INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

(Volume1, Issue 2)

ANALYSIS OF CONNECTING ROD USING Ti-6Al-4V, STEEL AND Al-LM6 COMPOSITES

Corresponding Author: Er. Sahil Guleria, Er. Harpreet Singh, sguleria37@gmail.com , harpreetrbcebtw@gmail.com

Rayat and Bahra Institute of Engineering and Bio-Technology, Department of mechanical Engineering (P.b), Mohali

ABSTRACT

Now days the light weight composite materials are widely used in engineering field. The composite materials has good characteristic of wear resistance, hardness and tensile strength. Due to less weight and good strength the composite materials plays a vital role in engineering field. Connecting rods can be made of composite material. The automobile engine connecting rod is a high volume production, critical component. It connects reciprocating piston to rotating crankshaft, transmitting the thrust of the piston to the crankshaft. Every vehicle that uses an internal combustion engine requires at least one connecting rod. It is subjected to multiple compressive & tensile forces generated by fuel combustion. The high magnitude of force is responsible for many kinds of failure. These failures need to be prevented & for this purpose analysis needed to be done. This study considers the case of static load stress analysis of the connecting rod. The model was developed in CATIA V5 R17 software, and then imported to ANSYS workbench. Using ANSYS workbench, model was analyzed for various stresses by applying suitable boundary conditions. Various parameters like equivalent stress, maximum shear stress, maximum and minimum principal stress and factor of safety are analyzed. Three materials were analyzed based upon their factor of safety viz., Structural Steel & Al-LM6 and Ti-6Al-4V. Ti-6Al-4V being light in weight having more yield strength and good safety factor became the best suitable material.

KEYWORDS: ANSYS Workbench, Connecting Rod, FEA, Von- mises stress, Stress Analysis

1. INTRODUCTION

The automobile engine connecting rod is a high volume production critical component. It connects reciprocating piston to rotating crankshaft and transmits the thrust of piston to the crankshaft. And thus, it converts the linear, reciprocating motion of a piston into the rotary motion of a crankshaft. Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine. Because of limitation of strength of material there are chances of permanent deformation & hence failure in case of high loads. Combustion in I.C. engine produces very high load which transmits to crankshaft via connecting rod. So connecting rod is susceptible to many stresses including equivalent, shear, etc. also fatigue failure is possible because of frequent alternate loading & change of direction. Forces acting on the connecting rod are:

- Forces on the piston due to gas pressure and inertia of the reciprocating parts.
- Force due to inertia of the connecting or inertia bending forces.
- Force due to friction of the piston rings and of the piston, and
- Forces due to friction of the piston pin bearing and crank pin bearing.

2. MODELLING AND ANALYSIS

The connecting rod is designed of I-section to provide the highest possible rigidity at the lowest weight. So, firstly a proper Finite Element Model is developed using CATIA V5 R17 software. Then using Finite Element Analysis software ANSYS, analysis is done to determine the stresses in the existing connecting rod for the given loading conditions. Various parameters like equivalent stress, maximum shear stress, maximum and minimum principal stress and factor of safety are analyzed. Boundary conditions for connecting rod are chosen such that critical case can be observed and studied. Two cases are analyzed, First for compression and then for tension. In the first case, compression pressure of 64.28MPa applied on the connecting rod at the pin end, and cylindrical support is given at the crank end. Compression pressure of 34.29MPa is applied on crank end, other end is fixed. In the second case, tension pressure of 70.88MPa applied at the pin end, other end is fixed. Tension pressure of 37.81MPa applied at the crank end, other end is fixed.

