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COMPARATIVE ANALYSIS OF MECHANICAL DEFORMATION IN I AND H BEAM CONNECTING ROD WITH DIFFERENT MATERIAL

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Abstract

Connecting Rods are practically generally used in all varieties of automobile engines. Acting as an intermediate link between the piston and the crankshaft of an engine. It is responsible for transmission of the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of rotate motion of crankshaft. Thus, this study aims to carry out for the load, strain and stress analysis of the crank end of the connecting rod of different materials. Based on which the High Strength Carbon connecting rod will be compared with connecting rod made up of Stainless Steel and aluminium alloy. The results can be used for optimization for weight reduction and for design modification of the connecting rod. Pro-E software is used for model and analyses are carried out in ANSYS software. The results archived can also identify the spot or section where chances of failure are high due to stress induced. Also the results obtained can be used to modify the existing designs so that better performance and longer life cycle can be archived.

Key Words: *Connecting Rod, Piston, Engine, Stainless Steel, Aluminium Alloy, Pro-E Software, ANSYS Software*

1.INTRODUCTION

Connecting Rods are used practically generally used in all varieties of automobile engines. Act in gas an intermediate link between the piston and the crank shaft of an engine of an automobile. It is responsible for transmission the up and down motion of the piston to the crankshaft of the engine, by converting the reciprocating motion of the piston to the rotary motion of crankshaft. While the one end, small end the connecting rod is connecting to the piston of the engine by the means of piston pin, the other end, the bigger end being connected to the crankshaft with lower end big end bearing by generally two bolts. Generally connecting rods are being made up of stainless steel and aluminum alloy through the forging process, as this method provides high productivity and that too with a lower production cost. Forces generated on the connected rod are generally by weight and combustion of fuel inside cylinder acts upon piston and then on the connecting rod, which results in both the bendingand axial stresses.

2. OBJECTIVE OF THE STUDY

The objectives of this project are to:

1. Developed a geometrical model for connecting rod using CAD software.

2. Investigate the stress analysis of steel and aluminium alloy of connecting rodusing ANASYS software.
3. Investigate the maximum stress of connecting rod using ANASYS software.

The computational stress from finite element analysis will be carried out on a CAD connecting rod design. The two different materials are chosen for analysis is structural steel and aluminium alloy. The geometry model for the connecting rod had drawn using CAD software. The analysis was running using ANASYS software. The apply load for the analysis is 900 only.

3 .LITERATURE REVIEW

MR.J.D.RAMANI, PROF. SUNIL SHUKLA In series of automobile engine components a connecting rod is highly critical and researchable one. The main idea of this study is to do analysis of connecting rod and get idea of stress producing during compressive and tensile loading. And then give idea about weight reduction opportunities for a production steel connecting rod. This has entailed performing a detailed load analysis. Therefore, this study has contain by two subjects, first, load and stress analysis of the connecting rod, and second, optimization for weight reduction. In the first part of the study, loads acting on the connecting rod and find out stress-time history at some critical point. The results were also used to determine the variation of Tensile and Compressive loading the component was optimized for weight reduction subject to space constraints and manufacturability.

WEBSTER ET AL. (1983) performed three dimensional finite element analysis of a high- speed diesel engine connecting rod. For this analysis they used the maximum compressive load which was measured experimentally, and the maximum tensile load which is essentially the inertia load of the piston assembly mass. The load distributions on the piston pin end and crank end were determined experimentally. They modelled the connecting rod cap separately, and also modelled the bolt pretension using beam elements and multi point constraint equations.

YOO ET AL. (1984) used vibrational equations of elasticity, material derivative idea of continuum mechanics and an ad joint variable technique to calculate shape design sensitivities of stress. The results were used in an iterative optimization algorithm, steepest descent algorithm, to numerically solve an optimal design problem. The focus was on shape design sensitivity analysis with application to the example of a connecting rod. The stress constraints were imposed on principal stresses of inertia and firing loads. But fatigue strength was not addressed. The other constraint was the one on thickness to bound it away from zero. They could obtain 20% weight reduction in the neck region of the connecting rod.

4 .CONNECTING ROD

The connecting rod is the main part of the engine. It rotates the crank shaft that helps the engine of any vehicle to rotate its wheels .It is situated between crank and piston of the engine. It is designed to resist stresses from combustion and piston movement. It is a light weight component. It should withstand with greater power loads though it is lower in weight. The main purpose of a connection rod is to provide fluid movement between pistons and a crankshaft and therefore the connecting rod is beneath tremendous stress from the load represented by the piston. When building a high performance engine, great attention is paid to the connecting rods. The most effective feature of a connecting rod ought to be the uniform shape.

The cross section of rod beam design ought to be spread and minimize stress load over massive uniformly shaped areas. In operation stress are generated and radiate from one or more source on a component because the rod functions. The structure of connecting rod in an engine is shown in the Fig.4.1.

