DESIGN AND ANALYSIS OF CONNECTING ROD

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Abstract—The connecting rod is an important part of an I.C. engine. It has to carry the thrust force from piston to the crank shaft. The connecting rod is subjected to high degree of stresses. The main objective of the paper is to replace the conventional material used for connecting rod with a new composite material to reduce its weight. This paper deals with the design of a connecting rod for Hero Splendor vehicle using aluminium fly ash silicon composite. The model of the connecting rod is developed using a modeling software. The static analysis of the designed connecting rod is done using FEM software and the results are compared with the existing material C70 steel. Further a wear test is carried out to check the wear characteristics of the new composite material and compare it with the existing material. By using aluminium fly ash silicon composite weight reduction of the connecting rod is achieved. The designed connecting rod is having higher stiffness to weight ratio than the existing connecting rod.

Keywords—Connectingrod, aluminium fly ash silicon composite, optimization, FEA

I. Introduction

The internal combustion engine connecting rod is one of the most vital parts of the engine. It converts the reciprocating motion of the piston to rotary motion of the crank shaft. It is subjected to various complex loads due to gas pressure and the inertia forces of the reciprocating parts. The stresses induced into the connecting rod due to the thrust and the pull of the piston are bending stresses, tension and compression in the axial directions. The connecting rod should be able to withstand these forces in adverse environmental conditions. The design and the weight of the connecting rod influence the performance of the engine. In this paper design of the I section of the connecting rod is done for aluminium fly ash silicon composite material for Hero Splendor vehicle. Further a wear test is carried out to check the wear characteristics of the new material

II. Design of I Section of Connecting Rod

Gas pressure and inertia forces induce axial stresses and bending stresses in the connecting rod. These forces are considered while designing the connecting rod I section. I section is selected for the cross section of the connecting rod to provide maximum rigidity with minimum weight.

A. Pressure Calculations

Consider a 100cc engine :
Engine type air cooled 4-stroke
Bore × Stroke (mm) = 52.4×57.88
Displacement = 97.2 c.c
Maximum Power = 5.5kw at 8000rpm
Maximum Torque = 1.05kgm at 4000rpm
Compression Ratio = 9.1:1

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 Ideal gas equation,
PV=m.Rspecific.T
Where,
P = Pressure
V = Volume
m = Mass
Rspecific = Specific gas constant
T = Temperature
But, mass = density * volume m
=737.22E-9*97.22*103 = 0.0716 kg
Rspecific = R/M Rspecific = 8.3143/0.11423
Rspecific = 72.787 Nm\kg0K
P = (0.0716*72.786*288.85)/97.2*103*10-9
P = 15.48 MPa
Force acting on the Piston Fp
Fp= P*A
Fp=15.48*106*2.1565*10-3
Fp=33398.38

B. Design of I Section

General I Section

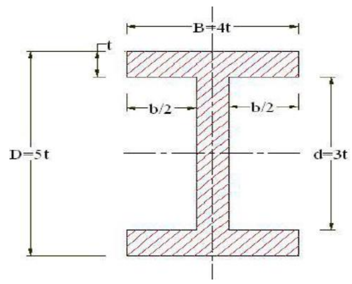

Fig. 1 Standard Dimensions of I Section

Thickness of the flange and web of the section=t
Width of the section B=4t
Height of the section H=5t
Area of the section A=11t2
Moment of inertia about x axis Ixx=34.91t4
Moment of Inertia about y axis Iyy=10.91t4
Herefore Ixx/Iyy=3.2
According to Rankine-Gordon formula,

$$F = \frac{\sigma * A}{1 + a(\frac{l}{K})^2}$$

$$33398.38 = \frac{363 * 11t * t}{1 + 0.0002\,(\frac{115.76}{1.78t})^2}$$

Let, A=C/s area of connecting rod
L=length of connecting rod
σ = Compressive yield stress
F=buckling load
Ixxand Iyy= radius of gyration of the section about x-x and y-y axis respectively
T=3.023 mm
Therefore
Width B=4t-12.092mm
Height H=5t=15.115mm
Area=11t2=100.523mm2
Height of the piston end H1=1.1H-1.25H
H1=1.1*15.115=16.625 mm'
Height at crank end H2=0.9H-0.75H
H2=0.8*15.115=13.6035 mm
Dimensions of big end
P=Di*Do*Pb
Di=0.81*39=31.59 mm
Dimendions of small end
Do=17.75 mm
Di=0.625=17.75=11.09375 mm

C. Material Properties

Material	Al composite
Ultimate Tensile Strength	422MPa
Yield Strength	363MPa
Young's Modulus	70GPa
Poisson's Ratio	0.33
Density	2611.61kg/m3

D. Model of Connecting Rod

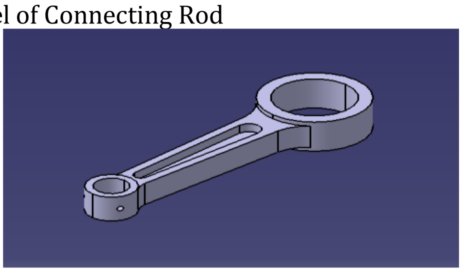

Fig. 2 Connecting Rod Model

III. ANALYSIS OF CONNECTING ROD MODEL

For the finite element analysis 15.48MPa pressure is applied. The meshing and the analysis are carried out using ANSYS software.

