International Journal of Advanced Technology in Engineering and Science
Vol. No.3, Special Issue No. 01, August 2015
www.ijates.com
ijates
ISSN 2348 - 7550

DESIGN EVALUATION THROUGH FINITE ELEMENT ANALYSIS FOR FATIGUE LIFE OF CONNECTING ROD USED IN TWO WHEELERS

Dipalee S. Bedse[1], Mangesh. A. Ahire[2].

[1,2]Department of Mechanical Engineering, Savitribai Phule Pune University(India)

Gokhale Education Society's R.H. Sapat College of Engineering, Management Studies and Research, Nasik – 5, India.

ABSTRACT

Connecting rod is the mechanical element which used in Internal Combustion Engine (IC Engine). The basic function of connecting rod is to transfer power from piston to the crank shaft and It converts reciprocating motion of piston in to rotary motion of crank shaft. The main objective of this paper is design evaluation through finite element analysis for fatigue life of Hero Honda Motor Cycle connecting rod. By using FEA and Experimentation method find the structural system of the existing connecting rod and on the basis FEA and Experimentation result recommend the best alternative design for connecting rod. 3D model of connecting rod is created in CATIA software and it will be analyze in HYPERMESH software. The structural strength of connecting rod will be verified on Universal Testing Machine (UTM).

Keywords: Connecting Rod, Finite Element Analysis, Model, Structural Strength.

I. INTRODUCTION

The intermediate component between crank and piston is known as connecting rod**.** Connecting rod is also known as conrod and is used to connect the piston to crankshaft. As a connecting rod is rigid, it may transmit either a push or a pull and so the rod rotates the crank through both halves of a revolution, i.e. piston pushing and piston pulling. Earlier mechanisms, such as chains, could only pull. In a few two stroke engines, the connecting rod is only required to push. Today, connecting rods are best known through their use in internal combustion piston engines, such as automotive engines. These are of a distinctly different design from earlier forms of connecting rods, used in steam engines and steam locomotives. One source of energy in automobile industry is internal combustion engine. Internal combustion engine converts chemical energy into Mechanical energy in the form of reciprocating motion of piston. Crankshaft and Connecting rod convert reciprocating motion into rotary motion. Connecting rod is one of the important driving parts of Light vehicle engine it forms a simple mechanism that converts linear motion into rotary motion that means the connecting rod is used to transfer linear, reciprocating motion of the piston into rotary motion of the crankshaft.[6]

II. SUMMARY OF LITRATURE REVIEW

Sr. No.	Author Name	Year	Study
1	Priyank D. Toliya, Ravi C. Trivedi, Prof. Nikhil J. Chotai	2013	The objective of this research is to investigate the failure analysis of the connecting rod of the automotive engine. In the starting of the work The static loads acting on the connecting rod, After that the work is carried out for safe design and life in fatigue. Fatigue Analysis is compared with the Experimental results.
2	P S Shenoy , A Fatemi	2006	In this study, detailed load analysis under service loading conditions was performed for a typical connecting rod, followed by quasi-dynamic finite element analysis (FEA) to capture stress variations over a cycle of operation. On the basis of the resulting stress-time histories, variation of stress ratio, presence of mean and bending stresses, and multiaxiality of stress states in various locations of the connecting rod under service operating conditions were investigated.
3	M.N. Mohammed, M.Z. Omar, Zainuddin Sajuri, A. Salah, M.A. Abdelgnei, M.S. Salleh	2011	The study applied a finite element analysis and metallographic examination. Based on the findings, It was found that it is possible for each casting defect to develop depending on the cyclic loading behavior of the connecting rod into the start point for crack initiation before the occurrence of catastrophic failure.
4	M.Omid, Mahamoodi	2008	FEA is used to find out displacement , stresses , tension and compression loading condition in the connecting rod of universal tractor(U650)
5	S B Chikalthankar, V M Nandedkar, Surendra Prasad Baratam	2012	The present work shows the complete connecting rod Finite Element Analysis (FEA) methodology. It was also performed a fatigue study based on Stress Life (SxN) theory, considering the Modified Goodman diagram.
6	R. Luria, C.J. Luisa, D. Salcedoa, J. Leóna et all.	2013	This present work deals with the design of a set of dies employed to manufacture a connecting rod by forging a billet of Nano structured aluminum alloy.
7	Atish Gawale, A. A. Shaikh , Vinay Patil	2012	This study deals with nonlinear static analysis and optimization of forged steel connecting rod. The design and weight of the connecting rod influence the engine performance. Hence optimization is to be carried out. The percentage weight reduction obtained was 7.35% by optimization.
8	Vivek. C. Pathade, Bhumeshwar Patle, Ajay N. Ingale	2012	The paper deals with the stress analysis of connecting rod by Finite Element Method using Pro/E Wildfire 4.0 and ANSYS WORKBENCH 11.0 Software
9	Bin Zheng , Yongqi Liu , Ruixiang Liu	2013	Stress distribution and fatigue life of CR in light vehicle engine were analyzed using the commercial 3D finite element software, ANSYSTM. The results showed that the medial surface of small end will be the critical