2.1 MESHING OF CONNECTING ROD

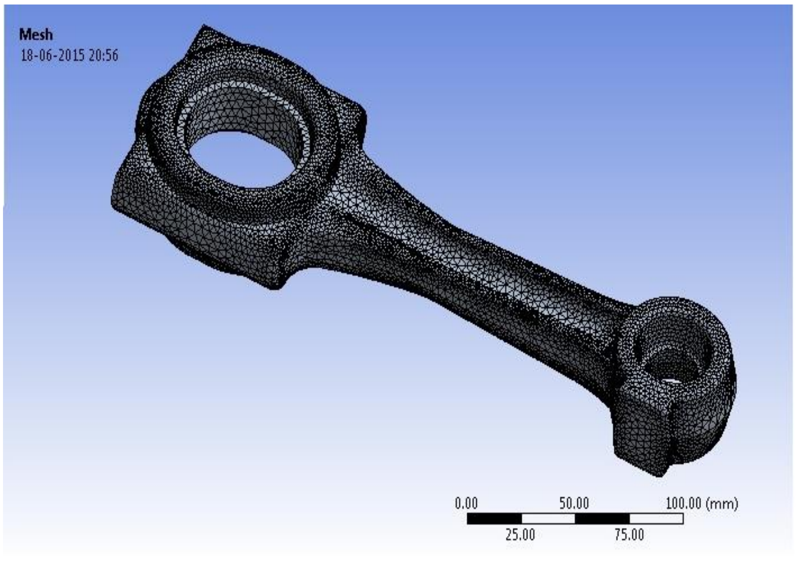

Figure 2.1: Meshed Model of Connecting Rod

2.2 PROPERTIES

Property	Structural Steel	AL-LM6	Ti-6Al-4V
Density	7.85e-006 kg m^-3	2600 kg m^-3	4430 kg m^-3
Coefficient of Thermal Expansion	12×10^{-6} (m/m°C)	22.2×10^{-6}(m/m°C)	8.6×10^{-6}(m/m°C)
Young's Modulus (MPa)	2.e+011	7.e+010	1.138e+05
Compressive Yield Strength (MPa	250	230	970
Tensile Yield Strength (MPa)	250	240	880
Tensile Ultimate Strength(MPa)	460	107	950

Table 2.1: Properties of various materials

3. RESULTS AND DISCUSSIONS

- EQUIVALENT STRESS

Equivalent Stresses are minimum at both the ends and nearly same for all three materials.

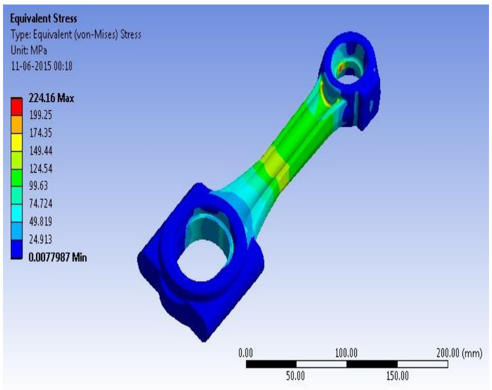

Figure 3.1: (a) (Ti-6Al-4V)