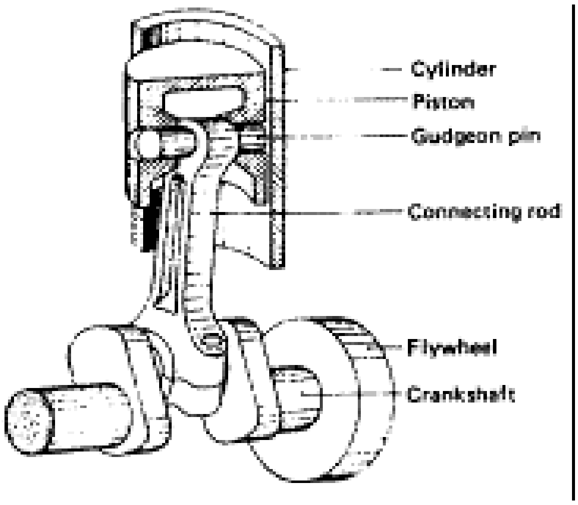


Fig.4.1 Connecting rod in engine

The other objectives are to design and develop a structural model of a connecting rod and to perform a finite element analysis of a connecting rod and to study the all load factors acting on the connecting rod and to study the stress and strain deformations induced in the connecting rod and to develop a structural optimisation model of connecting rod.

5 .METHODOLOGY

1. Design the connecting rod.
2. Material selection.
3. Structure design.
4. Cad modelling.
5. Export to iges format.
6. Import to ansys.
7. Mesh the solid model.
8. Select the analysis method.
9. Put the input value of material.
10. Solve the values by the way of analysis method.
11. Take the result from result data sheet.

6 . MATERIAL USED FOR ANALYSIS

The connecting rods are most usually made of structural steel or aluminum alloy for production engines. These materials have different properties and suitable for different engines.

1. Structural Steel
2. Aluminium Alloy
3. Titanium Alloy
4. Forged Steel
5. Beryllium

7 . 3D MODELING

Modelling of the engine parts and their assembling were carried out with Autodesk Inventor 2018 software. Theoretical calculations and setting of the gauge dimensions were followed by parametric assembling of the engine components. The component parts of the engine and the assembled engine block are presented in figure 3a and in figure 3b, respectively.

Figure 7.1 Component parts of the engine and engine block

8 . MESH GENERATION

The automatic generation method with tetrahedral elements was used for meshing. The solid model of I-beam connecting rod has been meshed into 50309 elements and 82498 (figure 6a) while model of 3D H-beam connecting rod has been meshed into 59143 elements and 96700 nodes

