DESIGN AND ANALYSIS OF CONTROL PANEL BRACKET FOR NVH

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ABSTRACT

Now a day it is very important for design and analysis industries to develop the ability to provide timely and accurate analysis of the product. Quick release of a new product into the market place, ahead of any competitors is an important factor to achieve a higher market share and increase profit margin but delivering a product in time but this should not be compromised with proper analysis of the product in view of its safety and strength. Analysis using various software modules is now accepted worldwide for the design analysis. As a result of the consumer desire for variety, batch production of products is now more important than mass production, which has resulted in the need for manufacturers to develop flexible manufacturing process to achieve a rapid turnaround in product development.

Keyword: - *vibration, Noise, Analysis, Frequency, Stress, Natural Frequency, Modal Analysis ANSYS, Control panel bracket ,Deformation*

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1. INTRODUCTION

Noise is defined as any unpleasant or unexpected sound created by a vibrating object and has an increasing importance to vehicle users and environments. Vibration is defined as any objectionable repetitive motion of an object, back-and-forth or up-and-down and represents an important issue closely related to reliability and quality of the vehicle. Harshness is customer perception which creates the impression of lack of isolation from the tire/wheel and suspension system.

2. CONTROL PANEL OF A GENERATOR

A control panel is a set of displays that indicate the measurement of different parameters like voltage, current and frequency, through the gauges and meters. These meters and gauges are set in a metallic body, usually corrosion proof, to protect from the effect from environmental factors. The panel may be set up on the body of the generator itself, which is usually the case with small generators.

2.1 Working of control panel

The control panel was becoming an increasingly complex master piece of electronics with a microprocessor that can manipulate input from sensors to help give feedback to the machine to adjust itself. The microchips will at that point take viable measures to control the presentation of the machine including shutdowns if, for instance, the oil weight is excessively low or the coolant temperature is excessively high, prompting development of warmth. In modern circumstances, this usefulness of control boards is ending up progressively basic. The microchip or microcontroller is implanted in the hardware inside the control board and is modified to take in the sensor info and respond to that with the customized control rules.

2.2 Design Frequency of Vibration

Many vibration issues are related with the DG set. The vibration level becomes severe when the engine runs at highest speed. The control panel should be able to sustain the vibrations generated by the Engine. The control panel bracket should be designed to avoid the resonance. The present thesis focuses on the increase in natural frequency of the control panel box beyond the frequency of engine vibrations. In the present study, the engine runs at a maximum speed of engine is 6000 rpm. The frequency of vibration is maximum at maximum speed of the engine.

Maximum Engine Speed= 6000 rpm

Speed in rps= (6000/60)

=100 (1/sec)

=100 Hz

But threshold frequency is always greater than 25% of natural frequency. Hence 125 Hz is designated as threshold frequency and is considered as design frequency of vibration. When the lowest natural frequency of system falls below threshold frequency, the system is subjected to the resonance. So in order to avoid resonance the lowest natural frequency of system must be greater than the design frequency of vibration.

3. LITERATURE REVIEW

D. Casagrande et al (2017) this paper presents a simulation study concerning the low and mid frequencies control of flexural vibration in a lightly damped thin plate equipped with five time-varying shunted piezoelectric patch absorbers. The board is energized by a downpour on-the-rooftop wide recurrence band stationary unsettling influence. The safeguards are made by piezoelectric patches associated with time-shifting RL shunt circuits.

Zhi-cheng Qiu (2016) he used a technique of Fuzzy fast terminal sliding mode for vibration control of a two-connected flexible plate using laser sensors. The fuzzy quick terminal sliding mode controller (FFTSMC) is examined to smother both the bigger and the littler sufficiency vibrations rapidly. Examinations on dynamic vibration control utilizing the structured FFTSMC are directed, contrasted and the old style corresponding subsidiary (PD) control calculation.

G.D. Shrigandhi et al (2016) he worked on Modal Analysis of Composite Sandwich Panel. Sandwich panels are thin-walled structures fabricated from two flat sheets separated by a low density core. The core investigated here is of aluminum honeycomb structure because of excellent crush strength and fatigue resistance. Sandwich panels have a very high stiffness to weight ratio with respect equivalent solid plate because of low density core. Modelling is developed in FEA by consideration of rotary inertia.

Dr.R.Rajappan et al (2015) he presented a paper on Static and Modal Analysis of Chassis by Using FEA. Truck undercarriage is a noteworthy part in a vehicle. In truck skeleton diverse kind of disappointments are happen because of static and dynamic stacking condition. In this present work static and dynamic burden attributes are investigated utilizing FE models from this work. It is found that indtifying location of high stress area, analyzing vibration, natural frequency and mode shape by using finite element method.

