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Vibration Analysis of Two Wheeler's Silencer by Using FEM Package and FFT Analyzer

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Abstract—This paper gives the first stage of vibration analysis of two wheeler exhaust system. The exhaust system is modeled by using CATIA and analyzed by using NASTRAN a conventional FEM package. Here we are going to compare the natural frequency by FEM package with the practically by using FFT analyzer, so as to compare working frequency with natural frequency for validation purpose
Keywords- silencer; Mode Shape; FEM; FFT Analyzer, natural frequency

I. INTRODUCTION

Silencer is the main part of exhaust system of Internal combustion engine, the basic function of silencer is to reduce noise generated by exhaust gases. The silencer reduces exhaust noise by dampening the pulsations in the exhaust gases and allowing them to expand slowly. The silencer slows down the gases and breaks up the pulsating sound waves, and so reduces the noise. Most Silencer design is performed by modifying existing designs

Vibration is transferred from engine to exhaust system, and then transferred to body structure. These vibrations will produce then fatigue in the system which affects on the life of silencer. So it is necessary to study the behavior of silencer under fatigue load by analyzing the vibration response in the system.

II. PURPOSE OF DESIGN

A new version of the two wheeler is planned for launch. The silencer for the existing version is not suitable in size and aesthetics to this new version of the motorcycle. A new variant for the silencer is thus necessary for launching the new version of the two wheeler.

Any new design to be introduced for silencer requires to undergo rigorous compliance norms in terms of the `resonating effect' it could create and consequently higher vibrations and/or failure of the structural parts. The new design for the silencer has to be subjected to simulation (CAE analysis) for identifying the natural frequencies in order to ensure a suitable `shift' from the vehicle's assembly level natural frequency to avoid resonance. If needed, random excitation could also be deployed for checking the response of the assembly to a particular frequency.

Besides, the supporting elements of the silencer has to be checked for adequate strength and integrity to avoid failure during prolonged operation. The structural analysis for these members is vital to avoid failure during its operation.

III. PRESENT THEORIES & PRACTICES

By using Modal analysis method we can describe a structure in terms of its natural characteristics which are natural frequency and Modal shapes. Modal analysis involves process of determining the modal parameters of a structure to construct a modal model of the response. Finite Element Analysis (FEA) and Experimental Modal Analysis (EMA) have been very different solving technologies for

noise and vibration problems. Experimental modal analysis is used to explain a dynamics problem and vibration in structure.

IV. MODEL AND MESHING OF SILENCER

The different material properties selected for silencer are as: Young's modulus of Elasticity E = 2e ^ 5 Mpa Yield Strength: 355 N/mm2. The Figure 1 shows the meshed model of silencer.

