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Design and FE Analysis of a connecting rod with different materials

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ABSTRACT

In this paper study the structural analysis is carried out on a connecting rod consists of carbon steel (CS), Aluminium 6061(Al 6061) and Aluminium 6061with boron carbide (Al+B_4C) to investigate and compare the performance of connecting rod. A 3D model of petrol engine connecting rod is created using Pro-E software and FE analysis is performed to obtain the variation of deformation, elastic strain, vonmisses stresses under various static and dynamic loads along with boundary conditions. From the results it has been observed that Aluminium 6061(Al 6061) alloy has given better performance in terms of factor of safety (FOS), reduced light weight and minimized the stresses as compared to other materials.

Keywords: Connecting rod, Forged steel, Composite material, FE ANSYS, Stresses, strain, Deformation.

1. Introduction

Connecting rod has two ends one is pin end and other is crank end. Pin end is attached with piston. The big end (crank end) is attached to the crank pin by a crankshaft. The connecting rod should be such that it can sustain the maximum load without any failure during high cycle fatigue. The connecting rod has generally three parts; pin end, crank end, and long shank. H D. Nitturkar et.al [1] investigated on structural analysis of connecting rod is considered for various materials i.e. magnesium alloy, titanium alloy, aluminium360, beryllium alloy 25 to determine the eqvilaent Vonmises stresses, deformation and strain of two wheeler piston. Also, aluminium alloy can be enhanced the best properties such as more F.O.S, reduce the stress, weight and stiffer than other materials. Atharuddin et.al [2] studied effect of various loads, stresses, strain, F.O.S and deformation of aluminium alloy connecting rod to replace the aluminum connecting rod by using FE ANSYS. Kumar et.al [3] studied about FE analysis of connecting rod is done by considering the Aluminium Alloy can be to decrease the weight, stress and stiffer compared to forged steel. Antony.S et.al [4] investigated on a connecting rod to determine the Vonmises stress distribution due to the action applied force. R.Anand et.al [5] investigated on connecting rod consists of Aluminium and forged steel to obtain the thermal stress distribution can be analyzed by using FE ANSYS. Wankhade.N.A et.al [6] investigated to design and analyzes the connecting rod used in a diesel engine in context of the lateral bending forces acting along its length during cycle of it. Kumar.S et.al [7] investigated on various materials such as carbon steel 40C8, aluminium 7075-T651 and Al 2014-7651 have been analysed by using ABAQUS. In addition that to determine von Mises stresses maximum and minimum principal stress and displacement at critical points. S.Saxena et.al [8] designing and analysis of Carbon steel connecting rod by using. analytical and FE ANSYS. Krishna.V et.al [9] studied design and FE analysis on the connecting rods having carbon steel, Aluminium 7475 and Ti-6Al-4V materials can be enhanced fatigue life. J. Manikandan et.al [10] investigated on boron carbide and silicon carbide of the connecting rod is used to find the stress distribution by using ANSYS.

2. Physical Properties and Modeling of the connecting rod

The modeling of various materials of the connecting rods designed by using Pro-E software as shown in Fig.2.1(a) After that the modeled part file export to ANSYS workbench, further to open the file in ansys workbench . Finally the meshing size of 5mm and boundary conditions (B.Cs) are applied at the lower end of the connecting rod as shown in Fig 2(b) and 2(c). and their input material properties as shown in Table 2.1.