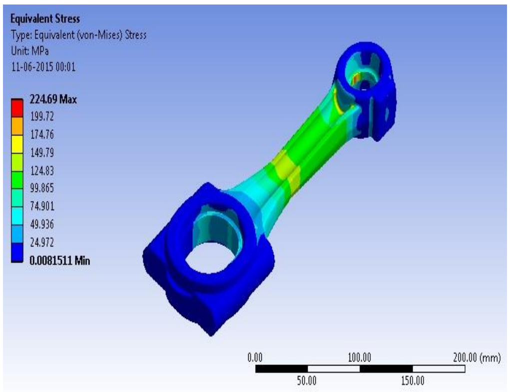

Figure 3.1: (b) Al- Lm6

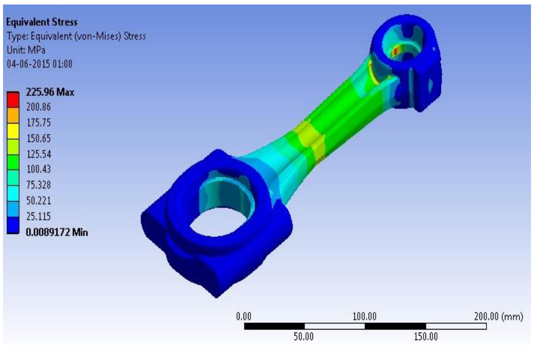

Figure 3.1: (c) Structured steel

- MAXIMUM SHEAR STRESS

Maximum Shear stresses remain nearly same for all three materials

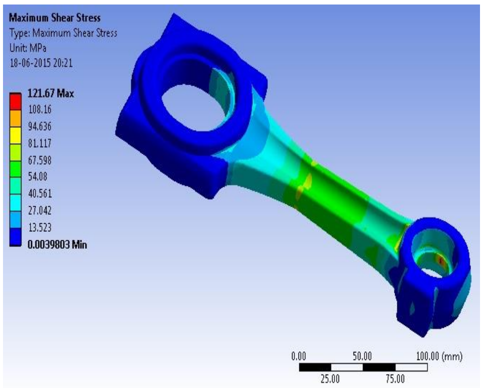

Figure 3.2: (a) (Ti-6Al-4V)

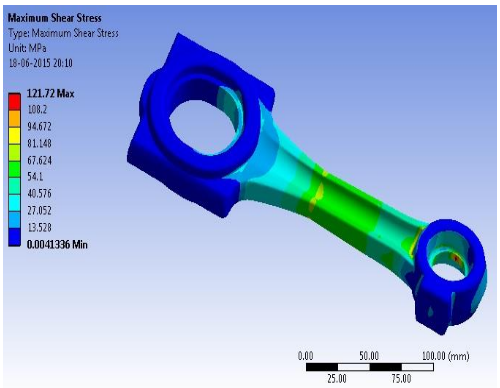

Figure 3.2: (b) Al- Lm6

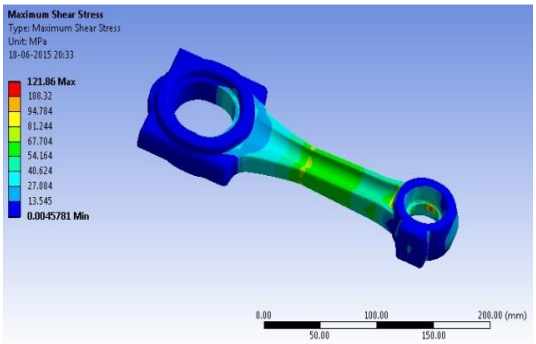

Figure 3.2: (c) Structured steel

- MAXIMUM PRINCIPAL STRESS

  Maximum Principal Stress is found out by finite element method analysis. Distribution of stress at connecting rod is very less as can be seen in figure.

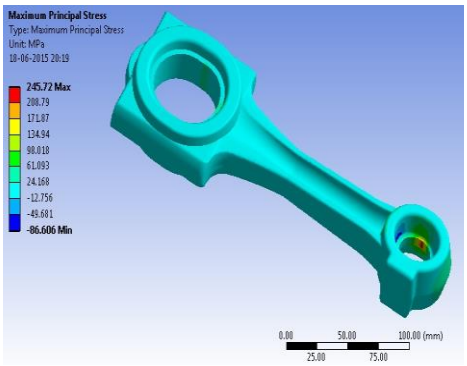

Figure 3.3: (a) (Ti-6Al-4V)

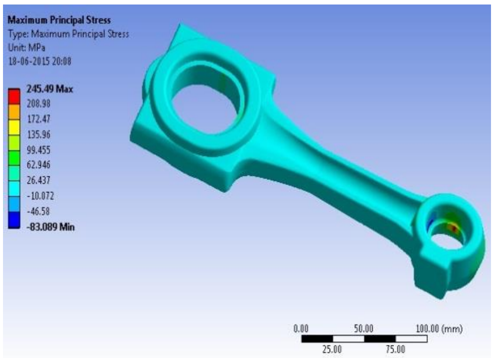

Figure 3.3: (b) Al- Lm6

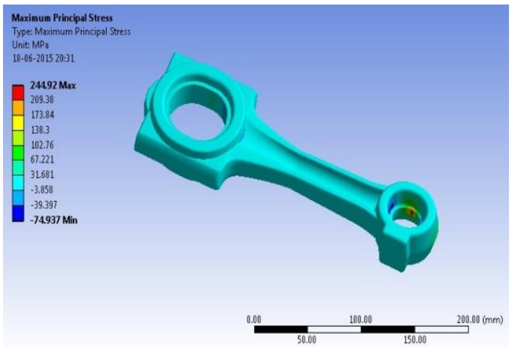

Figure 3.3: (c) Structured steel

- MINIMUM PRINCIPAL STRESS

Contours of Minimum principal stress can be seen in figure. Stresses are within design limits.

