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STATIC ANALYSIS OF CONNECTING ROD OF TWO WHEELER BY USING THEORETICAL, FEA AND EXPERIMENTAL METHOD

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Abstract- *Connecting rod is the link between the piston and the crank which transmits the push and pull motion from the piston pin to crank pin. The connecting rod converts the reciprocating motion of the piston to rotary motion of the crank. The automobile engine connecting rod is critical component. The connecting rod used for the analysis is manufactured by using forged steel. This paper describes theoretical, FEA and experimental analysis of connecting rod to find out the stress. 2D drawing of connecting rod is drafted from the calculations. A parametric model of connecting rod is modeled using CATIA software. Analysis is carried out by using ANSYS software. Parameters like deformation, stress are found and compared.*

Keywords: *Connecting rod, Finite Element Analysis, ANSYS, UTM (Universal Testing Machine)*

I. INTRODUCTION

Every vehicle uses an internal combustion engine and each engine requires at least one connecting rod. No of connecting rod depends upon the number of cylinders in the engine. It transmits the thrust of the piston to the crankshaft. In many cases, the major reason behind the failure of engine is the occurrence of the connecting-rod failure and sometimes, such a failure can be attributed to the broken connecting rod’s shank. Forces acted on the connecting rods are :

1. The effect of gas pressure on the piston and the inertia of the reciprocating parts.
2. Friction of the piston rings and the piston.
3. Inertia of the connecting rod.
4. Thermal stresses.

Connecting rod for automobile applications are typically manufactured by forging from wrought steel or powder metal. Figure 1 shows the existing connecting rod.

Fig.1: Existing connecting rod

II. PROBLEM STATEMENT

The objective of present study is to carry out the static analysis of a connecting rod used in a two wheeler. Connecting rod is the main component of internal combustion engine It is the most heavily stressed part in IC engine. During its operation, various forces such as compressive force due to gas pressure, inertia force due to reciprocating action (tensile as well as compressive) are acting on the connecting rod. The axial stresses arises due to these forces. When these stresses goes beyond its critical value, connecting rod fails. There is more work carried out on the analysis of connecting rod by theoretical method using conventional formulae. But theoretical methods have some limitations and some assumptions have to be made during the calculations. Hence it becomes necessary to carry out experimental analysis of connecting rod.

In this dissertation work, the study of effect of pressure on connecting rod by using analytical, experimental and theoretical technique in static condition is carried out.

III. THEORETICAL STRESS ANALYSIS

Specifications For Bajaj Pulsar 150cc Engine:

- Engine type air cooled 4-stroke
- Bore x Stroke (mm) = 58x56.40
- Displacement = 149.01 CC
- Maximum Power = 15.05 bhp @ 9000 rpm
- Maximum Torque = 12.45 N-m at 6500 rpm
- C. R. = 9.5:1
- Density of Petrol = 737.22 kg/m3
- Temperature = 60 0F = 288.855 0K
- Mass = Density × Volume = 737.22E-9 x149.01E3 = 0.10kg

Molecular Weight of Petrol 114.228 g/mole

From Gas Equation,

PV = M*R*T

P = 14.10 Mpa

Stress Calculations for Bajaj Pulsar 150cc Engine Connecting Rod:
Material used for connecting rod is Forged steel.
compressive yield stress = 415 MPa

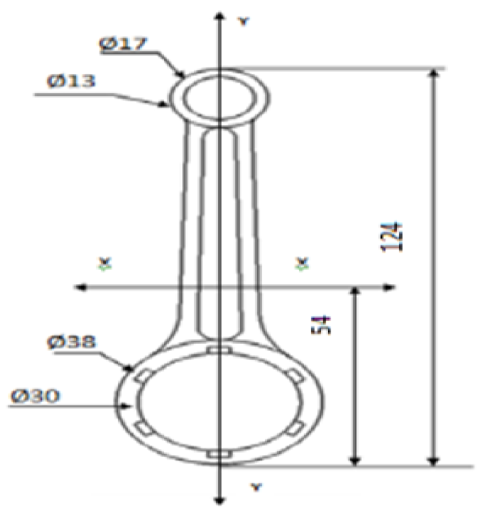

Fig.2: Dimensions for Bajaj Pulsar 150cc Engine connecting rod

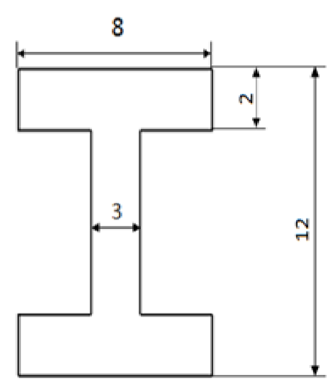

Fig.3:Section at X-X axis

The dimensions are as follows,
Thickness at the web section = t = 3 mm
Thickness of flange = 2 mm
Width of section = B = 8 mm
Height of section = H = 12 mm
Moment of Inertia of section about x axis= 138.66 mm4
Length of connecting rod (L) = 124 mm
Maximum force on the piston due to pressure,[7]

$$F_1 = \frac{\pi}{4} \text{ x } D^2 \text{ x } P = 37253.31\text{N} \qquad \text{.....(1)}$$

