DESIGN AND ANALYSIS OF FOUR WHEELER ROCKER ARM

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Abstract: A rocker arm is a valve train component in internal combustion engines. As rocker arm is acted on by a camshaft lobe, it pushes and opens either the intake or exhaust valve. This allows fuel and air to be drawn into the combustion chamber during the intake stroke or exhaust gases to be expelled during the exhaust stroke. The rocker arm is designed and analysed by applying different materials for it. The materials used for this analysis are Aluminium Alloy 6061, HDPE and Glass fibre. The design is created in Catia and the analysis is done in Ansys workbench 16.1. Based on our analysis Aluminium Alloy 6061 has the maximum fatigue stress.

Index Terms- Rocker arm, Stress, ANSYS, Strain.

I. INTRODUCTION

A **rocker arm** is an oscillating lever that conveys radial movement from the cam lobe into linear movement at the poppet valve to open 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 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 rocker arm is used to actuate the inlet and exhaust valves motion as directed by the cam and follower. It may be made of cast iron, cast steel, or malleable iron. In order to reduce inertia of the rocker arm, an I-section is used for the high speed engines and it may be rectangular section for low speed engines. In four stroke engines, the rocker arms for the exhaust valve are the most heavily loaded. Though the force required to operate the inlet valve is relatively small, yet it is usual practice to make the rocker arm for the inlet valve of the same dimensions as that for exhaust valve.

A. ORIGINS:

Dating back to the 19th century, rocker arms have been made with and without roller tips that press upon the valve.

USE OF ALLOYS:

Many light weight and high strength alloys, and bearing configurations for the fulcrum, have been used in an effort to increase the RPM limits for high performance applications, eventuallylending the benefits of these race bred technologies to more high-end production vehicles.

GEOMETRY:

Even the design aspects of the rocker arms geometry has been studiedand changed to maximize the cam information exchange to the valve which the rocker arm impose, as set forth by the Miller US patent,#4,365,785, issued to James Miller on December 28, 1982, often referred to as the MID-LIFT patent. Previously, the specific pivot points with rocker arm design was based in older and less efficient theories f over-arcing motion which increased wear in valve tips, valve guides and other valve train components, besides diluting the effective cam lobe information as it was transferred through the rocker arms motion to the valve. Jim Millers MID-LIFT patent set a new standard of rocker arm geometrical precision which defined and duplicated each engines specific push rod to valve attack angles, these designing the rockers pivot points so that an exact perpendicular relationship on both sides of the rocker arm was attained: with the valve and the pushrod, when the valve was at its mid-lift point of motion.

II DESIGN AND MODELLING:

The present study is to design the rocker arm for the four wheeler by changing various materials accordingly to it. Table 1 Shows the properties used for the materials.

Materials	Modulus of elasticity (GPa)	Poissons ratio	Density (kg/m3)
Aluminium Alloy 6061	68.9	0.33	270
HDPE	1.24	0.4	941
S-Glass fibre	87	0.2	2500

Table 1: Properties of materials

III A. INTRODUCTION TO CATIA:

CATIA started as an in-house development in 1977 by French aircraft manufacturer Avion Marcel Dassault, at that time customer of the CADAM software to develop Dassaults Mirage fighter jet. It was later adopted by the aerospace, automotive, shipbuilding, and other industries. Initially named CATI (conception assistee tridimensionelle interactive- French for interactive aided three-dimensional design), it was renamed CATIA in 1981 when Dassault created a subsidiary to develop and sell the software and signed a non-exclusive distribution agreement with IBM. In 1984, the Boeing company chose CATIA V2 as its main 3D CAD tool, becoming its largest customer. In 1988, CATIA V3 was ported from mainframe computers to UNIX. In 1990,General Dynamics Electric Boat Corp chose CATIA as its main 3D CAD tool to design the U.S Navys Virginia class submarine. Also, Lockheed was selling its CADAM system worldwide through the channel of IBM since 1978. In 1992, CADAM was purchased from IBM, and the next year CATIA CADAM V4 was published in 1996, it was ported from one to four UNIX operating systems, including IBM AIX, Silicon Graphics IRIX, Sun Microsystems SUN OS, and Hewlett-packard HP-UX. In 1998, V5 was released and was an entirely rewritten version of CATIA with support for UNIX, WINDOWS NT and WINDOWS XP (since 2001). In the year prior to 2000, problems causes by incompatibility between versions of CATIA (version 4 and version 5) led to $6.1B in additional costs due to years of project delays in production of the airbus A380.
In 2014, Dassault systems launched 3D experience platform R2014X and CATIA on the cloud, a cloud version of its software.