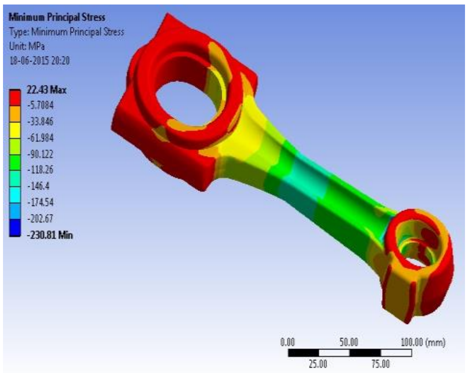

Figure 3.4: (a) (Ti-6Al-4V)

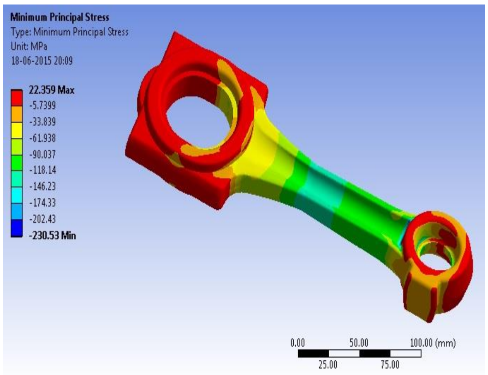

Figure 3.4: (b) Al- Lm6

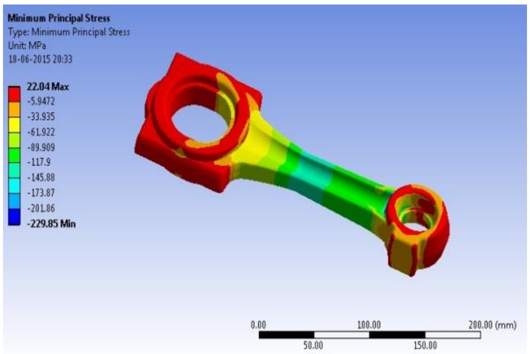

Figure 3.4: (c) Structured steel

- SAFETY FACTOR

Safety factor as can be seen in figure for titanium (Ti-6Al-4V) which is 3.9258 means design is much stronger than other two composite materials.

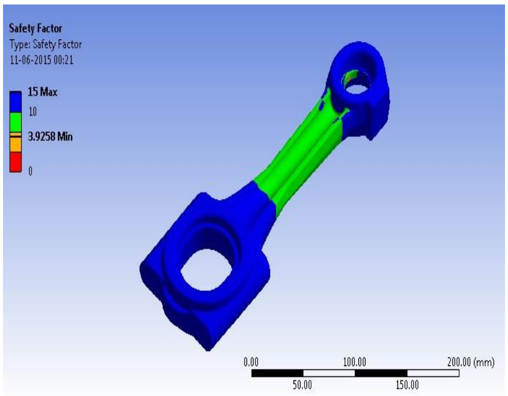

Figure 3.5: (a) (Ti-6Al-4V)

