Noise and Vibration Analysis of Car Floor Using FEA and Experimental Method (FFT)

Arun S K[1], Aravind K. U.[2] Dr. Maruthi B H[3], Chandru B T[4]

1 PG Student, arunsk29@gmail.com 2 Associate Professor 3 Professor & HOD, 4 Associate Professor

Deportment of Mechanical Engineering

East West Institute Of Technology, Bengaluru-91,

Karnataka, India

Abstract- **This project includes the comparison of the results obtained by the experimental model analysis and finite element model analysis of an automotive car floor. Here, it is concerned with the improvement of fatigue life of the car floor component and to improve the ride quality by increasing passengers comfort ability under the study condition. The main objective of the project is that the vibration characteristics such as frequencies, mode shapes and damping factors of an automotive car floor are determined and compared using FEM and FFT analyser techniques. First, the car floor geometry is modelled by using CATIA software and then it is meshed by using the HYPERMESH software. This meshed model is analysed under the free-free condition by using the ABACUS solver. We will get the results such as frequencies and mode shapes. Second, once again the results such as frequencies, mode shapes and damping factors are taken by the experimental analysis through FFT analyser. Third, the vibration can be optimized by changing the natural frequencies of the system of the automotive car floor by adding damper. With the damper the free – free analysis of the model is conducted to get the result like frequencies, mode shapes and damping factors, with both FEM and FFT analyser methods. Finally the results obtained by both the conditions are compared and then validated.**

Keywords- **CATIA, ABACUS, Car floor, vibration, Frequency.**

INTRODUCTION

In designing and manufacturing of any component vibration is the most important factor, where lot of core has to be taken for avoiding or reducing the vibration on the components and structure.

The carelessness may lead to higher problems to the components and structure which may fix the problems such as wear and tear of machine parts, such as gear and bearing. Because of these problems machine's efficiency decreases and also makes heavy sound which are undesirable.

Here to minimize these vibrations, the characteristics of the vibrations such as frequency, mode shape and damping factors of the components has to be designed properly by knowing these properties of the materials, characteristics of the metal before the manufacturing of the component.

Vibration: If motion in an object or component or structure repeats with its own, after a span of time may be said as vibration

Causes for vibration:

- Unbalanced forces
- External excitation
- Dry friction
- Earthquake
- Winds

These vibrations causes excessive stress, increases Bearing loads, energy losses. Fatigue, unwanted noise, failure of parts etc.

Elimination of these vibrations

- By shock absorber
- Dynamic vibration absorber
- By making system to rest on proper vibration isolator.

AUTOMOTIVE CAR FRAME

Car undercarriage is a skeletal casing on which different mechanical parts like motor, tires, pivot gatherings, brakes, guiding and so on are shot. The frame is thought to be the most critical segment of a car. It is the most urgent component that gives quality and dependability to the vehicle under various conditions. Car outlines give quality and adaptability to the car. The foundation of any vehicles, it is the supporting casing to which the body of a motor, hub gatherings are fastened. Tie bars, that are crucial parts of car casings, are clasp that predicament diverse vehicle parts together.

Car skeleton is thought to be one of the huge structures of a vehicle. It is typically made of a steel edge, which holds the body and engine of a car vehicle. All the more correctly, car body or vehicles case is a skeletal edge on which different mechanical parts like motor, tires, pivot gatherings, brakes, guiding and so forth are darted. At the season of assembling, the body of a vehicle is adaptably formed by structure of skeleton. Vehicles undercarriage is typically made of light sheet metal or composite plastics. It gives quality expected to supporting vehicular parts and payload put upon it. Car frame or car undercarriage keeps a vehicle inflexible, hardened and unyielding. Auto undercarriage guarantees low levels of clamor, vibrations and brutality all through the car.

Fig1: Body on floor car

OBJECTIVES OF THE PROJECT

- CATIA is a software tool used in our project for creating a CAD modal of the automotive car floor.
- In the next step, all the necessary details are verified and the geometry of the floor is Britten end and the meshing is done in the HYPERMESH software by importing the CAD modal from CATIA.
- We are proceeding for the next step by using the ABAQUS solver where we are discovering the mode shapes and frequencies of an automotive floor without the damper.
- Experimental mode analysis (EMA) is the another method where we use FAST FOURIER TRANSFER (FFT) analyser for determining the frequencies mode shape and damping ratios of floor without damper.
- Validation is the next step which is done on the results of FEA and EMA.
- In here the need of optimization of results are done by frosting of damper on the floor.
- The result with damper for the floor is generated by using both FEA and EMA.
- The foisted damper results of FEA and EMA are validated.

METHODOLOGY

Methodology is define as the successive step by step process of manufacturing or designing of component or solving problem etc.

