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Optimum design and 3D printing of a rocker arm of 4 cylinder Engine Using FEA

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Abstract **Rocker arm is vital component in valve actuating mechanism of an IC engine. [2] There is research is going on in industries for optimum design i.e. reduction in weight and increase in strength. Also failure of rocker arm is major concern, so in this project we have modeled the rocker arm in CAD software and done FEA analysis of the same model for different materials.[5][6] After that we have taken better material for modification to get optimum results, in this case we have taken structural steel material. [12]**

Keywords* — *Ansys. CATIA, FEA, Optimization, Rocker arm, steel

I. INTRODUCTION

Rocker arm is the part of the actuating component and is used to design to pintle on the hinge pin or Shaft i.e. secured to a bracket. The bracket is fixed on the cylinder head. First end of the rocker arm is in contact with the top of the valve stem, and the another end has actuated by the camshaft. In installation where the camshafts are positioned below the cylinder heads, rocker arms were actuated by pushrods. A lifter has rollers which are imposed by the valve spring to follow the profile of the cams. [1] Here we are studying and analyzing that by changing different materials.

Fig - 1: position of a rocker arm

A. *Types of Rocker Arm[12]*

-Stamped steel rocker arm

- Roller tipped rocker arm

- Full roller rocker arm

- Shaft rocker arm

-Center pivot rocker arm

- End pivot (Finger follower) rocker

B. *Working of rocker arm*

The Rocker arms are back and forth levers that convey radial movements from cam lobes into straight line movement at the poppet valves to open it. First end raised and lowered by the rotating lobes of camshafts,[3][4] while another end act as on valves stem. When a camshafts lobe raised the outside of the arms, the inside causes to move into a position of contact with downward on the valve stem, openings the valve. When the outside of a arms permits to return due to the camshaft rotation, then inside rises, allowing the valve springs to close the valves.[5]

II. METHODOLOGY

Before modeling and analysis of rocker arm we have taken three material i.e. structural steel, carbon steel and HMCF UD. We have done analysis of this material to check better suitable material for optimum results. [7]

Following are the steps used in this paper are:

a) Modeling of Rocker Arm in CAD Software for material structural steel
b) FEA Analysis of Rocker Arm for material structural steel
c) Modeling of Rocker Arm in CAD Software of material HMCF UD
d) FEA Analysis of Rocker Arm for material HMCF UD
e) Modeling of Rocker Arm in CAD Software of material Carbon steel EN6
f) FEA Analysis of Rocker Arm for material Carbon steel EN6

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g) Taking better material out of above mentioned material. And optimize the model in CAD Software.
h) FEA Analysis of optimized model.
i) Check weight and strength of an optimized model.

III. CAD MODELING OF ROCKER ARM BY CATIA SOFTWARE

We have prepared CAD Model for three different materials and saved in STEP format to ease for FEA.

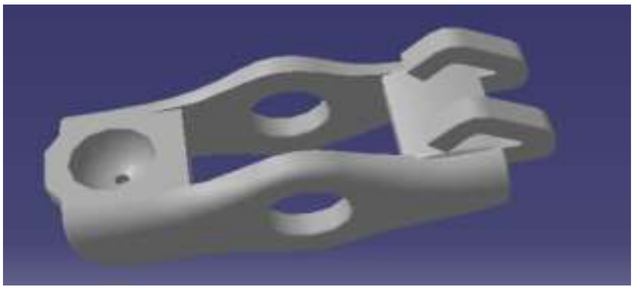


Fig - 2: Model of Rocker Arm before Modification

Fig - 3: Model of Rocker Arm after Modification

IV. FEA ANALYSIS USING ANSYS SOFTWARE

A. *Before Modification*

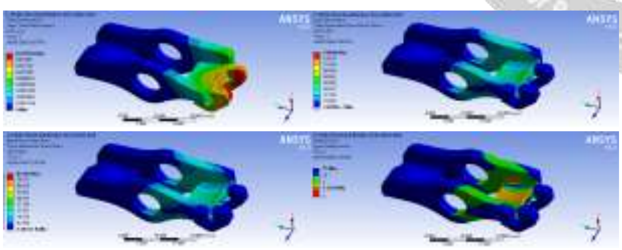


Fig - 4: Analysis at Valve end for structural steel

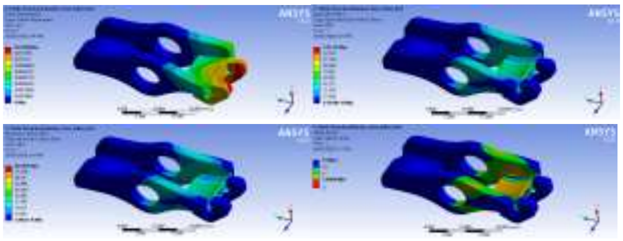
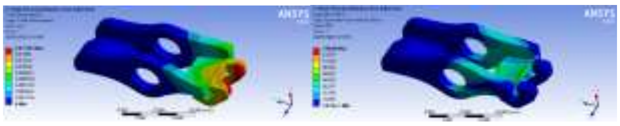


