STATIC ANALYSIS AND WEIGHT OPTIMIZATION OF CONNECTING ROD BY USING GRAY CAST IRON AND A NEW ALLOY(Ti-6Al-4V)

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Abstract- Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine. Connecting rod is a structural member in the engine, which transfers reciprocating motion in to rotary motion of crank shaft. The connecting rod while transferring the power from piston to crank shaft takes load from piston due to combustion process in the combustion chamber and inertia forces of the reciprocating parts (piston & connecting rod) due to this the connecting rod may fail. The inertia effect of the connecting rod will also reduce the power transmission. Hence the connecting rod is analyzed for reducing the inertia effect due to reciprocating parts i.e. connecting rod.

In this project the analysis is done on connecting rod with traditional material i.e. grey cast iron and a new alloy (Ti-6Al-4V) for optimizing the weight to reduce the inertia forces due to connecting rod for this process pro-e package is used to model the connecting rod & ansys-11.0 is used to carry out the analysis of connecting rod.

Key Words:*Design; Analysis; Connecting rod;Piston; Gray cast ironTi-6Al-4V.*

1. INTRODUCTION

The diesel internal combustion engine differs from the gasoline powered Otto cycle by using highly compressed, hot air to ignite the fuel rather than using a spark plug (compression ignition rather than spark ignition).

In the true diesel engine, only air is initially introduced into the combustion chamber. The air is then compressed with a compression ratio typically between 15:1 and 22:1 resulting in 40-bar (4.0 MPa; 580 psi) pressure compared to 8 to 14 bars (0.80 to 1.4 MPa) (about 200 psi) in the petrol engine. This high compression heats the air to 550 °C (1,022 °F). At about the top of the compression stroke, fuel is injected directly into the compressed air in the combustion chamber. This may be into a (typically toroidal) void in the top of the piston or a pre-chamber depending upon the design of the engine. Due to the explosion effect in the cylinder causes a raise in pressures inside the cylinder, which exerts a load on the piston, that in turn transfer to the connecting rod, which may cause a reason for failure of connecting rod.

1.2 CONNECTING ROD BACKGROUND

Every vehicle that uses an internal combustion engine requires at least one connecting rod depending upon the number of cylinders in the engine.

Connecting rods for automotive applications are typically manufactured by forging from either wrought steel or powdered metal. They could also be cast. However, castings could have blow-holes which are detrimental from durability and fatigue points of view. The fact that forgings produce blow-hole-free and better rods gives them an advantage over cast rods.

1.3CONNECTING ROD

Figure-1 shows the parts of Connecting rod

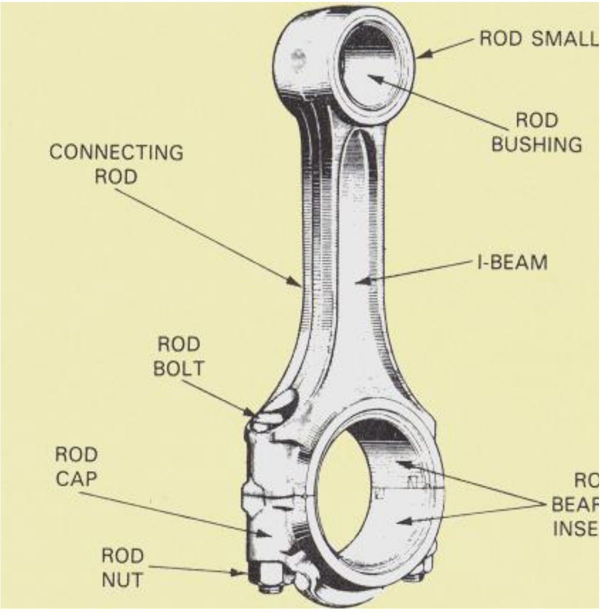

Fig -1CONNECTING ROD

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 rotary motion of the crank. It consists of a long shank, a small end and a big end. The cross -section of shank may be rectangular, circular, I-section tubular-section or H-section.

