Vibration Mode Suspension in Canopies Using Elastic Damping Technique

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Abstract - *The sheet metal structures (Canopy) utilized in dg sets is generally vulnerable subjected to the varied static and dynamic masses throughout their oscillation cycles. Thanks to this, they encountered resonance condition at varied in operation frequencies. Resonance results in harmonic excitation that any introduces the deformation and stresses resulting in the failures of flat solid structures. Reframing of flat solid structure with the assistance of elastic material like rubber, foam, bitumen, NBR latex etc. changes the stiffness of structure. Thus, stiffness alternation results in modification in dynamic characteristics like natural frequency, mode shapes, and harmonic response. Optimum distributions of damping material in shell structures subject to impact masses by topology improvement. The optimization aims at reducing the residual vibration responses once the appliance of impact masses. Above all, the dependence of each structural forced vibration and residual vibration on the damping layer distribution is taken into account by transient dynamic responses-based improvement approach. Until now, optimum distributions of damping material are continually meted out supported frequency domain responses or structural dynamic characteristics. Modal and Fourier analysis are simulated exploitation FEA (ANSYS Workbench). In experimentation, Impact hammer check and FFT analyzer are used for the validation purpose. Natural frequencies for sheet metal structure with and without reinforcement are calculated. Results and conclusion are drawn by scrutiny analytical and experimental values. Appropriate materials are recommended by analyzing the info alongside future scope.*

***Key Words*:** DG sets, residual vibration, Natural frequencies, FFT analyzer.

1. INTRODUCTION

A diesel generator (also called diesel genset) is that the combination of an ICE with an electrical generator (often associate alternator) to come up with current. This is often a particular case of engine-generator. A diesel compression-ignition engine is sometimes designed to run on fuel; however, some varieties are tailored for alternative liquid fuels or fossil fuel. Diesel generating sets are employed in places while not affiliation to an influence grid, or as emergency power-supply if the grid fails, moreover as for additional complicated applications like peak-lopping, grid support and export to the ability grid. Correct filler of diesel generators is crucial to avoid low-load or a shortage of power. Filler is sophisticated by the characteristics of recent physical science, specifically non-linear masses. In size ranges around fifty MW and higher than, associate open cycle turbine is additional economical at full load than associate array of diesel engines, and much additional compact, with comparable capital costs; except for regular part-loading, even at these power levels, diesel arrays are typically most popular to open cycle gas turbines, because of their superior efficiencies.

Fig-1: Emergency Diesel Generator (EDG) with canopy made up of sheet metal

Viscoelasticity is that the property of materials that exhibit each viscous and elastic characteristic once undergoing deformation. Viscous materials, like water, resist shear flow and strain linearly with time once a stress is applied. Elastic materials strain once stretched and straightaway come back to their original state once the strain is removed. Elastic materials have parts of each of those properties and, as such, exhibit time-dependent strain. Whereas physical property is sometimes the results of bond stretching on crystallographic planes in associate degree ordered solid, consistence is that the results of the diffusion of atoms or molecules within associate degree amorphous material.

2. PROBLEM STATEMENT

Canopy is the sheet metal covering used to cover the diesel generators. They restrict dust, water to come directly in contact with the engine assembly. When these EDG Emergency Diesel Generators works at very high rpm, there are a large no of parts inside the whole system working at various frequencies. These frequencies are transferred to the Canopy made up of sheet metal. If that transferred frequency is gets aligned with the natural frequency of the canopy, there is generation of high amplitude vibration due to the resonant effect. Because of that the nut and bolts used to hold the canopy will get loose and there is a possibility of sudden failure. To avoid it we need to find out the maximum deformation and respective frequency. Currently fine thickness damping is placed between two sheets which can absorb the vibrations. But as the total size of canopy is very high, we need a specified area only where we can put viscoelastic material to increase the damping.

3.OBJECTIVES

- Understand the effect of optimization to maximize the damping effect subject to constraint on maximum allowable volume of damping material.
- Modelling of exist sheet metal structures of an DG sets in CATIA V5 software.
- Modal and Harmonic analysis of sheet metal structures by using ANSYS 19 software.
- To perform Optimization of sheet metal structures of an DG set using optimal damping material.
- To manufacturing of optimized sheet metal structures of an DG set
- To perform experimental testing of existing and optimized model of optimized sheet metal structures using FFT and impact hammer test.
- Experimental testing and correlating results

4. METHODOLOGY

Step 1:- Started the work of this project with literature survey. I gathered many research papers which are relevant to this topic. After going through these papers, we learnt Canopy part subjected vibrations.

