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EVALUATION OF DESIGN ALTERNATIVES FOR AUTOMOBILE SILENCER WHILE ADDRESSING COMPLIANCE TO THE GENERIC NORMS FOR VIBRATION

Balraj .D.Kawade[1], Niranjan D. Khaire[2], Swapnil.S.Kulkarni[3]
[1]Student, [2]Professor,
Department of Mechanical Engineering, Rajarshi Shahu College of Engineering Pune, India
[3]Director, Able Technologies (I) Pvt. Ltd., Pune, India

ABSTRACT

In automobiles exhaust system is of great importance and silencer is used to minimize unwanted noise, the exhaust gas of high pressure and high temperature coming out of internal combustion engine leads to undesirable noise is known as noise pollution. Pollution creates more disturbance in the environment. Noise is measured in decibel. Audible waves are of frequency ranges from 20 Hz to 20000 Hz. To minimize sound frequency mufflers are used in silencer assembly. The exhaust gases coming out from engine are at very high speed and temperature. Silencer has to reduce noise, vibrations. While doing so it is subjected to thermal, vibration and fatigue failures which cause cracks. So it is necessary to analyze the .Vibrations which would further help to pursue future projects to minimize cracks, improving life and efficiency of silencer. Many researchers have studied and postulate behavior of silencer under loading and studied modal analysis with context to vibrations. Here we can study the given case and avoid resonance if any and look for safe design of silencer by modal analysis.

KEYWORDS: *Finite element method, silencer, muffler, resonance, vibrations, modal analysis, Radioss, hypermsh.*

I. INTRODUCTION

The most important objective of silencer shown in fig.1 is to reduce the vibration and noise coming from engine. When the natural frequency of any object matches to the operating frequency of the same object then resonance, and resonance is necessarily to be awvoided. Resonance leads to catastrophic failures. Therefore every machine or equipment should be properly addressed for overcoming vibration problems before installing. It is therefore necessary to study the behavior of silencer by analyzing the vibration modes and the response of vibrations by its sources. Modal analysis will be done for existing model on the basis of modal analysis, we can suggest weight optimization if natural frequencies are higher than the engine frequencies which is basically considered up to ~70 Hz followed by Frequency response analysis.

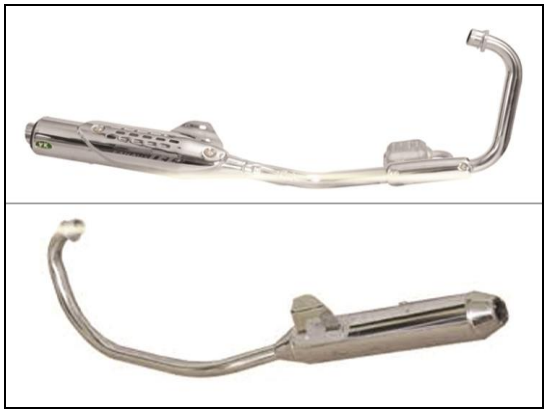

Figure 1: Bajaj pulsar silencer actual part

II. LITERATURE REVIEW

The initial study of Automobile silencer was carried out by Xing Sufang & Wang Xianrong and many more scholars around the world. The further study can be done by extracting the concepts put forth and the techniques used in the journals directly or indirectly.

All the journal papers mentioned below proved to be prime source of knowledge for research work in vibration norms in automobile silencer.

Dr.S.B.Wadkar et al, discussed on Cooling Gas Compressors Discharge Silencer. Discharge silencer are used with rotary compressors to avoid flow fluctuations of gas. In this paper an industrial problem of discharge silencer is discussed. A discharge silencer connected to a cooling gas compressor developed cracks at various locations on its body and supports. The vibration and noise levels of the system were very high. To find out the root causes of the high level of vibration measured on the discharge silencer, it was decided to carry out a CAE based investigation along with comparative study of the actual vibration on site measurements. Hyper-mesh with shell elements is used for meshing the various design models and modal analysis of the structure is done using Radioss as a solver. The response of the discharge silencer under dynamic loading condition through transient dynamic analysis is done using Ls-Dyna as a solver. Hyper-view is used for post-processing of the modal analysis results[1]. Vinay gupta et al, briefed about postulates the first stage in the design of an exhaust system, With the specified properties of the different material, the exhaust system is modeled by solid works. In this paper, the structures are automotive exhaust system and the materiel used for the exhaust system is described. The result are compared the deformation of silencer parts of three specified materials for same exhaust thrust. This paper plays a vital role of deciding the life cycle of silencer[2]

