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Modeling & Analysis of a 100cc I.C. Engine Connecting Rod

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Abstract - *In this project we are modeling a connecting rod in SOLIDWORKS 2018 software and doing static structural analysis in ANSYS WORKBENCH 19.2 software. Thus the part which is modeled is converted into igs file to import in ANSYS work bench and static structural analysis is carried out at 400 N of force by applying various materials including composite materials, materials used in this project are aluminum alloy (2024-T6, 7075- T6), structural steel and 6092/SiC/25p-T6 Al Metal Matrix Composite. By applying the boundary conditions on connecting rod the unknown variables such as stress, deformation, strain are found using the FEA based software (ANSYS).*

Key Words: *Connecting rod, ANSYS WORKBENCH, SOLIDWORKS, Al 2024-T6, Al 7075- T6, 6092/SiC/25p-T6 Al Metal Matrix Composite, Structural Steel.*

1. INTRODUCTION

A connecting rod is the intermediate member which connects a piston to a crank or crankshaft in a reciprocating engine. Together with the crank, it forms a simple mechanism that converts reciprocating motion into rotating motion. A connecting rod may also convert rotating motion into reciprocating motion, its original use. Earlier mechanisms, such as the chain, could only impart pulling motion. Being rigid, a connecting rod may transmit either push or pull, allowing the rod to rotate the crank through both halves of a revolution. Today, the connecting rod is best known through its use in internal combustion piston engines, such as automobile engines.

1.1 Dimension requirement for design: In designing a connecting rod, the following dimensions are required to be determined: (a) Dimensions of cross-section of the connecting rod, (b) Dimensions of the crankpin at the big end and the piston pin at the small end, (c) Size of bolts for securing the big end cap and (d) Thickness of the big end cap.

2. MATERIALS & METHOD: For analysis of the connecting rod, previous study models and data with some practical information is taken into consideration.

2.1 Input parameters: The connecting rod model which is used for analysis is of a 100cc commercial motorbike (Bajaj Discover). Measurements for which were taken practically with the help of a Caliper Scale. The engine specifications of Bajaj Discover 100 are below in the table.

Fig.1. Actual photograph of Bajaj Discover 100cc Connecting Rod.

Table -1: Specifications of Bajaj Discover 100.

Specification	Value
Compression Ratio	9:1
Displacement	94 cc
Cylinders	1
Max. Power	8 bhp @ 7500 rpm
Max. torque	8 Nm @ 5000 rpm
Bore	47 mm
Stroke	54 mm
Valves per cylinder	2
Fuel delivery system	Carburetor
Fuel type	Petrol
Ignition	Digital CDI
Spark Plugs	2 per cylinder
Cooling system	Air cooled
No. of gears	4
Gear box type	Manual
Transmission type	Chain drive
Clutch	Wet multiplate

Table -2: Dimensions of the connecting rod used for analysis.

Dimension	Value
Overall length	120 mm
Max. width	38 mm

Max. thickness	14 mm
Shank thickness	5.50 mm
Big end inner diameter	29 mm
Small end inner diameter	12.50 mm
Big end outer diameter	38 mm
Small end outer diameter	17 mm
Length from centers of both ends	92.50 mm

The material for connecting rod is mostly steel for production engines but now it is generally made of aluminum alloys for light weight and high impact absorbing ability and less costly or it can be made of titanium for lightness with strength at higher cost for high performance engines. Cast iron is also used but due to its heavy weight manufacturers often avoid it. The materials used in this analysis are Aluminum Alloy 2024-T6, Aluminum Alloy 7075-T6, Aluminum Silicon Carbide Metal Matrix Composite, and Structural Steel, which is also the default material applied to model in ANSYS software.

The model of connecting rod is designed in SOLIDWORKS 2018 software and is then exported to the ANSYS WORKBENCH19.2 software.

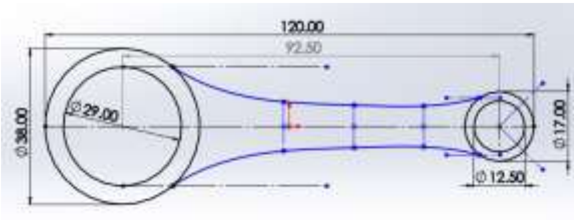


Fig.2. Initial sketch of the connecting rod.

