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VIBRATION ANALYSIS OF 2-WHEELER DASHBOARD VIBRATION FIXTURE

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Abstract- Climate are major problem in working of machine. Unwanted climate can beget resonance effect which can damage the delicate machine element, so while designing the machine; climate are also considered. After manufacturing of machine/ machine element it undergoes colorful vibration test, Institution transmit energy to test sample. Institution design must be rigid simple featherlight and most important profitable. Speedometer is a hand that measures and displays the real- time speed of a vehicle. In this study, we were probing the vibration sustainability of 2 wheeler dashboard using vibration institution. FEA analysis of 2 wheeler dashboard institution is being done on ANSYS workbench. Natural frequency of the dashboard institution is observed. Modal analysis will be performing on ANSYS.

I. INTRODUCTION

In the automotive and two- wheeler assiduity, the vibration characteristics of vehicle factors are critical for enhancing continuity, performance, and rider comfort. Among these factors, the dashboard plays a significant part as it houses essential instruments and controls that must remain stable and comprehendible under colorful operating conditions. Still, the dashboard of a two- wheeler is particularly susceptible to climate due to the vehicle's exposure to rough terrains, high pets, and variable environmental conditions. Inordinate or inadequately managed climate can lead to issues similar as structural fatigue, element loosening, and compromised readability of needles and pointers. Thus, analyzing and understanding the vibration response of the dashboard is essential to optimize its design and insure its life and trust ability.

Institutions are designed for testing the element abidance and insure fatigue failure of the element. The institutions are being manufactured using high strength to weight rate accoutrements. The institutions are meant to be stiff enough to absorb the climate and shocks generated by arbitrary climate generated due to changeable road conditions. The institutions do have some limitation, Institution should be light in weight it should cover the element respect to road shocks and climate. As technology keep on progressing the quantum of electrical and electromechanical factors put into two wheeler, exchanges and motorcars increase in number. They thus play a decreasingly larger part in assuring the proper functionality of a vehicle. A vibration test institution is the interface between the device under test and the vibration outfit. Still, the test institution needs to be more stiff and rigid than the corresponding part used for mounting on the vehicle, since climate during accelerated testing are much more severe than climate during true operation of the element. A dashboard is a way of displaying colorful types of visual data in one place. Generally, a dashboard is intended to convey different, but affiliated information in an easy- to- condensation form. The dashboard of a auto refers to the control panel in front of the motorist that displays colorful information about the vehicle's operation and status.

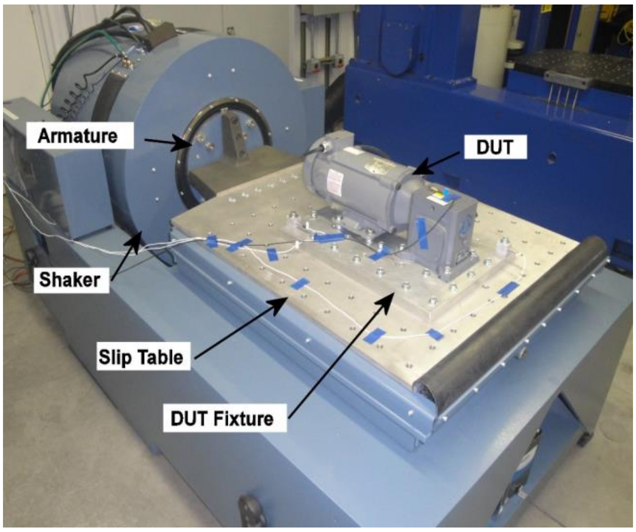


Fig 1 – vibrating shaker table

Climate are a major problem in the working of machine machines. Unwanted climate can beget resonance effect which can damage the delicate machine element, so while designing the machine, climate are also considered. After manufacturing of machine/ machine element it undergoes various vibration tests, Institutions transmit energy to test samples. Institution design must be rigid simple, feathery, and most importantly provident. Use of modern analysis tools and Computer backed Design software has made design of institutions royal. Vibration institution design is a necessary element of vibration testing that is constantly a challenge for multitudinous engineers. When it comes to the design of institutions, the choice of paraphernalia used is truly important. For illustration, common paraphernalia include magnesium, aluminium, and brand. Nearly all advanced ministries and dynamic mechanical systems employ electronics for controlling and covering its performance. The dynamic nature of the machine rudiments leads to the generation of climate within the system. These climate fatigue the mechanical factors in the long run as well as disturb the sound working of the electronic factors in the long run. If the frequency generated matches with the natural frequency of any of the element's resonance occurs and it might permanently damage the system. So, vibration testing of the electronic factors employed in a mechanical system is important for its proper working.

In the automotive sedulity, particularly in the design and manufacturing of two- wheelers, icing trust capability and durability is consummate. The dashboard of a two- wheeler is a critical element that houses essential instruments and controls, furnishing the rider with vital information analogous as speed, energy situations, and machine diagnostics. Given that two-wheelers constantly witness a wide range of operating conditions, including varying terrains, faves, and environmental factors, the dashboard is subject to dynamic forces and climate during operation. These climate can negatively affect the performance, safety, and life of the dashboard and its factors, analogous as displays, sensors, and connectors.

The vibration institution serves as an essential testing outfit that simulates the dynamic forces endured by the dashboard during normal operation and in extreme scripts. By mimicking the vibrational conditions encountered on different road shells or during rapid-fire- fire acceleration and deceleration, the institution allows for comprehensive evaluation of the dashboard's performance. The results from these analyses give precious perceptivity into the material parcels, structural integrity, and overall design of the dashboard system.

A dashboard is a way of displaying various types of visual data in one place. Generally, a dashboard is intended to convey different, but related information in an easy- to- condensation form. The dashboard of a bus refers to the control panel in front of the automobilist that displays various information about the vehicle's operation and status. It generally includes the following pivotal factors

• Speedometer displays the vehicle's current speed.

• Tachometer indicates the machine's rotational speed, measured in revolutions per minute (RPM).

• Energy hand shows the amount of energy remaining in the tank.

• Temperature hand monitors the machine's coolant temperature.

• Warning lights Alerts the automobilist to issues like low oil painting oil pressure, machine problems, or other system malfunctions.

• Timepiece Displays the current time.

• Controls for the vehicle's various systems, analogous as lights, windshield wipers, radio, and climate control.

The layout and specific features can vary between different makes and models of vehicles

Through advanced design ways and simulations, the design aims to develop a prototype that not only meets but exceeds the current morals in terms of safety, functionality, and aesthetic appeal. By using state- of- the- art paraphernalia and analysis tools, this design seeks to set a new standard in the design of two- wheeler dashboards and contribute to the advancement of automotive engineering.

Figure 1 new modern design assisted dashboard instrument cluster

Plenitude of people enjoy driving as a way to escape and relax. That could mean taking a trip to the seacoast or riding the trace with the windows down, and the volume twirled up. But if your dashboard suddenly starts to rattle, that peace and relaxation can snappily evaporate. A rattling dashboard is generally caused by panels or internal factors coming loose. Though utmost common with aged buses, it can be at any point to any auto. To correct this, you'll simply need to strain the fastenings of these pieces. You can also install padding to reduce the noise.