Step2:- After that the canopy shape which is required for our project are decided.

Step 3:- After deciding the components, the 3D Model and drafting will be done with the help of CATIA software.

Step 4:- The Analysis of the canopy will be done with the help of ANSYS using FEA.

Step 5:- The Experimental Testing will be carried out with the help of FFT analyzer.

Step 6:- Comparative analysis between the experimental & analysis result will be done and then the result & conclusion will be drawn.

5. CATIA MODEL

Three-dimensional model of Canopy set-up was making in Catia V5 R20 software.

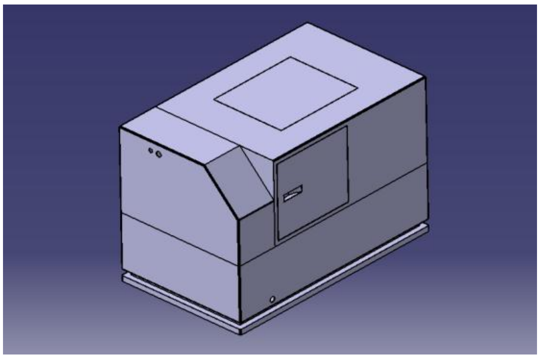


Fig-2: CATIA Model of the Canopy

FEA analysis of canopy of cummnins DG set in ansys

Material Selection – Structural Steel

Properties of Outline Row 4: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	1.2E-05	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modu...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa

Fig-3: Material properties of Canopy

6. MESH

Creating the foremost applicable mesh is that the foundation of engineering simulations. ANSYS Meshing is attentive to the kind of solutions that may be employed in the project and has the suitable criteria to form the most effective suited mesh. ANSYS Meshing is mechanically integrated with every problem solver inside the ANSYS work bench atmosphere. For a fast analysis or for the new and rare user, a usable mesh is created with one click of the mouse. ANSYS Meshing chooses and the applicable choices supported the analysis sort and also the geometry of the model.

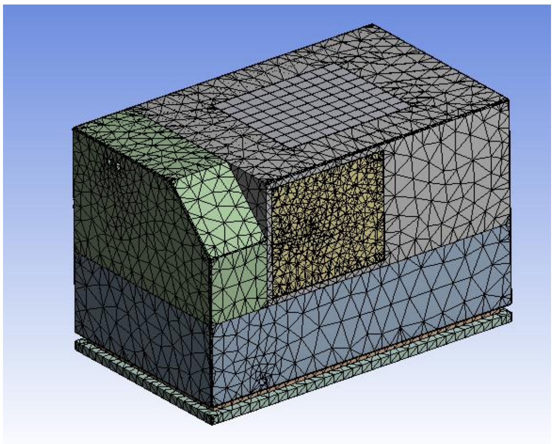


Fig-4: Meshing of Canopy set-up

After meshing of Canopy set-up nodes are 48461 and elements 22715.

Boundary Condition

A boundary condition for the model is that the setting of a well-known value for a displacement or an associated load. For a specific node you'll be able to set either the load or the displacement but not each.

The main kinds of loading obtainable in FEA include force, pressure and temperature. These may be applied to points, surfaces, edges, nodes and components or remotely offset from a feature.

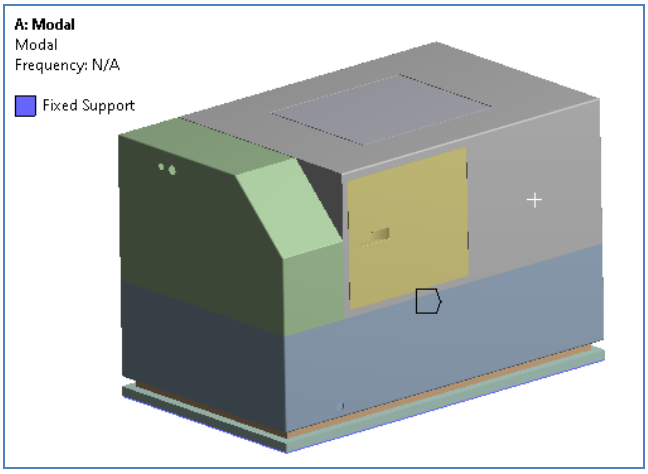


Fig-5: Boundary condition of Canopy set-up

7. RESULTS

In finite element method the total deformation and directional deformation are general terms irrespective of software being used. Directional deformation may be place because the displacement of the system in a very particular axis or user defined direction. Total deformation is that the vector sum of all directional displacements of the systems.

