STRUCTURAL ANALYSIS OF THE EXHAUST GAS SILENCER FOR THE FLOW THROUGH PERFORATED AND NON-PERFORATED SILENCER

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ABSTRACT

To minimize unwanted noise, the exhaust gas of high pressure and high temperature coming out of internal combustion engine passes through silencer. Various types of silencers like absorptive, reactive and resonating, perforated type are widely implemented in actual practice .perforated reactive mufflers have an effective damping capability. This paper deals with comparative structural analysis of such automobile silencer of both perforated and non-perforated one. Here, geometrical model of perforated and non-perforated silencers has been designed. The analysis of the models for the deformation, stress and strain the were analyzed using ANSYS WORKBENCH 14.0. Boundary Element Method had been adopted for the design analysis for a comprehensive comparative analysis on silencers of perforated and as well as non-perforated type.

Keywords: Deformation, Non-Perforated, Perforated, Silencer, Strain, Stress.

I.INTRODUCTION

The motion of the piston engine and compressor the associated intake and discharge of the gases are responsible the noise vibration and sound pollution and major pollution due to exhaust gases. When this exhaust gases passes through a muffler, then there is large pressure difference between the inlet and outlet of the muffler.If a vehicle which not have a muffler or silencer than it make very much noise due to high level difference of frequencies of sound. This noise is undesirable; and unwanted. To reduce this noise arising out the exhaust from internal combustion engine, mufflers are indispensible device in order to adopt with the stringent environmental regulations. The undesirable noise is known as noise pollution. A pollution is creates more disturbance the environment. Noise is measured in decibel. Audible waves are of frequency ranges from 20 Hz to 20000 Hz. The audible frequency of dog is 15 Hz to 50000 Hz. The aircraft is making more noise. Muffler containing more pressure hence sound is in the pressure waves forms. Because there high difference of pressure in the automobile muffler. Hence there stress, strain, deformation occurs at the silencer body.

Munjal [1] has done a descriptive analysis on design of the mufflers. In his report, he elaborated the main reason noise and vibration generated from of reciprocating engine. His design of muffler has been developed on the basis of experimental trial and error, as well as on the basis of electro-acoustic analysis on passive muffler using impedance mismatch of dissipative or reactive muffler. The main principal of the automobile industries muffler is conservation of acoustic energy into heat by means of highly porous-fibrous linings, called dissipative automobile muffler. The main purpose of the silencer there passes the high pressure heat, ventilation and air condition system. The automobile is working in vibro-acoustic hoses used in automotive weather control. Automobile main component muffler it creates noise pollution as well as air pollution.

Shital et al. [2] have worked on a practical approach on novel design of automobile muffler with prototype validation. This new area of the muffler and most advances related to the muffler of acoustic filter analysis. The complex design of the muffler it mostly affects the behavior of the acoustic gases like emission, vibration and fuel efficiency of the engine. The muffler play important role to reduction of the noise. They develop a model in modern take analysis in modern tool CAE and optimize the design with respect to requirement refer like noise and back pressure.

Bartlett et al. [3] have worked on modeling and analysis of the variable geometry of the engine exhaust system.In engine exhaust system, gases are generating very high pulsating due to its variation of pressure, temperature and velocity. Hence for their analysis, the variable geometry of the muffler had been taken into consideration.

Na et al. [4] simulated the scattering of acoustic plane waves at a sudden area expansion in the duct without flow, using a linearized Navier Stock equation solver in frequency domain. Their results on acoustic catering were based on wave decomposition techniques with good decision. Their analytical model for flow through the duct of the pipes, proposed the scattering of waves at the different area of discontinuity with the sharp edges. Sound wave of the scattering varies with cross-section. With a cited example Na et al. [4] considered a 3-D duct model having rectangular cross-section with expanding area, and simulated it for the flow of the downstream.

Patekar et al. [5] have theoretically modeled the exhaust silencer of a two wheeler using Finite Element Method (FEM)and experimentally validated using Fast Fourier Transform(FTT) analyses. The modal analysis for the six frequencies and compared with the natural frequency. In accordance with their study, it was noticed that the dynamic performance could be increased with increasing thickness of various parts.

II. THE BOUNDARY CONDITION OF THE MODEL

The silencer has the boundary condition inlet temperature, outlet temperature, inlet pressure, outlet pressure and also includes the fixed supports like holding the silencer.

III GERMETRIC MODEL OF THE SILENCER

In paper here included two types of the geometrics model one is the perforated model as shown in the fig no 1. Second geometric model is the non-perforated model as show in fig no 2.the both geometric model have the same dimension but only the difference perforation.