COMMON CAUSES OF A RATTLING DASHBOARD

The most common cause of a rattling dashboard is loose corridor. When the machine is on and the vehicle is moving, these loose corridor will joggle against each other, creating a rattling sound.

To correct it, you'll need to reattach all these pieces or place padding around them.

1. Loose Components

The interior of a auto, particularly the dashboard area, is subject to constant climate and jolts as you drive. This is especially true on uneven roads or during high- speed trip.

Over time, these climate can beget the screws, bolts, or clips that hold your dashboard factors together to come loose. This loosening can lead to corridor of the dashboard moving slightly against each other or against the frame of the auto, creating a rattling or buzzing noise. It's a common issue and frequently the first thing to check when you start hearing noises from the dashboard.

2. Temperature- Induced Expansion and Contraction

Dashboards are made from a variety of accoutrements, including plastics, vinyl, and other mixes. These accoutrements are affected by temperature changes. In hot rainfall, the accoutrements expand, and in cold rainfall, they contract.

This nonstop process can lead to creaking or cracking noises as the accoutrements rub against each other or against other corridor of the auto innards. These sounds are generally more conspicuous during extreme temperatures or when the interior temperature of the auto changes fleetly, similar as when the heating or air exertion is turned on.

3. Loose neat corridor

Loose neat corridor are frequently behind the colorful rattling sounds your gusto might produce. The plastic and essence bits that make up the face sub caste of your dashboard shouldn't be wobbling against each other. Indeed more importantly, they shouldn't be shaking against the internal factors that keep them fixed in place. Either way, if they've too important latitude, you'll have to take it down. Keep in mind that the dashboard also contains all the instruments you need to drive, from the speedometer, energy hand, and analogous pointers, to the entertainment and AC settings. All those features are generally set into the dashboard independently and can, thus, because individual rattling sounds. So, you may have to attack several sources of noise before the climate go down fully.

3. Worn out Padding The padding beneath your dashboard plays a pivotal part in dampening the sounds and climate from the machine and road. This padding is generally made from froth or a analogous material that acts as an insulator against noise and vibration.

Over time, this padding can degrade due to factors like temperature oscillations, moisture, and the natural aging of accoutrements. When this happens, the effectiveness of the padding in absorbing noise diminishes, which can lead to an increase in the quantum of noise filtering into the cabin from the dashboard area. Electrical element Issues ultramodern buses are equipped with colorful electrical factors within the dashboard, similar as the stereo system, air exertion controls, and navigation systems. These factors are intricately wired and, over time, connections can come loose due to the auto's movement, climate, or simply due to the aging of the factors. Loose connections can beget factors to serve intermittently or produce buzzing or creaking sounds. In some cases, electrical hindrance or malfunctions within these systems can also induce noise

Dashboard Damage

Physical damage to the dashboard, similar as cracks or loose trim, can also lead to patient noises. This damage can do from impact, long- term exposure to sun causing the accoutrements to degrade, or simply from the aging of the vehicle.

Damaged areas can move or joggle when the auto is in stir, especially over rough terrain, leading to creaking or rattling sounds

Machine or Mechanical Issues

Occasionally, the source of the noise isn't the dashboard itself but rather mechanical factors in the vehicle. These noises can be transmitted through the auto's structure and come audible at the dashboard.

Common sources include the machine, transmission, bus, or other corridor of the auto's mechanical system. The noises might be due to a variety of issues, similar as loose factors, worn belts, bad comportments, or problems with the machine mounts.

• Reduced Weight Lighter paraphernalia contribute to better energy effectiveness and bettered handling dynamics. Reducing unsprung weight allows the suspension system to reply more snappily to changes in the road face, enhancing lift comfort and control.

• Increased Strength modern composites and composites are finagled to repel ower stress, perfecting the durability and life of the steering knuckles. This means lower reserves and repairs over the vehicle's continuance.

• Improved Corrosion Resistance new paraphernalia are more resistant to rust and corrosion, which is particularly salutary for vehicles driven in harsh surroundings. This resistance helps maintain the integrity and safety of the steering knuckle over time.

These advancements help automotive manufacturers meet the adding demands for performance and effectiveness while also considering environmental impacts.

LITERATURE REVIEW

Jia- Sheng Hu et. al. (1) the development of motorcars has shifted from lattice structure and stir control to an intertwined dashboard for smart and safe vehicles. The proposed system can display and cover colorful driving scripts, including speed, battery SOC, retardation, avail, and TCS and ABS activation. This smart interface can help exclude tone- ignition problems in ultramodern electric vehicles, icing energy effectiveness and steering stability. By simplifying operation procedures, the system allows motorists to concentrate more on steering, reducing the threat of tone- ignition in electric vehicles.

Zhibiao Yan1 et. al. (2) this composition introduces vibration test norms and general test styles for electric vehicle motor control units. It proposes new conditions grounded on vibration data collected during vehicle tests. A comprehensive cargo vibration test system is proposed, integrating electrical and environmental loads. The test system determines the outfit and test process for comprehensive on- cargo vibration tests of environmental cargo. Three important principles in institution design are stressed featherlight, low damping, and no resonance. This new testing system is designed for motor regulators in electric buses.

H Radhwan et. al. (3) this final time paper report focuses on the design and analysis of wiles and institutions for manufacturing processes, fastening on job running and replacing homemade assembly with semi-auto wiles. The design aims to probe collected data and dissect the design of wiles and institutions to ease work running. The methodology includes data collection, brainstorming, interpretation, design conception, and attestation. The design of wiles and institutions is done using Unigraphics NX 7.5 software, and data analysis includes Finite Element Analysis (FEA) using CATIA software, ergonomic design analysis, time study analysis, and cost analysis. The exploration aims to give an understanding of ploy and institution design using Unigraphics NX 7.5 software and dissect named corridor of the product using FEA and other applicable analysis.

Phani Sowjanya et.al. (4) Vibration is a significant failure mode in avionic outfit, and to insure it can repel high climate, an automatic structure called an institution is placed between the outfit and the vibration machine. The institution must repel arbitrary excitation with a frequency range of 20- 2000Hz. This work focuses on designing institutions that support electronic outfit in dumdums and fighter aircraft, icing their natural frequency doesn't fall within the excitation range. After opting the applicable design, it's anatomized using finite element analysis to insure its effectiveness.

B Bârgău, D Simoiu et. al. (5) This paper aims to develop a design for automotive assiduity institutions, similar as side airbags, curtain airbags, motorist airbags, seat airbags, knee protection bias, seat belt securing bias, and steering bus, to test for vibration. Mechanical climate can beget aging products, fatigue of accoutrements, lower original mechanical parcels, and complete destruction of subassemblies. To help similar situations, auto manufacturers request simulations of vibration and destructive tests before blessing. The design will be estimated using the Finite Element Method (FEM) and Finite Element Analysis (FEA) to determine modal parameters, specifically fastening on a seat belt socket locking institution. The analysis will be done using Finite Element Method (FEM) and Finite Element Analysis (FEA).