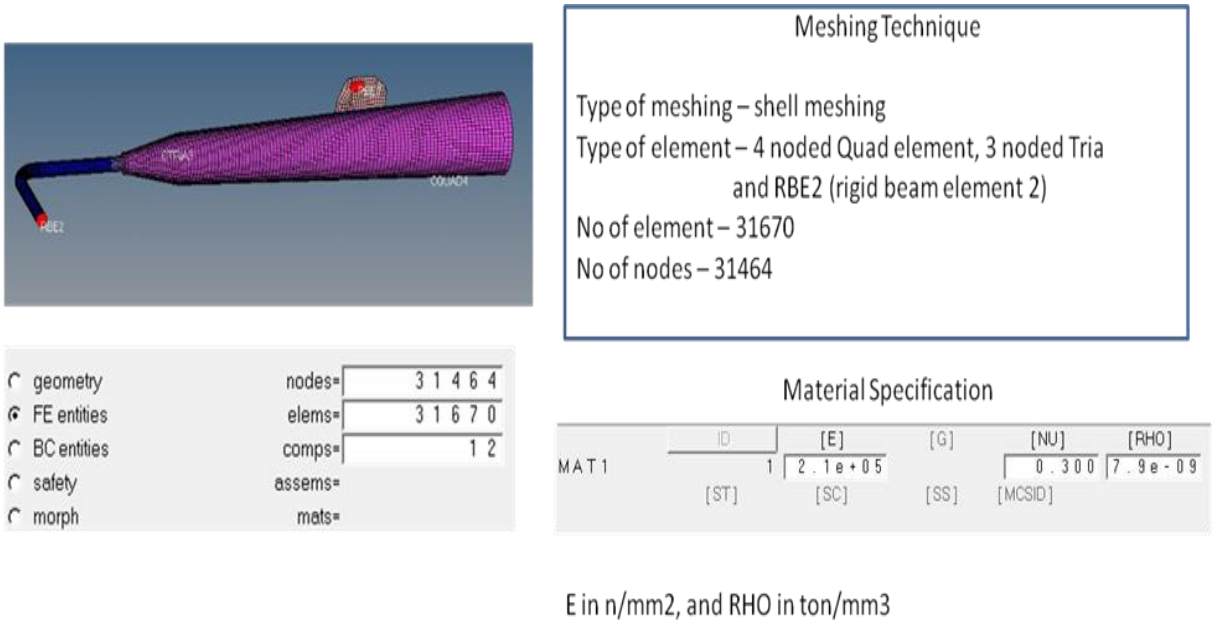

Figure 1. Two Wheeler Silencer Meshing.

V. MODAL ANALYSIS OF SILENCER

After generating the model of silencer by using CATIA software then analysis is done by using NASTRAN. The result obtained by modal analysis for first four natural frequencies are determined and tabulated as follows :

Table 1 .First Four Modal Frequency of Vibration by FEM Package

Mode Order	1	2	3	4
Frequency (Hz)	65.72	141.6	172.9	286.7

The different mode shapes are shown below :

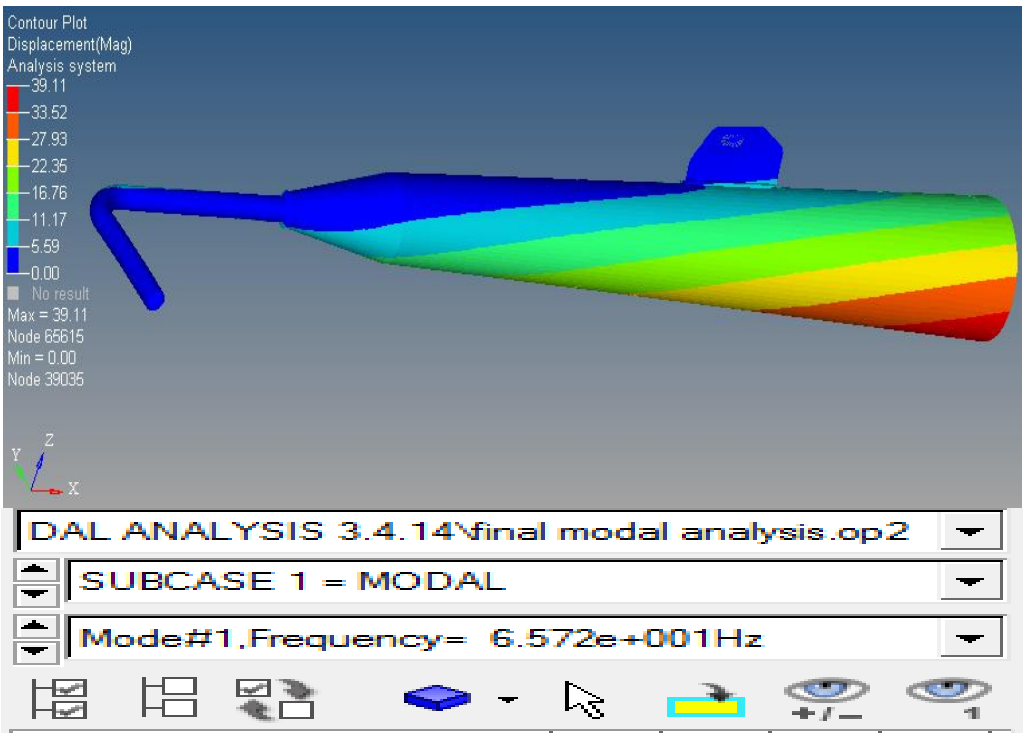

Figure 2. First Mode Shape.