B. INTRODUCTION TO ANSYS WORKBENCH:
ANSYS mechanical is a finite element analysis tool for structural analysis including linear, nonlinear and dynamic studies. This computer simulation product provides finite element to model behaviour and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS mechanical also includes thermal HYPER LINK and coupled analysis capabilities acoustics, piezoelectric, thermal- structural and thermos electric analysis.

IV WORKING:

The rocker arm (Figure 1) is an oscillating lever that conveys radial movement from the cam lobe into linear movement at the poppet valve to open 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 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 (Chin-Sung and Ho-Kyung, 2010). The drive cam is driven by the camshaft. This pushes the rocker arm up and down about the pin or rocker shaft. Friction may be reduced at the point of contact with the valve stem by a roller cam follower. A similar arrangement transfers the motion via another roller cam follower to a second rocker arm.

Fig1: rocker arm

This rotates about the rocker shaft, and transfers the motion via a tappet to the poppet valve. In this case this opens the intake valve to the cylinder head.

V. TYPES OF ROCKER ARM Rocker arms are of various types, there design and specifications are different for different types of vehicles (bikes, cars trucks, etc). Even for same type of vehicle category rocker arms differs in some way. Types of rocker arm also depend upon which type of Internal-combustion engine is used in a vehicle (i.e. Push Rod Engines, Over Head Cam Engines, etc).

A. Stamped Steel Rocker Arm- The Stamped Steel Rocker Arm is probably the most common style of production Rocker Arm. They are the easiest and cheapest to manufacture because they are stamped from one piece of metal. They use a turn-on pivot that holds the rocker in position with a nut that has a rounded bottom. This is a very simple way of holding the rocker in place while allowing it to pivot up and down.

Fig 2: Stamped steel rocker arm

B. Roller Tipped Rocker Arm- The Roller Tipped Rocker Arm is just as it sounds. They are similar to the Stamped Steel Rocker and add a roller on the tip of the valve end of the rocker arm. This allows for less friction, for somewhat more power, and reduced wear on the valve tip. The Roller Tipped Rocker Arm still uses the turn-on pivot nut and stud for simplicity. They can also be cast or machined steel or aluminum.

Fig 3: Roller tipped rocker arm

C. Full Roller Rocker Arm- The Full Roller Rocker Arm is not a stamped steel rocker. They are either machined steel or aluminium. They replace the turn-on pivot with bearings. They still use the stud from the turn-on pivot but they don't use the nut. They have a very short shaft with bearings on each end (inside the rocker) and the shaft is bolted securely in place and the bearings allow the rocker to pivot.

Fig 4: Full roller rocker arm

D. Shaft Rocker Arms- The Shaft Rocker Arms build off of the Full Roller Rocker Arms. They have a shaft that goes through the rocker arms. Sometimes the shaft only goes through 2 rocker arms and sometimes the shaft will go through all of the rocker arms depending on how the head was manufactured. The reason for using a shaft is for rigidity. Putting a shaft through the rocker arms is much more rigid than just using a stud from the head. The more rigid the valve train, the less the valve train deflection and the less chance for uncontrolled valve train motion at higher RPM.

