Stress Analysis Of Connecting Rod Of Tractor With Weight Optimization

Yogesh Kumar Bharti[1], Vikrant Singh[1], Dipanshu Singh[1], Afsar Hussain[1], Shyam Bihari Lal[2] ,Vineet Kumar Tripathi[3]

[1]B.Tech. Students, Department of Mechanical Engineering, Buddha Institute of Technology. GIDA Gorakhpur-273209(U.P.), India.

[2]Asst. Professor Mechanical Engineering Department, Buddha Institute of Technology, GIDA Gorakhpur-273209(U.P.), India

[3]Lecturer Mechanical Engineering Department, Buddha Institute of Technology, GIDA Gorakhpur-273209(U.P.), India.

ABSTRACT: Connecting rod is an important component of an Internal Combustion Engine. CR is a link between piston and crank shaft. Whenever energy is transmitting from one end to another end then it's called as conservation of mass energy. So that it's means energy is to convey to perform some work of piston to rotary motion of crank. Connecting rod consists of a long shank, a small end or piston pin end and a big end or crank end. The cross-section of the shank is various types; it may be I- section. FEA is the most appreciable technique for analyzing the complex machine component subjected to various forces and stresses. In the present work the FEA of I-section connecting rod are carried out. A parametric model of connecting rod is modeled using PRO-E 4.0 software and ANSYS 13.0 is used for the FEA. Investigate the stress by analyzing the steel(C-70) connecting rod and find out the maximum stresses generated and optimize the weight.

Keywords: Connecting rod, Pro-E 4.0 for solid Modeling, ANSYS 13.0 for Stress Analysis, FEA, Optimization.

I. INTRODUCTION

The Internal combustion Engine connecting rod is critical component which is subjected to complex loading. There are various forces acting on the connecting rod i.e. force on the piston due to gas pressure and inertia of the reciprocating parts, force due to inertia of connecting rod or inertia bending forces, force due to friction of piston rings and of the piston, force due to friction of piston pin bearing and crank pin bearing. The inertia loads on connecting rod are varying time to time under in-service conditions. Connecting rod design is very complex because the connecting rod is work in very complicated condition. FEA is capable to generate the stress distribution in component subjected to various loads. FEA is performed on ANSYS software for observed the critical point, where stress generated above elastic limit of material used.

Mirehei et al. interpreted the connecting rod fatigue of universal tractor (U650). The results notify that with fully reverse loading, evaluate longevity of a connecting rod and also find the critical points that more possibly the crack growth initiate from. The obtained result is useful for modification of connecting rod.

Suraj Pal and Sunil Kumar done Finite Element Analysis of the connecting of a Hero Honda Splendor has been done using FEA tool for both tensile and compressive loads and investigate the percentage reduction in weight.

P S Shenoy and A Fatemi Performed loads analysis and identified few geometric locations on the connecting rod at which stresses were traced over entire load cycle. They investigate that the load ratio or mean load varies over the length of connecting rod.

Atish Gawale et al. investigate the peak stresses occurred in connecting rod in the area of crank end and they optimize the weight of connecting rod. They observed maximum von-mises for both original as well as optimized model and compare to loading conditions.

The main objective of present work is to design and analysis of connecting rod of Tractor, made of Carbon Steel C-70. Connecting rod created in Pro-E 4.0 and Solid model is imported in ANSYS 13.0 for analysis. Investigate the maximum von-mises stress, maximum shear elastic strain and total deformation generated in connecting rod and result is use to optimize the mass of connecting rod.

II. MATERIAL INFORMATION

In the FEA, properties of material play an important role. The property of material is a basic input for optimization. Carbon steel C-70 is an improved material over some other materials used for manufacturing the connecting rods in nowadays. The steel C-70 is suitable for manufacture crank shaft, axels, connecting rod and other I.C. Engine parts.

