Media-Processing for Structural Failure Assessment

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Abstract - *Structural failures are both natural and human-caused, have been occurring with increasing frequency and effect in recent decades in many countries around the world. The developing countries are less able to deal with the causes and impacts of failures when compared to developed countries. It is important to develop the construction industries of the developing nations in order to equip them to manage the failures. It is necessary to provide construction industries of these developing countries with capacity and capability to prevent natural and manmade disasters is clearly evident. So the necessary precautions must be taken at the National and International levels to counteract this effect. In many cases the necessary precautions is simple and relatively an inexpensive one. This paper explains the role of Media in Processing the Structural Failure Assessment. Some examples of structural failures have been discussed here. The usage and function of Distributed Bruilliouin Sensing (DBS) have also given some information on the Structural Health Monitoring at local as well as global level associated with deformations, cracks and buckling, which may be considered as a solution to rectify the building failure. So we need to check the frequency level of the building to avoid major disaster. Also, the role of media in structural failure is important to analyze the failures and gives the solution for the engineers for the rehabilitation purposes.*

Key Words: *Structural failures, Multimedia, Structural Health Monitoring, Sensors.*

1. INTRODUCTION

Internet and cellular communication have become the increasingly sought after technical activity in recent times. So, all major areas of activity, development and planning revolve around these two major technologies. Engineering and Technology are no exception to this and different segments from education to system development are becoming dependent on internet and communication beginning from net courses to virtual buildings. Hence it has become necessary to think in terms of how internet and cellular communication can be adopted to suitably modify different engineering segments keeping the core intact. In structural engineering systems these could be from Planning, Analysis and Design, Erection and Construction, Maintenance and Damage Assessment and Rehabilitation. Here the details of how multimedia can be used to assess structural failure, model current status and suggestions on how rehabilitation can be done through internet and cellular communication, are presented.

2. ROLE OF MULTIMEDIA IN STRUCTURAL FAILURE

Structural systems show distress in different ways and this may be caused by ageing, improper design and construction, poor quality of materials used, inadequate maintenance and exposure to unanticipated loads and environmental conditions. Once the distress occurs in a structure causing improper functioning, its status is getting wide publicity through TV, Cellular Ad-hoc Networks and Internet. Some examples to illustrate this aspect are the Collapse of Railway Bridge and Failure of Girder in Delhi MRTS, besides many building failures in Mumbai and other places. Figure 1 and Figure 2 show some of the railway disasters reported in TV and papers.

Fig -1: Bridge Failure (Media Information)

Fig - 2: Bridge Failure (Media Information)

One can easily see how internet and media communications make details of structural failure available to every corner of the country. But how this information is going to be used for mitigating and repairing can only be done by engineers and for this the data provided through text and image are to be used to assess how and why the failure occurred, diagnosis and more than that how rectification, repair can be effected immediately.

2.1 Different forms of Multimedia

Multimedia has a wide range of forms beginning with simple text data to graphic images – hand sketched or photographically captured to TV news and then on to live video forms. Each one of these forms provides data and information on failure in different ways. From Figure 1, one can obtain textual data as "80 year old bridge ***collapses…***" or "Under construction bridge ***collapses***…" whereas visual data shows something different with one span falling in one case and members getting twisted with bridge intact in another. This extraction of information from text as well visual images is the basis for the engineer to decide whether a complete or partial failure has occurred and what is to be done for repair or replacement. Figure 3 gives an idea of this and here different forms of media-based data is shown on the left and steps needed to extract information and data for engineering model are shown next. Here the mention of 'archival based' is important as many major structural failures are available now to understand better like the collapse of Tacoma Narrows bridge or the 11th September disaster of Twin Towers. A damage analysis needs to be performed for finding how the failure occurred and the current status of the system.

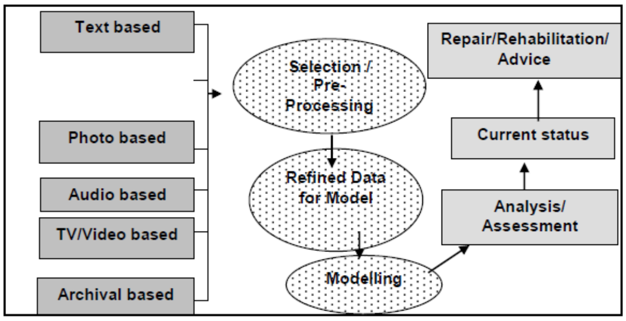

Fig – 3: Media Forms and Processing Steps

This aspect translated to a structural problem can mean a system or a component or a sub system and data could be in terms of location spread and intensity of damage and modeling could be simple beam model or a sophisticated FEM or a simulated experiment. This is shown in Figure 4 where media may be on a component or a sub-system or a system and data could be location in component or a portion of a sub system or a system. One can easily see how complex to arrive at a model and later analyze and suggest remedial measures.

