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Design and Optimization of Rocker Arm

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Abstract:

A rocker arm is a valve train component in internal combustion engines to function of combustion. As rocker arm is acted on by a camshaft yack , it pushes and opens either the intake valve or either exhaust valve. This allows fuel and air to be drawn into the combustion chamber during the intake stroke or exhaust gases to be exited during the exhaust stroke. Rocker arms was first invented on the 19th century, and have been changed a little in dimension function since then. Improvements have been made however in 20th century, in both efficiency of operation and construction materials. About rocker arm of Tata automobiles. It will make the exact design of rocker arm of Tata hexa , vista in reverse engineering process. The analyze rocker arm by using various composite materials. Over the year's rocker Arm have been optimized in its design and different engineering materials such as (Cast iron, Aluminium Alloy and Titanium) for better performance. Durability, Toughness, higher dimension, stability, wear predictive , strength, rigidity and cost of materials as well as economic factors are the reasons for optimization of Rocker Arm. The CAD models of Rocker Arm will be created using CATIA (P3 V5R14) and ANSYS(16.1) software will be used for analysis of rocker arm. The CAD model will be inherited in ANSYS Workbench and with Equivalent Stress and Maximum Shear Stress will be found. The obtained results are provided by ANSYS Workbench are compared to the results obtained by manual calculation.

Keywords – Design and analysis, Rocker arm, CAD models, ANSYS.

I.INTRODUCTION

1.1. A r**ocker arm** is an oscillating levers that conveys radial movements from the cam lobe into straight movement at the poppet valve to opens it. One end is raised and lowered by a rotating lobe of the camshaft (either directly or via a tappet (lifter) and pushrod) while the other end acts on the valve stem. When camshaft's lobes raises the external of the arm, the insides presses down on the valve stem, opened the valve. The arm is used to activate the inlet valve and exhaust valves motion as conducted by the cam and followers . It may be made alloys like of cast iron, cast steel, or malleable iron. Where into reduce passivity of the rocker arm, an I shape section is used for the higher rpm speed engines and it may be rectangular section for lower rpm speed engine. In four stroke engines, the rocker arms for the exhaust valve are the most heavily loaded with high load. Though the strength need to operate the inlet valve is relatively in low amount, yet it is constant practice to generate the rocker arm for the inlet valve of the same dimensions as that for exhaust valve.

1.2 WORKING OF ROCKER ARM

The rocker arm is an oscillating lever that conveys radial movement from the cam lobe into linear movement the poppet valve to open it. One end is raised and lowered by a rotating lobe of the camshaft (either directly or via at (lifter) and pushrod) while the other end acts on the valve stem. When the camshaft lobe raises the outside of the arm, the inside presses down on the valve stem, opening the valve. When the outside of the arm is permitted to return due to the camshafts rotation, the inside rises, allowing the valve spring to close the valve.
The drive cam is drives by the camshaft. This pushes the rocker arm upper and downer in periodic motion about the turn-on pin or rocker shaft. Friction may be reduced at the point of friction with the valve stem by a roller cam follower. A similar arrangement transfers the motion via another roller cam follower to a secondary rocker arm.

1.3 HISTORY OF ROCKER ARM

By the history of Rocker arms have been construct with and without "cone" roller tips that despondent upon the valve, as well as many lower weight and high strength alloys and bearing specifications for the blueprint, conation to increase the rpm limits higher and higher for hyper performance applications, eventually to afford the benefits of these race bred technologies to more top-end production vehicles. Through the construction aspects of the rocker arm's dimension has been studied and changed to maxim the cam info exchange to the valve which the rocker arm appoint, as set forth by the Miller US Patent, #4,365,775, issued on Jonny Miller on December 18, 1982, often to referring to as the MID-LIFT Patent rights. The specific axle points with rocker arm, construction was based on old and lower active theories of over-bending motion which increased wear on valve edge, valve guides and other valve train components, beyond diluting, The effective cam lobe info as it was transferred through the rocker arm's motion to the valve. John brito's Patent set a new common of rocker arm geometrical accuracy which defined and duplicate each and every engine's specific pushing-rod to valve attacking angles, then design the rocker's axle points so that an exact horizontal relationship on two sides of the rocker arm was attained with the valve and the pushing rod, when the valve was at its point of motion. Throughout the past of the rocker arm, its function has been studied enhanced upon, These improvements have resulted in rocker arms that are both more efficient and more opposing to wear. Some designs can absolutely use two rocker arms per valve, while others utilize a "cone" roller bearing to depress the valve.

considering energy is required to turn a rocker arm and damp a valve, their weight can be an necessary consideration. If a rocker arm is excessively bulky, it may require too much energy to move. This may avoid the engine from accomplish the desired speed of rotation.

