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Modal Analysis of a Square Plate with Reinforcement with Number of Stiffeners

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ABSTRACT

This Modal analysis is a major technique to determine the vibration characteristics of engineering structures and its component's. It is a process by which the natural frequencies, mode shapes of the structure can be determined with a relative ease. It should be a major alternative to provide a helpful contribution in understanding control of many vibration phenomena which encompasses in practice. In this work comparison of the natural frequency of the square plate with different number of reinforcement is found by using FEA .The main objective of this paper is to determine the natural frequency and mode shape of a square plate with different number of reinforcements. The number of ribs is increased in each iteration.

KEYWORDS: *Natural frequency, mode shapes, reinforcement, FEA.*

A. INTRODUCTION

Modal analysis is the study of the dynamic properties of systems in the frequency domain. Examples would include measuring the vibration of a car's body when it is attached to a shaker, or the noise pattern in a room when excited by a loudspeaker.

Modern day experimental modal analysis systems are composed of 1) Sensors such as transducers as, or non contact via a Laser vibrometer, or stereo photogrammetric cameras 2) Data acquisition system and an analogue-to-digital converter frontend (to digitize analogue instrumentation signals) and 3) Host PC (personal computer) to view the data and analyze it.

Classically this was done with a SIMO (single-input, multiple-output) approach, that is, one excitation point, and then the response is measured at many other points. In the past a hammer survey, using a fixed accelerometer and a roving hammer as excitation, gave a MISO (multiple-input, single-output) analysis, which is mathematically identical to SIMO, due to the principle of reciprocity. In recent years MIMO (multi-input, multiple-output) have become more practical, where partial coherence analysis identifies which part of the response comes from which excitation source. Using multiple shakers leads to a uniform distribution of the energy over the entire structure and a better coherence in the measurement. A single shaker may not effectively excite all the modes of a structure

Stiffening objects or processes brings rigidity and structural integrity. Stiffening is used in industry, architecture, sports, aerospace, object construction etc. In mechanics, "stiffening" beams brings anti-buckling, anti-wrinkling, desired shaping, reinforcement, repair, strength, enhanced function, extended utility. In medicalarts, aerospace, aviation, sports, bookbinding, art, architecture, natural plants and trees, construction industry, bridge building, and more. Mechanical methods for stiffening include tension stiffening, centrifugal stiffening, bracing, superstructure bracing, substructure bracing, straightening, strain stiffening, stress stiffening, damping vibrations, swelling, pressure increasing, drying, cooling, interior reinforcing, exterior loads or compression invite stiffening to stop buckling or reinforcing, wrapping, surface treating, or combinations of these and other methods. Beams under bending collapse while fulfilling desired functions, purposes, and benefits.

B. PROBLEM DEFINITION:

A square plate of (50X50) mm planar area is considered for analysis. Thickness of the plate considered is 2mm. The plate is then subjected to different number of reinforcements ie ribs i.e one, two, three and four. The reinforcement area will increase from single rib to four ribs.

The boundary conditions for the plate with different cut outs is kept same i.e all the four corners of the plate are constrained in all DOF

Four different square plates of above mentioned dimensions is considered with all four corners completely fixed in all DOF.

The geometry of square plate with single rib, two ribs, three ribs and four ribs is shown in figures from fig1 to fig4.