Factor of safety = $\frac{Maximum\ load}{Working\ load}$

For engine component factor of safety varies from 3 to 6.[8]

Working load (Wb) = 6208.88N

By using Rankine's formula,[8]

$$W_b = \frac{[\sigma c \times A]}{1+a\left[\frac{L}{Kxx}\right]^2} \qquad \text{.....(2)}$$

A = (8x2) + (3x8) + (8x2)
A = 56 mm2
K^2 xx = Ixx/A, K xx = 1.57 mm
a = 0.0002
By substituting Wb, A, a, L, Kxx in equation

Ϭc = 248.84 N/mm^2

IV. FINITE ELEMENT ANALYSIS OF CONNECTING ROD

FEA solution of engineering problem, such as finding deflection and stress in a component, requires steps as given below:

- **Modeling:**

Using CATIA software the connecting rod was modeled. The model is then converted into STEP (.stp)file which was imported in ANSYS 16 workbench.

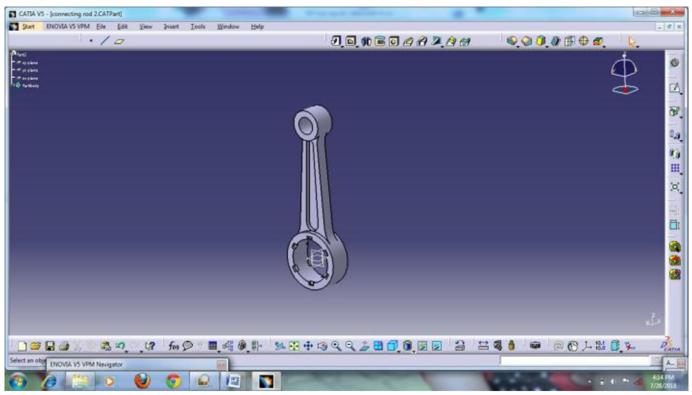

Fig.4: CATIA model of connecting rod

- **Pre-processor:**

In the Pre-processor phase, along with the geometry of the structure, the mechanical properties of the material of component were defined
1. Define material properties for connecting rod
Density - 7850 kg/m3
Young's modulus - 2x105 Mpa
Poison's ratio - 0.3
2. Meshing :
Type of element - Tetrahedron element
Type of mesh - solid

