Automotive Control Module under Various loading Failure mode analysis

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Abstract – *This main purpose of this module is mostly used to hold all the controls. When all the controls been assembled and tighten this module than it gets failed due to high vibration at off highway condition. The material used before is Polypropylene Homopolymer with 20% talc-filled material. Now decided to introduce with Polypropylene Homopolymer with 40% talc-filled material*

Key Words: RPM, Twist, Control module

1.INTRODUCTION

In the current situation of the cars and heavy industry market the joints and controls and very much important.

The control module is used to hold all the door, light controls and secure in the box. However due to rough road vibrations the control module is getting broken when it gets uneven load. The material used before is Polypropylene Homopolymer with 20% talc-filled material. Now decided to introduce with Polypropylene Homopolymer with 40% talc-filled material. The testing has been done with LS Dyna and verified with Experimental method

1.1 Literature review:

J. S. Lin and Kui-Sun Yim studied "Application of Random Vibration Test Methods for Automotive Subsystems Using Power special Density (PSD)" Source: SAE 2000-01-1331. This paper gives information about a PSD method of random vibration test method. References [1]. S. Timoshenko studied Study of thin wall structure. This paper shows that if we use the thin and shell walled plastic and shell structure with intimate properties than it will sustain with a very high load. References [2]. Guido Muzio Candido and Zeus studied "development of plastic parts in automotive factory" Source: SAE 2006-01-2626. This paper mainly focus on the injection molded parts and how it give more flexible tooling and reducing the time line for development of huge parts to marker in less cost. References [3,4]. Jeong Kim, Joo-Cheol Yoon, Beom-Soo Kang studied "The modeling of joints with the help of bolts and FEA". Source : Science Direct 2006. The main focus of this paper is to see the structural parts analysis and the model use to test is Marine diesel engine. References [5]

1.2 Theory:

Bolting Joints and engine excitation: These joints are mainly used to fasten the parts and assemblies with proper torque. Mike Guo and Shujath Ali studied "Study on rationalize the FEA Simulation which mostly deals with Fastened Joints". Source: SAE 2006-01-2626. These are to be done mostly with Linkages and it is proved with FEA and various trails and numerical methods

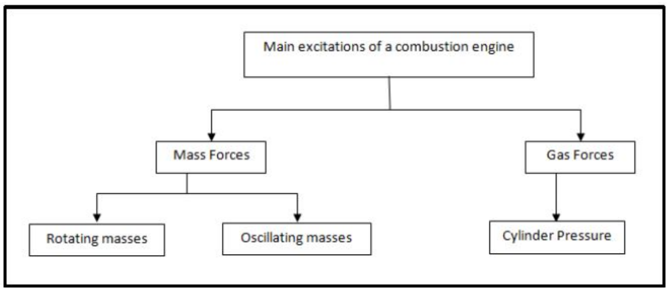

Fig -1: Engine Excitation

Eigen value represents the natural frequency of

M x ⍰t ⍰ ⍰ Kx ⍰t ⍰ = 0
Eq. 1

2. MATERIAL CHARACTERISTICS FOR CONTROL MODULE

The martial compositions are listed in the below table

Table -1: Materials

Sr. No	Material	Max Stress (MPa)	Strain at break (%)
1	PP 20% TF Homopolymer	33	14
2	PP 20% TF Copolymer	23	>40

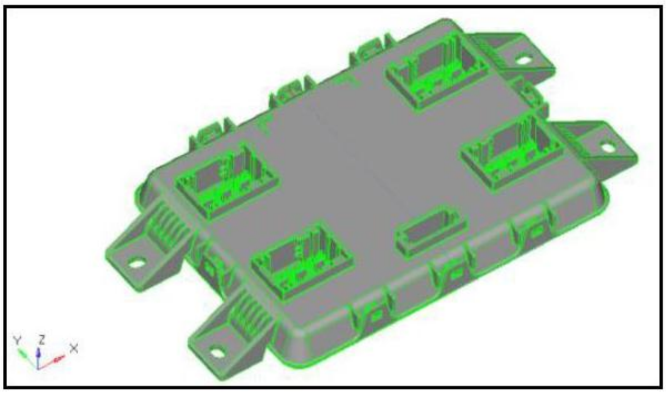

Fig -2: Control module

3. GEOMETRY:

The Catia model is converted in to IGES for FEA analysis and it is imported in Hypermesh. The control module is meshed with about 62627 nodes and 61470 elements. The mesh is accordingly optimized and proper quality check of all the elements has been performed. Three parts, cover, base and PCB of the Control Body Module refer with fig. 2, 3

