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Study of Static and Frequency Response Analysis of Hangers with Exhaust System

Vinutha B.S [1], Hemanth.K [2]

[1]M.Tech Scholar, [2]Associate Professor

REVA University, Bangalore.

India

ABSTRACT

The breaking of exhaust hanger can cause the vehicle exhaust pipes to hang visibly low underneath the vehicle, from the lack of support. If any of the exhaust hangers break or fail, they can place additional stress on the vehicle's exhaust pipes, which can cause them to break or crack. It is therefore necessary for a design engineer to describe and assess the dynamics of various system design proposals during the product development. The objective of the present work is to design and analyse the static and dynamic properties of the hangers with exhaust system, FEM is carried out for the exhaust system. Pre processing performed by using hyper mesh, model analysis is performed using MSC Nastran for exhaust component to determine the natural frequency along with mode shapes.

Keywords: *Hangers, Exhaust system, Static and dynamic properties, FEM analysis.*

1. INTRODUCTION

Every increasing demand for durability, lighter and cost effective designs of automotive products have lead to more frequent usage of powerful Numerical techniques for solving structural problems. In the automotive industry, the detection of structural failures has traditionally relied on proving ground road load tests. It is generally recognized that developing designs through testing and retesting using several prototypes is not helping in accelerating the product development. Hence virtual structural calculations of automotive components have become an essential part for vehicle manufacturers. Hence designing the exhaust system for structural analysis is extremely important. Exhaust system Hangers are the mounts that are used to secure and support the exhaust pipes to the underside of the vehicle. The exhaust system hangers are analysed statically and dynamically using Hypermesh and MSC Nastran.

2.METHODOLOGY

In thePresent work, Finite Element analyses were used to regulate the characteristics of the Exhaust system. The arrangement of all the analysis results were used to grow virtual model created by FEM tools and the model was modernized based on the correlation process.

The literature evaluation of the Exhaust system was carried out to find basic understanding of the work. Data like classical natural frequency values of Exhaust system, excitation sources and mode shape were examined.

For the purpose of this study, the Exhaust system was modelled using CATIA V-5 Software according to the original size of structures. The model was then imported into Finite Element pre-processing software Hypermesh for the FE modelling and then it is imported into Finite Element solver software MSC Nastran to carry the FE analysis like linear static analysis and Dynamic Analysis[1].

Simulation of FE Model

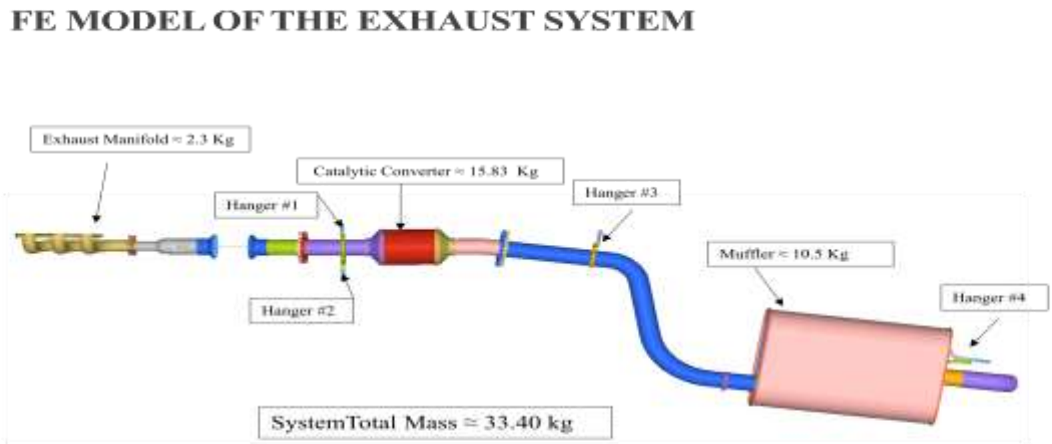

Fig1. FE Model of the Exhaust system

Table.1 . Tabulation of Model Summary

Number of Grid	•	Points	•	159895
• Number of CBush	•	Elements	•	5
• Number of Chexa	•	Elements	•	32382
• Number of Cpenta	•	Elements		3046
• Number of Cquad	•	Elements	•	115433
• Number of CTRIA3	•	Elements	•	7
• Number of RBE2	•	Elements	•	1385

Tabulation of Material property: SS410 (Steel)

Table 2 Details of Material Property

Young's Modulus	Poisson's ratio	Density
2.15 E05 MPa	0.3	7.7 E-9 ton/mm^3

Boundary conditions:

- Flange inlet and body side ends of the isolators are fixed in all DOF.