The material used for manufacturing of connecting rods varies from mild carbon steel (0.35-0.45 %C) to alloy steels (chrome-nickel or chrome-molybdenum). The carbon steel having 0.35

percent has an ultimate tensile strength about 650 MPa when properly heat treated, these steel are used for manufacturing of connecting rod of industrial engine and steel having an ultimate tensile strength of about 1050 MPa used for connecting rods of Automobiles engines and Aero engines.

Table: 1. Mechanical properties of C-70 steel.

Properties	Values
Tensile strength	621 MPa
Yield strength	483 MPa
Young's modulus	207 GPa
Poisson ratio	0.30
Density	7700 kg /m^3

III. FINITE ELEMENT ANALYSIS

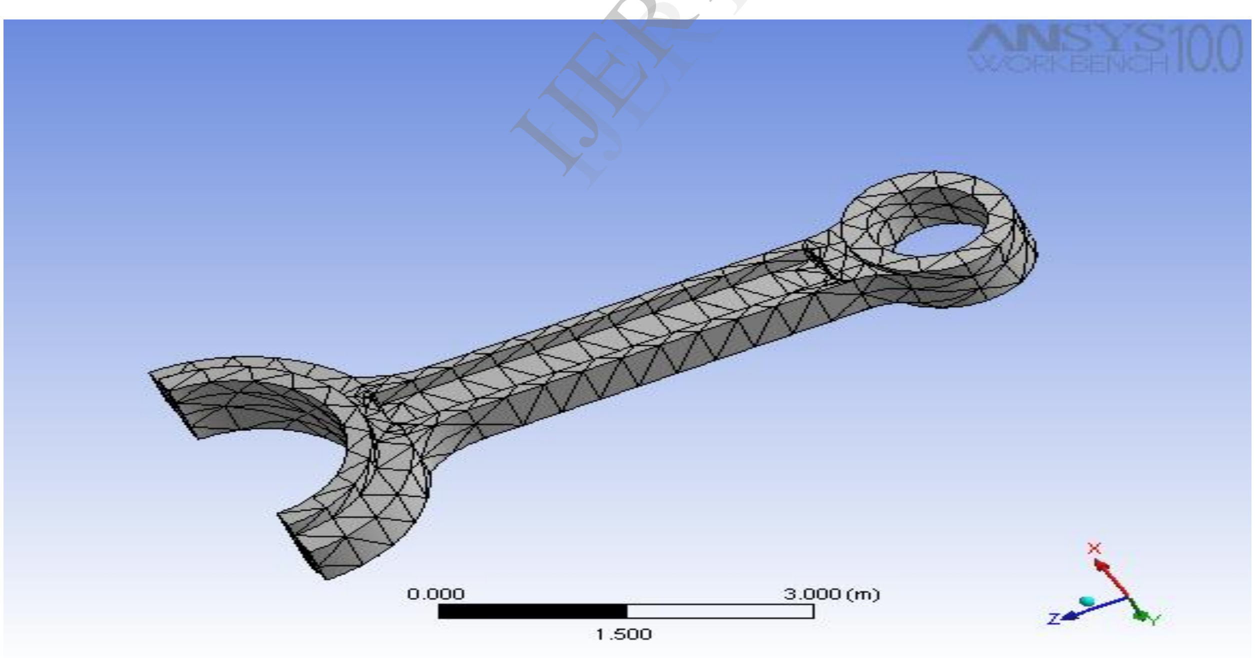

Figure 1: Meshing of Connecting Rod (SOLID 187)

