DESIGN AND ANALYSIS OF CONNECTING ROD USING DIFFERENT COMPOSITE MATERIALS.

MOHD SAMEERODDIN (Vardhaman College of Engineering), Mechanical Engineering.

MD KASHIF GOHAR DESHMUKH (Vardhaman College of Engineering), Mechanical Engineering.

MOHD NADEEM SULEMAN (Shadan College of Engineering and Technology), Mechanical Engineering.

ABSTRACT:

Connecting rod is one of the important components of the whole engine assembly as it acts as a mediator between piston assembly and crankshaft. It’s converting the reciprocating motion of the piston to rotary motion of the crank; also it faces a lot of tensile and compressive loads during its life time. Generally connecting rods are manufactured using carbon steel and in recent days aluminium alloys are finding its application in connecting rod. In this work connecting rod is replaced by aluminium and it also describes the modelling and thermal analysis of connecting rod. Catia solid modelling software is used to generate the 3-D solid model of Connecting rod. Ansys software is used to analyze the connecting rod. The main aim of the project is to analysis the thermal stresses of connecting rod by varying material with same geometry.

Keywords: connecting rod, ANSYS, thermal analysis, catia, structural steel.

1. INTRODUCTION

1.1 CONNECTING ROD BACKGROUND

Each vehicle that uses an inside burning motor requires no less than one interfacing pole contingent on the quantity of barrels in the motor.

Associating bars for car applications are regularly produced by fashioning from either created steel or powdered metal. They could likewise be thrown. Be that as it may, castings could have blow-openings which are unfavorable from sturdiness and weakness perspectives. The way that forgings deliver blow-gap free and better bars gives them leeway over cast poles.

The associating pole is the middle of the road part between the cylinder and the crankshaft. Its essential capacity is to transmit the push and draw from the cylinder stick to the crankpin and in this
way change over the responding movement of the cylinder into rotating movement of the wrench. It comprises of a long shank, a little end and a major end. The cross - area of shank might be rectangular, round, I-segment tubular-segment or H-segment.

**FORCES ACTING ON THE CONNECTING ROD:**

The various forces acting on the connecting rod are as follows:

1. Force on the piston due to gas pressure and inertia of the reciprocating parts.
2. Force due to inertia of the connecting rod or inertia bending forces.
3. Force due to friction of the piston rings and of the piston, and
4. Force due to friction of the piston pin bearing and the crankpin bearing.

We shall now derive the expressions for the forces acting on a vertical engine, as discussed below.

**2. LITERATURE REVIEW**

The interfacing bar is subjected to a perplexing condition of stacking. It experiences high cyclic heaps of the request of 108 to 109 cycles, which extend from high compressive loads because of ignition, to high ductile loads because of latency. Thusly, toughness of this part is of basic significance. Because of these elements, the interfacing bar has been the theme of research for various angles, for example, creation innovation, materials, execution reenactment, exhaustion, and so on. For the present examination, it was important to explore limited component demonstrating methods, enhancement strategies, improvements underway innovation, new materials, weariness displaying, and producing cost investigation. This concise writing study audits some of these viewpoints.

Mohamed AbdusalamHussin1, Er. Prabhat Kumar Sinha2, Dr. Arvind Saran Darbari(2014) design and examination of associating pole utilizing aluminum amalgam 7068 T6, T6511This paper portrays outlining and Analysis of interfacing bar. As of now existing interfacing pole is produced by utilizing Forged steel. In this illustration is drafted from the estimations. A parametric model of Connecting pole is demonstrated utilizing SOLID WORK programming and to that model, examination is done by utilizing ANSYS.

- Dr. N. A. Wankhade1, Suchita Ingale2(2017) Review on Design and Analysis of Connecting Rod Using DifferentMaterial Forces created on the associated bar are by and large by weight and ignition of fuel inside chamber follows up on cylinder and afterward on the interfacing bar, which brings about both the twisting and pivotal burdens. The present paper endeavors to plan and break down the interfacing pole utilized as a part of a diesel motor in setting of the parallel bowing powers acting along its length amid cycle of it The horizontal twisting pressure are usually called as whipping pressure and this whipping pressure frames the base of assessment of execution of different materials that can be utilized for assembling of associating bar. The customary material utilized is steel which is designe utilizing CAD apparatus which is CATIA V5 and thusly broke down for twisting pressure following up on it in the field of limited component examination utilizing ANSYS workbench
14.5 and this method is taken after for various material which are aluminum 7075, aluminum 6061 and High Strength Carbon.

- D.Gopinatha, Ch.V.Sushma, al (2015) Design and Optimization of Four Wheeler Connecting Rod Using Finite Element Analysis, The main objective of research was to explore weight reduction opportunities for the production of forged steel, aluminium and titanium connecting rods. This has entailed performing a detailed load analysis. Therefore, this study has dealt with two subjects, first, static load stress analysis of the connecting rod for three materials, and second, optimization for weight of forged steel connecting rod. In this research, firstly a proper geometrical model was developed using CATIA. Then the model is imported to the HYPERMESH which is a finite element pre-processor that provides a highly interactive and visual environment to analyse product design performance and the Finite Element model was developed. The stresses were found in the existing connecting rod for the given loading conditions using Finite Element Analysis software ANSYS 11.0. The topology optimization technique is used to achieve the objectives of optimization which is to reduce the weight of the connecting rod.

### 3.1 DESIGN:

CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages of product design whether started from scratch or from 2D sketches. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse.