			surface whereby damage will initiate at the maximum stretch condition. In order to increase the reliability of CR, some improvement is carried out. Safety factor of CR increases by 59%.
10	Kuldeep B, Arun L.R, Mohammed Faheem	2013	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.

III. RESEARCH GAP

Most of the studies are done on Heavy Vehicle connecting rod had focused on stress, deflection, critical surface area of connecting rod, weight of connecting rod and all these studies are carried out by FEA software and there is very experimentation and validation results are found. In other side very less research work done on the stress distribution and fatigue life of connecting rod used in light vehicle engine. The new analysis will examine the calculation for the stresses and fatigue failure of the Hero Honda Motor Cycle connecting rod.

IV. SPECIFICATION OF THE PROBLEM

The aim this present work is to design a connecting rod based upon its fatigue life. 3D model connecting rod will be created in CATIA software and it will be analyzed in HYPERMESH software. Find out stresses, deflection of existing connecting rod. Structural strength of connecting rod is verified over an UTM. As for the fatigue life determined by the FE analysis the same shall be compared with historical data. Recommend the best design for connecting rod experimentation and validation.

V. OBJECTIVES

a) Study the existing system of connecting rod find out problem areas, different parameters such as stresses, deflection , fatigue failure of the component for redesign of connecting rod.
b) 3D CAD model of connecting rod will be created in CATIA and it'll be analyzed in HYPERMESH software.
c) To conduct test on Universal Testing Machine to find stress and deflection of existing connecting rod.
d) To analyze the alternative geometry for connecting rod using suitable tools such as HYPERMESH software.
e) To recommend the best alternative design for the connecting rod through experimentation and validation.

VI. SPECIFICATION OF EXISTING CONNECTING ROD

Specifications of Splendor 100CC Engine

- Displacement : 97.2CC
- Bore X Stroke : 50 X 49.5 (in mm)
- Max. Power : 5.5Kw at 8000rpm

- Max. Torque : 7.95Nm at 5000rpm
- Compression Ratio : 9:1

Table1 Dimension of Connecting Rod

Sr. no.	Parameters	Value
1.	Length of connecting rod	123mm
2.	Outer Diameter of Big end	39.02mm
3.	Inner Diameter of Big end	30.19mm
4.	Outer Diameter of small end	17.75mm
5.	Inner Diameter of Small end	13.02mm

VII. MATHEMATICAL CALCULATION

7.1 Pressure Calculation

- Density of Petrol (C_8H_{18}), ρ = 750 Kg/m^3 = 750 x 10 $^{-9}$Kg/mm^3
- Operating Temperature, T = 293.15 K
- Mass = Density x Volume = m = 750x10 $^{-9}$ x 97.2x10^3 = 72.9x10^{-3} Kg
- Molecular weight of petrol,

  M =114.228x10 $^{-3}$ Kg/mole
- Gas constant for petrol, R = 8314.3/114.228x10^{-3} = 72.79x10 ^{3}J/Kg.mole.K

From Gas law equation , PV = mRT = P = mRT/V = 72.9x10 $^{-3}$x72.79x10 ^{3}x293.15/ (97.2x10 ^{3} **= 16 MPa**

7.2 Design Calculation

- Gas Force = Pressure x Cross section area of piston

  Fl = P x π/4 x D^2= 16xπ/4x50^2 = 31415.93 N

VIII. METHODOLOGY

8.1. Finite Element Analysis Method

By using design parameters of existing connecting model create 3D CAD model of connecting rod using CATIA software and then model is imported in HYPERMESH software for further analysis

