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Modelling and Simulation of a 2-D Spring-Mass System Using Ansys Apdl

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Abstract: *This work is aimed at using Finite Element Analysis Software (ANSYS APDL) to demonstrate the modelling and Simulation of a 2-D spring mass system to obtain its first two natural frequencies and mode shape. Modal analysis of dynamic properties of systems subjected to vibration was used to implement the results. This study is useful to structural engineers as it will be used to predict the natural frequencies of vibration and excitation response of bridges, buildings and dynamic systems. In this study, analytical analysis was used to compare the numerical results obtained using ANSYS to validate the results. The material used in this study was steel.*

Keywords: *Modelling, Spring mass, ANSYS, Vibration, Simulation*

I. Introduction

The mode shapes, natural frequencies and vibration of a 2-D Spring mass system is characterized using modal analysis established in ANSYS 16.1. This study is very useful in the designing of structures subjected to dynamic loadings and when pre-stressing Turbine blades. This is made possible from the natural frequencies and mode shapes obtained during the Simulation process. Spring mass system is basically known for vibrational analysis and is also used to represent shock absorbers in Mechanical systems.

1.2 Purpose Of Study

The aim of this study is to obtain the first two natural frequencies and mode shapes of a 2-D Spring mass system using ANSYS APDL.

1.3 Benefit Of Study

This study is beneficial to structural engineers in predicting the natural frequencies of vibration and excitation response of bridges, building and dynamic systems.

II. Methodology

In this study, the Simulation process was done using ANSYS APDL and the theoretical analysis was used to validate the results obtained from ANSYS. The methods are given below:

2.1 The Theoretical Analysis

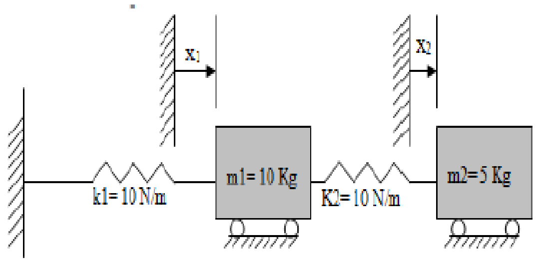

Figure 1.0 Model of the spring-mass system[1][1]

The Figure 1.0 shows two degrees of freedom (2-DOF) system that is made up of two modes of vibration which corresponds to two natural frequencies. Using Newton's second law of motion, the equation of motion for the two mass systems becomes:

Mass 1

$$M_1\ddot{X}_1 + (K_1 + K_2) X_1 - K_2 X_2 = 0 \quad \text{(a)}$$

Mass 2

$$M_2\ddot{X}_2 + K_2 X_2 - K_2 X_1 = 0 \quad \text{(b)}$$

The combination of equations (a) and (b) gives;
$M\ddot{X} + K X = 0$
Therefore, solving the equations, we have:

ω_{n1} = SQR (0.634 * K/M_1) = SQR (0.634 * 10/10) = 0.7962 rad/s

ω_{n2} = SQR (0.634 * K/M_2) = SQR (0.634 * 10/5) = 2.1753 rad/s

The theoretical natural frequencies are;

$F_{n1} = \omega_{n1}/2\pi$ = 0.7962/2*3.142 = **0.1267 Hz**

$F_{n2} = \omega_{n2}/2\pi$ = 2.1753/2*3.142 = **0.3462 Hz**

2.2 The Simulation Process

The masses shown below were created using rectangular blocks andmodelling of the masses was down as point masses without using any material properties. The element types were selected as solid, Quad 4node-42 denoted by combination and spring –Damper 14. The material properties for the masses and springs were clearly defined. Mapped meshed with 3 or 4 sided was used for the first part. The second part was also mapped meshed but after the element attributed was properly defined. Then creation of the node at the wall and spring elements were done. Rigid body constraints were applied to the system and solved. The natural frequencies were obtained and mode shapes displayed.