The big end of the connecting rod is usually made split (in two halves)so that it can be mounted easily on the crankpin bearing shells . The split cap is fastened to the big end with two cap bolts. The bearing shells of the big end are made of steel, brass or bronze with a thin lining (about 0.75mm)of white metal.

The connecting rods are usually manufactured by drop forging process and it should have adequate strength, stiffness and minimum weight. The material mostly used for connecting rods varies from mild carbon steels to alloy steels. The carbon steel having 0.35 percent carbon has an ultimate tensile strength of about 650 MPa.

When properly heat treated and a carbon steel with 0.45 percent carbon has a ultimate tensile strength of 750 MPa. These steels are used for connecting rods of industrial engines. The alloy steels have an ultimate tensile strength of about 1050 MPa and are used for connecting rods of aero engines and automobile engines.

Tae Hee Lee and J.J. Jung Done the Met model-Based Shape Optimization of Connecting Rod Considering Fatigue Life.To optimize a connecting rod satisfying fatigue life, met model-based design optimization is proposed. To approximately predict both volume and fatigue life of connecting rod, wriging met model is constructed based on maximum eigenvalue sampling. Fatigue analysis is accomplished for the calculation of fatigue life. The results of metamodel-based design optimization are compared with those of classical optimization. The advantages of metamodel-based optimization are discussed.[1]

R. J. Yang, and et al Shape optimization of Connecting rod. This paper describes a successful process for performing component shape optimization. Special attention is focused on design modeling issues. A modular software system is described. Some of the modules are widely available commercial programs, e.g. PDA/PATRAN and MSC/NASTRAN, while other modules are written uniquely for this system. The upper end (pin end) of an automotive connecting rod is optimized under a variety of initial Assumptions illustrate the use of the system.[2]

Lu and Pai-Chuan Studied The shape optimization of a connecting rod with fatigue life constraint. This paper presents a deterministic approach, considering the fatigue life requirement, in the optimal design of a connecting rod for a newly developed motor-cycle engine. The main idea is to use the finite element method to calculate the stresses upon the connecting rod, and to use sound fracture mechanics theorems, along with material fatigue properties, to calculate fatigue life during the optimization process. The life requirement is treated as a side constraint, and the volume of the of the connecting rod as the objective function [3]

1.4 DIMENSIONS OF CONNECTING ROD

The details of Dimensions of Connecting rod is given in Table-1

Table-1DIMENSIONS OF CONNECTING ROD

Various parts	Dimensions
Outer diameter of Small end connecting rod(mm)	48
Inner diameter of Small end connecting rod(mm)	38
Outer diameter of big end connecting rod(mm)	78.5
Inner diameter of big end connecting rod(mm)	68

