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Modal Analysis Of Rectangular Plate With Changing Hole Location Along The Length Of Plate.

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Abstract: Modal analysis is technique to determine the characteristics of vibration of engineering structures and its component's. It is a process by which the natural frequencies, mode shapes and damping factor of structure can be determined with a relative ease. It provides a major contribution in understanding the control of many vibration phenomenons which encompasses in practice. [3]In this work we found the natural frequency by using FEA. The main objective of this paper is to determine the natural frequency and mode shape of a rectangular cantilever beam condition with hole at different locations and to analyze the results obtained by finite element method. The cantilever beam of rectangular plate with hole is designed and analyzed using Hypermesh and Optistruct. The analysis result helps in comparing the natural frequencies of the rectangular plate with different locations of the hole. The results obtained are tabulated and analyzed.

***Index Terms* -** Modal analysis,Natural frequency,Rectangualr plate,Mode shapes,Analysis.

1. INTRODUCTION

In the actual engineering structure, such as aerospace, ship and marine, plate structures are considered as major engineering substructures, especially wherever the weight is a main issue. It is often necessary to fix up an appropriate number of cutouts based on experience for structural maintenance, weight reduction, or performance optimization. On one hand, stress concentration occurs around the cutouts, and the static strength of the component is reduced; on the other hand, the quality and stiffness distribution of the structure will change for the existing cutouts, which have a great influence on the mechanical properties such as natural frequency and structural load-bearing performance of the structure. Therefore, analysis of the mechanical properties of the structure with cutouts has been a hot issue in the research, which is of great significance in the engineering structure design.[1]

Vibrations ensue when a body is subject to any arrangement of forces. In other words, high intensities of strain, stress and noise are set up in the body as a result of vibrations. Unlike static deformations, the degree of vibration in a body under a system of force is reliant on both the magnitude and the period of the exciting force.Vibrations in different structures occur at different frequencies. If a structure vibrates at frequencies higher or closer to the natural frequency of the body, the vibration may be exceptionally high. It is therefore necessary to evaluate the natural frequencies of structures under loading. Modal analysis is a process to describe various natural features of a geometry (structure) which may include damping, mass, modes shapes (dynamic properties) and frequency (Polytech, 2001). Generally resonant vibrations can be characterised by simple and effective use of Modes. Modes are known to be inherent properties of a structure. This within a structure is caused by interaction between the elastic properties and inertial of the materials. In analysis of structure, Modal analysis helps to identify areas of weakness in design that needs improvements.[2]

Modal analysis is significant in evaluating the mode shapes generated by a component under vibrational excitation, as the mode shapes can be used to determine the displacement or response of the component under the influence vibration in real life application. Result obtained from the modal analysis will generate a number of resonances which the frequency and damping effect can be determined by measurement.[2]

The main purpose of modal analysis is to study the dynamic properties of structures like natural frequency, damping and mode shapes. In modal analysis we examine and compare different techniques for modal analysis of simple rectangular cantilever beams. The modal analysis is used to understand the dynamic properties of structure such as natural frequency, damping ratio and mode shape. With modal analysis, the modal parameters of the structures can be extracted. The modal parameters, including natural frequency, damping ratio, and mode shape, are the fundamental elements that describe the movement and response of a structures to free vibrations. So knowing the modal parameters helps to understand the structure's response to free vibration conditions as well as to perform design validation.[3]

2. PROBLEM DEFINITION

A square plate of (100X50) mm planar area is considered for analysis. The thickness of the plate considered is 2mm. The plate is then subjected to different circular cutouts along the length of plate. The hole location is changed from 25mm, 50mm and 75mm along the length of the plate.

The boundary conditions for the rectangular plate with different hole locations is considered as follows. The plate is considered as cantilever beam with one side fixed and other end free.

Three different cases of the above-mentioned dimensions are considered with one side fixed other end free in all DOF. A circular cut out of 10 mm diameter hole is considered. The geometry of a rectangular plate with circular cut-out at 25mm, 50mm and 70mm is shown in figures from fig1 to fig3.