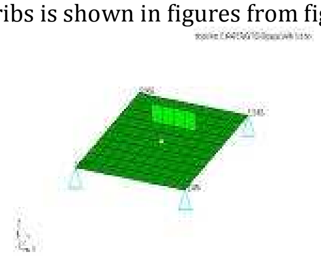

Fig. 1 Square plate with single rib

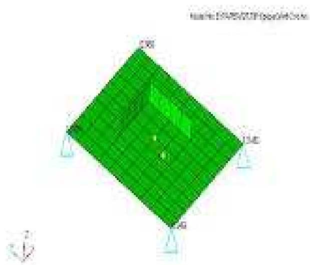

Fig 2 Square plate with two ribs

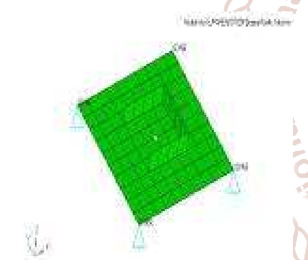

Fig 3 Square plate with three ribs

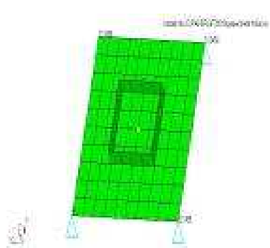

Fig 4 Square plate with four ribs

C. RESULT ANALYSIS:

The modal analysis of all the plates with different reinforcements is carried out and the results are tabulated as shown in below table.

Mode Shape	With 1rib	With 2ribs	With 3ribs	With 4ribs
1	2900	2892	2873	2862
2	5611	5586	5562	5540
3	5634	5595	5570	5540
4	7056	7448	7801	8269
5	12862	12811	12814	12860
6	13069	13336	13577	13932

Table1: Natural frequencies of plate with increase in number of ribs for 6 mode shapes.