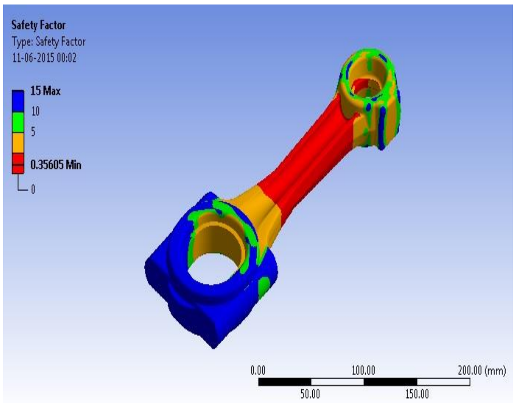

Figure 3.5: (b) Al- Lm6

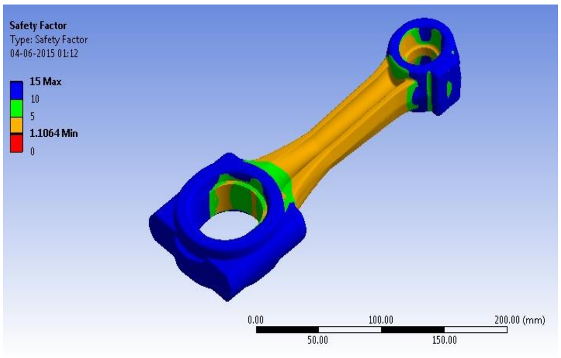

Figure 3.5: (c) Structured steel

3.1 RESULTS FOR STATIC LOADING

Parameter	Ti-6Al-4V		Al -lm6		Structural Steel	
	Min	Max	Min	Max	Min	Max
Equivalent stress(MPa)	0.0077987	224.16	0.0081511	224.69	0.0089172	225.96
Maximum Shear stress(MPa)	0.0039803	121.67	0.0041336	121.72	0.0045781	121.86
Maximum principal stress(MPa)	-86.606	245.72	-83.089	245.49	-74.937	244.92
Minimum principal stress(MPa)	-230.81	22.43	-230.54	22.359	-229.85	22.04

Table 3.1: Maximum and Minimum Values of Stress Parameters

3.2 FATIGUE TOOL RESULTS

Parameter	Ti-6Al-4V		Al-lm6		Structural Steel	
Safety Factor	Min	Max	Min	Max	Min	Max
	3.9258	15	0.35605	15	1.1064	15

Table 3.2: Maximum and Minimum Values of safety factor

4. CONCLUSIONS

- Factor of safety for Ti-6Al-4V is more as compared to other two composite materials, means that design is much stronger.
- The analysis performed in this study gave scope for optimization. Analysis of different parameters has suggested modification in existing connecting rod.
- From the analysis we came to know that composite material can be a best alternate of conventional structural steel connecting rod due to light weight.
- The maximum stresses occurred in static structural analysis are less than the yield strength of material. Hence the design is safe.

REFERENCES

1. A. Mirehei, M. HedayatiZadeh, A. Jafari, M. Omid "*Fatigue analysis of connecting rod of universal tractor through finite element method*", Journal of Agricultural Technology, V.4 (2), May 2008.

2. Arshad Mohamed Gani P, VinithraBanu T "*Design and Analysis of Metal Matrix Composite Connecting Rod*" , International Journal of Engineering Research and General Science Volume 3, Issue 2, March- April, 2015

3. Christy V Vazhappilly, P.Sathiamurthi "*Stress Analysis of Connecting Rod for Weight Reduction-A Review",* International Journal of Scientific and Research Publications, Volume 3, Issue 2, February 2013.

4. Mohd Nawajish, Mohd Naimuddin, Mayank "*A comparative study and analysis of connecting rod",* International Journal of Engineering Technology, Management and Applied Sciences, Volume 3 Special Issue, March 2015

5. Om Parkash, Vikas Gupta, Vinod Mittal "*Optimizing the Design of Connecting Rod under Static and Fatigue Loading",* International Journal of Research in Management, Science & Technology, Vol. 1; No. 1, June 2013

6. Prof. P. K. Sharma, Borse R. R. *"Fatigue analysis and optimization of connecting rod using Finite Element Analysis",* International Journal Of advance research in Science and Engineering, (IJARSE), Vol. No.1, Issue No. I, 2012.

7. R A Savanoor, Abhishek Patil, Rakesh Patil and Amit Rodagi "*finite element analysis of IC engine connecting rod by ansys",* International journal of mechanical engineering and robotic research, Vol. 3, No. 3, July 2014.

8. Ansys workbench 14.0

9. CATIA V5

10. Sharma P.C. and Dr. Aggarwal D. K. *"Books of machine Design".*

