ANALYSIS FOR EXHAUST MANIFOLD OF AN OFF-ROAD VEHICLE DIESEL ENGINE-FEM APPROACH

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Abstract-This paper presents an analysis to investigate stresses under situations on different materials used for present exhaust manifold. Analysis is carried out on different materials i.e. cast iron, structural steel and Aluminum alloy. Initially Hypermesh 12.0 is used for the purpose of meshing. ABAQUS Software is used for the Analysis. The objective of the analysis is to ensure serviceability of exhaust manifold. The results suggest the suitable material for the manifold.

Index Terms – ***Exhaust Manifold, FEM, Analysis.***

I. INTRODUCTION

Exhaust manifold is a part of diesel engines and is required to collect the exhaust gases from the cylinder head and send it to the exhaust system. This is found in between the engine and exhaust system. Exhaust manifold plays an important role in the performance of automobile. Particularly, the efficiencies of emission and the fuel consumption are nearly related to the exhaust manifold. The manifold may be a casting or made of relatively light material depends on working environment. The purpose of the exhaust manifold is to collect and carry these exhaust gases away from the engine cylinders with a minimum of back pressure, without affecting engine performance. In this an investigation is made on an exhaust manifold of an off-road vehicle diesel engine. In First Step, FEM analyses are done on a component by using ABAQUS software. The results are sequentially examined for stress, strain and deformation.

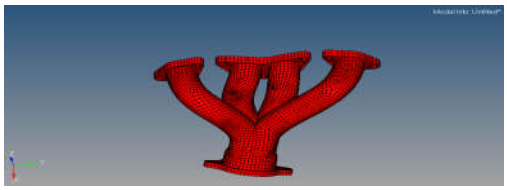

Fig 1.Geometry for Exhaust Manifold of an off-road Vehicle diesel engine

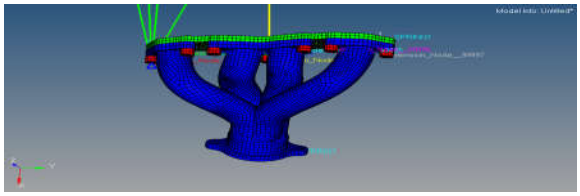

Fig 2.Meshing of exhaust manifold

II.LITERATURE REVIEW

[1]. This paper mainly investigates the effects of intake runner length on the performance characteristics of a four-stroke, single-cylinder spark-ignited engine and in addition to electronically controlled fuel injector as an observation. In this paper basic intake tuning mechanisms were described. Engine performance characteristics such as brake torque, brake power, brake mean effective pressure and specific fuel consumption were taken into consideration and virtual simulation software LOTUS ENGINE SIMULATION was used to evaluate the effects of the variation in the length of intake plenum on these parameters. It was found that change in runner length will effect the rpm at which peak value of torque was occurred. Accordingly a system to adjust the manifold length was designed and developed. According to the simulation graphs, in order to increase the torque performance, plenum length must be extended with considerable low engine speeds and shortened as the engine speed increases.[2]This Paper intends to design an Intake Manifold for an 870cc naturally aspirated diesel engine for Greaves Cotton Limited. The present manifold delivers a maximum volumetric efficiency of 84% at rated torque, i.e. 2400 RPM. The objective of the paper will try to achieve higher volumetric efficiency taking the space considerations into account.[3] Reports that the gases come out from engine will meet nearly 1100K above, and this will meet tail gas heating effect.

Because the tail gas heating will lead to thermal stress as high as hundreds of MPa, and it can also lead to thermal fatigue and fracture. [4] Here the calculation for exhaust manifold is carried out based on combination of CFD and FEA software for the distribution of temperature and thermal stresses of Exhaust manifold which was demonstrated of stainless steel.

III.OBJECTIVES

1).The main objective of this study is to investigate safety factor for every material.
2)To determine suitable material for the manifold design under observation.
The followed objectives will results into check whether the material is applicable for optimization and safety.

IV.METHODOLOGY

To simulate the stresses and deformations, the FE simulations have been performed using ABAQUS under off-road conditions of the Exhaust manifold.

A)Material properties

The material properties of Cast iron, Structural steel and aluminium alloy are taken into account and following properties are used for simulation purposes.

Table.1 Material properties for selected metals

Material Properties	Unit Of Measurement	Cast Iron	Structural Steel	Aluminium alloy
Density	Kgm^{-3}	7200	7850	2700
Isotropic Thermal Conductivity	$Wm^{-1}C^{-1}$	52	61	
Young's Modulus	Pa	1.1e11	2.0e11	
Poisson's Ratio	-	0.28	0.30	0.334
Yield strength	Mpa	-	350	345
Ultimate Stress	Mpa	400	-	-

B)Boundary conditions and Loading.

a)Boundary Conditions :
Exhaust manifold is mounted on engine wall by two mounting flanges and practically fixed, there is no displacement possibility in normal direction and the surfaces which are connected to adjacent devices.

b)Loading Conditions:
Here we are considering exhaust manifold of an off-road vehicle diesel engine. So there is no much more Temperature Load but it is 300K ,considering to normal condition inside manifold design.