At mode1

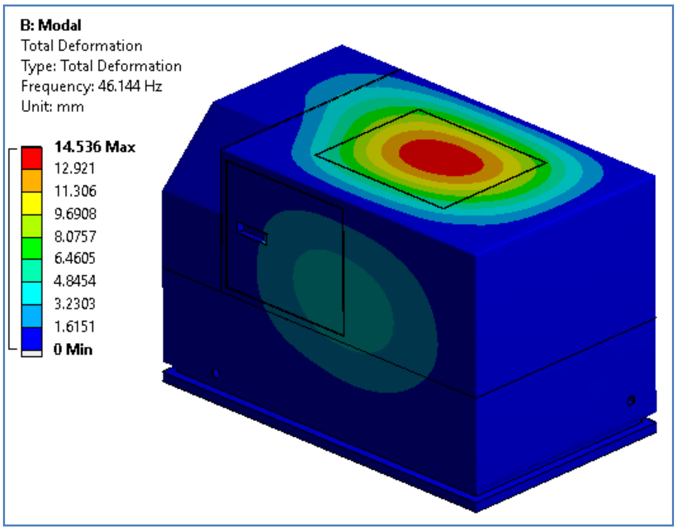


Fig-6: Mode shape 1

Natural frequency of Canopy set-up at mode shape 1 was 46.144 Hz

At mode 2

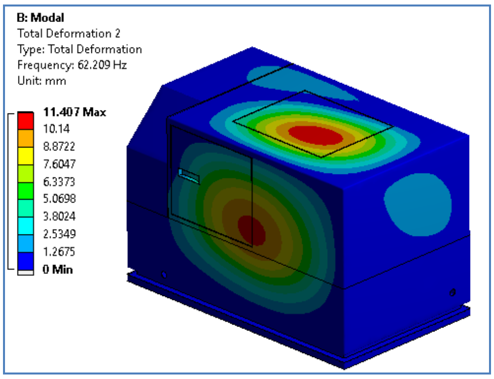


Fig-7: Mode shape 2

Natural frequency of Canopy set-up at mode shape 2 was 62.209Hz

At mode 3

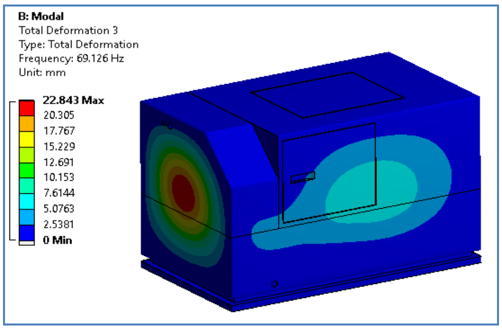


Fig-8: Mode shape 3

Natural frequency of Canopy set-up at mode shape 3 was 69.126Hz

At mode 4

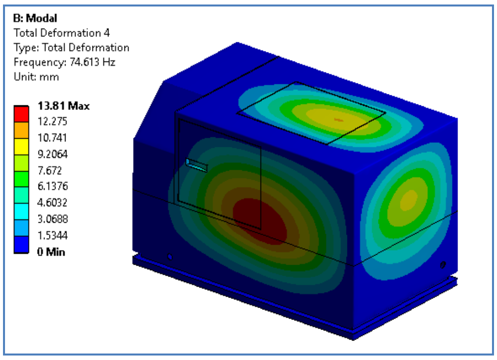


Fig-9: Mode shape 4

Natural frequency of Canopy set-up at mode shape 4 was 74.613Hz

At mode 5

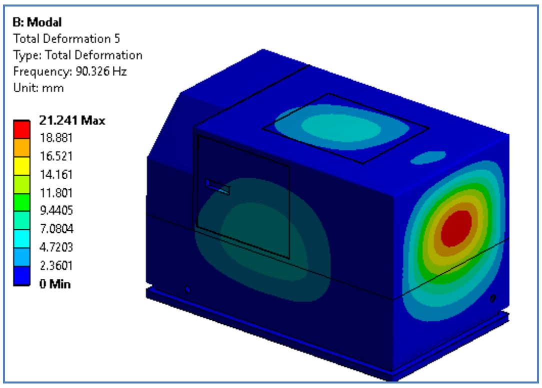


Fig-10: Mode shape 5

Natural frequency of Canopy set-up at mode shape 5 was 90.326 Hz

Table 1 - Tabular representation of the mode shapes with respective frequency

Tabular Data

	Mode	Frequency [Hz]
1	1.	46.144
2	2.	62.209
3	3.	69.126
4	4.	74.613
5	5.	90.326
6	6.	94.619

A. Harmonic analysis of canopy

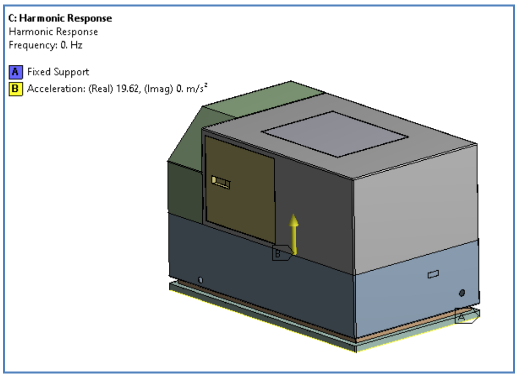


