DESIGN AND ANALYSIS OF CONNECTING ROD

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Abstract

The connecting rod is the intermediate member between the piston and the Crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crank pin, thus converting the reciprocating motion of the piston into rotary motion of the crank. Existing connecting rod is manufactured by using Carbon steel. This paper describes modelling and analysis of connecting rod. In this project connecting rod is replaced by Aluminium Sic for a motorbike. A parametric model of connecting rod is modelled using CREO PARAMETRIC 3.0 software. Analysis is carried out by using ANSYS 15.0 software. Finite element analysis of connecting rod is done by considering two materials, viz. Carbon steel (Existing material) and Aluminium Sic (Proposed material) . The best combination of parameters like Von misses stress and strain, Deformation, and weight reduction were done in ANSYS software.

We know that composite materials have properties of high strength to weight ratio as well as good chemical resistance properties, so reducing weight and improving strength of connecting rod by composite material.

Keywords: *connecting rod, modelling, creo parametric, ANSYS.*

1) INTRODUCTION

A **connecting rod** is a shaft which connects a piston to a crank or crankshaft in a reciprocating engine. Together with the crank, it forms a simple mechanism that converts reciprocating motion into rotating motion.

A connecting rod may also convert rotary motion into reciprocating motion, its original use. Earlier mechanisms, such as the chain, could only impart pulling motion. Being rigid, a connecting rod may transmit either push or pull, allowing the rod to rotate the crank through both halves of a revolution. In a few two-stroke engines the connecting rod is only required to push.

Today, the connecting rod is best known through its use in internal combustion piston engines, such as automobile engines. These are of a distinctly different design from earlier forms of connecting rod used in steam engines and steam locomotives.

Fig.1. A typical connecting rod

2. THEOTRICAL CALCULATIONS OF CONNECTING ROD

2.1 Pressure Calculation for 150cc Suzuki Engine Specification:

Engine type = air cooled 4-stroke
Bore x Stroke (mm) = 57×58.6
Volume = 149.5 CC
Maximum Power = 13.8 bhp @ 8500 rpm
Maximum Torque = 13.4 Nm @ 6000 rpm
Compression Ratio = 9.35/1
Density of Petrol C8H18 = 737.22 kg/m^3
= 737.22E-9 kg/mm^3
Temperature = 60^0 F
= 288.855 ^{o} K
Mass = Density × Volume
= 737.22E-9 x149.5E3
= **0.11kg**
Molecular Weight of Petrol 114.228 g/mole
From Gas Equation,
PV = MRT
R = Rx/Mw
= 8.3143/114228
= 72.76
P = (0.11×72.786×288.85)149.5E, P = **15.5 MPa.**

2.2 Design Calculations for Existing Connecting Rod:

Thickness of flange & web of the section = t
Width of section B = 4t
The standard dimension of I – Section,
Height of section, H = 5t
Area of section, A = 2(4t×t) +3t×t
A = $11t^2$
Moment of Inertia (M.O.I) of section about x axis:
I xx = 112 $[4t\ \{5t\}^3 - 3t\ \{3t\}^3]$
= $41912[t^4]$

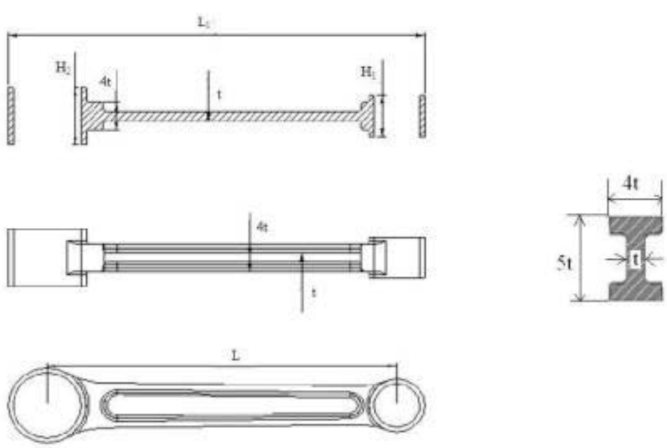

Fig.2.2 Connecting rod dimensional specifications

M.O.I of section about y axis:

