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COMPREHENSIVE MECHANICAL SURVEY OF STATIC STRUCTURAL ANALYSIS OF DIFFERENT MATERIALS FOR CONNECTING ROD

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Abstract: *The connecting rod, which joins the crankshaft and piston, is a crucial component of many car engines. The piston's rotary motion is transferred into rotational motion via the engine's crankshaft. The connecting rod is secured to the crankshaft at its large end by two bolts that pass through the bottom big end bearing; a piston pin connects the rod's tiny end to the piston. A digitally created connecting rod for a diesel engine was created using SolidWorks 2021 Premium. On the connecting rod, finite element analysis is done. To do static analysis, we use the analytical workbench R18.1 program to assess the strain, deformation, and stress caused by applied loads on various materials. The durability and dependability ANSYS Workbench R18.1 software is used to perform a fatigue test on the connecting rod in order to evaluate its condition. The modal section is undergoing modifications. Ansys Workbench R18.1 is used for static structural analysis while working with IGS file formats. The structural steel S500, the maraging alloy, the aluminum alloy A360, and the magnesium alloy AZ91D-F are tested under a 10KN load. A better material was chosen for the connecting rod by examining deformation; this lengthened its lifespan and reduced the possibility of material failure.*

Keywords: *Function and Importance of Connecting Rods, Forces Acting on Connecting Rods, Design Requirements, Mechanical Property Calculation and Analysists, Load Focus, Material Selection and Impact, Factor of Safety Evaluation.*

1. Introduction

A interfacing pole in an inside combustion motor is imperative for changing over warm vitality changing it into mechanical control assignment of changing over warm into work must be carried out with greatest adequacy, guaranteeing ideal efficiency.

The interfacing pole passes on the gas weight from the cylinder to the crankshaft. Two segments are associated by joining them together.

The interfacing pole transmits the gas strengths delivered by the cylinder to the crankshaft. content needs to be reworded with the same wording and number of words.

the fundamental work of the component is to exchange straight movement from the cylinder stick to the crankpin converting the piston's direct development to the crankshaft's rotational movement. Inside the organization Combustion motors as often as possible utilize interfacing poles that have an L-shaped design.

2. Literature Review

The emphasis lies in the design, analysis, and optimization of a connecting rod for an engine, employing advanced CAD and simulation tools.

- **Function of the Connecting Rod:**
  - The connecting rod links the piston to the crankshaft, transferring the piston's linear motion into rotational motion for the crankshaft.
- **Design and Digital Production:**
  - The connecting rod is designed digitally using SolidWorks 2021 Premium, a widely used CAD

software known for its robust modeling capabilities.

- **Finite Element Analysis (FEA):**

- FEA is conducted using ANSYS Workbench R18.1 to perform static analysis.
- The analysis evaluates strain, deformation, and stress distribution under applied loads using various materials.

- **Material Selection and Testing:**

- Materials tested include structural steel S500, Maraging alloy, aluminum alloy A360, and magnesium alloy AZ91D-F.
- Static structural analysis under a 10 kN load is performed to assess the suitability of each material for the connecting rod.

- **Fatigue Analysis:**

- The durability and reliability of the connecting rod are assessed through fatigue testing using ANSYS Workbench R18.1.
- This analysis is crucial for predicting the lifespan of the connecting rod under cyclic loading conditions.

- **Modal Analysis:**

- Changes to the modal section are mentioned, likely referring to modal analysis to understand the natural frequencies and mode shapes of the connecting rod.

- **Optimization through Analysis:**

- Deformation analysis plays a key role in selecting a material that enhances the longevity and reduces the risk of material failure.
- By analyzing deformation characteristics, a more suitable material for the connecting rod is chosen, potentially optimizing its performance and reliability.

3. Overview

The detailed design and structural analysis of connecting rods in engine assemblies, emphasizing their critical role in energy transfer and motion conversion within the engine.

3.1 Function and Importance of Connecting Rods

- Connecting rods are essential components that transfer energy from the piston's linear motion to the crankshaft's rotational motion.
- They convert the reciprocating motion of the piston into rotary motion, crucial for engine operation

3.2 Forces Acting on Connecting Rods

- Combustion Pressure: High combustion pressures exert significant forces on the connecting rod.
- Inertia: The mass of the connecting rod contributes to inertial forces.
- Reciprocating Mass: Forces from the reciprocating masses of the piston and other related components also impact the connecting rod.

3.3 Design Requirements

- Connecting rods must be rigid to withstand the forces they experience during the engine's operation.
- They need to be lightweight to minimize inertial forces and improve overall engine efficiency.

3.4 Mechanical Property Calculation and Analysis

- The study involves calculating and analyzing mechanical properties such as strength and deformation of the connecting rod.
- Ansys software and the finite element method (FEM) are employed for stress and deformation analysis.
- Special emphasis is placed on fatigue analysis to ensure long-term durability under cyclic loading conditions.

3.5 Load Focus

- Given that axial compressive forces exceed axial tensile forces, the design analysis concentrates on axial compressive loads.
- This decision reflects the operational conditions where compression is more critical than tension for the connecting rod's structural integrity.