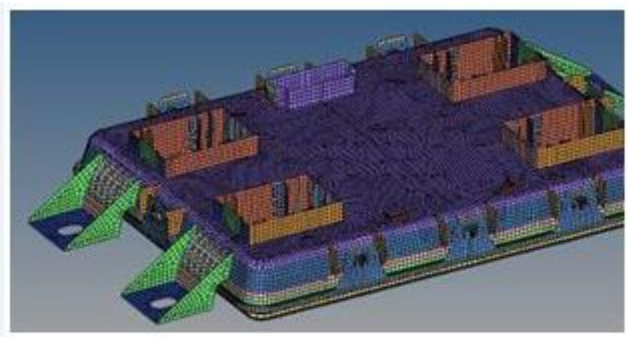

Fig -3: Finite Element Model of Control Module

4. MODEL ANALYSIS:

The same Creo model which was imported in IGES is performed for this modified Control Body Module. The material used as polypropylene copolymer with 20% talc filled which is used for modified Control Body Module. After testing the natural frequency is obtained 116 Hz. This model analysis is safe enough which is also greater than the engine excitation frequency.

The frequency to be carried out by FFT analyzer and the testing to be done with the numerical method. The sample results to be carry forwarded to the further testing and the solution to be obtained with the desired material with proper result.

Table -2: Frequency

Modes	Frequency (Hz)
1	116
2	160
3	188
4	190
5	209

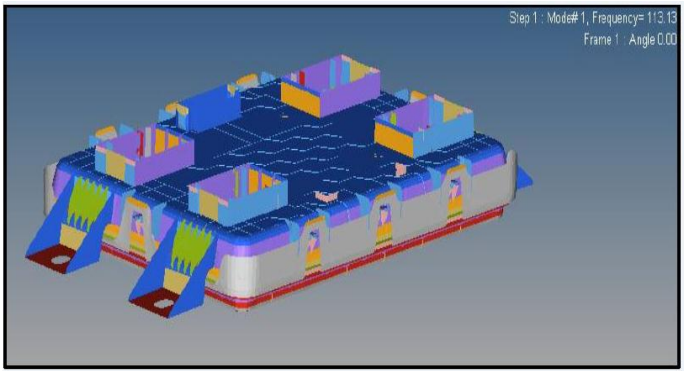

Fig -4: Natural Frequency of CM

5. RANDOM VIBRATION:

The Random Vibration analysis is executed which is done after Modal Analysis for the modified Control Module. Spectrum analysis is performed, after finishing the Modal Analysis

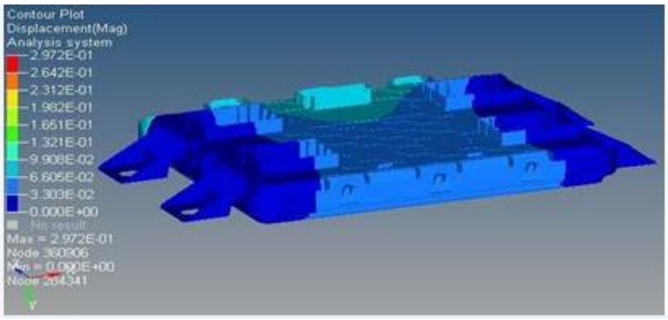

Fig -5: Random Vibration Analysis Displacement

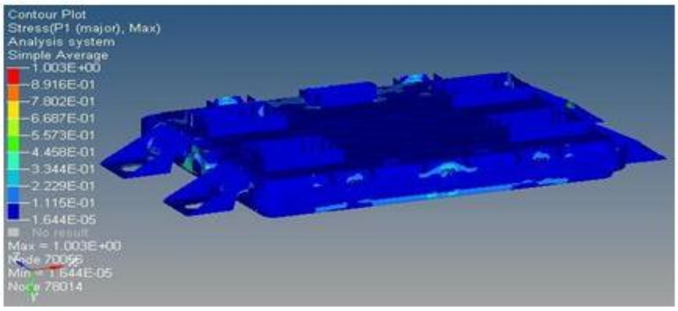

Fig -6: Random Vibration Analysis Stress plot.