Durability of the material can also be a consideration, as weak material may stress or wear too fastly. Large automotive applications make use of branded steel for these reasons, as this material can provide a balance between mass and durability. Some applications, particularly internal combustion engines, may make use of heavier duty materials. Diesel Engines such as these can work at higher rpm torques and lower rpm running speeds, allowing such cast alloy materials as cast iron or counterfeit carbon steel to be used.

TABLE 1 PROPERTIES OF ALUMINUM COMPOSITE

S. No	Mechanical properties	Value	Units
1	Density	2.76	g/cm3
2	Ultimate Tensile strength	331.22	MPa
3	Modulus of elasticity	90.6	GPa
4	Poisons ratio	0.31	-
5	Tensile yield strength	288.48	MPa

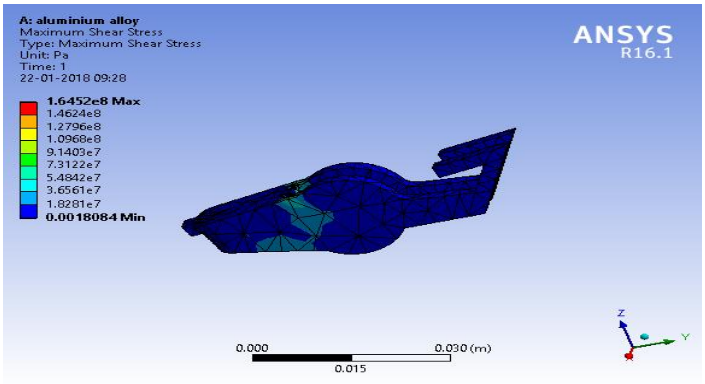
TABLE 2 PROPERTIES OF STRUCTURAL STEEL

S. No	Mechanical Properties	Value	Units
1	Density	7.84	g/cm3
2	Ultimate tensile strength	460	MPa
3	Modulus of elasticity	200	GPa
4	Poisons ratio	0.30	-
5	Tensile yield strength	250	MPa

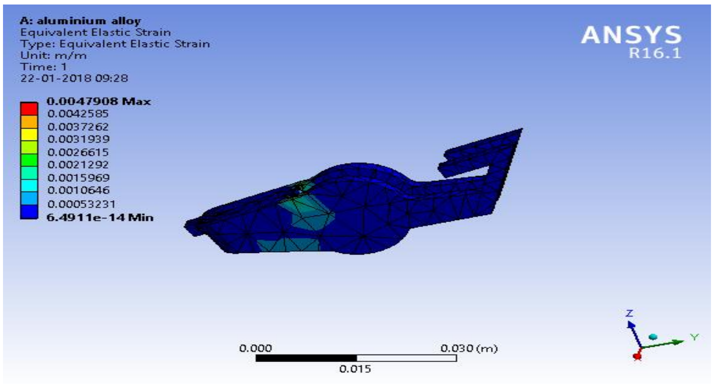
TABLE 3 - PROPERTIES OF Al-6061

S. No	Mechanical Properties	Value	Units
1	Density	2.7	g/cm3
2	Ultimate tensile strength	310	MPa
3	Modulus of elasticity	68.9	GPa
4	Poisons ratio	0.33	-
5	Tensile yield strength	276	GPa