Here in our project we are analysing the floor by two methodology those are FEA and EMA.

- In this FEA analysis method we proceeding by the following steps
  - Creating 3D modal
  - Meshing
  - Analysis
  - Post-processing
  - Result
- In EMA method following are the steps used
  - Car floor
  - Marking required number of points
  - Hitting on the marked points by hammer
  - Data analysis
  - Extracting frequencies, damping factor and mode shapes.
  - Results

FINITE ELEMENT METHOD

GEOMETRY

The primary requirement of the FEA is the geometry of the part which is generated by using the software known as CATIA V5 R20, CATIA is as multiplatform CAD/CAM/CAE software suite developed by the French company Dassault system.

This software helps used in the creation of the geometry very accurately with the use friendly commands for the better modal. Then after the modelling, this modal is imported by the meshing software for the next process called meshing.

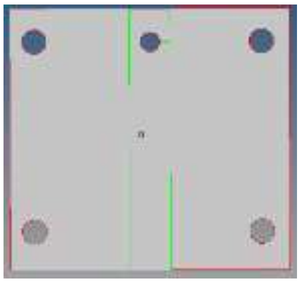

Fig2: Catia model of automotive car floor

MESHING

The approximation of geometry domain in the form polygonal or polyhedral mesh is known as mesh generation. In 3-D meshing used in FEA contains tetrahedral, pyramids, prisms or hexahedral. Meshing can be defines as discretization for 1-D, 2-D and 3-D.

The HYPERMESH tool is used for meshing of floor. Finite element quality is the suitable which is used for meshing. 19882 and 19862 are the total number of elements and nodes respectively used for the generation of FE modal

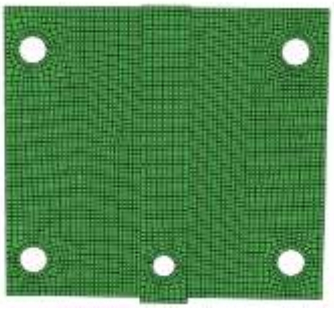

Fig3; Meshed model of automotive car floor

NUMERICAL ANALYSIS

The external vibrations which are excreted on the structure, deforms the structure which can be described by the method known as modal analysis. The deformation of the structure is in the form of number of well deformed wave like shapes or of the form of modes. Each mode exhibits its own frequency, mode shape and damping factor. Dynamic factors or characteristics of the structure like mode shape, frequency are known by the methods finite element method and experimental method. Here we are determining the frequency, mode shape and damping factor for the structure on the basis of different conditions like

- free-free condition
- fixed-fixed condition

For both the above condition we have to deal with damper and without damper. Ultimately we have to compare the results of FEA and EMA for the optimization.