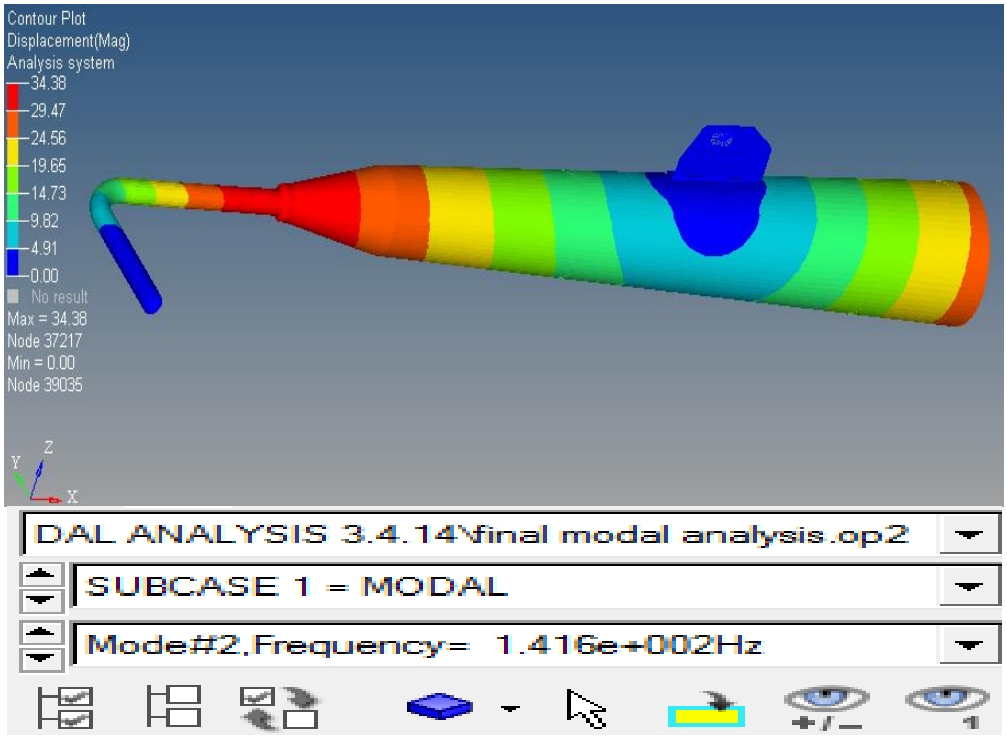

Figure 3. Second Mode Shape.