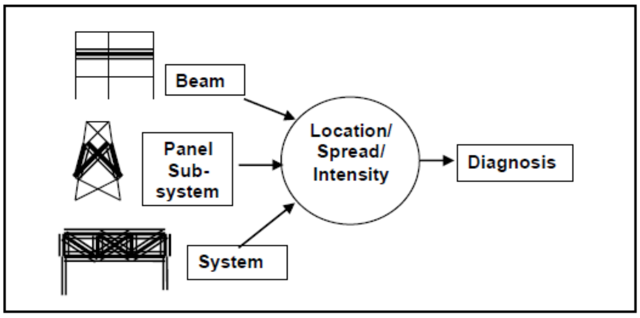

Fig – 4: Structural Connotation

2.2 Structural Failures

Structural Failure is a part of engineering that deals with the capability of a structure to support a designed structural load without breaking and includes the study of past structural failures in order to prevent failures in future design. System failures have been captured on many occasions and some of them are discussed here. A typical failure shown in Figure 5 is referred one at the Bhuj Earthquake, 2001(M_w=7.6). It is said that many structural failures were caused by this earthquake as shown in Figure 6. The Indian National Trust for Arts and Cultural Heritage (INTACH) has estimated that of 250 heritage buildings inspected in Kachchh and Rajkot, about 40% either collapsed or were seriously damaged, while only 10% remained undamaged. Some of the heritage buildings in Bhuj, Jamnagar, Wankaner, Morbi, Maliya, Halvad, Dranghedra and Ahmadabad were also inspected.

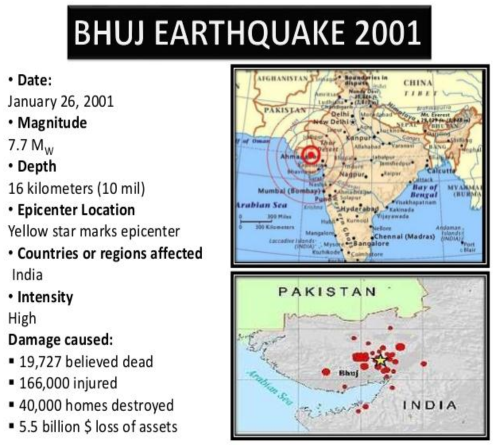

Fig – 5: Bhuj Earthquake

Fig – 6: Column Shear Failure during Bhuj

Likewise, there are structrues that collapses due to the foundation failure. Foundation failure refers to a case where the foundation settles below the original level of construction. This failure occurs mainly due to the poor soil conditions, ground preparations or sometimes caused due to plumbing leaks, drainage works. Figure 7 shows the Ocean Tower, one of the example of famous foundation failure in Texas in South Padre Island. The tower was orginally designed to a 31-storey building which housed high-end condominiums. However, construction of the tower couldn't be completed because of foundation problmes which was identified in early 2008. The expansive soil beneath the tower began to compact, causing the building to sink and lean. Construction ceased and the building had to be demolished in 2009.

Fig – 7: Ocean Tower - Unfinished & Controlled

Demolition

Bridge failures can lead to injuries, loss of life, and property damage on a scale equal to plane crashes, natural disasters. The best way for the engineers is to prevent the catastrophic accidents is to understand the factors that cause bridges to fail. Figure 8 and Figure 9 show a 28m section of the collapsed bridge and I-85 was closed to traffic and they diverted the traffic. A massive fire collapsed a bridge on Interstate 85 (I-85) in Atlanta , Georgia on March 30, 2017 is shown in Figure 10 and Figure 11. There was some good news in the aftermath of the fire and structural failure that no deaths or even injuries were reported. In mid-June 2017, the repair works started and the works were completed by August 2017.

Fig – 8: Collapse of Bridge in I-85

Fig – 9: Collapse of Bridge in I-85

Fig – 10: Collapse of Bridge in I-85

Fig – 11: Collapse of Bridge in I-85

Typical photographic images of major failures indicate clearly the level at which failure had occurred. Figure 12 shows some typical beam failures due to variety of reasons.