Finite element model:

- Linear material properties.
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3. RESULTS AND DISCUSSION

1.Linear Static Analysis

Though the static analysis is one of the simplest of the analysis, it is carried out in almost all of the FE problems. This is because the probability that a member/structure is subjected to static loading is more than that of the dynamic loading in normal operating conditions. So the determination of displacements, stresses of various components is as important in the static conditions as it is in dynamic conditions. Consider axial, vertical and lateral are X,Y and Z respectively.

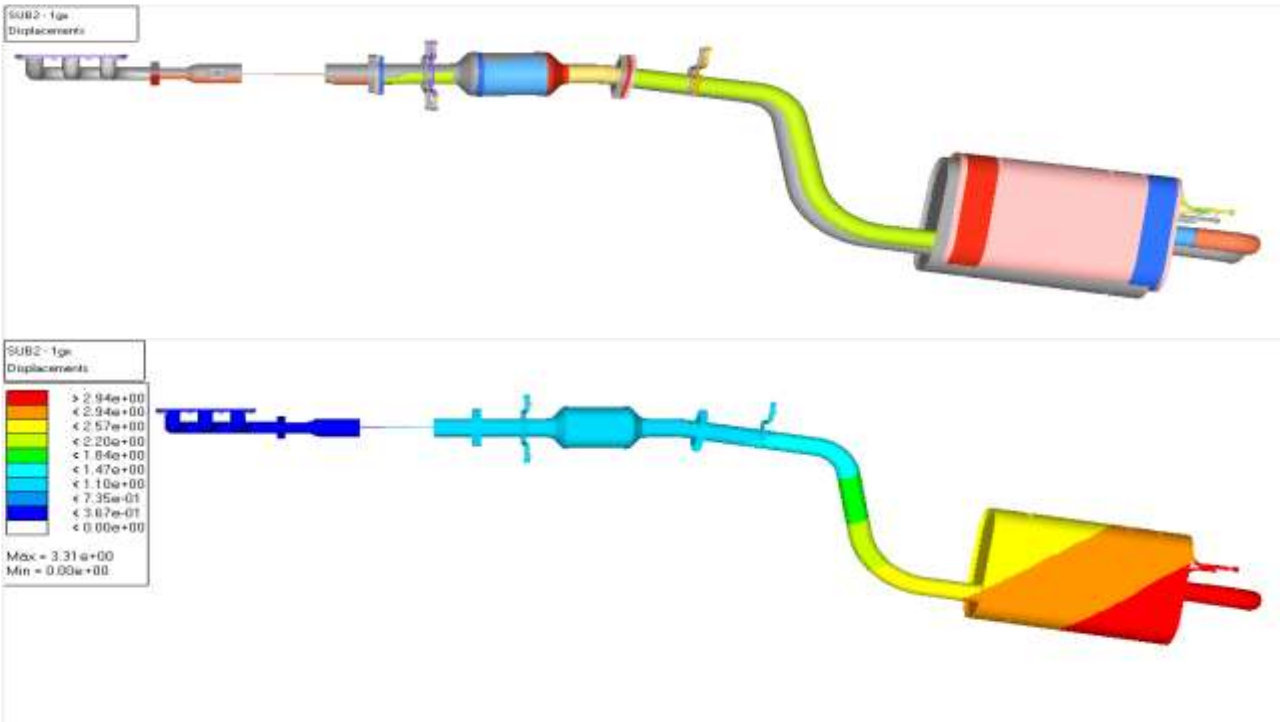

Fig 1: Maximum displacement for Axial load Condition

The maximum stress and maximum displacement in 1g load conditions i.e., due to self weightare carried out as shown in fig1. And It is observed that maximum displacement is more in vertical load condition when compared to axial load and lateral load condition.

