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Modeling and Analysis of I.C Engine Rocker Arm

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ABSTRACT:

Over the years rocker arms have been optimized in its design and material for better performance. Durability, toughness, high dimension stability, wear resistance, strength and cost of materials as well as economic factors are the reasons for optimization of rocker arm. This paper reviews the various types of rocker arms, based on published sources from the last 40 years in order to understand rocker arm for its problem identification and further optimization. This paper present what rocker arm is, where it is used and why it is used, History related to rocker arm and it working is described. Various types of rocker arm used in vehicles and different materials used for making rocker arm are studied in this paper. Reasons for Failure of rocker arm are also discussed in this paper. In fast moving world the time is very important criteria. But in the manual program time takes more and more for every work in the world in the production department drawing is very important for design the various parts.

In the manual work, its takes more time and is also very difficult to draw various components compare to CAD. So, to avoid these difficulties, CAD implements for quick & accurate design. Computer aided design have various packages are Auto CAD, Pro-E, etc. Auto CAD is using for 2D drawing and Pro-E is the latest implement in CAD, Which is especially using for 3D modeling. Most of the industry Pro-E is using for creating a new Design and modification of existing Design. ANSYS software is used for analyzing the 3d modeling objects. The ANSYS program has much finite element analysis, capabilities, ranging from a simple, linear, static analysis to a complex non–linear, transient dynamic analysis. Jithendra

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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. As a rocker arm is acted on by a camshaft lobe, it pushes open either an intake or exhaust valve [1][2]. 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. Rocker arms were first invented in the 19th century and have changed little in function since then.

Improvements have been made, however, in both efficiencies of operation and construction materials [1] [3] [4]. The drive cam is driven by the camshaft. This pushes the rocker arm up and down about the trunnion 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. 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. The effective leverage of the arm (and thus the force it can exert on the valve stem) is determined by the rocker arm ratio, the ratio of the distance from the rocker arm's center of rotation to the tip divided by the distance from the center of rotation to the point acted on by the camshaft or pushrod.



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Current automotive design favors rocker arm ratios of about 1.5:1 to 1.8:1. However, in the past smaller positive ratios (the valve lift is greater than the cam lift) and even negative ratios (valve lift smaller than the cam lift) have been used. Many pre-World War II engines use a 1:1 (neutral) ratio.

2. LITERATURE SURVEY DESIGN AND ANALYSIS OF ROCKER ARM 2.1. DESIGN AND ANALYSIS OF ROCKER ARM

Syed Mujahid Husain and Siraj Sheikh

In this paper we discussed about Rocker arm of Tata Sumo victa that was designed and analyzed to find the critical regions. CAD models of Rocker Arm was created using Pro/E and ANSYSV11software was used for analysis of rocker arm. The CAD model was inputted in ANSYS Workbench and Equivalent Stress and Maximum Shear Stress was found. The obtained results provided by ANSYS Workbench are compared to the results obtained by manual calculation.

2.2. Stress Analysis of Glass/HDPE Composite Rocker Arm by Finite Element Method Antaryami Mishra

An attempt has been made in this investigation to find out various stresses under extreme load condition for a polymer matrix composite rocker arm. Glass fibre reinforced (10% volume fraction) High Density Polyethylene (HDPE) composite rocker arm of fuel injection pump has been considered for analysis owing to its light weight, higher strength and good frictional characteristics. A 2-D finite element analysis has been carried out to find out the maximum stresses developed in the rocker arms made of steel and composite. Further comparison has been made with that of the theoretical calculated strength from failure point of view. It is observed that almost same stresses are developed for both the materials i.e steel and the composite. Maximum von Misses stress developed is around 1473 Pa which is much less compared to tensile strengths of steel and composite i.e 410 and 493 MPa respectively. With this it may be concluded that the stresses developed in the composite is well within the limits without failure. Therefore the proposed composite may be considered as an alternate material for steel to be used as rocker arm.

1. ROCKER ARM:

A rocker arm is a valve train component in internal combustion engines. As the arm is acted on by a camshaft lobe, it pushes open either an 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. Rocker arms were first invented in the 19th century and have changed little in function since then. Improvements have been made, however, in both efficiency of operation and construction materials. Many modern rocker arms are made from stamped steel, though some applications can make use of heavier duty materials. In many internal combustion engines, rotational motion is induced in the crank shaft as the pistons cause it to rotate. This rotation is translated to the camshaft via a belt or chain.

In turn, lobes on the camshaft are used to push open the valves via rocker arms. This can be achieved either through direct contact between a camshaft lobe and rocker arm or indirectly though contact with a lifter driven pushrod. Overhead cam engines have lobes on the camshaft which contact each rocker arm directly, while overhead valve engines utilize lifters and pushrods. In overhead cam engines, the camshaft can be located in the head, while overhead valve engines have the camshaft in the block. Both varieties are seen in the US, but regulations have contributed to the decline of overhead valve applications elsewhere in the world. Throughout the history of the rocker arm, its function has been studied and improved upon. These improvements have resulted in arms that are both more efficient and more resistant to wear. Some designs can actually use two rocker arms per valve, while others utilize a "rundle" roller bearing to depress the valve. These variations in design can result in rocker arms that look physically different from each other, though every arm still performs the same basic function.



