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# Design and analysis of connecting rod using different alloy material

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## ABSTRACT

The connecting rod is a type of engine that functions as a lever arm, transmitting movement from the piston to the crankshaft. Connecting rod is generally made of a cast aluminium alloy & is constructed to endure high pressures caused by fire heat & piston movement. In our project, the standard connecting rod used today is mainly made of aluminium, replacing the proposed materials based on magnesium, titanium & Beryllium alloy. Stressful and robust load on structural analysis, twisting, pressure and safety testing, comparative analysis is based on and concluded with selected connecting material. Modelling work is done with Solid Works Software and analysis is done with ANSYS software is best for FEM.

**Keywords:** Connecting Rod, Different Alloy Material, Solid Works & Ansys Software

## INTRODUCTION

The connecting rod is a component of the engine that functions as a lever arm, transmitting movement from the piston to the crankshaft. Connecting rod is generally made of a cast aluminium alloy & is constructed to endure high pressures caused by fire heat & piston movement. A piston pin attaches the connecting rod's lower end to the piston. A pivot point b/w the piston as well as the connecting rod is provided by the piston pin, also known as the wrist pin. The piston pin is detained in place by spring clips, also known as piston pins.

The connecting rod's wide end attaches to the crankpin magazine, which serves as a pivot point for the crankshaft. The connecting rods are produced as one or two pieces. The cap is a removable two-piece connecting rod that provides space to carry the crankpin magazine. The stick coupon is attached to the connecting rod with two carpet screws for installation and removal from the crankshaft.

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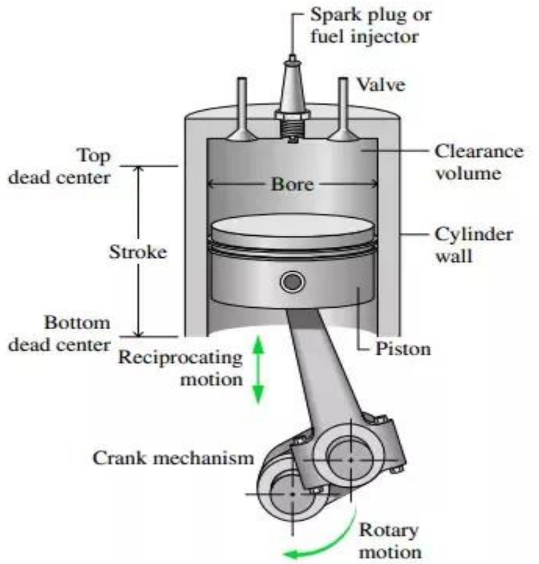



**Fig. 1 Connecting Rod**

## LITERATURE REVIEW

A connecting rod made of titanium alloy is lighter than a conventional connecting rod, with a life cycle of nearly $10^7$ cycles compared to $10^6$ for the existing material [1]. As a result, while there are design criteria to strengthen and reduce the vibration of the hydraulic engine connector, Titanium alloy is the safest and finest choice for a connecting rod [2] it was found that the Aluminium-based rod has a higher-pressure resistance compared to the Steel-based rod. And there is a good chance of improving the make-up. So metal is the best choice for connecting rods.

Also, most researchers have used CATIA modelling software and ANSYS software for analysis. This can be used to design any connecting rod in Automobile. Connecting rods can be designed for weight loss and cost reduction and prolonging life time Aluminium alloy has a simpler and more comfortable life and in addition to both the C45 and Alloy Steel are discussed [3].The FEA method helps to assess the estimated values of compression bending that work with a variety of materials such as Al 7075; Al 6061 and High-grade carbon fiber used for comparison with conventional steel materials. The high-strength connecting rod of carbon fiber suffers slightly in the case of bending due to inertia and thus may be the best fit to connect the diesel engine rod [4].

The lowest pressures between all loading conditions are found in the neat end head and at the end of the piston. Equipment can therefore be reduced from those components, thereby reducing material costs [5]. In order to proceed properly the dynamic analysis of the connecting rod is required. After processing the dynamic loading conditions, it will be re-analysed for small items. It will give more accurate results. [6] suggested work in the analysis of the connecting rod has been effective in reducing weight, increasing the pressures of von misses; decrease in von weight, decrease in flexibility etc. This research will help to develop and improve the connecting rod. The features of the connecting rod can be improved through modal analysis, static and temperature analysis and results validation.