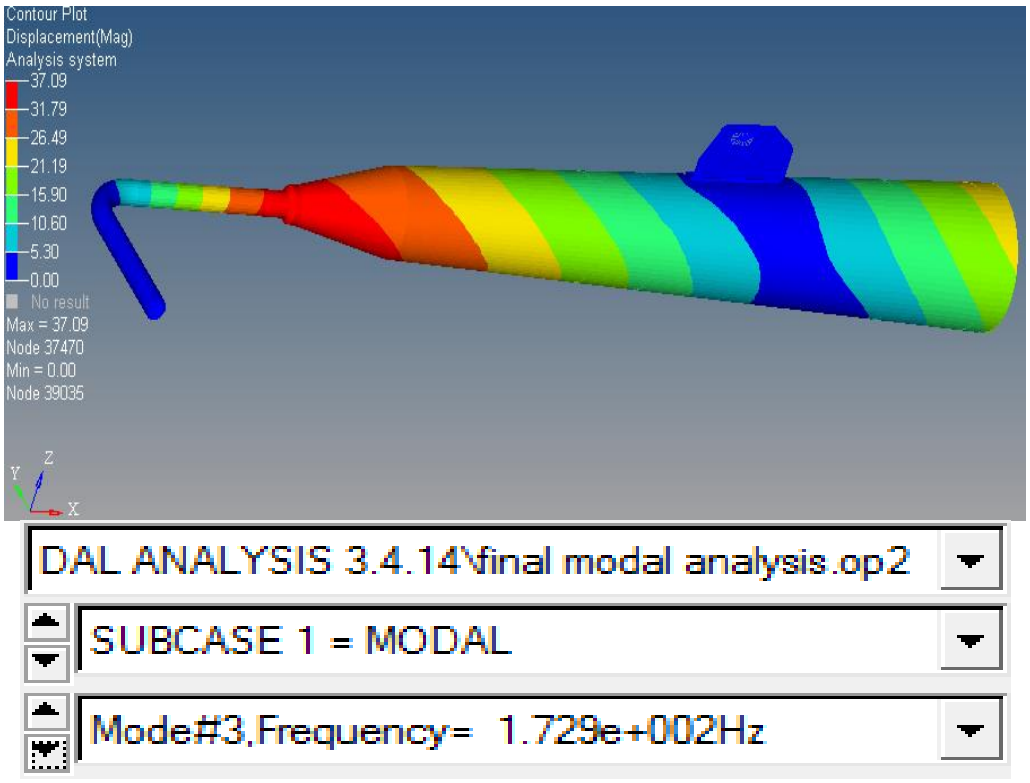

Figure 4. Third Mode Shape.

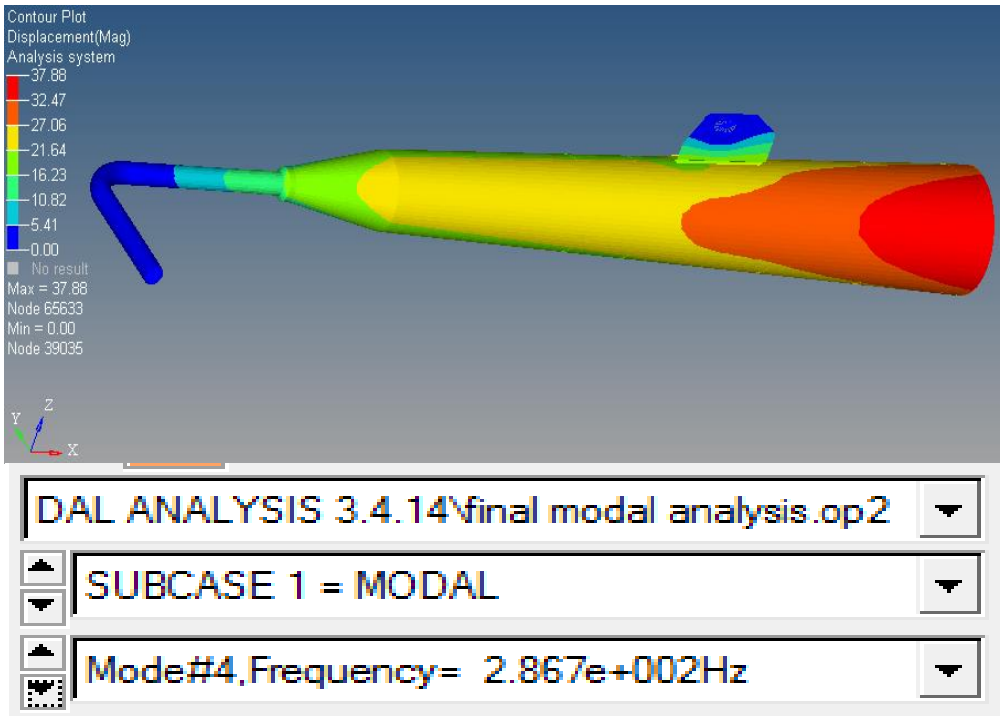

Figure 5. Fourth Mode Shape.

VI. EXPERIMENTAL VALIDATION

The experimental validation is done by using FFT (Fast Fourier Transform) analyzer. FFT spectrum analyzer computes the magnitude of its sine and cosine components, and displays the spectrum of these measured frequency components. The advantage of this technique is its accuracy and speed. FFT spectrum analyzers also measure all frequency components at the same time.