Shank length(mm)	160
Width of connecting rod(mm)	32.4
Thickness(mm)	24.1

2. MODELING OF CONNECTING ROD

2.1 MODELING OF CONNECTING ROD IN PART DESIGN MODEL

Figure-2 shows part model of rod

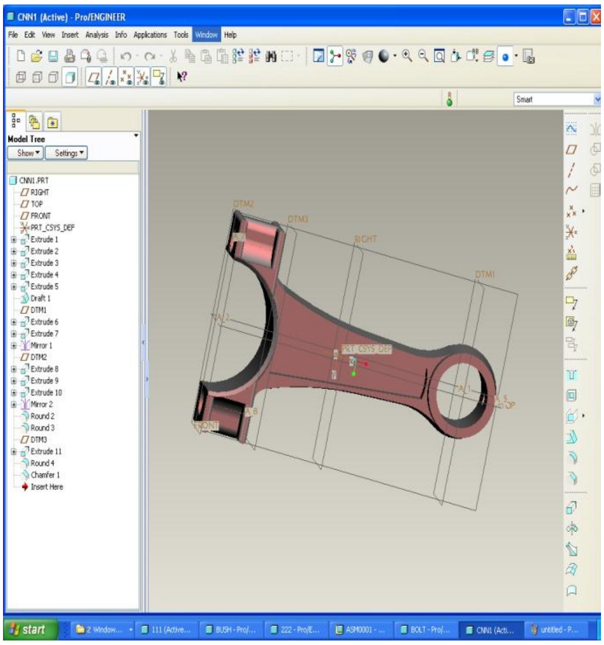

Fig -2 PART MODEL OF ROD IN Pro/E

Figure-3 shows part model of Cap

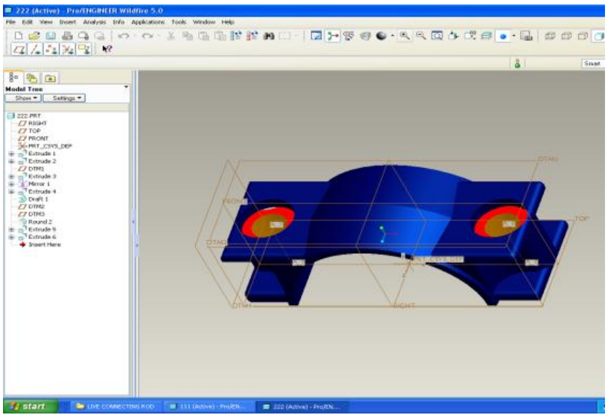

Fig -3 PART MODEL OF CAP IN Pro/E

Figure-4 shows assembled connecting rod

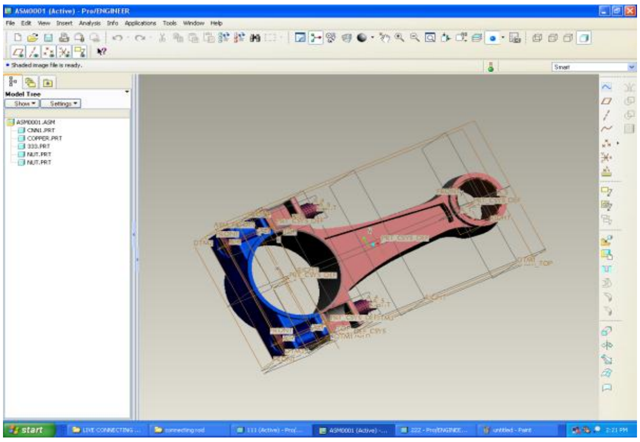

Fig -4 ASSEMBLED CONNECTING ROD

3. STRUCTRAL ANALYSIS

3.1STRUCTRAL ANALYSIS USING GRAY CAST IRON

Figure-5 shows Displacement of Connecting rod under given load in static analysis

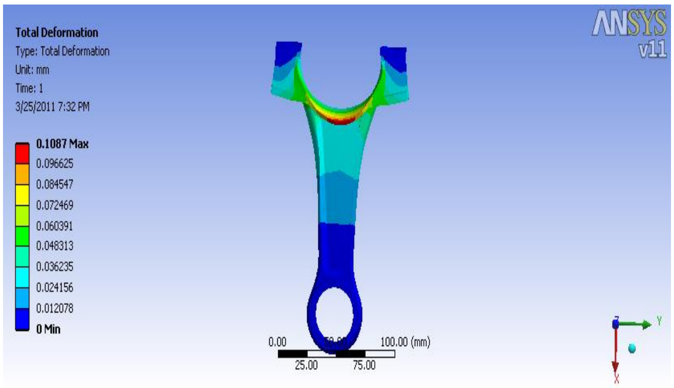

Fig -5 DISPALCEMENT OF CONNECTING ROD (GCI)

Figure-6 shows Von misses stresses in Connecting rod red lines indicates the maximum stress intensity and blue color indicates minimum stress intensity

