



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 4, April 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

 ijrset@gmail.com

 www.ijrset.com

A Comparative Structural Analysis Study of Connecting rod of IC Engine for Four Different Materials

Mr. Sachin Bandgar¹, Mr. Bharat Kharad²

Department of Mechanical Engineering, VA's College of Engineering, Ahmednagar, India¹

Assistant Professor, Department of Mechanical Engineering, VA's College of Engineering, Ahmednagar, India²

ABSTRACT: The connecting rod is a major link inside of combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft. It has to work on high r.p.m. because of which it has to bear severe stresses which make its design vital for internal combustion engine. Connecting rod, automotive should be lighter and lighter, should consume less fuel and at the same time they should provide comfort and safety to passengers, that unfortunately leads to increase in weight of the vehicle. This tendency in vehicle construction led the invention and implementation of quite new materials which are light and meet design requirements. Lighter connecting rods help to decrease lead caused by forces of inertia in engine as it does not require big balancing weight on crankshaft. The four materials are selected for the study after thorough literature study. The four materials are AISI 1040, AISI 4140, Al 6061 and composite material Silicon carbide reinforced zirconium diboride (SiC ZrB₂). The mechanical properties tensile strength, % elongation and the micro hardness are experimentally evaluated. The experimental results of tensile testing are validated using software package of ANSYS.

KEYWORDS: Connecting Rod, IC engine, Tensile strength

I. INTRODUCTION

The automobile engine connecting rod is a high-volume production critical component. It connects reciprocating piston to rotating crankshaft, transmitting the thrust of piston to the crankshaft. A combination of axial and bending stresses acts on the rod in operation. The axial stresses are produced due to cylinder gas pressure (compressive only) and the inertia force arising in account of reciprocating action (both tensile as well as compressive), whereas bending stresses are caused due to the centrifugal effects. To provide maximum rigidity with minimum weight the main cross section of the connecting rod is made an I-section is made to blend smoothly into two rod ends called the small end (piston end) and big end (crank end).

The aim of this paper is to analyse Mechanical properties of four suggested materials for connecting rod as per literature review. The structural analysis like Total deformation, Equivalent elastic strain and Equivalent Von mises stresses are evaluated using ANSYS package and analysed for suitable material of connecting rod.

Table 1: Mechanical properties of materials

Sr.no	Properties	AISI 1040	AISI 4140	Al 6061	Silicon Carbide reinforced Zirconium diboride (SiC ZrB ₂)	Units
1	Density	7800	7800	2700	2060	Kg/m ³
2	Tensile strength	620	655	290	1070	Mpa
3	Yield strength	415	415	276	930	Mpa
4	Youngs modulus	210	210	68.9	486	Gpa
5	% Elongation	25	27	17	20	
6	Hardness	93	153	58	90	HRC

II. EXPERIMENTAL PROCEDURE

150 CC four stroke air cooled IC engine considered for study. I section is considered as cross section of connecting rod.

Engine type air cooled 4-stroke
 Bore × Stroke (mm) = 57×58.6
 Displacement = 149.5CC
 Maximum Power = 13.8bhp at 8500rpm Maximum
 Torque = 13.4Nm at 6000rpm
 Compression Ratio = 9.35/1
 From gas equation, P ~ 16 MPA.

- Density of petrol at 288.855 K - $737.22 \times 10^{-9} \text{ kg/mm}^3$
- Molecular weight M - 114.228 g/mole
- Ideal gas constant R – 8.3143 J/mol.k

The corresponding I section dimensions are calculated by referring standard reference book. 3D Model of connecting rod was drawn in Autodesk fusion 360 software.