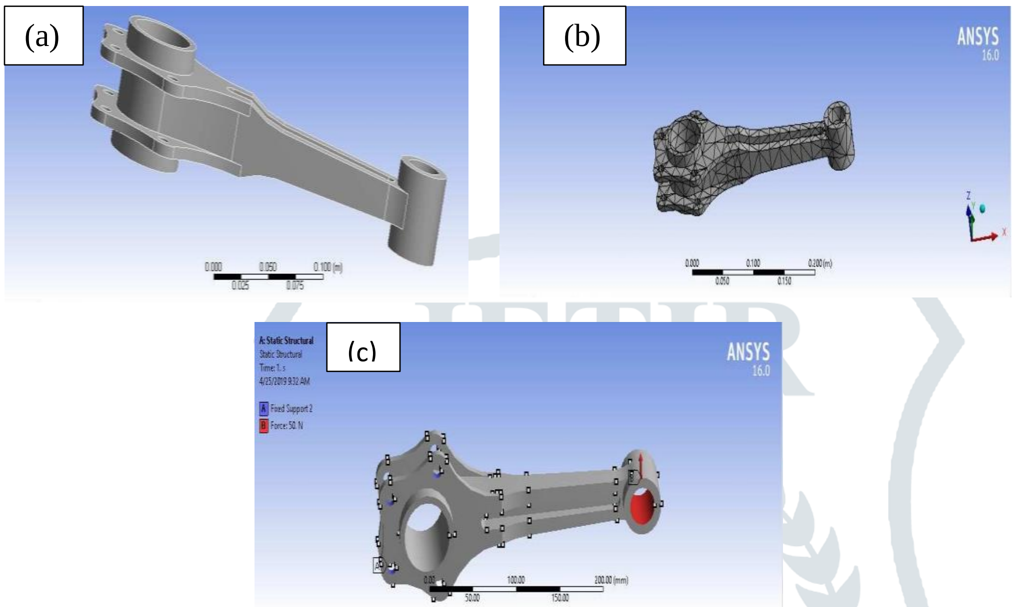

Fig.2.1 (a) Modeling (b) Meshing (c) Boundary conditions

Table 2.1 Material properties of Al 6061, Al6061+B_4C and CS

S.no	Properties	Al 6061	Al6061+B_4C	Carbonsteel
1.	Density(ρ)	2.67	2.69	7.89
2.	Modulus of elasticity (E)	75-85	198-205	205-215
3.	Poisson's ratio (ν)	0.33	0.31	0.28

3. Static analysis of connecting rod

3.1 Carbon steel

A static analysis is used to determine the total deformation, elastic strain and equivalent Vonmises stress are obtaind in the direction of applied force 50 N is applied at the end of the lower end crankshaft, but neglecting the inertia and damping effects**.**The following values obtained from the static analysis of carbon steel are total deformation is 0.0091071mm, equivalent vonmisses stress 0.141 MPa and elastic strain 7.052e-6 respectively as shown in Fig 3.1 to Fig.3.3.

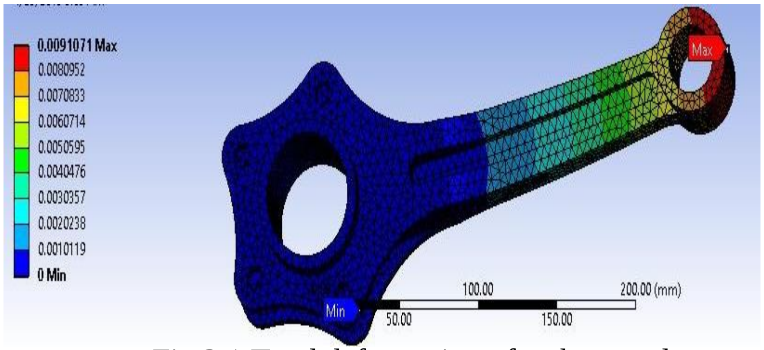

Fig 3.1 Total deformation of carbon steel

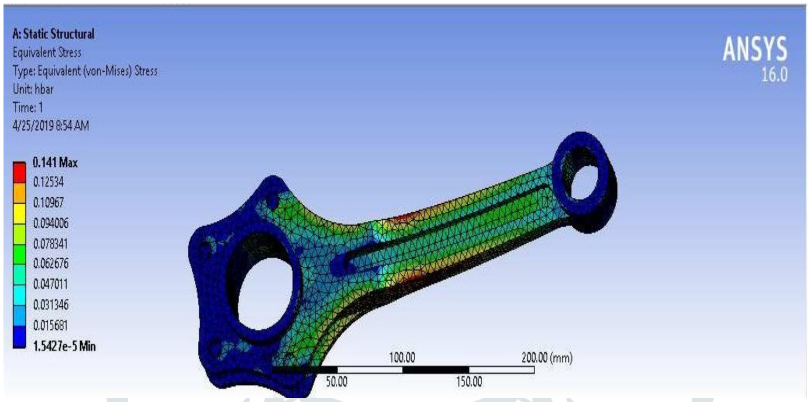

Fig 3.2 Equivalent Von misses stress of carbon steel

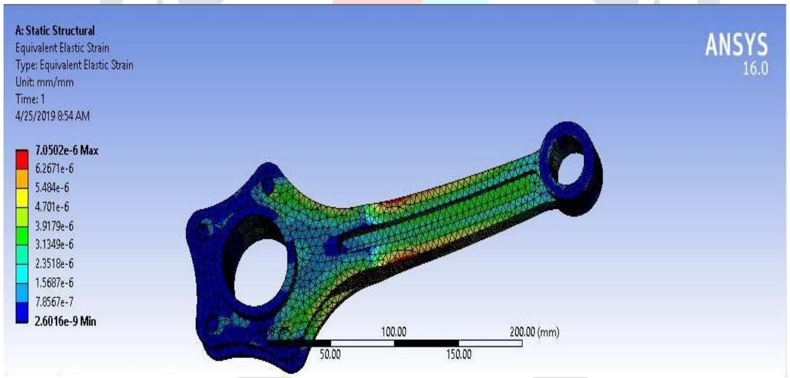

Fig 3.3 Equivalent elastic strain of carbon steel

3.2 Aluminium 6061

The physical mechanical properties of Al 6061 are represented in Table 2.1 A static load applied in the Y- axis direction of applied force -50 N is applied at the end of the connecting rod**.** The following values obtained from the static analysis of carbon steel are total deformation is 0.025761mm, elastic strain 0.10498 and equivalent vonmisses stress 2.014e-5 MPa respectively as shown in Fig 3.4 to Fig.3.6.

