

# Design and Analysis of Agricultural Tractor Footrest to Reduce Vibration Level

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**ABSTRACT:** The design and analysis plays a major role for determining the root cause for the problem. Once the problem and its root cause were well defined, the solution for addressing the problem would be made clear. The engine excitation frequency and the chassis natural frequency were coming closer and it leads chassis to resonate. The resonance increases vibration levels at the Tractor footrest which was reducing comfort level of the operator. The vibration reduction methodologies like stiffening the structure, isolating the source from excitation and dampening techniques were studied to reduce vibration levels at footrest. Design of existing tractor foot rest in CATIA software and FEA analysis is to be performed using ANSYS software. In present investigation static, modal analysis and harmonic is to be performed on tractor footrest to determine stress, deformation and natural frequency and also to improve the existing design using bead pattern to obtain improved natural frequency. Experimental and FEA analysis results will be compared and conclusion will be drawn.

**KEYWORDS:** CATIA, Design, ANSYS footrest, Vibration.

## 1. INTRODUCTION

In early American homes the footstool was very valuable and took precious space although the living quarters were cramped. In line with this, the exhibition 'A History of the World' at Mevagissey Museum in Cornwall showed an emigrant's footstool which was made by an emigrant from Cornwall in North America sometime around 1850's. The term vibration describes repetitive motion that can be measured and observed in a structure. Unwanted vibration can cause fatigue or degrade the performance of the structure. Therefore, it was desirable to eliminate or reduce the effect of vibration. There were higher vibrations on the footrest of the tractor, and it was reducing comfort level of the operator [1,2]. This examination was started to lessen current vibration level and to give solace to the operator. The modular examination was utilized to discover characteristic recurrence of benchmarking farm truck model and gauge work vehicle model [4]. The objective was set to expand regular recurrence of standard farm hauler model to benchmark as the two work vehicles have three chambers motor which was causing reverberation with frame [6]. The higher vibration level at the hassock of the work vehicle which was found during the client association and reported as voice of client [7]. The benchmarking assessment was likewise finished with chosen farm vehicle model subjectively to survey the vibration level contrasts in the view of clients, for understanding the degree of the vibration issue and building up a scale for setting up an objective for accomplishment [9, 11].