Anjali Reddy et.al. (6) This paper discusses the design of vibration testing institutions for arbitrary vibration loads, following shop 810 service norms. After opting the applicable material and configuration, CAD models are generated and checked for natural frequentness and mode shapes using Finite Element Analysis. The institutions' response to the shop 810 standard Random Vibration profile input is measured, and their transmissibility is calculated. Experimental testing is conducted, and the results are compared to Finite Element results, indicating that the institutions can be used for bullet package testing at the Defence Research and Development Laboratory in Hyderabad.

Venkat1, Varun1 et. al. (7) the study focuses on designing and developing two institutions for bias operating under vibration surroundings. The institutions must be stiff to avoid institution resonance and cargo modification. Two institutions were designed one with a single mount 3 exposure capability and one able of contemporaneous lading for three axes. The institutions were tested using a vibration shaker and a hand-held analyzer, yielding good correlation for natural frequency estimates. Institution- 1 allows contemporaneous testing of 4 units with 3 exposures, while institution- 2 allows testing for all 3 axes lading in a single test, reducing testing time across multiple bias. The institutions can be salutary as they reduce the time and homemade labor needed for changing exposure and slip- table arrangement during vibration testing. Overall, these institutions can significantly reduce testing time and trouble for bias operating under vibration surroundings.

Xia Hua et. al. (8) the study focuses on designing and developing two institutions for bias operating under vibration surroundings. The institutions must be stiff to avoid institution resonance and cargo modification. Two institutions were designed one with a single mount 3 exposure capability and one able of contemporaneous lading for three axes. The institutions were tested using a vibration shaker and a hand- held analyzer, yielding good correlation for natural frequency estimates. Institution- 1 allows contemporaneous testing of 4 units with 3 exposures, while institution- 2 allows testing for all 3 axes lading in a single test, reducing testing time across multiple bias. The institutions can be salutary as they reduce the time and homemade labor needed for changing exposure and slip- table arrangement during vibration testing. Overall, these institutions can significantly reduce testing time and trouble for bias operating under vibration surroundings.

Problem statement

The machines which are available for testing the components against real life example of vibration and shock do have some limitations. They have a restricted area for mountings. These vibration components are unable to mount directly on the respective machine. So, we need to design such fixtures which can hold the component and can be mounted on the testing machine.

Objectives

- To design the vibration test fixture for dashboard whose natural frequency is higher than the maximum test frequency using solidworks 2022 software
- Static, modal analysis of dashboard vibration Fixture by using ANSYS 21.
- To perform the experimental testing of fixture by using FFT Analyser & impact hammer test.

METHODOLOGY

- Find out literature survey, gathered research papers.
- Learnt about vibration fixture.
- Describe literature gap, identify need of project.
- Finalizing concept 3d model and drafting will be done of 2 wheeler dashboard vibration fixture.
- Material selection design and modification of 2 wheeler dashboard vibration fixture.
- Finite element analysis of the dashboard vibration fixture.
- Mesh generation and applying boundary condition
- Perform the experimental testing of dashboard vibration fixture using FFT Analyser

3D CAD MODEL OF 2 WHEELER DASHBOARD VIBRATION FIXTURE:

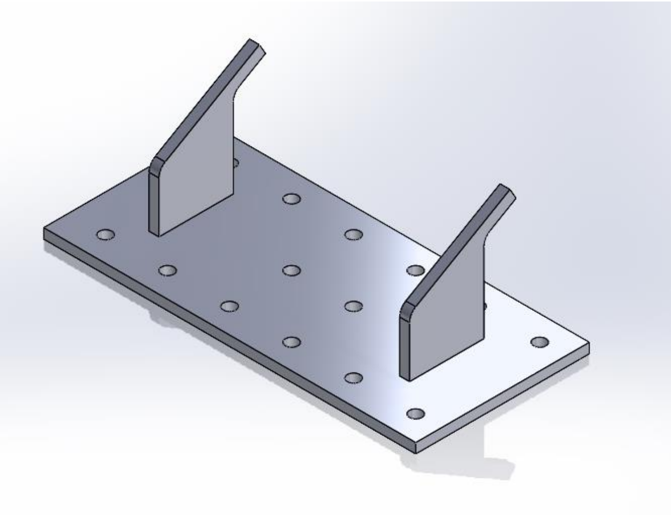


Figure 4 - Different material used for dashboard

2D DRAFTING OF 2 WHEELER DASHBOARD VIBRATION FIXTURES

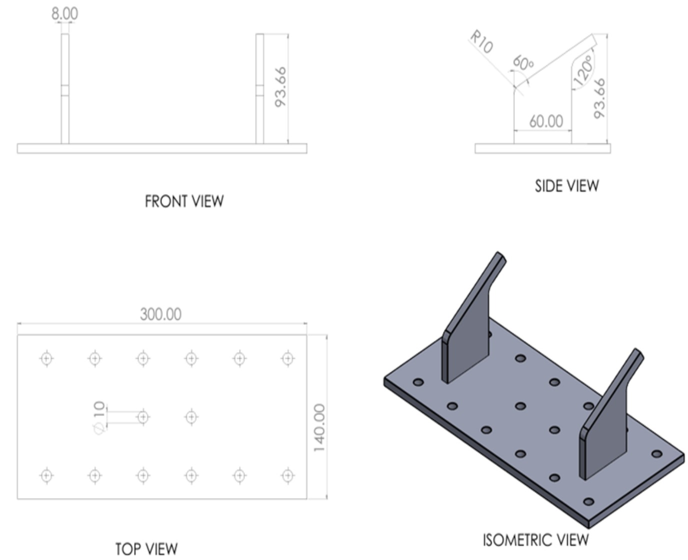


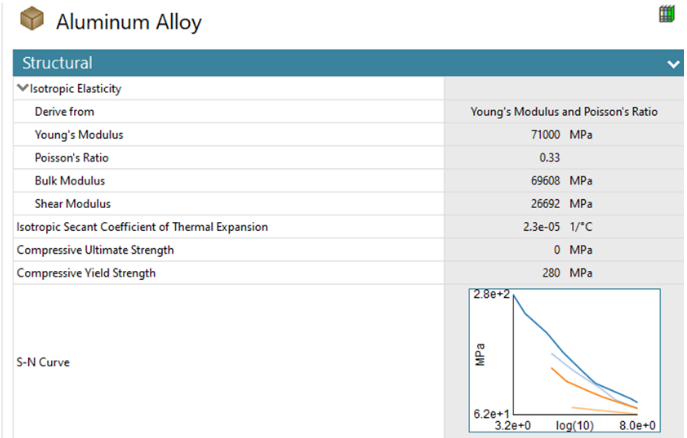
Figure 5 - Different material used for dashboard

Finite Element Analysis

FEA solution of engineering problems, such as finding deflections and stresses in a structure, requires three steps:
1. Pre-processing
2. Solution
3. Post processing

