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Design and Analysis of a Connecting Rod

Sebastian Antony, Arjun A., Shinos T. K
B.Tech. Mechanical Dept.
Muthoot Institute of Technology and Science
Ernakulam, India

Anoop P.
Assistant Professor, Mechanical Dept.
Muthoot Institute of Technology and Science
Ernakulam, India

***Abstract*— The main function of a connecting rod is to convert linear motion of piston to rotary motion of crank. It is the main component of an internal combustion (IC) engine and is the most heavily stressed part in the engine. During its operation various stresses are acting on connecting rod. The influence of compressive stress is more in connecting rod due to gas pressure and whipping stress.**

The objective of this study is to carry out a FEA analysis of a connecting rod and obtain its stress distribution on application of the force.

Geometry of connecting rod used for FEA, its generation, simplifications and accuracy is done by using Catia. Mesh generation, the load application, particularly the distribution at the contact area, factors that decide application of the restraints and validation of the FEA model are also discussed. FEM was used to determine structural behavior under static load condition (static FEA).

Keywords—Connecting Rod, Catia, Ansys, FEA

I. INTRODUCTION

In modern automotive internal combustion engines, the connecting rods are most usually made of steel for production engines, but can be made of aluminium (for lightness and the ability to absorb high impact at the expense of durability) or titanium (for a combination of strength and lightness at the expense of affordability) for high performance engines. They are not rigidly fixed at either end, hence the angle between the connecting rod and the piston changes as the rod moves up and down and rotates around the crankshaft. Connecting rods are manufactured by means of forging.

Being one of the most integral parts in an engine’s design, the connecting rod must be able to withstand tremendous loads and transmit a great deal of power. In a reciprocating piston engines, connecting rod connects the piston to the crank or crankshaft. Together with the crank, they form a simple mechanism that converts reciprocating motion into rotating motion.

As the connecting rod is rigid, it may transmit either a push or a pull and so the rod may rotate the crank through both halves of a revolution, i.e. piston pushing and piston pulling.

The small end is attatched to the piston pin and the big end connects to the bearing journal on the crank. Typically there is a pinhole bored through the bearing and the big end of the connecting rod so that pressurized lubricating motor oil squirts out onto the thrust side of the cylinder wall to lubricate the travel of the pistons and piston rings.

II. FINITE ELEMENT ANALYSIS

A. Design

The connecting rod is designed using CATIA V5 6R 2014 according to the specifications given below.

Parameter	Value
Length of connecting rod	150
Outer diameter of big end	56
Inner diameter of big end	48
Outer diameter of small end	32
Inner diameter of small end	24

Table 1: Dimensions of Connecting Rod

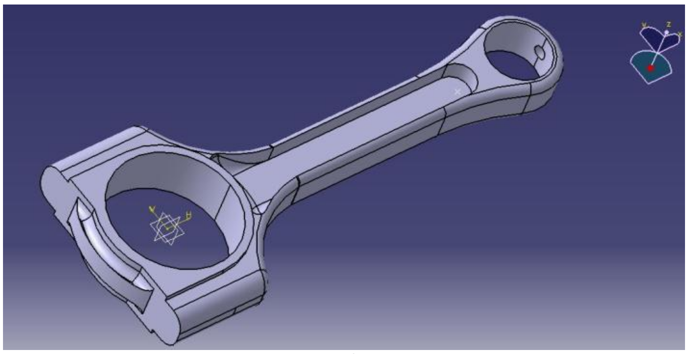

Fig 1: Catia Model of Connecting Rod

B. Meshing

The connecting rod model is imported to the ANSYS (mechanical APDL 14.5) by converting the Catia file into .anf extension file format. The element type selected is solid185. After successful import of model material property is defined. The materials and their properties used and necessary for the analysis is given in table 2.

