Vibration Analysis Damage Detection in Structure

Sweta Verma*[1], Pradeep Kumar[2], Novel Kumar Sahu[3]
*[1]Mtech Scholars, Department of Civil Engineering, RSR Rungta College of Engineering and Technology, Bhilai, Chhattisgarh, India
[2]Assistant Professor Department of Civil Engineering, RSR Rungta College of Engineering and Technology, Bhilai, Chhattisgarh, India
[3]HOD (Civil) Department of Civil Engineering, RSR Rungta College of Engineering and Technology, Bhilai, Chhattisgarh, India

Article Info
March-April-2022

Publication Issue :
Volume 6, Issue 2

Page Number : 223-227

Article History
Accepted : 01 April 2022
Published : 09 April 2022

ABSTRACT
Steel, Power, and construction are indispensable industries for progressive growth of economic and social development. For maintenance, purposes are inspected on regular basis. The main point is to examine and is useful for the detection of surface damages cracks, concrete spalling in the structure, corrosion of steel members, and incomplete failure components, they can be particularly limited at detecting embedded and minor damage, For example fatigue cracks in the structure, corrosion of reinforcement, and delamination Structural health monitoring systems to replace conventional non-destructive inspection techniques which require considerable down-time, human effort and cost .Vibration based damage detection is the most promising techniques for implementation in Structural Health Monitoring (SHM) In the modern era, the concept of detection of damages based on dynamic measurement of structures is critical in focusing on the power of the modern city it is based, on changes in natural frequencies, flexibility and modal curvatures. The measurement of frequency for both before and after the damage to locate the damage and estimate its severity in shear buildings. These are the parameter to estimation are examined in detail reference to a masonry building affected by diffused damage. The changes induced by damage in the dynamic response are exploited to build a procedure for damage detection based on the variation of natural frequencies, both for continuous and discrete models.

Keywords: Damage Indicator, Modal Analysis, Cantilever Beam Damage Detection, Sensitivity Analysis, Frame Structure, Modal Sensitivity.

I. INTRODUCTION

In vibration analysis, the appearance of a cracks damage its model frequencies diverge from the original value. The neural system of the human brain serves as an inspiration for the design of the artificial neutral network. Enhanced damage detection can save revenue and save lives, depending on the app. Bridges are generally regularly inspected for maintenance purposes. The scan is usually visually guided and can be used to identify surface damage, such as cracks, spalling of concrete, corrosion of steel elements, and sometimes-faulty components. The times when we need to evaluate a product to determine concerning a failure mechanism. An evaluation methodology that does not cause damage to the structure is used to identify judgement changes in the structure and to prevent unexpected failures. Non-destructive structural assessment involves numerous difficult processes. Non-destructive techniques are capable of detecting all kinds of damage and failure, and depletion of structural rigidity, such depletion leads to changes in the dynamic effects of the structure, such as damping, natural frequency and eigen-mode. It is a simplified technique to compute the eigen frequency than that of damping changes. Simulation tool and eigen-mode analysis can detect damage.

II. METHODS AND MATERIAL

NDE is used to describe more natural measurements. The NDE test is used to determine material properties such as formability, toughness and other physical properties of the structure. Computer analysis and repair planning of complex buildings use the non-destructive assessment approach in four distinct ways:

1. Structure damage location
2. Internal damage assessment, including the kind, form, and amount of the damage.
3. Post repair quality assurance
4. Visual including optical magnification

Non-destructive component testing plays a decisive role. This system performs its function reliably and is inexpensive. This type of test sample will not be destroyed. This is useful in determining the strength of the existing structure and the local strength of the concrete. The easiest way to carry out the analysis and the interpretation of the test results is not so simple, so special knowledge is required to analyze the type hardening properties of concrete and measure other properties of concrete and evaluate its durability, elasticity, resistance. Parameters are to get. Some properties of concrete are resistance to penetration, hardness, resonant frequency and the ability to accommodate ultrasonic pulse rates. The non-destructive test method is used to test concrete and can be further developed.