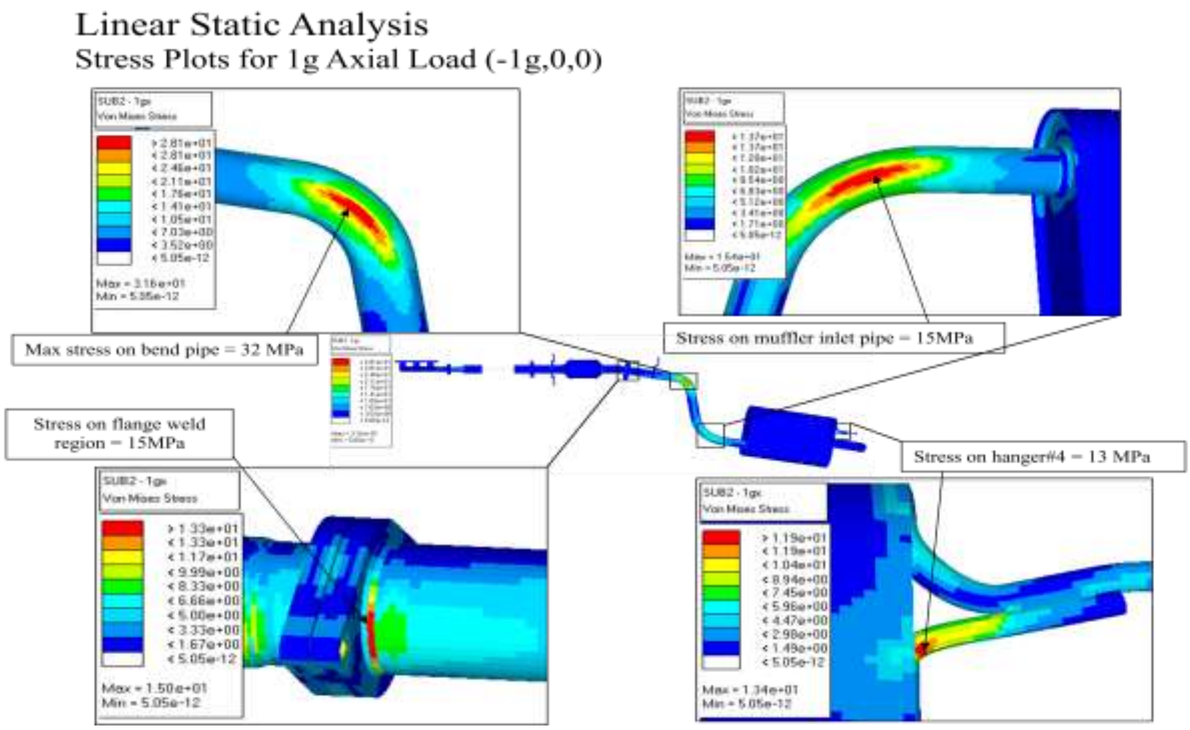

Fig 2: Stress Plot for 1g load condition along the Axialload

from the linear static analysis , After placing the hangers, the stress in the different locations of the exhaust system are found out. The stress should always maintain within 50Mpa as per the study. Table 3 shows themaximum stress and maximum displacement for different load conditions [2].

Table 3. Maximum stress and maximum displacement for different load conditions

Static Loading	Max. von Mises Stress	Max. Displacement
1g Axial load (-1g, 0, 0)	**32 MPa**	**3.31 mm**
1g Lateral load (0, -1g, 0)	**40 MPa**	**11.5 mm**
1g Vertical load (0, 0, -1g)	**49 MPa**	**15.2 mm**

Frequency response analysis

When an excitation frequency is close to natural frequency of component. There would be big difference in static and dynamic results. Static analysis would probably show stress magnitude within yield stress and safe but in reality it might fail [2].

In dynamic analysis there are two types of vibration one is free vibration and another one is forced vibration. For this analysis forced vibration is considered. Forced vibration response to the external force./excitation in that frequency response is considered it is frequency domain which is steady state sinusoidal excitation limited to linear static structures.

