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# Comparative Study of the Connecting Rod Manufactured Using Forging and Sintering

Kadiam Bhargav V Siva Kumar

**Abstract**— Connecting rod is a major part inside of an internal combustion engine. The rod connects the crankshaft with the piston. The connecting rod pushes the piston up, and is helped back down by the piston's reciprocal motion. In this paper a structural and thermal analysis is conducted on a connecting rod of a two cylinder 4-stroke S217 engine. The model is developed using Solid modeling software i.e. PRO/E. Further finite element analysis is done to determine the von-misses stresses shear stress, strains and heat distribution for the given loading conditions.

**Keywords** — ANSYS Workbench, connecting rod, Finite Element analysis, PRO/E

## 1 INTRODUCTION

Connecting rod is a component produced in large volumes in the internal combustion engine. Connecting rod is an integral component of internal combustion engine and it is classified under functional component. It acts as a linkage between piston and crank shaft. The main function of connecting rod is to transmit the translational motion of piston to rotational motion of crank shaft. It connects the piston to the crank shaft .The connecting rod transfers power from the piston to the crankshaft and delivers it in to transmission. There are several types of materials and manufacturing processes used in the production of connecting rods like casting, forging, and powdered metallurgy.

## 2 DESIGN CALCULATIONS FOR CONNECTING ROD

### 2.1 Engine specifications

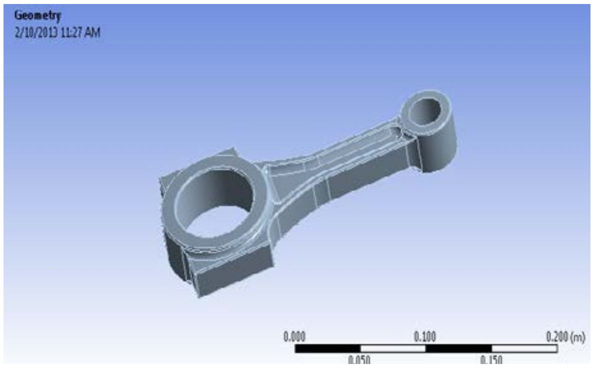
Type-S217 --- two cylinders, Four Stroke, Direct injection
Bore--- 92 mm
Stroke --- 127 mm
Cubic Capacity --- 1.7 litres
Compression Ratio --- 18.5:1

### 2.2 Dimensions of the connecting rod

Length of connecting rod----- 232 mm
Small end radius------ 12.50 mm
Big end radius------ 30 mm

## 3 FINITE ELEMENT MODEL

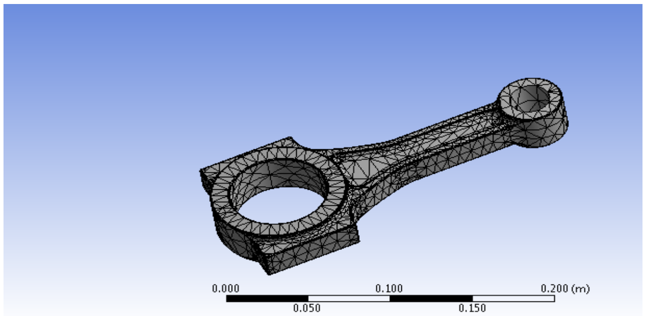
Fig shows the 3-Dimensional model in PRO/E environment.




The procedure of using FEM usually consists of following steps. (a) Applying the material; (b) meshing; (c) determining and imposing loads and boundary conditions; (d) solving ; (e)simulation.

## 4 MESHING

Figure shows the meshed model in ansys consisting of 23307 nodes and 13367 elements.




## 5 DEFINING MATERIAL PROPERTIES

The ansys demands for material properties which are defined using module engineering data.

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| Material property | Forged steel | Sintered steel |
| --- | --- | --- |
| Poisson Ratio | 0.3 | 0.3 |
| Density kg/m3 | 7850 | 7418 |
| Young's Modulus (GPa) | 210 | 221 |
| Tensile Yield Strength (MPa) | 550 | 250 |
| Tensile Ultimate Strength(MPa) | 900 | 460 |
| Compressive Yield Strength(MPa) | 550 | 250 |
| Thermal conductivity(W/m*K) | 29.3 | 21.54 |

## 6 LOADS AND BOUNDARY CONDITIONS

### 6.1 Boundary Conditions for structural analysis

The big end of the connecting rod is fixed in all degrees of freedom.

At the small end pressure of 8Mpa is distributed on the outer end .Considering the following calculation…..

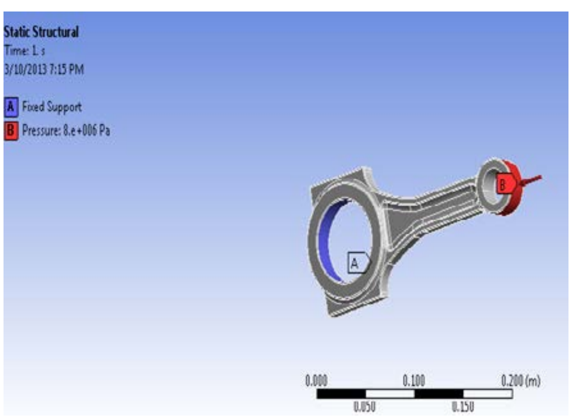
Compressive peak pressure=80 bar=8*106 Pa