Fig - 5: Analysis at Valve end for Carbon Steel



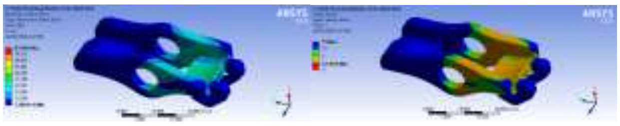


Fig - 6: Analysis at Valve end for HMCF UD

B. *After Modification*

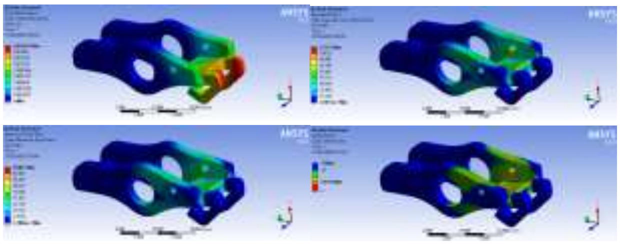


Fig - 7: Analysis at Valve end for structural steel

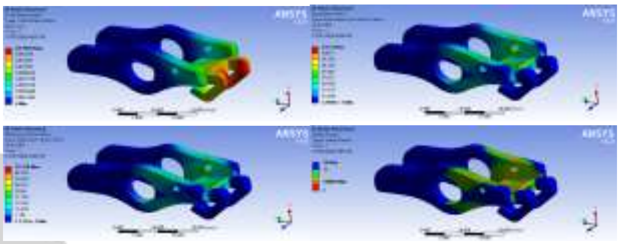


Fig - 8: Analysis at Valve end for Carbon Steel

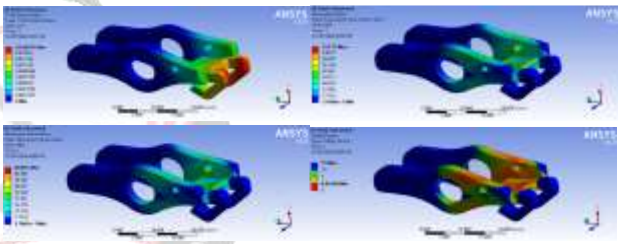


Fig - 9: Analysis at Valve end for HMCF UD

V. COMPARATIVE ANALYSIS

Result	Material		
	Structural Steel	HMCF UD	Carbon Steel EN6
Total Deformation(mm)	0.015	0.015	0.014
Equivalent Stress (Mpa)	144.89	144.89	143.17
Equivalent Strain (mm/mm)	0.00083	0.00083	0.00078
Max. Shear Stress (MPa)	83.49	83.49	82.49
Safety Factor	1.7	0.8	1.6
Weight (kg)	0.02416	0.0049244	0.024129

Table -1: Comparative Analysis before Modification

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Result	Material		
	Structural Steel	HMCF UD	Carbon Steel EN6
Total Deformation(mm)	0.016	0.016	0.016
Equivalent Stress(Mpa)	121.75	121.75	122.3
Equivalent Strain(mm/mm)	0.00072	0.00072	0.00069
Max. Shear Stress(MPa)	69.82	69.82	70.12
Safety Factor	2.0	0.9	1.8
Weight (kg)	0.023827	0.0048565	0.023797

Table -2: Comparative Analysis after Modification

VI. OPTIMUM RESULT

Result	Material		
	Structural Steel	HMCF UD	Carbon Steel EN6
% change in weight	-1.38	-1.38	-1.38
% change in strength	17.65	12.50	12.50
NOTE:- +ve sign indicates the increase in value -ve sign indicates the decrease in value			

The optimum results that we have got for different material as shown in the table:-

The percentage change in weight for all material is equal that is -1.38% i.e. reduction in weight.

The percentage change in strength for structural steel is 17.65% (i.e. increase in strength) which is highest than other material like HMCF UD and Carbon steel both have same percentage change in strength.

VII. Conclusion

Rocker arm is an important component of engine, failure of rocker arm is major concern. The finite element method is widely approach and located commonly used for analyzing fracture mechanics problems. Steel is that the better material in terms of strength. HMCF UD is compare to steel and Carbon steel has low strength and stiffness. Now we can conclude that both steel and Carbon steel is better for design a rocker arm based on strength and weight.

Observed that from above FEA analysis, we can use material as a structural steel for optimum results. For material structural steel getting percentage change in weight is -1.38% i.e. reduction in weight.

Similarly getting percentage change in strength is 17.65% i.e. increase in strength. From above results we have got optimum design model for rocker arm.

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