GEOMETRIC MODEL

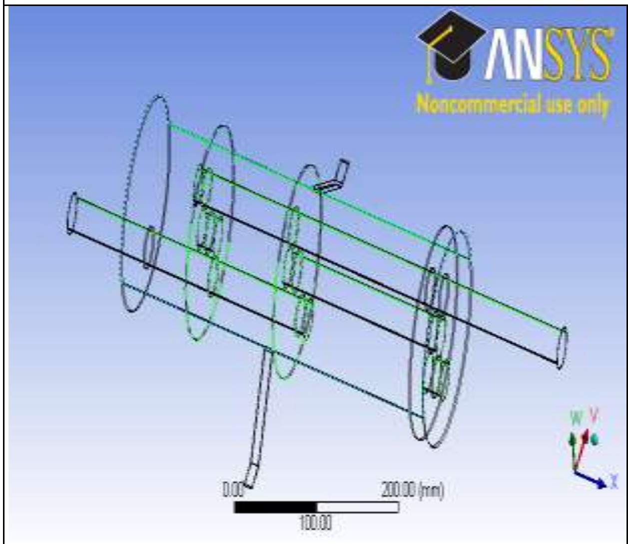

FIG. 1:NON-PERFORATED MODEL

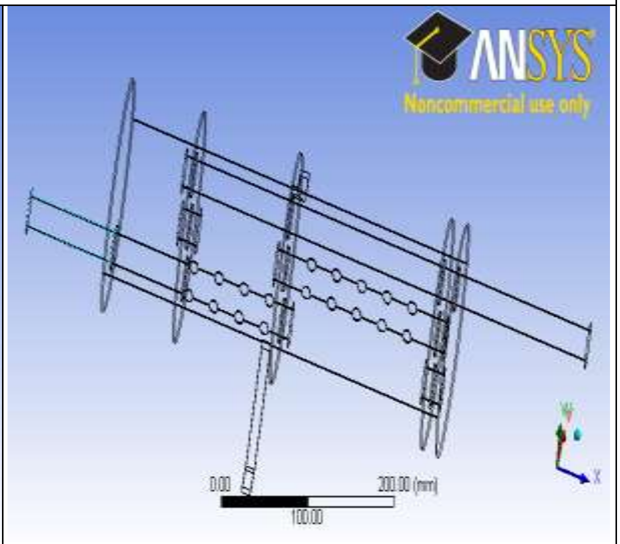

FIG. 2: PERFORATED MODEL

VI. RESULT ANALYSIS

In this paper, it has been discussed about the structural analysis of the both types of the silencer model. In the structural analysis includes the von Mises stress, von Mises strain and the total deformation. The deformation for non-perforated silencer model as show in the fig no.3 and thefor the perforated silencer the total deformation is show in the fig no. 4. The equivalent von Mises stress for the non-perforated silencer model show in the fig. 5 and for the perforated silencer model. The elastic strain is show for the both silencer model fig.7 for the non-perforated and the fig.8 for the perforated silencer.