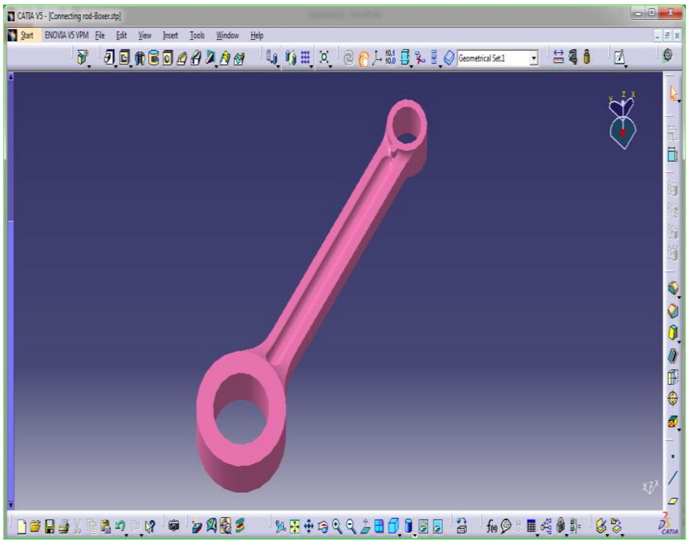

Fig.1 Connecting Rod Using CATIA Software

8.1.1 Meshing

Create meshing of model the mesh should be finer and represent the geometry in critical areas. Here we done solid meshing because a part with all the three dimensions (x, y, z in a Cartesian coordinate) comparable are usually meshed with solid elements. The mesh model of connecting rod is as shown in fig.2

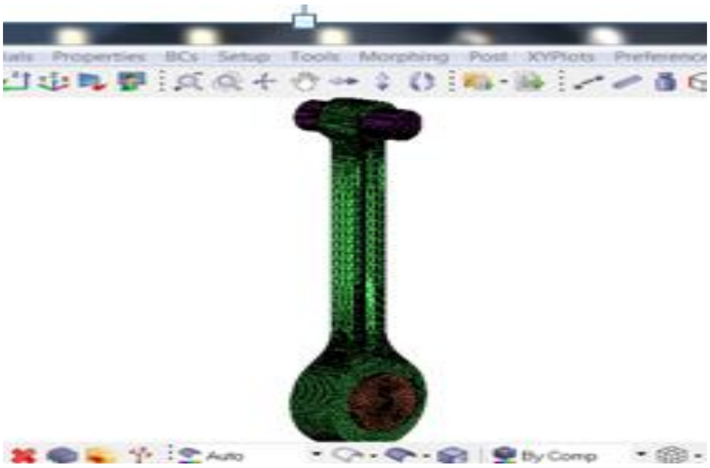

Fig. 2 Meshing of Connecting Rod

8.1.2 Load Diagram of Connecting Rod

Make crank end fix and apply pressure of 16MPa load at the piston end of connecting rod which is calculated by mathematical calculation. The load diagram is shown in Fig.3

ijates
ISSN 2348 - 7550

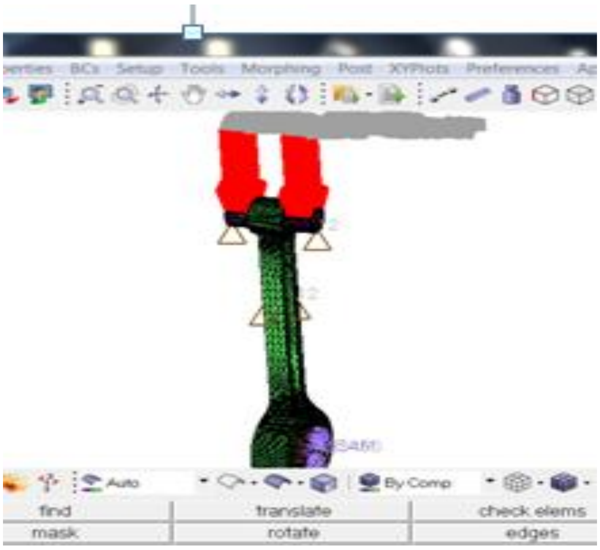

Fig. 3 Load of Connecting Rod

8.1.3 Results and Discussion

By FEA test we get the values of maximum and minimum von-misses stress. It is shown in Fig. 4 and Fig. 5.

