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Simulation and Modelling of Connecting rod of IC by Using Material C70S6

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A B S T R A C T

The role of the connecting rod is to transmit the thrust force which is developed in the cylinder as a consequence of the combustion of the fuel during the power cycle, to the crankshaft for availing the rotating motion to drive an automobile. It acts as a transitional connection among the piston and crankshaft which changes the reciprocating motion of piston into the rotary motion of the crankshaft.

The aim of this research work is to determine the best design parameters of the connecting rod to reduce critical buckling stress for existing material C70S6. Now a day this material is widely using in different automobile sector.

Keywords: Image Connecting Rod, Simulation, Stress, Deformation

1. INTRODUCTION

Connecting rod is a main part in an internal combustion engine of automobile vehicle. Almost all automobile vehicles that has an internal combustion engine requires at least one or more connecting rods which depend upon the number of cylinders used in the I.C. engine. The role of connecting rod conveys thrust force in the cylinder. Crankshaft provides rotational motion to drive a vehicle. It performances as an intermediate link between piston and crankshaft, transforms the reciprocating motion of piston into the rotary motion of the crankshaft. Both end of the connecting rod are shaped like as human eyes. In this, upper end has small end and lower one is larger end, which is connected by a beam like shank. The upper portion of the connecting rod is attached to the piston using a gudgeon pin, while the lower end is connected to the crankshaft by means of crank pin. It may be noted that the smaller length will decrease the ratio l / r. This increases the angularity of the connecting rod which increases the side thrust of the piston against the cylinder liner which in turn increases the wear of the liner. The larger length of the connecting rod will increase the ratio l / r [1-4] This decreases the angularity of the connecting rod and thus decreases the side thrust and the resulting wear of the cylinder. But the larger length of the connecting rod increases the overall height of the engine. Hence, a compromise is made and the ratio l / r is generally kept as 4 to 5.Connecting rod having different type of section such as I section and H section. Usually two types of connecting rod are broadly used in vehicle. Figure 1 shows the type of connecting rod.D.Gopinath et al. The aim of authors study was to reduce the weight of connecting rods and optimization of connecting rod made by different material such as forged steel, aluminium and titanium. They had selected three different types of materials forged steel, aluminum and titanium and also calculate the load calculation for the connecting rod. Static stress analysis was done for the all the connecting rod for three materials and then Vonmises stresses and shear stresses among these materials were compared and then optimize the weight of forged steel connecting rod. The rib and the web thicknesses were reduced, while maintaining forgebility. Based on the conclusion the following results were observed. Mass of the optimized connecting rod was 483 grams and the optimized geometry was 10.38% lighter than the current connecting rod for the same strength. The stresses occurred in the transition area between pin end and crank end as well as shank region was high for the forged steel connecting rod. The value of stress at the middle of shank region was well below allowable limit of 250MPa [5] J.P. Fuertes et al The authors used the two different grade of aluminum alloy, first one is AA1050 and other one is AA5083 aluminum alloys. In this research, the authors developed the design and the connecting rod were used in the experimentation process. Based on the results it was observed that there is an improvement in the mechanical properties when the starting material is ECAP-processed before carrying out the isothermal forgingA. Strozzi et al There are several typical and uncommon modes of failure of connecting rods in internal combustion engines which depends on the various loads, its type and on the stress field. There are various types of fracture and fracture may takes place at various positions of connecting. It may be at shank or at the small or big ends depend on the loading conditions and stress field [8].The objective of this present work is to determine the safe load of the connecting road with C70S6 material and attain the optimum design. Also, investigate the effect of structure steel on the deformation, stress and strain of connecting rod.

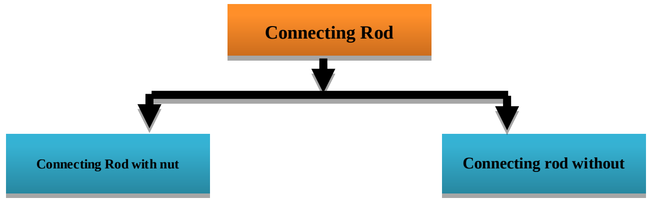


Fig 1 Type of Connecting rod

2. METHODOLOGY AND SIMULATION PROCESS

The structural steel and aluminium alloy materials have been selected based on the literature review for connecting rod. The aluminium normally used now a day is in the form of metal matrix composite consists of alloys of aluminium and silicon carbide in form of continuous fiber. This type of metal matrix composite is used widely because there is 25% reduction in weight with stiffness increased by 29% and strength by 20% makes it first choice of manufactures. The cost of MMC connecting rod still makes it unfeasible for mass production volume. Table 1 show chemical composition of the structural steel.