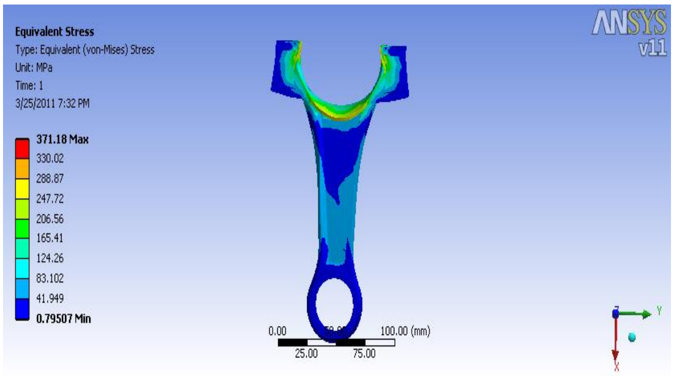

Fig -6 VON MISSES STRESS (GCI)

3.2STRUCTRAL ANALYSIS USING A NEW ALLOY (Ti-6Al-4V)

Figure-7 shows Displacement of Connecting rod under given load in static analysis

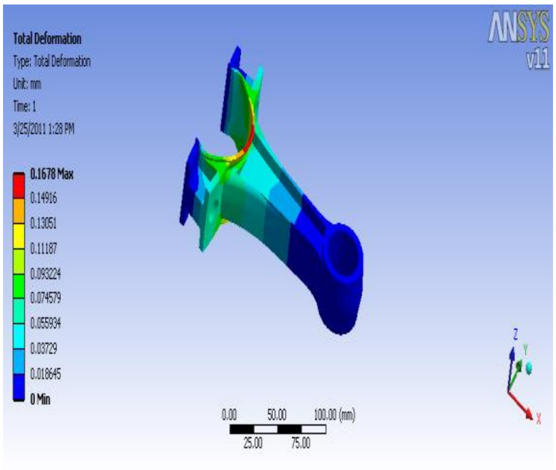

Fig -7 DISPLACEMENT OF CONNECTING ROD (Ti-6Al-4V)

Figure-8 shows Von misses stresses in Connecting rod red lines indicates the maximum stress intensity and blue color indicates minimum stress intensity

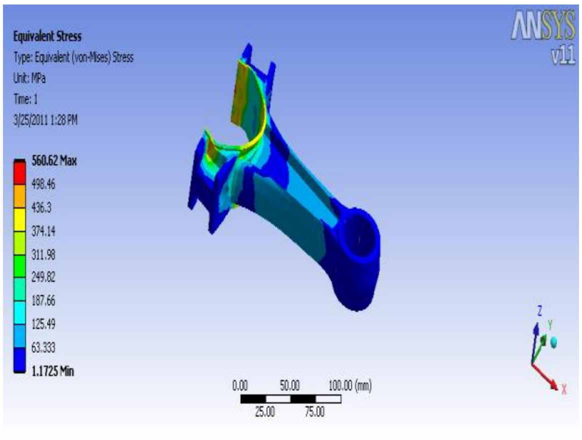

Fig -8 VON MISSES STRESS (Ti-6Al-4V)

4. RESULTS AND DISCUSSION

Results of analysis for given two materials, the comparison of results shown in below table-2

Table-2 COMPARISION OF RESULT PARAMETERS

	GREY CAST IRON	TI-6Al-4V
Total deformation(mm)	0.1087	0.1051
Max Equivalent stress(mpa)	371.18	351.32
Min Equivalent stress(mpa)	0.7950	0.7347
Max Stress intensity(mpa)	393.06	376.96
Min Stress intensity(mpa)	0.8576	0.8483
Mass(kg)	0.94875	0.59597

5. CONCLUSION

With this analysis by comparing the above results for both the materials i.e. cast iron &Ti-6Al-4V the weight of the Ti-6Al-4V has reduced to 37.5%when compared to cast iron, hence the inertia forces of the connecting rod reduces. So Ti-6Al-4V material may suitable for connecting rod material for light weight applications.

The future scope of our project to analyze the connecting rod by implementing the advanced materials like composites.

6. REFERENCES

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