Modal analysis of design 1

MATERIAL PROPERTIES



Aluminum Alloy

Structural	
Isotropic Elasticity	
Derive from	Young's Modulus and Poisson's Ratio
Young's Modulus	71000 MPa
Poisson's Ratio	0.33
Bulk Modulus	69608 MPa
Shear Modulus	26692 MPa
Isotropic Secant Coefficient of Thermal Expansion	2.3e-05 1/°C
Compressive Ultimate Strength	0 MPa
Compressive Yield Strength	280 MPa
S-N Curve	

Geometry

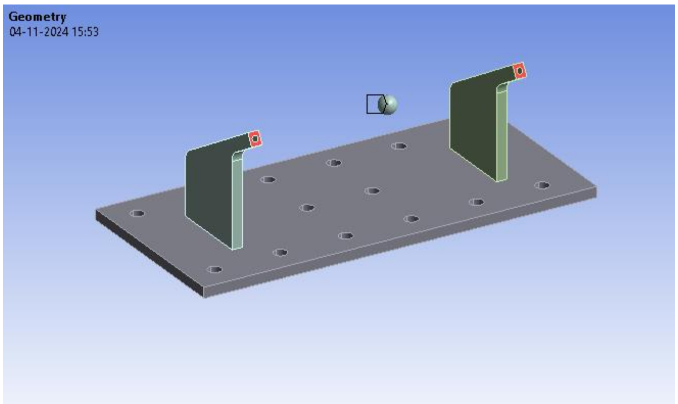
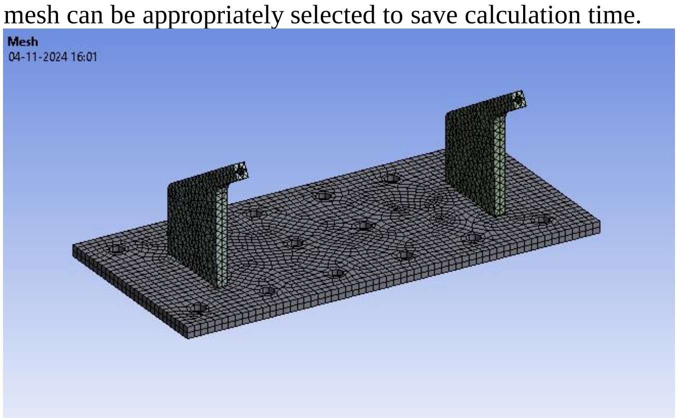


Figure 6 – Geometry of 2 wheeler dashboard

MESHING

As the main link of finite element analysis, grid division can best reflect the idea of finite element. The quality of the web site not only affects the efficiency of model analysis, but also directly affects the accuracy of analysis results. Therefore, according to the existing hardware, without affecting the accuracy of the calculation results, the method of dividing the mesh can be appropriately selected to save calculation time.



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Statistics

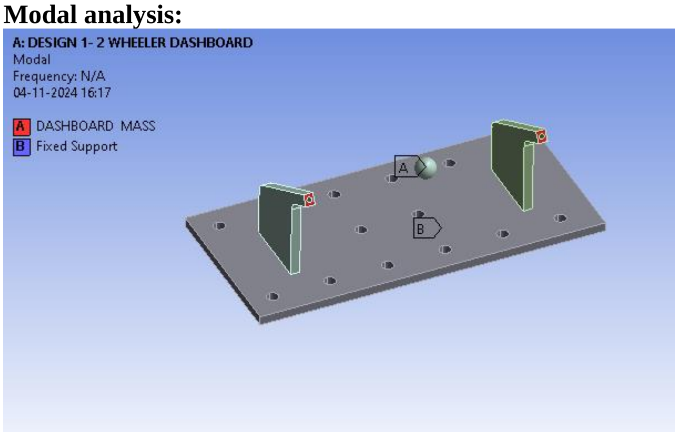
Nodes	30171
Elements	8617

Figure – finite mesh model of 2 wheeler dashboard vibration fixture

Final mesh model, it contains 30171 nodes and 8617 elements

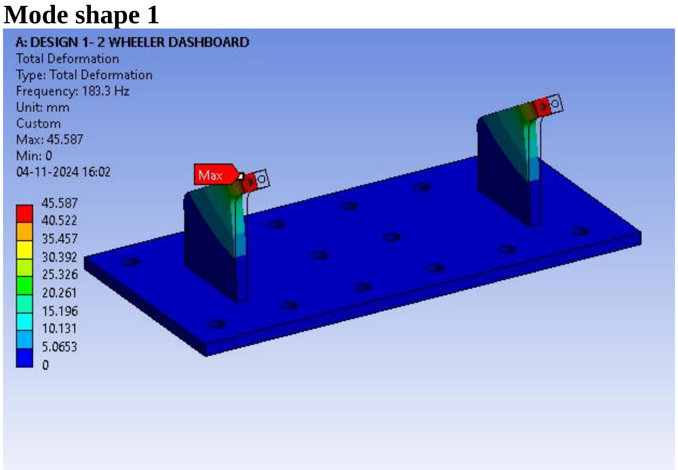
When shapes are complex or the range of length scales of the inflow is large, a triangular/ tetrahedral mesh can be created with far smaller cells than the original mesh conforming of quadrilateral/ hexahedral rudiments. This is because a triangular/ tetrahedral mesh allows clustering of cells in named regions of the inflow sphere. Structured quadrilateral/ hexahedral morass will generally force cells to be placed in regions where they aren't demanded. Unshaped quadrilateral/ hexahedral morass offer numerous of the advantages of triangular/ tetrahedral morass for relatively-complex shapes

Modal analysis:



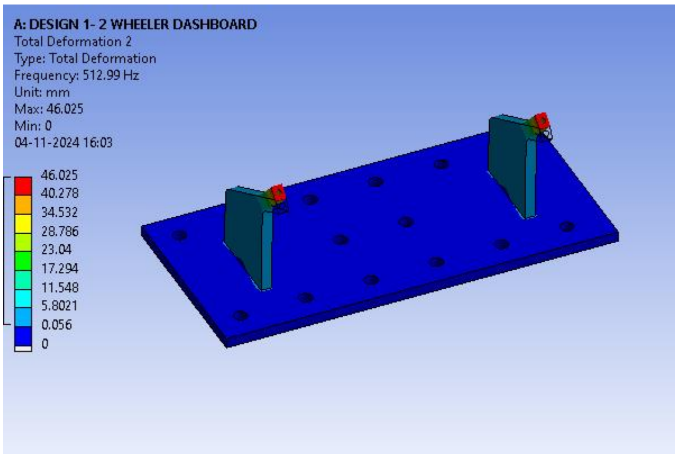
Modal analysis results

Mode shape 1



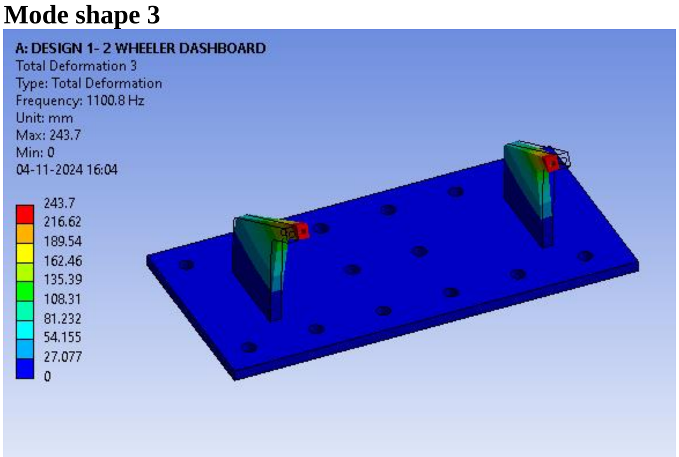
Natural frequency is observed to be 183.3 Hz for Mode shape 1