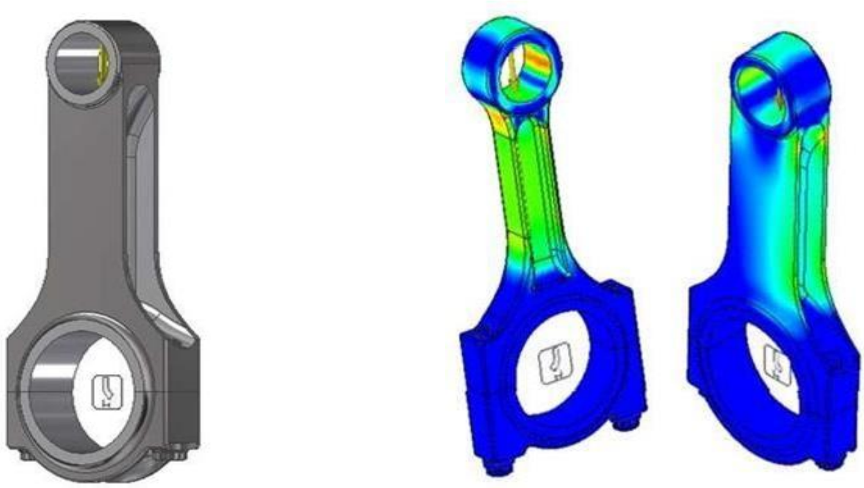


Figure 8 Constraints

9 . MERITS

1. We can easily identify the mechanical deformation of connecting rods.

2. Easily identify the stress analysis.

3. Comparison between different types of materials used in connecting rods.

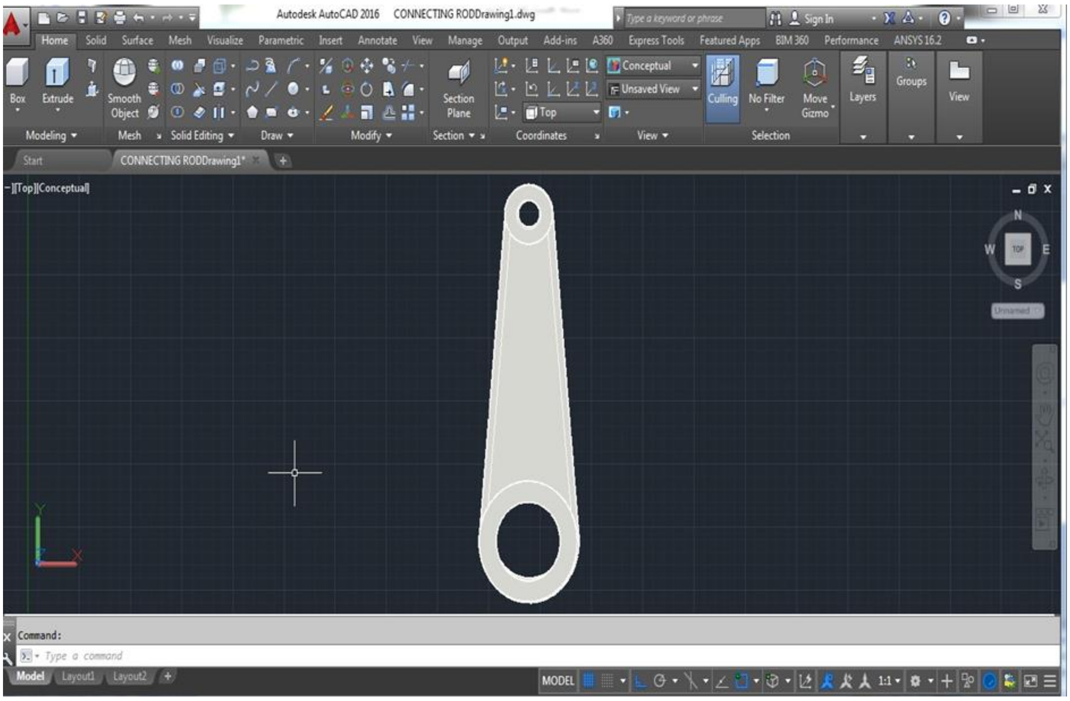
A. Software Used