Weight of the piston for the engine (m) =0.6 kg

a= area of the piston= π*B2/4=6.647e-3 m2

Pressure (p) = F/a=884.61 Pa

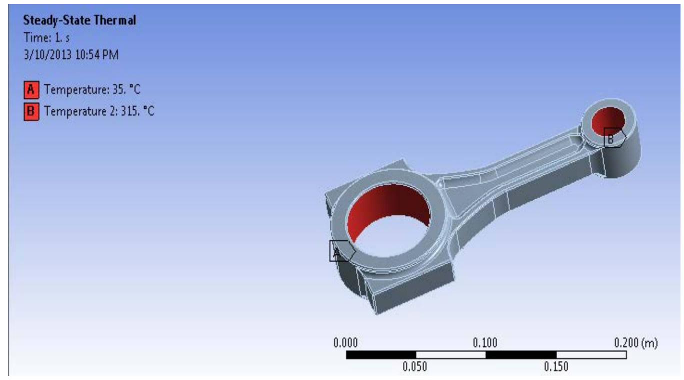
Total pressure on piston end =8 MPa




### 6.2 Boundary Conditions for thermal analysis

Temperature at the big end: 35oc

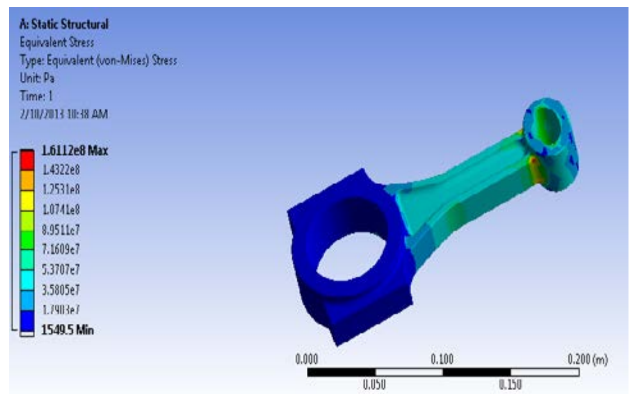
Temperature at the small end: 315oc



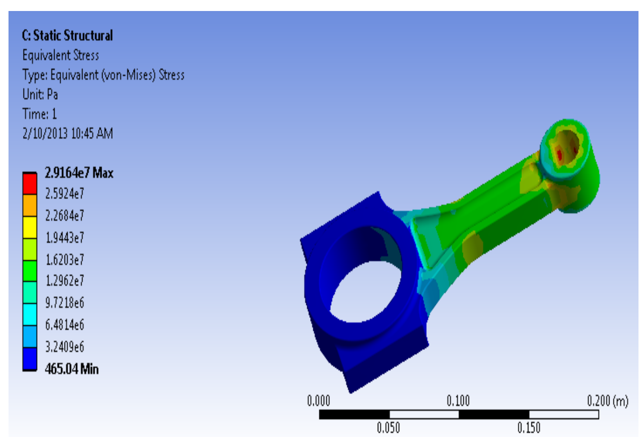

## 7 OUTPUT OF THE ANALYSIS

### 7.1 Structural analysis

**Forging**




**Sintering**

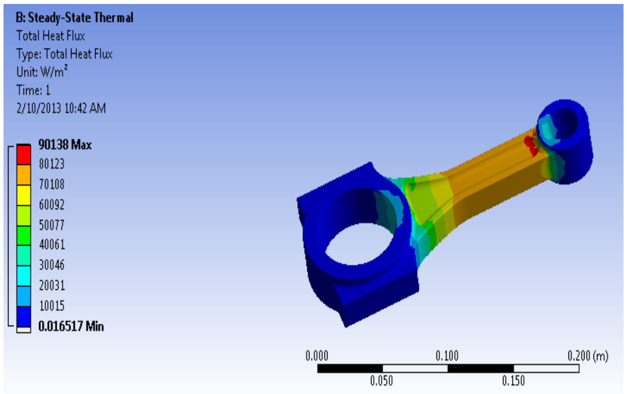



**INFERENCE**

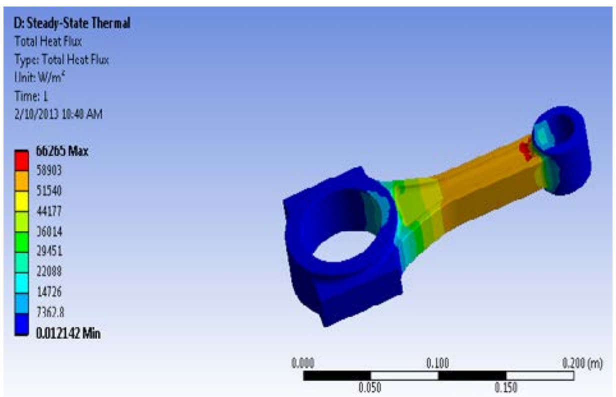
Forged connecting rod has value greater than sintering due to higher density of forging process

### 7.2 Thermal analysis

**Forging**




### Sintering




### INFERENCE

Due to higher density for the forged connecting rod it has greater total heat flux.

## 8 RESULTS

| | Forging | Sintering |
|---|---|---|
| **Von-mises stress(Pa)** | $1.6112*10^{8}$ | $2.9167*10^{7}$ |
| **Total heat flux (W/m2)** | 90138 | 66265 |

## 9 CONCLUSIONS

- The von-mises stress for the forged connecting rod is higher than that of the sintered one
- The analysis results shows that the connecting rod produced by sintering has less total deformation and strain energy than the connecting rod manufactured by forging.
- The total heat flux, directional heat flux and thermal error are higher for the forged connecting rod compared to the sintered connecting rod

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