IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Vibration Analysis Of The Structure Of A Flour Mill Motor Using Mathematical Concepts And Experimentation

Miss. Sayali Patil[1], Prof. S. A. Kore[2], Dr. Pankaj. P. Awate[3], Prof. Swapnil S. Jadhav[4]
[1] (Student, Department of Mechanical Engineering, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon, Sangli, India.)
[2,3] (Associate Professor, Department of Mechanical Engineering, Padmabhooshan Vasantraodada Patil Institute of Technology, Budhgaon, Sangli, India.)
[4] (Assistant Professor, Department of Automation and Robotics, Dr. D. Y. Patil Institute of Technology, Pimpri, Pune-18, India)

Abstract: *Vibration refers to mechanical oscillations about an equilibrium position. The oscillations may be periodic such as the motion of a pendulum or random such as the movement of a tire on a gravel road. Vibration is omnipotent, universal and multifaceted phenomena. It is an interdisciplinary field where physicist, mathematician and engineer interact in a closed loop. Research in vibration control has been an on-going studyfor decades, ever since the invention of mechanical systems. The vibration causes the effect on the operator of machineries. Increase the harshness level in working area. Continuous noise &harshness is hazardous for human being. With above motivation flour mill motor foundation was taken for vibration study to reduce the vibration level present in it and to reduce the overall vibration and noise present in the system. The present work includes comparison of numerical vibration analysis of flour Mill and verification of same using the experimentation. In order to carryout numerical vibration analysis Ansys Workbench is used.*
Keywords: *Flour Mill, Noise and Harshness, Vibration, Omnipotent, Ansys Workbench*

I. Introduction

Vibration is occasionally desirable. For example the motion of a tuning fork, the reed in a woodwind instrument or harmonica, or the cone of a loudspeaker is desirable vibration, necessary for the correct functioning of the various devices. More often, vibration is undesirable, wasting energy and creating unwanted sound – noise. For example, the vibration motions of engines, electric motors, or any mechanical device in operation are typically unwanted. Such vibrations can be caused by imbalances in the rotating parts, uneven friction, the meshing of gear teeth, etc. Careful designs usually minimize unwanted vibrations. Vibration isolation concerns means to bring about a reduction in a vibratory effect. A vibration isolator in its most elementary form may be considered as a resilient member connecting the equipment and foundation. The function of an isolator is to reduce the magnitude of motion transmitted from a vibrating foundation to the equipment or to reduce the magnitude of force transmitted from the equipment to its foundation. The purpose of vibration isolation is to control unwanted vibration so that its adverse effects are kept within acceptable limits. Vibrations originating from machines or other sources are transmitted to a support structure such as a facility floor, causing a detrimental environment and unwanted levels of vibration. If the equipment requiring isolation is the source of unwanted vibration, the purpose of isolation is to reduce the vibration transmitted from the source to the support structure. Conversely, if the equipment requiring isolation is a recipient of unwanted vibration, the purpose of isolation is to reduce the vibration transmitted from the support structure to the recipient. In India Flour Mills are often seen in each village, town and even district places, which are commonly used to grind the grains into flour. Most important concern about flour mill is noise and vibration from the flour mill. The objective of the study is to produce results which may help to rectify problems associated with mechanical systems design and which also may be of significance during design of mechanical systems in view to control vibrations and add to comfort of the operator. Motivated from the problem associated in the working of the Flour Mill. The vibration causes the effect on the operator of machineries, increase the Harshness level in working area. Continuous noise &harshness is hazardous for human being. In the case lightly damped structures can produce high levels of vibration from low level sources if frequency components in the disturbance are close to one of the system's natural frequencies. This means that well designed and manufactured sub-systems, which produce low level disturbing forces, can still create problems when assembled on machineries. In order to overcome these problems, at the design stage it is necessary to model the system accurately and analyze its response to anticipated disturbances. In this research work a mathematical model of the system and formulation of the equations of motion, analysis of the vibration characteristics (natural frequencies and modes),the forced vibration response to prescribed disturbances is carried out. The present paper deals with comparison of Modal analysis results using the Finite element method and Experimental modal analysis results. The CAD model created in 3D CAD modeling software was imported. For finite element analysis the Ansys Workbench moduleis used.

