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DESIGN & ANALYSIS OF CONNECTING ROD BY COMPOSITE MATERIAL

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Abstract**—** Connecting rod is one of the important components of the whole engine assembly as it acts as a mediator between piston assembly and crankshaft. Its converting the reciprocating motion of the piston to rotary motion of the crank. Also it faces a lot of tensile and compressive loads during its life time. Generally connecting rods are manufactured using carbon steel and in recent days aluminium alloys are finding its application in connecting rod. In this work connecting rod is replaced by aluminium based composite material reinforced with Boron carbide. And it also describes the modelling and analysis of connecting rod. Pro-e solid modeling software is used to generate the 3-D solid model of Connecting rod. Ansys software is used to analyze the connecting rod. The main aim of the project is to analysis the stress, strain, deformation of connecting rod by varying material with same geometry.

Keywords**—** connecting rod, ANSYS, composite, boron carbide, analysis

I. INTRODUCTION

A Connecting rod is the link between the reciprocating piston and rotating crank shaft. Small end of the connecting rod is connected to the piston by means of gudgeon pin. The big end of the connecting rod is connected to the crankshaft.

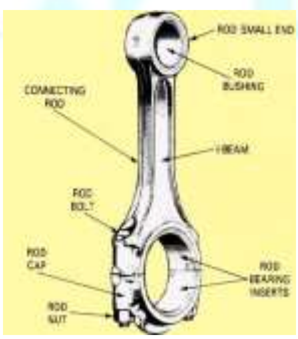

Fig.1.General diagram

A typical connecting rod is shown in fig 1. A combination of axial and bending stresses act on the rod in operation. The axial stresses are product due to cylinder gas pressure and the inertia force arising on account of reciprocating motion.

Whereas bending stresses are caused due to the centrifugal effects. To provide the maximum rigidity with minimum weight, the cross section of the connecting rod is made as and I – section end of the rod is a solid eye or a split eye this end holding the piston pin.

The big end works on the crank pin and is always split. In some connecting rods, a hole is drilled between two ends for carrying lubricating oil from the big end to the small end for lubrication of piston and the piston pin.

II. LITERATURE REVIEW

Kuldeep B "Analysis and optimization of connecting rod using Alfasic composites". This research is motivated by the responsible to transmit the push and pull from the piston pin to crank pin, thus converting the reciprocating motion of the piston to rotary motion of the crank. Generally connecting rods are manufactured using carbon steel and in recent days aluminium alloys are finding its application in connecting rod.

In this work connecting rod is replaced by aluminium based composite material reinforced with silicon carbide and fly ash. And it also describes the modelling and analysis of connecting rod. FEA analysis was carried out by considering two materials. The parameters like von misses stress, von misses strain and displacement were obtained from ANSYS software. Compared to the former material the new material found to have less weight and better stiffness. It resulted in reduction of 43.48% of weight, with 75% reduction in displacement.

Prof. N.P.Doshi "Analysis of Connecting Rod Using Analytical and Finite Element Method". The connecting rod is a major link inside of a combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft and sending it to the transmission. The most common types of materials used for connecting rods are steel and aluminum.

Connecting rods are widely used in variety of engines such as, in-line engines, V-engine, opposed cylinder engines, radial engines and oppose-piston engines. For the project work we have selected connecting rod used in light commercial vehicle of tata motors had recently been launched in the market.

We found out the stresses developed in connecting rod under static loading with different loading conditions of compression and tension at crank end and pin end of connecting rod. Design of connecting rod which is designed by machine design approach is compared with actual production drawing of connecting rod. We found that there is possibility of further reduction in mass of connecting rod.

S. Venkatesh "Design and Analysis of Connecting Rod with Modified Materials and FEA Analysis‖ The main objective is to reduce the weight of connecting rod by replacing steel with aluminium fly ash composite material without losing any of its strength and hardness. Experimental results are obtained from the compressive and tensile tests of connecting rods. Spectrometer test is also performed and the results are found out. It is found that by using aluminium fly ash composite material weight is greatly reduced up to 50% without losing any of its strength and hardness. Finally aluminium and steel connecting rods are analyzed with the help of Ansys and the FEA results are compared with the experimental results both the results are give equal value.

