A Review Paper: Study of Vibrational characteristics causing failure of silencer bracket

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Abstract- In automobiles exhaust system is having incredible significance and silencer is used to minimize unwanted clamor, the exhaust gas of high pressure and high temperature leaving internal combustion engine leads to undesirable noise. To limit sound frequency mufflers are used in silencer assembly. The exhaust gases leaving out of engine are very fast and having high temperature. Silencer has to diminish noise, vibrations. At the same time it is exposed to high temperature, vibrations and fatigue failures which cause cracks and finally failure occurs. So it is important to analyze the vibrations which help us to understand and design future projects to limit cracks and failures, improve the life and also the efficiency of silencer. Numerous analysts have studied and postulate behavior of silencer under loading and studied modal analysis with context to vibrations. Here we can ponder the given case and avoid resonance if any and look for safe design of silencer by modal analysis. The exhaust muffler designers need simple and fast modeling tool, especially at the initial stages. FEM and Boundary element strategies are favorable of building fast prototype for muffler design and can be effectively contrasted with the results from FFT analyzer experimental setup.

Key words **–** Natural frequency, Automobile exhaust system, Silencer, analyze the vibrations, mode shapes, Experimental modal analysis, Silencer bracket design, avoid resonance, Finite element method, Excitation frequency, FFT analyzer.

I. INTRODUCTION

Automotive silencer is the main part of the exhaust system. In automotive engine the pressure waves are generated when the exhaust valve over and again opens and radiates high pressure gas into exhaust system. These pressure pulses produce exhaust sound. As the engine speed increases, the pressure fluctuations increases and the sound discharged is of higher frequencies. The silencer needs to permit the entry for exhaust gases while limiting the transmission of sound. This initiates vibrations in exhaust system. Since the silencer is at the tail end with constrained degree for supporting along its length. The influence of vibrations is most prominent over this segment. Likewise silencer has to withstand the stresses induced due to fluctuating loads. Much research has been done on the dynamic investigation of exhaust systems. Consequently it is important to analyze vibrations characteristics of silencer in order to improve the successful life expectancy and performance of the silencer. Numbers of methods are accessible for designing, evaluating and testing of silencer. Finite element method and experimental modal analysis have been commonly used for vibration related issues of the exhaust system. The most imperative target of silencer is to diminish the vibration and noise originating 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 diminished. Resonance leads to catastrophic disappointments. The silencer vibration contributes the total vibrations of vehicles. Due to vibrations it is exposed to a few anxieties. Therefore every machine or equipment should be properly addressed for conquering vibration issues before installing. It is therefore necessary to ponder the behavior of silencer by investigating the vibration modes and reaction of vibrations by its sources.

IMPORTANCE OF THE PRESENT STUDY

Mechanical structures exposed to dynamic stacking cause undesirable vibration levels that can result in mild discomfort to structural breakdown. A vital wonders in auxiliary elements, and can take place when a structure is energized at a frequency equal to its natural frequency. Each natural frequency is related to a Specific diversion or mode shape. The reaction abundancy increments amplitude increases radically at resonance; otherwise it leads to a disappointment of the structure. The dynamic examination of the exhaust system can be done by exciting the structure in a proper way and concurrently measuring the excitation force and the resulting response in appropriate degrees of opportunity. Numerical strategies, such as the Finite Element Method (FEM) and the Boundary Element Method (BEM) are shown to be convenient for complex muffler geometries and are applicable for any muffler setups. Impact testing is a simple and fast method for obtaining efficient estimation of a system's modal properties and frequency response data. Data can be collected from labeled points in an exhaust system either by hitting with an impact hammer and utilising an accelerometer on the specimen.

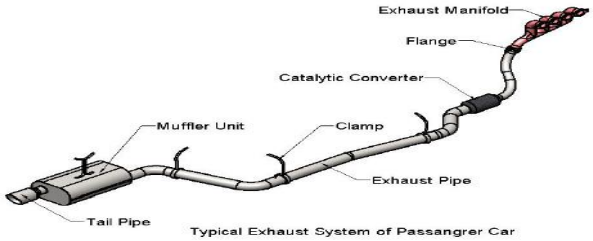


Figure 1- Typical Exhaust system with silencer bracket

II. PROBLEM STATEMENT

A) Objectives

a) Experimental analysis of existing silencer bracket for Static condition using FFT analyzer.
b) FEA modal vibration analysis of possible design alternatives to optimize the design and reduce incidence of failure.

