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Review Study of 2-Wheeler Silencer's Natural Frequency by FFT(Fast Fourier Transform) Analyzer

Tushar J. Awari ,
PG Student (Design), Department of Mechanical Engineering, NBN Sinhgad School of Engineering,
Ambegaon (BK) Pune-41, India
tushar.j.awari@gmail.com

Dr. S.Y.Gajjal,
Professor, Department of Mechanical Engineering, NBN Sinhgad School of Engineering,
Ambegaon (BK) Pune-41, India
Shekhar.gajjal@sinhgad.edu

***Abstract*— Automobile engines are operated at an extremely broad range of revolutions. Ideally natural frequency of different parts should never match with engine Excitation frequencies but practically there are moments when resonance could not be avoided. Due to this we have to find not only the resonance frequency but also the vibration amplitude at the same time. To reduce this vibrations we design and modify two wheeler silencer. This can be achieved by two methods namely experimental and FEM analysis. The experimental analysis is carried out with the help of FFT analyzer to evaluate the natural frequency and vibration amplitude and to distinguish it from the working frequency to avoid resonating condition.**

Keywords—Natural frequency; Excitation frequency; Resonance; Silencer; FEM analysis; FFT analyser.

I. INTRODUCTION

Internal combustion engines are typically equipped with an exhaust muffler to suppress the acoustic pulse generated by the combustion process. A high intensity pressure wave generated by combustion in the engine cylinder propagates along the exhaust pipe and radiates from the exhaust pipe termination. Generally Motorcycle engines are operated at an extremely broad range of revolution speeds. Ideally, the natural frequency of not only the motorcycle itself but also of each part forming the structure of the body and the engine should never match the engine excitation frequency at any point over that entire range, but in reality resonance sometimes cannot be avoided because the range is so broad. Therefore, the vibration amplitude at resonance must be kept low.

One of the objectives when designing a new automobile exhaust pipe is to lengthen it's durability period, which can be measured in terms of its life span and mileage. The exhaust pipe is subjected to several stresses, most of which are due to vibration. Particular attention should be given to gas forces which will induce vibration. These vibrations will then induce a fatigue life to the system. It is therefore necessary to study the fatigue behavior of the exhaust pipe by analyzing the vibration modes and the response of vibrations by its sources

This can be done by experimental and analysis in which 1st we clarified the muffler vibration conditions based on the results of experimental modal analysis and the measurement of the vibration at various points on the muffler when the engine was operating with the muffler attached to the motorcycle. Then FEM vibration response analysis was carried out in order to predict the vibration amplitude of various muffler parts when the engine is operating. These results were compared with the actual measurement results in order to verify the effect of this method.

II. NEED FOR ANALYSIS

The Automobile silencer under study belongs to a popular 2-Wheeler manufacturer in India. Motorcycle Engine operating at very high speed, due to which The exhaust gases coming out from engine are at very high speed which causes large amplitudes of vibration and fatigue failure which cause cracks in the silencer. To reduce this vibration analysis has to be done. Which improves life and efficiency of the silencer.

III. RELATIVE THEORY

Every exhaust system of industries or automobiles where hot gases discharge from the combustion chamber into the surrounding atmosphere at relatively high velocities has a silencer as an integral part of the system. automotive silencer used to reduce the audible noise level to human comfort which is the primary source of vibration. It has to withstand stresses induce due to hot gases and other factors like vibration, fatigue etc. to solve noise and vibration problem the techniques like theoretical and experimental are both different technologies. FFT(fast furious transformer) is used for experimental validation. This method carried advantage of being fast and accurate. FEA(finite element analysis) is theoretical approach to solve noise and vibration problem in which modal analysis is the method used to described a structure in terms of natural characteristics which are frequency, damping and modal

shapes and its dynamic properties. The finite element method is a powerful tool for the numerical solution of a wide range of engineering problems.

IV. Objectives

Study and selection of existing design of motorcycle silencers.

Determining resonant frequency and corresponding amplitude at same time of silencer using FFT analyzer.

V. Experimental Setup

Fig.-1-Experimental setup to determine natural frequency

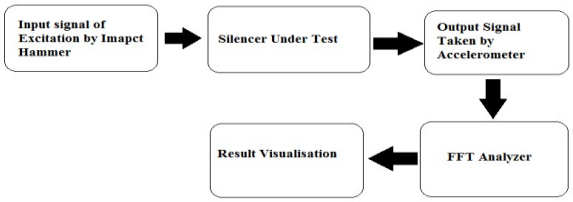


Fig.-2-Block diagram of Experimental setup

Procedure :-

Experiment is carried out as follows-

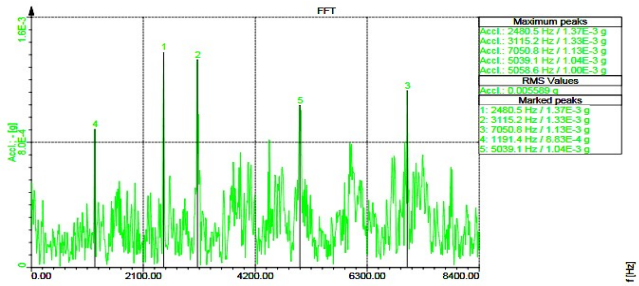
1.Mark the different points on the silencer at which response to be measure

2.Mount accelerometer at marked positions and input signal of excitation is given by Hammer at same position for different positions of accelerometer.