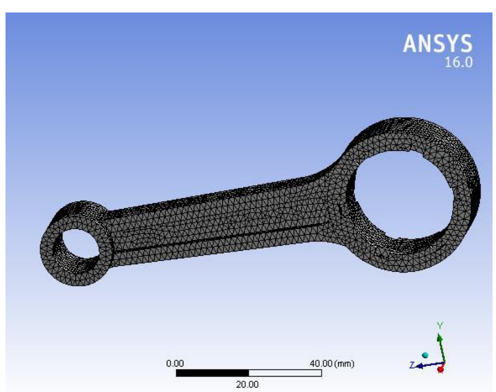

Fig.5: Meshed model of connecting rod

3. Constraints and force applied on model. The force 6200N is applied at small end of connecting rod.

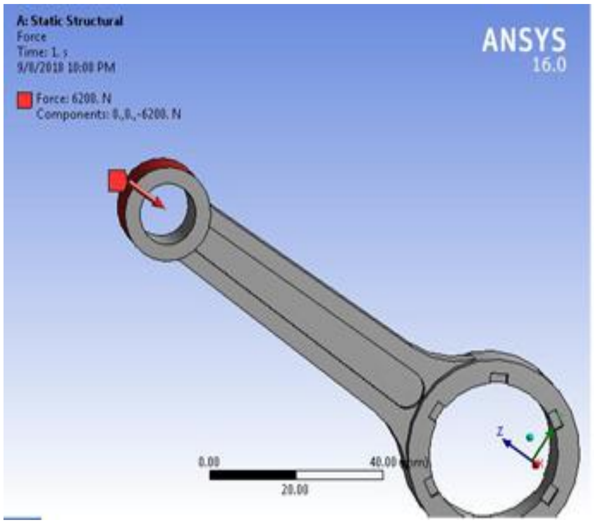

Fig.6: Force on connecting rod

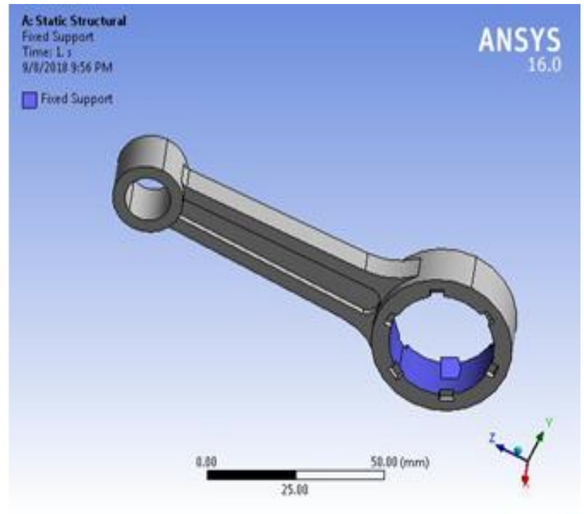

Fig.7: Constraint for connecting rod

- **Post-processor:**

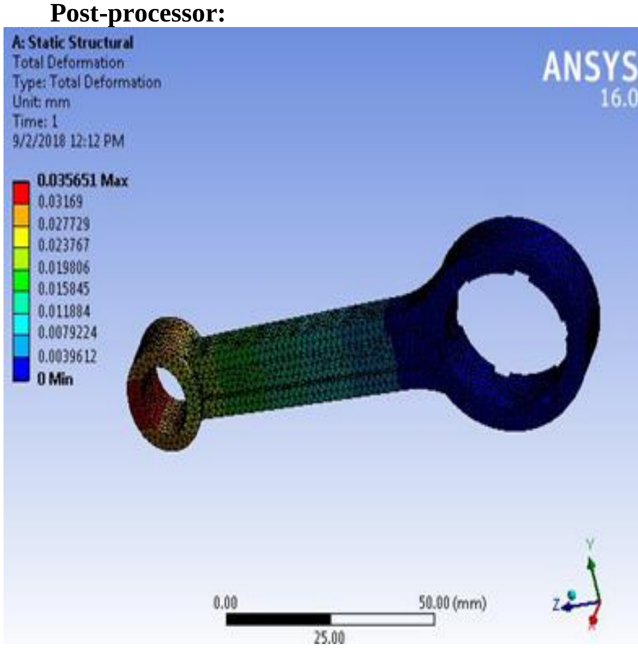

Fig.8: Total deformation of connecting rod

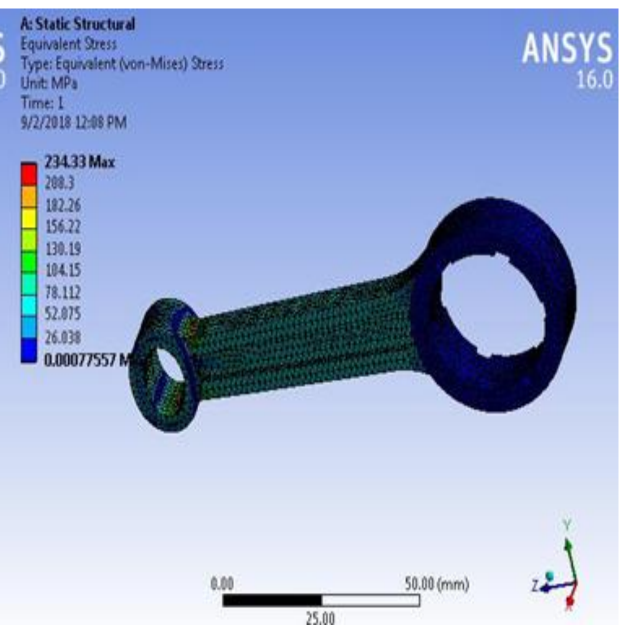

Fig9: Equivalent stress on connecting rod

From above, for load 6200N the stress on the connecting rod is 234.33 N/mm^2

V. EXPERIMENTAL ANALYSIS

Experiments on a connecting rod is carried out for validation with the analytical Results. Experimental analysis is done on the UTM. The procedure followed for experimental analysis is given below:

- Firstly took the connecting rod.
- Select the shaft which will fix with minimum tolerance in the connecting rod big eye.
- The Fixture was Prepared for Testing on Universal Testing Machine (UTM).
- To apply load that is compressive load, two fixture assemblies are made that are lower fixture & upper fixture.
- The upper fixture has provision of small eye of connecting rod.

