DESIGN AND STRUCTURAL ANALYSIS OF CONNECTING ROD USING VARIOUS MATERIALS

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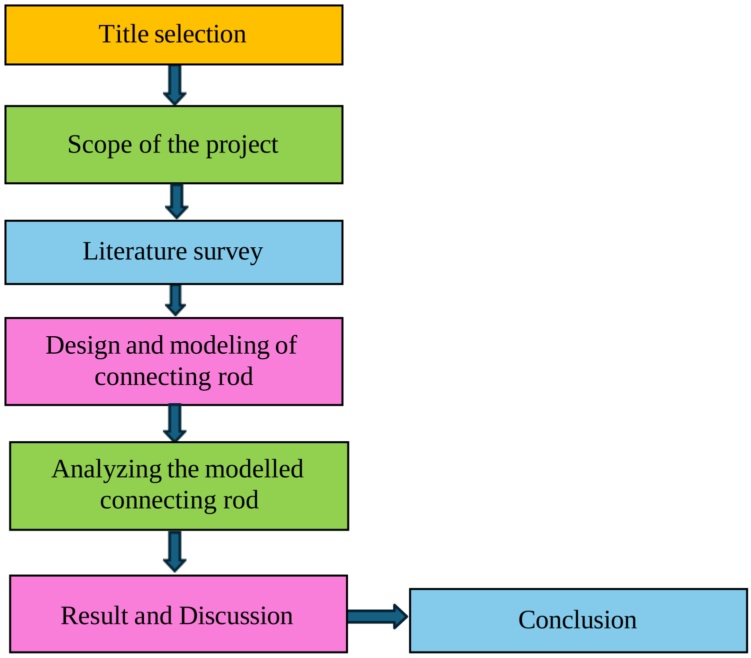
Abstract: *The objective of project is to carry out the structural analysis of a connecting rod made from three different types of materials. Connecting Rods has a wide use in all sorts of automobile engines acting as a crucial middle point between the piston and therefore the crankshaft of an engine of an automobile. The performance of a connecting rod in an engine depends on its design and weight. Hence, for the assembly of a long-lasting, economical and light-weight connecting rod, analysis and optimization become necessary. The material of connecting rod is replaced with Structural steel, Magnesium alloy and Titanium alloy. The model of connecting rod is made in Catia v5 and imported in Ansys workbench for static analysis. After analysis, a comparison is formed on connecting rod and therefore the three composite rods in terms of Von Misses stress, equivalent strain and total deformation. All these parameters also are found analytically and compared with results of Finite Element Analysis. The general work is split into three phases. First, concept and a review of existing material. Second, we do model and static structural analysis. Third, is comparison of elastic strain, total deformation, and maximum Von misses stress value in alloy connecting rods*

Keywords: *Connecting rod, CATIA, ANSYS Workbench 19.2, Structural Analysis.*

I. INTRODUCTION

A connecting rod is the part of a piston engine which connects the piston to the crankshaft. Together with the crank, the connecting rod converts the reciprocating motion of the piston into the rotation of the crankshaft. Connecting rods connect two mechanical parts, such as a piston and a crankshaft, and transmit the motion of one part to the other. This allows for efficient motion transfer between different parts of a mechanical system, which is essential for proper operation. the connecting rod is divided into several areas, namely the top is the pinned, the middle area is called the shank, and the bottom is the crank-end/big-end. The pin-end and crank-end bores are each equipped with bearing mounts with very high accuracy. 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.