3.6 Material Selection and Impact

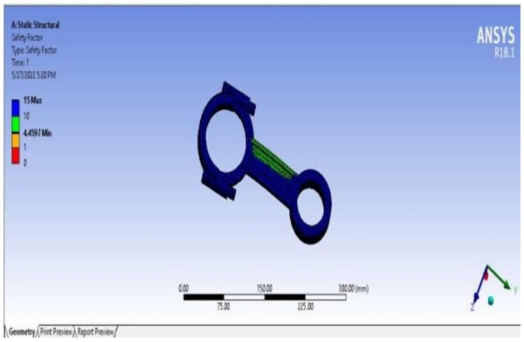
- The study investigates how material properties influence stress distribution and deformation characteristics of the connecting rod.
- Optimization considerations may involve evaluating different materials to enhance performance and reliability.

3.7 Factor of Safety Evaluation

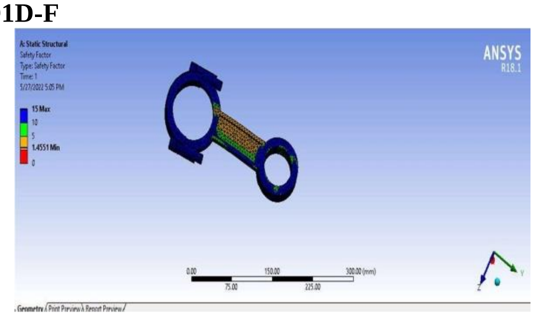
- The Factor of Safety (FoS) is rigorously evaluated to ensure the connecting rod design meets safety margins.
- FoS analysis is critical to prevent failure and ensure the longevity of the engine components under various operating conditions.

Sr. No.	Material	Factor of safety	
		Maximum	Minimum
1.	S500	15	4.4597
2.	Maraging 350	15	7.2633
3.	AZ91D-F	15	1.4551

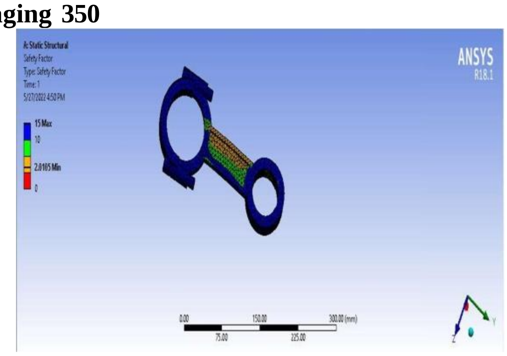
S 500



AZ91D-F



Maraging 350



4. Material Selection

Four materials were utilized in this investigation. Connecting rods for engine manufacturing commonly utilize structural steel or aluminum alloy. These materials offer diverse characteristics and are suitable for various engine types:

- S500 Structural Steel
- A360 Aluminum Alloy
- AZ91D-F Magnesium Alloy
- Maraging 350 Alloy Steel

Table 1: Comparison of Mechanical Properties for Various Materials under Specific Conditions

Sr. No.	Parameter	Mar ageing 350	A360	S500	AZ91D-F
1	Total deformation(mm)	0.31501	0.78326	0.30007	1.392
2	Equivalent stress (MPa)	156.95	157.68	156.94	158.06
3	Equivalent strain (mm)	0.00079157	0.0019748	0.00075390	0.0035353
4	Max principal stress(MPa)	176.1	177.78	176.11	178.83

Maraging 350

5. Discussion on Results

Structural analysis of the connecting rod was conducted using ANSYS Workbench. In the mechanical stress analysis, the distribution of stress under load is visualized with colors ranging from blue to red, indicating varying intensities across different sections of the connecting rod. The red color denotes the highest stress concentrations. A comparison was made among four materials—Magnesium alloy, A360 aluminum alloy, S500 structural steel, and Maraging 350 alloy steel—based on total deformation, minimum stress, and strain criteria to assess their mechanical properties. Among the materials tested, S500 structural steel and Maraging 350 alloy steel exhibited favorable mechanical properties. Specifically, S500 demonstrated superior characteristics compared to Maraging 350, with a maximum total deformation of 0.30007 mm and an equivalent stress value of 156.94 MPa. Despite having higher equivalent stress values in general, S500 exhibited lower total deformation compared to the other materials tested.

The Factor of Safety (FoS) for S500 was calculated to be 4.4597, indicating its capability to sustain heavy or repetitive loads. An FoS exceeding 3 suggests the material can withstand substantial stress levels with a margin of safety.

In conclusion, S500 structural steel emerges as a promising choice for the connecting rod material, offering robust mechanical properties that include low deformation under load and a high Factor of Safety, essential for ensuring durability and reliability in engine applications.

6. Conclusion

In conclusion, S500 structural steel emerges as a promising choice for the connecting rod material, offering robust mechanical properties that include low deformation under load and a high Factor of Safety, essential for ensuring durability and reliability in engine applications.

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