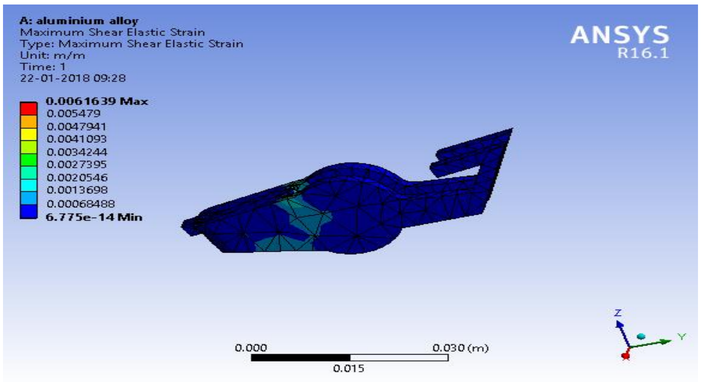
II MAXIMUM SHEAR STRESS OF ALUMINIUM ALLOY ROCKER ARM



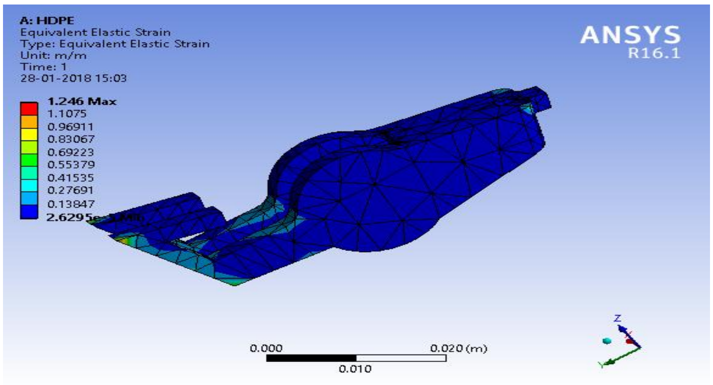
2.1 EQUIVALENT ELASTIC STRAIN OF ALUMINIUM ALLOY ROCKER ARM



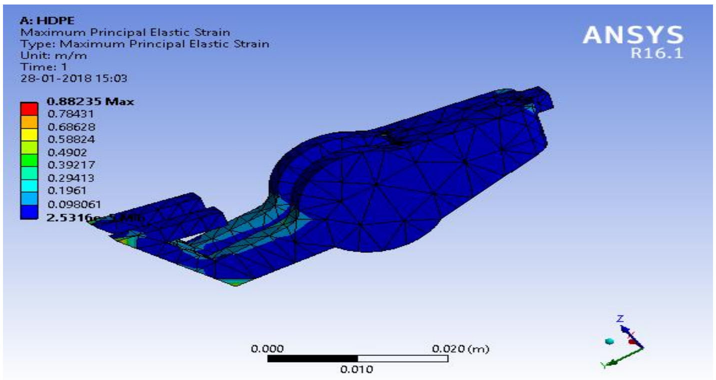
2.2 MAXIMUM SHEAR ELASTIC STRAIN OF ALUMINIUM ALLOY ROCKER ARM



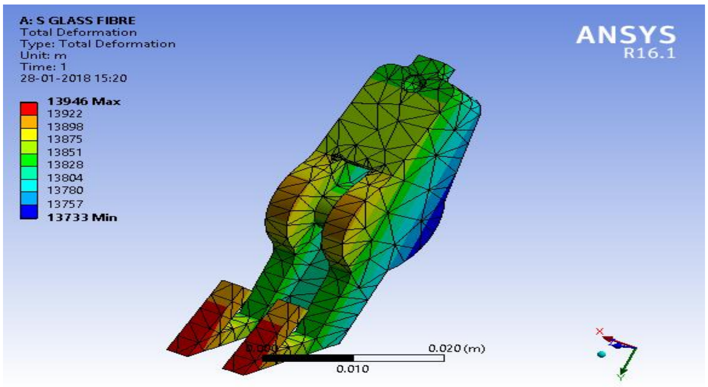
2.3 EQUIVALENT ELASTIC STRAIN OF HDPE MATERIAL ROCKER ARM