$I\,yy = 2\times112\times t\times\{4t\}^3+112\{3t\}t^3$

$= 13112[t^4]$

$Ixx\,.\,Iyy = 3.2$

Length of connecting rod (L) = 2 times the stroke

L = 117.2 mm

Buckling load W_B = maximum gas force × F.O.S

$W_B = (\sigma c\times A)(1+a\,(L/K_{xx})^2$

= 37663N

σc= compressive yield stress = 415MPa

K xx = I xx . A

K xx = 1.78t

A = $\sigma c\pi 2E$

A = 0.0002

By substituting σc, A, a, L, Kxx on W_B then

$4565t^4-37663t^2-81639.46 = 0$

$t_2 = 10.03$

t = 3.167mm

t = 3.2mm

Width of section B = 4t

= 4×3.2

= 12.8mm

Height of section H = 5t

= 5×3.2

= 16mm

Area, A $= 11t^2$

= 11×3.2×3.2

$= 112.64mm^2$

Height at the big end (crank end) = H_2

= 1.1H to 1.25H

= 1.1×16

H_2 =17.6mm

Height at the small end (piston end) = 0.9H to 0.75H

= 0.9×16

H_1 = 12mm

Stroke length (l) =117.2mm

Inner diameter of the small end d_1 = $\mathbf{FgPb_1}\times\mathbf{l_1}$

$= 6277.16712.5\times1.5d_1$

= 17.94mm

Where,

Design bearing pressure for small end pb_1 = 12.5 to 15.4N/mm²

Length of the piston pin l_1 = (1.5to 2) d_1

Outer diameter of the small end $= d_1+2t_b+2t_m$

= 17.94 + [2×2] + [2×5]

= 31.94mm

Where,

Thickness of the bush (t_b) = 2 to 5 mm

Marginal thickness (t_m) = 5 to 15 mm

Inner diameter of the big end d_2 $= FgPb_2\times l_2$

$= 6277.16710.8\times1.0d_1$

=23.88mm

Where,

Design bearing pressure for big end pb_2 = 10.8 to 12.6N/mm²

Length of the crank pin l_2 = (1.0 to 1.25) d_2

Root diameter of the bolt = ((2Fim)(πxSt))1/2
= (2×6277.167π×56.667)1/2
= 4mm

Outer diameter of the big end = $d_2 + 2t_b + 2d_b + 2t_m$
= 23.88+2×2+2×4+2×5
= 47.72mm

Where,

Thickness of the bush [t_b] = 2 to 5 mm
Marginal thickness [t_m] = 5 to 15 mm
Nominal diameter of bolt [d_b] = 1.2 x root diameter of the bolt
= 1.2×4
= 4.8mm

S. No.	Parameters (mm)
1	Thickness of the connecting rod (t) = 3.2
2	Width of the section (B = 4t) = 12.8
3	Height of the section (H = 5t) = 16
4	Height at the big end = (1.1 to 1.125)H = 17.6
5	Height at the small end = 0.9H to 0.75H= 14.4
6	Inner diameter of the small end = 17.94
7	Outer diameter of the small end = 31.94
8	Inner diameter of the big end = 23.88
9	Outer diameter of the big end = 47.72

Table 2.2: Specifications of connecting rod

3) MODELING

3.1. CAD/CAE softwares used for Connecting rod design

- CREO parametric 3.0 is a solid modeling computer-aided design (CAD) and computer-aided engineering (CAE) computer program that runs on Microsoft Windows. CREO Parametric is published by Dassault Systemes.
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- CERO Parametric provides mechanical engineers with an approach to mechanical design automation based on solid modeling technology and the features such as 3D modeling, parametric design, feature-based modeling, associativity, capturing design intent, combining features into parts, and assembly. The three dimensional model of the assembly of connecting rod is shown in the fig.

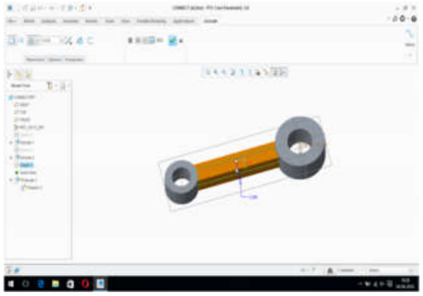
 

Fig. 3.1. Modelling Stages Of Connecting Rod

4) FINITE ELEMENT ANALYSIS

The finite element method (FEM), sometimes referred to as finite element analysis(FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. Simply stated, a boundary value problem is a mathematical problem in which one or more dependent variables must satisfy a differential equation everywhere within a known domain of independent variables and satisfy specific conditions on the boundary of the domain. Boundary value problems are also sometimes called field problems. The field is the domain of interest and most often represents a physical structure.

The field variables are the dependent variables of interest governed by the differential equation. The boundary conditions are the specified values of the field variables (or related variables such as derivatives) on the boundaries of the field. Depending on the type of physical problem being analyzed, the field variables may include physical displacement, temperature, heat flux, and fluid velocity to name only a few.

4.1 Analysis of connecting rod

While analyzing in ANSYS the following procedure is used for defining the problem:

1. Export the model / assembly
2. Specify materials
3. Add constraints
4. Add loads
5. Specify contact conditions
6. Meshing

The amount of details required will depend on the dimensionality of the analysis (1D, axis-symmetric, 3D).