Table. 1 shows the chemical composition of the structural steel

Element	C	Mn	N	P	S
% of composition	0.25%	1.25%	0.012%	0.045%	0.045%

2.2 Connecting rod model: Catia V5 software has been used to create the connecting rod model. Catia V5 is widely used modeling software that is applied to develop a varied range of products. It is use to develop the 3D Model of different parts of products. Catia is capable to make assembly of product and it also able to create the part modeling. It has wide application in automotive and aerospace industries for part and tool design. It is a complete design software package which includes CAD/CAM/CAE.

2.3 Design parameters of connecting rod: The design of connecting rod is taken from the Figure 16 shown below. It shows various parts and dimensions of connecting rod.

Table 2 Design parameters for connecting rod

Parameters	Size (mm)
Thickness (t)	5.5
Width (4t)	22
Height (5t)	27.5
Height at the small end (H1)	24.75
Height at the big end (H2)	34.375
Inner dia. of the small end	35
Outer diameter of small end	49
Inner dia. of the big end	45
Outer diameter of big end	63

2.4 Type of Mesh

In this section discusses geometry of connecting rod used for FEA, its generation, simplifications and accuracy. Mesh generation and its convergence is discussed. The load use, particularly the distribution at the contact area, aspects that select load distribution, the calculation of the pressure factors depending on the magnitude of the resultant force, application of the limitations and authentication of the FEA model are also discussed. Three FEM were used to determine structural behavior under three different conditions, namely, static load condition, service operating condition (quasi dynamic FEA) and test condition.

A finite element mesh generation of connecting rod is generated using global element length and at the area of chamfer an element length is changed. Number of elements and nodes are 6947 element and 13124. The convergence at chamfer area is obtained with local size of mesh. predicted words.

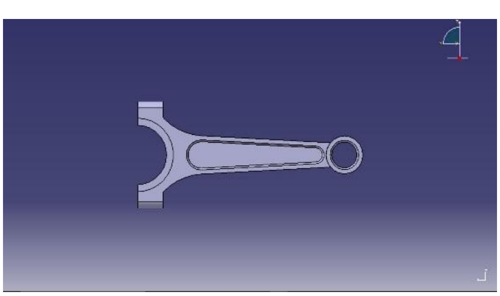


Fig. 2 3D model of the connecting rod

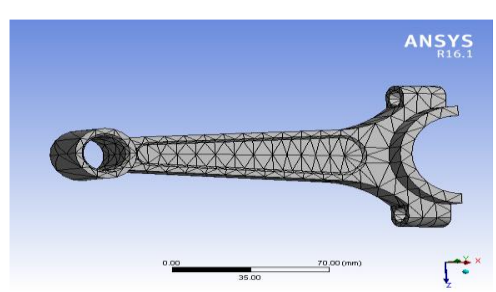


Fig. 3 Meshed 3 D model of the connecting rod

3. RESULTS AND DISCUSSION

Connecting rod is one of the most critical and important component of internal combustion engine. The connecting rod is the intermediate member between the piston and the crankshaft. Its primary function is to transmit the push and pull from the piston pin to the crankpin and thus convert the reciprocating motion of the piston into the rotary motion of the crank. The usual form of the connecting rod in internal combustion engines. It is always use in vehicle as a continuous cyclic loading. The stress and deformation analysis of connecting rod is vital to know the stress level on connecting rod. In the results and discussion section the FE analysis for stress and deformation for structural steel and aluminum alloy based material has been performed on different parameters of connecting rod. Calculating the stress and deformation for various geometry of connecting rod, can know how much stress will develop on particular geometry of connecting rod.

3.1 Static Analysis of structural steel

The static analysis of connecting rod has been investigated with respect to structural steel properties and boundary conditions as mentioned in material specifications Table 1 & 2. The one end of the helical spring has been fixed supported. The force of 1640 N has applied on the other end as shown in Figures. The big end of the connecting rod has been fixed supported shown in Figure 21. The force of 1040 N has applied on the small end as shown in Figure 22. The maximum deformation at the small end side has been observed. The red color contour has indicated the maximum deformation. 1.23 mm maximum deformation has been recorded in the structural steel connecting road shown in Figure 31. Physical deformations can be calculated on and inside a part or an assembly. Fixed supports prevent deformation; locations without a fixed support usually experience deformation relative to the original location. Deformations are calculated relative to the part or assembly. Component deformations (Directional Deformation) Deformed shape (Total Deformation vector). The three component deformations Ux, Uy, and Uz, and the deformed shape U are available as individual results. Scoping is also possible to both geometric entities and to underlying meshing entities (see example below).