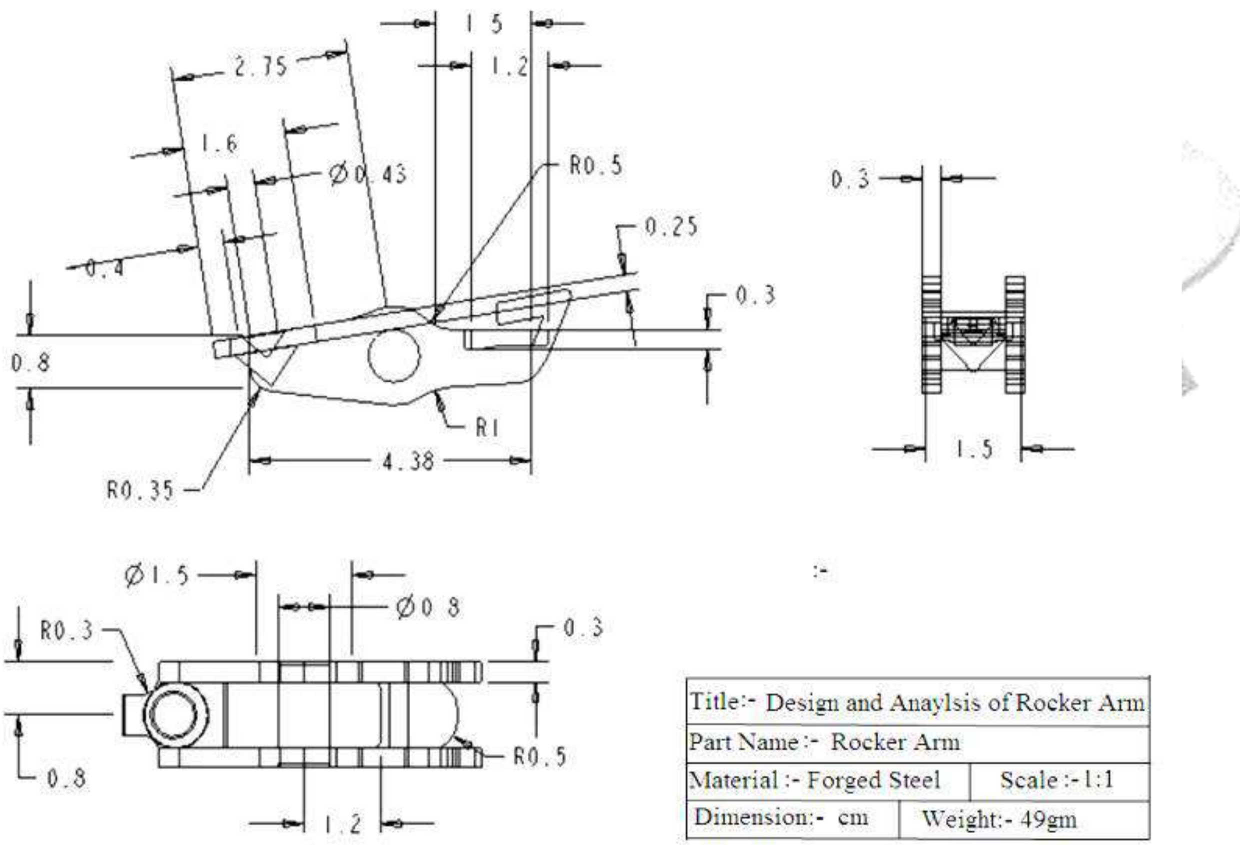
Fig 5: Shaft rocker arm

E. Centre Pivot Rocker Arms- The Centre Pivot Rocker Arm looks like a traditional rocker arm but there is a big difference. Instead of the pushrod pushing up on the lifter, the Cam Shaft is moved into the head and the Cam Shaft pushes directly up on the lifter to force the valve down. In this case the pivot point is in the centre of the rocker arm and the Cam Shaft is on one end of the rocker arm instead of the pushrod.