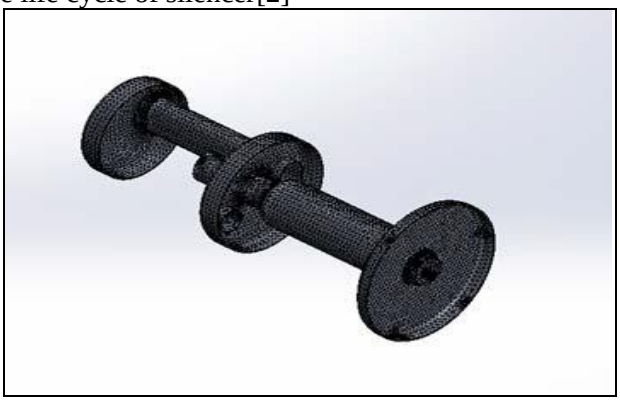

Figure 2: Maffle and baffle

S. Rajadurai et al, summarizes the systematic FEA study of exhaust system for passenger car and explaining about the usage of Altair's Pre-processing tool HyperMesh, solver RADIOSS and Post-processor tool HyperView for performing different kind of analysis to validate the design.

Today's exhaust system are developed to deliver minimum noise, emissions, maximum durability, packaging, safety, flow rates, lower system restriction, high temperature compatibility, Corrosion resistance, easy serviceability and cost effectiveness. The exhaust system has various attributes including vibration, acoustics, thermal distribution and durability, flow and power loss in addition to its interface with vehicle[3].

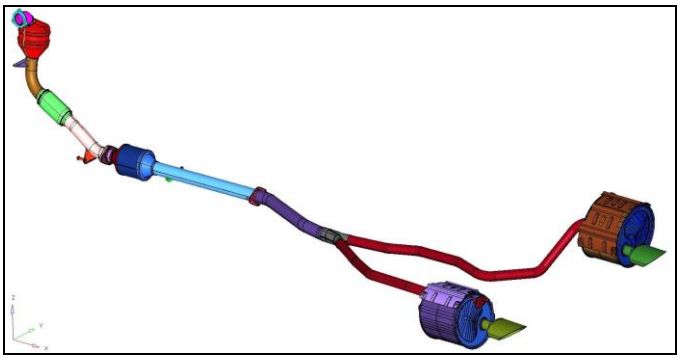

Figure 3: CAD model of exhaust system

Ying-li Shao, explained conventional muffler of internal combustion engine is mostly constructed as a mixture or combination of perforated ducts, baffle or perforated baffle, expansion chamber, etc., and the noise reduction is limited and backpressure is high hence the fuel efficiency is low. In order to solve the problems of traditional exhaust silencers with poor characteristics of noise reduction in low-frequency range and high exhaust resistance, a new theory of exhaust silencer of diesel engine based on counter-phase counteract and split-gas rushing has been proposed. Taking the single-cylinder diesel engine CG25 as the experimental engine, the author measured the exhaust noise and its spectra. By comparing the results of the new types of mufflers to those without a muffler and those with the original muffler of the engine, the new theory of muffler has been verified[4].

Wang Jie et al, did modal analysis of automotive exhaust muffler In order to improve the design efficiency, resonating of the exhaust muffler should be avoided with its natural frequency. The solid modeling is created by the PRO-E and modal analysis is carried out by ANSYS to study the vibration of the muffler so as to distinguish working frequency from wnatural frequency and avoid resonating[5] Mr. K.S. Tanpure et al discusses initial primitive stage in the design analysis of a Genset silencer. The geometry of the exhaust system is modeled by using a conventional FEM package after considering specified properties of material, dimensions of silencer. Modal Analysis of the muffler is carried out and the results are compared with the reading taken on FFT analyzer, so as to distinguish working frequency from natural frequency, avoid resonating condition and to find the stress concentration at various regions of silencer[6]. BJ Furman, elaborates the use of vibration measuring instruments in actual experimental setup like vibration transducers ,accelerometers and vibrometer.[7]

Figure 4: Diesel genset silencer

III. METHODOLOGY

Basically three different methodology are used – 1. Computational method, 2. Analytical Method/ Numerical Method, 3. Experimental Method Computational Method: The general process flow chart for computational method is as below,