The non-destructive techniques utilized here are: The most widely utilised NDE methods at the moment are:

1. Pulse velocity method.
2. Testing for Radiographic
3. Testing of Eddy current (ET).
4. Liquid penetrant inspection (LPI).
5. Flux Testing
6. Acoustic emission testing (AET).
7. Infrared thermography.
8. Optical Testing for concrete
9. Vibration test

These are the different method to identify the damage. Any type of structural defect reduces stiffness and modifies the damaged damping area. This variation of the dynamic properties diminishes the natural frequencies and the moderation of vibration modes in the structure. The above possessions is used to detect and specify the damage to the structure.

Monitoring such damage is extremely insignificant to preserve the useful life of structures. In the event of structural damage, several monitoring and detection methods have been devised. Shapes may be inspected for fractures in curvature mode. Absolute alterations in the curvature type confine the forms to the damaged region. Useful for spotting flaws in the structure.

III.RESULTS AND DISCUSSION

A vibration damage detection system that has been experimentally validated has been developed to predict the location and seriousness of damage in composite structures. The analyses of system and categorizes the heat and vibration analysis properties. To generate damage scenarios for ANN training, various models based on numerical analysis of composite structures with various types of imperfections were used.

A Matlab result of a G4 building to find the natural frequency and modes of the structure is as below:

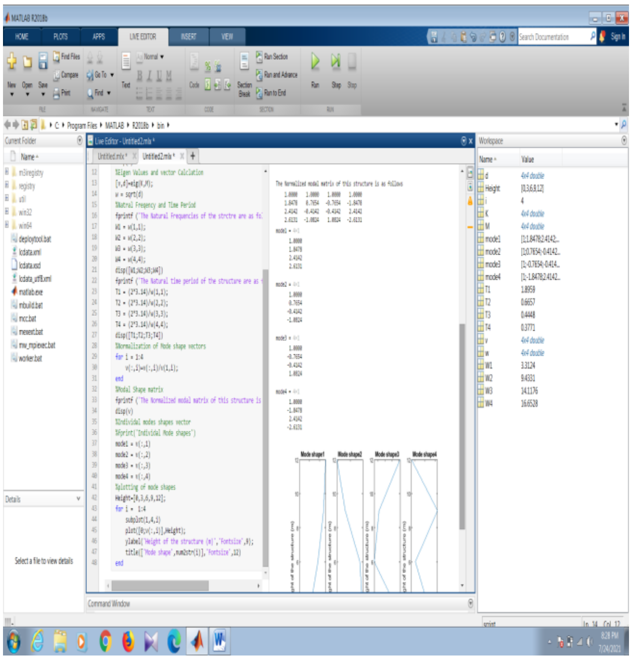

FIGURE 1. CODING DONE ON MATLAB

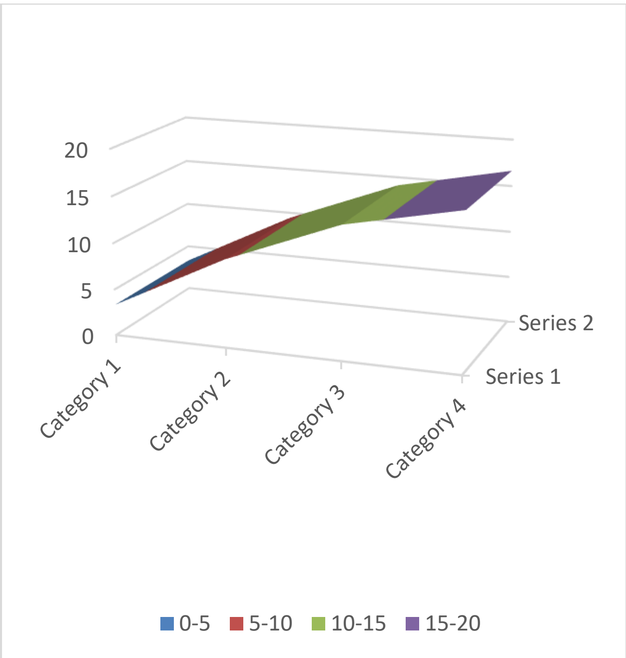

FIGURE 2. FIGURE REPRESENTS THE DIFFERENT MODE SHAPE OF THE STRUCTURE OF DIFFERENT CATEGORIES BASED ON THEORETICAL AND ANALYTICAL ANALYSIS

Graphical representation on comparison of theoretical and analytical frequency:

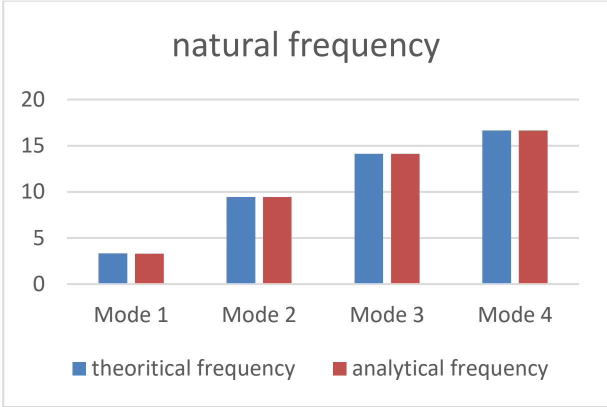

FIGURE 3. GRAPHICAL REPRESENTATION OF MODES AND NATURAL FREQUENCY

IV.CONCLUSION

Monitoring for structural degradation is critical to ensuring that civil structures continue to function properly for as long as possible. Successful monitoring provides us with precise data on the state, usability, integrity, and safety of buildings and other construction-related infrastructure. Monitoring the development and spread of damage is critical to ensuring the long-term viability of a building. There are several natural and man-made variables that might lead to structural damage. In order to offer effective early warning of structural deterioration or other anomaly, several monitoring and detecting methods have been devised.

V. REFERENCES

[1]. A.M. Yan, G. Kerschen, P. De Boe, J.C. Golinval, "Structural damage diagnosis under varying environmental conditions - Part II: local PCA for non-linear cases", Mech. Syst. Signal Process, 19 (4) (2005) 865–880, https://doi.org/10.1016/j.ymssp.2004.12.003.

[2]. O. Avci, O. Abdeljaber, S. Kiranyaz, M. Hussein, D.J. Inman, "Wireless and real-time structural damage detection: a novel decentralized method for wireless sensor networks", J. Sound Vib. (2018).

[3]. M. Chaabane, A. Ben Hamida, M. Mansouri, H.N. Nounou, O. Avci, "Damage detection using enhanced multivariate statistical process control technique", in: 2016 17th Int. Conf. Sci. Tech. Autom. Control Comput. Eng. STA 2016 - Proc., 2017, https://doi.org/10.1109/ STA.2016.7952052.

[4]. F.N. Catbas, O. Celik, O. Avci, O. Abdeljaber, M. Gul, N.T. Do, "Sensing and monitoring for stadium structures: a review of recent advances and a forward look", Front. Built Environ., 3 (2017) 38, https://doi.org /10.3389/ fbuil.2017.00038.

[5]. M.M. Abdel Wahab, G. De Roeck, "Damage detection in bridges using modal curvatures: application to a real damage scenario", J. Sound Vib. (1999), https://doi.org /10.1006/jsvi.1999.2295.

[6]. S. Park, C.B. Yun, Y. Roh, J.J. Lee, "PZT-based active damage detection techniques for steel bridge components", Smart Mater. Struct. (2006), https://doi. org /10.1088/0964-1726/15/4/009.

[7]. Y.Y. Li, "Hypersensitivity of strain-based indicators for structural damage identification: a review", Mech. Syst. Signal Process, 24 (3) (2010) 653–664,https://doi.org/ 10.1016/j.ymssp.2009.11.002.

[8]. A. Diez, N.L.D. Khoa, M. Makki Alamdari, Y. Wang, F. Chen, P. Runcie, "A clustering approach for structural health monitoring on bridges", J. Civ. Struct. Heal. Monit. (2016), https://doi.org/10.1007/s13349-016-0160-0.

[9]. C.R. Farrar, S.W. Doebling, D.A. Nix, "Vibration-based structural damage identification", Philos. Trans. R. Soc. A Math. Phys Eng. Sci. (2001), https://doi.org/10.1098/ rsta.2000.0717.

[10]. A.P. Adewuyi, Z.S. Wu, "Vibration-based structural health monitoring technique using statistical features from strain measurements", J. Eng. Appl. Sci.(2009).

[11]. R.P. Bandara, T.H.T. Chan, D.P. Thambiratnam, "Frequency response function based damage identification using principal component analysis".

[12]. Brownjohn JMW. "Structural health monitoring of civil infrastructure". Philos Trans R Soc A Math Phys Eng Sci. 2007; 365(1851): 589-622.