3.Record the response i.e. output signal taken by accelerometer which has to be display in FFT software in the form of sine and cosine wave form

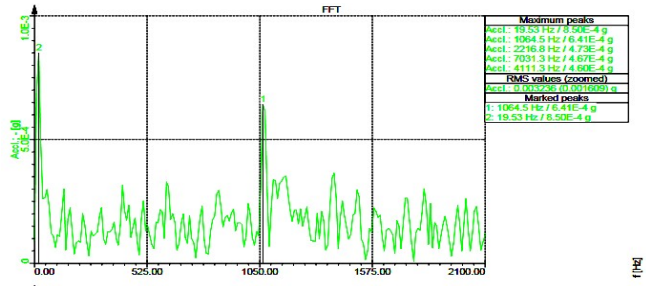
Finally we recorded responses at 7 different positions on silencer starting from exhaust end i.e. 50mm, 150mm, 250mm, 350mm, 450mm, 550mm, 650mm :-

1) At 50 mm



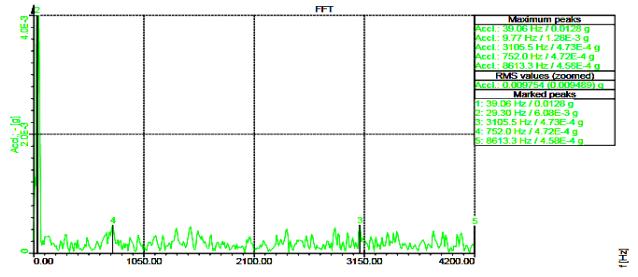
Natural Frequency at 50mm from backend of silencer	Accl. : 2480.5 Hz	Accl. : 3115.2 Hz	Accl. : 7050.8 Hz	Accl. : 5039.1 Hz	Accl. : 5058.6 Hz

2) At 150 mm



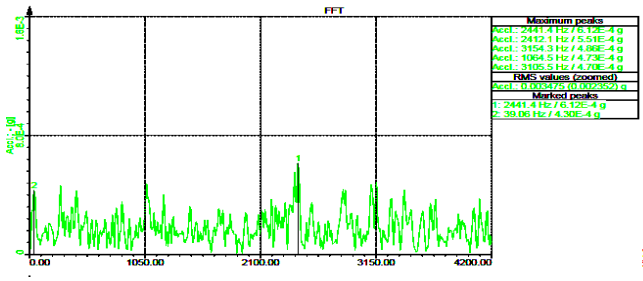
Natural Frequency at 150mm from backend of silencer	Accl. : 19.53 Hz	Accl. : 1084.5 Hz	Accl. : 2216.8 Hz	Accl. : 7031.3 Hz	Accl. : 4111.3 Hz

3) At 250 mm



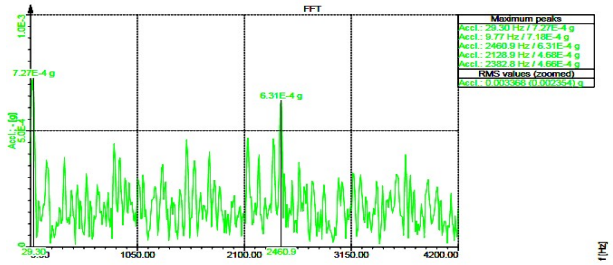
Natural Frequency at 250mm from backend of silencer	Accl. : 39.06 Hz	Accl. : 9.77 Hz	Accl. : 3105.5 Hz	Accl. : 752.0 Hz	Accl. : 8613.3 Hz

4) At 350 mm



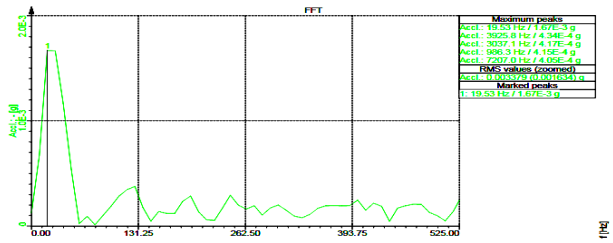
Natural Frequency at 350mm from backend of silencer	Accl. : 2441.4 Hz	Accl. : 2412.1 Hz	Accl. : 3154.3 Hz	Accl. : 1064.5 Hz	Accl. : 3105.5 Hz

5) At 450 mm



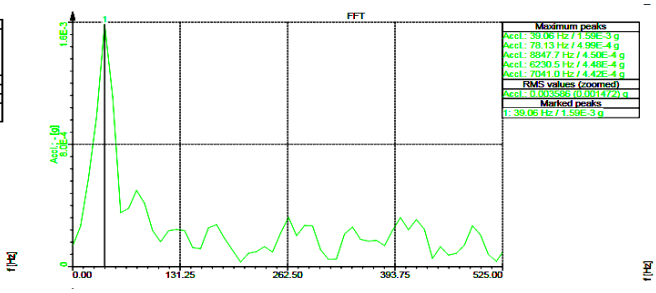
Natural Frequency at 450mm from backend of silencer	Accl. : 29.30 Hz	Accl. : 9.77 Hz	Accl. : 2460.9 Hz	Accl. : 2128.9 Hz	Accl. : 2382.8 Hz

6) At 550 mm



Natural Frequency at 550mm from backend of silencer	Accl. : 19.53 Hz	Accl. : 3925.8 Hz	Accl. : 3037.1 Hz	Accl. : 986.3 Hz	Accl. : 7207.0 Hz

7) At 650 mm



Natural Frequency at 650mm from backend of silencer	Accl. : 39.06 Hz	Accl. : 78.13 Hz	Accl. : 8847.7 Hz	Accl. : 6230.5 Hz	Accl. : 7041.0 Hz

VI. Conclusion

The silencer natural frequencies have been calculated by using FFT analyzer. The procedure followed to determine natural frequency i.e. Experimental method is easy to understand and execute and also fast, accurate and reliable.

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