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A REVIEW PAPER ON EVALUATION OF OPTIMUM DESIGN PARAMETER FOR CONNECTING ROD USING FEA

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ABSTRACT

The automobile engine connecting rod is highly volume production and critical component. It connects to rotating crankshaft to reciprocating piston. It transmits the thrust of the piston to the crankshaft. Every vehicle that uses internal combustion engine which requires one connecting rod depending upon the number of cylinders in the engine. Connecting rod is automobile application are typically manufactured by either from wrought steel or powdered metal.

***Keywords**:* connecting rod- I-section, rectangular section

I. INTRODUCTION

Connecting rod is a component of internal combustion engine and it is classified under function of machine. It is used to in between piston and crank shaft. The main function of connecting rod is to transmit the reciprocating motion of piston to rotational motion of crank shaft. The functions of the connecting rod also transmit the thrust of the piston to the crankshaft. Connecting rod has three main zones. The piston pin end, the centre shank and the big end. The piston pin end is called the small end, the crank end is the big end and the centre shank is of I-cross section/Rectangular section. Connecting rod is a pin jointed in which more weight is concentrated towards the big end.

II. SYSTEM COMPONENT

1. Connecting rod with nut and bolt-

The connecting rod with cap at the larger end is joined by means of bolt and nut as shown in fig.1. This type of connecting rod is most widely used in multi cylinder engines. For example trucks, tractor etc.

Fig. 1 connecting rod with nut and bolt

2. Connecting rod without nut and bolt-

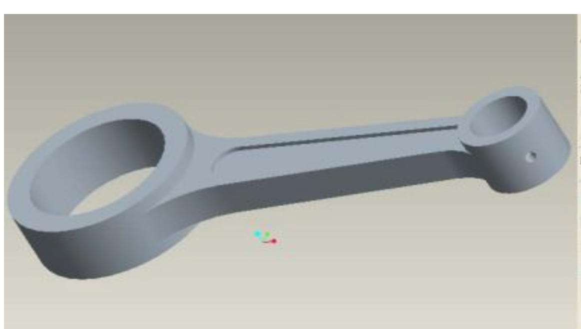

Fig. 2 Connecting rod without nut and bolt

III. PROBLEM STATEMENT

"Radiance Global Engineering Solutions, Pune" is currently working on stationary IC Engine Design project. Now from there we are getting wok under their supervision and guidance to design the connecting rod with modeling and analysis of the same for different materials.

IV. OBJECTIVES

1. Design of connecting rod.
2. Study of different materials used for connecting rod.
3. Comparative analysis study for different materials of connecting rod using ANSYS.
4. Optimization of connecting rod using Fillet radius.

V. METHODOLOGY

1. Design of connecting rod for both I and Rectangular Section.
2. 3D model of both sections based on design.
3. Analysis of both Con rod and selecting the best from two options.
4. Study of different materials used for connecting rod.
5. Analysis of connecting rod for different materials of connecting rod and suggesting the best for further implementation.
6. Fillet radius optimization between beam section and small and big end of rod.
7. Validation of the results and conclusion.

VI. CONSTRUCTION OF CONNECTING ROD

Typical connecting rod used in IC Engine is as shown in the figure 3.1. The body of Connecting rod consists of three parts as follows

1. Small End
2. Big End
3. Shank or Body

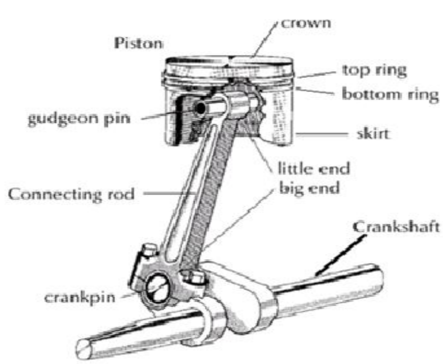

Fig. 3 Connecting rod

Small End

The small end of the connecting rod is completely integral with the body of the connecting rod and carries piston pin bearing. The connecting rod is connected to the piston through the small end, with the help of the piston pin or gudgeon pin.

Big End

The big end of the connecting rod is usually split as shown in figure, to take the crank pin bearing shells. The connecting rod is connected to the crank through the big end, with the help of crank pin.

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Shank or Body

The shank or body of the connecting rod connects the small end and big end. It is tapered shape from small end to the big end. It is continuously subjected to compressive and tensile forces.

The usual shapes of the cross section of the connecting rod are : rectangular, circular, elliptical, tubular, I-section, H-section.

In low speed engines, the section is usually circular with flattened sides, elliptical or rectangular. The larger dimensions of the cross section are in the plane of rotation.

In high speed engines weight reduction is major objective, I-section H-section are commonly used. I-section H-section have higher section modulus per unit area as compared to circular, elliptical or rectangular sections. Hence they offer better resistance against bending as well as buckling[18].

VII. LOADS ACTING ON CONNECTING ROD

The stresses in the connecting rod are set up by a combination forces. The various forces acting on connecting rod are as follows and schematic representation of connecting rod mechanism is shown in figure 4.

