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DFME ANALYSIS, CAD MODELLING AND MODAL ANALYSIS OF A COWL

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ABSTRACT

Bus cowl or cabin for driver is a crucial part of bus which is mounted on chassis and is further connected to engine hood, bus body, dashboard, steering column, various pedals etc. Its function is to provide strength and enough space for driver to comfortably ride the bus. DFME or design failure mode effect analysis is a systematic procedure for the analysis of a component for vehicle's safety. The main purpose of DFME is to find and evaluate the potential failures that the product design may cause and try to reduce the potential failures. The first part of the project was that a VE cowl (SKL Pro 3011L RP RD BS4 ABS DD) was taken and studied practically in detail and DFME analysis was done on it to make improvements and prevent failures. In second part of the project an original new cad model of cowl on CATIA V5 based on the research was designed, meshing was done on Hypermesh and Modal analysis was done using Nastran.

Keywords

Cowl, DFMEA, CAD modeling, MODAL Analysis, Nastran, CATIA V5.

1. INTRODUCTION

The ability to predict the reliability of components and systems is important in technical design. Reliability prediction is designed to prevent malfunctions, for example through planned maintenance. The reliability of the individual components is superior to the corresponding system reliability. Optimizing the reliability analysis process requires the use of appropriate quality control tools such as Failure Mode and Effect Analysis (FMEA) or Fault Tree Analysis (FTA). Through these analyzes it is possible to examine the critical parameters of the analyzed process. These are the two commonly used methods for failure analysis. According to MIL-STD-1629 REV.A Standard DFME is a reliability evaluation/design technique which examines the potential failure modes within a system and its equipment, in order to determine the effects on equipment and system performance. Each potential failure mode is classified according to its impact on mission success and personnel/equipment safety. It is a bottom-up method, starting at the component level, which is used to find failure modes and to identify their effects. By adding a criticality analysis, qualitative DFMEA becomes quantitative DFMECA (Design failure mode, effects and criticality analysis).

2. METHODOLOGY

DFMEA (Design Failure Mode and Effect Analysis) is the application of the Failure Mode and Effects Analysis (FMEA) method specifically to product/service design.

There are 11 steps to complete DFMEA:

1. Design Review – Use the product/service design drawings or documents to identify each component and its relation with other components of product/service
2. Brainstorm potential failure modes
3. List potential failure modes
4. List potential effects of failure modes
5. Assign the severity ranking which should be based on consequences of failure (1 to 10) (Threat to human life, accident or safety issue is scored 10)
6. Assign the occurrence ranking (1 to 10)
7. Assign detection ranking based on the chance of detection prior to failure (1 to 10) (Easy for detection gets less score – 1, difficult to detect should be assigned higher score)
8. Calculate the SOD (Severity x Occurrence x Detection) number or risk priority number (RPN)
9. Develop action plan to reduce vital RPNs (Above set baseline)
10. Implement the improvements identified
11. Calculate RPN again based on improvements. Do mistake proofing.

3. DETAILED STUDY OF EVERY FUNCTION OF COWL AFTER BRAINSTORMING AND PHYSICAL INSPECTION

3.1 1st function of cowl

To provide strength to support loads

Potential failure mode

Sagging of cowl due to loads

Causes of failure

Low strength of materials used

Poor quality of material used

Effects of failure

Bad quality impression

Discomfort while driving

3.2 2nd function of cow

Ergonomically design the best suitable placing of driver control and seating position

Potential failure mode

Improper alignment of driver controls and seat.

Causes of failure

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1. Insufficient space available
2. Difficulty in placing of mountings due to constrained or incorrect design.

Effects of failure

1. Fatigue to driver
2. Reduced ride's feel due to difficulty in driving

3.3 3rd function of cowl

To provide high stiffness

Potential failure mode

1. Deformations in cowl during manufacturing it.
2. Formed stresses at connections due to incorrect designing

Causes of failure

1. Mounting failure of seat, steering column and pedal cluster.
2. Low stiffness of material used.

Effects of failure

Occurring of roadside accidents

3.4 4th function of cowl

To be corrosion resistant

Potential failure mode

Corrosion of structure at early stages

Causes of failure

1. Improper coating
2. Reaction with air and moisture

Effects of failure

1. Reduced cowl life
2. Bad quality impression
3. Delamination and removal of corroded chips.

3.5 5th function of cowl

To meet the vibration criteria

Potential failure mode

1. Vibrating cowl
2. Squeaking noise
3. Rattling noise
4. Buzzing noise

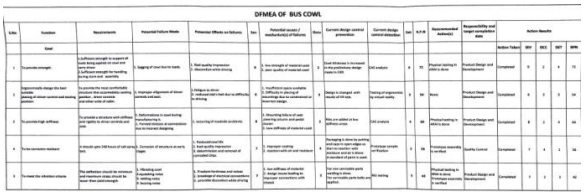
Causes of failure

1. Low stiffness of material
2. Design issues leading to improper connections with chassis

Effects of failure

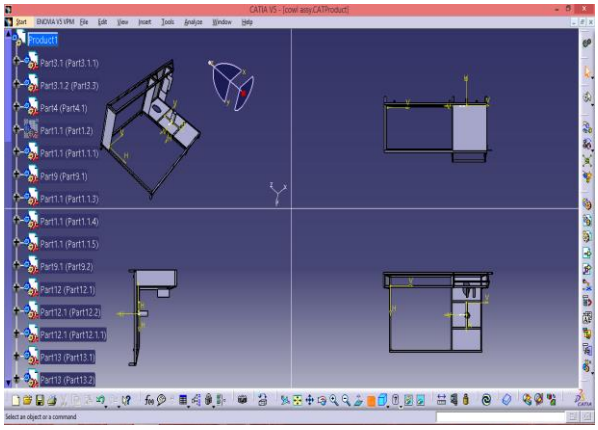
1. Produce harshness and noises
2. Breakage of electrical connections
3. Provides discomfort while driving