1. CAD &ANASYS

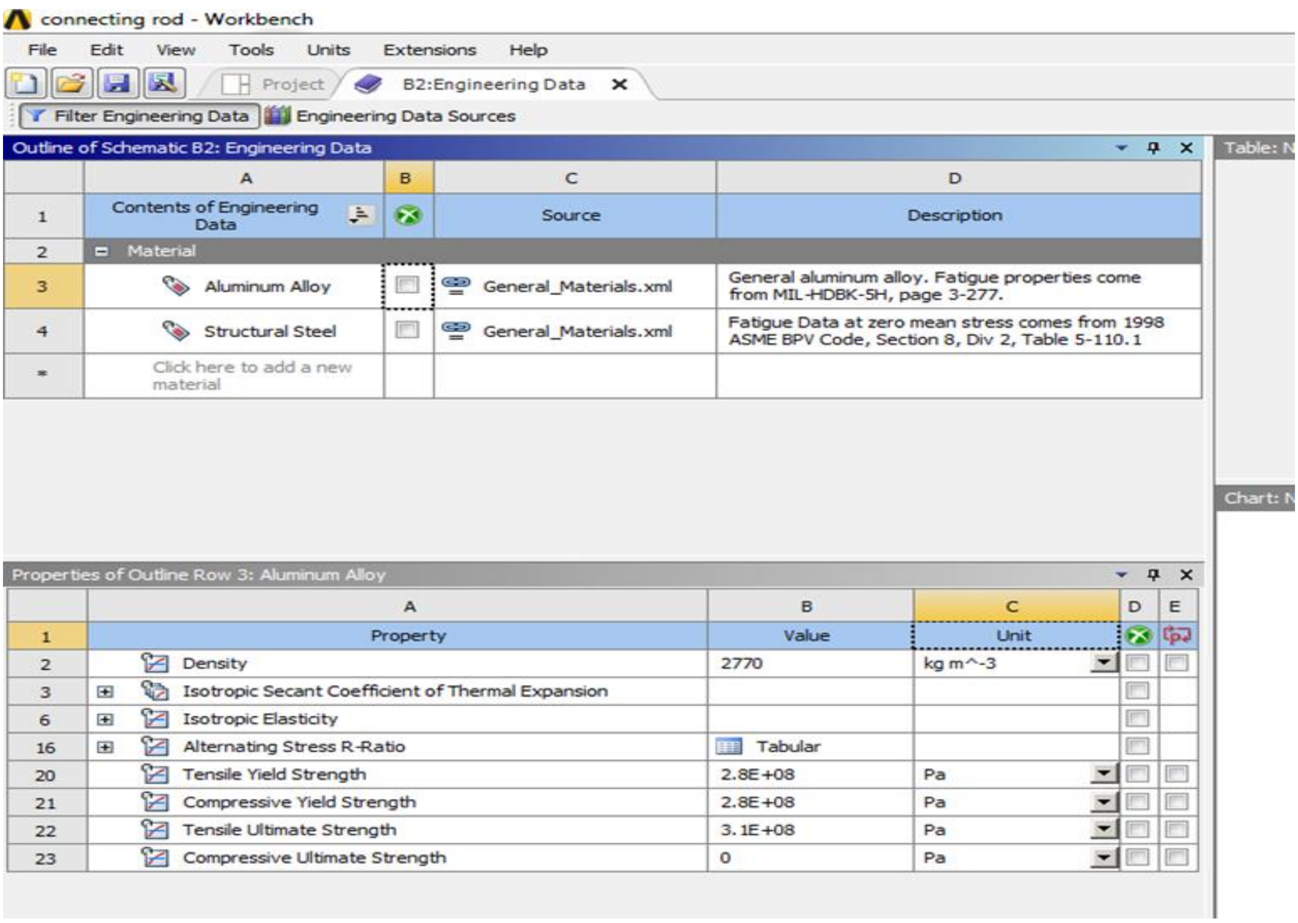
10 . PROCEDURE OF ANALYZING

Structure of the connecting rod:I & H

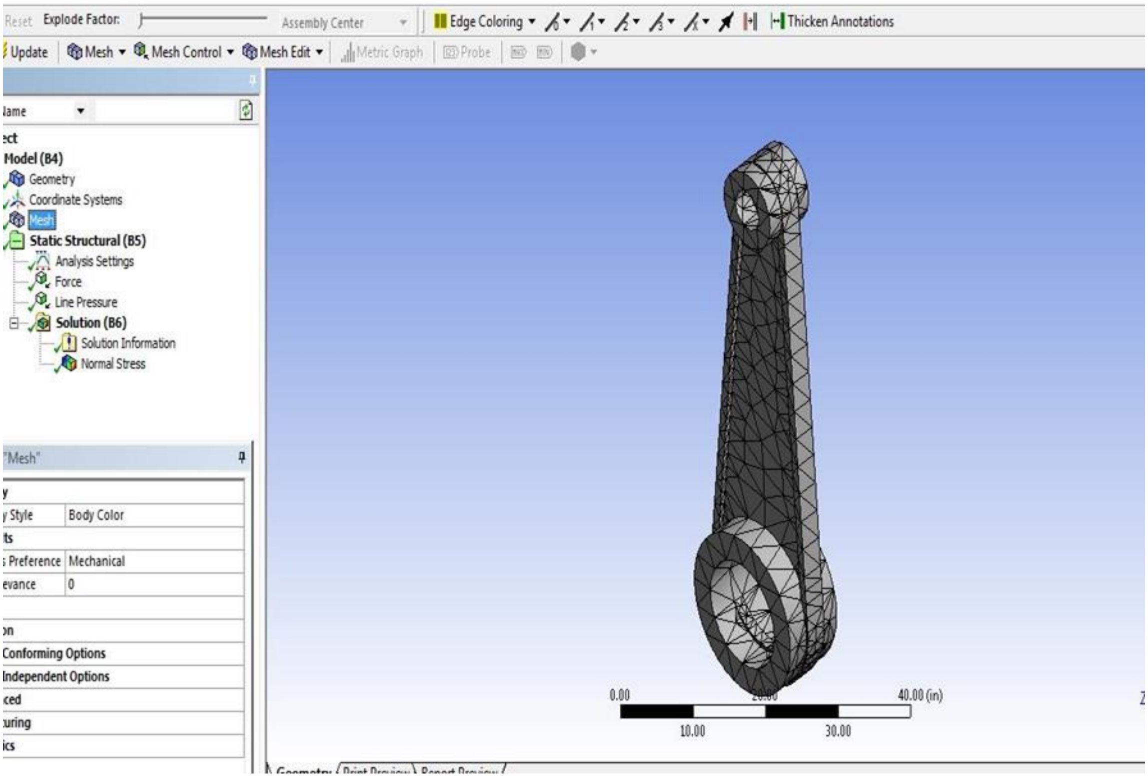
CAD VERSION: AUTOCAD 2016



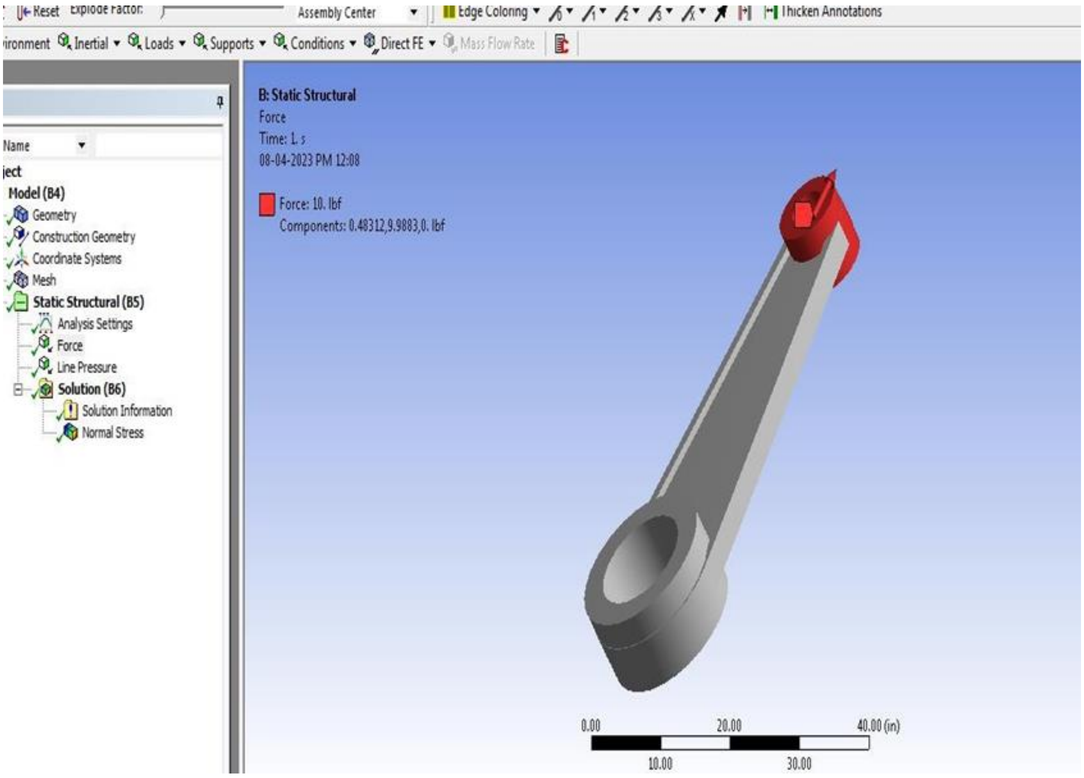
ANASYS MATERIAL SELECTION



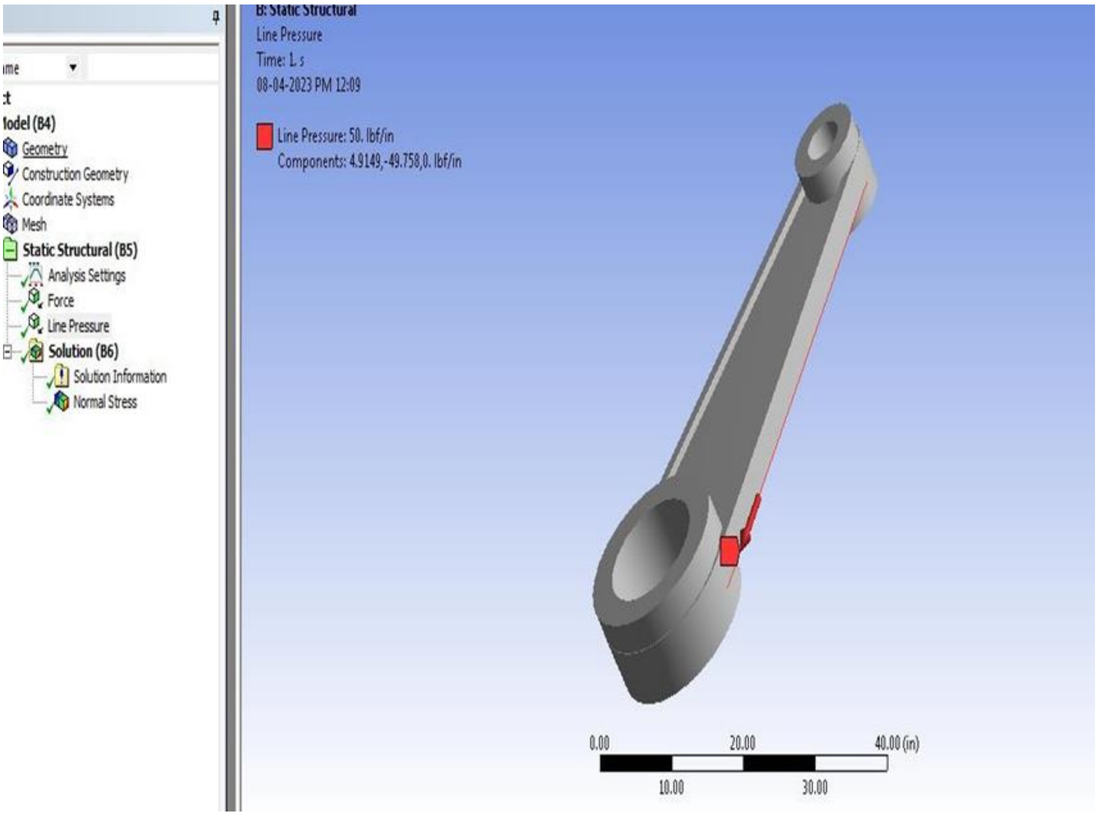
MESH TOOL