The use of a rod to connect the connection between the piston and the crank shaft. The function of the connecting rod is to move the input power from the piston pin to the small pin, by changing the repetitive transmitting of the piston into a revolving shaft crank movement [7]. Generally, the production of connecting rods is made of carbon steel and aluminium alloys are later used for the manufacture of connecting rods. [8] Aluminium alloy 7075-T6 is a second production method although it has a lower safety feature than titanium alloy but the weight of the connecting rod is much lower than titanium alloy. It can also be seen that the aluminium alloy 2024-T6 is not working as its safety feature is low and the product may fail. It can also be concluded that although carbon steel has a great safety feature but as it increases the weight of the product it therefore does not work.

The connecting rod produces high volume of the motor side so the connecting rod is under greater pressure than the other part of the engine [9]. In view of these facts, the present study is devoted to the investigation of connecting rods using a variety of materials by static analysis. For this purpose, a car connecting rod was selected and static analysis and rod formation was performed. The selected items were stainless steel, stainless steel, Aluminium Alloy 7075, High Power Carbon Fiber, Al fly ash silicon composite, and AISI 4340 Steel alloy material. [10] Analysis we can determine the temperature values and also that we can choice the finest material for the rod connection. According to this project we convert materials with different temperatures into the connecting rod and analyse the connecting rod and compare the two visible thermal temperatures at different temperatures. With the above result, he concluded that Carbon Steel is better than Aluminium alloy.

## PROBLEM IDENTIFICATION

Connecting rods can be fabricated of different marks of SS & Al. Steel rods are the most extensively manufactured & utilized as connecting rods. Their applications are best used by everyday drivers and chase endurance due to their high strength and long life of fatigue. The problem with using metal rods is that the equipment is extremely heavy, which uses a lot of energy and adds pressure to the rotating assembly and consumes a lot of fuel. The problem with fixing is the use of different alloy tools based on weight loss and less fuel consumption.

## OBJECTIVE

To propose the new material replacing the existing material and improvising the material performance, reduce weight & improve the safety factor for required application.

**Table 1 Alloy Material Properties**

| Description | Units | Al | Mg | Ti | Be |
|---|---|---|---|---|---|
| Density | $g/cm^3$ | 2.7 | 1.8 | 4.43 | 2.16 |
| Young's Modulus | GPa | 80 | 44 | 113.8 | 180 |
| Poisson Ratio | - | 0.33 | 0.29 | 0.342 | 0.2 |
| Tensile Strength | MPa | 115 | 180 | 950 | 430 |

## WORKING METHODOLOGY

- Need & Study
- Problem Identification
- Material Selection
- Design of Connecting Rod using Solid Works Software
- Structural Analysis using Ansys Software
  - Tensile Strength
  - Compressive Strength
- Analysis Result & Comparative based on (Safety Factor)
- Conclusion

### Tensile strength

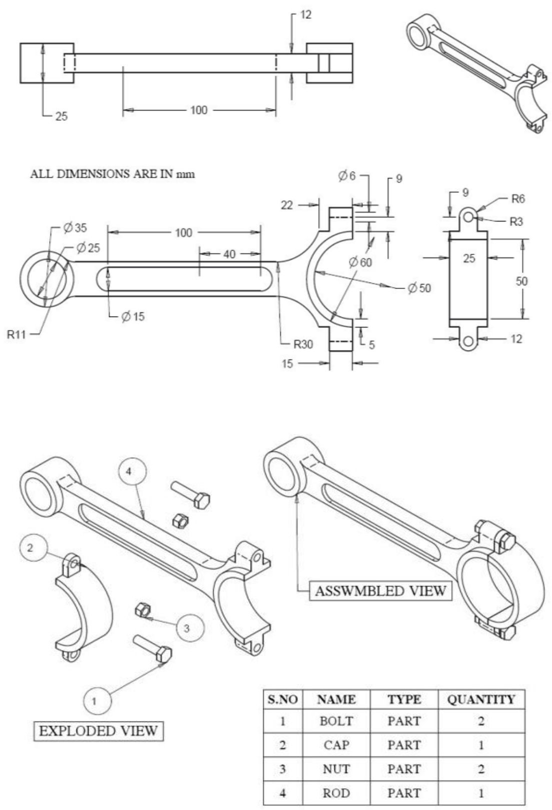
Tensile strength, a high load that can be supported by an asset without breaking when stretched, is separated by the initial crossing point. Strong power has power measurements in the area of each unit. Strength is the amount of load or pressure that can be handled by an object before it can stretch and break. As the name implies, the ability to withstand a great deal of resistance and discomfort caused by the loads of equipment placed on an object. The ability to withstand cracking under stiff pressure is one of the most important and highly rated features of applications.

## Compression Strength

Compression test is a standard test method used to establish the force of compression or to eliminate the resistance of an object and the ability of something to recover after the use of compressive force and held for a specified period of time. Compression test is used to determine the performance of the asset under load. The maximum pressure exerted by the asset can keep time under load (continuous) determined.