## II. DESIGN AND ANALYSIS EXISTING TRACTOR FOOTREST

### 2.1 Design of tractor footrest: -

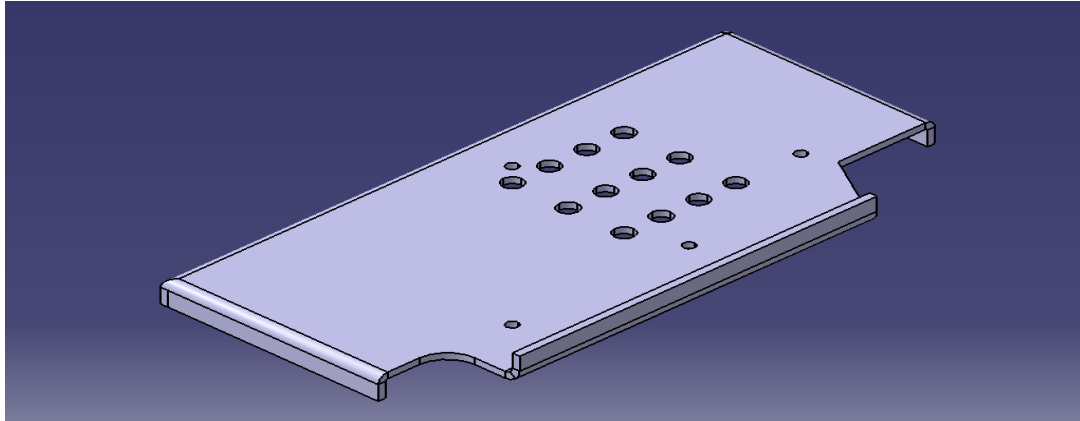


Fig. 2.1 CATIA 3D view tractor footrest

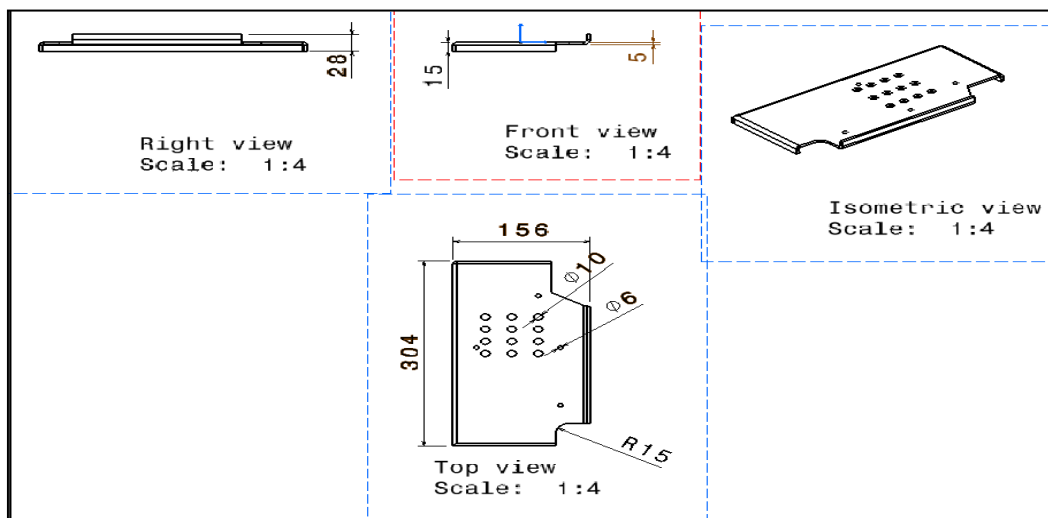


Fig. 2.2 Drafting of tractor footrest

Computer-aided design (CAD) supported structure (CAD) is the utilization of Computer-aided design frameworks (or workstations) to help in the creation, adjustment, examination, or advancement of a plan. Computer aided design programming is utilized to build the efficiency of the fashioner, improve the nature of configuration, improve correspondence through documentation, and to make information base for assembling. Computer aided design yield is frequently as electronic records for print, machining or other assembling tasks. Its utilization in structuring electronic frameworks is known as electronic plan mechanization (EDA). In mechanical plan it is known as mechanical structure computerization (MDA) or Computer aided design helped drafting (CAD), which incorporates the way toward making a specialized drawing with the utilization of program. Computer aided design is a significant modern workmanship broadly utilized in numerous applications. Counting car, shipbuilding and aviation businesses modern and structural plan, prosthetics and some more. Computer aided design is additionally generally used to deliver PC activity for embellishments in motion pictures, promoting and specialized manuals, regularly called DCC computerized content creation. The cutting-edge pervasiveness and intensity of PCs imply that even aroma container and cleanser allocator is configuration utilizing method of by designers of the 1960s. In light of its tremendous monetary significance, CAD has been a significant main thrust for research in computational geometry, PC illustrations (both equipment and programming), and discrete differential geometry. The plan of geometric models for object shapes, specifically, is at times called PC supported geometric structure (CAD).

## 2.2 TYPES:

There are several different types of CAD, each requiring the operator to think differently about how to use them and design their virtual components in a different manner for each. There are many producers of the lower-end 2D systems, including a number of free and open-source programs. These provide an approach to the drawing process without all the fuss over scale and placement on the drawing sheet that accompanied hand drafting since these can be adjusted as required during the creation of the final draft. 3D wireframe is basically an extension of 2D drafting (not often used today). Each line has to be manually inserted into the drawing. The final product has no mass properties associated with it and cannot have features directly added to it, such as holes. The operator approaches these in a similar fashion to the 2D systems, although many 3D systems allow using the wireframe model to make the final engineering drawing views.

**2.2.1 Parametric modelling:** demonstrating permits the operator to utilize what is alluded to as "structure purpose". The articles and highlights made modifiable. Any future adjustments can be made by changing how the first part was made. On the off chance that a component was expected to be situated from the focal point of the part, the operator ought to find it from the focal point of the model. The component could be found utilizing geometric article effectively accessible in the part, yet this arbitrary arrangement would overcome the structure purpose. On the off chance that the administrator plans the part as it works the parametric modeler can make changes to the part while keeping up geometric and useful connections.

**2.2.2 Direct or Explicit modelling:** give the capacity to alter geometry without a history tree. With direct demonstrating, when a sketch is utilized to make geometry the sketch is consolidated into the new geometry and the planner just alters the geometry without requiring the first sketch. Likewise, with parametric displaying, direct demonstrating can incorporate connections between chose geometry (e.g., juncture, concentricity). Top end frameworks offer the abilities to join increasingly natural, style and ergonomic highlights into structures. Freestyle surface displaying is frequently joined with solids to permit the creator to make items that fit the human structure and visual prerequisites just as they interface with the machine.