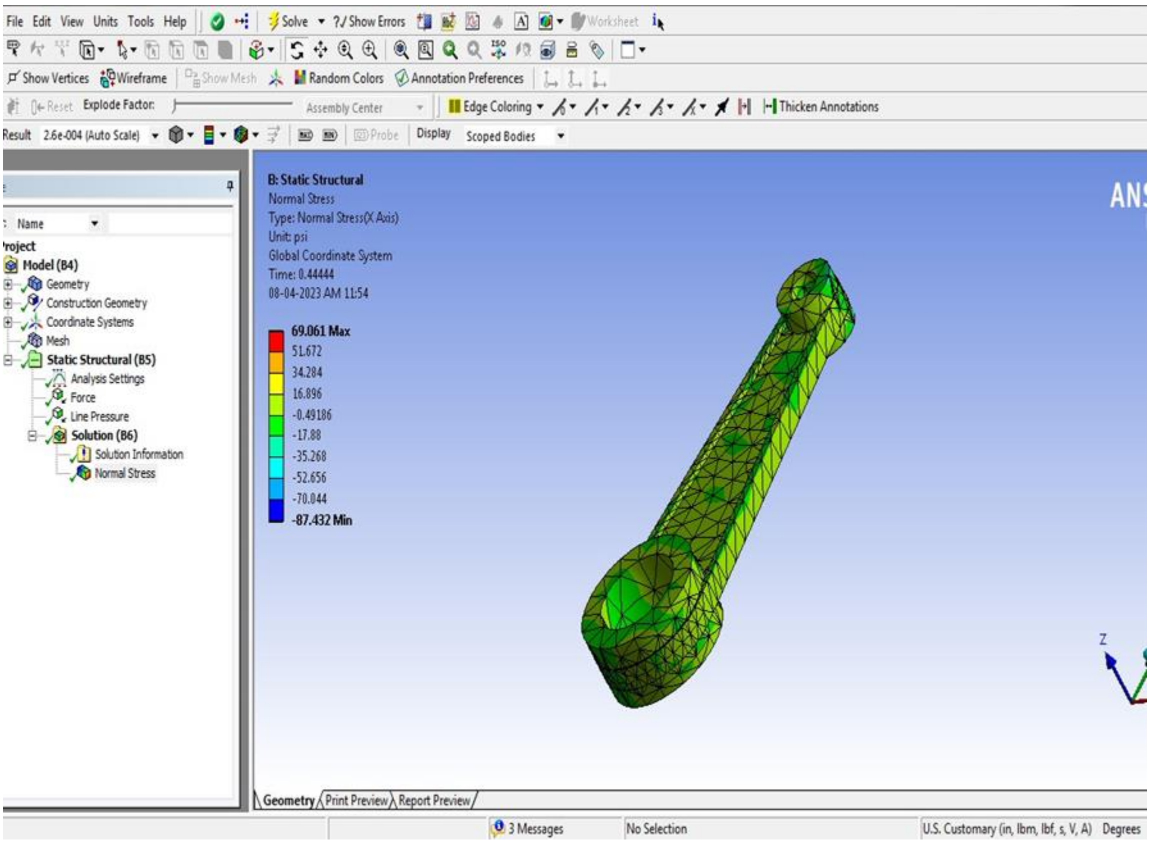
FORCE APPLY



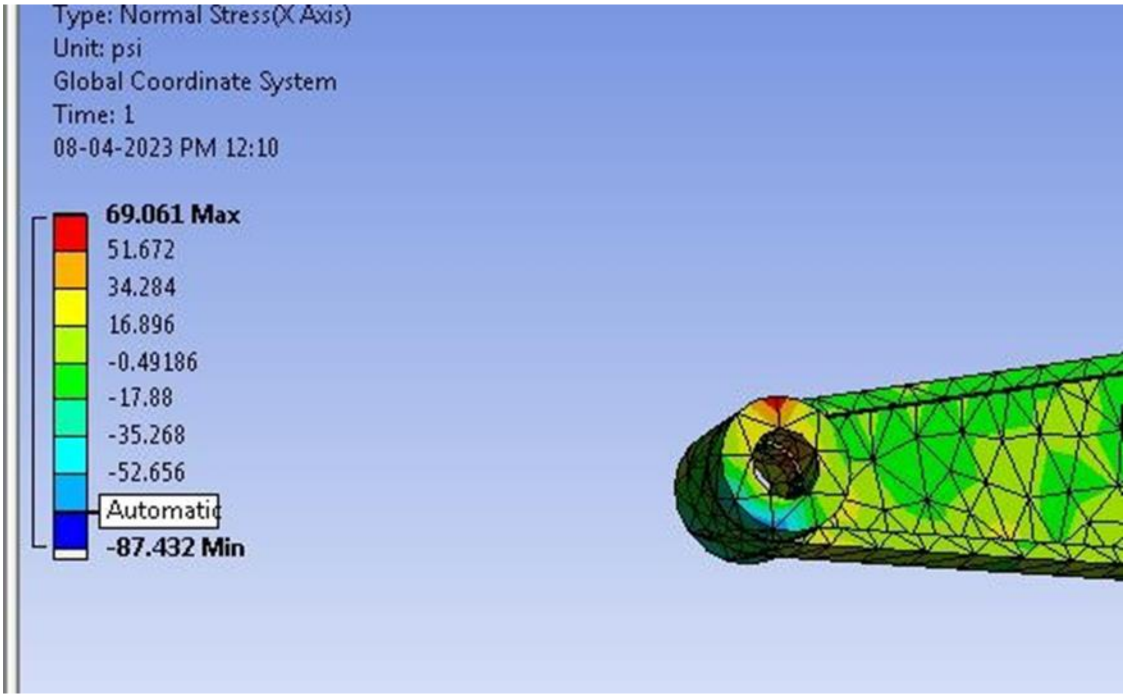
LINE PRESSURE APPLIES

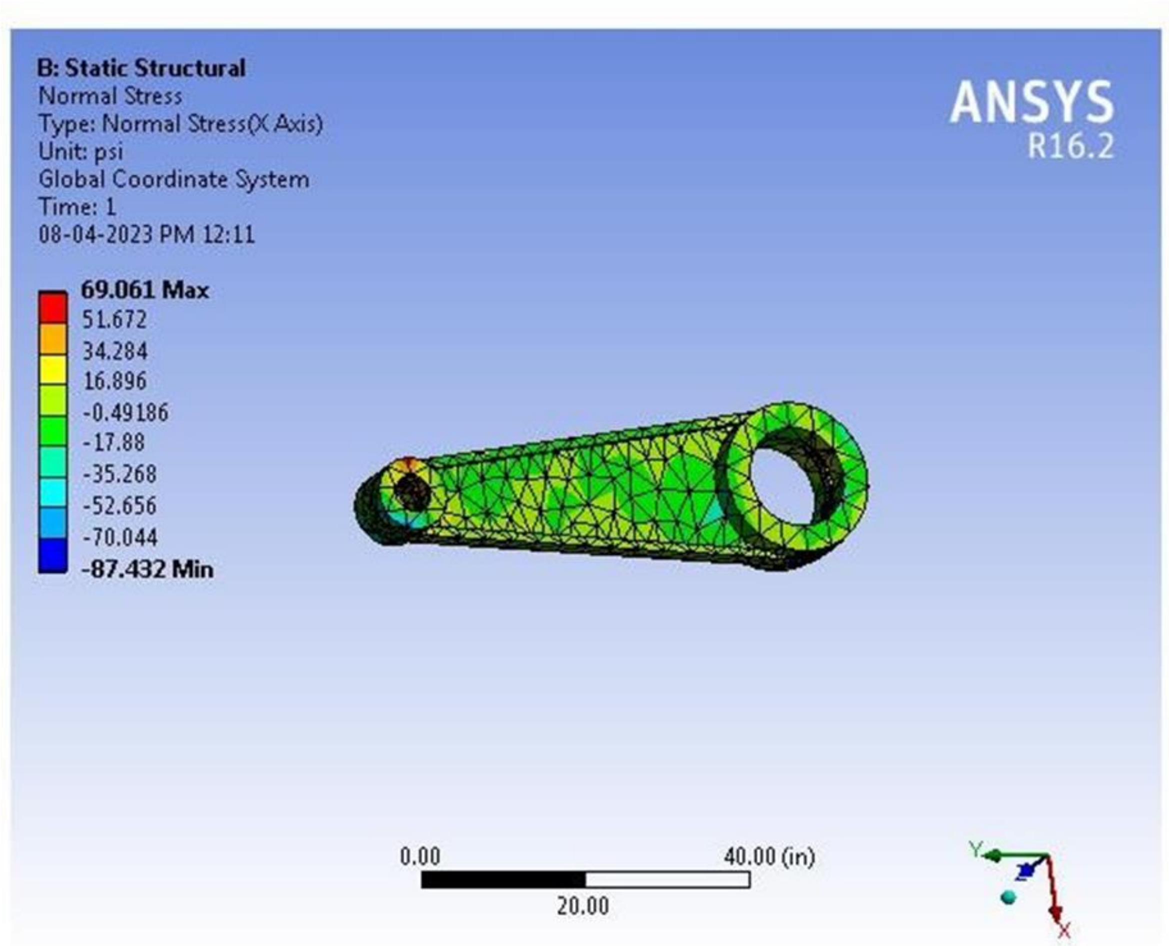


RESULT NORMAL STRESS



MAX STRESS ACTINT POINT

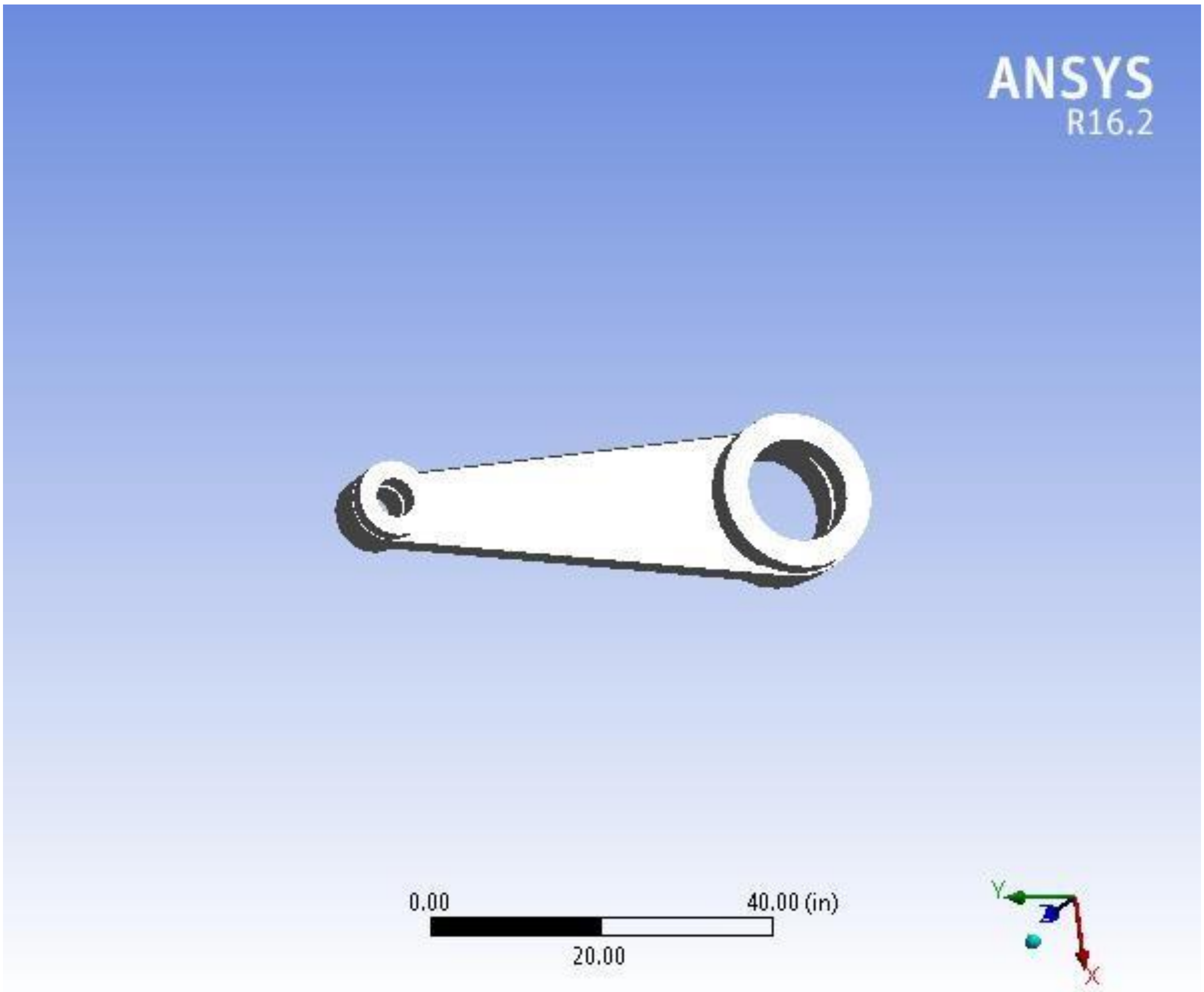




FINAL REPORT:

Project

First Saved	Thursday, March 23, 2023
Last Saved	Saturday, April 08, 2023
Product Version	16.2 Release
Save Project Before Solution	No
Save Project After Solution	No



11 . CONCLUSION

The following conclusions obtained from this study:

1.The maximum stress is between pin-end and rod-linkage, and between bearing-cup and connecting rod linkage.

2.The maximum tensile stress was obtained in lower half of pin end and between pinend and rod linkage.

3.Results of FEM method and results of experimental equations were similar (Maximumdifference was only ±13%) this shows accuracy of our modeling, meshing and loading

4.Common stresses in connecting rods like this connecting rod is between 350 to 650 MPa. It can be extract that cause of high fail of this component is over stresses of common range.

5. Value of F.O.S. (Factor of Safety) of connecting rod is between 1.6 to

1.7. Which indicate Safe Design of Connecting Rod.

12 . REFERENCE

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