A. Equivalent Stresses

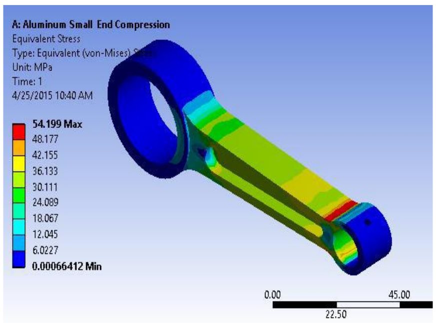

Fig. 3 Equivalent stresses in connecting rod for Al fly ash composite

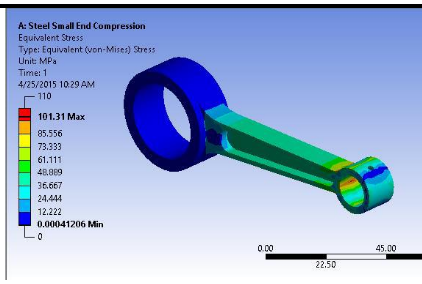

Fig. 4 Equivalent Stresses in connecting rod for C70 steel

B. Total Deformation

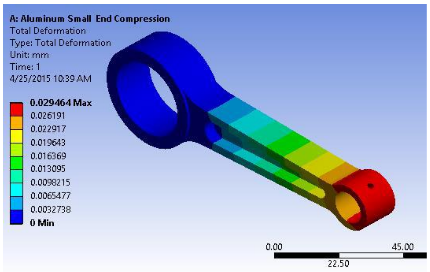

Fig. 5 Total Deformation in connecting rod for Al fly ash composite

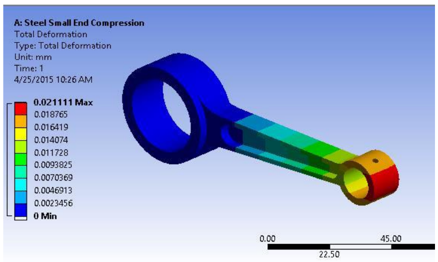

Fig. 6 5 Total Deformation in connecting rod forC70 steel

C. Equivalent Strain

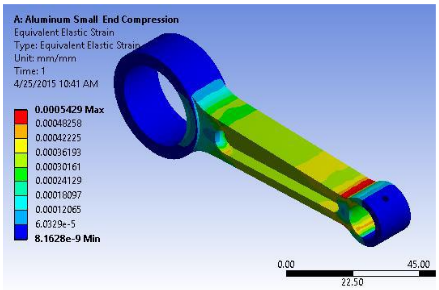

Fig.6 Equivalent Strain in connecting rod for Al fly ash composite

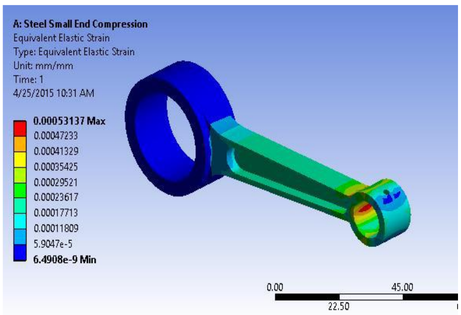

Fig. 7 Equivalent Strain in connecting rod forC70 steel

D. Maximum Shear Stress

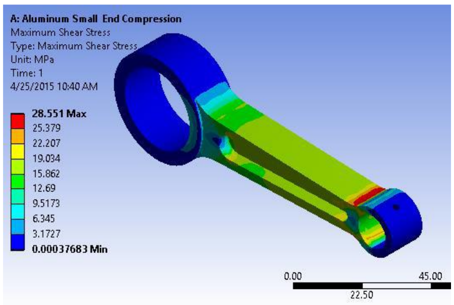

Fig. 8 Maximum Shear Stressin connecting rod for Al fly ash composite

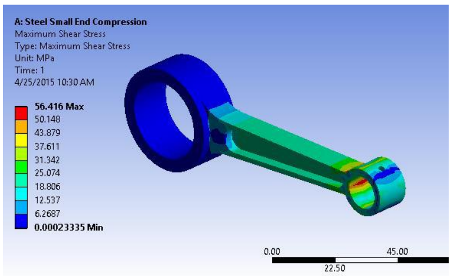

Fig. 9 Maximum Shear Stressin connecting rod forC70 steel

E. FEA Analysis Result Comparison

TABLE I

Sr. No.	Parameter	Al Composite	C70 Steel
1	Equivalent Stress	54.199 MPa	101.31 MPa
2	Total Deformation	0.02946 mm	0.0211 mm
3	Equivalent Strain	0.000542	0.0005313
4	MaximumShear Stress	28.551 MPa	56.416 MPa

From the comparison it is observed that the new material can withstand the adverse conditions in the engine and has better comparative results with respect to old material C70 steel.

IV. CONCLUSION

It can be concluded that the proposed aluminium fly ash composite is better than C70 steel in equivalent stress, shear stress, total deformation and equivalent strain. By changing the composition of the new composite better wear properties can be obtained. Also the mass of connecting rod using C70 steel is 0.1222 kg whereas that of aluminium fly ash composite is 0.054 kg. Hence weight reduction is successful.

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