Mode shapes of Square plate with single rib

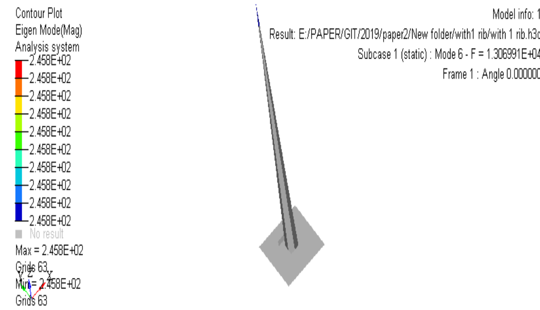

Fig 5 Mode shape 1with Natural frequency 2900

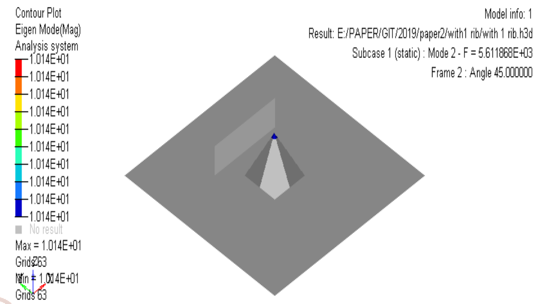

Fig 6 Mode shape 2 with Natural frequency 5611

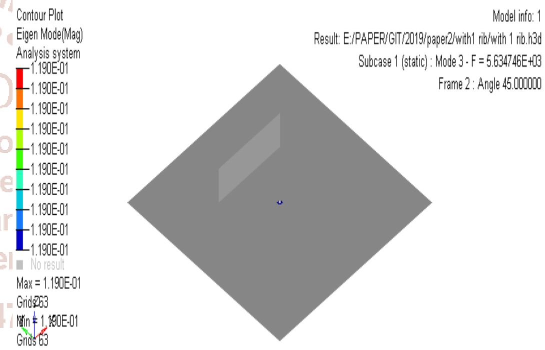

Fig.7 Mode shape 3 with Natural frequency 5634

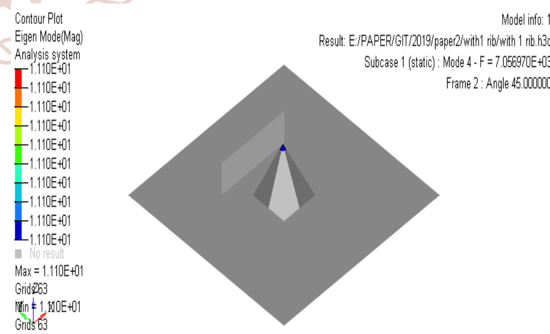

Fig.8 Mode shape 4 with Natural frequency 7056

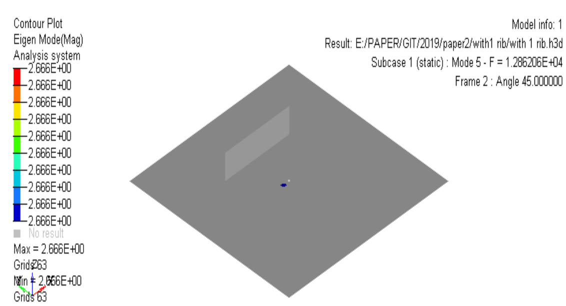

Fig.9 Mode shape 5 with Natural frequency 12862

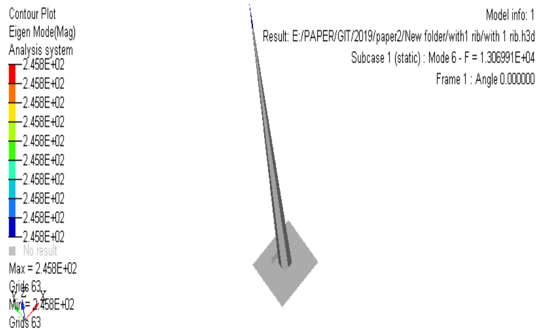

Fig.10 Mode shape 6 with Natural frequency 13069

Mode shapes of Square plate with two ribs

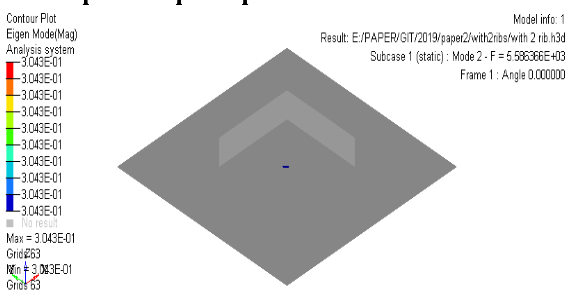

Fig.11 Mode shape1 with Natural frequency 2892

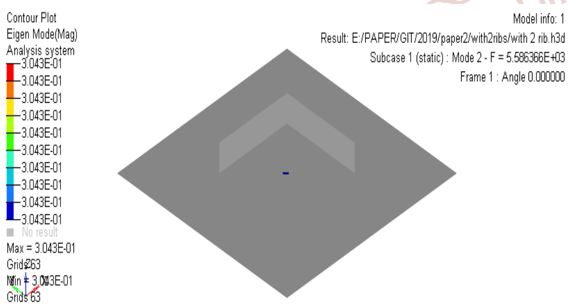