## 2.3 FEA (FINITE ELEMENT ANALYSIS):

The finite element method (FEM) is a numerical method for solving problems of engineering and mathematical physics. Typical problem area of interest includes structural analysis, heat transfer, fluid flow, mass transport and electromagnetic potential. The analytical solution of these problems generally requires the solution to boundary value problems for partial differential equations. The finite element method formulation of the problem results in the system of algebraic equations. The finite element method formulation of the problem results in a system of algebraic equations. The method yields approximate value of the unknowns at discrete number of points over the domain. To solve the problem, it subdivides a large problem into smaller, simpler part that is called finite element.

Basic Concept:

The subdivision of a whole domain into simpler parts has several advantages:

- Accurate representation of complex geometry
- Inclusion of dissimilar material properties
- Easy representation of the total solution
- Capture of local effects.

FEM is best comprehended from its molecule application, known as limited component investigation (FEA). FEA as applied in designing is a computational instrument for performing building examination. It incorporates the utilization of work age procedures for partitioning complex issue into little components, just as utilization of programming program coded with FEM calculation. In applying FEM, the intricate issue generally a physical framework with the fundamental material science, for example, the Euler-Bernoulli pillar condition, or the Naiver-Stocks conditions communicated in either PDE or basic condition, while the isolated little components of the mind boggling issue speak to various territory in the physical framework.

### 2.4 Modal Analysis:

Every object has an internal frequency (or resonant frequency) at which the object can naturally vibrate. It is also the frequency where the object will allow the transfer of energy from one form to another with minimum loss. As the frequency increases toward the “resonant frequency,” the amplitude of resonance asymptotically increases of infinity. In other words, the results of the model analysis are these frequencies at which the amplitude increases to infinity.