In this analysis small amount of deflection of 0.28mm occurred. In this test 1Mpa of deflection stress is induced in this module which is less than yield stress of the material being used here. Due to these reason and results performed the module is not damage due to uneven road vibrations.

6. TEST PARAMETERS:

The Control Body Module the half sine pulse is given to the, ten times in each axis along both x & y axis.

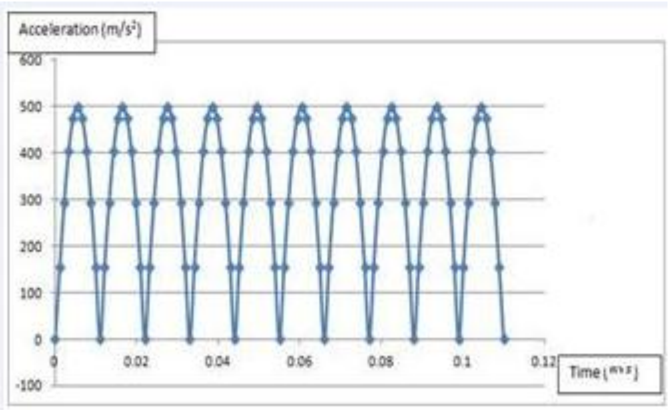

Chart -1: Shock Pulse for Sinusoidal.

7. ANALYSIS RESULTS:

By using LS-DYNA the simulations are performed using above Boundary condition. The mechanical shock Stress plot

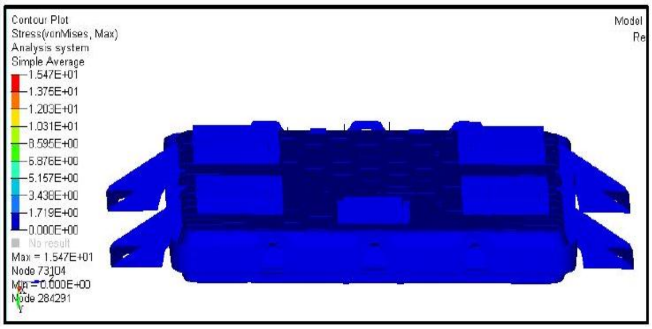

Fig -7: +ve X direction Mechanical shock Random

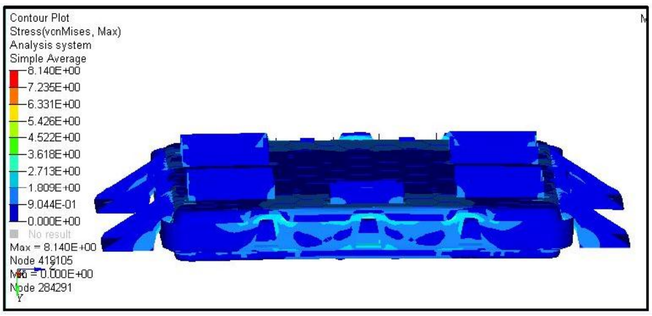

Fig -8: +ve Y direction Mechanical shock

Table -3: Mechanical Shock

Sr.no	Mechanical Shock side	Stress N/mm^2	Results
1	+ve X Direction	15.23< 23	Safe
2	+ve Y Direction	8.13< 23	Safe

8. RESULT SUMMERY:

Table -4: Experimental analysis

Control Module Design	Modified Design Virtual Analysis	Modified Design Experimental Analysis	% Difference
Deformation In Vertical Y-direction (12 Hrs)	10.2 mm	14 mm	25%

9. CONCLUSIONS

The Control Module frequency archives the target goal value frequency. In all the 3 directions Z, Y,X for mechanical shock Maximum stress is under yield limit so we can concluded that Body Module is safe for vibration loading.

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