Fig-11: Frequency response

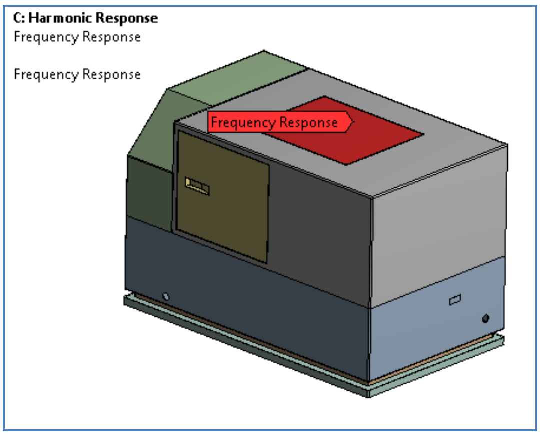


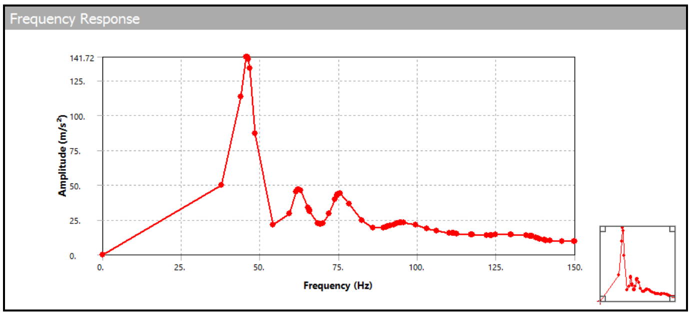
Fig-12: Frequency response

Details of "Acceleration"

Scope	
Boundary Condition	Fixed Support
Definition	
Base Excitation	Yes
Absolute Result	Yes
Define By	Magnitude - Phase
Magnitude	19.62 m/s^2
Phase Angle	0. °
Direction	Y Axis
Suppressed	No

Fig-13: Detail of acceleration

Frequencies response is calculated at top side because at both 1 and 2 mode shape maximum deformation is on top side.



Graph-1: Frequency response

No patch on surface – maximum acceleration is observed around 141.72 m/s2.

B. Harmonic analysis of canopy with circular viscoelastic patch

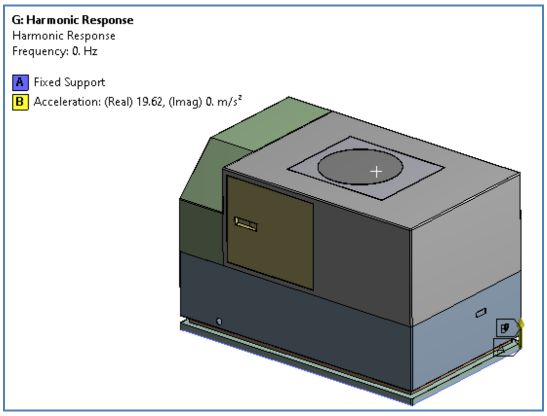


Fig-14: Frequency response

Details of "Acceleration"	
Scope	
Boundary Condition	Fixed Support
Definition	
Base Excitation	Yes
Absolute Result	Yes
Define By	Magnitude - Phase
Magnitude	19.62 m/s²
Phase Angle	0. °
Direction	Y Axis
Suppressed	No