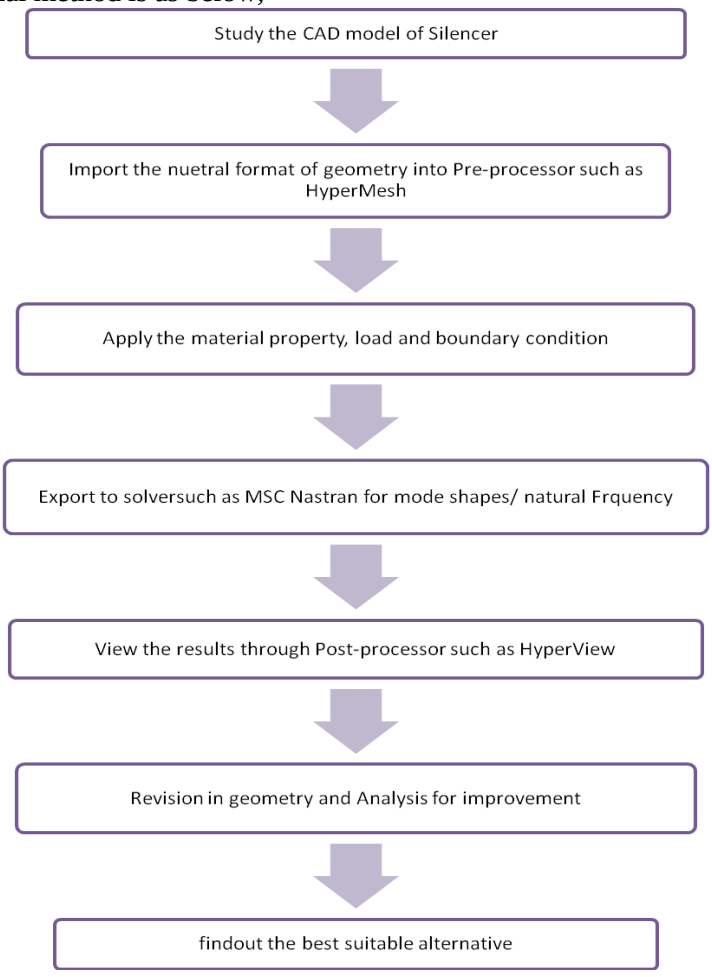

Figure 5 methodology flowchart

1. Numerical Method: Using mathematical formulae we can find out the natural frequency of the silencer.
2. Experimentation: For experimentation purpose we would use FFT (Fast Fourier Transport) setup to find out the vibrations induced in silencer. Using FFT setup, we would find natural frequency, mode shapes, FRF of silencer in which hammer or shaker would use for excitation purpose. Vibrometer use for measuring vibrations. Typical setup for Vibrometer is as shown in fig.6

Figure 6: Typical Vibrometer

IV. CONCLUSION

For silenecr vibration analysis we can use FEM simulation methodology described in above references.The above references proven the FEM simulation as a better solution over conventional trial and error method for predicting the errors in modal analysis. A generalized and simple method can be developed for modal analysis by systematic method for modal analysis

V. FUTURE SCOPE

The design of the silencer using Finite Element Techniques. Natural frequencies can be determined and the mode shapes can be reviewed in the light of its performance contributing to any increased likehood of undesired trends. FFT analyzer can be used to validate the solution for benchmark. Predication of the improved design can be made using analytical tools including F.E. Modeling with HyperWorks and Radioss. Basic estimates for model Analysis can although be made using Mathematical Formulation

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BIOGRAPHY

Balraj Dilip Kawade, M.E Design Mechanical Engineering Department, Rajarshi Shahu College Of Engineering, Tathwade, Pune.

Niranjan D. Khaire, Assist.Professor, Department of Mechanical Engineering, Rajarshi Shahu College of Engineering, Tathwade, Pune-33. India.

Swapnil S.Kulkarni Director, Able Technologies India Pvt. Ltd., Pune. The Company offers Engineering Services and Manufacturing Solutions to Automotive OEM's and Tier I and Tier II Companies. He is a Graduate in Industrial Engineering with PG in Operations Management. With around 20 years of working experience in the domain of R&D, Product Design and Tool Engineering, he has executed projects in the Automotive, Medical and Lighting Industry. His area of interest is Research and Development in the Engineering Industry as well as the emerging sector of Renewable Energy.