II. Modal Analysis Using Finite Element Method

Basic steps in the finite element method:

Discretisation of the domain:

The geometry (solid model) is divided into a number of finite elements by imaginary lines or surfaces. The Interconnected elements may have different sizes and shapes. The success of this idealization lies in how closely this discredited continuum represents the actual continuum. The choice of the simple elements or higher order elements, straight or curved, its shape, refinement is to be decided before the mathematical formulation.

Identification of variables: The elements are assumed to be connected at their intersecting points referred to as nodal points. At each node, unknown displacements are to be prescribed. They are dependent on the problem at hand. The problem may be identified in such a way that in addition to the displacement which occurs at the nodes depending on the physical nature of the problem, certain other quantities such as strain may need to be specified as nodal unknowns for the element, which however may not have a corresponding physical quantity in the generalized forces. The value of these quantities can however be obtained from variation principles.

Choice of approximating functions: After the variables and local coordinates have been chosen, thenext step is the choice of displacement function, which is the starting point of mathematical analysis. The function represents the variation of the displacement within the element. The function can be approximated in many ways. A convenient way of expressing it is by polynomial expressions. The shape of the element or the geometry may also be approximate. The coordinates of corner nodes define the element shape accurately if the element is actually made of straight lines or planes. The weightage to be given to the geometry and displacements also need to be decided for a particular problem.

Formation of element stiffness matrix:

After the continuum is discretised with desired element shapes, the element stiffness matrix is formulated. Basically it is a minimization procedure. The element stiffness matrix for majority of elements is not available in explicit form and requires numerical integration for this evaluation. The geometry of the element is defined in reference to the global frame.

Formation of the overall stiffness matrix:

After the element stiffness matrix in global coordinates is formed, they are assembled to form the overall stiffness matrix. This is done through the nodes which are common to adjacent elements. At the nodes the continuity of the displacement functions and their derivatives are established. The overall stiffness matrix is symmetric and banded.

Incorporation of boundary conditions:

The boundary restraint conditions are to be imposed in the stiffness matrix. There are various techniques available to satisfy the boundary conditions.

Formation of the element loading matrix:

The loading inside an element is transferred at the nodal points and consistent element loading matrix is formed.Formation of the overall loading matrix:

The element loading matrix is combined to form the overall loading matrix. This matrix has one column per loading case and it is either a column vector or a rectangular matrix depending on the number of loading conditions.

Solution of simultaneous equations:

All the equations required for the solution of the problem are now developed. In the displacement method, the unknowns are the nodal displacement. The Gauss elimination and Choleky's factorization are most commonly used methods.

Calculation of Modal Frequencies and Mode Shapes:

The nodal displacement values are utilized for calculation of Modal frequencies and Mode shapes

Table 1: Modal analysis of Motor Foundation

Sr. No.	Linear Modal Analysis (ANSYS) (Hz)
1	137.5
2	176.01
3	179.5
4	455.47
5	508.56
6	779.24