[13]. Sim SH, Spencer BF. "Decentralized identification and multimetric monitoring of civil infrastructure using smart sensors", Newmark Structural Laboratory Report Series 2015; University of Illinois at Urbana-Champaign, Report 38.

[14]. Fan W, Qiao PZ. "Vibration-based damage identification methods: a review and comparative study", Struct Health Monit. 2011; 10(1):83-111.

[15]. Reynders E, De Roeck G. "Continuous vibration monitoring and progressive damage testing on the Z24 bridge", Encyclopedia of Structural Health Monitoring 2009; John Wiley and Sons, Ltd, 2149-2158.

[16]. Reynders E, De Roeck G., "Vibration-based damage identification: The Z24 Bridge benchmark". In: Encyclopedia of Earthquake Engineering. Springer- Verlag Berlin Heidelberg; 2014.

[17]. Aguirre DA, Gaviria CA, Montejo LA. "Wavelet-based damage detection in reinforced concrete structures subjected to seismic excitations", J Earthq Eng. 2013; 17(8):1103-1125.

[18]. M. Cao, Q. Pizhong, "Integrated Wavelet Transform and its application to vibration mode shapes for the damage detection of beam-type

structures", Smart Mater. Struc. 17 (2008) 055014, DOI: 10.1088/0964-1726/17/5/ 055014.

[19]. M. Solis, M. Algaba, P. Galvan, "A combined wavelet-modal analysis for damage location in beams", Proc., Int. Conf. Noise Vib. Eng. ISMA 2012 (2013) 777–790, http://past.ismaisaac.be/downloads/isma2012/papers/isma2012_0780.pdf

[20]. P. Cawley, R.D. Adams, "The location of defects in structures from measurements of natural frequencies", J. Strain Anal. Eng. Des. 14 (1979) 49–57, DOI: 10.1243/03093247V142049

[21]. O.S. Salawu, "Detection of structural damage through changes in frequency: a review", Eng. Struct. 19 (1997) 718–723, DOI: 10.1016/S0141-0296(96)00149-6

[22]. R. Clara Serra, M. Raffy, C. Gontier, "A subspace fitting method for structural modal identification in time domain", in: Proceedings of the 25th International Conference on Noise and Vibration engineering (ISMA25), Leuven, Belgium, 2000, https://www. researchgate.net/profile/Roger_Serra/publication/257297978_A_Subspace_Fitting_Method_For_Structure_Modal_Identification_in_Time_Domain/links/00b495253f3646e6ae000000.pdf&hl=fr&sa=X&scisig=AAGBfm1thGwyXo1CO8tG1vfjIKDP1ZmhGg&nossl=1&oi=scholarr&ved=0ahUKEwicooK6nOzXAhVGblAKHec2AnIQgAMIKigAMAA.

[23]. G. Gautier, R. Serra, J.-M. Mencik, "Vibratory diagnosis by finite element model updating and operational modal analysis", Mechanics & Industry 14 (2013) 145–149, DOI: 10.1051%2fmeca%2f2013055

[24]. G. Gautier, J.-M. Mencik, R. Serra, "A finite element-based subspace fitting approach for structure identification and damage localization", Mech. Sys. Signal Process. 58–59 (2015) 143–159, DOI: 10.1016%2fj.ymssp.2014.12.003

[25]. T. G. Chondros, A. D. Dimarogonas and J. Yao, "A continuous cracked beam vibration theory", Journal of Sound and Vibration, vol. 215, no. 1, pp. 17–34, 1998.

[26]. P. F. Rizos, N. Aspragathos and A. D. Dimarogonas, "Identification of crack location and magnitude in a cantilever beam from the vibration modes", Journal of Sound and Vibration, vol. 138, no. 3, pp. 381–388, 1990.

[27]. W. M. Ostachowicz and M. Krawcz "Analysis of the effect of cracks on the natural frequencies of a cantilever beam", Journal of Sound and Vibration, vol. 150, no. 2, p. 191, 1991.

Cite this article as :

Sweta Verma, Pradeep Kumar, Novel Kumar Sahu, "Vibration Analysis Damage Detection in Structure", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 6 Issue 2, pp. 223-227, March-April 2022.
URL : https://ijsrce.com/IJSRCE226224