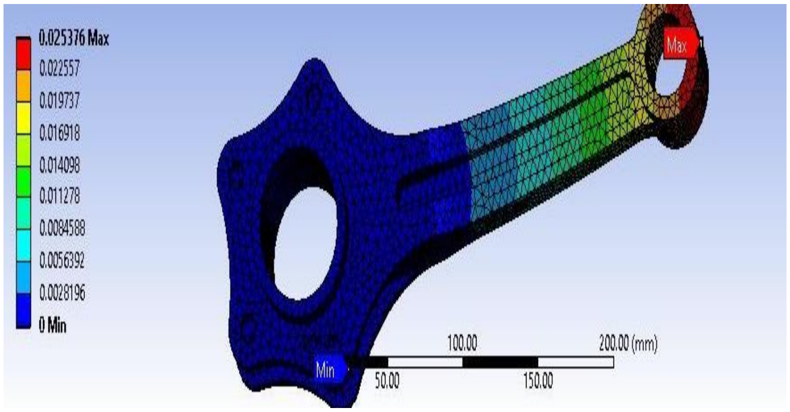

Fig 3.4 Total deformation of Al 6061

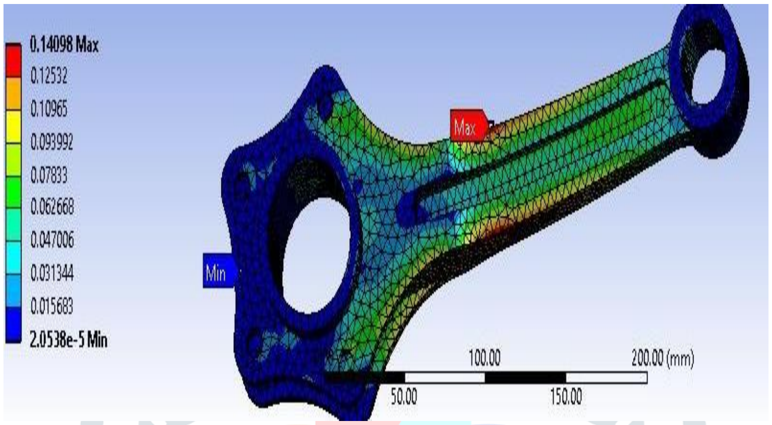

Fig 3.5 Equivalent elastic strain of Al 6061

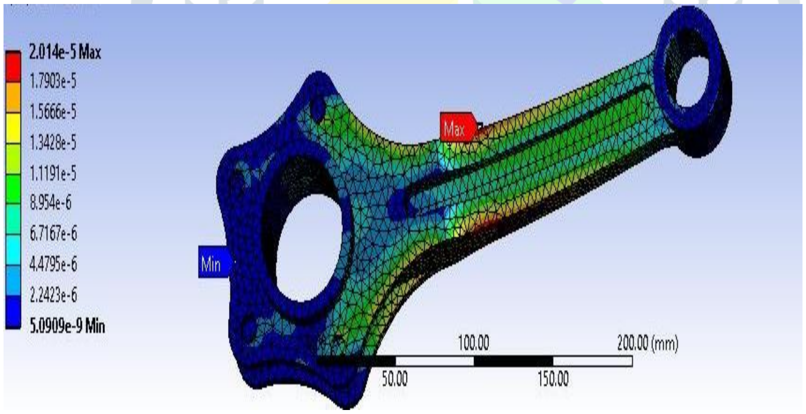

Fig 3.6 Equivalent Von misses stress of Al 6061

3.3 Aluminium 6061 +Boron carbide (B_4C)

The physical mechanical properties of Al 6061with Boron carbide (B_4C) are represented in Table 2.1 A static load applied in the Y- axis direction of applied force -50 N is applied at the end of the connecting rod**.** The following values obtained from the static analysis of Al 6061 steel + B_4C are total deformation is 0.008718mm, elastic strain 0.10498 and equivalent vonmisses stress 2.014e-5 MPa respectively as shown in Fig 3.7 to Fig.3.9.