- The whole system is kept under UTM.

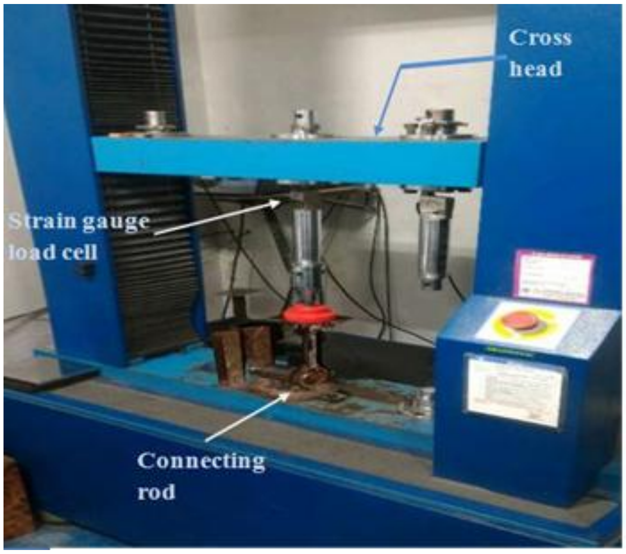

Fig.10: Experimental setup

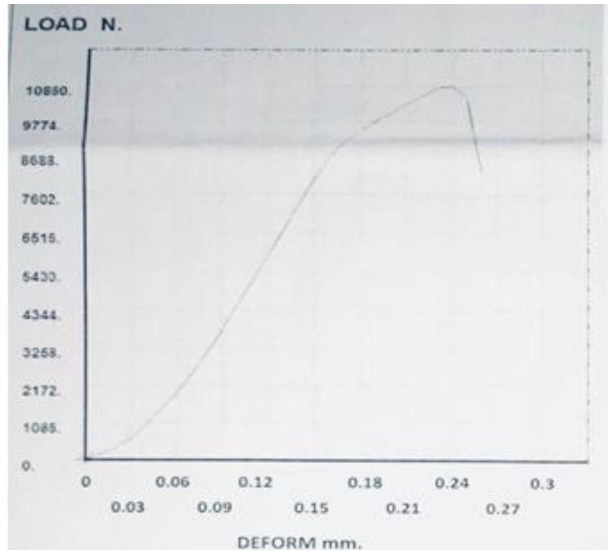

Fig.11: Compression test graph

Fig. shows the Experimental setup and Result graph of load vs deformation. The peak load applied is 10860 N. And the deformation obtained is 0.24mm

Time (sec.)	Disp. (mm.)	Load (N.)	Strain	% Strain	% Elongation (%mm.)
0.9	0.01	176	0.0001	0.01	0.01
5	0.05	1441	0.0005	0.05	0.05
9	0.08	3107	0.0008	0.08	0.08
15.6	0.13	6200	0.0013	0.13	0.13
21	0.17	9065	0.0017	0.17	0.17
25	0.20	10025	0.0020	0.20	0.20
30.3	0.24	10860	0.0024	0.24	0.24

Table no.1: Result table of compression test of connecting rod by using UTM

From above result table strain for load 6200 is 0.0013.
Using Hook's law,

$$\text{Young's Modulus} = \frac{Stress}{Strain}$$

$$200 = \frac{Stress}{0.0013}$$

Stress = 0.26 Gpa
= 260 Mpa

VI. RESULT AND DISCUSSION

The results of all these methods for certain load is compared and tabulated below.

Sr. No.	Methods	Load (N)	Stress (N/mm2)
1	Theoretical	6200	248.84
2	FEA	6200	234.33
3	Experimental	6200	260

Table no.2: Results for all methods

Sr. No.	Comparison between results	% error
1	Experimental & Theoretical	5
2	Experimental & FEA	9
3	FEA & Theoretical	6

Table no.3: Comparison of all results

If comparison of experimental result and FEA result is done, there is good agreement between two results. The percentage error is 9%. This is because finite element method is approximate method. And if comparison is done between experimental result and theoretical result the error observed is 5%. These variations in result are because theoretical method is based on various assumptions. There is 6% error between theoretical result and FEA result.

CONCLUSION

Owing to the results obtained by different methods used to carry out Static analysis of connecting rod of two wheeler, following conclusions can be drawn at the end of dissertation work.

- Maximum stress occurs at the piston end of connecting rod.
- The results for stress in static state by experimental method and theoretical method are very close to each other. The error recorded is 5%.
- There is good agreement between experimental method and finite element method.
- This static structural analysis of connecting rod will be further useful for optimization that is reduction in weight by reducing dimensions and changing material.

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