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RESEARCH ARTICLE

FINITE ELEMENT ANALYSIS OF CONNECTING ROD UNDER STATIC LOADING CONDITION

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ABSTRACT

An engine connecting rod is dynamic component of a vehicle, transmitting the axial cyclic motion of piston to the rotational motion of crankshaft. The connecting rod is therefore considered as a key component in terms of the structural durability and efficiency of an engine. Connecting rod is a major link inside of an I.C engine. Its primary function is to transmit the push and pull from the piston pin to the crank pin thus converting the reciprocating motion of piston into rotary motion of the crank. In the present investigation a 4-stroke petrol engine of a specified model, market available connecting rod is selected for the investigation. For present investigation the designed connecting rod is modeled using solid modeling software i.e. catia. The modeled connecting rod imported to the hypermesh for the meshing purpose. Later it is imported to abaqus for analysis. In this analysis four materials are selected and analyzed. The software results of four materials are compared and utilized for designing the connecting rod.

INTRODUCTION

Connecting rod is a major link inside of a combustion engine. It connects the piston to the crankshaft and is responsible for transferring power from the piston to the crankshaft and sending it to the transmission. There are different types of materials and production methods used in the creation of connecting rods. The most common types of connecting rods are steel and aluminum.

The most common type of manufacturing processes are casting, forging and powdered metallurgy. Connecting rod is among large volume production component in the I.C engine. They are different types of materials and production methods used in the creation of connecting rods. The major stresses induced in the connecting rod are combination of axial and bending stresses in operation. The axial stresses are produced due to cylinder gas pressure (compressive only) and the inertia force arising in account of reciprocating action (both tensile as well as compressive), whereas bending stresses are caused due to the centrifugal effects. It consists of a long shank, a small end and a big end. The cross-section of the shank may be rectangular, circular, tubular, I-section or H-section. Generally circular section is used for low speed engines while I-section is preferred for high speed engines.

In modern automotive internal combustion engine, the connecting rods are most usually made of steel for production engine. But can be made of aluminum or titanium for high performance of engines of cast iron for application such as motor scooters.

They are not rigidly fixed at either end , so that the angle between the connecting rod and piston can change as the rod moves up and down and rotates around the crank shaft .T he big end connects to the bearings journal on the throw connecting rod is under tremendous stress from the reciprocating load represented by the piston ,actually stretching and being compressed with every rotation, and the load increases to the third power with increasing engine speed. Connecting rod for automotive applications are typically manufactured by forging from either wrought steel or powder metal [4]. Schematic diagram for connecting rod as shown in figure: 1.

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Figure 1 Model of connecting rod

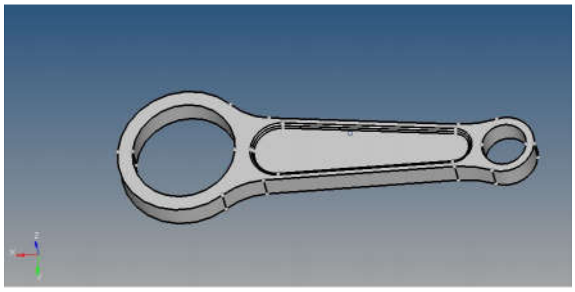

Figure 2 Catia Model of connecting rod

Table 1 Dimensions of connecting rod

Sl no	Parameter	Value
1	Length of connecting rod	94.27 mm
2	Outer diameter of big end	39.02 mm
3	Inner diameter of big end	30.19 mm
4	Outer diameter of small end	17.75 mm
5	Inner diameter of small end	13.02 mm

METHOD AND SOFTWARE USED

Fea

The finite element analysis (FEA) is a computing technique that is used to obtain approximate solutions to the boundary value problems in engineering. It uses a numerical technique called the finite element method (FEM) to solve boundary value problems. FEA involves a computer model of a design that is loaded and analyzed for specific results.

Abaqus

ABAQUS is being used by designers across a broad spectrum of industries such as aerospace, automotive, manufacturing, nuclear, electronics, biomedical, and many more. ABAQUS provides simulation solutions that enable designers to simulate design performance directly on desktop. In this way, it provides fast, efficient and cost-effective product development from design concept stage to performance validation stage of the product development cycle. ABAQUS package help to accelerate and streamline the product development process by helping designers to resolve issues related to structural deformation, heat transfer, fluid flow, electromagnetic effects, a combination of these phenomena acting together, and so on.