III. FORCES ACTING ON THE CONNECTING ROD

1. The combined effect (or joint effect) of,
   a) The pressure on the piston, combined with the inertia of the Reciprocating parts.
   b) The friction of the piston rings, piston, piston rod and the cross head.
2. The longitudinal component of the inertia of the rod.
3. The transverse component of the inertia of the rod.
4. The friction of the two end bearings.

 Axial forces :

Axial forces resulting from gas pressure and inertia of piston assembly modified by the side thrust arrising in consequence of the connecting rod crank angle.

The maximum axial load is compressive (at TDC).

- Tensile stresses occur after firing, due to piston inertia.
- Bending stresses also occur after firing.

 Transverse forces :

Transverse forces Known as whip, are caused by inertia effects of the rod mass. Fortunatly axial & transverse forces do not occur at the same time.

IV. MATERIAL PROPERTIES

Sl. No	Parameters	0ld Material (Al6061)	New Material (Al6061+B_4C)
1	Density (g/cm3)	2.7	2.68
2	Youngs modulus(GPa)	70-80	195
3	Poisson's ratio	0.33	0.32

Table.1.Material properties

V. THEORETICAL CALCULATION OF CONNECTING ROD

1. Pressure calculation:

Consider a 150cc engine 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

- Density of petrol at 288.855 K - 737.22*10-9 kg/mm3
- Molecular weight M - 114.228 g/mole
- Ideal gas constant R – 8.3143 J/mol.k

From gas equation,

PV=m.Rspecific.T

Where, P = Pressure, V = Volume, m = Mass

Rspecific = Specific gas constant

T = Temperature Mass = density * volume m =737.22E-9*150E3 m = 0.11 kg Rspecific = R/M

Rspecific = 8.3143/0.114228

Rspecific = 72.76

P = m.Rspecific.T/V

P = 0.11*72.786*288.85/150E3

P = 15.4177 MPa P ~ 16 MPA.

2. Design calculation of connecting rod:

In general

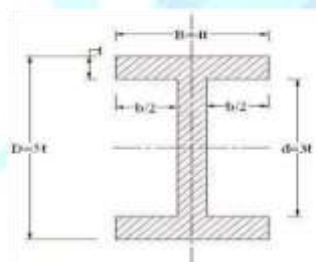

Fig.2. Standard dimensions of I section

1. Thickness of flange and web of the section = t = 2
2. Width of the section B = 4t= 4×2 = 8
3. Height of the section H = 5t = 5×2 = 10
4. Area of the section A = $11t^2$= 11×4 = 44
5. Moment of inertia about x axis Ixx= 34.91t4
   = 34.91×16 = 558.56
6. Moment of inertia about y axis Iyy= 10.91t4
   = 10.91×16= 174.56
7. Therefore Ixx/Iyy = 558.56/174.56 = 3.2

VI. ANALYSIS

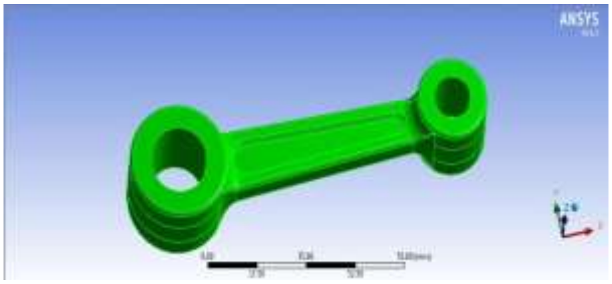

Fig.3. Model of connecting rod

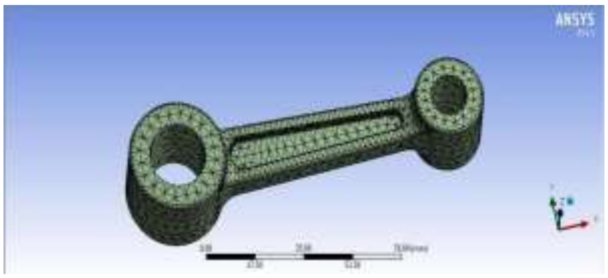

Fig.4. Meshed model of connecting rod

1.Tensile load:

Al6061- Von mises stress:

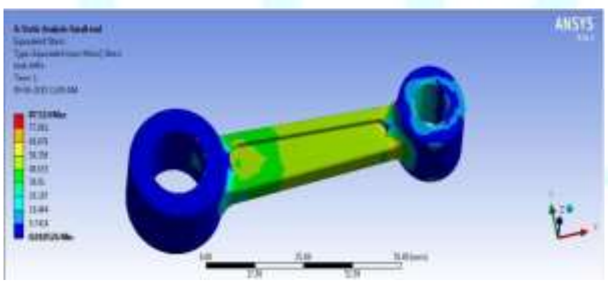

Fig.5. Al6061- Von mises stress

From the fig.5. the maximum stress occurs at the piston end of the connecting rod is 87.524MPa and minimum stress occurs at the crank end of the connecting rod is 0.018526MPa.