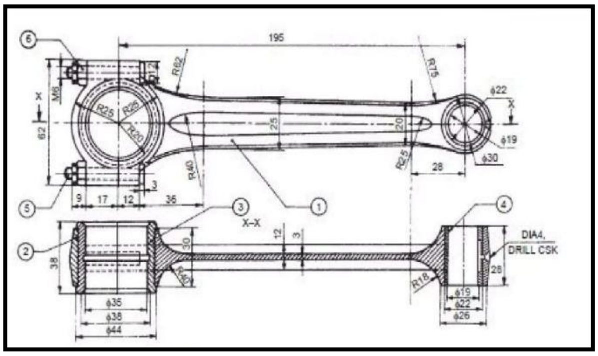
II. METHODOLOGY

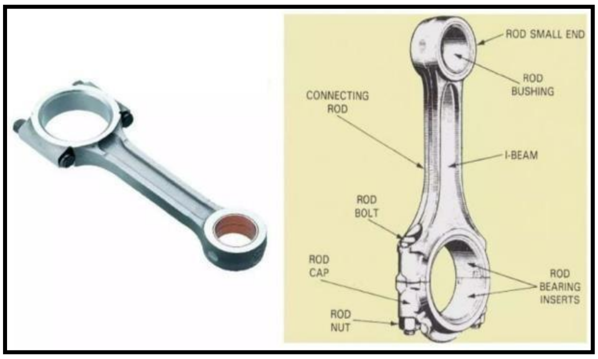


III. CAD MODEL

CAD model of existing connecting rod has been prepared in CATIA as shown in figure, the dimensions were measured from existing connecting rod.

2D-DRAFTING





3.1 ANALYSIS OF CONNECTING ROD:

Generate a finite element mesh. The mesh quality can significantly impact the accuracy of the results. Ensure an adequate number of elements in critical areas (stress concentrations, complex geometry). The sensitive regions have been re-meshed manually considering the shape and size of the parts.

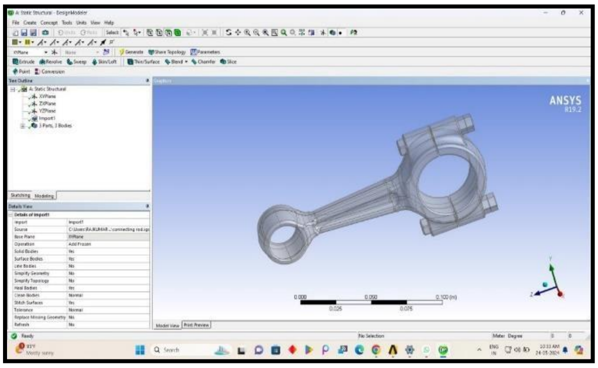


Fig-1: Before meshing

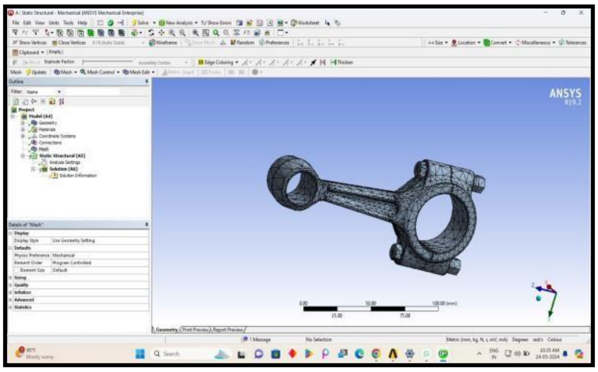


Fig-2: Meshed model

3.2 LOADING CONDITIONS:

The accurate thermal analysis of a connecting rod requires a comprehensive understanding of the thermal and mechanical loads it experiences during operation. By considering the conditions, engineers can predict the performance, identify potential failure modes, and optimize the design for better durability and efficiency.

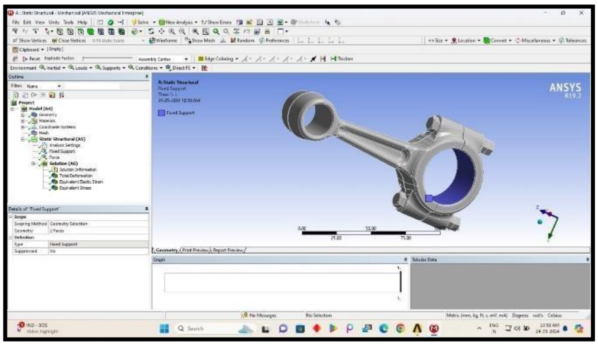


Fig-3: Loading Conditions

3.3 MATERIALS USED:

3.3.1 TITANIUM ALLOY

Titanium alloys are alloys that contain a mixture of titanium and other chemical elements. Such alloys have very high tensile strength and toughness even at extreme temperatures. They are light in weight, have extra ordinary corrosion resistance and the ability to withstand extreme temperatures.