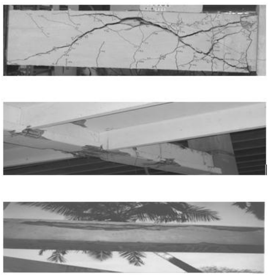

Fig – 12: Media Data for Component Failure

It can be clearly seen that media based information on structural failures is a clear and detailed way to understand structural failure and now one has to see how new information can be used to generate data for modeling for analysis and diagnosis. For this one needs to know about how data and information are gathered and transmitted through internet and cellular communication and only a brief idea will be given here.

2.3 Sensor Technology in Failure Assessment

Structural Failure prevention in Civil Infrastructures requires the use of techniques that allow temperature and strain measurements in real time over lengths of a few meters to tens of kilometers. Here comes the role of **Sensor Technology**. The recent advancements in **Sensor** Technology have been developed and implemented in various Civil Structures such as Bridges, Buildings, Tunnels, Power Plants, and Dams. Many advanced types of sensors, from wired to wireless sensors, have been developed to continuously monitor structural condition through real-time data collection.

The **Distributed Brillouin Sensor** technique has the advantage to combine all these characteristics. The sensing mechanism of the DBS involves the interaction of two counter propagating light waves, the Stokes and the Pump, in an Optical Fibre. Spatial information is obtained through time domain analysis. An analytical model describing the sensing mechanism based on Stimulated Brillouin Scattering (SBS) interaction is introduced and validated experimentally. This model development leads to the implementation of a Signal Processing Method grounded in the physics of Brillouin Scattering. An analytical approximation, valid for the optimum sensing region, reconstructs the Brillouin Spectrum Distribution from input sensing parameters and measured data. These data are obtained with a Spectrum Analysis Methodology, based on three original tools: the Rayleigh Equivalent Criterion, the Length-Stress Diagram, and the Spectrum Form Factors. This methodology has been successfully used on experimental spectra. The DBS and the signal processing approach were then used to monitor the structural changes of steel pipes, composite columns and concrete elements. The DBS measured the strain distribution of those structures while they were stressed. The DBS provided detailed information on the structure's health at local and global level, associated with deformations, cracks and buckling. This work demonstrates that the DBS is capable of extracting critical information useful to engineers: engineer's experience and judgement in conjunction with appropriate data processing methods make possible to anticipate structural failures.

2.4 Features of Multimedia Files

Having described how structural failure information is transmitted or disseminated, one should know the characteristics of these media types. Both internet and cellular communication depend on mostly *digital communication*, it is preferable to know the basics of how this is done. Normal physical happenings are analogue that is continuous in time and space; whereas when this is used as data it has to be converted to discrete data as binary basis is the mode on which digital communication rests. This is shown in Figure 13 in a simple way where a sine curve is used as analogue for transmission in normal telephone lines and the same curve has to be split into segments for digital communication.

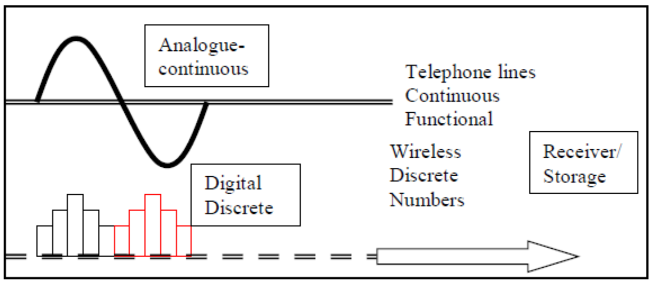

Fig – 13: Analogue and Digital Transmission of Media Files

It is very clear that digital transmission depends on the number of discrete entries and where they were taken. With this as basis, any data or information has to be necessarily converted to discrete form and sent either through laid out cables or by wireless communication. This is a major area of

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activity and both hardware and software trends in storing, transmitting, receiving and processing this kind of data have brought in many variations and sophistications, making it possible to carry an entire book or a three-hour movie in a tiny flash memory or the small card used in cameras. Our interest is how to translate this kind of data into a structural one and later develop a method of analysis and strengthening means.

2.5 Processing Media Files for Failure-Example

To demonstrate the process involved in using media files for failure analysis, a beam problem is chosen. The beam failure picture taken and stored in digital form can be transmitted easily through wired and wireless communication to different centres as shown in Figure 14. Here the image captured in a cell camera is the data which gets transmitted as shown. Internet for worldwide coverage and NET for local coverage are the principal hubs through which the information can go to media centres in the form of audio or image or video files.