TOTAL DEFORMATION

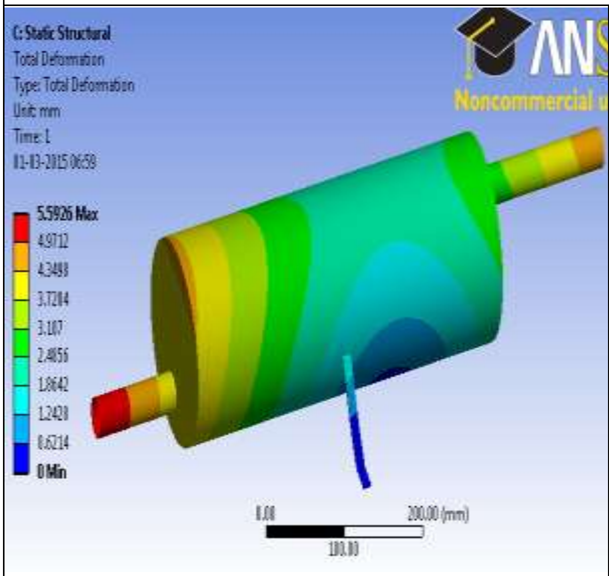

FIG. 3: TOTAL DEFORMATION FOR NON-PERFORATED SILENCER

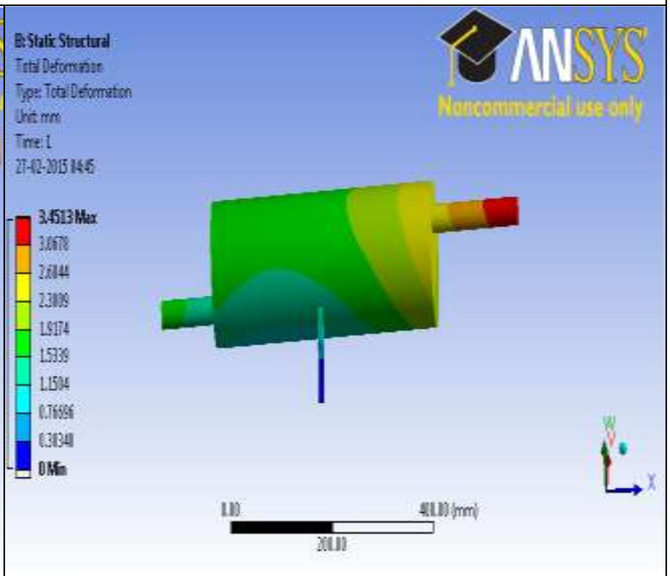

FIG. 4: TOTAL DEFORMATION FOR THE PERFORATED SILENCER

EQUIVAENT (VON-MISES) STRESS

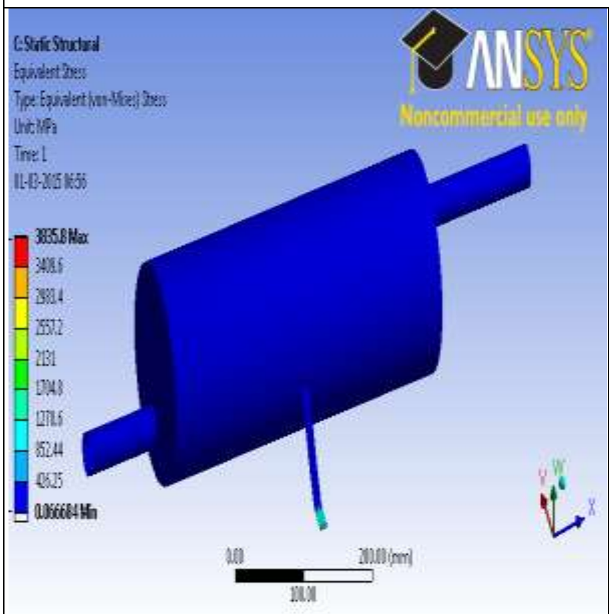

FIG. 5: EQUIVALENT (VON-MISES) STRESS

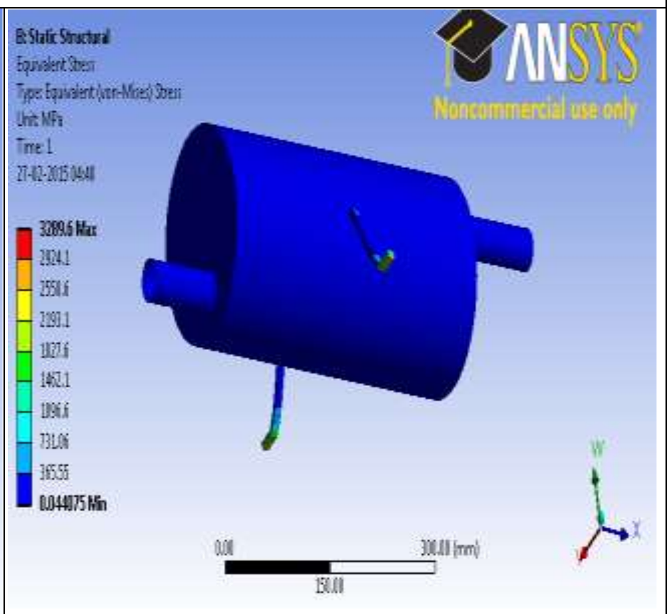

FIG. 6: EQUIVALENT (VON-MISES) STRESS

EQUIVALENT ELASTIC STRAIN

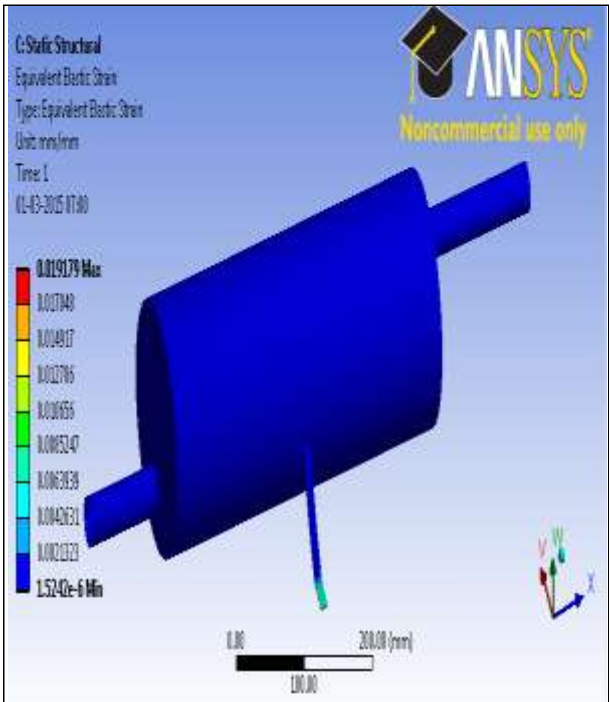

FIG. 7: EQUIVALENT ELASTIC STRAIN

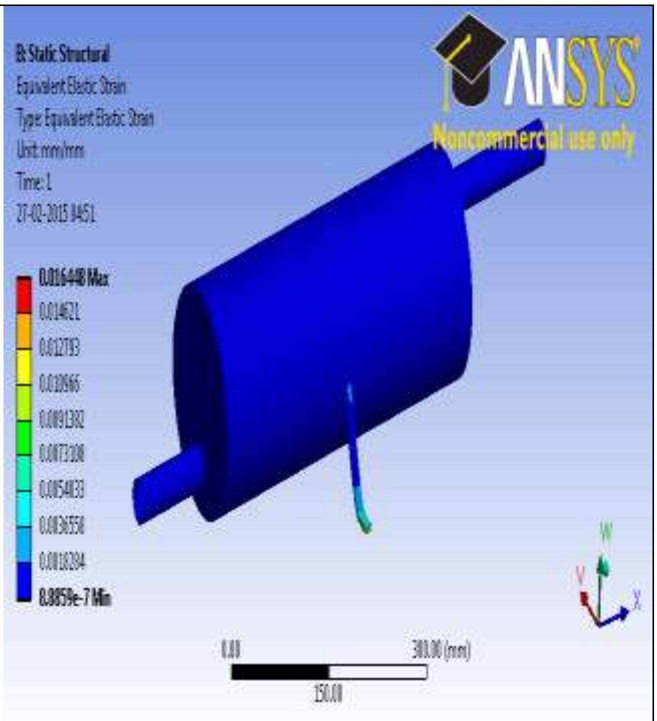

FIG. 8: EQUIVALENT ELASTIC STRAIN

V. CONCLUSION AND FUTURE SCOPE

It has been observed here in structural analysis of both type (perforated and non-perforated) silencer where stress developed at discontinuity. These stresses is not depend only upon inside pressure of exhaust gases but also extremely affected by temperature of gases. Total deformation is much larger at used pressure and temperature parameter. There were generated different types of stress, strains, and the deformation. The two kinds analysis were disused was structural analysis. The results of the two silencer perforated and non-perforated were analyzed.

FOR THE NON-PERFORATED SILENCER

TABLE NO. 1