Mode shape 2



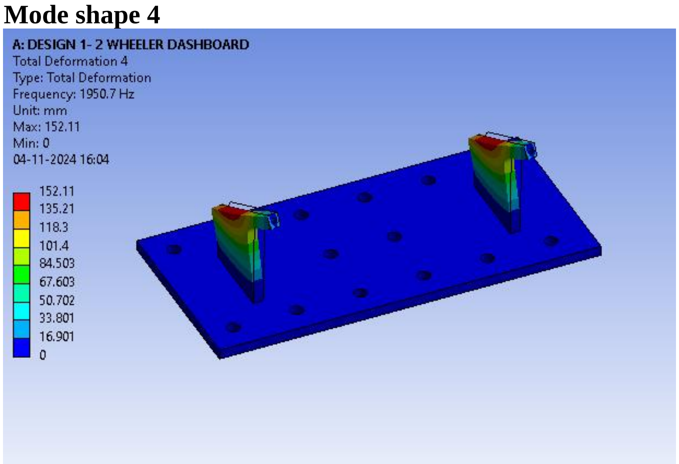
Natural frequency is observed to be 512.99 Hz for Mode shape 2

Mode shape 3



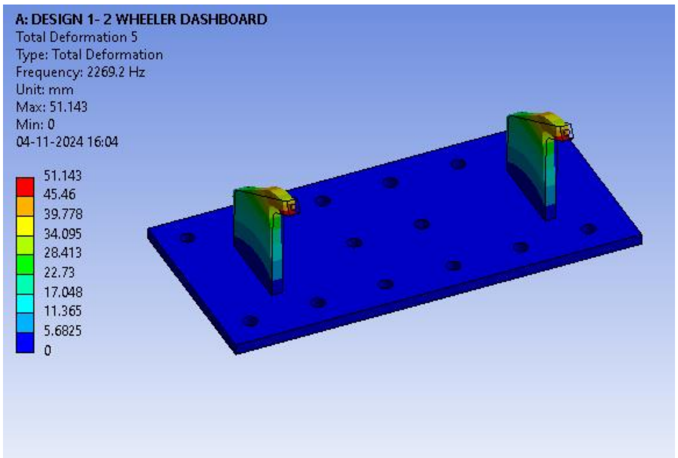
Natural frequency is observed to be 1100.8 Hz for Mode shape 3

Mode shape 4



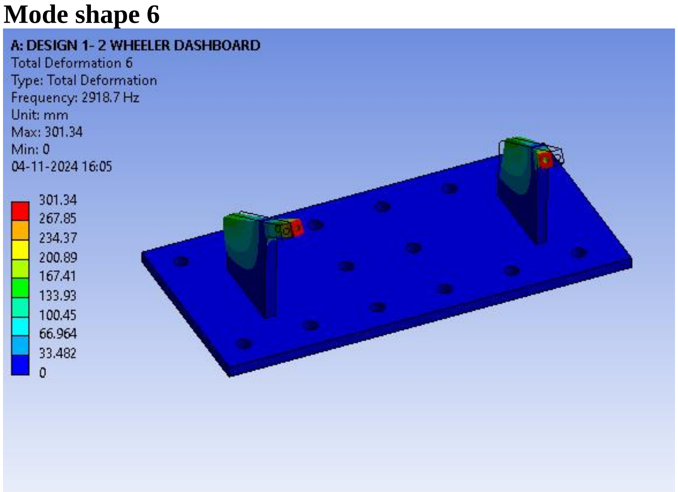
Natural frequency is observed to be 1950.7 Hz for Mode shape 4

Mode shape 5



Natural frequency is observed to be 2269.2 Hz for Mode shape 05

Mode shape 6

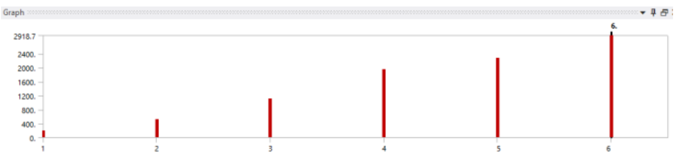


Natural frequency is observed to be 2918.7 Hz for Mode shape 6

Tabular Data

	Mode	Frequency [Hz]
1	1.	183.3
2	2.	512.99
3	3.	1100.8
4	4.	1950.7
5	5.	2269.2
6	6.	2918.7

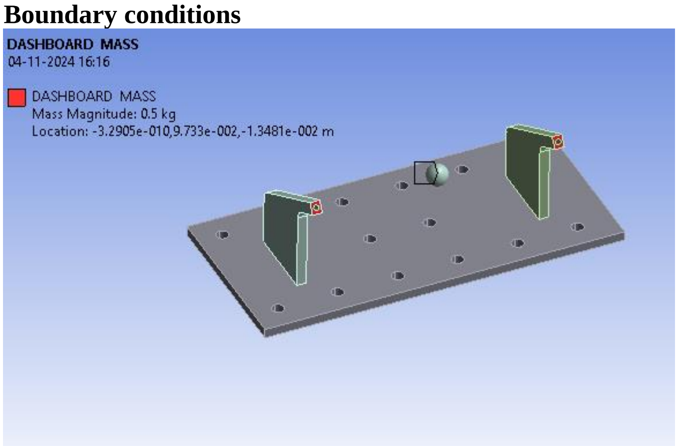
Table: frequency mode shape results



Graph 1. Frequency of different mode shapes

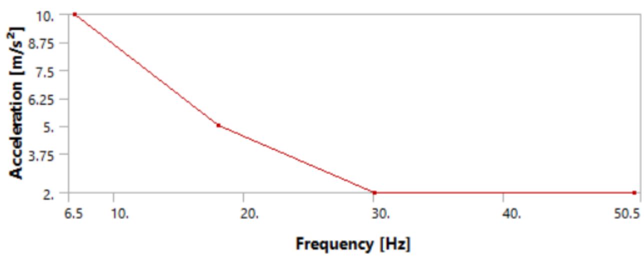
HARMONIC RESPONSE ANALYSIS OF 2 WHEELER DASHBOARD VIBRATION FIXTURES

Boundary conditions



Tabular Data

	Frequency [Hz]	Acceleration [m/s²]
1	7.	10.
2	18.	5.
3	30.	2.
4	50.	2.