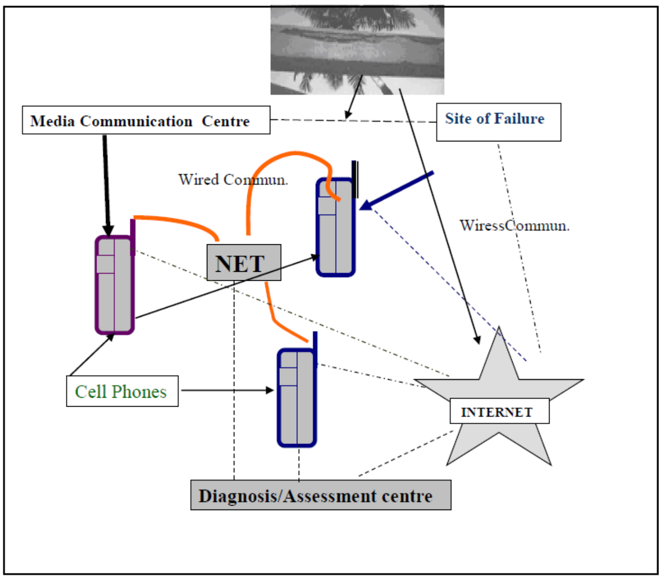

Fig – 14: Wireless communication to different centres

2.6 Failure Parameters

Structural Failures occur due to variety of reasons and after the failure had occurred, an assessment is needed to find the current status of the structure. For this assessment, besides defining type of failure like flexure, shear or bond or excessive deflection or fatigue, certain parameters are needed for modeling. These parameters can be broadly classified into

a) level of failure-component or sub-system or system

b) Type of failure

c) Location of failure relative to size of structure

d) Spread of failure

e) Intensity of failure

2.7 Uncertainty Processing

Another major problem with media information is the amount of CERTAINTY with which one can say whether the information provided is *correct, complete and authentic!*

So this again brings in a major factor in failure assessment. For example the beams shown in Figure 10 can all be given interpretations like 'certainly the damage is dangerous' or 'the damage is not major and the beam can still work' etc. So certainty about the value of damage and the structure are not clear. So if an interpretation has to be made it should be either statistics based or random! But the assessment has a bearing on repair and rehabilitation and that is why a study including this dimension is needed. Both statistical and random analysis methods can be adopted so that in the end one can say whether repair is immediately necessary or not.

2.8 Applications

Typical applications based on media information are many and here two cases are presented. In Figure 13, the failure of the twin towers during 11th September are shown and based on the media data many theories on failure are proposed and one such theory is shown in Figure 15. Here the collapse of one of the towers and the basic model are shown and this model and failure pattern are based on visual information and oral data provided by many. As this is a major catastrophe, lot of money and time are spent to 'understand' the failure pattern, causes and what precautions are needed for such future construction.

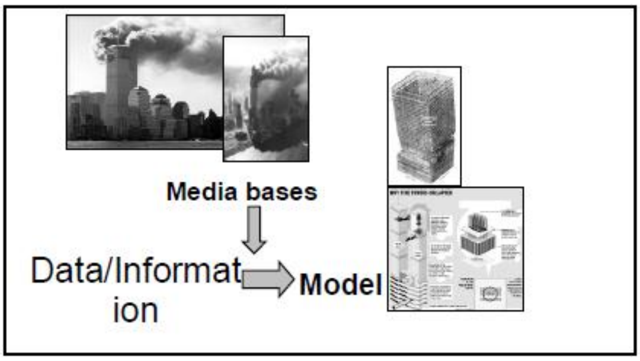

Fig – 15: Media based Failure assessment

3. CONCLUSIONS

In this paper, an attempt is made to review the role of media in structural failure assessment with the internet and cellular communication, and found that it has reached a dominant level in providing information on failures to different strata of society in a short period of time. The state of art in Distributed Bruilliouin Sensing (DBS) was also discussed. The DBS with the help of media provides detailed information on the structure health. With the help of this, the structure can be prevented from failure. Also means of assessing failure based on the media information are presented with some examples.

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REFERENCES

1. Ravet F, Omnisens, Morges (2011), "Distributed Brillouin Sensor Application to Structural Failure Detection", pp. 93-136, Springer-Verlag Berlin Heidelberg, 2011.

2. Vasavada , Rabindra J., Edmund Booth, "Effect of the Bhuj, India earthquake of 26 January 2001 on Heritage Buildings, United Kingdom: http://www.booth-seismic.co.uk, 2001.

3. "List of bridge failures" - Wikipedia.

4. "Ocean Tower" - Wikipedia.

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