Fig-15: boundary condition

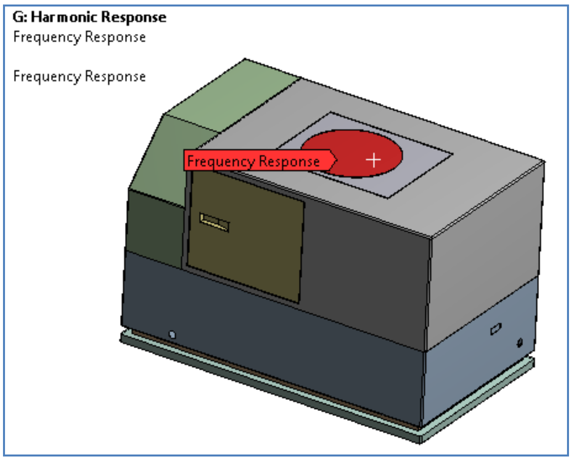
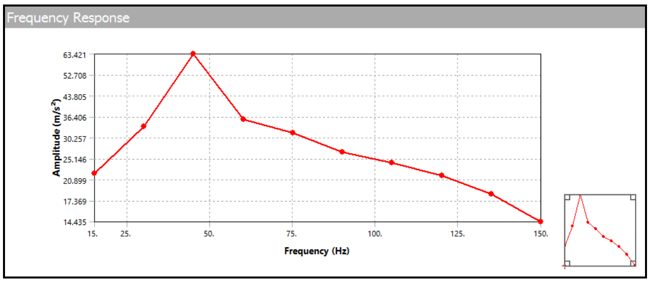


Fig-16: Frequency response



Graph-2: Frequency response

No patch on surface – maximum acceleration is observed around 63.42 m/s2.

C. Harmonic analysis of canopy with rectangular visco elastic patch

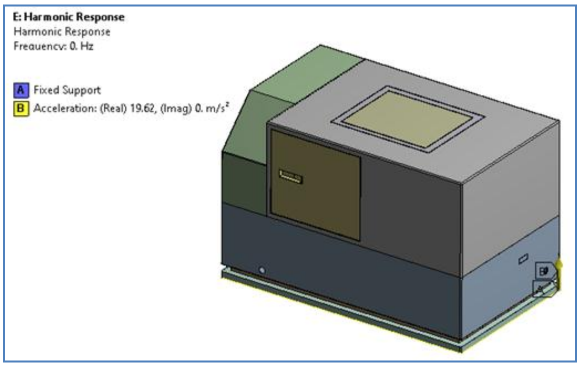


Fig-17: Boundary condition

Details of "Acceleration"	
Scope	
Boundary Condition	Fixed Support
Definition	
Base Excitation	Yes
Absolute Result	Yes
Define By	Magnitude - Phase
Magnitude	19.62 m/s²
Phase Angle	0. °
Direction	Y Axis
Suppressed	No

Fig-18: Detail of acceleration

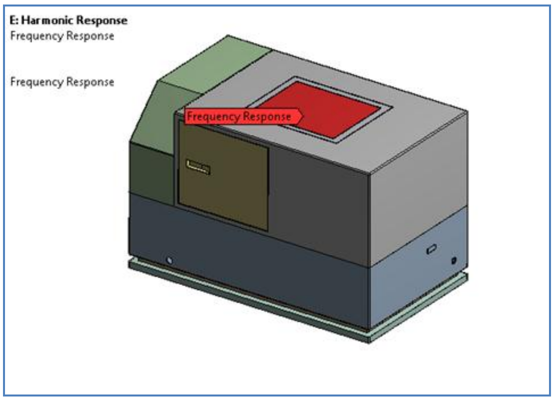
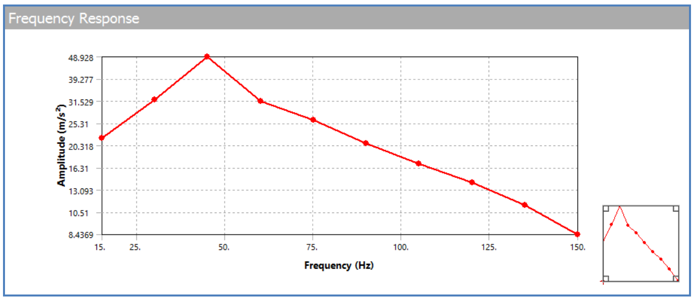


Fig-19: Frequency response for rectangular patch



Graph-3: Frequency response

No patch on surface – maximum acceleration is observed around 48.92 m/s2.