S NO.	TYPE OF THE ANALYSIS	MAXIMUM VALUE	MINIMUM VALUE
1.	TOTAL DEFORMATION (mm)	5.5926	0
2.	EQUIVALEN VON-MISES STRESS (MPa)	3835.8	0.066684
3.	EQUIVALENT ELASTIC STRAIN (mm/mm)	0.019179	1.5242×10^{-6}

FOR THE PERFORATED SILENCER

TABLE NO. 2			
S NO.	TYPE OF THE ANALYSIS	MAXIMUM VALUE	MINIMUM VALUE
1.	TOTAL DEFORMATION (mm)	3.4513	0
2.	EQUIVALEN VON-MISES STRESS (MPa)	3289.6	0.044075
3.	EQUIVALENT ELASTIC STRAIN (mm/mm)	0.016448	8.8859×10^{-7}

Here noticed that the stress value in non-perforated more than the compared to perforated silencer. Also the similarly the total deformation and the strain compared there maximum deformation, strain were developed in the non-perforated. But in the perforated was getting less. So here clearly justified the perforated silencer much better than the non-perforated silencer.

There is more future scope in modeling of the silencer. The designer of the silencer can change design of the silencer like increase or decrease the length and diameter of the silencer. Here discussed in detail circular type of the silencer. For the future also can change its shape of the silencer like elliptical, tapper, rectangular etc.

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