## DESIGN & ANALYSIS OF CONNECTING ROD

The Design process is a way of unbearable a great development into controllable portions. Architects, engineers, scientists, & other experts use design techniques to solve various problems. Use this process to describe the steps required to complete each research, & remember to stick to all your ideas and drawings throughout the process.




| S.NO | NAME | TYPE | QUANTITY |
|---|---|---|---|
| 1 | BOLT | PART | 2 |
| 2 | CAP | PART | 1 |
| 3 | NUT | PART | 2 |
| 4 | ROD | PART | 1 |

**Fig. 2 Connecting Rod Model with Dimension**

FEA is a computerized technique of expecting how a product responds to practical energy, heat, vibration, fluid flow & other visible properties. The FEA controls whether the invention will break down, wear out, or perform as intended. It's called prediction, and it's used in the product development process to forecast what will happen when the material is used.

The FEA method helps to break down a virtual object into a large number of small cubes. Statistics aid in the prediction of each item's results. The computer then combines all of the actions together to predict how the real thing will behave.

Meshing is an important part of the engineering simulation process in which complex geometries are separated by simple materials that can be used as complex earth measurements on a large scale. The mesh influences accuracy, consistency, and speed of imitation. In addition, as meshing often takes up a large portion of the time it takes to achieve simulation results, the better and more automatic meshing tools are, the faster and more accurate the solution.

The connecting rod design creating in solid works software and analysis based on compressive (20kN) and tensile load (17.5kN) acting in different alloy material with help of Ansys software. To predicted result is mention in the Table 2 & 3.

**Table 2 Overall Comparison of Compressive Result**

| Description | Alloy Materials | | | |
|---|---|---|---|---|
| | **Al** | **Mg** | **Ti** | **Be** |
| Deformation (mm) | 0.3828 | 0.6976 | 0.2689 | 0.1711 |
| Stress (Mpa) | 284.1 | 287.91 | 282.88 | 295.21 |
| Safety Factor | 0.3871 | 0.6252 | 3.3583 | 1.4566 |

**Table 3 Overall Comparison of Tensile Result**

| Description | Alloy Materials | | | |
|---|---|---|---|---|
| | **Al** | **Mg** | **Ti** | **Be** |
| Deformation (mm) | 0.3945 | 0.7187 | 0.2772 | 0.1761 |
| Stress (Mpa) | 248.59 | 251.92 | 247.52 | 258.31 |
| Safety Factor | 0.4424 | 0.7145 | 3.8380 | 1.6647 |

Observed the Table 2 & 3 is better performance of the beryllium alloy material. So, both compressive & tensile load acting is deformation (0.1711 & 0.1761mm), stress (295.21 & 258.31MPa), and safety factor (1.4566 & 1.6647) obtained and image mention in the below Fig. 3 to 5.

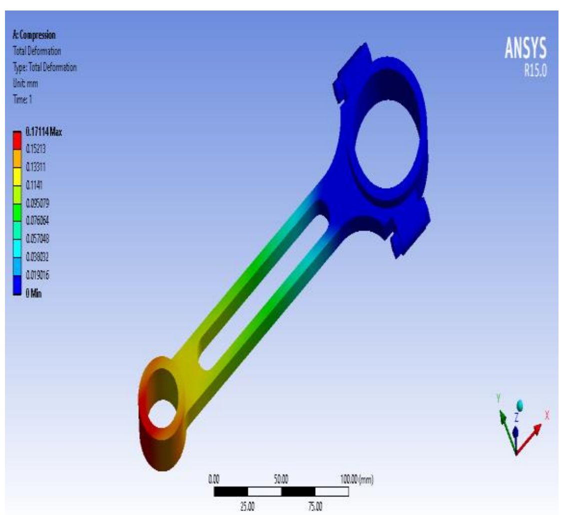



**Fig. 3 (a) Compressive Deformation**

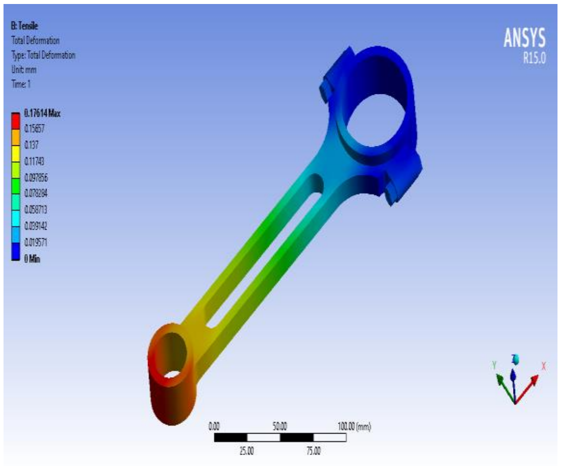



**Fig. 3 (b) Tensile Deformation**

Fig. 3 (a) & (b) both compressive and tensile deformation is mention and numerical value represented in the Table 2 & 3.