1. Force on the piston due to gas pressure and inertia of the reciprocating parts.

2. Force due to inertia bending forces or inertia of the connecting rod
3. Force due to friction of the piston and piston rings and
4. Force due to friction of the crankpin bearing and the piston pin bearing

It is known that the force on the piston due to pressure of gas,

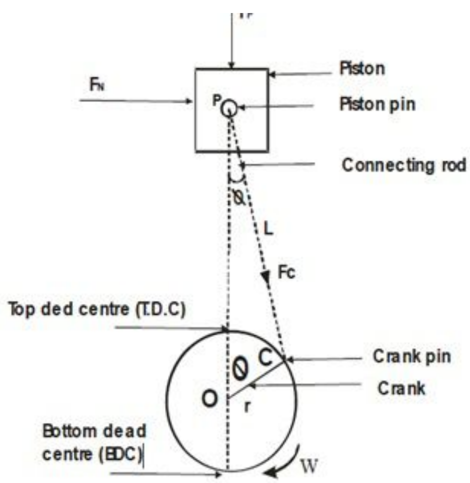

Fig. 4. forces acting onconnecting rod

F_{max} = Pressure * Area , $F_{max} = \frac{\pi D^2}{4} * P_{max}$

And inertia force of reciprocating parts,

$$F_I = M_r (W_{max})^2 r(\cos\theta + \frac{\cos 2\theta}{n}) = M_r (W_{max})^2 r(1 + \frac{1}{n}) \quad (\theta = 0)$$

Where,

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Maximum angular speed,

$W_{max} = (\frac{2\pi N_{max}}{60})$

The inertia force of reciprocating parts opposes the force on the piston when it moves during its downward strokes (i.e., when the piston moves from the Top dead centre to Bottom dead centre). On the other hand, the inertia force of the reciprocating parts helps the force on the piston when it moves from the Bottom Dead Centre (BDC) to Top Dead Centre.

F_P = Force due to gas pressure ± inertia force = $F_{max} \pm F_I$

The negative sign is used when piston moves from Top Dead Centre to Bottom Dead Centre and positive sign used when piston moves from Bottom Dead Centre to Top Dead Centre. When mass of the reciprocating parts (m_r = mR.g) is to be taken in to consideration, then $F_P = F_{max} \pm F_I \pm m_r$

The force F_P gives rise to a force F_c in the connecting rod and a thrust F_N on the sides of the cylinder walls from figure. We see that force in the connecting rod at any instant,

$F_c = F_P / \text{Cos}\,\Phi$

The force in the connecting rod will be maximum when the crank and the connecting rod are perpendicular to each other (i.e. when $\theta = 90°$). But at this position, the gas pressure would be decreased considerably. Thus, for all practical purposes, the force in the connecting rod F_c is taken equal to the maximum force on the piston due to pressure of gas F_I, neglecting piston inertia effects, as the connecting rod transfers forces and motions between piston and the crankshaft, it is subjected to large alternating loads. The connecting rod is loaded in compression (under prevailing gas pressure) and in tension (primarily due to inertia force). It is also stressed in bending due to its pivoting motion.

IX. STATIC ANALYSIS OF CONNECTING ROD

Sr No.	Properties of Material	C-70
1	Density (kg/m^3)	7800
2	Modulus of Elasticity (Gpa)	212
3	Tensile Strength (Mpa)	966
4	Yield Strength (Mpa)	574
5	Poissions Ratio	0.30

Table 1

These are the property of C-70 material as shown in table 1.
These properties are to be used in material library in ANSYS to define the C-70 material for the connecting rod. After defining the material it is selected for the connecting rod for further analysis

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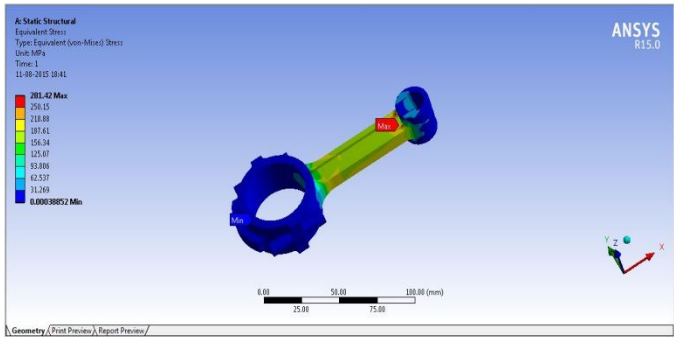

Fig. 7. Von-mises Stress for C-70

Same boundary conditions are applied for the connecting rod using C-70 material and contour has been plotted as shown in the figure 4.10. From the figure 4.10 it can be seen that maximum stress occurred is 281.42 Mpa and is occurring at small end of the connecting rod.

XI. CONCLUSION

This project is regarding the weight and cost reduction opportunities that forged steel connecting rod offer. In this project load analysis is performed on the model created in ANSYS design modeller. In this Von-mises Stress, Total deformation are measured. After the analysis Forged steel material is selected for the Optimization depending on the material proprties and cost basis as compared to the other materials.

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