Material	Young’s modulus (GPa)	Poisson’s ratio	Density (Kg/mm^3)
Steel	200	.303	8050
Aluminium	69	.334	2700

Table 2: Material Properties

After defining the element type and material property, meshing is done. Meshing is probably the most important part in analysis. Meshing means to create a mesh of some grid-points called 'nodes'. It's done with a variety of tools & options available in the software. The results are calculated by solving the relevant governing equations numerically at each of the nodes of the mesh. For the design under consideration, finite element mesh is generated using tetrahedral mesh type taking fine size to 1mm and minimum edge length as 0.1mm with 50730 nodes.

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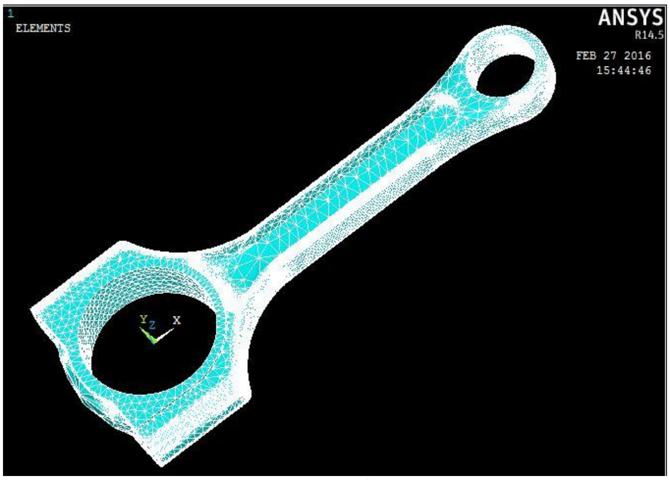


Fig 2: Meshed Model Of Connecting Rod

C. Load Analysis

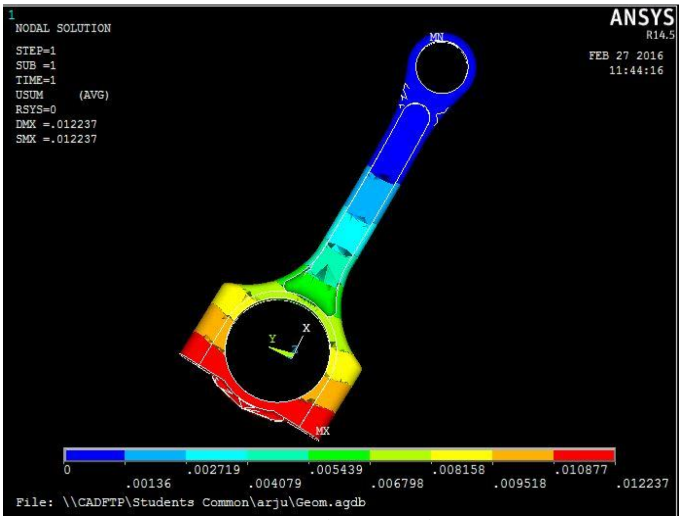
1. Compressive Loading:
 Crank End: p = 37.66 MPa
 Piston pin End: p = 69.98 MPa

2. Tensile Loading:
 Crank End: p = 41.5 MPa
 Piston pin End: p = 77.17 MPa

Since the analysis is linear and elastic, for static analysis the stress, displacement and strain are proportional to the magnitude of the load. Therefore, the result obtained from FEA is applied to several elastic load carries in a proportional manner.

a) *Compression at Bigger end*

For the analysis of connecting rod, a compressive force of magnitude 37.66MPa is applied on the bigger end, keeping the smaller end fixed.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NODAL SOLUTION