The stress is based on load and area, so both stress image mention in the Fig. 4 (a) & (b).

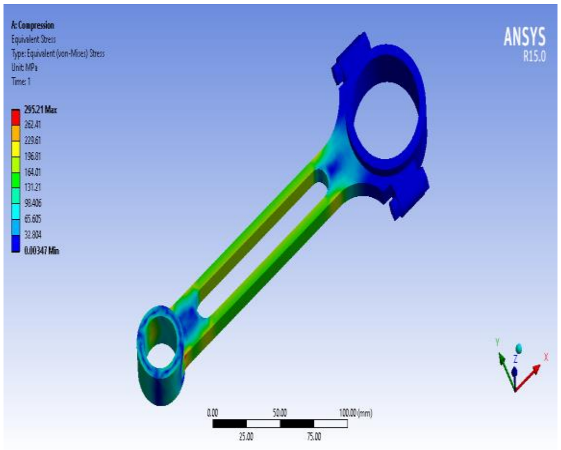



**Fig. 4 (a) Compressive Stress**

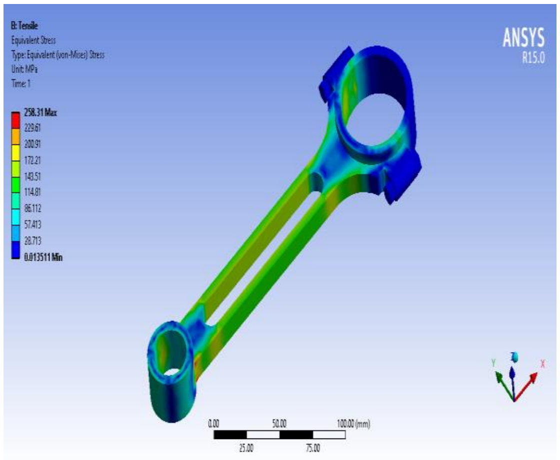



**Fig. 4 (b) Tensile Stress**

The safety factor is based on tensile stress and working stress, its image mention in the Fig. 5 (a) & (b). So, safety should indicate the colour and numerical based.

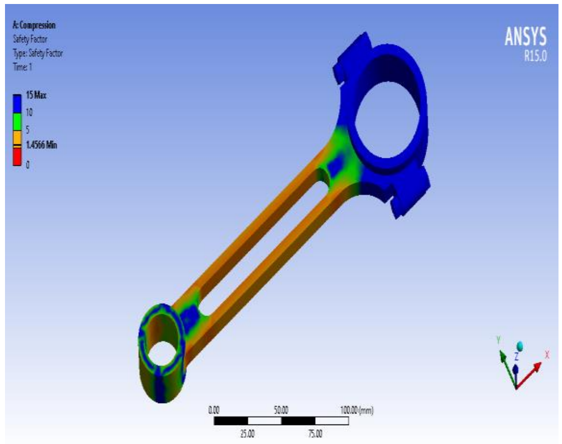



**Fig. 5 (a) Compressive Safety Factor**

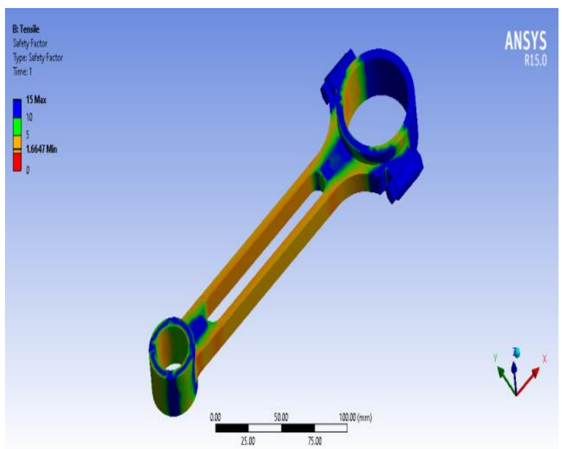



**Fig. 5 (b) Tensile Safety Factor**

## CONCLUSION

The connecting rod is the translation part b/w the piston & the Crankshafts. Its critical measurements to move the push & pull from the piston rod has decreased, which is why it turns the rotating drive of the piston into a revolving crank motion. In addition, the connecting rod is designed using 4 different alloy materials and with the best comparison of the alloy material to connect the rod based on the strength and pressure of the load is beryllium alloy material, the reason for which is the reduction of loading pressure working 20kN (0.17114mm) and loading strength load 17.5kN (0.17614mm) on Ansys software.

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