Fig.12 Mode shape2 with Natural frequency 5586

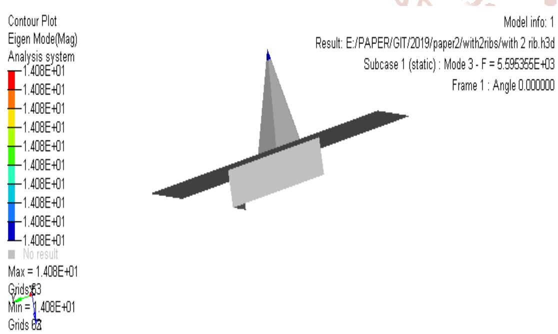

Fig.13 Mode shape3 with Natural frequency 5595

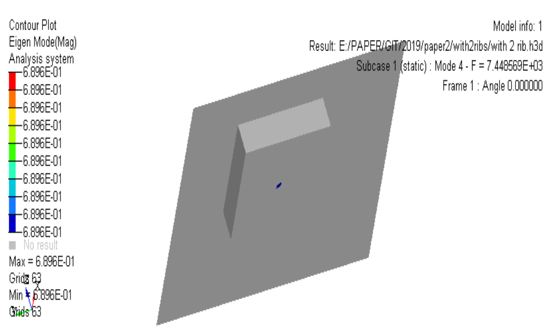

Fig.14 Mode shape4 with Natural frequency 7448

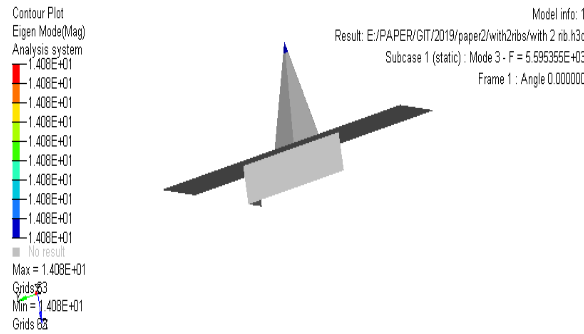

Fig.15 Mode shape5 with Natural frequency 12811

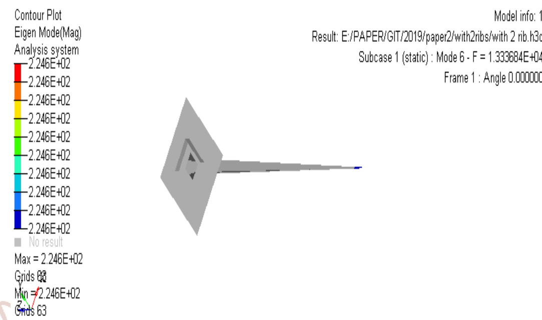

Fig.16 Mode shape6 with Natural frequency 13336

Mode shapes of Square plate with three ribs

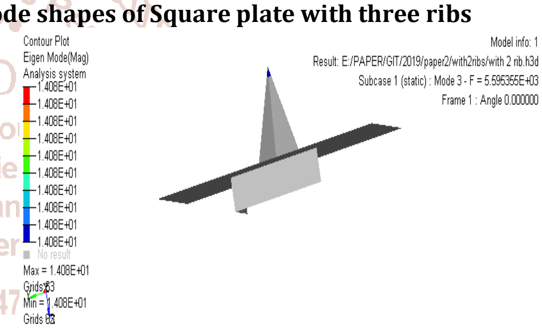

Fig.17 Mode shape1 with Natural frequency 2873

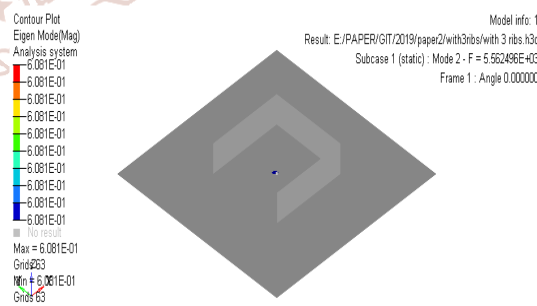

Fig.18 Mode shape2 with Natural frequency 5562

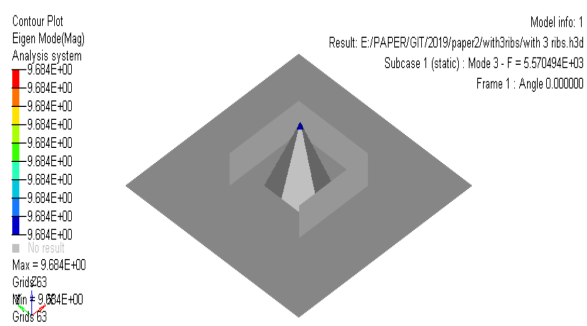

Fig.19 Mode shape3 with Natural frequency 5570