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TIME=1
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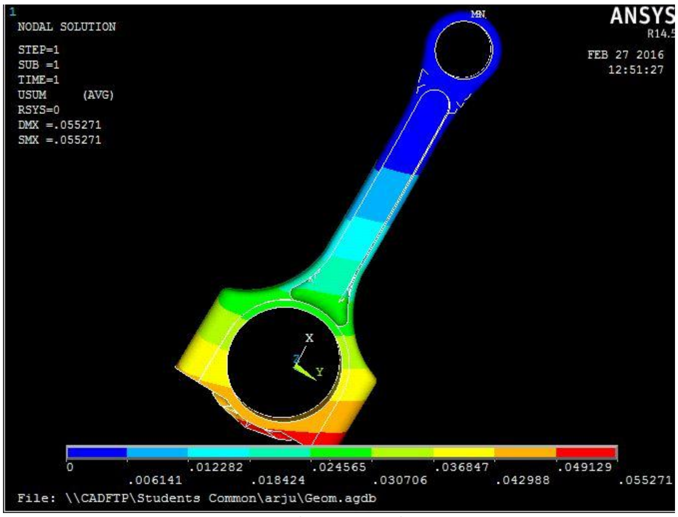
RSYS=0
DMX =.012237
SMX =.012237
```

Fig.3: Total Deformation of Steel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SMX =.055271
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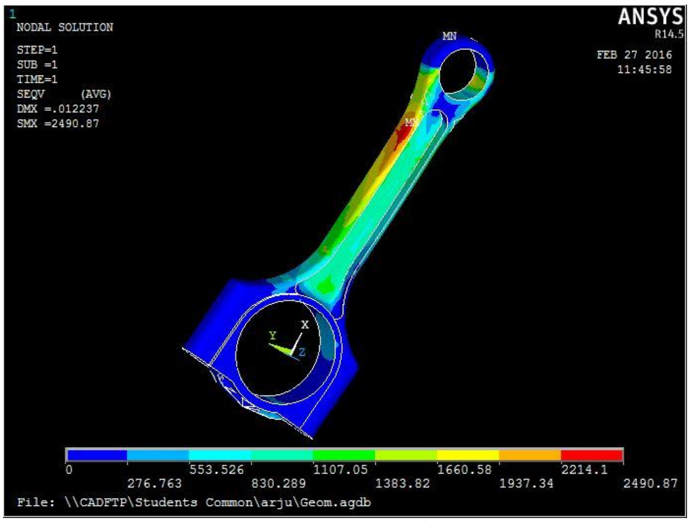
Fig.4: Total Deformation of Aluminium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NODAL SOLUTION

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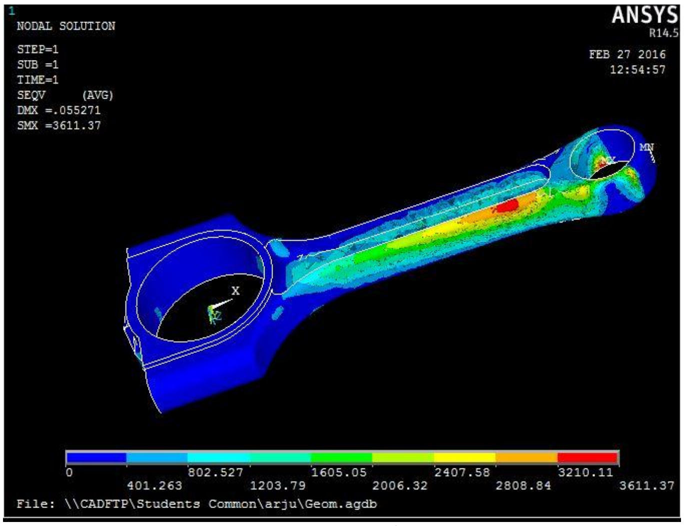
Fig.5: Von-Mises Stress of Steel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SMX =3611.37
```

Fig.6: Von Mises Stress of Aluminium

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b) Tension at bigger end

A tensile force of magnitude 41.15 MPa is applied at the bigger end while keeping the smaller end remain fixed.