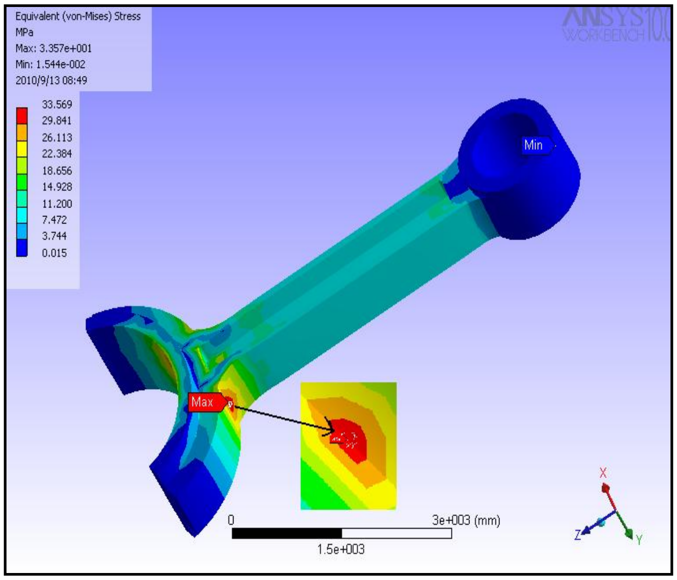

Fig. 2: Equivalent (Von-Mises) Stress

Fig3: Shape Optimization

Finite element analysis of connecting rod has been carried out for investigation of critical stresses, elastic strain and total deformation.

The analysis connecting rod done at load 9500N and find out the value of maximum von-mises stress, maximum shear elastic strain and total deformation of connecting rod. The result obtain by FE Analysis is validate by available existing result.

Table: 2. FEA Result

Parameters.	Result.
Equivalent Stress	26.944MPa
Elastic Strain	1.852e-4 m/m
Total deformation	7.78e-4 m

IV. OPIMIZATION

The objective of optimization of connecting rod is to minimize the mass and manufacturing cost and reduce the storage space. The weight of optimized connecting rod is certainly lower than the weight of original connecting rod. The factors have been addressed during the optimization- load factor, stresses under the loads.

I. Optimization Statement:
   a) Objective Function: Minimize Mass and Cost
   b) Subject to Constraints
      1. Maximum Von-mises stress < Allowable stress
      2. Side Constraints (Component Geometry)
      3. Manufacturing Constraints.

II. Optimized Model

V. SHAPE RESULTS

The optimization of I-section connecting rod is done and the results are following:

Table: 3. Total Weights

Name	Scope	Target Reduction	Predicted Reduction
"Shape Finder"	"Geometry"	20%	11.23%

Table: 4. Total Weights

Name	Original	Optimized	Marginal
"Shape Finder"	1.7385 kg	1.5433 kg	1.22e-02 kg

VI. RESULT AND CONCLUSIONS

The result find out by FEA tool in this present work the value of Equivalent Stress, Shear Elastic Strain and Total Deformation (Shown in Table 3) is well in agreement with available previous results. The weight optimization of connecting rod, consider following properties.

Table: 5. Properties Taken in Optimization Task

Properties	Values
Centroid X	4.1846e-011 m
Centroid Y	1.85e-002 m
Centroid Z	-0.11472 m
Moment of Inertia Ip_1	1.5119e-002 $kg.m^2$
Moment of Inertia Ip_2	1.6078e-002 $kg.m^2$
Moment of Inertia Ip_3	1.3236e-003 $kg.m^2$

This work investigates the weight and cost reduction opportunities that steel C-70 connecting rods offer. The maximum stresses developed near the big end connecting rod, it the region which is more susceptible for failure. The following conclusions can be drawn from this work:

1) The optimization done by considering optimum parameter for suggestion of modification in previous connecting rod.
2) The parameter taken in account to reduce 20% weight of steel C-70 connecting rod.
3) The weight of the steel C-70 connecting rod is reduced by 0.1952 kg, which is about 11.23% of original weight of connecting rod. Thus the optimized connecting rod is 11.23% lighter than original connecting rod.
4) The stress is found maximum at the crank end so the material is increased in stressed portion to minimize the stress.
5) The model presented here, is safe and under permissible limit of stresses.

Abbreviation

CR Connecting rod

FE Finite Element

FEA Finite Element Analysis

Fig Figure

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