B) Scope

a) In this project we have to study the design of existing silencer of the vehicle and location of its mounting bracket.
b) The present study is aimed to analyze the static characteristics of silencer bracket and its material.
c) Find the vibration parameters of bracket analyzed for computational simplicity. Find natural frequency by using the concept of free vibration test.
d) Modal using FEA software for existing design to study the vibration parameters such as damping factors and mode shapes.
e) In this study the FFT analyzer can be used to experimentally validate the results obtained by using FEA software.

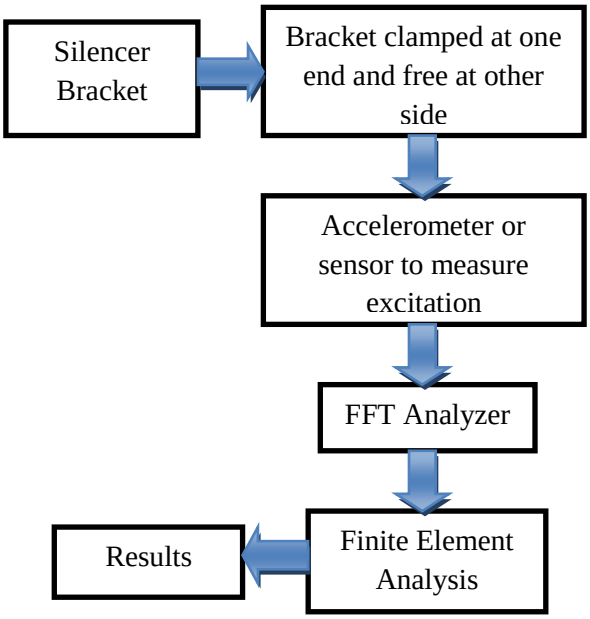
III. METHODOLOGY

1) The project focuses on the study of vibration properties of exhaust system. Experimental investigation of silencer bracket using FFT analyzer for vibration examination with respect to boundary conditions.
2) The Geometric modeling of existing silencer bracket using CAD software which is subjected to free-free vibrations by providing cantilever type boundary conditions to the specimen.
3) Modal analysis is process of determining the undesirable dynamic characteristics of a system in forms of natural frequencies, damping factors and mode shapes, and using them to solve a mathematical and scientific model for its dynamic characteristics.
4) The FFT spectrum analyzer tests the input signal, computes the magnitude of its sine and cosine components and shows the spectrum of these measured frequency components. The experimental validation of investigation is done by using FFT analyzer.

IV. EXPERIMENTAL ANALYSIS

Experimental results outcomes are required for enhancing the examination by giving certain fundamental information or parameters that can't be anticipated accurately by explanatory or numerical strategies. Experimental modal examination is a method used to infer the model of a straight tie in variation vibratory framework. Typical measurement setups for experimental modal analysis consist of three constituent parts. The initial segment is responsible for generating the excitation force and applying it to the test structure. The second part is to gauge and secure the reaction information and the third part provides the signal processing and flag handling ability to get FRF information capacity to derive FRF data from measured force and response data.

For experimental modal investigation of silencer impact hammer is used for giving excitation to the silencer. The temperature of silencer measured to assure it is used for giving excitation to the silencer. The temperature is measured of silencer to estimate and guarantee that it is inside working temperature scope of accelerometer. An accelerometer used has a magnetic base and is situated toward the finish of silencer. The FFT spectrum analyzer is used to investigate and experimentally validate the data. The impact is given toward the finish of silencer by using impact hammer attached through cables to the FFT analyzer.



Flow chart 1- Experimental Analysis

The response from silencer is additionally estimated with the assistance of accelerometer connected toward the finish of silencer. Analyzer gets simple voltage signals from the accelerometer. The investigated signals used to find natural frequencies and mode shapes in graphical structure by using the software installed in computer.