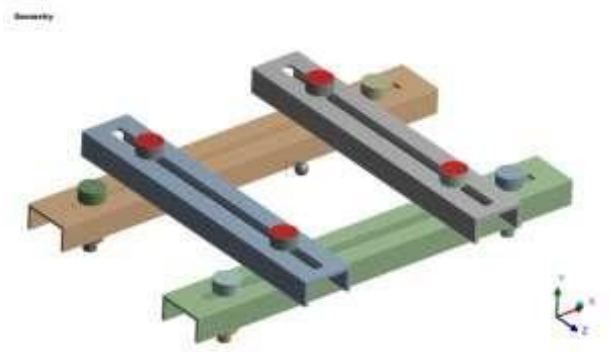

Fig 1: Motor Foundation and Motor weight as pointMass

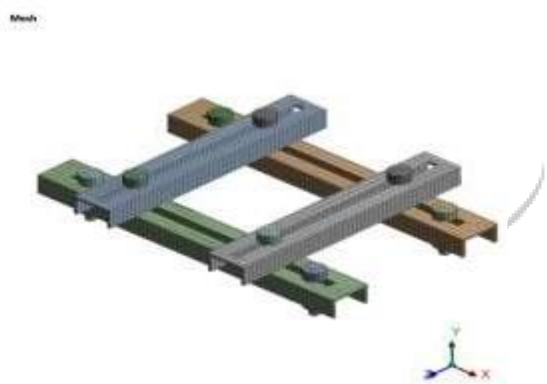

Fig 2: Motor Foundation Mesh Model

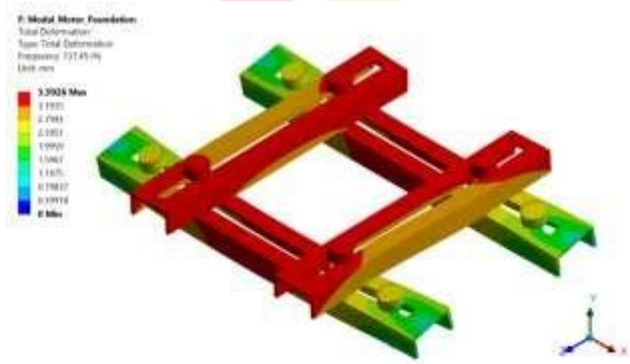

Fig3: Motor Foundation Mode Shape No.1

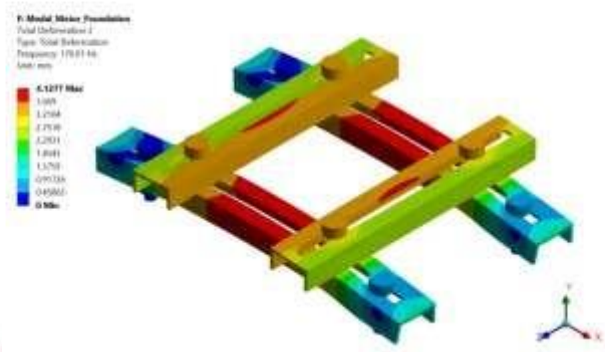

Fig 4: Motor Foundation Mode Shape No.2

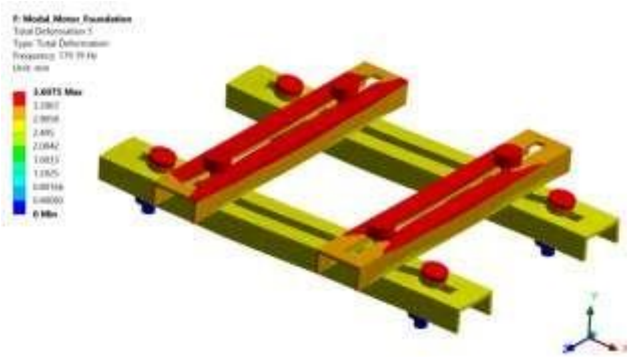

Fig 5: Motor Foundation Mode Shape No.3

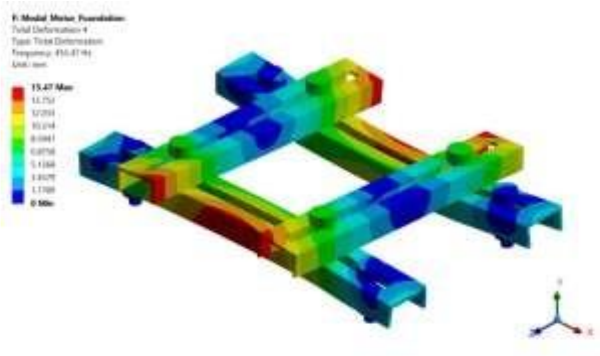

Fig 6: Motor Foundation Mode Shape No.4

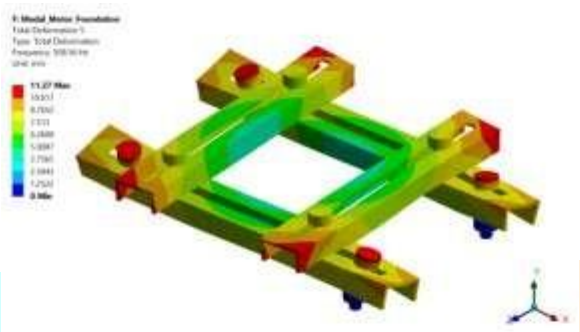

Fig 7: Motor Foundation Mode Shape No.5

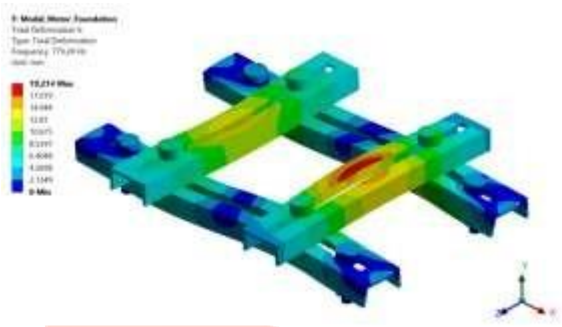

Fig 8: Motor Foundation Mode Shape No.6

III. Experimentation

Experimentation gives real insight of the system. In order to find out actual results experimentation is necessary because in theoretical analysis behavior of system parameters considered is linear but in actual those system behaves nonlinear in actual practices, so in order to find out difference in theoretical and experimental analysis experimentation is necessary.

To carryout Experimental Modal Analysis following are the basic equipment required.

1. FFT Analyzer.
2. Modal Hammer
3. Accelerometer

Fig.9: Four Channel FFT Analyzer

Fig. 10: Accelerometer