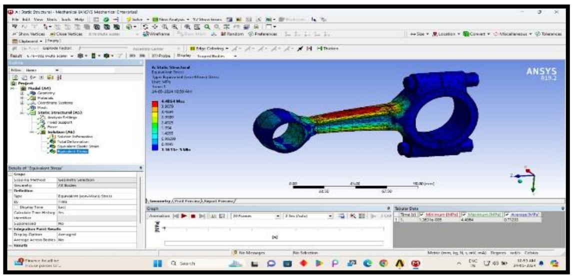


Fig 1: Total deformation

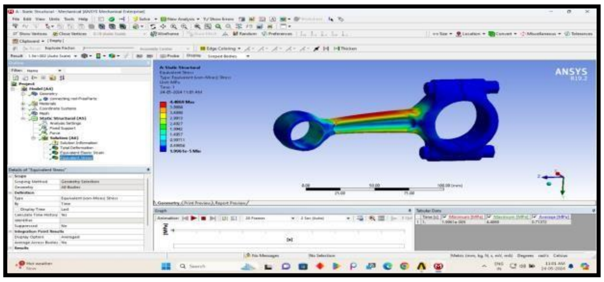


Fig 2: Elastic stress

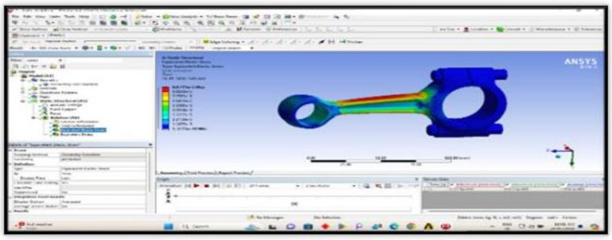


Fig 3: Equivalent elastic strain

3.3.2 MAGNESIUM ALLOY

Magnesium alloys are mixtures of magnesium the lightest structural metal with other metals, often aluminum, zinc, manganese, silicon, copper, rare earths and zirconium. Magnesium alloys have a hexagonal lattice structure, which affects the fundamental properties of these alloys. Plastic deformation of the hexagonal lattice is more complicated than in cubic latticed metals like aluminum, copper and steel; therefore, magnesium alloys are typically used as cast alloys, but research of wrought alloys has been more extensive.