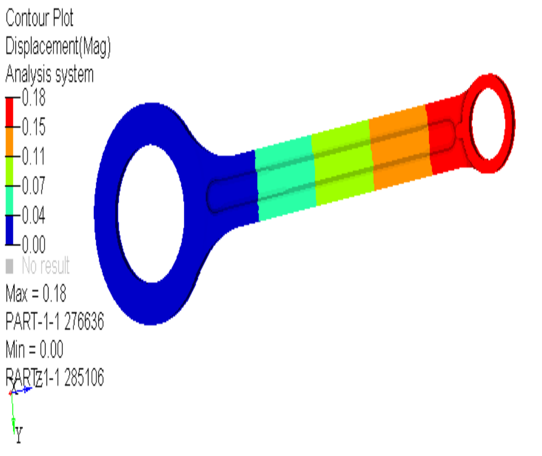

Fig. 4 Displacement Plot

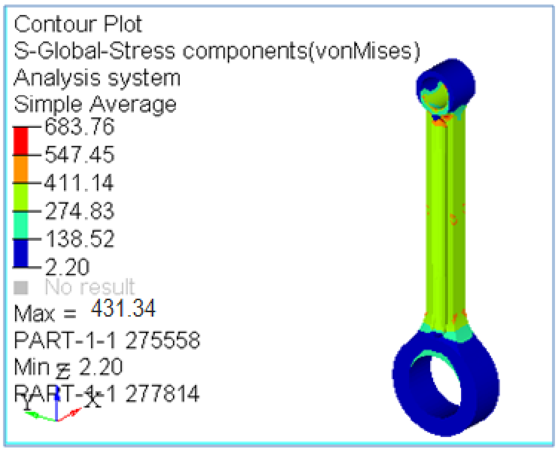

Fig. 5 Stress Component

Name	**Maximum**	**Minimum**
Von-misses stress	431.34N/mm^2	2.20 N/mm^2
Displacement	0.18 mm	0.0 mm

8.2. Experimentation

8.2.1 Experimental Setup Information

The specs for the UTM (Universal Testing Machine) used for the Test are as below

Make: Star Testing System (India) - Software based

Model No: SPS 248

Type: DC Servo Control

Speed for loading: 5mm/min to 500mm/min

Strain Gauge

Type - Fixed Gauge

Gauge length - 25 to 50mm

Strain gauge positioned with the terminal

Fig. 6 UTM Machine

Fig. 7 Tensile Test Set Up [EthikaEngg. Solution pvt ltd. Pune

8.2.2 Observation Chart

Load (N)	Deflection (mm)	Max stress(N/mm^{2})
31000	0.1812	431.153

IX. FEA AND EXPERIMENTATION RESULT

As we compare FEA and Experimentation test we get the same result for Stresses and Deflection. By using same inputs analyze the alternative geometry for connecting rod through experimentation and validation.

Test	Experimentation	FEA
Deflection (mm)	0.1812	0.18
Max stress(N/mm^{2})	431.153	431.34

X. NEED OF MODIFIED GEOMETRY

After studying existing model of connecting rod we found that the stress concentration is more at oil hole portion and neck radius portion of crank and piston end so to reduce this stress and improve its fatigue life we modify the geometry by making some changes in the present design.

XI. DISCUSSION & CONCLUSION

From the above study we can conclude that as we conduct test on FEA and UTM machine we got the same result for stresses and deflection and the maximum stress concentration is occurred at oil hole portion and at neck radius of crank and piston end In order to reduce stresses , deflection at neck radius and improve fatigue life of connecting rod we can make small changes in geometry of connecting rod.

XII. ACKNOWLEDGMENT

The authors of this present work acknowledge the technical support given by Ethika Engg. Solutions India pvt ltd.

REFERENCES

[1] Afzal, "Fatigue Behavior and Life prediction of Forged Steel and PM Connecting Rods", Master's Thesis, University of Toledo, 2004

[2] Ahad Ridzun Bin Ibrahim, "Analysis of Connecting Rod Fracture Using Finite Element Analysis",pp.110-112.

[3] 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.

[4] Atish Gawale, A. A.Shaikh1 and Vinay Patil, "Nonlinear static finite element analysis and optimization of connecting rod." World Journal of Science and Technology 2012, 2(4):01-04. ISSN: 2231 – 2587.

[5] Mr. H. B. Ramani, Mr. Neeraj Kumar, Mr. P. M. Kasundra, "Analysis of Connecting Rod under Different Loading Condition Using Ansys Software". International Journal of Engineering Research & Technology (IJERT),Vol. 1 Issue 9, November- 2012 ISSN: 2278-0181

[6] Swapnil B. Ikhar, "Modeling and Analysis of Connecting Rod of Two Wheeler (Hero Honda Splendor)" Discovery, Volume 24, Number 83, October 4, 2014

[7] P. G. Charkha, S. B Jaju, "Analysis & Optimization of Connecting Rod", Second International Conference on Emerging Trends in Engineering and Technology,2009,IEEE, pp. 86-91.

[8] Pravardhan S. Shenoy, "Dynamic load analysis and optimization of connecting rod", 2004,pp. 30-42.

[9] P. S. Shenoy and A. Fatemi, "Connecting Rod Optimization for Weight and Cost Reduction", University of Toledo, SAE Technical Paper Series, Paper No- 2005-01-0987.

[10] V.B.Bhandari Design Data book.