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VIBRATIONAL ANALYSIS OF GENSET SILENCER USING FEA & FFT ANALYZER

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ABSTRACT

This paper postulates the 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.

I.   INTRODUCTION

Major objective when designing a new automobile exhaust pipe is to extend its durability period, which can be measured, in terms of its life span and mileage. The exhaust pipe is subjected to several stresses, which are mostly generated 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. 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.

II.   NEED FOR ANALYSIS

The Diesel/ Gas genset, while delivering power to the output shaft, consumes fuel and releases the exhaust gases through the silencer. The silencer vibrates due to the pulsating nature of Engine at frequencies corresponding to the excitation source. If the natural frequency of the silencer corresponds with this excitation frequency, resonance occurs which could prove detrimental to the life of the silencer while adding to its nuisance factor, contributing to noise. Every new silencer designed for the application has this potential capacity of being obstructive to its performance. Besides, any undue vibrations would lead to faster deterioration of structural integrity of the subassembly. While contributing to magnified occurrences of failure. Any catastrophic failure of silencer would lead to stoppages of power generation. For reasons of elevated levels of sound in the immediate vicinity of the Generator.

III.   EXISTING GENSET SILENCER (CASE STUDY)

SPECIFICATIONS OF SILENCER

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- Material Used : CRCA Steel Sheet
- Typical Thickness :- 0.8 to 2 mm
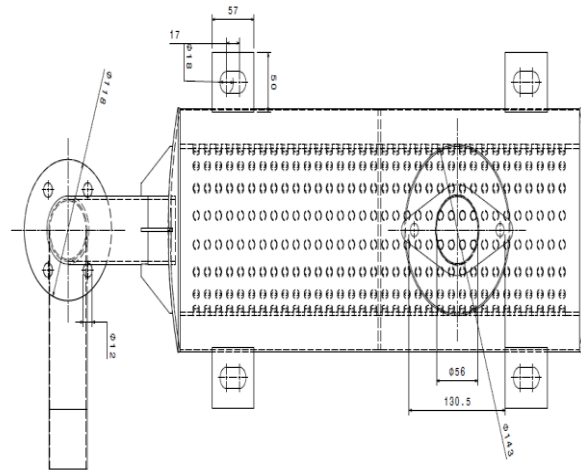- Weight: - Approx. 8~15Kg

Fig 1: Diesel Genset Silencer

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Fig 2: Dimensions of Genset Silencer (Top View)
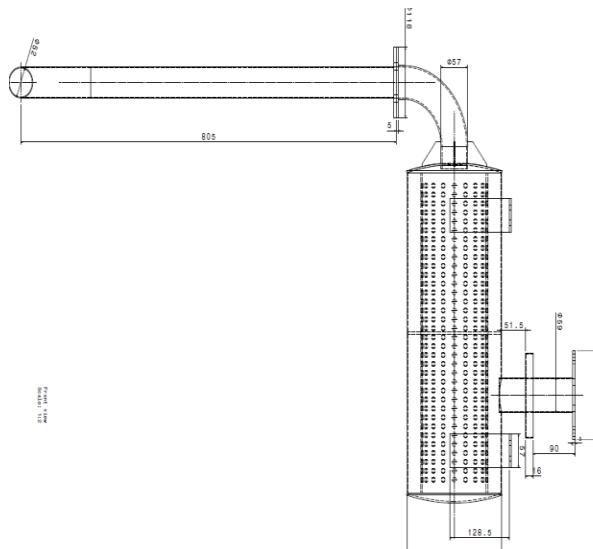
Fig 3: Dimensions of Genset Silencer (Side View)

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IV.   MODELLING AND MESHING OF SILENCER