Graph. Acceleration vs. frequency

Result:

1. **Total deformation**

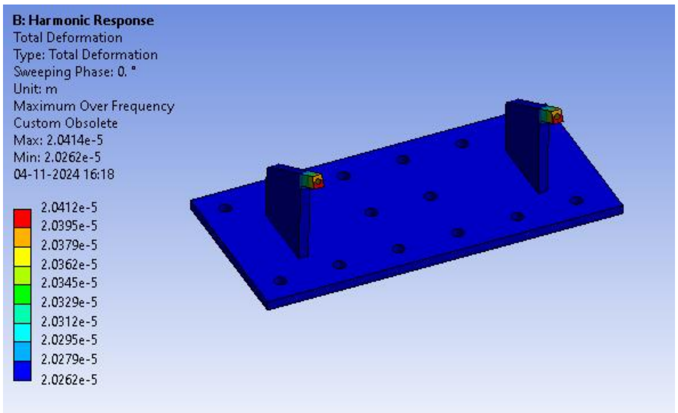


Fig: Total deformation plot

2. Equivalent stress

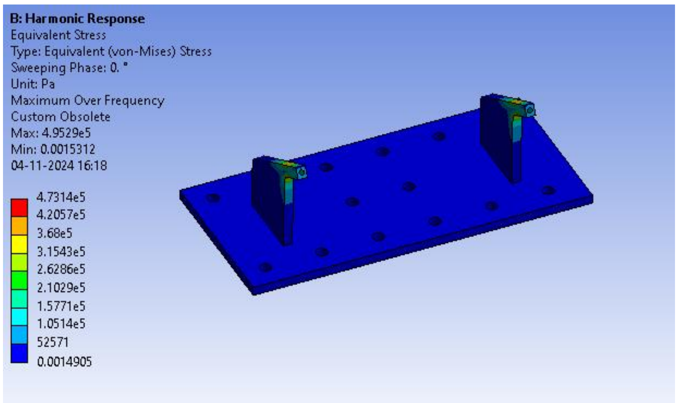


Fig: Von Misses Stress plot

VIBRATION ANALYSIS OF DESIGN 2-WHEELER DASHBOARD VIBRATION FIXTURES WITH STIFFENER

GEOEMTRY

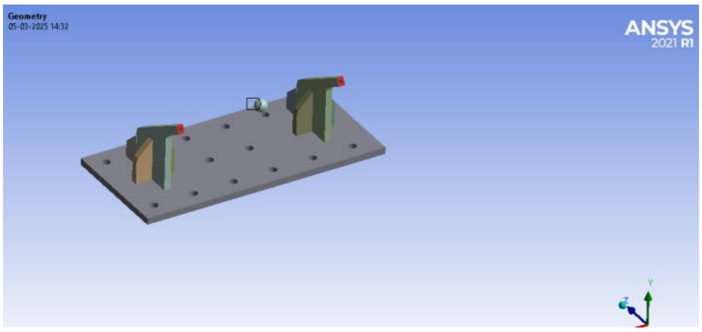
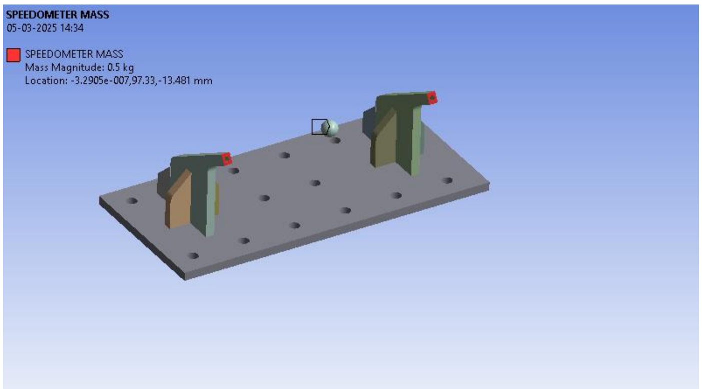
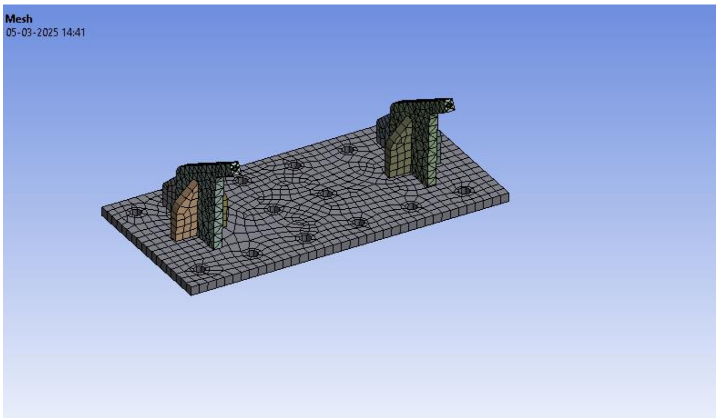


Figure: Geometry model of the vibration fixtures with stiffener



MESHING



Statistics	
Nodes	10033
Elements	2347

Type	Element Size
Element Size	8.0 mm

Figure: Meshing of the vibration fixtures with stiffener

Final vibration fixtures mesh model, it contains 10033 nodes and 2347 elements.

BOUNDARY CONDTIONS

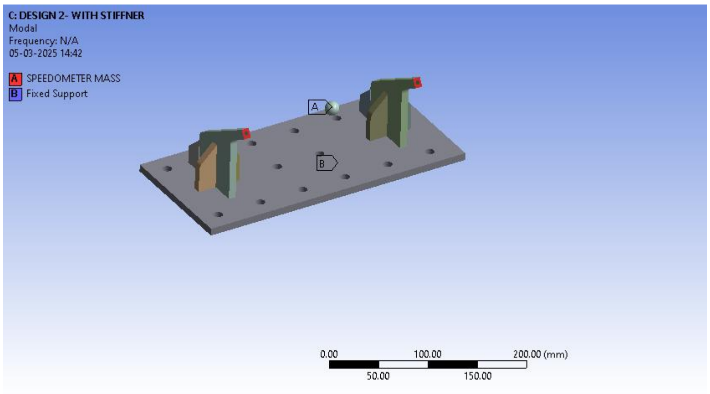
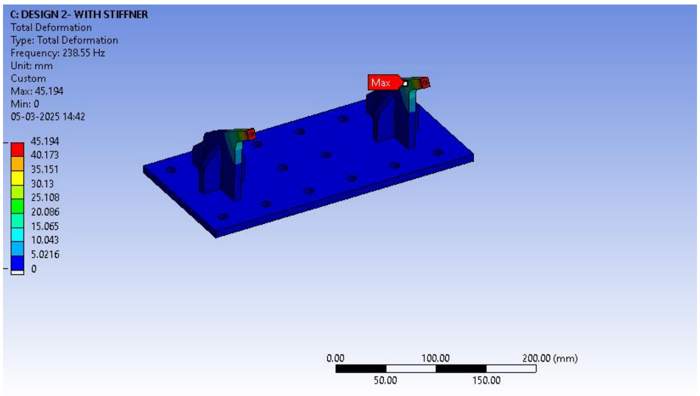