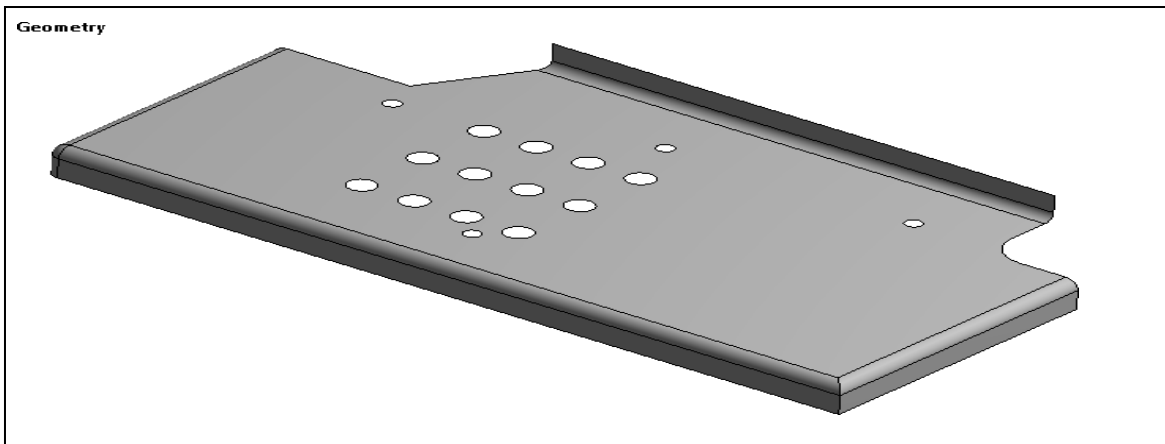


Fig. 2.3 Geometry imported in ANSYS

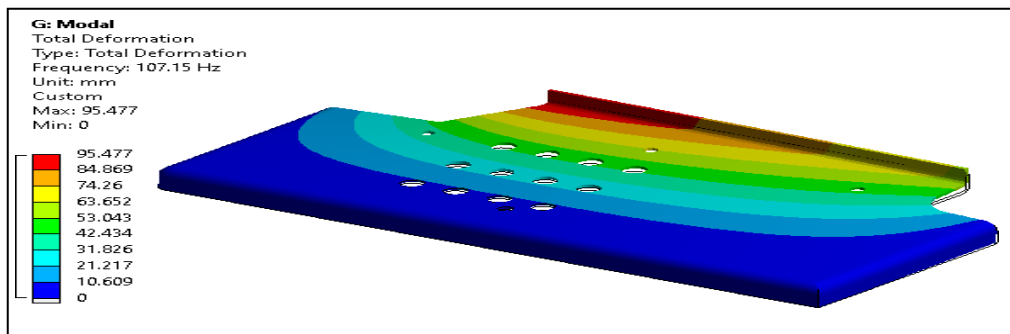


Fig. 2.4 Mode shape 1

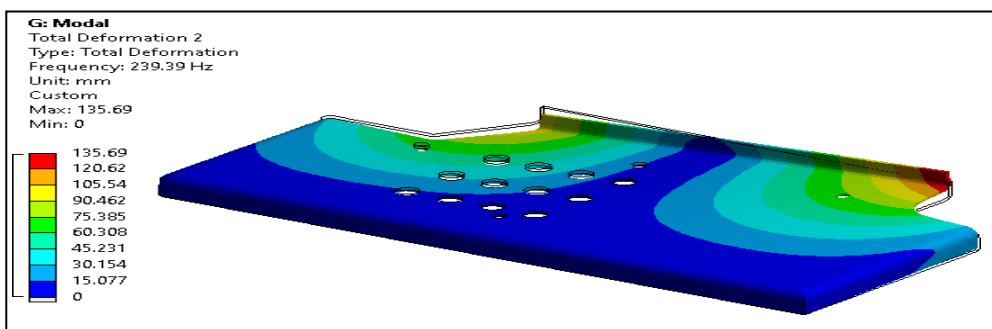


Fig. 2.5 Mode shape 2

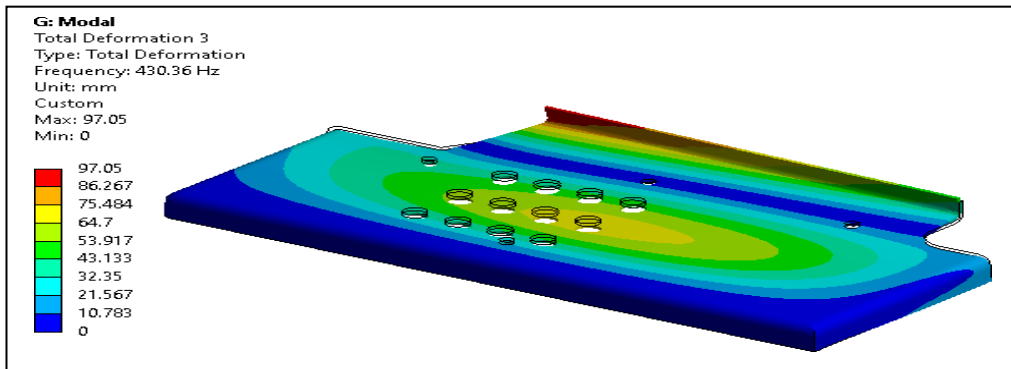


Fig. 2.6 Mode shape 3

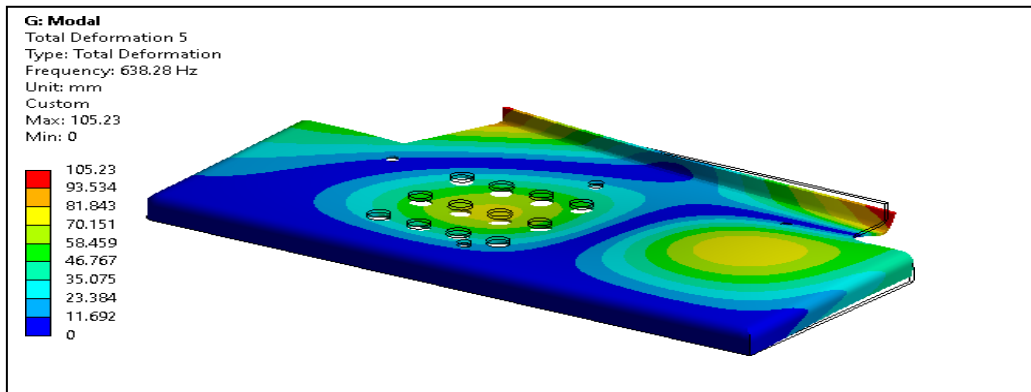


Fig. 2.7 Mode shape 4

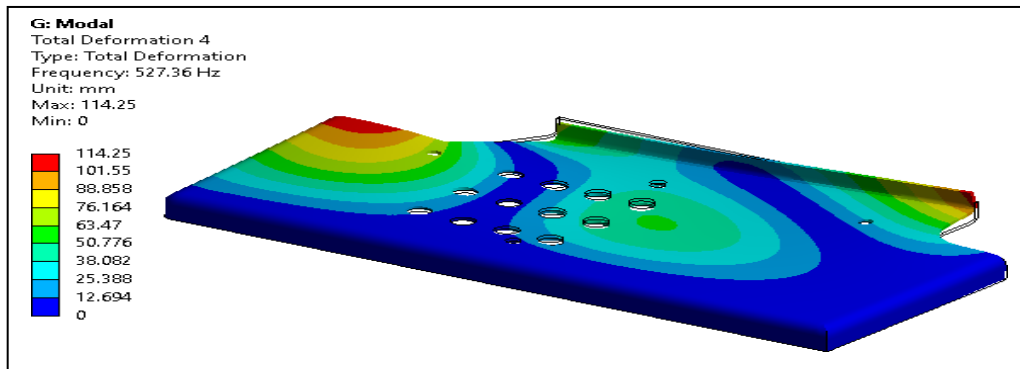


Fig. 2.8 Mode shape 5