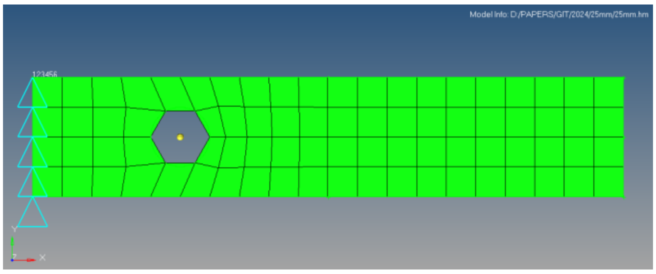


Fig 1 :Hole at 25mm from fixed end.

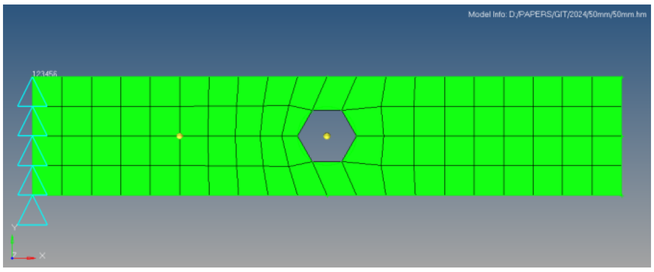


Fig 2: Hole at 50 mm from fixed end.

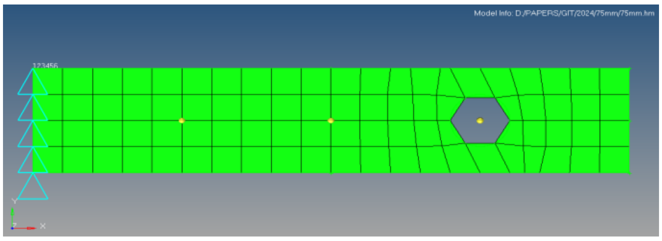


Fig 3: Hole at 75 mm from fixed end.

3.MATERIAL AND MECHANICAL PROPERTIES

The material selected for the case is Mild steel and the mechanical properties applied for the plate are given below in the table 1.

Table -1: Mechanical properties of mild steel

Material	Mild Steel
Density	7850Kg/mm3
Poissons ratio	0.3
Youngs Modulus	2E5

4. RESULT ANALYSIS

The mode shapes for case 1 are shown below in figures from fig 4 to fig8

Case 1: Plate with hole at distance of 25mm from fixed end.