V. LITERATURE REVIEW

V.P. Patekar, [1] the principal stage in the plan examination for the design analysis of an exhaust system is studied with the specified properties of the material. The exhaust system is modeled by utilizing a FEM package. The results are compared with the reading taken on FFT analyzer, so as to distinguish working frequency from natural frequency and prevent the resonating condition.

Balraj D. Kawade, [2] In automobiles exhaust system is of extraordinary significance and silencer is utilized to limit undesirable unwanted noise, the exhaust gas of high pressure and high temperature leaving internal combustion engine causes unwanted noise which is known as noise pollution. Pollution creates more disturbances in the environment. To reduce the frequency of sound mufflers are used in silencer. The exhaust gases leaving from engine operating at high speed and temperature. Silencer has to reduce noise, vibrations. While performing this it is subjected to high temperature, vibrations and fatigue failures which cause cracks and breaking of assembly. So it is important to examine the vibrations which help us to develop new projects to limit cracks and failures, improving life and performance of silencer. Numerous researchers have studied and explained behavior of silencer under loading and studied modal analysis with context to vibrations. Here we can ponder the given case and prevent resonance if any and look for safe design of silencer by modal analysis.

Mukesh D. Bankar, [3] the vibrations of silencer are influencing the execution of silencer and it is uncomfortable to operators. So it is important to reduce the vibrations. Modal analysis is a technique which is utilized to discover normal attributes of structure like natural frequency and mode shapes. In this paper, three silencers having diverse material are taken and modular examination is done utilizing limited component investigation FEA

technique by utilizing ANSYS 16.0 programming and these outcomes are contrasted and perusing taken on exploratory modular investigation by utilizing FFT analyzer. In experimental modal analysis, the characteristic frequencies and mode states of silencers of various materials are acquired by estimating and breaking down the info and yield reaction motions by utilizing FFT analyzer. The examination is done to break down the working frequency from natural frequency and avoid resonating condition. Also we can choose the best material for silencer which has minimum vibrations.

R. Renugadevi, [4] the vibrations created in car engines transfer to the silencer exhaust manifold, these continuous vibrations cause breakage in silencer ventilation system. Two kinds of vibration can influence the: the sonic pressure waves coming from the exhaust ports, and the vibration of the engine itself because of torque. Pressure wave vibrations are transparent, transferring through the exhaust system either to absorb into or cancel out in the muffler. These waves are symphonious, similar to the vibration of a speaker, yet they are normally too minute to cause noise through component movement. Engine vibrations, on the other hand, can easily cause vibrations of your exhaust pipes enough to cause component rattling or impact. This task manages the damping of such later referenced vibration issues with an idea of CAE (Computer Aided Engineering). In this project we are utilizing vibration absorption materials as dampers and monitoring the system under various conditions for modal (natural vibrations) and harmonic (forced vibrations) response. The modeling of the system is carried out with Solid Works package and analysis using ANSYS.

Suresh P. M, [5] Experimental modular examination, otherwise called modular investigation or modular testing, manages the assurance of regular frequencies, damping proportions, and mode shapes through vibration testing. So as to keep up an ideal commotion and agreeable ride, the modes of a muffler need to be analyzed. Modular examination is done both tentatively through FFT analyzer and limited component investigation. The common frequencies gotten by both the techniques concur with one another. This is helpful while planning and designing of exhaust muffler to avoid the resonance.

Somashekar G, [6] a poison of worry to the humankind is exhaust sound which should be about 105dB in the internal combustion engine. Anyway this sound can be diminished adequately by methods for an all around planned and well-designed silencer. The reasonable structure and advancement will improve the sound dimension, and yet the execution and performance of the engine should not be hampered. Muffler design is an important research area for an automotive industry because the fact that new guidelines and models for commotion emanation are shaped. To look at the execution of any muffler, certain parameters are used. These parameters are Numerical modular examination, Experimental modular investigation. In this venture both Numerical and Experimental Modal investigation is directed. The analysis directed on thickness of existing muffler body by FFT analyzer. Additionally various emphases are done by changing the thickness muffler body, perforation of baffle plates. This philosophy helps commercial users and OEM (Original Equipment Manufacturers) to design and modify the silencer or muffler accordingly.