Fig. 2.1 3D Model of Connecting rod in Autodesk fusion 360

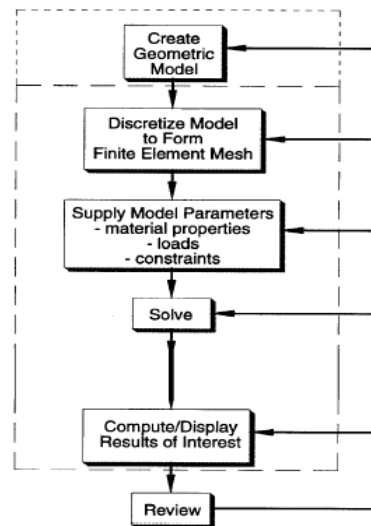



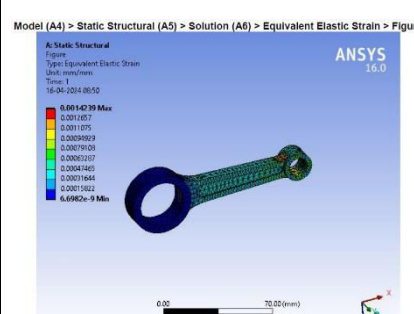
Fig. 2.2 Overall steps in FEA Solution

III. RESULTS

3.1 Structural Analysis of the Connecting Rod:

Structural analysis is the most important application of the finite element method as it provides valuable mechanical properties for design and analyze purpose. The structural analysis process for the connecting rod has been carried out for the push and pulling action named as the tension and compression process. The considered four materials are evaluated in Ansys and total deformation, equivalent strain and equivalent stress has been analyzed.

Table 2: Ansys analysis of four materials

Material	Total Deformation	Von mises stresses	Equivalent elastic strain
AISI 1040			

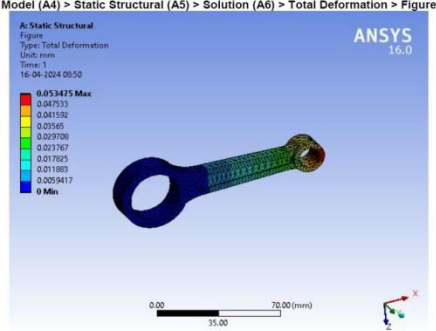
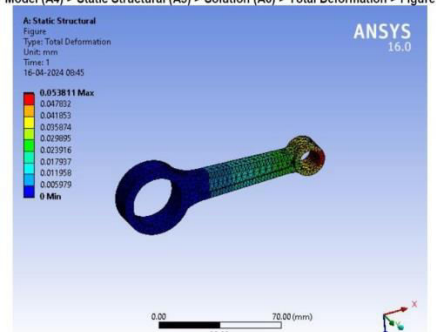
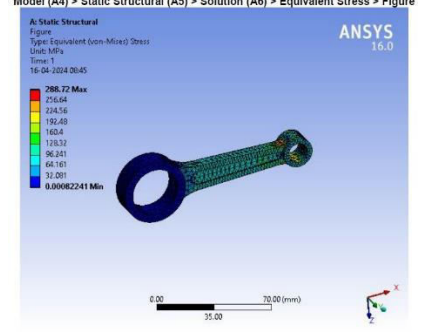
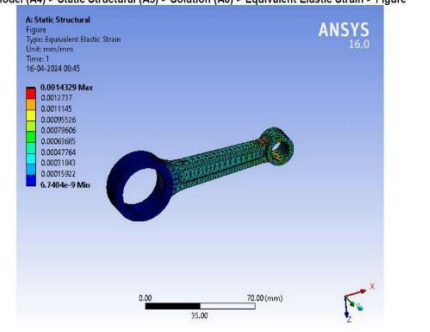
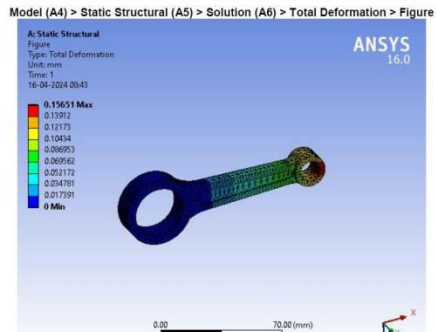