Ashutosh Kumar et al (2015) he have carried modal analysis of stiffened plate. The stiffened plates are subjected to dynamic load many times over it's life span. Strength of these structures are increased by adding stiffeners to its plate. His work is related with the analysis of rectangular stiffened plate which forms the basis of a structures.. In order to improve the strength of structure and reduce its weight, stiffeners are added to the plate structure. The stiffeners are very helpful in the buckling prevention. He carried FEA of the stiffened plate and found that modal frequency is increasing with addition of stiffeners and overall stiffness of the plate can be effectively increased by addition of stiffener which can yield better result.

4. PROBLEM STATEMENT

Control Panel is vital component of a Diesel Generator set. The control panel should be able to sustain the vibrations generated by the Generator. The control panel bracket should be designed to avoid the resonance. The present project focuses on the increase in natural frequency of the control panel bracket beyond the frequency of engine vibrations. A Diesel generator set includes diesel engine, alternator and control panel mounted on a common base frame. The control panel is less rigid in comparison with generator and alternator. With higher engine speed mechanical vibrations are also higher, due to its speed dependency. The objective of the study is to design the control panel to meet required norms without resonance. There are many methods to do this. In this project we are dealing with FEM.

5. METHODOLOGY

Literature review was carried out to understand past work carried out in the field of design analysis and design development of control panel bracket. For carrying out the methodology, two analyses are done. These two methods are briefed in the subsequent part of the present chapter as following.

A. Finite element analysis

This is the conventional method which is being presently used in the industry. This method of analysis requires various software modules for preprocessing, solver and post processing. In the present report modal analysis is used to find out the natural frequencies of the control panel bracket. The model was created using CATIA V6/R2014 software. Then the model was imported to the ANSYS 16.0 and then it was analyzed.

B. Experimental Method- FFT Analyzer test

This method is a laboratory method which is used to find out the vibration characteristics of the component by experimental setup consisting of fast Fourier transform analyzer. The actual model of the control panel box isused for the finding of the experimental values of natural frequencies. This test was carried out by using 4 channels OROS made FFT analyzer.

6. DESIGN AND ANALYSIS OF A CONTROL PANEL BRACKET

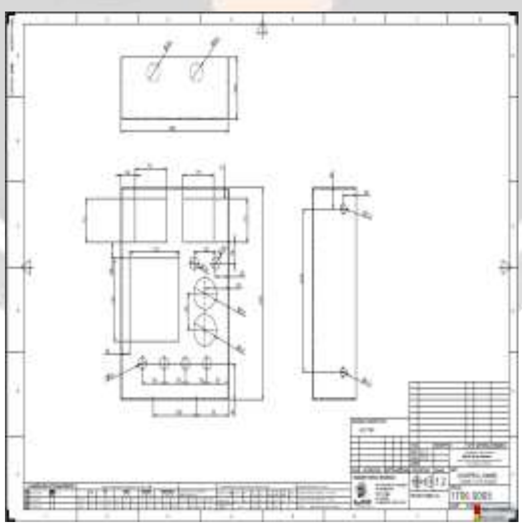

Fig 1 CAD Model

Finite Element Analysis of Control Panel Bracket is carried out in two different stages

1. Static Structural Analysis

2. Modal Analysis

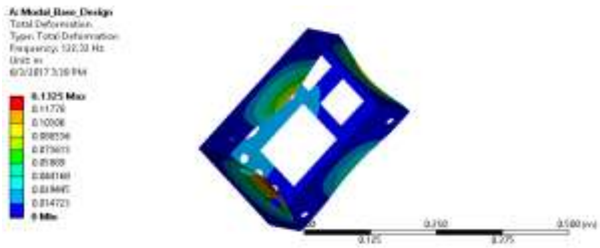

Fig 2 Total deformation mode 1

Table 1 Modal analysis result for control panel bracket

	Mode	Frequency (Hz)
1.	1.	122.32
2.	2.	127.74
3.	3.	130.09
4.	4.	132.67
5.	5.	196.11
6.	6.	223.47
7.	7.	273.91
8.	8.	285.13
9.	9.	288.03
10.	10.	294.37

The diesel engine used in the generator runs at a maximum speed of 6000 rpm. So the frequency of vibration of engine at maximum speed is125 Hz. In case of base model the first mode of natural frequency is at 122.32 Hz, which is less than the design frequency. It means, as the speed of engine increases there is a point where natural frequency of control panel becomes equal to the external excitation frequency and this leads to resonance. The change in. base model is that embossing are are provided to horizontal and vertical surfaces as shown in Fig resonance. The change in. base model is that embossing are provided to horizontal and vertical surfaces as shown in Fig.