Figure. Boundary condition of vibration fixtures with stiffener

MODE SHAPE 01



Natural frequency is observed to be 238.55 Hz for Mode shape 01

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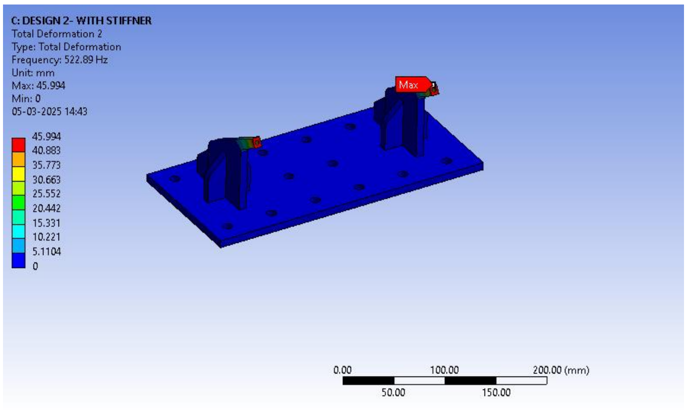
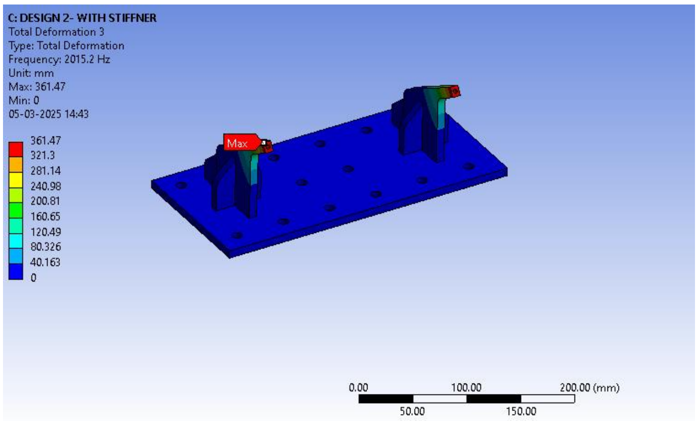
MODE SHAPE 02



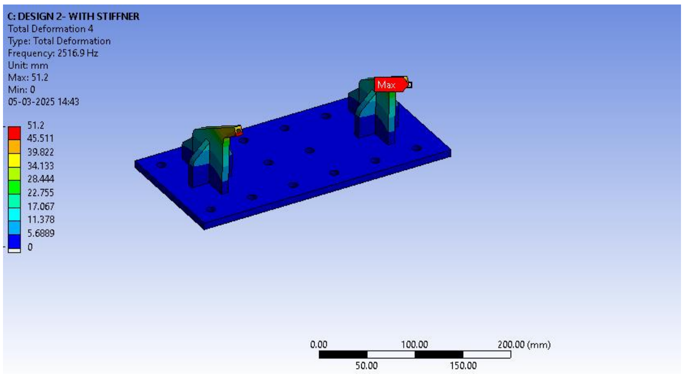
Natural frequency is observed to be 522.89 Hz for Mode shape 02

MODE SHAPE 03



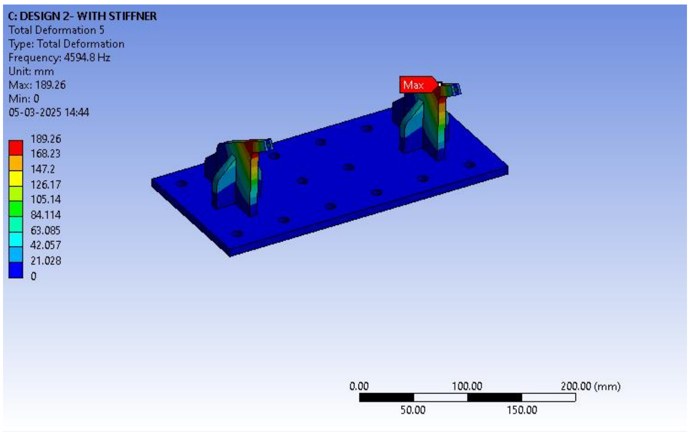
Natural frequency is observed to be 2015.2 Hz for Mode shape 03

MODE SHAPE 04



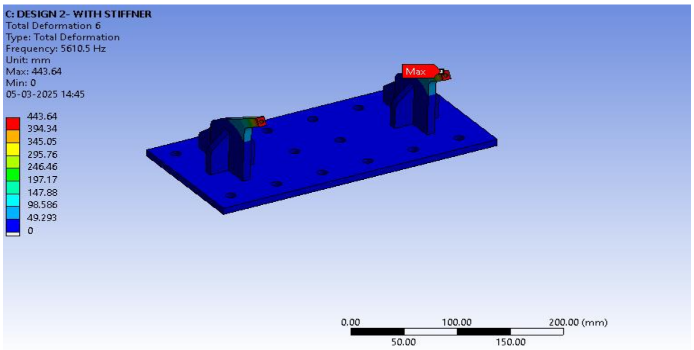
Natural frequency is observed to be 2516.9 Hz for Mode shape 05

MODE SHAPE 05



Natural frequency is observed to be 4594.8 Hz for Mode shape 05

MODE SHAPE 06



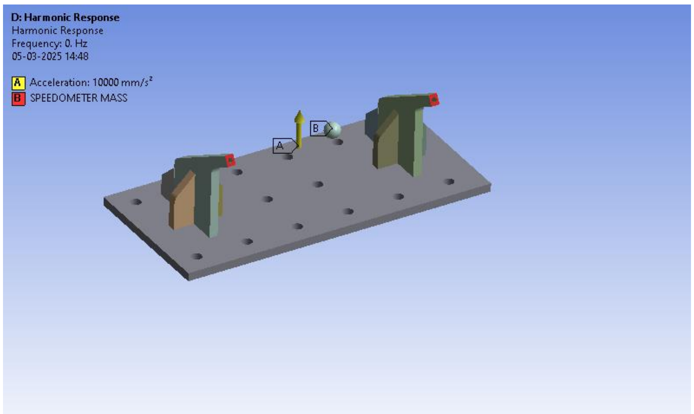
Natural frequency is observed to be 5610.5 Hz for Mode shape 06

Tabular Data

	Mode	✔ Frequency [Hz]
1	1.	238.55
2	2.	522.89
3	3.	2015.2
4	4.	2516.9
5	5.	4594.8
6	6.	5610.5

Table: frequency mode shape results

HARMONIC RESPONSE ANALYSIS OF 2 WHEELER DASHBOARD VIBRATION FIXTURES



Tabular Data

	Frequency [Hz]	Acceleration [mm/s²]
1	7.	10000
2	18.	5000.
3	30.	2000.
4	50.	2000.
*		