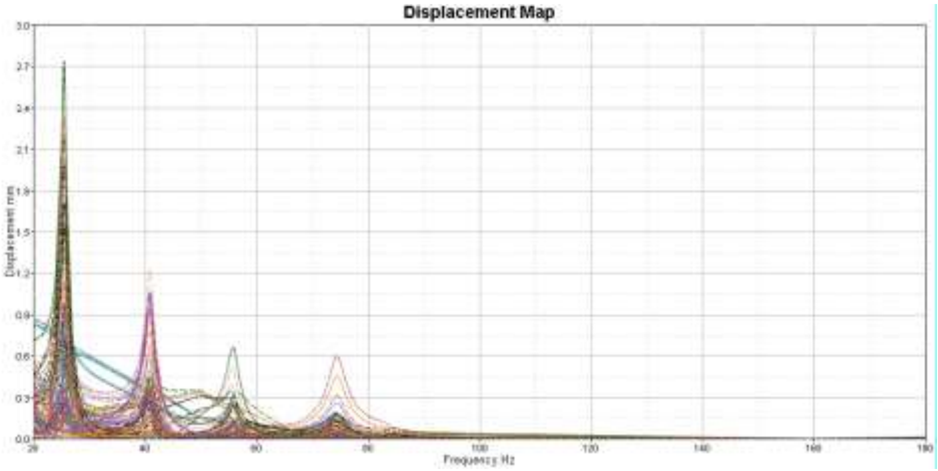

Fig 3: Graph Displacement v/s Frequency

Table.4: Tabulation of frequency and displacement

Sl.No	Frequency	Displacement
1	25.51	2.73
2	40.72	1.21
3	55.30	0.61
4	74.44	0.60

From fig.3 Displacement v/s frequency graph is shown the peak value of displacement based on the frequency. For higher frequency the displacement is very less. Based on the study applying frequency and displacement for whole exhaust system and found out maximum stress acting in different parts of the exhaust system. Table.4 shows the displacement values with respect to frequency[3].

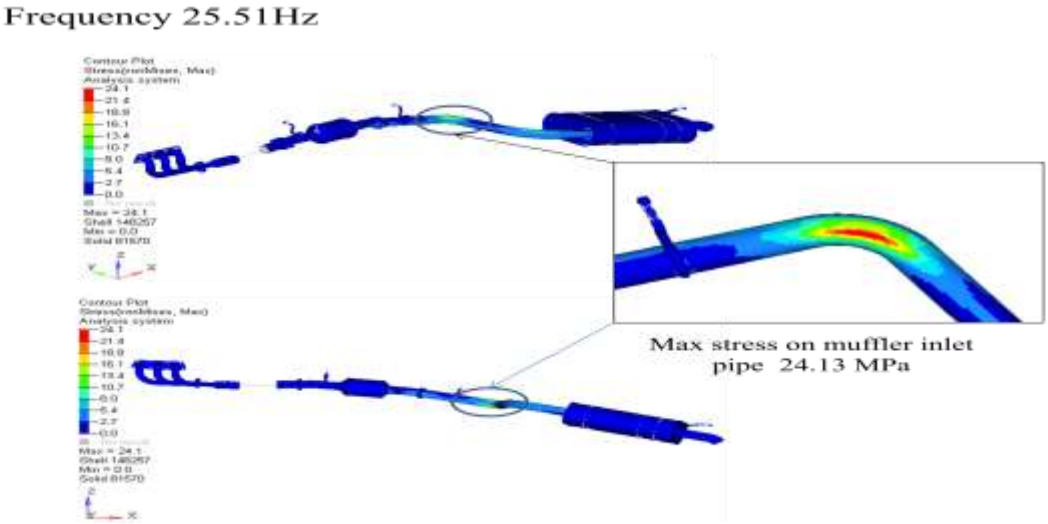

Figure 4. The maximum stress obtained in the muffler.

As per the table.4 frequency and displacement values are applied to whole exhaust system when excitation force is applied the maximum stress is obtained. Fig.4 shows the maximum stress obtained in the muffler for frequency 25.51Hz and displacement 2.73mm.

4. CONCLUSION

The Static Analysis Carried Out Was As Per The Requirement, The Stress Obtained From The Analysis Was Below 50 MPa Which Is Consiredarable. It Is Also Found That With The Increase In Stress, The Displacement Also Increases For Different Load Conditions.

The Frequency response analysis graph shows the peak value of displacement. For higher frequency the displacement is very less. And when frequency and displacement is applied to whole exhaust system it shows the maximum stresses which are acting in the different part of the exhaust system.

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