Al6061-Total deformation:

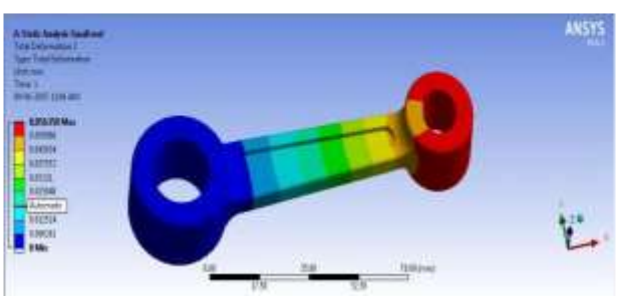

Fig.6. Al6061-Total deformation

From the fig.6. the maximum displacement occurs in the connecting rod is 0.056358mm Al6061- Von mises strain:

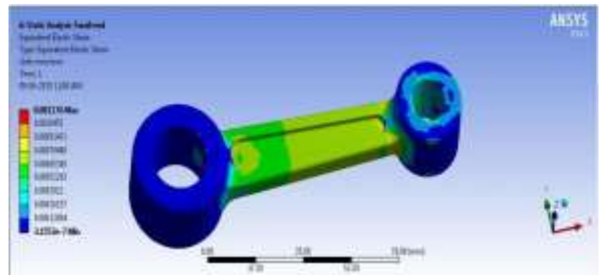

Fig.7.Al6061- Von mises strain

From the fig.7. the maximum Von-mises strain occurs at the piston end of the connecting rod is 0.001176mm and minimum Von-mises strain occurs at the crank end of the connecting rod is 3.1553e-7mm.

Al6061+B_4C - Von mises stress

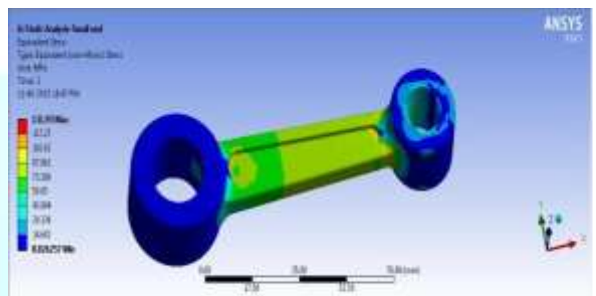

Fig.8. Al6061+B_4C - Von mises stress

From the fig.8. the maximum stress occurs at the piston end of the connecting rod is 131.93MPa and minimum stress occurs at the crank end of the connecting rod is 0.026257MPa.

Al6061+B_4C -Total deformation

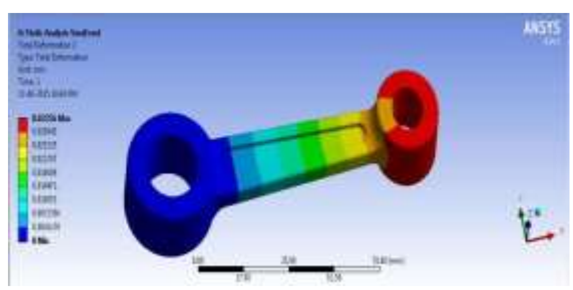

Fig.9. Al6061+B4C -Total deformation

From the fig.9. the maximum displacement occurs in the connecting rod is 0.03256mm

Al6061+B4C - von mises strain:

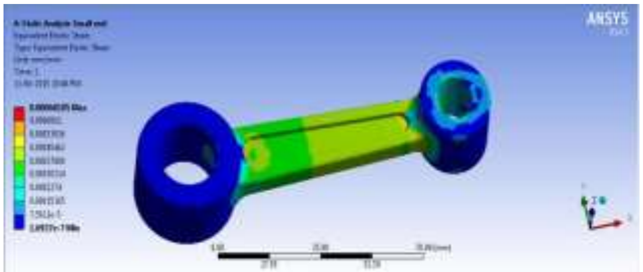

Fig.10.Al6061+B4C - Von mises strain from the fig.10. the maximum von-mises strain occurs at the piston end of the connecting rod is 0.00068185mm and minimum von-mises strain occurs at the crank end of the connecting rod is 1.6927e-7mm.