Sidharam Ambadas Basargi, [7] motivation behind the plan venture performed was to figure out which modes are high and may influence the car antagonistically while in task. Research was performed before the test to figure out which frequencies to search for modes. It leads the trial so information from 20 Hz to 20 KHz could be gathered. The force was produced by the engine at different speed. By increasing the speed it is estimated by utilizing FFT analyzer by choosing the focuses on the Silencer were picked, subsequent to taking a gander at the information and resolved to be under damped. In this way, our plan examine proposes expanding the mass, increment the damping, or giving a negative firmness to make the silencer more damped. The motivation behind this report is additionally to the investigation of impacts caused by it on Engine. In India, the transportation segment is developing quickly and number of vehicles on Indian streets is expanding at exceptionally quick rate. This has lead to packed streets and noise pollution. So, it is necessary to study noise generated by four stroke petrol engine. The study of noise generated by four stroke petrol engine is carried out with and without mufflers to check the performance of the muffler.

Vinay Gupta, [8] the paper hypothesizes the main stage in the structure of an exhaust system, with the specified characteristics of the different material, the exhaust system is modeled by solid works. One of the objectives when designing a new automobile silencer is to increase its life and durable period, which can be measured in terms of its life span and mileage. Gas combustion from an internal combustion engine will flow through the exhaust pipe which comprises principally of clips associated with an engine. The internal force from the combustion pressure is called vibration noise which transfers through the exhaust pipe. The noise may have an alternate kind of normal for vibration modes. The structures are automotive exhaust system and the materiel used for the exhaust system is described. The result is compared for the deformation of silencer parts for three specified materials for same exhaust thrust. This paper can play an important role for deciding the life cycle of silencer.

R. V. Bhortakke, [9] A Silencer is a part of the exhaust system which assumes an essential job in mechanical application. This paper depicts a short survey of a Design and Development of Industrial Silencer. Setting up of these vibrations in engine have an adverse effect on silencer. Vibrations are propagated to inlet pipe of silencer through intermediate pipe. This to and fro movement of inlet pipe with respect to shell, causes breaking of the welding at the joint. Also, the velocity and the pressure of the outlet gases are very high which may cause disappointment of welding accordingly lessening its proficiency. Silencer needs modes that are found far from the frequencies that engine operate at. By studying whether the engine is idling or running at the maximum amount of revolutions per second. With the predefined properties of the materials, the exhaust system is designed and modeled by using a conventional FEM package.

Krishnal Bhangale, [10] The Engine exhaust is the major source for producing noise in automobile. There are several challenges in designing the muffler system by considering size, engine back pressure, noise level, emission norms and also cost. The loss occurring at engine frequency and first few harmonics frequency are important. Recent efficient muffler systems are designed by considering the linear

plane wave theory using transfer matrix method. Development of fibrous material strands that is used in hot exhaust system without binders has made use of combination of muffler and exhaust system. For all these to happen exhaust muffler designers need simple and rapid modeling tool, especially at the initial stage. FEM and Boundary element methods require more time. This paper is about plane wave based techniques such as transfer matrix method has advantage of building fast prototype for muffler design finds transmission loss and can be easily compared with the experimental setup.

VI. CONCLUSION

The silencer is exposed to exceptional vibrations which are in charge of fluctuating loads and hence localized stresses. By using FEM, Modal investigation can be performed to discover dynamic qualities and FRA is performed to find out localized stresses induced in silencer.

The silencer natural frequencies can be determined by utilizing the ANSYS package and by FFT analyzer. By both the technique the natural frequencies are compared and that are useful while the design of silencer to avoid the resonance. The dynamic performance can be execution can be expanded by expanding the thickness of different part and by analyzing the silencer.

Many Researchers have proved that, for silencer vibration analysis we can use FEM technique portrayed in above references. The FEM simulation is superior arrangement over conventional trial and error method for predicting the errors in modal analysis. A generalized straightforward strategy can be developed for modal investigation by systematic method for modal analysis.

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