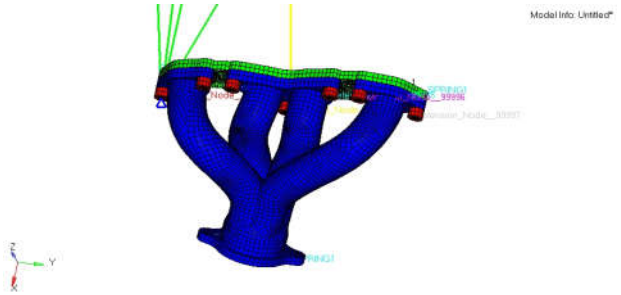

Fig 3.Boundary conditions applied to the geometry

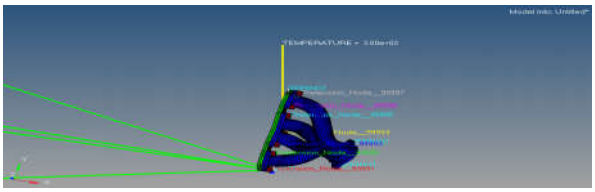

Fig.4 Boundary conditions and Loadings applied to Geometry

C) ANALYSIS

Initially the CAD model is developed as per the required geometry.And further the model is meshed using HYPERMESH 12.0, boundary conditions and loads are applied. The meshed model is then analysed with ABAQUS Software, for the purpose of Analysis of different materials i.e. Cast iron, Structural steel and Aluminium alloy. Materials are analysed under prescribed conditions. The analysis includes 14682 nodes, 7450 C3D8I elements, 282 C3D6 elements with respect to MANIFOLD, BOLTS, HEAD.

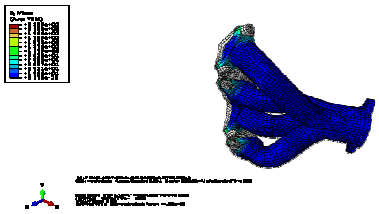

Fig.5 Von-Mises Stress of Structural steel

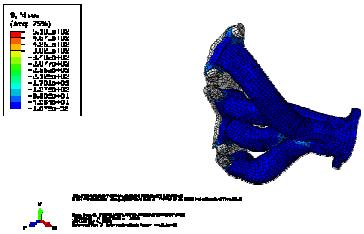

Fig.6 Von-Mises Stress of Cast Iron

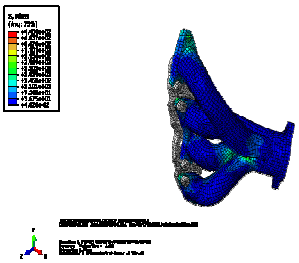

Fig.7 Von-Mises Stress of Aluminium alloy

V.RESULTS

In case of Cast iron and Structural steel after deformation areas remain same and both will affect by Temperature load due to generated shape and Boundary conditions of exhaust manifold. Following shows detail results of individual material under testing conditions.

Table.2 Results calculated for each simulation

S.NO	Materials	Stress (MPa)	FOS
1	Cast iron	510.3	0.78
2	Structural steel	235.9	1.5
3	Aluminium alloy	440.4	1.27

VI. CONCLUSION

From the above investigated result of analysis, the Factor of safety for Structural steel is more. And result shows materials are appropriate for investigating exhaust manifold for an off-road vehicle Diesel engine under given condition. Based on following observations Structural steel is safer selection as compared to Cast iron and Aluminium alloy.

REFERENCES

1. *Shrinath Potul, Rohan Nachnolkar, Sagar Bhave ,"Analysis Of Change In Intake Manifold Length And Development Of Variable Intake System" VOLUME 3, ISSUE 5,2014 ISSN 2277-8616 223*
2. *Suresh Aadepu, I.S.N.V.R.Prasanth, Jarapala.Murali Naik ,"Design of intake manifold of IC engines with improved volumetric efficiency" Volume No: 1(2014), Issue No: 6 (June) ISSN No: 2348-4845*
3. *Bin Zou,Yaqian Hu,Zhien Liu,Fuwu Yan and Chao Wang in Zou",The Impact of Temperature Effect on Exhaust Manifold Thermal Modal Analysis" Research Journal of Applied Sciences,Engineering and Technology6(15):2824-2829,2013 ISSN:2040-7459;e-ISSN:2040-7467.*
4. *Zhu Maoqina, Lv Juncheng and ZhongXiangbo "Development for Stainless Steel Exhaust Manifold and CAE Analysis". Advance Material Research Vol. 462(2012).Trance Tech Publications, Switzerland.*