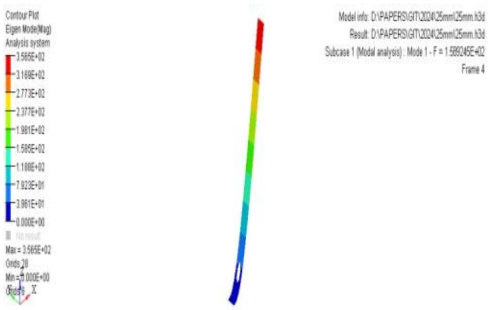


Fig 4: Mode shape1

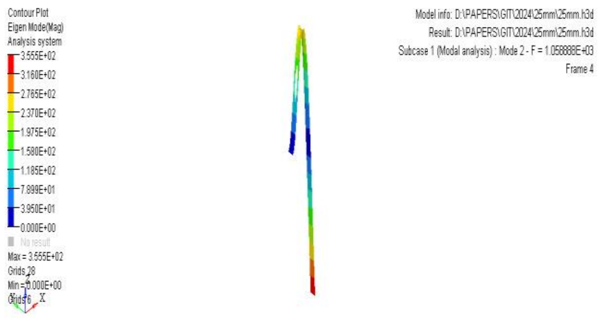


Fig 5: Mode shape2

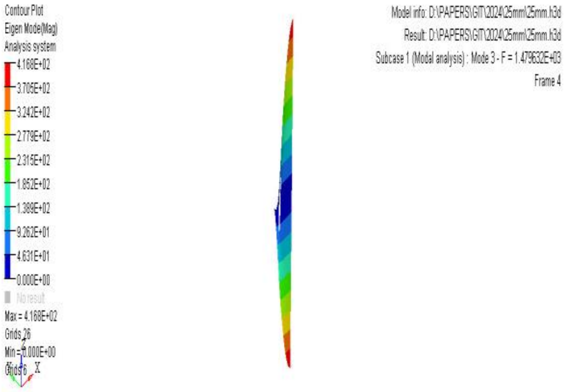


Fig 6: Mode shape3

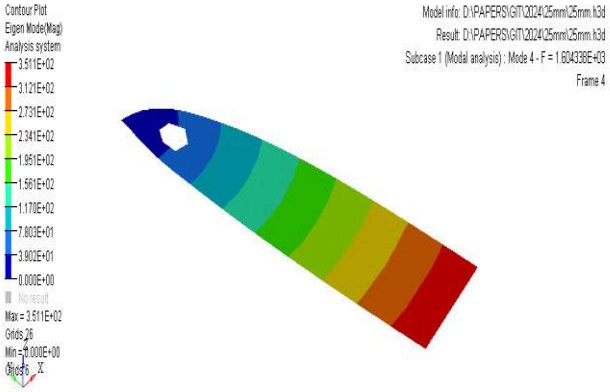


Fig 7: Mode shape4

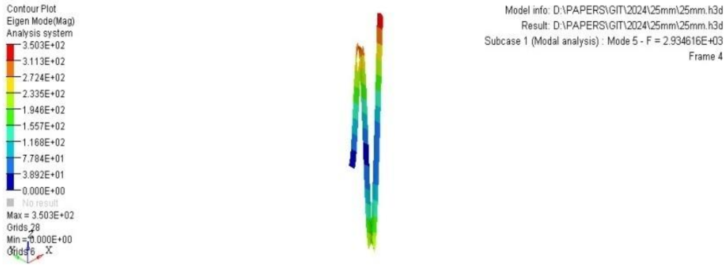


Fig 8: Mode shape 5

The mode shapes for case 2 are shown below in figures from fig 9 to fig13

Case 2: Plate with hole at distance of 50mm from fixed end

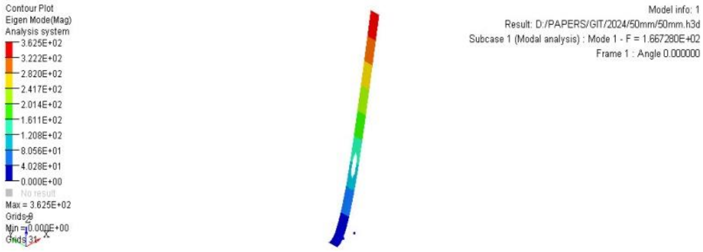


Fig 9: Mode shape1

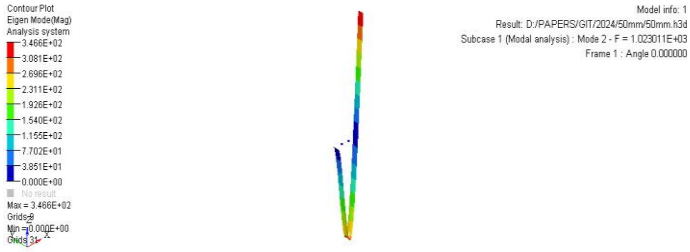


Fig 10: Mode shape2

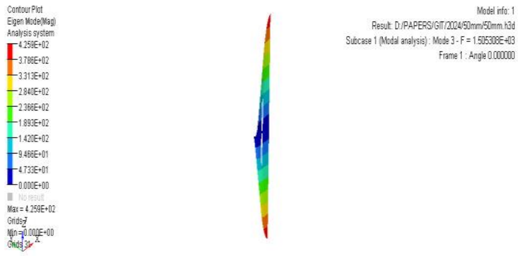


Fig 11 Mode shape 3

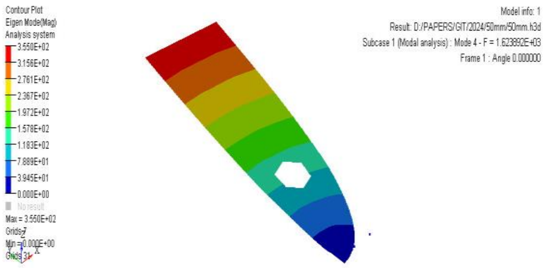


Fig 12 Mode shape 4

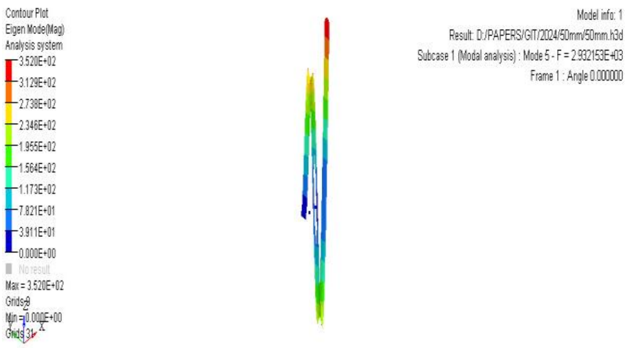