RESULT

1. **TOTAL DEFORMATION**

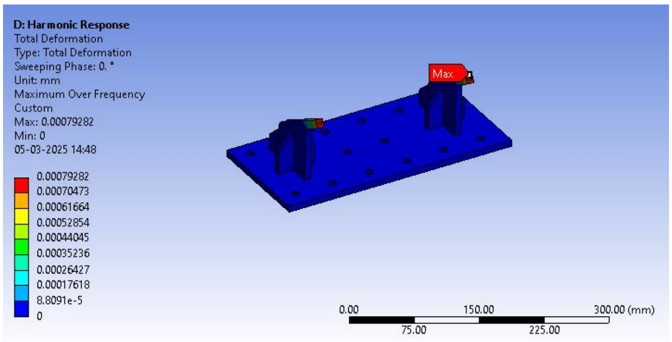


Fig: Total deformation plot

2. **EQUIVALENT STRESS**

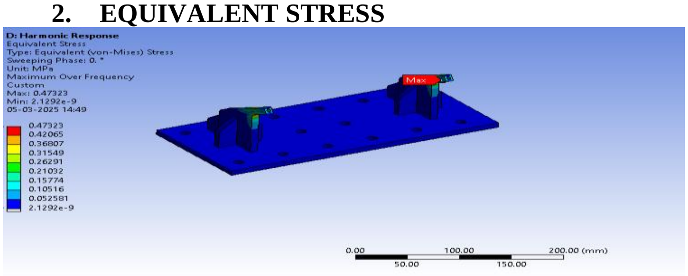


Fig: Von Misses Stress plot

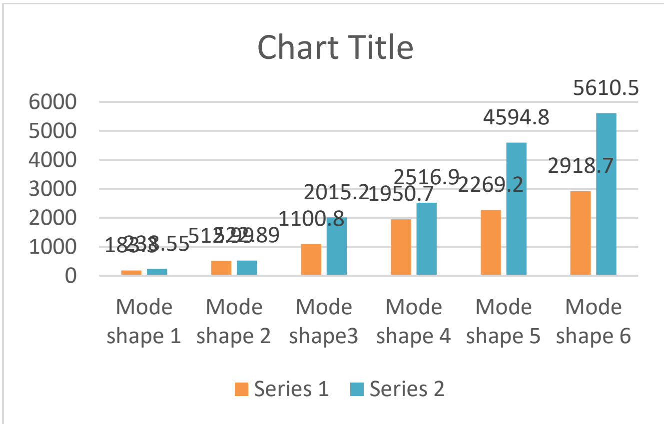
Results	Minimum	Maximum	Units	Reported Frequency (Hz)
Total Deformation	0.	7.9282e-004	mm	50.
Equivalent Stress	2.1292e-009	0.47323	MPa	50.

Table:

COMPARISON BETWEEN TWO DIFFERENT DESIGNS

Mode shape No.	DESIGN 1 VIBRATION FIXTURES NATURAL FREQUENCY (Hz)	DESIGN 2 VIBRATION FIXTURES WITH STIFFENER NATURAL FREQUENCY (Hz)
1	183.3	238.55
2	512.99	522.89
3	1100.8	2015.2
4	1950.7	2516.9
5	2269.2	4594.8
6	2918.7	5610.5

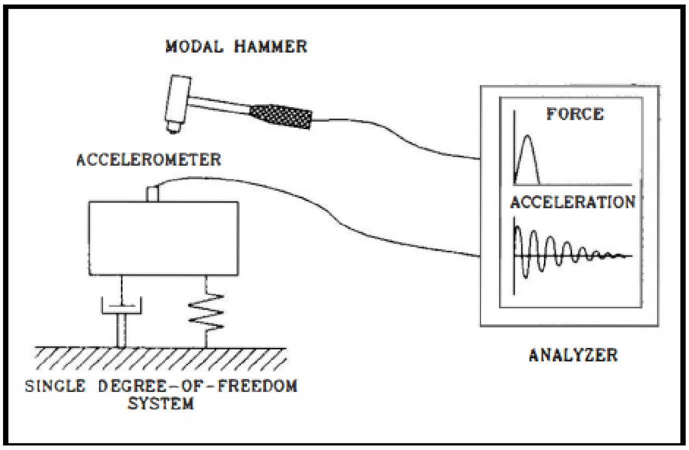
GRAPH OF VIBRATION CHARATERISTICS IN TWO DIFFERENT DESIGN

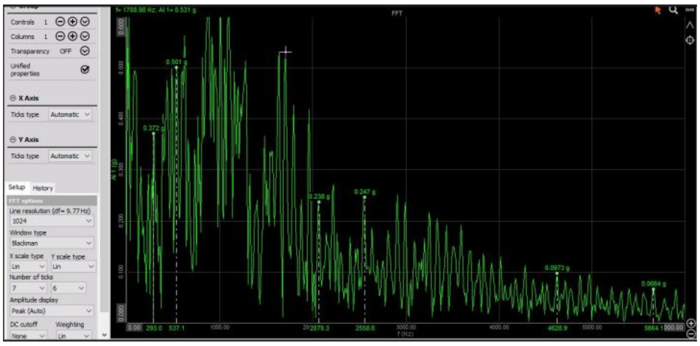


Joining process of fixture

Manufactured vibration fixture

EXPERIMENTAL TESTING





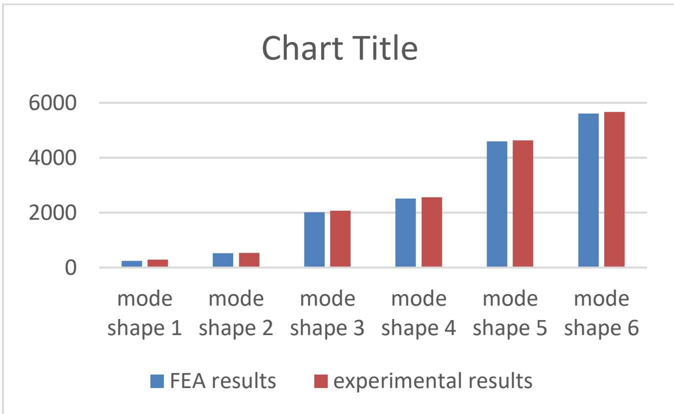
Graph. Numerical and Experimental results graph

Experimental testing results

Mode shape	FEA (Hz)	Experimental (Hz)
1	238.55	293
2	522.89	537.1
3	2015.2	2070.3
4	2516.9	2558.6
5	4594.8	4628.9
6	5610.5	5664.1

Fig: Numerical and Experimental results comparison

Comparison graph between FEA and experimental testing



Conclusion

The modal analysis of the vibration fixture was conducted using Finite Element Analysis (FEA) and validated through experimental modal testing via Fast Fourier Transform (FFT) vibration analysis. The comparison of natural frequencies from both approaches across the first six mode shapes indicates a high degree of correlation, thereby confirming the reliability of the numerical model.

The FEA results predicted the natural frequencies as 238.55 Hz, 522.89 Hz, 2015.2 Hz, 2516.9 Hz, 4594.8 Hz, and 5610.5 Hz. Correspondingly, the experimental values were observed as 293 Hz, 537.1 Hz, 2070.3 Hz, 2558.6 Hz, 4628.9 Hz, and 5664.1 Hz. Respectively.

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