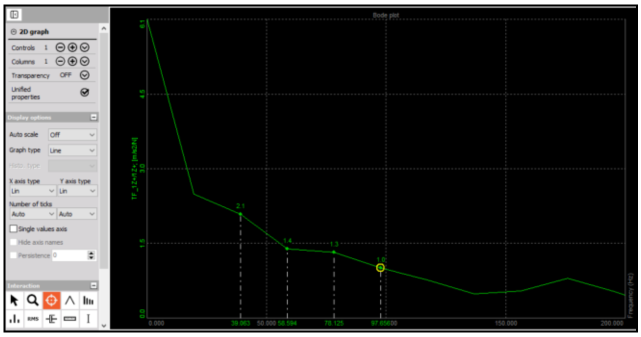
Acceleration has reduced compared to circular and existing design.

D.FFT analysis

FFT is one main property in any sequence being used in general. To find this property of FFT for any given sequence, many transforms are being used. The major issues to be noticed in finding this property are the time and memory management. Two different algorithms are written for calculating FFT and Autocorrelation of any given sequence. Comparison is done between the two algorithms with respect to the memory and time managements and the better one is pointed. Comparison is between the two algorithms written, considering the time and memory as the only main constraints. Time taken by the two transforms in finding the fundamental frequency is taken. At the same time the memory consumed while using the two algorithms is also checked. Based on these aspects it is decided which algorithm is to be used for better results

DEWE-43 Universal Data Acquisition Instrument

When connected to the high-speed USB 2.0 interface of any computer the DEWE-43 becomes a powerful measurement instrument for analog, digital, counter and CAN-bus data capture. Eight simultaneous analog inputs sample data at up to 204.8 kS/s and in combination with DEWETRON Modular Smart Interface modules (MSI) a wide range of sensors are supported Voltage Acceleration Pressure Force Temperature Sound Position RPM Torque Frequency Velocity And more The included DEWESoft application software adds powerful measurement and analysis capability, turning the DEWE-43 into a dedicated recorder, scope or FFT analyzer.

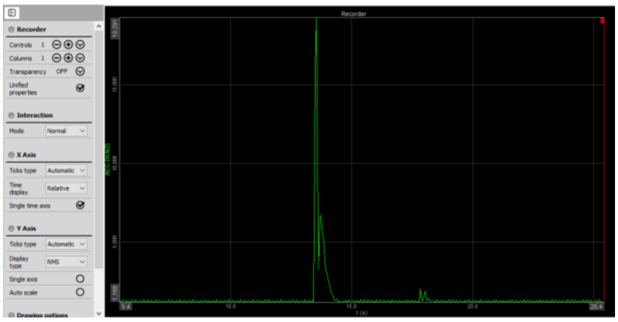


Graph-4: Setup natural frequency

E. Acceleration determination on surface

Fig- 20: Experimental setup

Fig-21: Experimental setup for surface



Graph-5: Maximum acceleration for surface

No patch on surface – maximum acceleration is observed around 19.29 m/s2.