Fig 13 Mode shape5

The mode shapes for case 3 are shown below in figures from fig 14 to fig18

Case 3: Plate with hole at distance of 75mm from fixed end

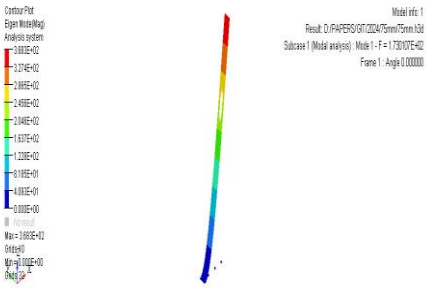


Fig 14 Mode shape 1

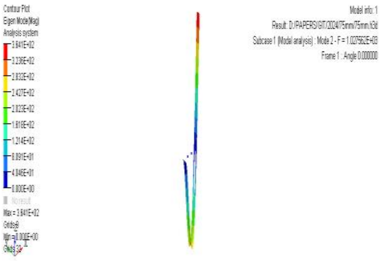


Fig15 Mode shape 2

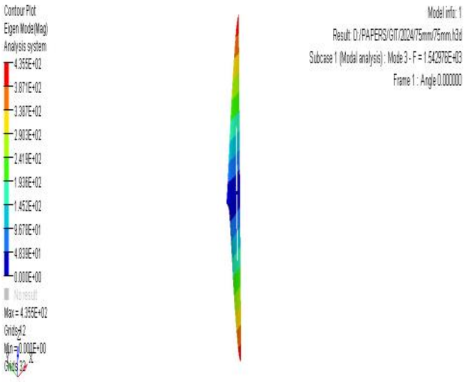


Fig 16 Mode shape 3

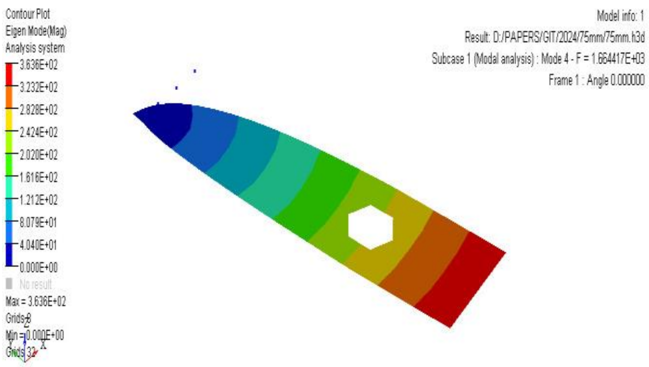


Fig17 Mode shape 4

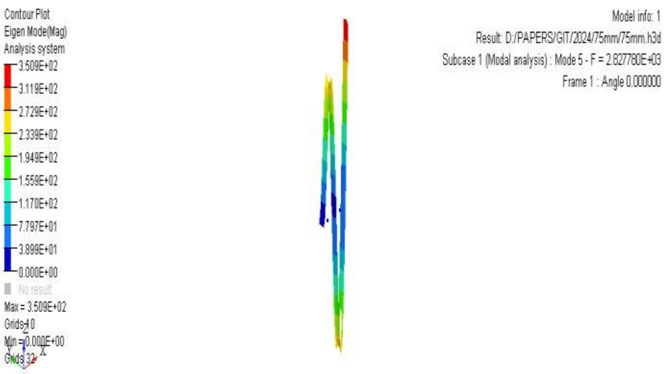
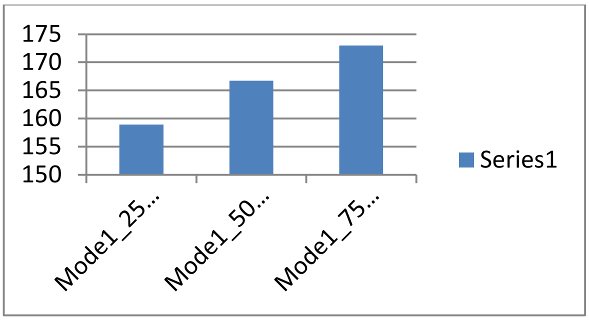
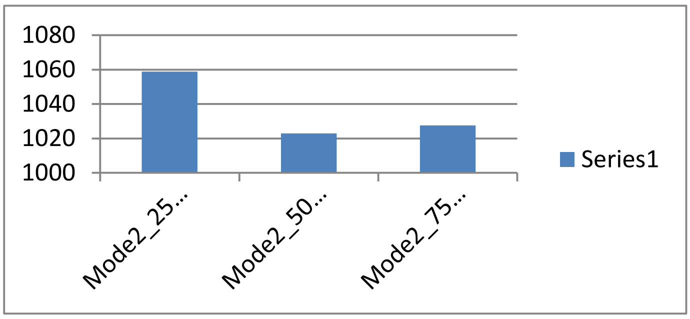


Fig 18 Mode shape5

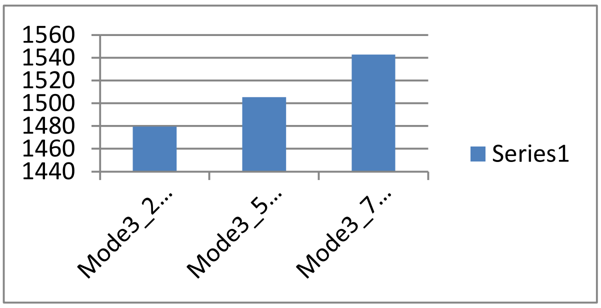
The bar chart graph for the different mode shapes for the three cases is shown in below figures.



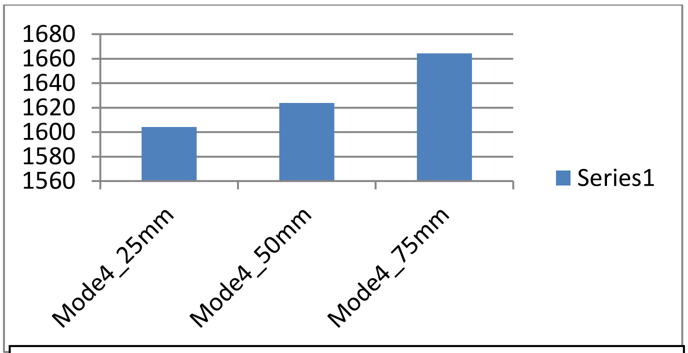
We can see that there is an increase in natural frequency from case 1 to case 3.



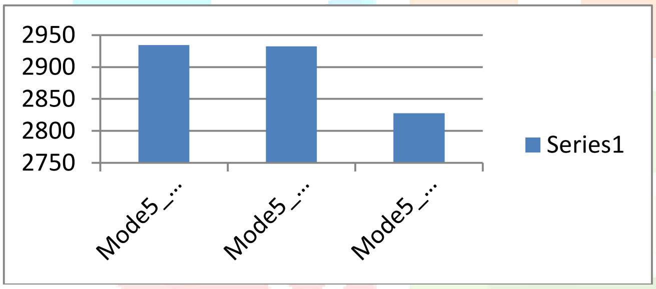
We can see that there is an decrease and increase in natural frequency from case 1 to case3.



We can see that there is an increase in natural frequency from case 1 to case 3.



We can see that there is an increase in natural frequency from case 1 to case 3.



We can see that there is a decrease in natural frequency from case 1 to case 3.

5. CONCLUSION

Whenever we require change in frequencies instead of changing the whole plate we can just relocate the hole position in order to obtain the desired change in frequency. As a result of that we can avoid the resonance.

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