Fig.3. Final extruded Isometric view of the connecting rod.

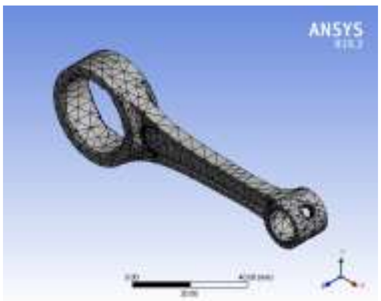


Fig.4. Meshing of the model in ANSYS.

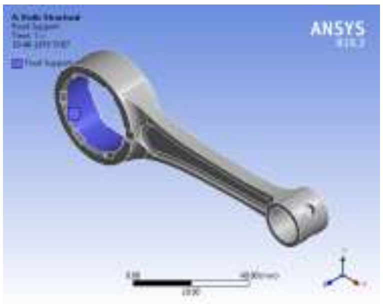


Fig.5. Applying fixed support to the model.

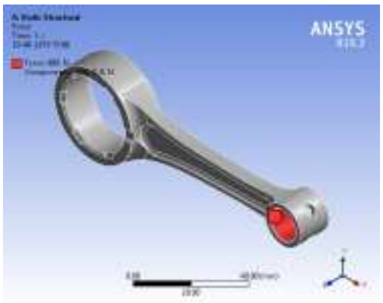


Fig.6. Applying load to the model.

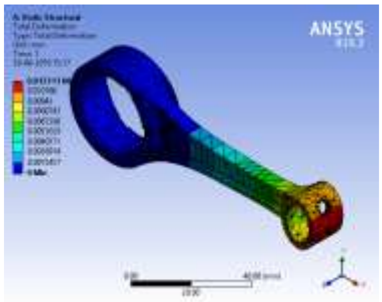


Fig.7. Total Deformation in Aluminum 2024-T6.

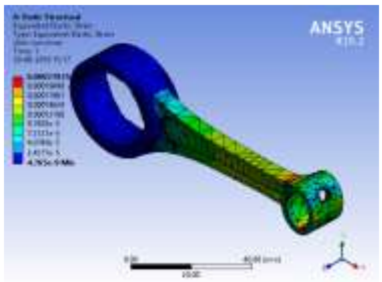


Fig.8. Equivalent Elastic Strain in Aluminum 2024-T6.

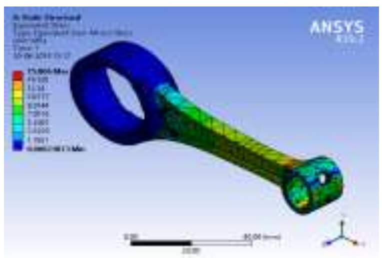


Fig.9. Equivalent sress in Aluminum 2024-T6.

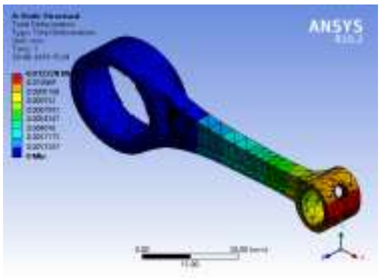


Fig.10. Total Deformation in Aluminum 7075-T6.

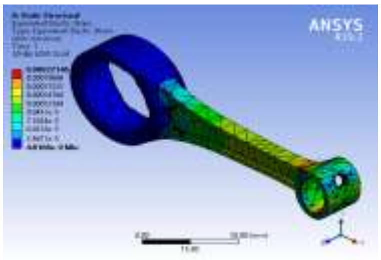


Fig.11. Equivalent Elastic Strain in Aluminum 7075-T6.

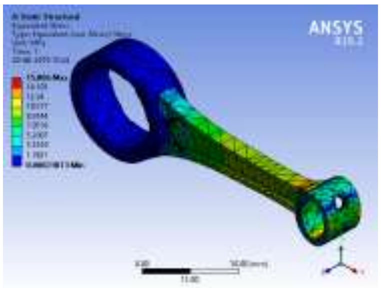


Fig.12. Equivalent Stress in Aluminum 7075-T6.