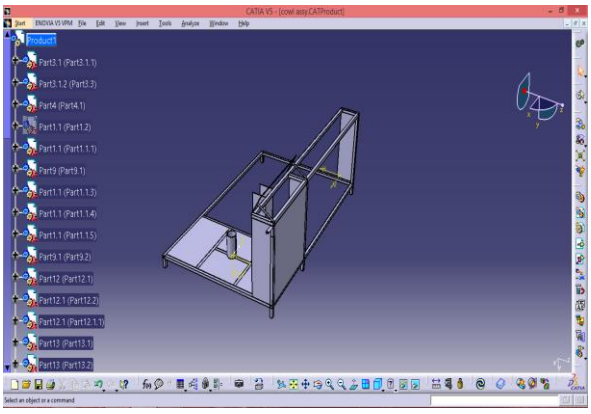
4. DFMEA OF COWL



5. DESIGN

The design of 3D model is done using CATIA V5 software with proper dimensions. All the linkages of the system are shown using line diagrams.





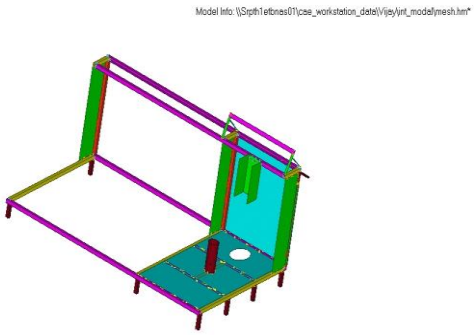
6. MODAL ANALYSIS

Modal analysis determines the mode shapes (vibration shapes) and frequencies for that particular mode shape of a structure for a free vibration analysis.

-->ND defines the root numbers or mode shapes that should be known starting from V1 frequency till v2 frequency

--> The Function which you are seeing is the frequency of the structure for that particular mode the governing equation for free-free (normal) modal analysis is dependent on mass and stiffness of the structure.

Eigen values are calculated based on these parameters and corresponding vectors are calculated based on the eigen values (these vectors are also called as eigenvectors)



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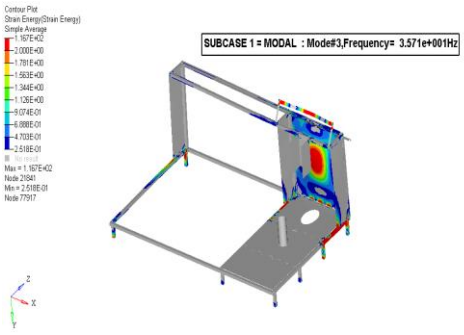
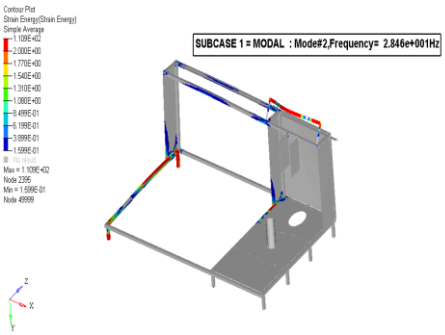
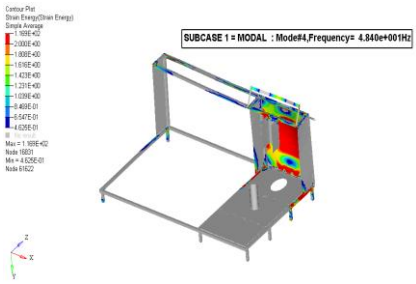
From this Eigen value the frequency is calculated and the frequency is directly proportional to this value.

The static value is the static displacement (relative displacement) and it is recommended not to reply on these displacement values.

It is important to know these frequencies. For instance if the loads are applied on the structure whose natural frequency matches with the applied load frequency, this will result in resonance and thus failure in the structure.







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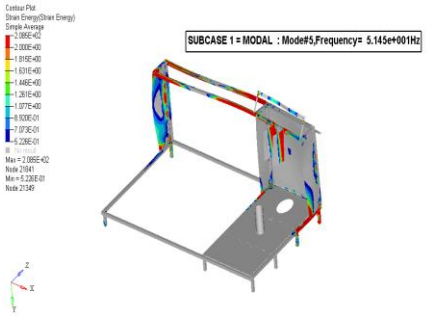

Modal analysis helps determine the modes of vibrations and these are the frequencies at which those modes are triggered.

Modal analysis doesn't give any information about the real deformation that an excitation of one of those modes will actually cause.

7. RESULT

[1] DFMEA Report was made

[2] Cad modelling was done on CATIA V5

[3] Modal analysis was done successfully done using Hypermesh and Nastran.

8. REFERENCES

[1] McDermott, R.E., Mikulak, R.J., Beauregard, M.R., The basic of FMEA, Publisher Productivity Press, ISBN 978-1-56327-377-3, United State of America, 2008.

[2] Stamatis, D.H., Failure mode and effect analysis: FMEA from theory to execution, Library of Congress Cataloging-in-Publication Data, ISBN 0-87389-5983, United State of America, 2003.

[3] Kenneth W. Dailey, The FMEA Pocket Handbook, Publisher DW Publishing, ISBN 0-947221-2-X, United State of America, 2004

[4] Huang, G.Q., Shi, J., Mak, K.L., Failure Mode and Effect Analysis (FMEA) Over the WWW, The International Journal of Advanced Manufacturing Technology, Vol. 16, No. 8, 2000. Pp. 603-608.