SOFTWARE USED: Catia V5 R20
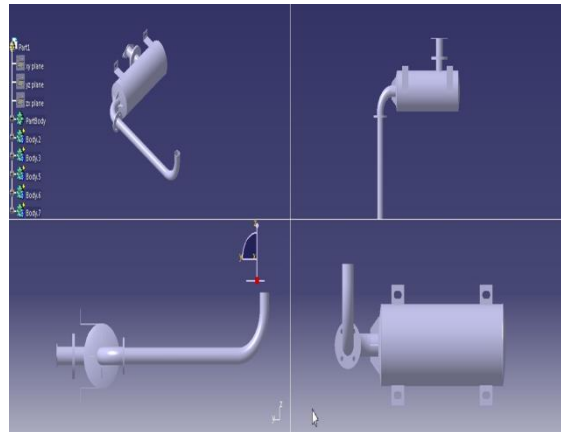
Fig 4: Model of Genset Silencer
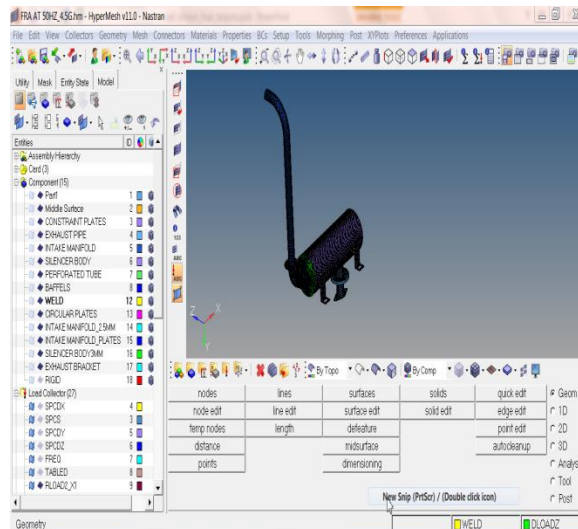
MESHING

Fig 5: Meshed Model of Silencer in Hypermesh

Type of Meshing = Shell Meshing
Type of Elements = 4 Noded Quad,
3 Noded Tria, Rbe2
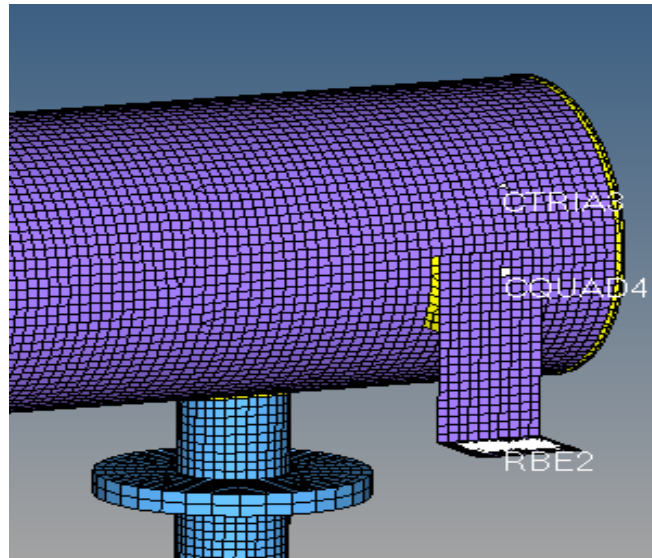No of Elements   = 33754
No of Nodes   = 34720

Fig 6: Silencer showing type of element & meshing

Table 1: Properties of Material Selected

	ID	[E]	[G]	[NU]	[RHO]	[A]
MAT1	1	2.1e+05		0.300	7.9e-09	
	[ST]	[SC]	[SS]	[MCSID]		

After generating the model of silencer with catia v5r20, the geometry is meshed with hypermesh & further analysis is done using Nastran. The result obtained by modal analysis for first five natural frequencies are determined and tabulated as follow.
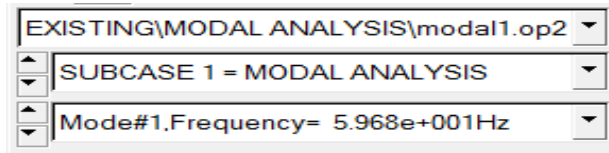
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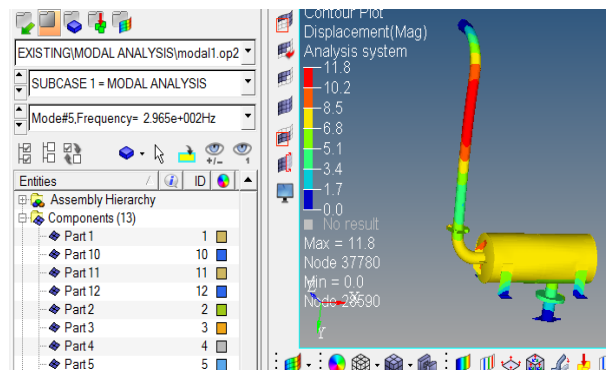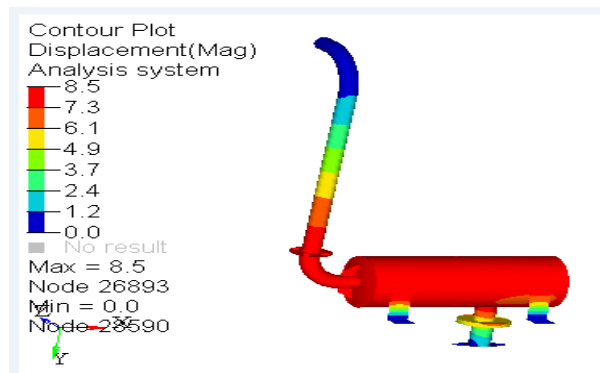**International Journal of Engineering Sciences & Management Research**