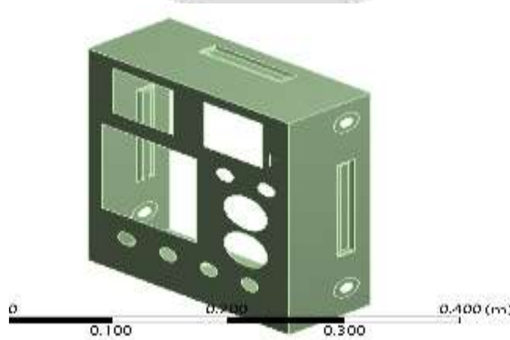

Fig 3 Embossing on a control Panel

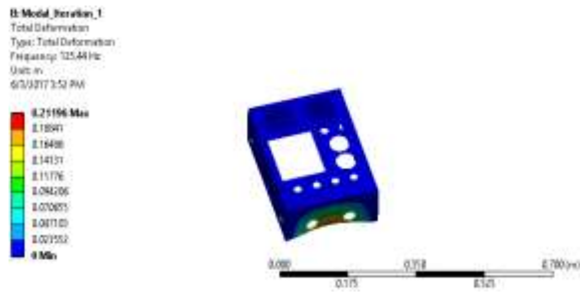

Fig 4 Total deformation mode

Table 2 Modal analysis result for control panel after embossing

	Mode No	Frequency (Hz)
1.	1.	125.44
2.	2.	152.8
3.	3.	191.7
4.	4.	194.16
5.	5.	209.03
6.	6.	230.05
7.	7.	277.9
8.	8.	332.75
9.	9.	406.67
10	10	427.28

7 HARMONIC RESPONSE ANALYSIS

Harmonic response analysis is a technique used to determine the steady-state response of a linear structure to loads that vary sinusoidally (harmonically) with time. The idea is to calculate the structure's response at several frequencies and obtain a graph of some response quantity (usually displacements) versus frequency."Peak" responses are then identified on the graph and stresses reviewed at those peak frequencies.

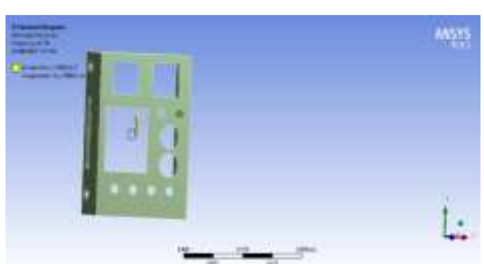

Fig 3 Harmonic response analysis

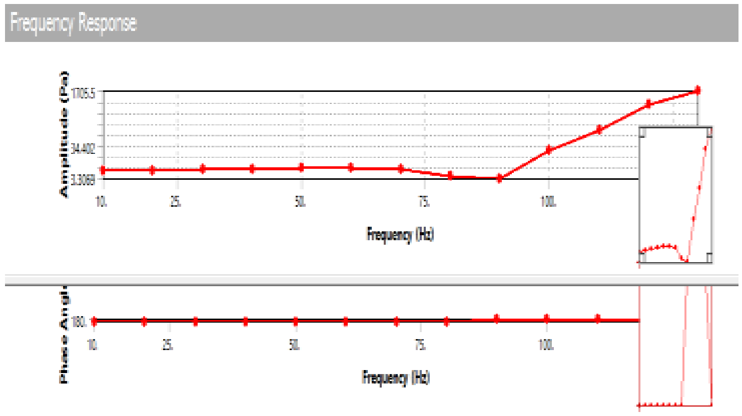

Fig 4 frequency response amplitude in Pa

Table No 3 Result of Frequency response analysis

	Frequ ency (Hz)	Amplitude [Pa]	Phase Angle [^{0}]
1.	10.	5.6905	0.
2.	20.	5.9049	0.
3.	30.	6.2415	0.
4.	40.	6.6563	0.
5.	50.	7.0523	0.
6.	60.	7.2153	0.
7.	70.	6.6581	0.
8.	80.	4.2015	0.
9.	90.	3.3069	180.
10	100.	25.815	180.
11	110.	105.93	180.
12	120.	651.28	180.
13	130.	1705.5	0.

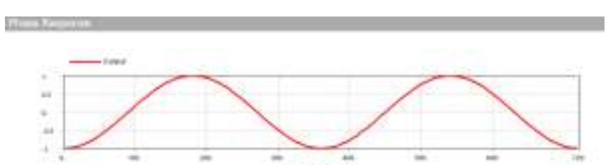

Fig 5 Phase response amplitude in Pa

8 RESULT

8.1Comparative Study of Natural Frequencies of Control Panel Brackets by FEA

With the use of finite element method, we have obtained significant results of natural frequencies of Base modeland iteration 1.

Mode No	Base Model(HZ)	Iteration 1(HZ)
1	122.32	125.44
2	127.74	152.8
3	130.09	191.7
4	132.67	194.16
5	196.11	209.03

8.2 Comparative Study of Natural Frequencies of Iteration 1 by FEA and Experimental Modal Analysis

The comparative study of natural frequencies of Base model, and Iteration 1 shows that Iteration 1 is safe for design frequency of external excitation which is 125 Hz. Now the physical model of Iteration 1 is actually tested in laboratory using FFT Analyzer. The results of first five modes of vibration are obtained from FFT Analyzer and then compared with results obtained using FEA of Iteration 1.

Mode	Frequency (Hz) (FEA)	Frequency (Hz) (FFT Analyzer)
1	125.44	113.25
2	152.8	130.35
3	191.7	150.65
4	194.16	175.60
5	209.03	190.56

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