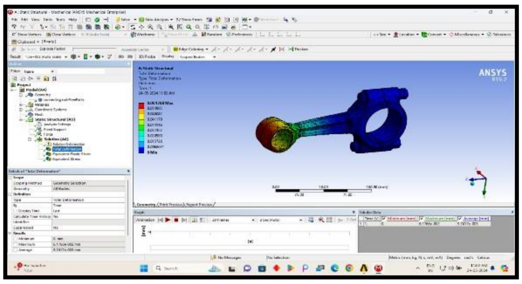


Fig 1: Total deformation

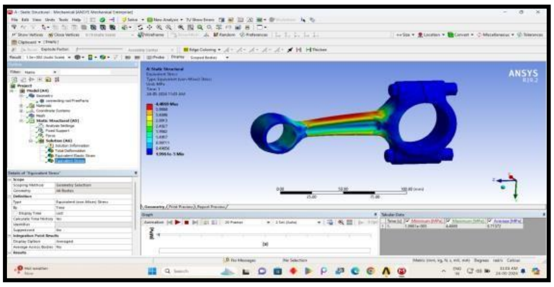


Fig 2: Elastic stress

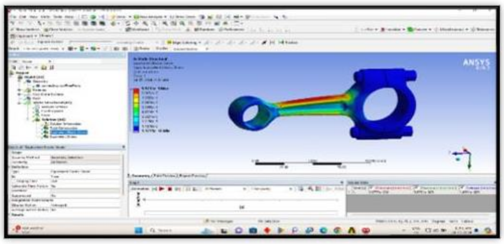


Fig 3: Equivalent elastic strain

3.3.3 STRUCTURAL STEEL

Structural steel is a category of steel used for making construction materials in a variety of shapes. Many structural steel shapes take the form of an elongated beam having a profile of a specific cross section. Structural steel shapes, sizes, chemical composition, mechanical properties such as strengths, storage practices, etc., are regulated by standards in most industrialized countries.