4.1.1 Solution:

Assigning loads, Constraints and Solving**:**

Here we specify the loads (Point or pressure), constraints (translational and rotational) and finally solve the resulting set of equations

4.1.2 Post processing:

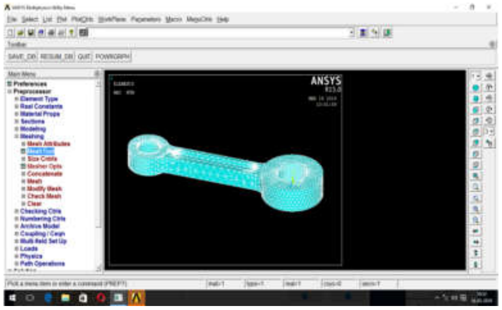
Further processing and Viewing of the Results

In this stage one may wish to see:

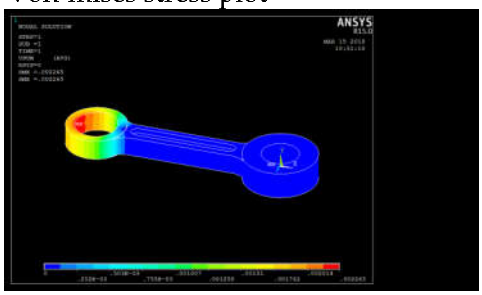
- Lists of nodal displacements
- Element forces and moments
- Deflection plots
- Stress contour diagrams

EXISTING MODEL

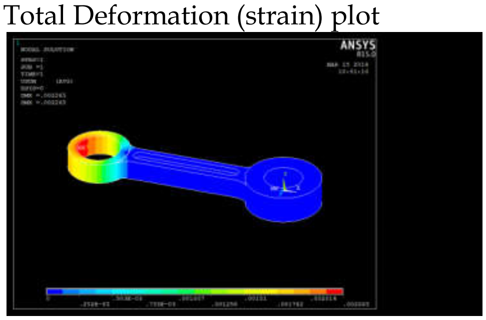
Meshed model



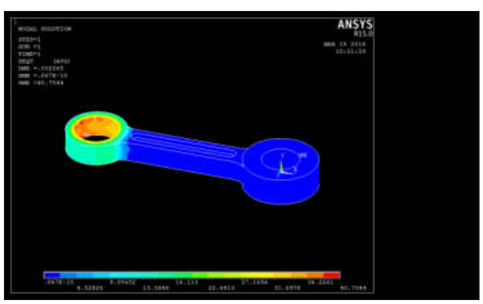
Von-mises stress plot



Total Deformation (strain) plot

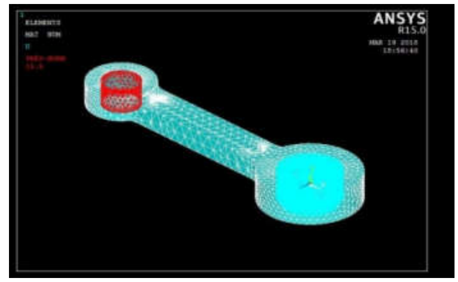


Max. shear stress plot

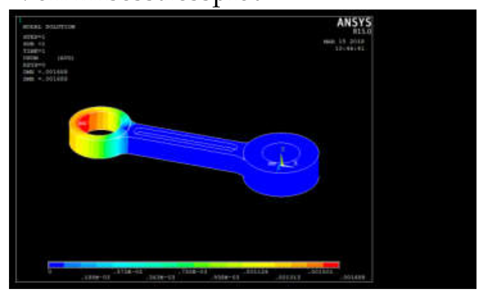


PROPOSED MODEL

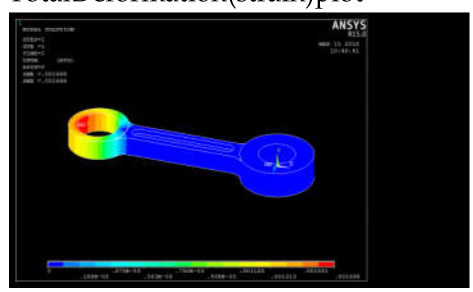
Meshed model



Von-misesstressplot



TotalDeformation(strain)plot



Max. shear stress plot

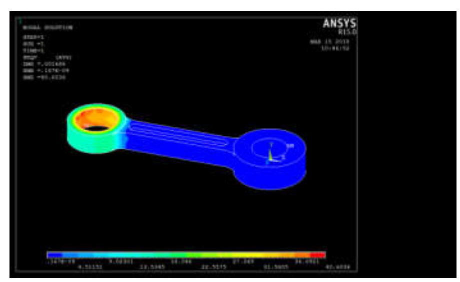


Fig. 4.1. Comparison of stress, strain, deformation of connecting rod

S.No	Description	Carbon steel (existing)	Al-Sic (proposed)
1	Von misses stress (Mpa)	40.75	40.603
2	Von misses strain	0.200E-03	0.151E-03
3	Total deformation (mm)	0.002265	0.0016
4	Weight(N)	3.16	1.21

TABLE 4.1: Comparison of stress, strain, deformation of connecting rod

5) RESULTS AND DISCUSSION

1. The static structural analysis of the connecting rod is done by using Ansys 15.0 software. The maximum stress, strain and deformation occurred are shown.
2. By this study we achieve that the stress, strain and deformation of the connecting rod using proposed material is far better than existing material.

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