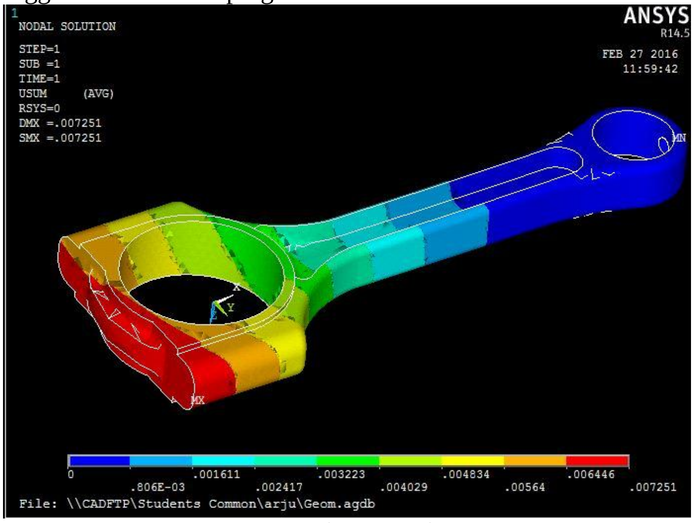

Fig.7: Total Deformation of Steel

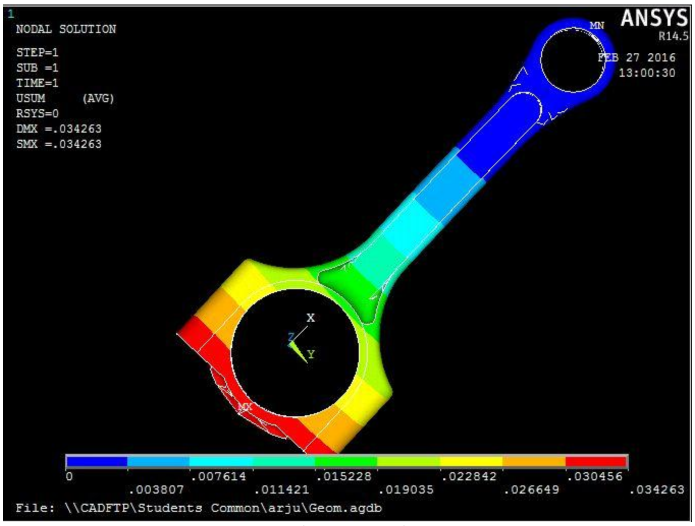

Fig.8: Total Deformation of Aluminium

Fig.9: Von-Mises Stress of Steel

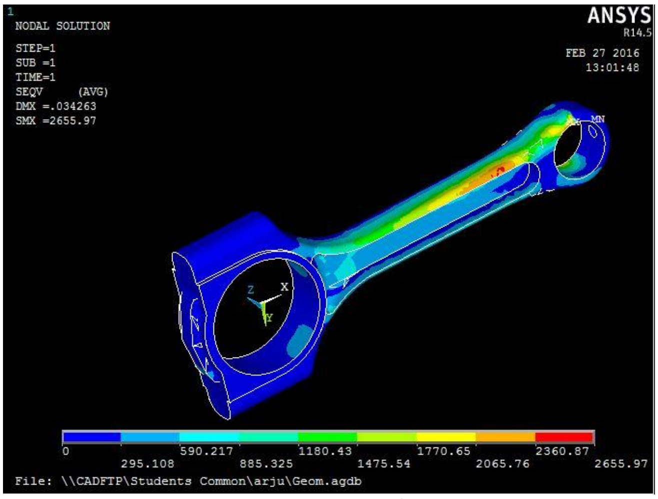

Fig.10: Von Mises Stress of Aluminium

c) Compression in Smaller End

A compressive load of magnitude 69.98 MPa is applied at the smaller end keeping the bigger end fixed.