![Fig 3.1: Sketch of model](image1)

**Fig 3.1:** Sketch of model

![Fig 3.2: 3d model](image2)

**Fig 3.2:** 3d model

### 4 Ansys:

ANSYS is general-purpose finite element analysis software, which enables engineers to perform the following tasks:

1. Build computer models or transfer CAD model of structures, products, components or systems
2. Apply operating loads or other design performance conditions.
3. Study the physical responses such as stress levels, temperatures distributions or the impact of electromagnetic fields.
4. Optimize a design early in the development process to reduce production costs.
5. A typical ANSYS analysis has three distinct steps.
6. Pre Processor (Build the Model).
al203 material properties:

<table>
<thead>
<tr>
<th>Density</th>
<th>Young's Modulus MPa</th>
<th>Poisson's Ratio</th>
<th>Bulk Modulus MPa</th>
<th>Shear Modulus MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.46e-006 kg mm^-3</td>
<td>16,900</td>
<td>0.3</td>
<td>14,083</td>
<td>6500</td>
</tr>
</tbody>
</table>

forged steel material properties

<table>
<thead>
<tr>
<th>Density</th>
<th>Young's Modulus MPa</th>
<th>Poisson's Ratio</th>
<th>Bulk Modulus MPa</th>
<th>Shear Modulus MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.85e-006 kg mm^-3</td>
<td>2.1e+005</td>
<td>0.3</td>
<td>1.75e+005</td>
<td>80769</td>
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</tbody>
</table>

titanium TIC material properties

<table>
<thead>
<tr>
<th>Density</th>
<th>Young's Modulus MPa</th>
<th>Poisson's Ratio</th>
<th>Bulk Modulus MPa</th>
<th>Shear Modulus MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.93e-006 kg mm^-3</td>
<td>5.1e+005</td>
<td>0.191</td>
<td>2.7508e+005</td>
<td>2.1411e+005</td>
</tr>
</tbody>
</table>

- Material Data : al203

Results:

<table>
<thead>
<tr>
<th>Object Name</th>
<th>Total Deformation</th>
<th>Directinal Deformation</th>
<th>Equivalent Elastic Strain</th>
<th>Shear Elastic Strain</th>
<th>Equivalent Stress</th>
<th>Shear Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>1.092e-004 mm</td>
<td>1.213e-002 mm</td>
<td>6.581e-007 mm/m/m</td>
<td>1.63e-003 mm/m/mm</td>
<td>6.378e-003 MPa</td>
<td>10.607 MPa</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.16823 mm</td>
<td>1.2455e-002 mm</td>
<td>8.919e-003 mm/m/m</td>
<td>1.99e-003 mm/m/mm</td>
<td>150.4 MPa</td>
<td>12.983 MPa</td>
</tr>
</tbody>
</table>

Total Deformation

Equivalent Elastic Strain

Equivalent Stress

Material Data of forged steel:

Results:

<table>
<thead>
<tr>
<th>Object Name</th>
<th>Total Deformation</th>
<th>Directinal Deformation</th>
<th>Equivalent Elastic Strain</th>
<th>Shear Elastic Strain</th>
<th>Equivalent Stress</th>
<th>Shear Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>7.9893e-004 mm</td>
<td>-2.521e-003 mm</td>
<td>5.3122e-008 mm/m/m</td>
<td>-1.3188e-004 mm/m/m</td>
<td>6.409e-003 MPa</td>
<td>-10.652 MPa</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.3205e-002 mm</td>
<td>-5.5104e-004 mm</td>
<td>7.231e-004 mm/m/m</td>
<td>1.6131e-004 mm/m/m</td>
<td>151.6 MPa</td>
<td>13.029 MPa</td>
</tr>
</tbody>
</table>

Total Deformation
### Equivalent Elastic Strain

![Equivalent Elastic Strain Image]

### Equivalent Stress

![Equivalent Stress Image]

From this project results are obtained from ansys software with accurate design and dynamic analysis and loads are taken from original connecting rod values and design measurements also taken connecting rod design formulas and above results are observing:

- Deformation value is less in AL203 comparing with existing material.
- Equivalent Stress are least in AL203 materials comparing with other two materials.
- Equivalent Total Strain is more in AL203 materials comparing with other two materials.
- Comparing with existing material AL203 materials is more in Shear Elastic Strain, Equivalent Total Strain, Stress Intensity, and better in structural error.

Comparing with existing material aluminum alloy is more in Equivalent Stress, Shear Elastic Strain,
CONCLUSION

In this thesis, a broken connecting rod made of forged steel is replaced with Titanium TIC and AL203. The materials are changed so that the weight of the connecting rod is less when Titanium TIC and AL203 are used compared to Forged Steel. The connecting rod is modeled in Catia, forces are calculated. Analysis is done on the connecting rod using materials Titanium TIC and AL203. After validating the analysis results,

- Forged steel Mass: 0.19498 kg,
  Titanium TIC Mass: 0.12245 kg
  AL203: Mass 8.5942e-002 kg, less weight obtained for AL203 comparing to the other materials

- In order to optimize the stress of connecting rod we have changed some of its parameters and the stress level gets reduced in AL203
- A weak and strong section of connecting rod is verified and possible modifications have been done to correct it.
- Some of the mistakes in reference data is being corrected by us through calculation and analysis of connecting rod.
- A comparison is also made between theoretical factor of safety which is less than working factor of safety (factor of safety obtained in Ansys).
- We could not bring a major change in the existing design.
- The result obtained by us is nearly equal to the reference paper result and any change in this result is not very much favorable.

Reference:


5. Mohammed Mohsin Ali Ha, Mohamed Haneef Analysis of Fatigue Stresses on Connecting Rod Subjected to Concentrated Loads At The Big End