Fig 11. Measurement at Foundation of MotorFigure below shows the Experimental results obtained from modal analysis,

Experimental Modal analysis of Motor Foundation:

Table .2 Natural frequencies of foundation

Sr. No.	Experimental Modal Analysis (Hz)
1	140
2	170
3	180
4	450
5	510
6	780

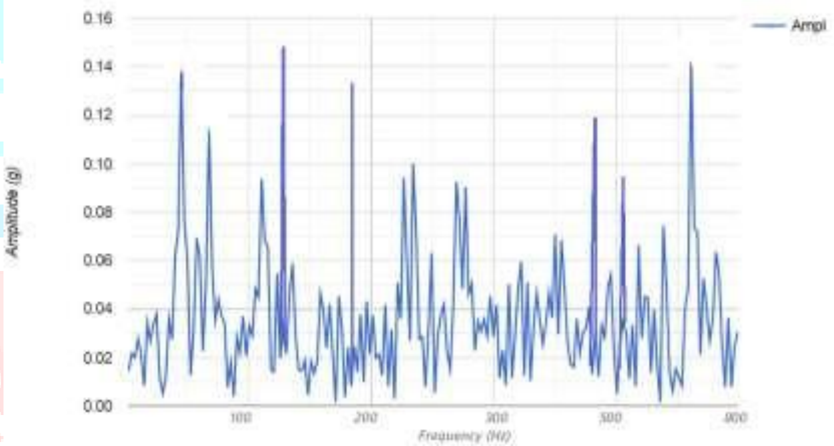

Fig.12: Modal Analysis experimental results Figure 12 shows experimental result for Modal analysis of Foundation of Motor.

Table No. 3 shows the comparison between the Numerical Modal Analysis and Experimental Modal Analysis ofMotor Foundation

Comparison of Numerical Modal Analysis and Experimental Modal Analysisof Motor Foundation:

Table 3: Comparison of Numerical Modal Analysis and Experimental Modal Analysis of Motor Foundation

Mode Shape No.	Motor Foundation		
	Numerical Modal Frequencies (Hz)	Experimental Modal Frequencies (Hz)	% Variation
1	137.5	140	1.785714286
2	176.01	170	3.535294118
3	179.5	180	0.277777778
4	455.47	450	1.215555556
5	508.56	510	0.282352941
6	779.24	780	0.097435897

Table No.3 indicates the Comparison of Numerical Modal Analysis and Experimental Modal Analysis of Motor Foundation. Maximum percentage variation in EMA and FEA is 3.5%, which shows FEA result are having quiet good agreement with Experimental results.