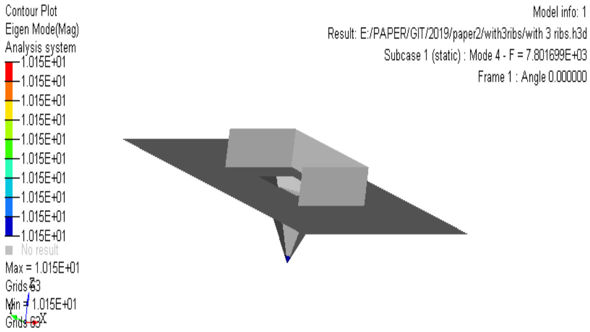

Fig.20 Mode shape 4with Natural frequency 7801

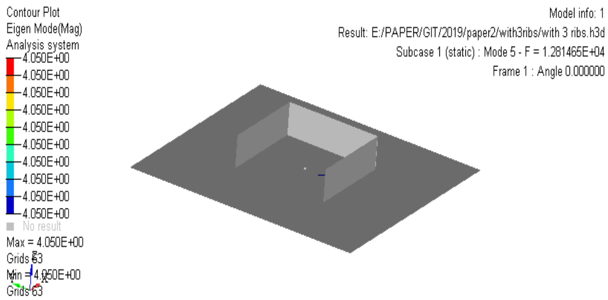

Fig.21 Mode shape5 with Natural frequency 12814

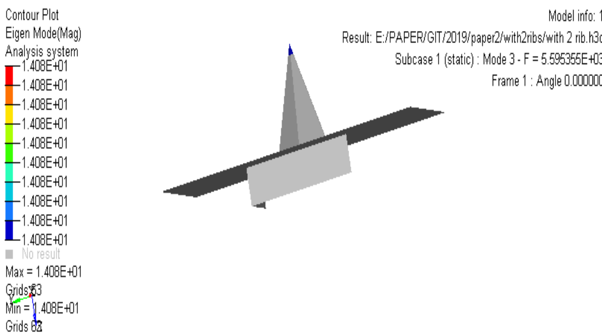

Fig.22 Mode shape6 with Natural frequency 13577

Mode shapes of Square plate with Four Ribs

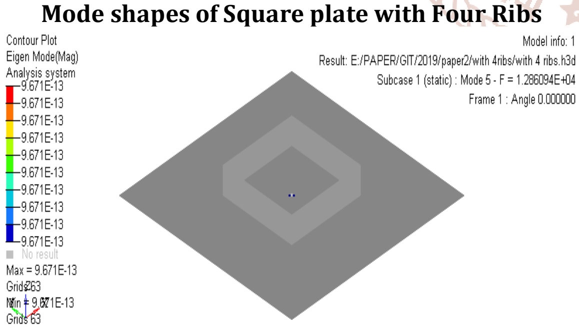

Fig.23 Mode shape1 with Natural frequency 2862

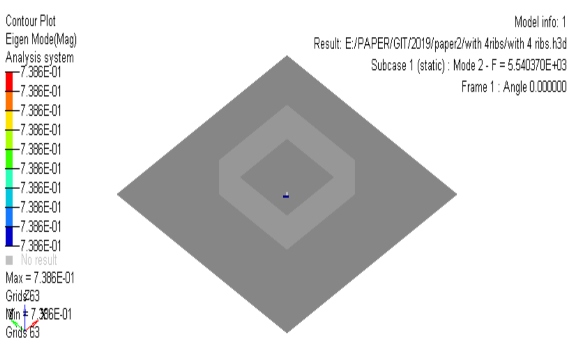

Fig.24 Mode shape2 with Natural frequency 5540

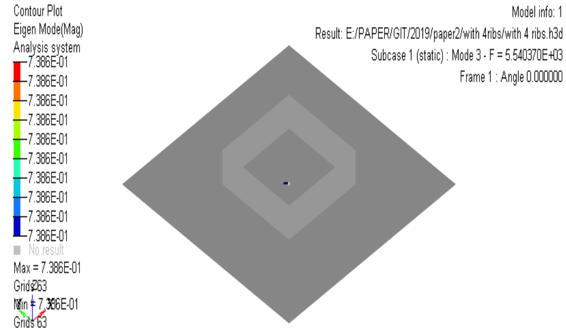

Fig.25 Mode shape3 with Natural frequency 5540

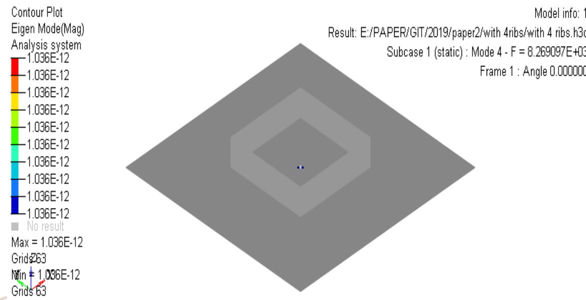

Fig.26 Mode shape4 with Natural frequency 8269

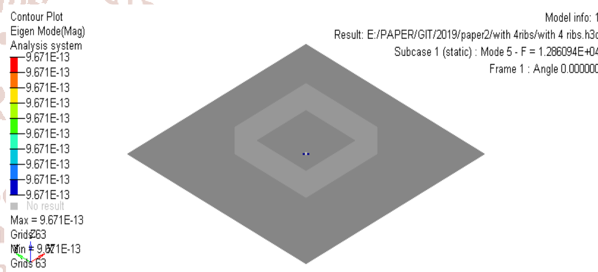

Fig.27 Mode shape 5with Natural frequency 12860