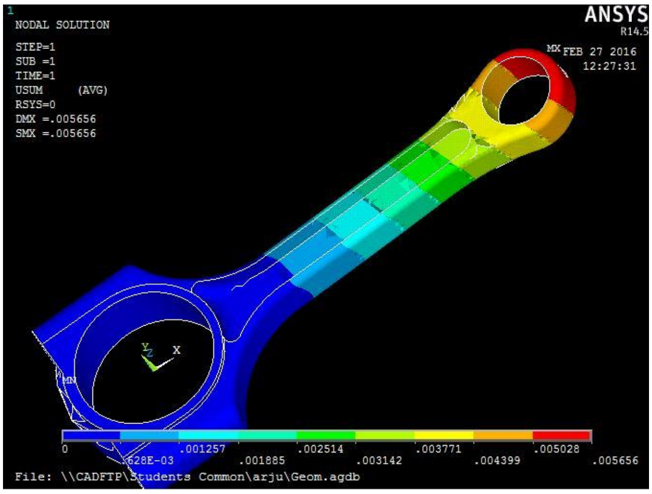

Fig.11: Total Deformation of Steel

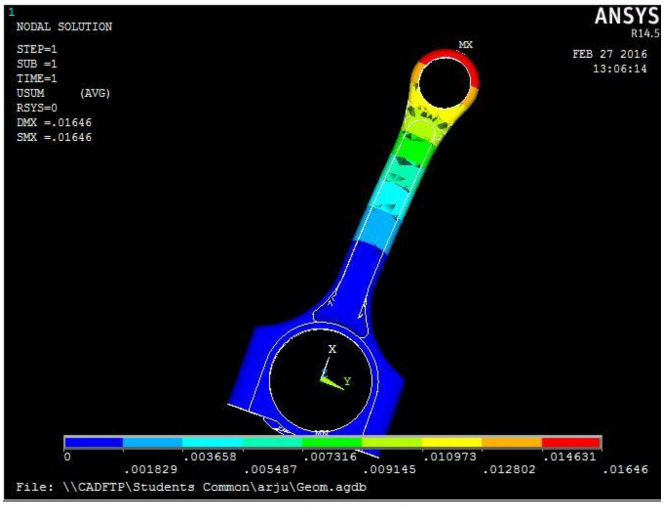

Fig.12: Total Deformation of Aluminium

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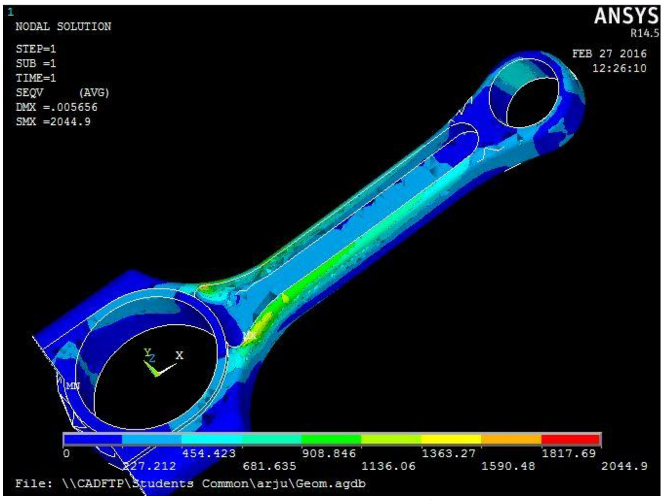

Fig.13: Von-Mises Stress of Steel

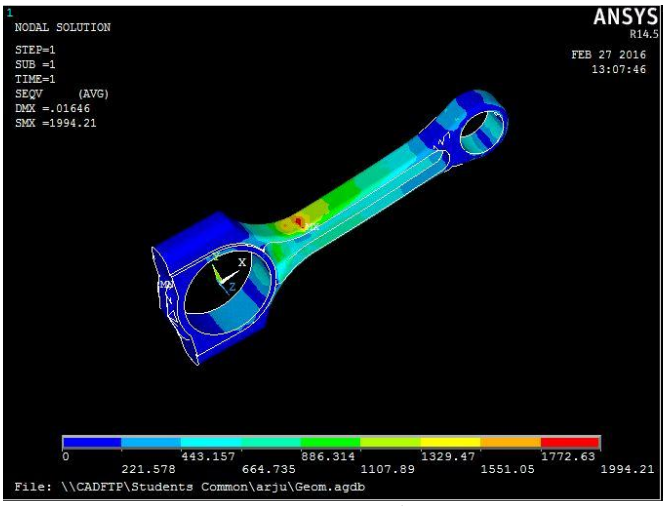

Fig.14: Von Mises Stress of Aluminium

d) Tension in Smaller End

A tensile force of 77.17 MPa is applied at the smaller end while keeping the bigger end remains fixed.