Fig 7: Frequency of 1ˢᵗ Mode

Fig 8: Frequency of 5ᵗʰ Mode

Table 2: Modal Frequencies of Vibration by Finite Element Analysis (First 5)

Mode Order	1	2	3	4	5
Frequency (Hz)	59.68	155.3	208.3	277.9	296.5

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V.   EXPERIMENTATION USING FFT ANALYZER

The FFT Spectrum Analyzer takes a time varying input signal, like you would see on an oscilloscope trace, and computes its frequency spectrum. The spectrum is probably dominated by a single frequency component, if the signal in the time domain is periodic in nature. What the spectrum analyzer does is represent the time domain signal by its component frequencies. Method of working of an FFT spectrum analyzer is entirely different. If the input signal is digitized at a high sampling rate, then the sampled data will accurately represent the input signal. The advantage of this technique is its speed. The entire spectrum takes only 4 ms to measure. The FFT spectrum analyzers technique offers the flexibility of being hundreds of times faster than traditional analog spectrum analyzers as it measures around all the components at same time. The limitation of this measurement is its resolution. The results obtained by FFT Analyzer for first five natural frequencies are determined and tabulated as follow.
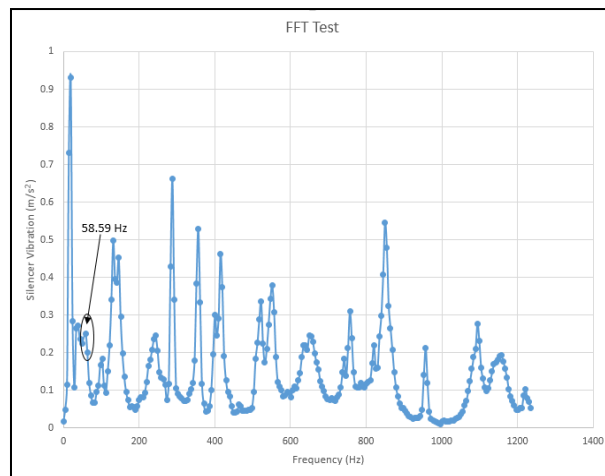

Fig 9: Frequency Shown by FFT Analyzer (Mode Order 1)

Table 3: Modal Frequencies of Vibration by FFT Analyzer (First 5)

Mode Order	1	2	3	4	5
Frequency (Hz)	58.59	164.8	238.6	297.2	310.8

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VI.   RESULT

The table presented below shows the natural frequency of silencer obtained using finite element method & FFT analyzer. It concludes that the results compared between this two methods gives almost analogous values. The results shown are almost same.

Table 4: Comparison between Modal Frequencies of Vibration by FEM Package & FFT Analyzer

Sr. No	Frequency using FEM Package (Hertz)	Frequency using FFT Analyzer (Hertz)
1	59.68	58.59
2	155.3	164.8
3	208.3	238.62
4	277.9	297.23
5	296.5	310.8

VII.   CONCLUSION

The silencer natural frequencies have been calculated by using the FEM package and by FFT analyzer. The natural frequencies hence found are nearly same by using both the methods. This data is valuable for designing of silencer & to avoid the condition of resonance. The dynamic performance can be increased by increasing the thickness of different part or changing the material type or by changing the stiffness. Furthermore is to add the support for partition, increase the support etc.

VIII.   ACKNOWLEDGEMENT

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IX.   REFERENCES

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