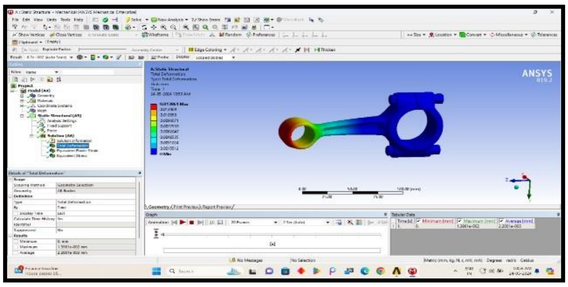


Fig 1: Total deformation

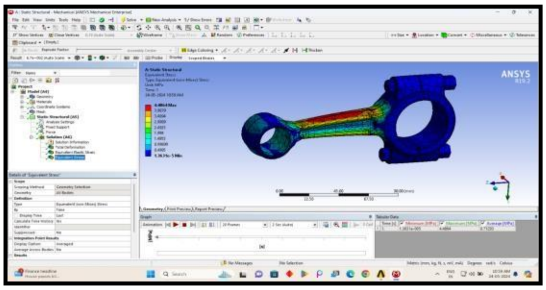


Fig 2: Elastic stress

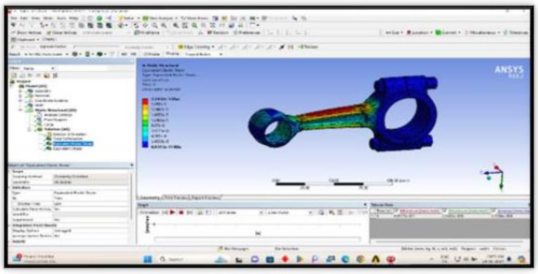


Fig 3: Equivalent elastic strain

IV. ANALYSIS RESULTS

1. Total deformation:

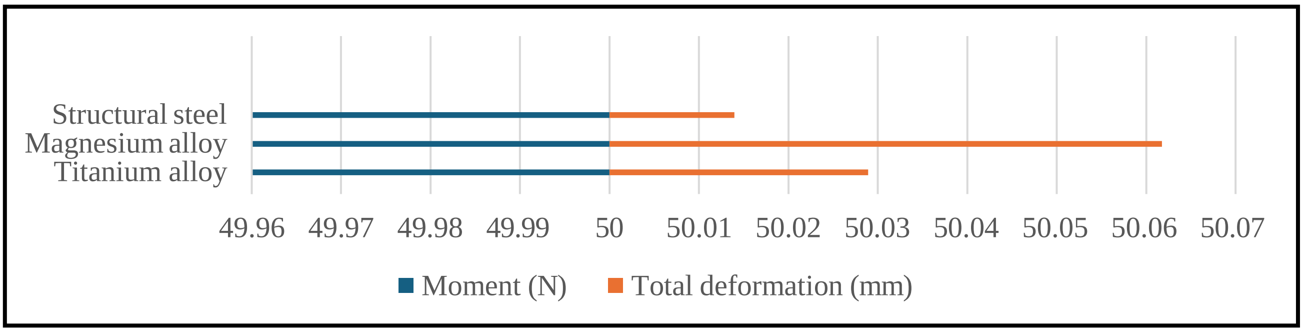


Fig 4.1 – Total deformation graph

2. Equivalent stress:

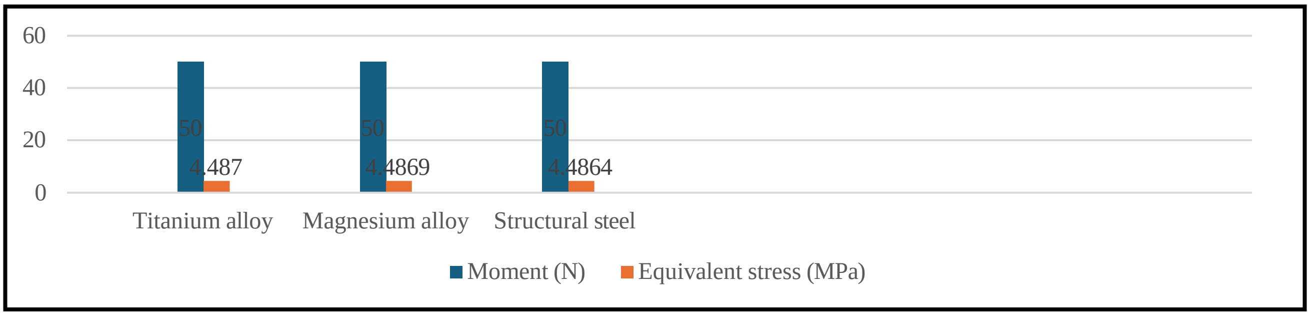
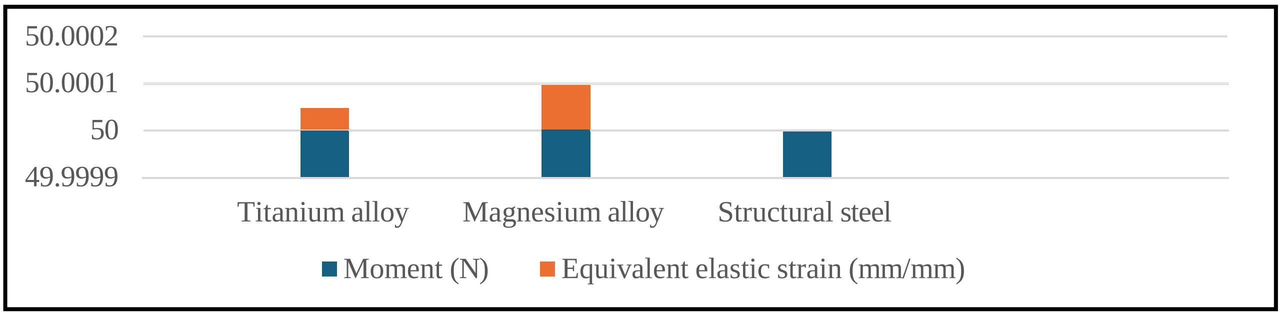


Fig 4.2- Equivalent stress graph

3. Equivalent elastic strain:



Tab 4.3 – Equivalent elastic strain graph

Comparison Table:

Materials	**Total deformation**	**Equivalent stress**	**Equivalent elastic strain**
Titanium alloy	2.8926E-002	4.487	4.6741e-005
Magnesium alloy	6.1768E-002	4.4869	9.9711e-005
Structural steel	1.3961E-002	4.4864	2.2432e-005

V. CONCLUSION

For general applications with cost-effectiveness and high durability Structural Steel is the best option due to its high stiffness, low deformation, and cost-effectiveness. When performing structural analysis of a connecting rod using Ansys software, the choice of material depends on various factors including the specific application requirements, mechanical properties, weight considerations, and cost. Ultimately, the best material for your structural analysis in Ansys will depend on the specific requirements of your application, including load conditions, environmental factors, and budget constraints. Conducting detailed simulations with Ansys can help you better understand how each material performs under the different types of specific conditions.

VI. REFERENCES

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