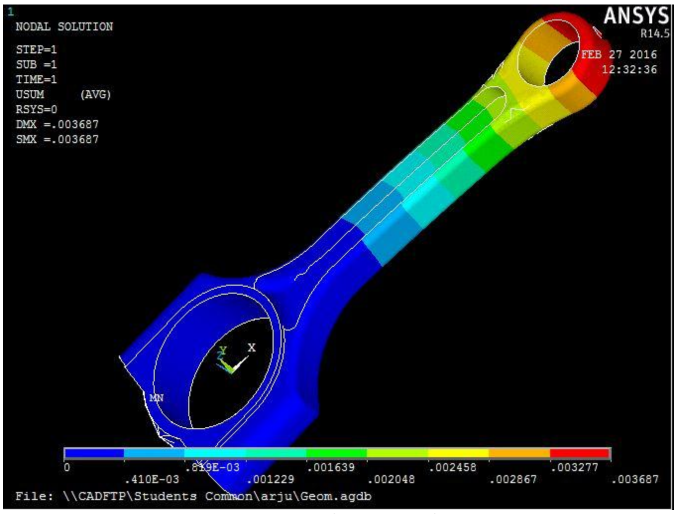

Fig.15: Total Deformation of Steel

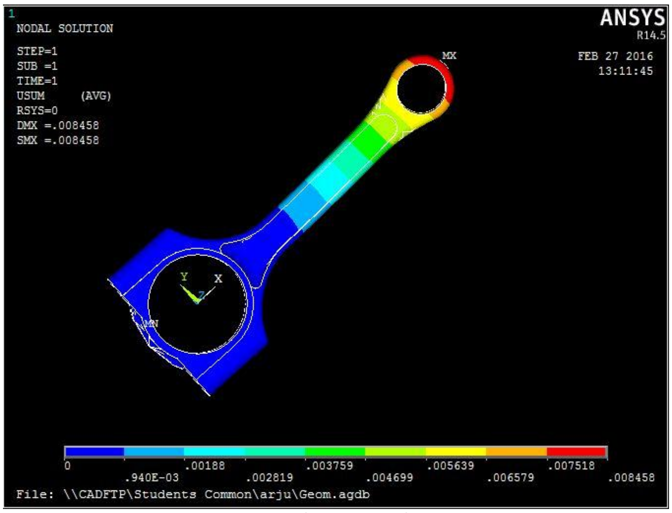

Fig.16: Total Deformation of Aluminium

Fig.17: Von-Mises Stress of Steel

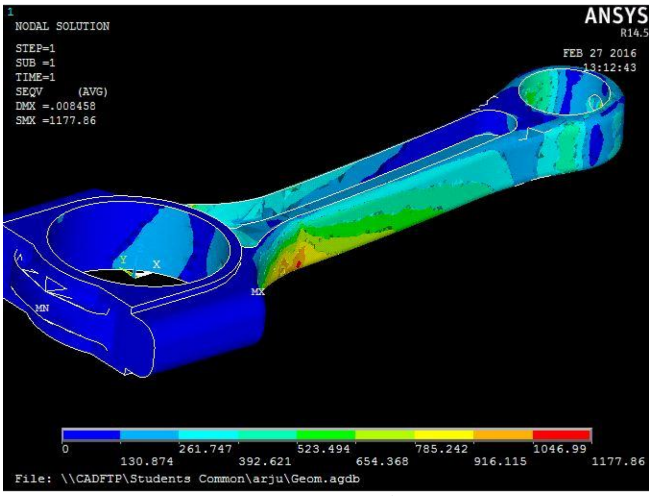

Fig.18: Von Mises Stress of Aluminium

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III. RESULTS AND DISCUSSIONS