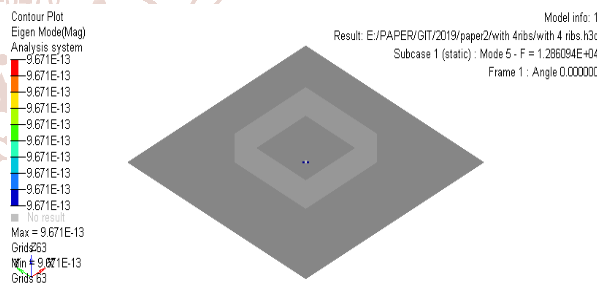

Fig.28 Mode shape6 with Natural frequency 13932

The bar chart showing the variation of natural frequency in each mode for increasing number of ribs is shown in the below figures.

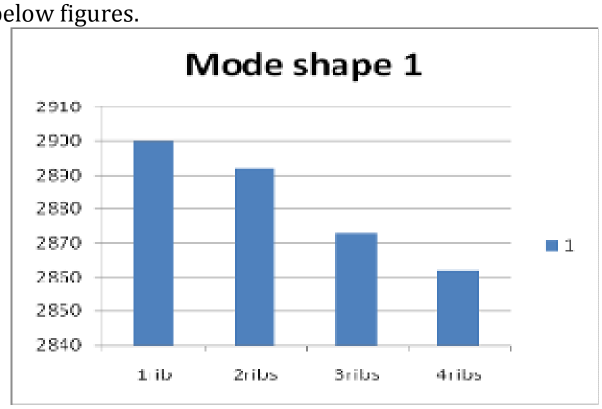

Fig.29 Variation of natural frequency for Mode shape 1

It has been observed that for mode shape 1 the natural frequency is decreasing.

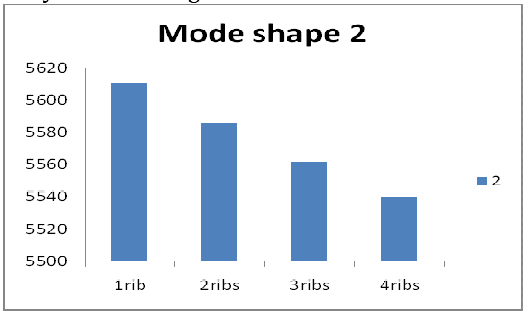

Fig.30 Variation of natural frequency for Mode shape 2

It has been observed that for mode shape 2 the natural frequency is decreasing.

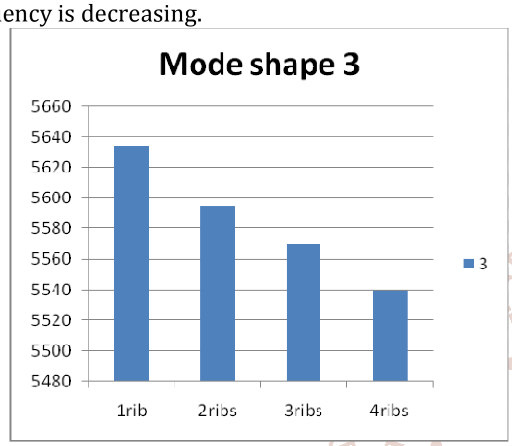

Fig.31 Variation of natural frequency for Mode shape 3

It has been observed that for mode shape 3 the natural frequency is decreasing.