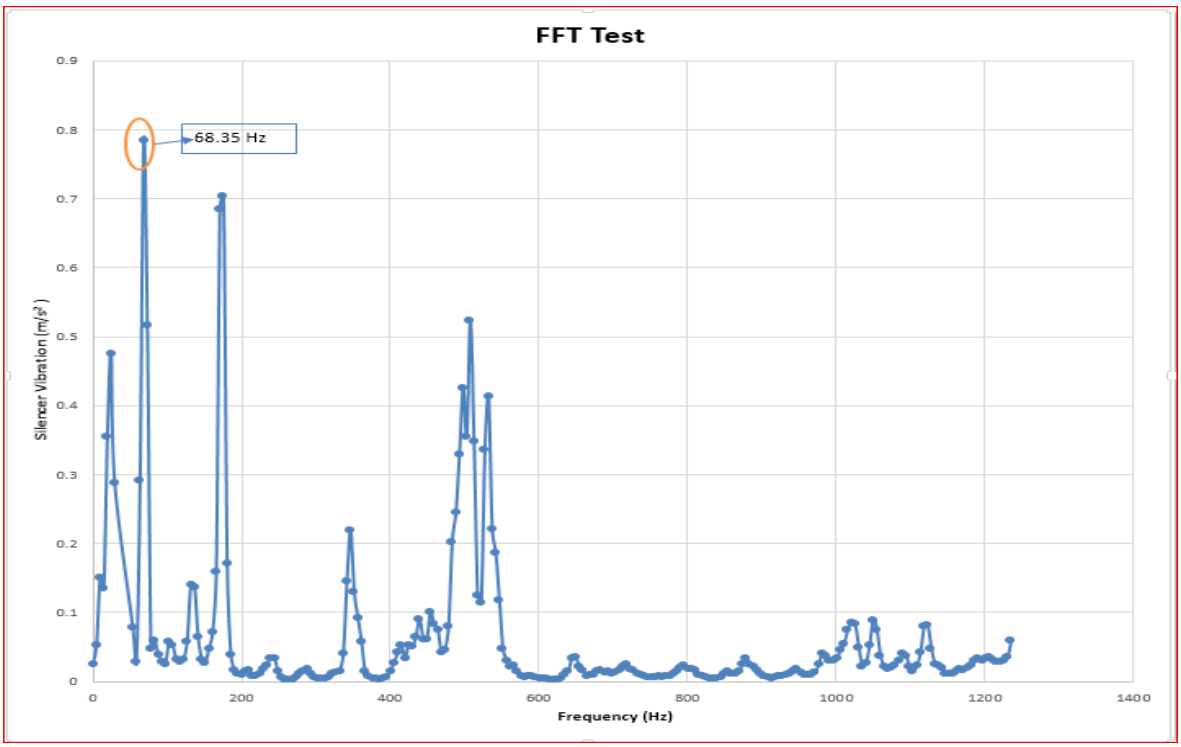

Figure 6. Frequency response showing different mode

The result obtained by FFT analyzer for first four natural frequencies are determined and tabulated as follows:

Table.2 : First Four Modal Frequency of Vibration By FFT Analyzer

Mode Order	1	2	3	4
Frequency (Hz)	68.35	147.03	179.53	297.73

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VII. RESULT

The following table shows the comparison for the first four natural frequencies of vibration of silencer by FEM package and FFT analyzer. The comparison shows that the natural frequency by both methods is nearly same. The percent variation in results by FFT and FEM are near 3.84%.

Table 3. Comparison of Modal frequency by FEM & FFT Analyser

Mode Order	1	2	3	4
Frequency by FEM (HZ)	65.72	141.6	172.9	286.7
Frequency by FFT (Hz)	68.35	147.03	173.53	301.73

VIII. CONCLUSION

The silencer natural frequencies have been calculated by using the FEM (NASTRAN) package and by FFT analyzer. The natural frequency of silencer obtained through FFT test concurs with the results obtained by FEM method. Considering variation in the material properties and specifications in the test specimen, the results are acceptable and nearly same.

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