RESULTS ON FREE-FREE CONDITION WITHOUT DAMPER

MODE SHAPES

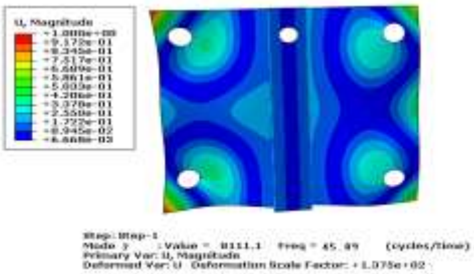

Fig 4: 7TH mode shape

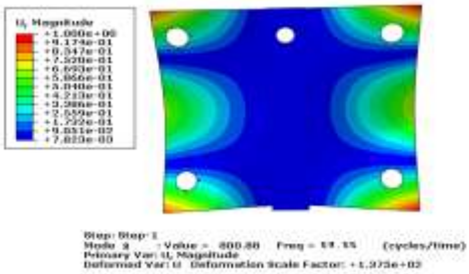

Fig 5: 8th Mode Shape

FREQUENCIES WITHOUT DAMPER

Frequency response on free – free condition without damper

Mode shape number	Frequency(HZ)
7	45.89
8	59.55

RESULTS ON FREE-FREE CONDITION WITH DAMPER

MODE SHAPES

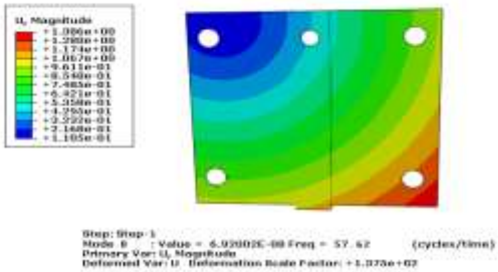

Fig 6: 7th Mode Shape

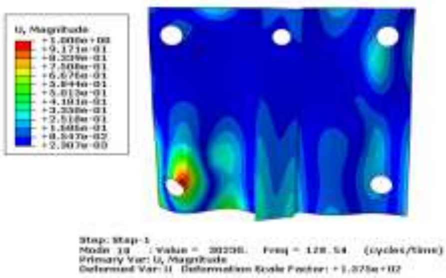

Fig 7: 8th Mode Shape

FREQUENCY WITH DAMPER

Frequency response on free – free condition with damper

Mode shape number	Frequency(HZ)
7	43.41
8	57.62

EXPERIMENTAL MODAL ANALYSIS

Work Carried In Experimental Analysis:
Exploratory investigation is utilized to accept the modular examination result and we are just in the field of element. In this anticipate the point is to do free limit condition. The floor part is hanged uninhibitedly utilizing holders and is appeared as a part of the figure to minimize the anxiety in segment and to permit the unbending body modes got from floor.

Fig 8: Automotive car floor with damper

RESULTS ON FREE-FREE CONDITION WITHOUT DAMPER

MODE SHAPES

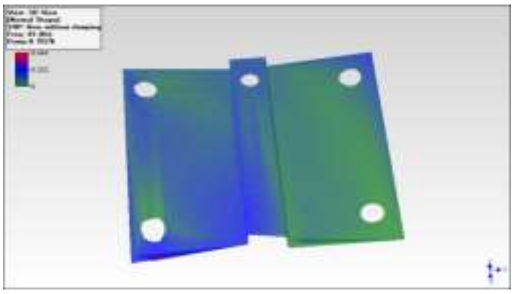

Fig 9: 7TH mode frequency response and mode shape

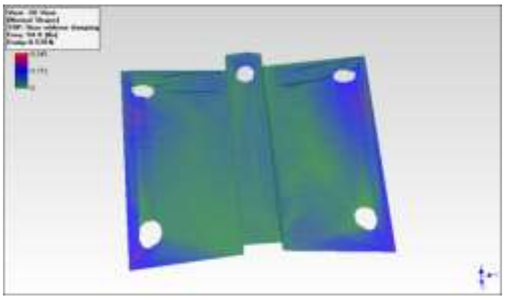

Fig 10: 8TH mode frequency response and mode shape

FREQUENCY WITHOUT DAMPER

TABLE 5.1: Frequency response on free – free condition without damper

Mode shape number	Frequency(HZ)
7	43
8	54.9

RESULTS ON FREE-FREE CONDITION WITH DAMPER

MODE SHAPES

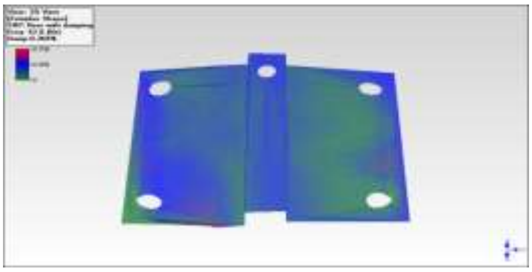

Fig 11: 7TH mode frequency response and mode shape

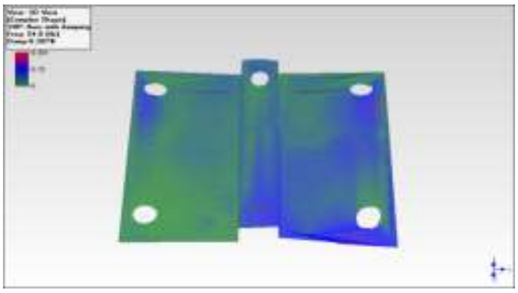

Fig 12: 8TH mode frequency response and mode shape

FREQUENCY WITH DAMPER

TABLE 5.2: Frequency response on free – free condition with damper

Mode shape number	Frequency(HZ)
7	42.8
8	54.8

CONCLUSION

The auxiliary vibration excitations of car vehicle are created by a wide range of sources. In our task we have consider one of the key component of car vehicle that is car floor model vibration excitation under free condition. Firstly the displaying is refined for the car floor model in CATIA and coincided in HYPERMESH then the FEM modular examination was conveyed out utilizing Abaqus as a solver. Also, exploratory modular examination was led utilizing FFT analyser. To got the aftereffects of modular parameters by FEM and FFT examination of without stiffener condition. To accept the FEM results with FFT examination results. To enhance the modular parameters by including stiffener in the structure T-segment are welded on the deterministic supplementary vibration floor region. Again both FEM and FFT examination was led of with stiffener condition. At last got the outcomes and it's accepted. Up to sixth mode for floor, it indicates as rigid condition where the motions are constrained under free-free condition. In X, Y and Z axes these have three translatory and rotational modes. So in our investigation we have neglected the first six modes.

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