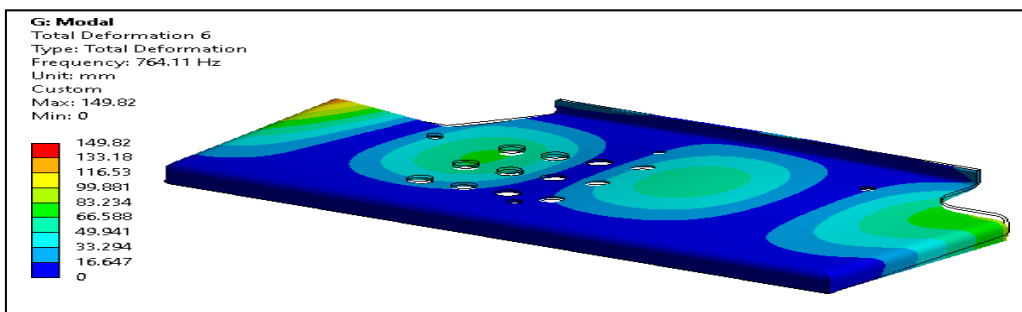


Fig. 2.9 Mode shape 6

Table No. 3.2 Tabular data analysis Existing Geometry

Tabular Data		
	Mode	Frequency [Hz]
1	1.	107.15
2	2.	239.39
3	3.	430.36
4	4.	527.36
5	5.	638.28
6	6.	764.11

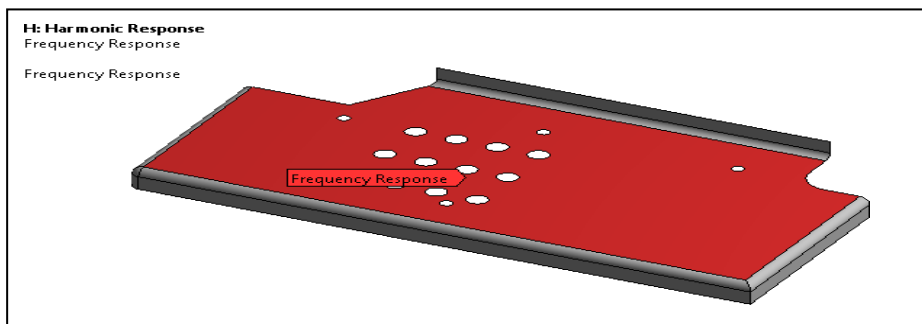
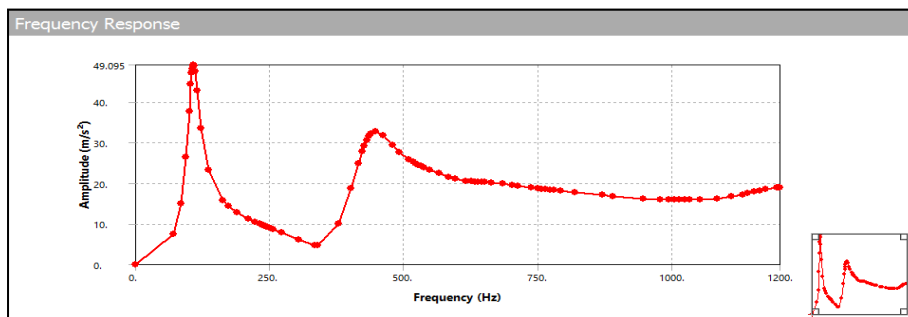


Fig. 2.7 Frequency response surface 1



Graph No. 2.1 Frequency Vs Amplitude response (1)