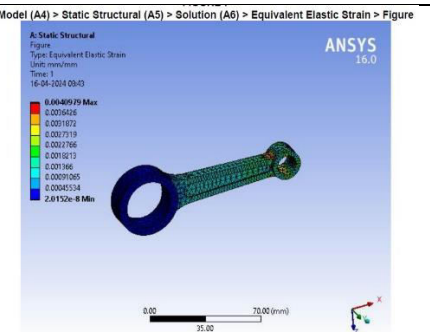
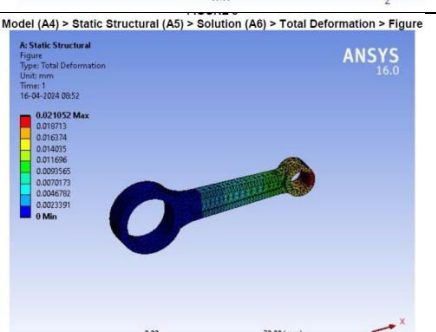
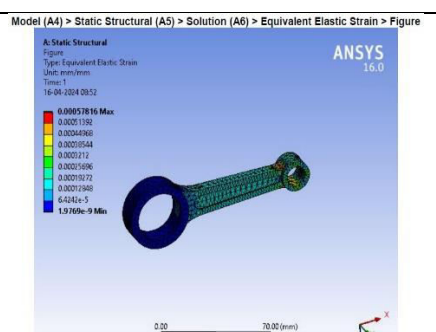
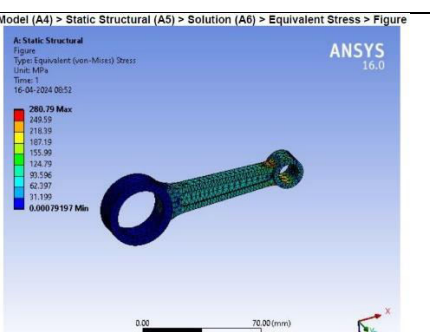
	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure</p> 		
AISI 4140	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain > Figure</p> 
Al 6061	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain > Figure</p> 
SiC ZrB2	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Total Deformation > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Elastic Strain > Figure</p> 	<p>Model (A4) > Static Structural (A5) > Solution (A6) > Equivalent Stress > Figure</p> 

Table 3: Comparative table of four materials

Sr. No	Material	Mass (Kg)	Deformation (mm)	Max. principal Strain (N/mm ²)	Misses Stress (N/mm ²)
1	AISI 1040	0.132	0.053475	1.42E-03	286.92
2	AISI 4140	0.131	0.053811	1.43E-03	288.72
3	Al Alloy (6061 T6)	0.0453	0.15651	4.10E-03	282.21
4	Composite (SiC Reinforced ZrB ₂)	0.034546	0.005009	5.78E-04	280.79

IV. CONCLUSION

- In this study, we have calculated pressure value for a connecting rod used in a 150cc bike. We have modelled the connecting rod by using 3D parametric software Autodesk fusion 360.
- We have done analysis on four different most considered materials AISI 1040, AISI 4140, Al 6061 and composite material Silicon carbide reinforced zirconium diboride (SiC ZrB₂). To validate the UTM results, we have evaluated structural analysis on the connecting rod
- By analysing the results getting by the ANSYS software, the SiC reinforced ZrB₂ has the minimum deformation, von mises stress and equivalent elastic strain. So the SiCreinforced ZrB₂ is better than other three materials.

REFERENCES

1. Pushpendra Kumar Sharma¹, BorseRajendra R, "fatigue analysis and optimisation of connecting rod using finite element analysis", International Journal Of advance researchin Science and Engineering, Vol. No.1, Issue No. I, pp-3367- 3371, September 2012.
2. Ram Bansal, "Dynamic simulation of connecting rod made of aluminium alloy using finite element analysis approach", IOSR Journal of Mechanical and Civil Engineering, Volume5, Issue 2, PP 01-05, Jan. - Feb. 2013
3. Pravardhan S. Shenoy, Ali Fatemi (2005) "Connecting Rod Optimization for Weight and Cost Reduction." SAE InternationalJournal
4. Athavale S. and Sajanpawar, P. R., (1991), "Studies on Some Modeling Aspects in the Finite Element Analysis of Small Gasoline Engine Components," Small Engine Technology Conference Proceedings, Society of Automotive Engineers of Japan, Tokyo, pp. 379-389
5. Webster, W., D.Coffell R., and Alfaro D.,(1983),"A Three Dimensional Finite Element Analysis of a High Speed Diesel Engine Connecting Rod," SAE Technical Paper Series, Paper No. 831322
6. Hippoliti, R., 1993, "FEM method for design and optimization of connecting rods for small two-stroke engines," *Small Engine Technology Conference*, pp. 217-231.
7. Balasubramaniam, B., Svoboda, M., and Bauer, W., 1991, "Structural optimization of I.C. engines subjected to mechanical and thermal loads," *Computer Methods in Applied Mechanics and Engineering*, Vol. 89, pp. 337-360



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details