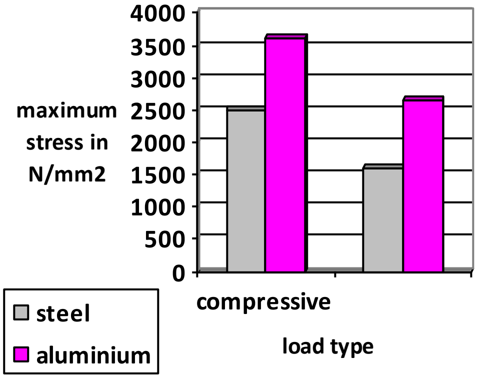
Material: Steel

Method of loading	Load applied (MPa)	Maximum displacement (mm)	Maximum stress (N/mm^2)
Compressive at bigger end	41.15	0.012	2490.87
Tensile at bigger end	37.66	0.007	1605.51
Compressive at small end	77.17	0.005	2044.90
Tensile at smaller end	69.98	0.003	1267.33

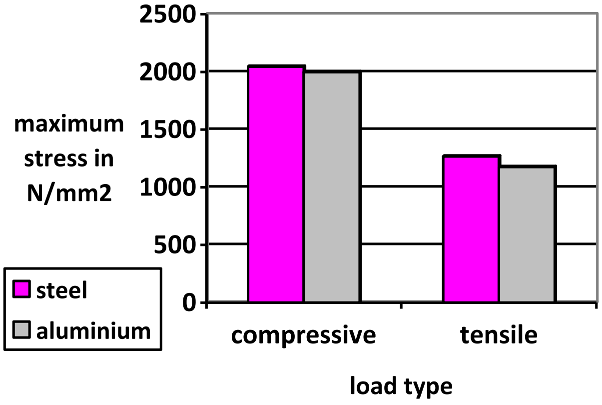
Material: Aluminium

Method of loading	Load applied (MPa)	Maximum displacement (mm)	Maximum stress (N/mm^2)
Compressive at bigger end	41.15	0.055	3611.37
Tensile at bigger end	37.66	0.034	2655.57
Compressive at small end	77.17	0.016	1999.21
Tensile at smaller end	69.98	0.008	1177.86

Comparison of von mises stress variation for the two materials are as shown below,



Graph 1: Load applied at The Bigger End



Graph 2: Load applied at smaller End

Buckling and bending stresses, non – symmetric shape of connecting rod, Flash and bolt holes was eliminated while analysis. We could conclude that the influence of compressive stress is more in connecting rod due to gas pressure and whipping stress as shown. The piston region suffers tensile stress due to inertia loads. The more stressed part of the rod is being shown using von misses stress plot.

IV.CONCLUSION

It was observed that connecting Rod made up of Aluminium has higher intensity of stress induced as compared to connecting Rod made up of Steel. Also there is a great opportunity to improve the design. Hence steel is a better choice for connecting rods.

REFERENCE

[1] Hippoliti, R., 1993, “FEM method for design and optimization of connecting rods for small two-stroke engines,” *Small Engine Technology Conference*, pp. 217-231.

[2] Serag, S., Sevien, L., Sheha, G., and El-Beshtawi, I., 1989, “Optimal design of the connecting-rod”, *Modelling, Simulation and Control, B, AMSE Press*, Vol. 24, No. 3, pp.49-63.

[3] Mukesh Kumar, Veerendra Kumar” Finite Element Analysis of I.C Engine Connecting Rod: A Review”,*International Journal Of Engineering Sciences & Research Technology July, 2014*

[4] Kuldeep B, Arun L.R, Mohammed Faheem “Analysis and optimization of Connecting rod using Alfasic Composites”,International Journal of Innovative Research in Science, Engineering and Technology;*Vol. 2, Issue 6, June 2013*

[5] Abhinavgautam, K Priya Ajit “Static Stress Analysis of Connecting Rod Using FEA Approach”, *Journal of Mechanical and Civil Engineering (IOSR-JMCE) Volume 10, Issue 1 (Nov. - Dec. 2013)*

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