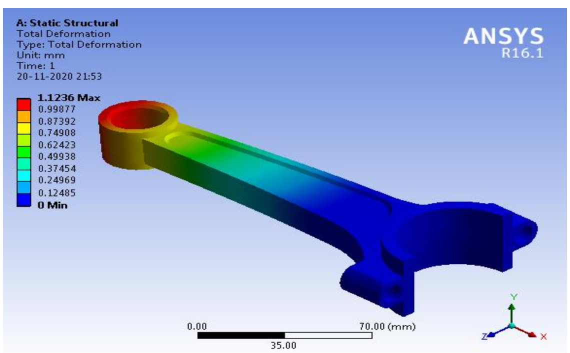
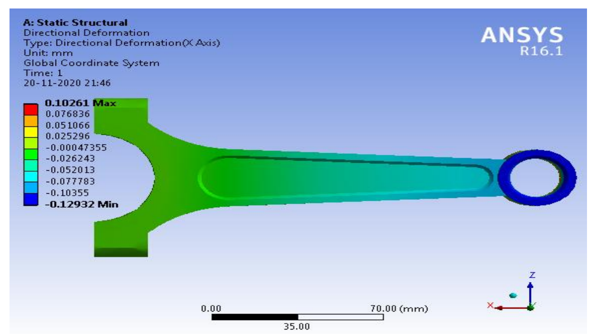


Fig. 4 Total deformation of structural steel connecting rod



Fig, 5 X directional deformation of structural steel connecting rod

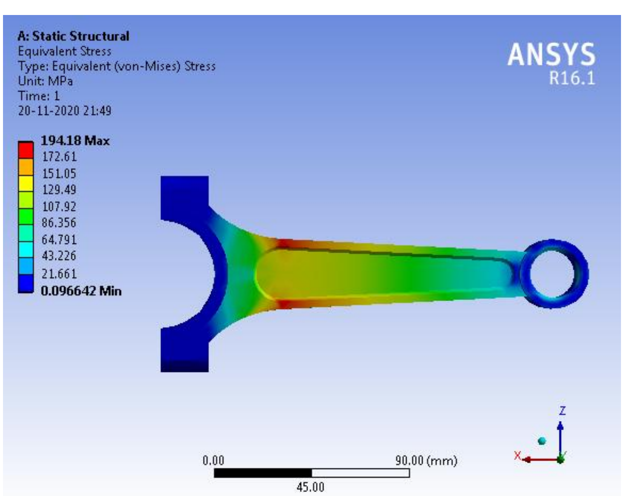


Fig 6 Top view of equivalent stress in connecting rod structural steel

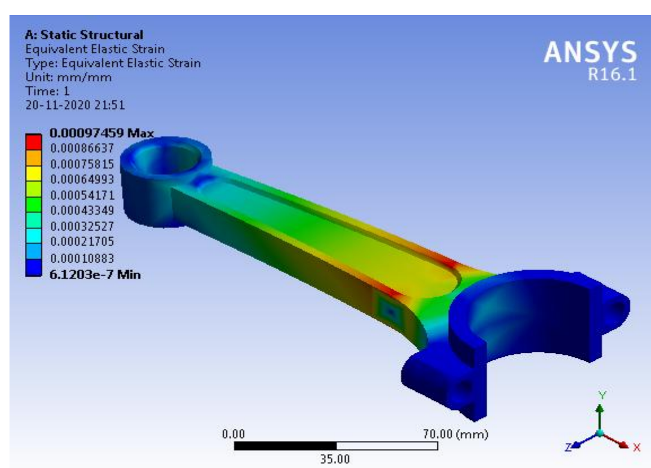


Fig 8 equivalent elastic strain in connecting rod

Numerical data is for deformation in the global X, Y, and Z directions. These results can be viewed with the model under wireframe display, facilitating their visibility at interior nodes. After applying loads and supports to the model, add a Total Deformation result object, highlight the object, set Scoping Method to Named Selection, and set Named Selection to the Selection object defined above that includes the mesh node criteria. Before solving, annotations are displayed at each selected node as shown below. Any element containing a selected node will display a contour color at the node. If all nodes on the element are selected, the element will display contour colors on all facets. Element facets that contain unselected nodes will be transparent as shown in Fig 4.The displacements of the connecting rod has been recorded in all three possible direction such as in x- direction, y-direction, z-direction and also find out the total displacement. Figure 31 shown the X direction deformation of the connecting rod. The 0.106 mm, X direction deformation has been observed as depicts in Fig 5.

4. CONCLUSION

In the present work deformation, stress analysis & strain is performed by using structure steel for the connecting rod. First deformation & stress analysis is performed by using structure steel material for the internal combustion engine connecting rod. The connecting rod used for this analysis is taken from a reference paper. After performing the deformation, stress analysis & strain analysis is performed by changing the material.

The model of connecting rod for analysis purpose are designed in Catia V5 designing software. After that numerical and FEM analysis are executed to estimate the deformation, Von mises stress and elastic strain is calculated by applying the external force having the value 1040 N of load. After performing the analysis results are obtained from analysis are used to predict the structural behavior of connecting rod under given load. The following conclusions are drawn from this study:

The 0.000397 mm, Y direction deformation has been observed as depicts in Figure 33. The bigger end side there is a higher deformation as compare to the small end. The 0.005156 mm, Z direction deformation has been observed.The 0.106 mm, X direction deformation has been observed. The Maximum von mises stress 194.18 MPa has been recorded

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