Modeling

Connecting rod of Hero Honda splendor, market available is selected for the present investigation. The dimensions of the selected connecting rod are found using vernier calipers, screw gauge and are tabulated and presented in the Table 1. The material of Connecting rod is Cast Iron. According to the dimensions, the model of the connecting rod is developed using CATIA. It is imported into design modeler of ABAQUS. The modeled connecting rod is as shown in figure: 2. In this analysis four materials are used materials are,

1. Aluminum 360
2. Cast Iron
3. C70S6 Steel
4. Structural Steel

MATERIAL PROPERTIES

The material used for selected connecting rod is Cast Iron and the properties of the material are presented in the Table 2

Table 2 Property of Cast iron

Sl no	Material Properties	Cast iron
1	Young's modulus	1.78e5 MPa
2	Density	7.197e-6Kg mm^3
3	Poison's ratio	0.3
4	Tensile strength	100 to 200MPa
5	Compressive strength	400 to 1000MPa
6	Shear strength	120MPa

The material used for selected connecting rod is structural steel and the properties of the material are presented in the Table 3

Table 3 Property of structural steel

Sl no	Material Properties	Structural steel
1	Young's modulus	2e5 MPa
2	Density	7.85e-6Kg mm^3
3	Poison's ratio	0.3
4	Tensile strength	460 MPa
5	Compressive strength	250 MPa
6	Shear strength	250 MPa

The material used for selected connecting rod is aluminum 360 and the properties of the material are presented in the Table 4

Table 4 Property of Aluminum 360

Sl no	Material Properties	Aluminum 360
1	Young's modulus	80e3 MPa
2	Density	2.68e-6Kg mm^3
3	Poison's ratio	0.33
4	Tensile strength	303 MPa
5	Compressive strength	170 MPa
6	Shear strength	190 MPa

The material used for selected connecting rod is C70S6 and the properties of the material are presented in the Table 5

Table 5 Property of C70S6

Sl no	Material Properties	C70S6
1	Young's modulus	210e3 MPa
2	Density	7.85e-6Kg mm^3
3	Poison's ratio	0.3
4	Tensile strength	550 MPa
5	Compressive strength	550 MPa
6	Shear strength	190 MPa

RESULTS AND DISCUSIONS

The connecting rod is imported to hypermesh where we carried out meshing by making use of hexa element with the size of 3mm size. Applying the boundary conditions i.e fixing the bid end and applying the load of 677N at the small end of connecting rod.

The material used for connecting rod is cast iron.

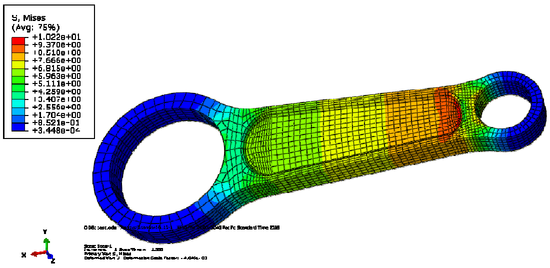

Figure 3 Von misses stress

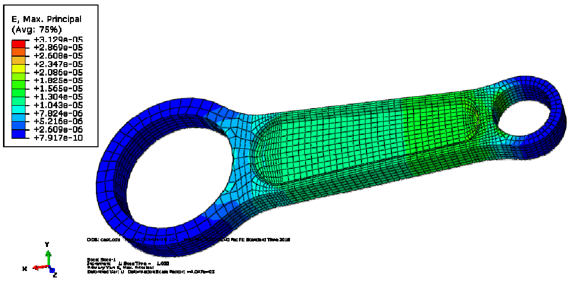

Figure 4 Elastic strain of cast iron material

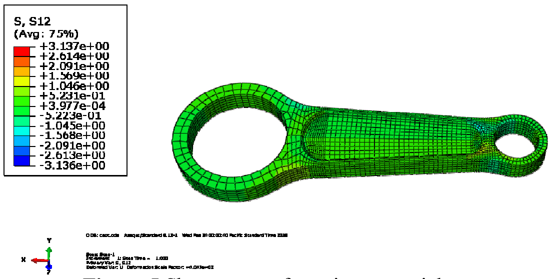

Figure 5 Shear stress of cast iron material

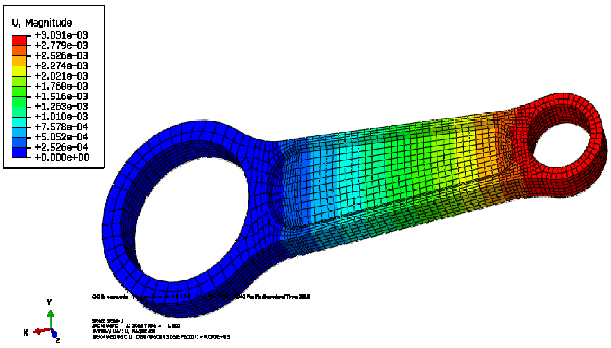

Figure 6 Deformation of cast iron material

The material used for connecting rod is aluminum 360

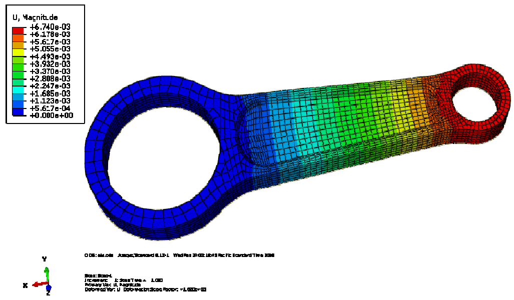

Fig 7 Deformation of aluminum 360

The maximum deformation occurs at the small end i.e 6.740e-3 and the minimum deformation occurs at the big end.