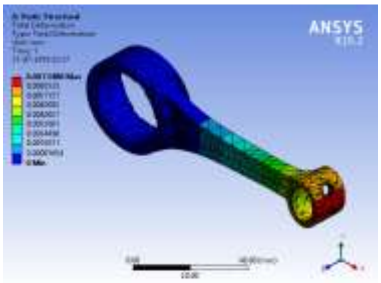


Fig.13. Total Deformation in 6092/SiC/25p-T6 Al Metal Matrix Composite.

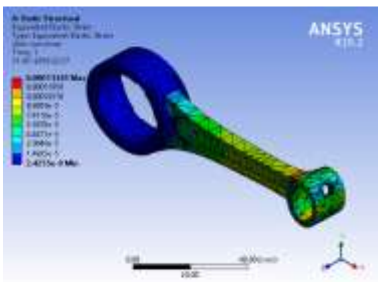


Fig.14. Equivalent strain in 6092/SiC/25p-T6 Al Metal Matrix Composite.

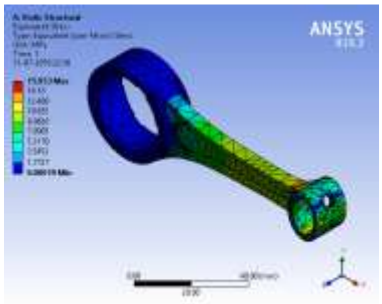


Fig.15. Equivalent stress in 6092/SiC/25p-T6 Al Metal Matrix Composite.

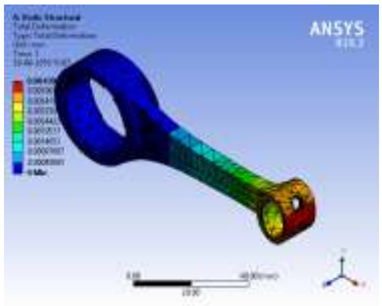


Fig.16. Total Deformation in structural steel.

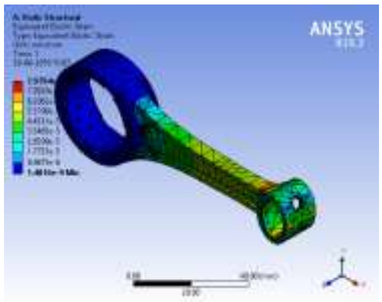


Fig.17. Equivalent strain in structural steel.

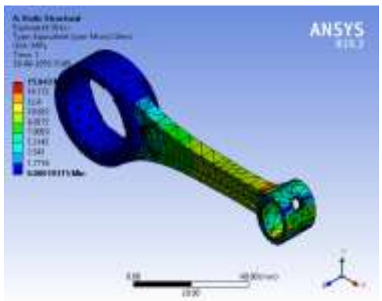


Fig.18. Equivalent stress in structural steel.

Result and Discussion: The big end of the connecting rod was fixed whereas a load of 400N was applied on the small end, then Meshing of the model was performed. Different materials were applied one by one and solution was obtained for Total Deformation, Equivalent Elastic Strain, Equivalent Stress. From analysis we found the mass of the connecting rod by applying different materials are:

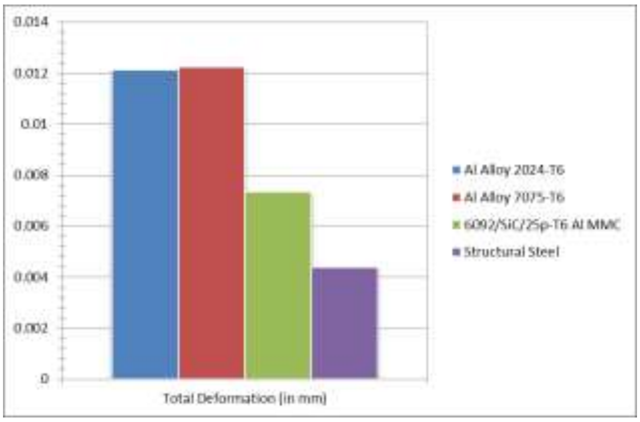
Table - 3. Statistics of Meshing used for analysis.