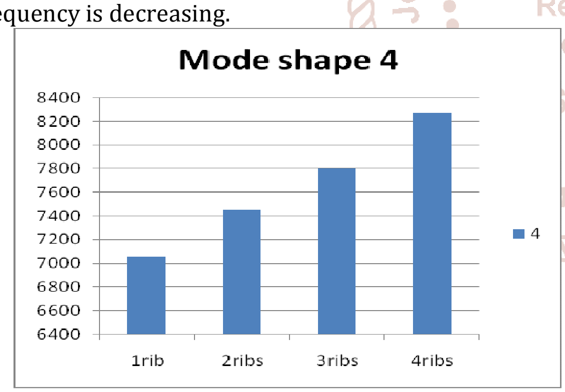

Fig.32 Variation of natural frequency for Mode shape 4

It has been observed that for mode shape 4 the natural frequency is increasing.

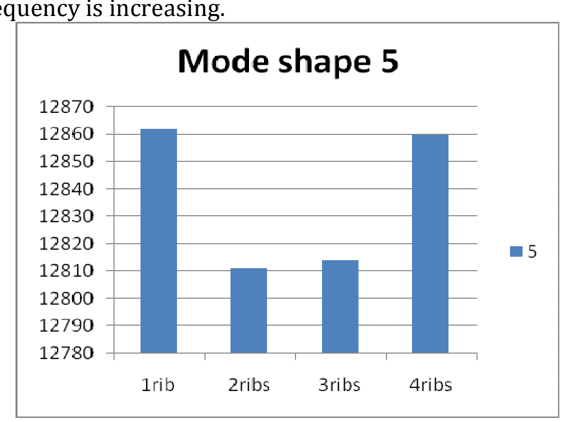

Fig.33 Variation of natural frequency for Mode shape 5

It has been observed that for mode shape 5 the natural frequency is decreasing and increasing.

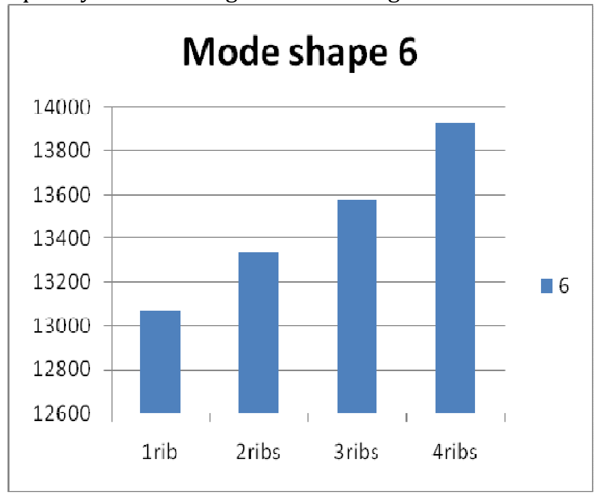

Fig.34 Variation of natural frequency for Mode shape 6

It has been observed that for mode shape 6 the natural frequency is increasing.

CONCLUSION

The finite element formulation is used to study effect of reinforcements on the free vibration of Mild steel plate. The results obtained from finite element software are presented and discussed above. The conclusions that can be made from the present study are summarized as follows:

It has been observed that the natural frequency for the plate with increasing number of ribs is decreasing for mode shape 1, 2 and 3 and is increasing for mode shape 4, 5 and 6. Hence in order to have decrease in frequency of plate number of ribs should be increased for mode shapes 1, 2 and 3 where as to obtain increase in frequency of plate number of ribs should be increased for mode shapes 4, 5 and 6. Hence depending on the requirement of the frequency the reinforcement on the plate can be selected.

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