2.COMPRESSIVE LOAD:

Al6061- Von mises stress:

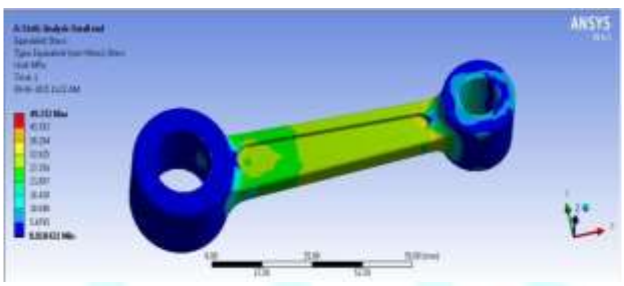

Fig.11.Al6061- von mises stress

From the fig.11. the maximum stress occurs at the piston end of the connecting rod is 49.232MPa and minimum stress occurs at the crank end of the connecting rod is 0.010421MPa.

Al6061-Total deformation:

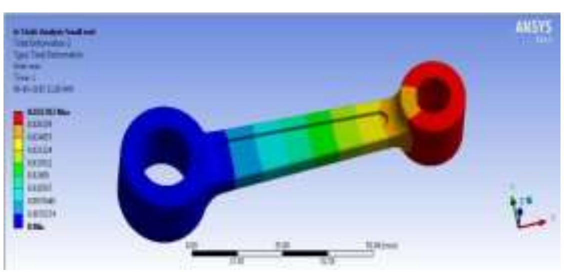

Fig.12.Al6061-Total deformation

From the fig.12. the maximum displacement occurs in the connecting rod is 0.031702mm

Al6061- Von mises strain:

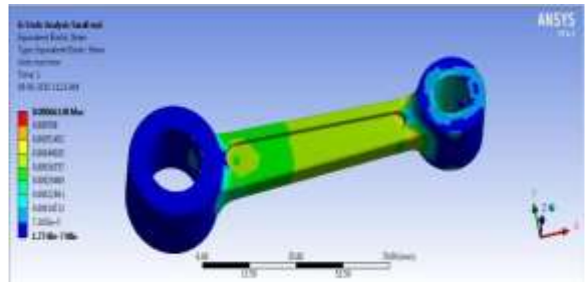

Fig.13.Al6061- Von mises strain

From the fig.13. the maximum Von-mises strain occurs at the piston end of the connecting rod is 0.00066148mm and minimum Von-mises strain occurs at the crank end of the connecting rod is 1.7748e-7mm.

Al6061+B_4C - Von mises stress:

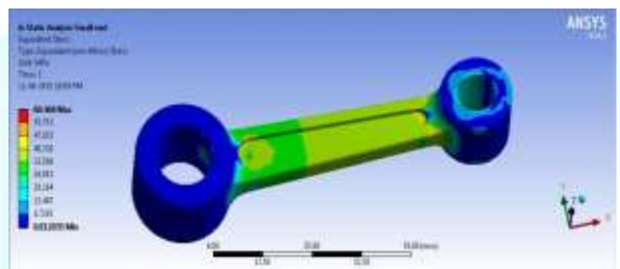

Fig.14. Al6061+B_4C - von mises stress

From the fig.14 the maximum stress occurs at the piston end of the connecting rod is 60.468MPa and minimum stress occurs at the crank end of the connecting rod is 0.012035MPa.