F. Circular viscoelastic patch

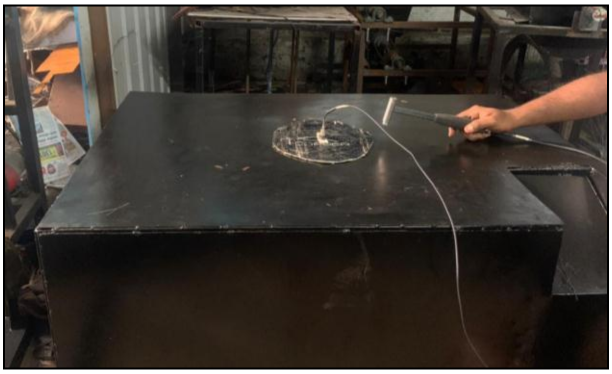
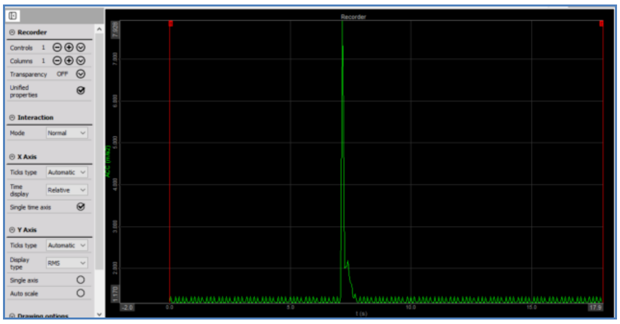


Fig-22: Experimental setup for circular patch



Graph-6: Maximum acceleration for circular patch

Circular patch – maximum acceleration is observed around 7.92 m/s2

G. Rectangular viscoelastic patch

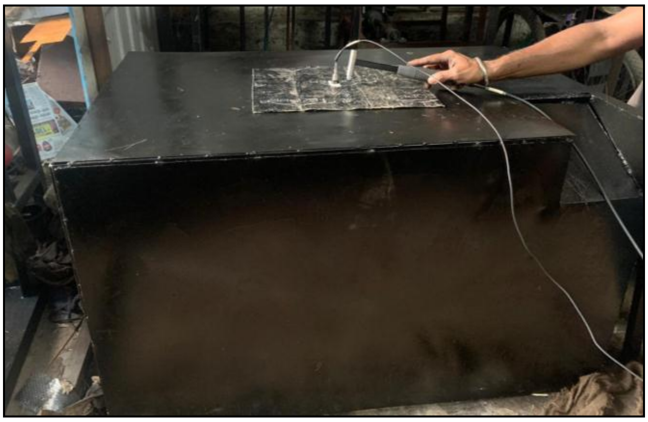
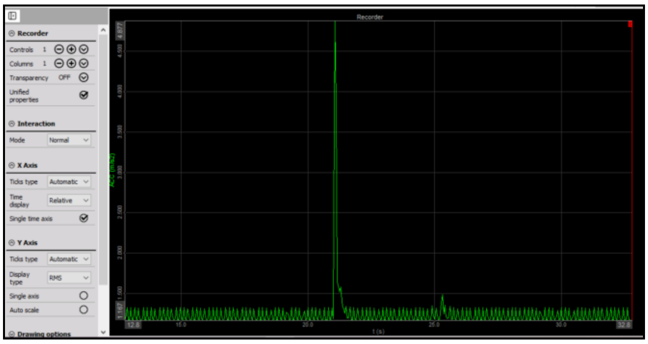


Fig-23: Experimental setup for rectangular patch



Graph-7: Maximum acceleration for rectangular patch

Rectangular patch – maximum acceleration is observed around 4.87 m/s2

TABLE 2 - Natural frequency

Mode Shape	FEA	Experimental
1	46.14	39.06
2	62.20	50.00
3	69.12	58.59
4	74.61	78.12
5	90.32	97.65

TABLE 3 - Excitation Amplitude

Sr. No.	Setup	Analysis Result (m/s^2)	Experimental Result (m/s^2)
1	Canopy without patch	141.72	19.29
2	Canopy with circular patch	63.421	7.92
3	Canopy without circular patch	48.928	4.87

TABLE 4 - Damping Percentage

Sr. No	Setup	% damping in analysis	% damping in experiment	% Error
1	Canopy with circular patch	63.421	7.92	3.7
2	Canopy without circular patch	48.928	4.87	10.2

8. CONCLUSIONS

- In present research canopy is designed and modal analysis have been performed to reduce vibration created in engine or generator inside it.
- Modal and harmonic analysis have been performed to determine optimum shape viscoelastic patch namely circular and rectangular shape in which max acceleration is reduced to 48.92, 63.42 compared to surface acceleration of 141.72 m/s2 amplitude respectively.
- In experimental testing FFT and FEA results are almost in similar range for setup natural frequency.
- In experimental it is observed that maximum acceleration of rectangular, circular and without patch is in 4.87, 7.92 and 19.29 m/s2 respective.
- It is observed that rectangular shape viscoelastic patch has better absorbing characteristics than other shape to reduced vibration.

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