | 462.44 | 50.231 |
| 9 | 260.03 | 25.258 |
| 10 | 57.629(Min) | 0.28374(Min) |

| Sr. No. | Normal Strain without using bearing | Normal Strain when using bearing |
|---|---|---|
| 1 | 0.0027437Max | $8.4247e^{-5}$Max |
| 2 | 0.0024395 | $7.4891e^{-5}$ |
| 3 | 0.0021352 | $6.5536e^{-5}$ |
| 4 | 0.001831 | $5.6181e^{-5}$ |
| 5 | 0.0015268 | $4.6825e^{-5}$ |
| 6 | 0.0012226 | $3.747e^{-5}$ |
| 7 | 0.00091836 | $2.8114e^{-5}$ |
| 8 | 0.00061414 | $1.8759e^{-5}$ |
| 9 | 0.00030992 | $9.4037e^{-6}$ |
| 10 | $5.7058e^{-6}$Min | $4.8301e^{-8}$Min |

## VI. CONCLUSION

From the project it is knew that the old bridges as well as new must be monitored regularly to avoid further losses and failure of structure. From this project it can be concluded that structural health monitoring of bridges and other structure is very necessary to be done and for which sensors are the Effective preventive measure to avoid the future accidents. In this project vibration analysis is done with the help of fast Fourier transform to know the current condition of vibration over a bridge when moving load is there, and to increase the life of bridge remedy must be applied which should be elastomeric bearing, we can provide different remedy also.

In the same manner for avoiding the future accidents and failure of structures continuous monitoring is done using sensors which must be installed for all new construction of bridges as well as old bridges.

Mostly the old bridges must be monitored carefully to avoid failure like Mumbai-Goa Bridge. For this I have done the research on old bridge i.e. Ozar bridge and monitored first manually and find damage i.e. vibration are more than natural condition so remedy is applied, not only vibration but there are more types of damages can be their to be monitored i.e. deflection, temperature, strain etc.

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