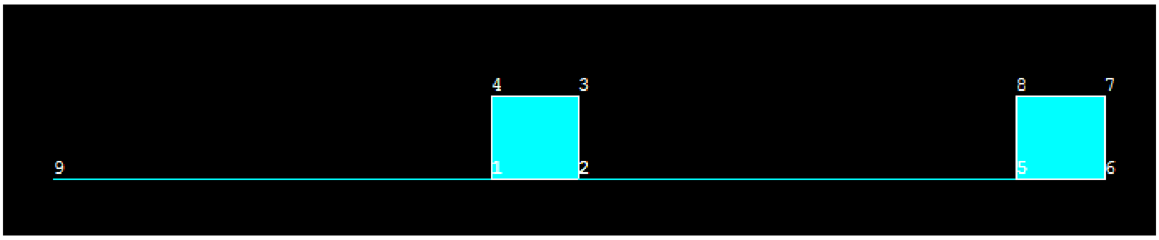

Figure 2.0 The Solid model

The modelled configuration and nodes are shown in Figure 2.0 above with node 9 at the wall. The line linking the blocks and the wall is used to represent the spring.

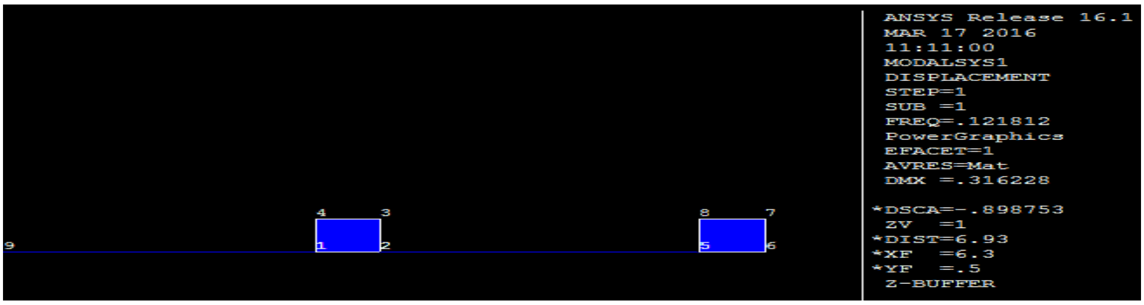

Figure 3.0 Mode shape 1

The first mode shape when displaced at step1, sub 1 to a frequency of 0.121812Hz is shown in Figure 3.0 above

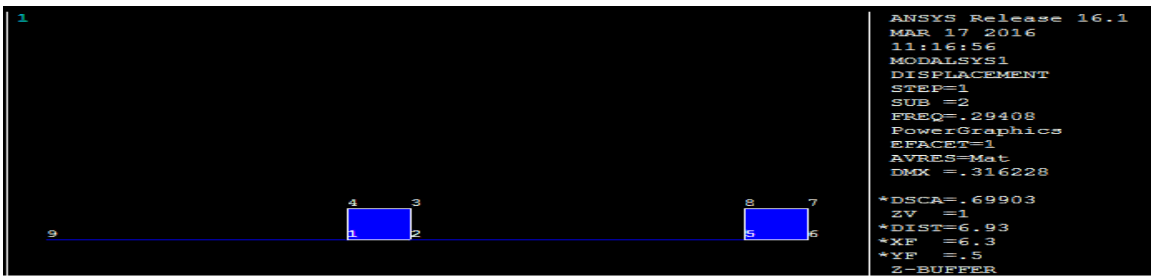

Figure 4.0 Mode shape 2

The second mode shape vector when displaced at step1 and sub2 at a frequency of 0.29408Hz is shown in Figure 4.0 above

III. Results And Comparison

Table 1.0 Results from theoretical calculation and ANSYS

		Theoretical values	ANSYS results	% error
The Spring mass system	Frequency 1 (Hz)	0.1267	0.1218	3.9
	Frequency 2 (Hz)	0.3462	0.3162	8.7

IV. Analysis Of Results And Discussion

From Table1.0 shown above, since the percentage error obtained for both the theoretical analysis and ANSYS is very small and negligible, the solution from ANSYS is valid and acceptable.

V. Conclusion

The results obtained shows that, the theoretical values are usually higher than the Numerical (ANSYS) results. Therefore, theoretical analysis is usually said to have many assumptions and approximations which made them exact solutions. However, since ANSYS results are very close to the exact solutions with very small error difference, the ANSYS results is therefore acceptable and valid to be used for the prediction of natural frequencies and excitation response of structures and dynamics systems.

References

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