Al6061+B_4C -Total deformation:

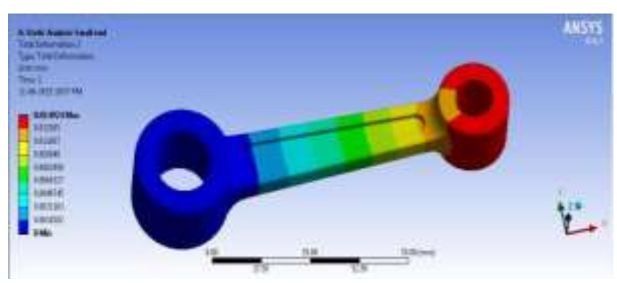

Fig.15. Al6061+B_4C -Total deformation

From the fig.15. the maximum displacement occurs in the connecting rod is 0.014924mm

Al6061+B_4C - von mises strain:

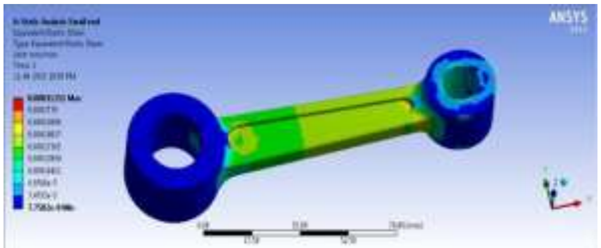

Fig.16.Al6061+B_4C - Von mises strain

From the fig.16. the maximum Von-mises strain occurs at the piston end of the connecting rod is 0.00031251mm and minimum Von-mises strain occurs at the crank end of the connecting rod is 7.7582e-7mm.

VII. RESULT COMPARISON

S. No	Material	Tensile load			Compressive load		
		Stress (MPa)	Displacement (mm)	Strain (mm)	Stress (MPa)	Displacement (mm)	Strain (mm)
1.	Al6061	87.524	0.056358	0.001176	49.232	0.031702	0.00066148
2.	Al6061 + B_4C	131.93	0.03256	0.00068185	60.468	0.014924	0.00031251

Table.2. Result comparison

VIII. CONCLUSION

[1]The present material used for connecting rod Al6061 is high deformation when compare to Al6061+B4C. So Al6061+B4C have low deformation, the result is increasing the life time of the connecting rod.

[2]Al6061 connecting rod has low von mises stress, so the result is low strength. So conclude Al6061+B4C connecting rod has high von mises stress, so it has high strength.

[3]Al6061+B4C connecting rod have low von mises strain, so the result is high hardness.

IX. REFERENCES

[1] K. Sudershan Kumar, Dr. k. Tirupathi Reddy, Syed Altaf Hussan ―Modeling and analysis of two Wheeler connecting rod‖, International Journal of Modern Engineering Research, Vol -2, Issue- 5, pp-3367-3371, Sep-Oct-2012.

[2] Vivek.c.pathade, Bhumeshwar Patle, Ajay N. Ingale ‖Stress Analysis of I.C. Engine Connecting Rod by FEM‖, International Journal of Engineering and Innovative Technology, Vol-1, Issue-3, pp-12-15, March2012.

[3] *Pushpendra Kumar Sharma1, Borse Rajendra R*, ―fatigue analysis and optimisation of connecting rod using finite element analysis‖, International Journal Of advance research in Science and Engineering, Vol. No.1, Issue No. I, pp-33673371, September 2012.

[4] Ram Bansal, ―Dynamic simulation of connecting rod made of aluminium alloy using finite element analysis approach‖, IOSR Journal of Mechanical and Civil Engineering, Volume 5, Issue 2, PP 01-05, Jan. - Feb. 2013.

[5] Ali Fatemi and Mehrdad Zoroufi, ―Fatigue Performance Evaluation of Forged Versus Competing Process Technologies: A Comparative Study‖, 24th Forging Industry Technical Conference, Cleveland, Ohio, 2002.

[6] 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.

[7] El-Sayed, M. E. M., and Lund, E. H., 1990, ―Structural optimization with fatigue life constraints,‖ Engineering Fracture Mechanics, Vol. 37, No. 6, pp. 1149-1156.

[8] Joseph C. Slater, ―Wright Finite Element Method: An easily extensible research-oriented finite element code‖, April 5, 2004.

[9] Pai, C. L., 1996, ―The shape optimization of a connecting rod with fatigue life constraint,‖ Int. J. of Materials and Product Technology, Vol. 11, No. 5-6, pp. 357-370.

[10] Park, H., Ko, Y. S., Jung, S. C., Song, B. T., Jun, Y. H., Lee, and Lim J. D., 2003, ―Development of Fracture Split Steel Connecting Rods,‖ SAE Technical Paper Series, Paper No. 2003-01-1309.

[11] Pravardhan S. Shenoy, ―Dynamic load analysis and optimization of connecting rod‖, 2004, Master's thesis, University of Toledo.