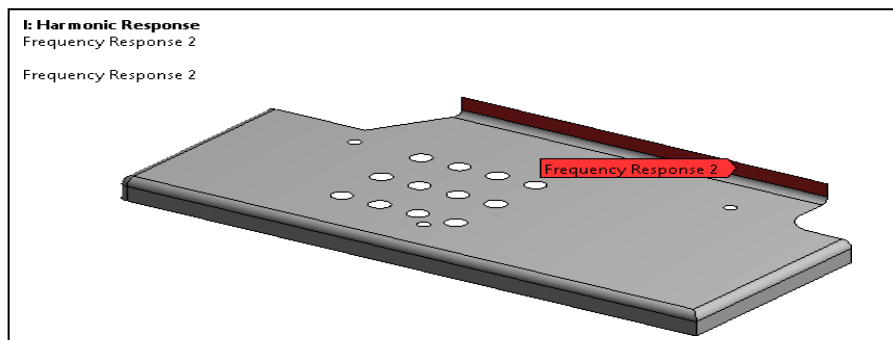
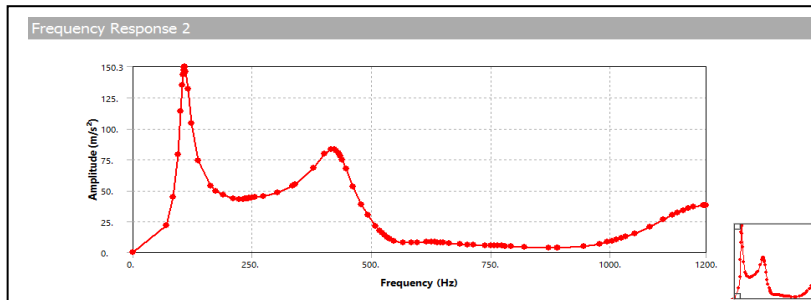


Fig. 2.11 Frequency response surface 2



Graph No. 2.2 Frequency Vs Amplitude response (2)

- It is observed from harmonic analysis that frequency response at surface and at edge are 49.095 m/s<sup>2</sup> and 150.3 m/s<sup>2</sup> respectively.