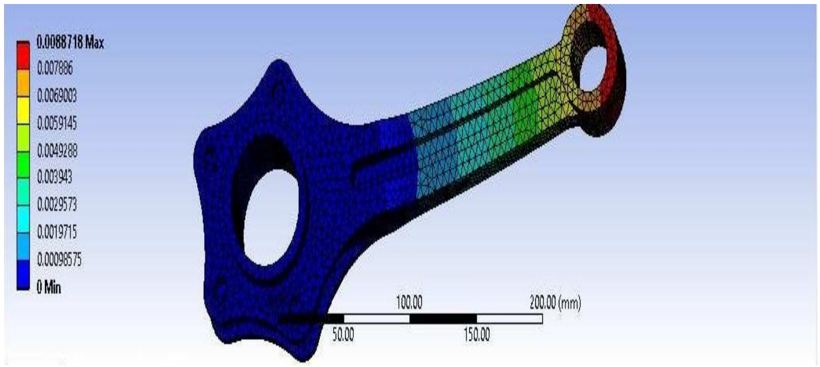

Fig 3.7 Total deformation of Al 6061 + B_4C

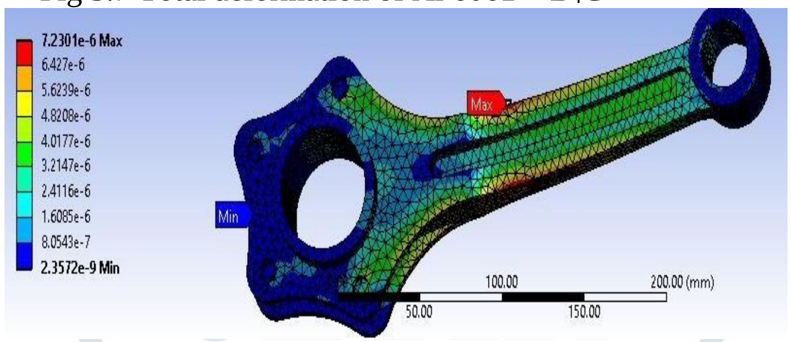

Fig 3.8 Equivalent elastic strain of Al 6061 + B_4C

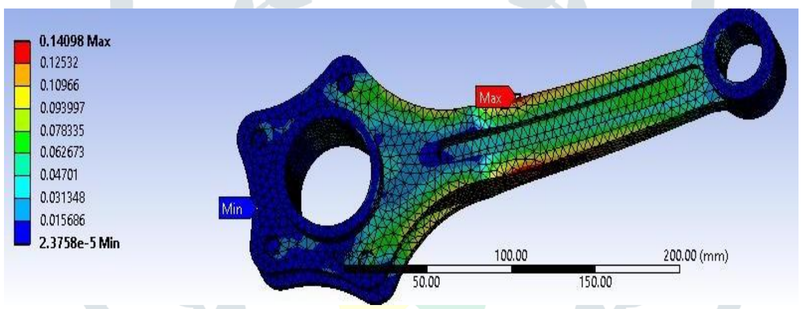

Fig 3.9 Equivalent Von misses stress of Al 6061 + B_4C

Table 3.1 Comparison of Deformation, Elastic strain and Von misses stress

Type of material	Total deformation (mm)		Equivalent elastic strain		Equivalent Von misses stress (MPa)	
	Min	Max	Min	Max	Min	Max
Carbon steel	0	0.009107	1.5427e-5	0.141	2.6016e-9	7.0502e-6
Al 6061	0	0.025376	20538e-5	0.14098	5.0909e-9	2.014e-5
Al 6061+B_4C	0	0.008871	2.3572e-9	7.2301e-6	2.3758e-5	0.14908

4.Conclusion

In this paper the following conclusions are drawn as shown in below:

- Analytical calculations of I-section connecting rod made of Al 6061, CS and Al 6061 +B_4C materials are used to design the connecting rod.
- Three dimensional modeled of connecting rod made up of Al 6061, CS and Al 6061 +B_4C materials created by using Pro-E software as per ASME standards.
- The values obtained from the FE analysis of carbon steel are total deformation is 0.0091071mm,

Equivalent Vonmisses stress 0.141 MPa and elastic strain 7.052e-6 respectively.

- The values obtained from the FE analysis of carbon steel are total deformation is 0.025761mm, elastic strain 0.10498 and equivalent vonmisses stress 2.014e-5 MPa respectively.
- The values obtained from the FE analysis of Al 6061 steel + B_4C are total deformation is 0.008718mm, elastic strain 0.10498 and equivalent vonmisses stress 2.014e-5 MPa respectively.
- Al 6061 alloy gives the better performance in terms of FOS, weight, stiffness, deformation, minimized stress and strain as compared to other materials

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