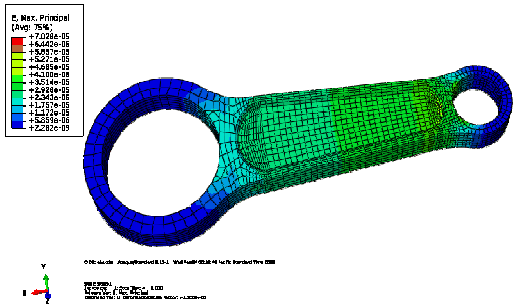

Figure 8 Elastic strain of aluminum 360

The maximum strain occurs at the small end i.e 7.028e-5 and the minimum deformation occurs at the big end 2.282e-9.

Material used for connecting rod is C70S6 Steel

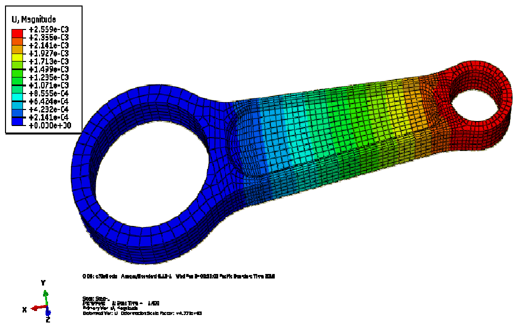

Figure 9 Deformation of C70S6 Steel

The maximum deformation occurs at the small end i.e. 2.569e-3 and the minimum deformation occurs at the big end.

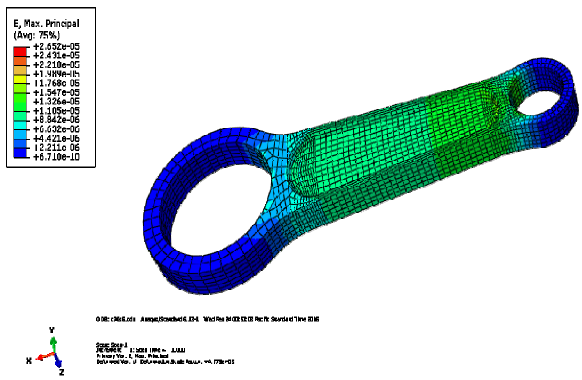

Figure 10 Strain results of C70S6

The material used for connecting rod is structural steel

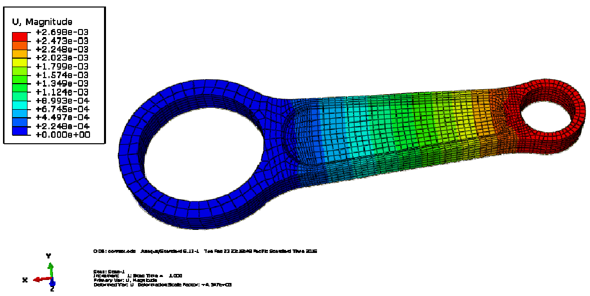

Figure 11 Deformation of structural steel material

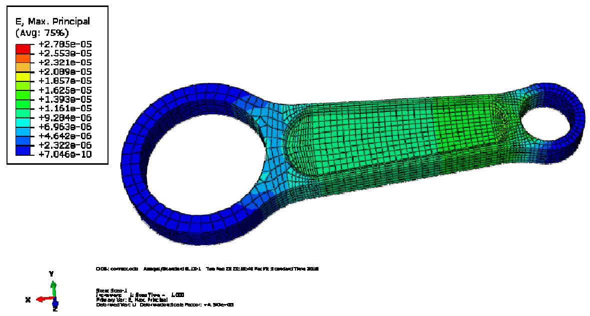

Figure 12 Strain results for structural steel materials

Comparison Table

Table 6 Comparison results

Sl no	Type	Cast iron	Aluminum 360	C70S6	Structural steel
1	Deformation	30031e-3mm	6.74e-3mm	2.56e-3mm	2.69e-3mm
2	Strain	3.12e-5	7.028e-5	2.65e-5	2.78e-5

CONCLUSIONS

Finite element analysis of the connecting rod of a Hero Honda Splendor has been done using FEA tool ABAQUS.

1. The static analysis is carried out by abaqus tool as we got the von-misses stress, shear stress, and deformation and strain results.
2. From the above table of static analysis, the stress induced by using ANSYS is less than the material allowable limit of stress. So the model presented here is well for safe design under given loading conditions
3. Maximum stress occurs at the piston end of the connecting rod. Von-mises stress, principal stress and shear stress are same for Cast Ion, Aluminum 360, C70S6 Steel and Structural Steel because of same load is applied.
4. Comparing the different results obtained from the analysis, it is concluded that the Deformation and Elastic Strain induced in the C70S6 Steel is less than the Cast Iron for the present investigation. Here C70S6 Steel can be used for production of connecting rod for long durability as cast iron is brittle material.

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