III. MAXIMUM PRINCIPAL ELASTIC STRAIN OF HDPE MATERIAL ROCKER ARM



3.1 TOTAL DEFORMATION OF GLASS FIBRE MATERIAL ROCKER ARM



IV. ROCKER ARM PRODUCTION INDUSTRY

Auto tech industries was established in 1984. Auto tech manufacturers rocker arm, BBR and shafts, which are used in diesel engines for vehicles and generators. Autotech supplies these products for the various companies like CUMMINS, ASHOK LEYLAND, TATA, SCANIA, VOLVO AND EATON. Auto tech industries are producing. In F5 plant, the company is manufacturing the rocker arm intake and exhaust, BBR and shaft, which are assembled and supplied to SCANIA. The rocker arms are manufactured under various process. The material used for production is CG 40.
A **coordinate measuring machine** (**CMM**) is a device for measuring the physical dimensional characteristics of an body. This machine may be automatically contained by an operator or it may be electronically contained, by defining by a probing is attached to the third moving axis of this machine. It may be mechanical, optical, laser etc. A machine which catching readings in xyz of degrees of rotating arrangement these readings in mathematical form is known as a CMM.

4.1 ROUNDNESS TESTER

Roundness is the amount of how tightly in the shape of an object accession of that a mathematically and scientifically correct circle Roundness applies in two dimensions, such as the cross sectional circles along a cylindrical object such as a shaft or a spherical roller for a bearing. Where geometric dimension and tolerance control of a cylinder can also include its attachment to the vertical axis, complaint cylindricity.

4.2 BBR

Inlet, exhaust and bearing bracket these three are together called BBR.

Process made to produce BBR:

1) Intake and exhaust.
2) Ball pin pressing
3) Coolant oil washing
4) RPO oil washing (rust oil)
5) Visual screw height torque
6) Cleaning.

Assembly process of BBR:

1) Numbering
2) Bronze
3) Double pin pressing
4) Diesel washing
5) Coolant oil
6) RPO oil
7) Visual assembly.

4.3 ROCKER ARM PARTS:

1) Inlet
2) Exhaust
3) Injector
4) Shaft

V. ROCKER ARM OPERATION:

The branded cast steel Rocker Arm is probably the most common style of manufacturing Rocker Arm. They are the finist and cheapest to production because they are branded from one piece of metal. They use a turn-on axle that holds the rocker in area with a nut that has a cylindrical bottom .This is a very easy way of cramping the rocker in place while allowing it to axle of arm up and down.

Thus Roller Tipped Rocker Arm is just as it sounds. They are similar to the branded Steel Rocker and add a roller on the edge of the valve end of the rocker arm. This allows for less friction clearance, for somewhat more torque, and reduced wear on the valve edge . The Roller Tipped Rocker Arm still uses the turn-on axle nut and stud for simplicity. They can be also be cast or machined cast steel or cast aluminium. The Full Roller Rocker Arm is not a branded cast steel rocker. They are either machined cast steel or cast aluminium. They restore the turn-on axle with bearings. They still use the framing from the turn-on axle but they don't use the nut in turn of gudgeon pin . Since having very short shaft with bearings on each end and the shaft is bolted securely in place and the bearings allow the rocker to pivot edge. The Shaft Rocker Arms frame it off of the Full Roller Rocker Arms. Have a shaft that goes through the rocker arms. Meanwhile the shaft only goes through two rocker arms and sometimes the shaft will go through all of the rocker arms depending on how the head was produced. The reason for using a shaft is for durability. Having a shaft through the rocker arms is much more tough than just using a framing from the head. The huge rigid the valve train across axle arm, the less the valve train alteration and the low chance for ungoverned valve train motion at higher rpm.

The middle axle Rocker Arm looks like a unconventional rocker arm but there is a big difference. Instead of the pushrod pushing up on the lifting rod, the Cam Shaft is moved along into the head and the Cam Shaft pushes directly up on the lifter to force the valve down.

The End Pivot or Finger Follower puts the pivot point at the end of the Rocker Arm. In order for the Cam Shaft to push down on the Rocker Arm is must be located in the middle of the rocker arm.

5.1 APPLICATIONS OF ROCKER ARM:

A rocker arm is a main component and it is used in the operation of an (ICE) internal combustion engine because it is liable for translating the geometry of the camshaft into motion for opening and closing the intake and exhaust valves.

VI. CONCLUSION

Rocker arm is a main component of engine, thus failure of rocker arm makes engine useless also requires costly appropriation and replacement. An extensive research in the pastly clearly signed out that the problem has not yet been conquered completely and designers are facing lot of failures often ,strain and stress clustering and effect of loading and other factors. The finite element method is the most popular approach and found commonly used for analysing fracture mechanics problems.

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