#### IV. MODIFIED GEOMETRY WITH 15 MM BEAD DIAMETER

Fig. 4.1 Geometry imported in ANSYS

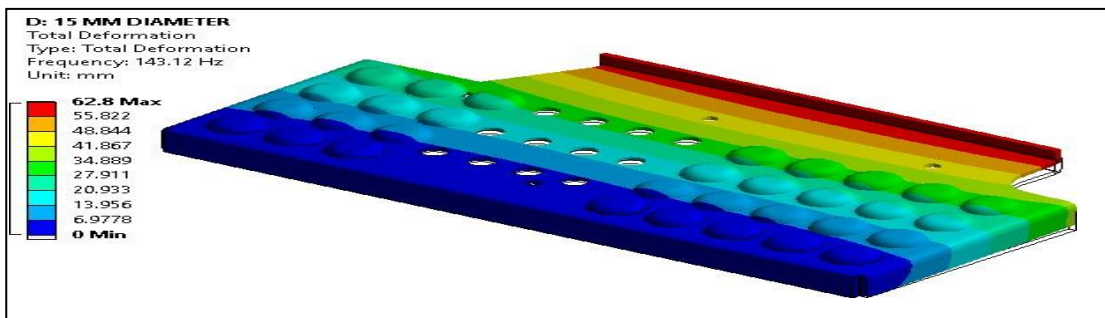


Fig. 4.2 Mode shape 1

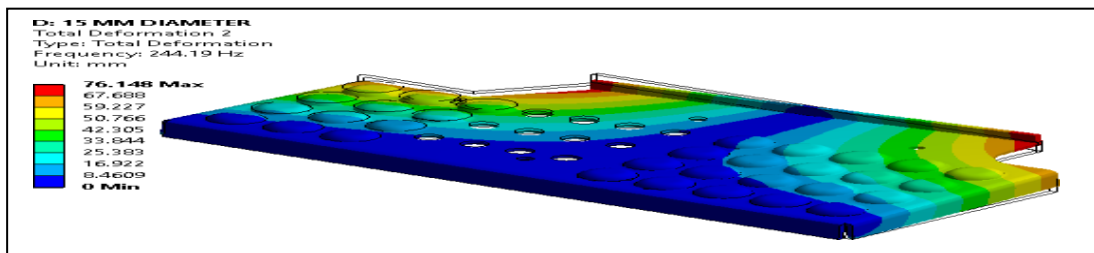


Fig. 4.3 Mode shape 2

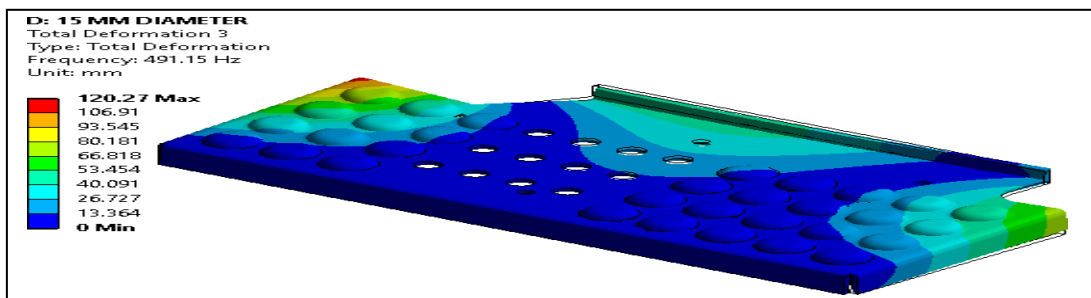


Fig. 4.4 Mode shape 3

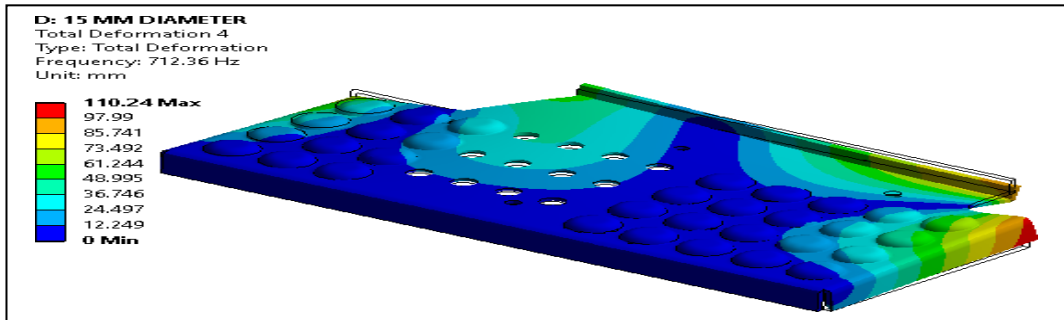


Fig. 4.5 Mode shape 4

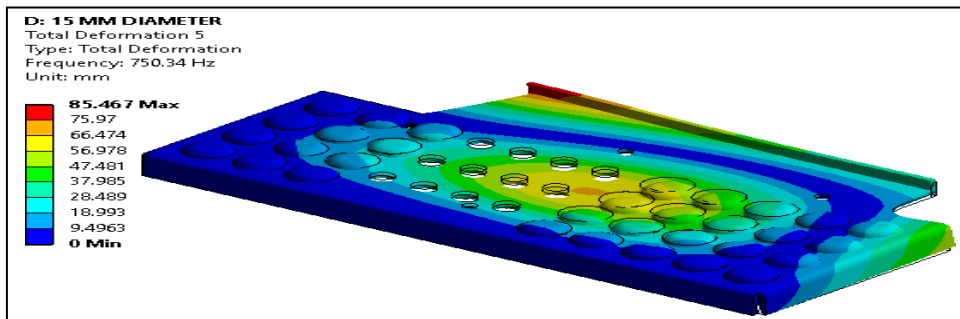


Fig. 4.6 Mode shape 5

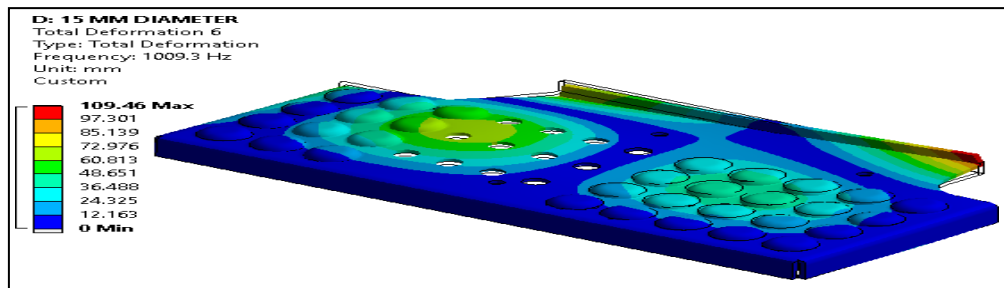


Fig. 5.4 Mode shape 6

Table No. 4.1 Tabular data analysis 15 mm diameter

Tabular Data		
	Mode	<input checked="" type="checkbox"/> Frequency [Hz]
1	1.	143.12
2	2.	244.19
3	3.	491.15
4	4.	712.36
5	5.	750.34
6	6.	1009.3