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Since energy is required to move a rocker arm and depress a valve, their weight can be an important consideration. If a rocker arm is excessively heavy, it may require too much energy to move. This may prevent the engine from achieving the desired speed of rotation. The strength of the material can also be a consideration, as weak material may stress or wear too quickly. Many automotive applications make use of stamped steel for these reasons, as this material can provide a balance between weight and durability. Some applications, particularly diesel engines, may make use of heavier duty materials. Engines such as these can operate at higher torques and lower rotational speeds, allowing such materials as cast iron or forged carbon steel to be used.

3.1. Rocker Arm- Form & Function:

For all the changes in the performance engine over the years, one constant remains - no matter what series they're running, no matter what the payout, no matter if it's just a couple of guys trying to outdo each other stoplight to stoplight, racers will often spend money they don't have in search of the most horsepower from hopefully, a durable engine. Engine builders are faced with the challenge of answering that call. Luckily, advancements in the upper valve train components mean there's a much broader list of components to choose from when it comes to designing the perfect engine; not only for racing - performance is apparent everywhere today, even at the standard production engine level. Rocker arms have come a long way since just opening valves with a pushrod. In modern automotive engines today, rocker arms serve doubleduty, opening the valves, pushrods and lifter bore. Take the Chrysler Neon 2.0L SOHC engine, for example. The exhaust rocker arm is designed like a wishbone. The rocker arm has a roller bearing on one end, riding on a single camshaft lobe, while the other end, two encapsulated hydraulic lifters rides on two exhaust valves. It's topped off with a plastic cap to pivot on the valve tip what a challenge it is to make this part: you have a metal roller bearing pinned to an aluminum body with a metal hydraulic lifter bored

inside the aluminum arm. The hydraulic lifter unit's clearance-to-bore is so minute that the inside has to be thermally deburred. Otherwise the lifter may not leak down properly. Contrast that with another popular engine, the Nissan KA24, which is found in Altimas, 240SX and pickups. That engine has a steel rocker arm with a sintered hardened pad that rides on the camshaft lobe with an encapsulated hydraulic lifter built inside on the other end to open the valve. Rocker arms simply aren't what they used to be. With lighter, stronger materials, as well as computer-aided design, modeling and manufacturing, it is easier and faster for rocker arm manufacturers to develop new parts in faster time, in an effort to keep up with the latest demands of their customers. As it turns out, keeping up with those changes can be a challenge, because racers tend to be a fickle bunch, according to manufacturers we've spoken with. Steel or aluminum?Lightweight components or heavy duty? What was popular 10 years ago - or 10 minutes ago - may be outdated now. Regardless of application, the demand flip-flops.

General drawing of rocker arm:



Fig.1. Rocker Arm



Fig.2. Drawing of rocker arm



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Fig.3. Assembly of Rocker Arm

5.2. DESIGN OF ROCKER ARM IN PRO-E:

Step:1



Fig.15. Draw this profile and extrude.

Step 2:



Fig.16. Draw this profile and remove the material.

Step 3:



Fig.17. Draw the profile and extrude

Step 4:





Step 5:



Fig.19.Draw the profile and revolve, remove the material

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Fig.23. Static Structural Force



Fig.24. Total Deformation in HDPE at Ends



Fig.25.Equivalent Stress in HDPEat Ends



Fig.26. Maximum Shear Stress in HDPE at Ends

Material Data

HDPE

TABLE.12

HDPE > Constants

Density 9.41e-010 tonne mm^-3



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Fig.29.Total Deformation in HDPE at Hole







Fig.31. Maximum Shear Stress in HDPE at Hole

Results and discussion:

It is observed from the results that maximum shear stresses are developed at sharp corners and hole of the rocker arm. A comparison of maximum shear stress, total deformation and equivalent stress values forhdpe, steel and aluminum alloy. To compare the hdpe, steel and aluminum alloy, the maximum shear stress values nearly equal to the steel (T _{max} =50.7 Mpa) and aluminum alloy (T _{max} =50.86 Mpa) load acting on the both ends of the rocker arm. The load acting the hole maximum stress values of steel and aluminum alloy is T _{max} =20.32 Mpa and T _{max} = 37.934.The deformed shape has been depicted in Fig.36, 40, 47 and 51. So the above results are to given steel as the high strength and stiffness than aluminum alloy. Aluminum alloy is light weight and less cost to replace easy.

CONCULSION:

Rocker arm is an important component of engine, failure of rocker arm makes engine useless also requires costly procurement and replacement. An extensive research in the past clearly indicates that the problem has not yet been overcome completely and designers are facing lot of problems specially, stress concentration and effect of loading and other factors.

The finite element method is the most popular approach and found commonly used for analyzing



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fracture mechanics problems. Lightweight rocker arms are a plus for high rpm applications, but strength is also essential to prevent failure. In recent years, after market steel roller tip rockers have become a popular upgrade for the most demanding racing applications. Some of these steel rockers are nearly as light as aluminum rockers. But their main advantage is that steel has better fatigue strength and stiffness than aluminum. So we can say that steel is the better material in terms of strength and aluminum is good for making low cost rocker arms, HDPE is compare to steel and aluminum alloy low strength and stiffness. Now we can conclude that both steel and aluminum alloy is better for design a rocker arm based on strength, weight and cost.

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