Fig 6: Centre pivot rocker arm

F. End Pivot (Finger Follower) Rocker Arms- 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.

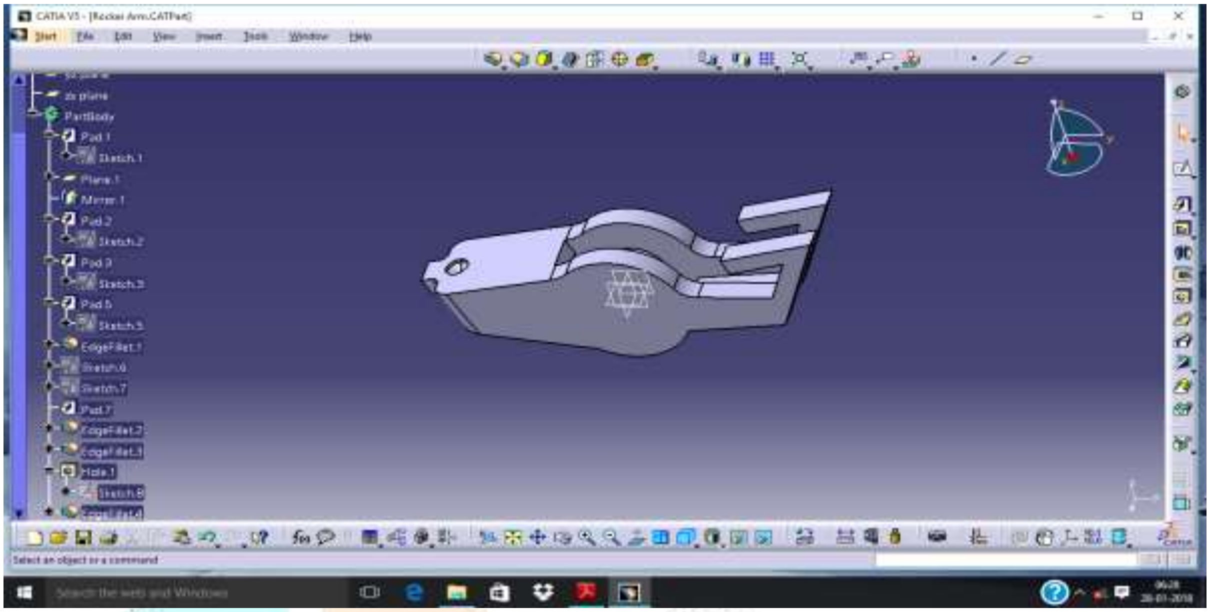
Fig 7: End pivot rocker arm



Title:- Design and Anaylsis of Rocker Arm	
Part Name :- Rocker Arm	
Material :- Forged Steel	Scale :- 1:1
Dimension:- cm	Weight:- 49gm