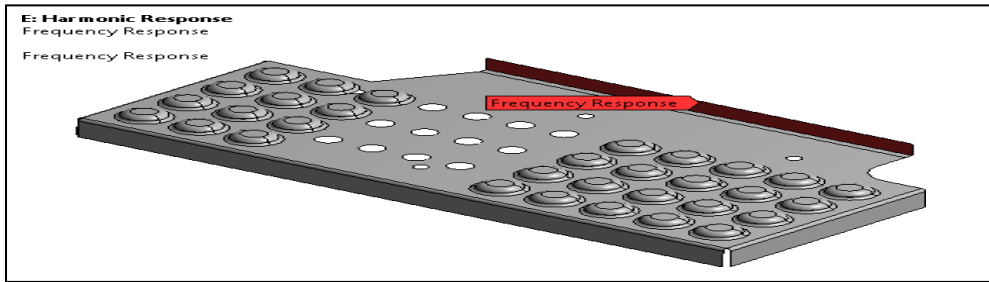
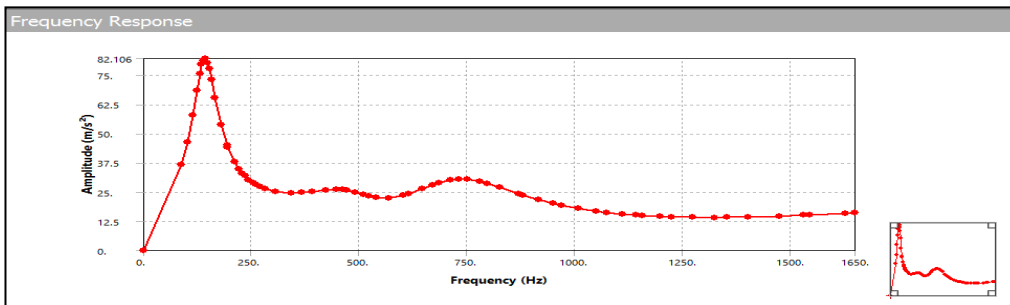


Fig.4.8 Frequency response surface (1)



Graph No. 4.1 Frequency Vs Amplitude response 1

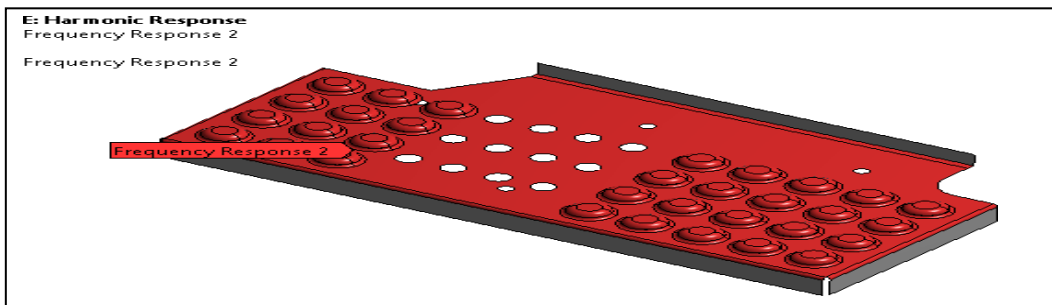
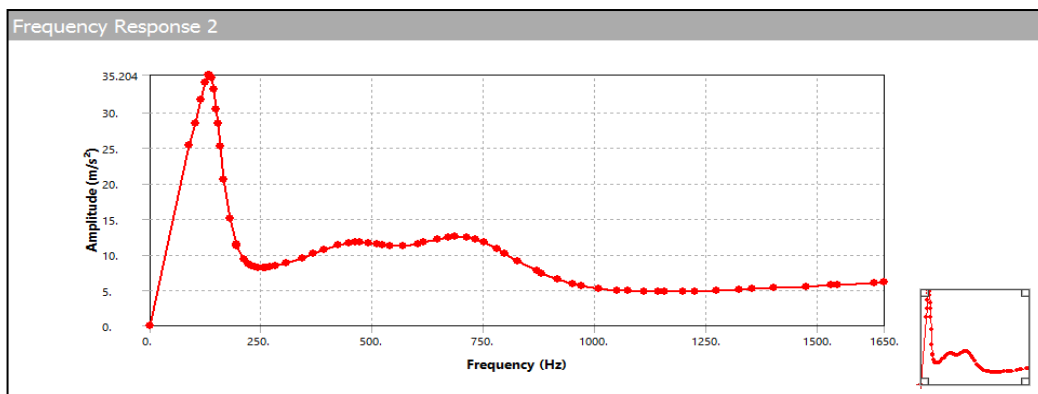


Fig. 4.9 Frequency response surface 2



Graph No. 4.2 Frequency Vs Amplitude response 2

- It is observed that frequency have been improved compared to existing pattern design.

## V.CONCLUSION

- It is observed from harmonic analysis that frequency response at surface and at edge are  $35.204 \text{ m/s}^2$  and  $82.106 \text{ m/s}^2$  respectively.
- In present investigation static, modal and harmonic analysis is performed to determine stress and structural deformation with mode shape of respective frequency with existing and modified agricultural tractor footrest.
- It is observed that BEAD pattern has improved the structural deformation and equivalent stress concentration reduction with reducing natural frequency along existing agricultural tractor footrest with respect to modified agricultural tractor footrest.

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