IV. Conclusion

In this paper Comparison between Experimental Modal analysis and Numerical Modal analysis is carried out. A comparative result shows the percentage variation in Experimental and numerical modal analysis resultis
3.5 %. As seen from comparison conclusion can be drawn like FEA result is having quiet good agreement withExperimental results.
From above calculation it is proved that FEA results are consistent and can be used as alternative time consuming and costly Experimental calculation.

Conflict of interest The authors declare that there is no conflict of interests regarding the publication of thispaper.

References

[1] Brandt, "Noise and Vibration Analysis - Signal Analysis and Experimental Procedures", John Wiley Sons, Inc., First ed., 2011.
[2] Carrela A. et.al., 2009, "Using Nonlinear Springs to Reduce the Whirling of a Rotating Shaft", Mechanical Systems and Signal Processing journal, Volume No.23, pp.2228–2235.
[3] Dan Russell, "The Dynamic Vibration Absorber", Acoustics and Vibration Animations.
[4] G. K. Groover and A. K. Nigam, "Mechanical Vibrations", Edition-2011.
[5] Irshad M. Momin, Dr. Ranjit G Todkar, "Design and Development of a Pendulum Type Dynamic Vibration Absorber for a SDoF Vibrating System Subjected to Base Excitation", International Journal of Mechanical Engineering and Technology (IJMET), pp.214-228, September-December 2012.
[6] Ohijeagbon, I. O Olusegun, H. D., Adekunle, A. S., Oladosu, O. A. Bodunde, A.,―Analysis of Vibration Effect on Factory Foundation in a Flour Mill‖, LAUTECH Journal of Engineering and Technology 7(1) 2012:44-5.
[7] J. Breckling, Ed., The Analysis of Directional Time Series: Vinay V. Nesaragi, Maruthi B.H., Chandru B.T., Dileep Kumar, ‖Design and Noise, Vibration, Harshness Analysis of Engine Bonnet of the Car‖, International Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue7(Version 2), July 2014,pp.05-11.
[8] Rahul R.Joshi, Prof.Dr. V.R. Naik, ―Vibration Analysis of Critical Components of Plain Weaving Machine‖, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 6, June 2013, ISSN:2319-8753.
[9] F. Al-Badour, M. Sunar, L.Cheded,―Vibration Analysis of Rotating Machinery Using Time-Frequency Analysis and Wavelet Techniques, article is in press‖,Mechanical Systems and Signal,doi:10.1016/j.ymssp.2011.01.017.
[10] Zhang Junhong, Han Jun, ―CAE Process to Simulate and OptimiseEngine Noise and Vibration‖, Mechanical Systems and Signal Processing 20(2006)1400–1409.
[11] Gabriel-PetruANTONetal.,―NVHTest Calculation Correlation Of An Engine In The Automotive Industry‖, Renault Technologie Roumanie – DIM /DAPEMNVH, Barba Center Sos. Pipera- Tunari, Nr. 1/VI, Voluntari, Jud. Ilfov, 077190,Romania.
[12] E. Downham, ―The Rationale of Monitoring Vibration on Rotating Machinery in Continuously Operating Process Plant‖, Journal of Engineering for Industry Paper No. 71-Vibr-96.
[13] Yogendra S.Rajput, ―A Vibration Analysis of Vehicle Frame‖, IJERA, ISSN: 2248- 9622, Vol. 3, Issue 2, March -April 2013,pp.348-350.
[14] Vanee Chonhenchob, Sher Paul Singh, Jay Jagjit Singh, Joseph Stallings and Gary Grewal, ―Measurement and Analysis of Vehicle Vibration for Delivering Packages in Small-Sized and Medium-Sized Trucks and Automobiles‖, The Sound and Vibration in Rolling Bearings‖, Motion & Control No. 6 — 199936.