Parameters	Value
Physics Preference	Mechanical
Element Order	Quadratic
Smoothing	High
Nodes	16681
Elements	9402

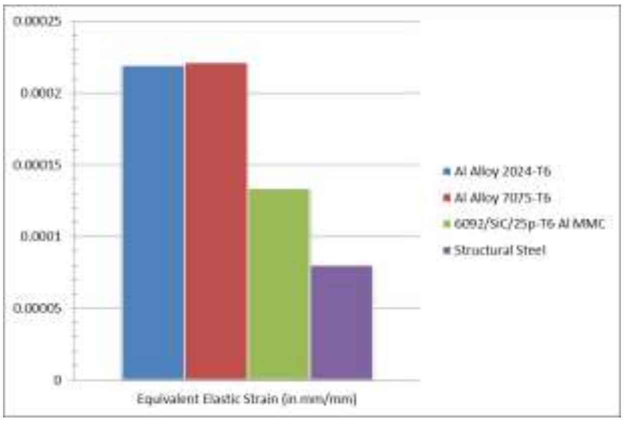
Table - 4. Comparison table of all the applied materials.

Materials	Total Deformation (mm)	Max. Equivalent Elastic Strain (mm/mm)	Max. Equivalent Stress (MPa)
Al Alloy 2024-T6	0.012111	0.0002194	15.866
Al Alloy 7075-T6	0.012228	0.0002215	15.866
6092/SiC/25p-T6 Al Metal Matrix Composite	0.0073488	0.0001334	15.953
Structural Steel	0.004396	0.000079794	15.943

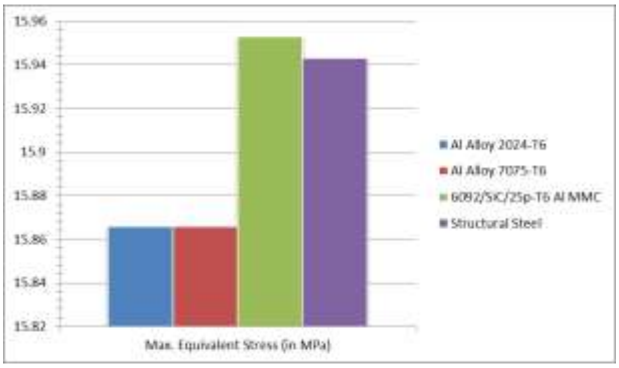
For a better understanding of the differences in results, graphs are given below with comparison of parameters of different materials:



Graph – 1 Comparison of Total Deformation of different materials.



Graph - 2 Comparison of Max. Equivalent Elastic Strain of different materials.



Graph - 3 Comparison of Max. Equivalent stress of different materials.

3. CONCLUSIONS

This research project analyzed the stress, strain and deformation that connecting rod with different material offers. The connecting rod which is made of aluminum alloy chosen for this project belongs to Bajaj Discover 100cc bike. First, the connecting rod model was made with SOLIDWORKS 2018 software. Load analysis was performed based on the input data in ANSYS WORKBENCH 19.2. The results obtained after performing the analysis shows the difference in the structural behavior of the connecting rod. It is concluded that structural steel shows least stress, strain and deformation on same static load condition. But due to its heavy weight it cannot be considered. Although, the second best results come for 6092/SiC/25p-T6 Al MMC with more stress generation compared to all other materials (Al Alloy 2024-T6, Al Alloy 7075-T6 and structural steel). Also the generally used aluminium alloys are cost efficient due to their large market and higher production, so the composite aluminium with silicon carbide may increase the cost. Hence, 6092/SiC/25p-T6 Al MMC is best suitable material if cost is no issue, otherwise Al Alloy 2024-T6 among these four materials is good for connecting rod obtained from this research analysis.

Scope for Future Work: Due to limitations of computer processing hardware, a very setting of mesh could not be obtained. Also, because of the same reason explicit dynamic analysis could not be performed which could have shown a more close real to life analysis of the connecting rod. So, for future work, a higher mesh setting can be applied for analysis and explicit dynamic analysis can be performed.

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