Fig 8: Rocker arm Design Specification

VI DESIGN AND ANALYSIS OF FOUR WHEELER ROCKER ARM



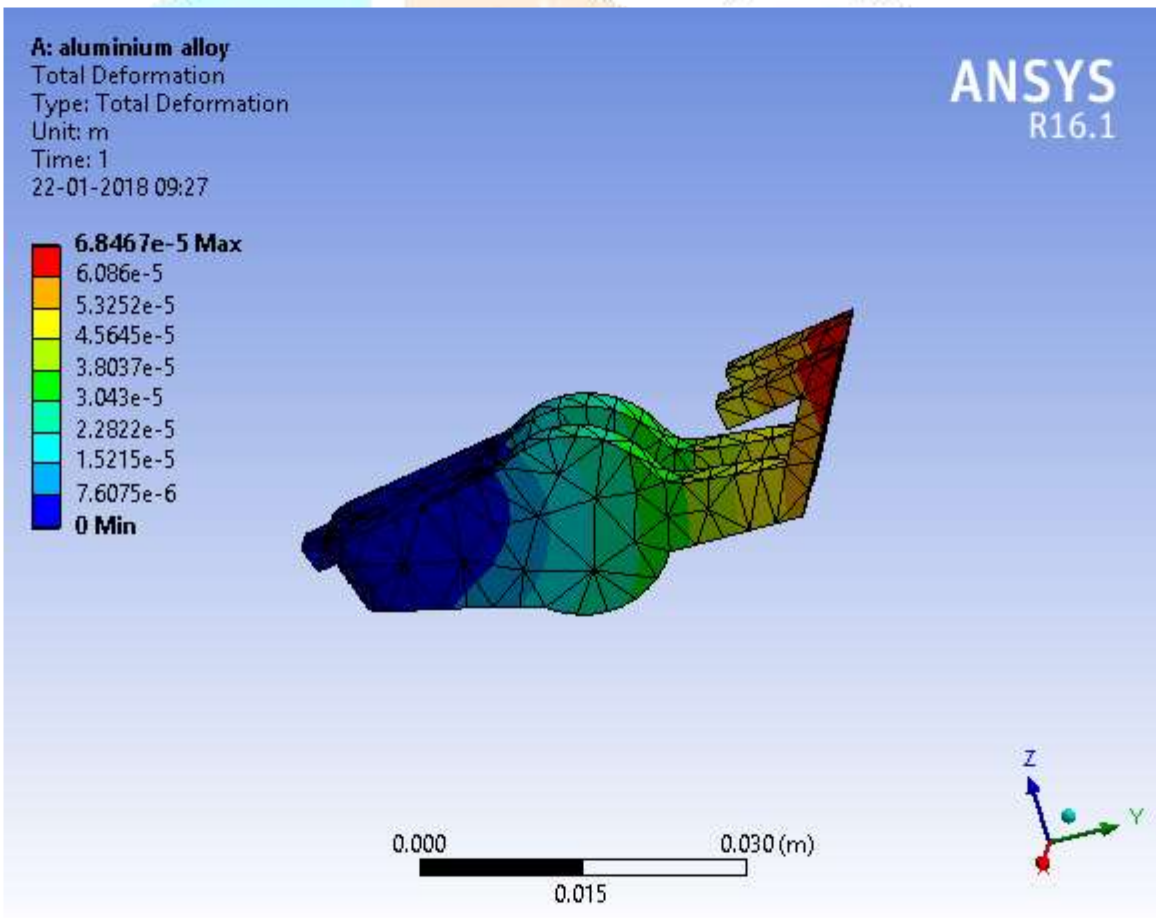


FIG 9: ANALYSIS OF ALUMINIUM ALLOY

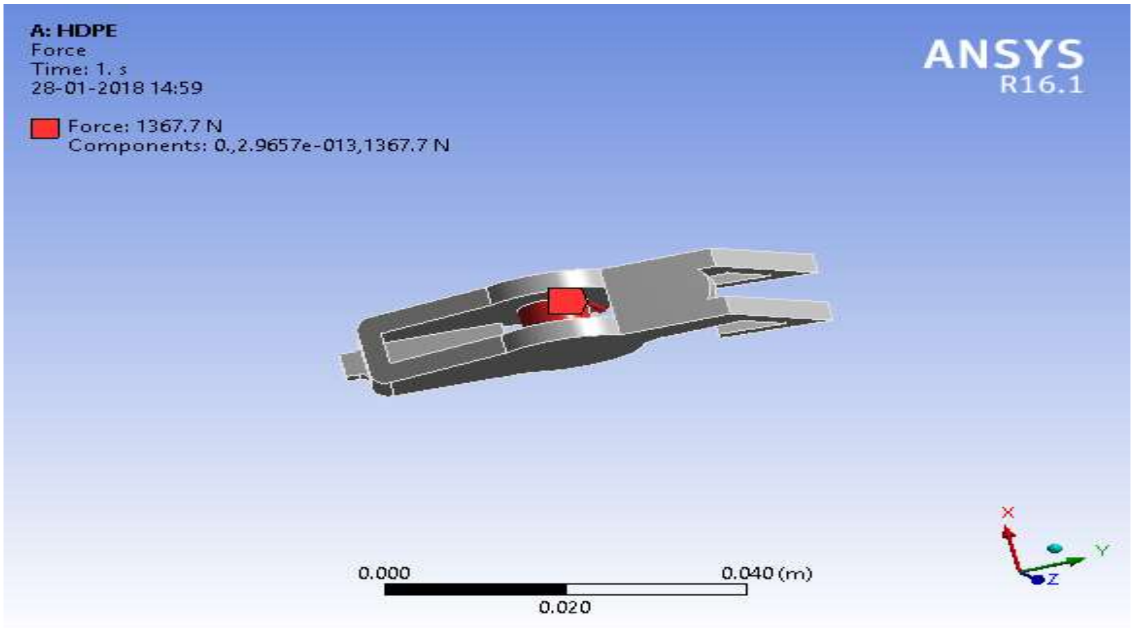


FIG 10: FORCE ACTING AT THE CENTRE OF THE ROCKER ARM

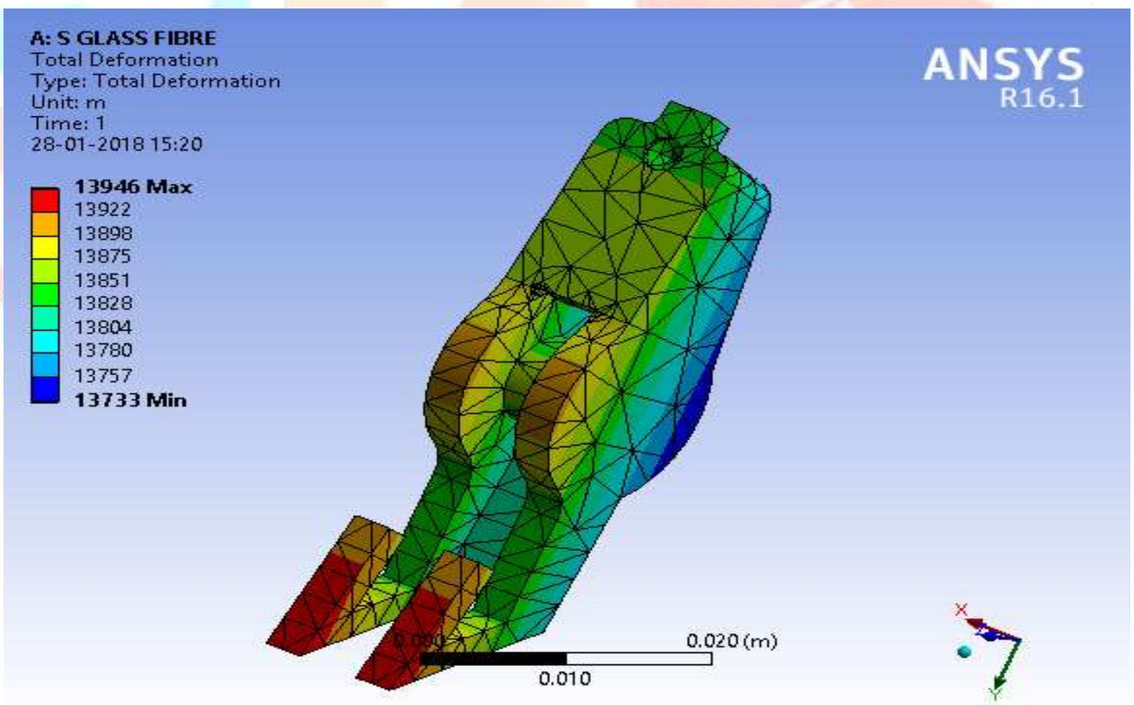


FIG 11: ANALYSIS OF S- GLASS FIBRE MATERIAL

VII RESULT:

As a result Aluminium alloy produces the maximum fatigue stress. This would make the rocker arm to protect from the brake when it is in motion.

VIII CONCLUSION:

Rocker arm is an important component of engine, failure of rocker arm makes engine useless. The shear stress at the pin of a rocker arm was evaluated by calculation as 13.69 N/mm2 and Ansys software it came ot to be nearly 12.76 N/mm2 this both values shear stress are or critical shear stress. Thus we conclude that pin of rocker arm is under shear stress.

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