STUDIES ON MECHANICAL BEHAVIOR OF SG IRON AND GREY CAST IRON FOR ROCKERARM

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ABSTRACT

Over the year's rocker arms have been optimized for better performance, durability, toughness and high dimensional stability, wear resistance, strength, etc. in terms of on design and material. Economic factors are also the reason for optimization of rocker arms. The evaluation of material properties for different grades of rocker arms is consider for analysis to choose and recommend a best one for a specific application, as rocker arms are performing an important role during the operation of engines by controlling the inlet and exhaust valves to open and close at correct timings. Various types of rocker arms are used in vehicles also different materials are used or making rocker arms. This project work describes four essential properties, chemical composition, tensile strength, microstructure and hardness of three important types of materials used for making rocker arms, namely aluminum alloy, grey iron and spheroidal graphite iron. Identification of superior grade for making rocker arms, to enhance cyclic load, based on evaluation of different grade material properties is the expected outcome of this project. The experimental results obtained, for the above material properties, are presented in this report. The effect of induction hardening on the tip of the rocker arm, for the spheroidal graphite iron is also reported.

Keywords: Rocker arm, Grey Cast Iron & Engine

1. INTRODUCTION

A rocker arm is a value train component in an internal combustion engine as that rocker arm is acted on by a cam shaft lobe it pushes open either an intake or exhaust valve. This allows fuel and air to be drawn in to the combustion chamber during the intake stroke or exhaust gasses to be expelled during the exhaust stroke.

2. LITERATURE SURVEY

The most popular materials used in the manufacture of rocker arms are forged alloy steel and Aluminum cast. Most of the literature were discussed about design and stress analysis of rocker arm due fatigue stress in light vehicles but not about heavy vehicles and also discussed properties of various materials expect SG iron.

Syed Mujahid Husain and Sieraj Sheik (2013) Descibes that failure of rocker arm makes the engine useless. An attempt was made to calculate type of stresses developed on pin and rocker arm and found that pin of rocker arm was subjected to shear stress. The shear stress was analyzed and the same was compared with manual calculation. Rocker arm was made out of stamped steel (forged).

Tawanda Mushiri and Charles Mibohwa (2015) the comparison of mechanical properties between chrome alloy steel and composite rocker arm and recommends an optimized composite of glass/HDPE material with light weight and reasonable strength.

Jafer Sharief.K. Durga Sushmith (2015) four different materials were tested at three load points, on the model. It was observed that the stress values of steel and alloy steel materials are nearer to each other. But only composite material got the better values in stress intensity and total deformation when compared to other materials. It was concluded that by using composite material the stress values are reduced thereby the life time of the rocker arm increases. The analysis about comparison of cost between composite and structural steel.

3. PROBLEM DEFINITION

The rocker arm is a very important of engine. Failure of part makes engine useless and also the procurement and replacement of the rocker arm is costly. Research done so far clearly indicates that the problems has not yet been overcome completely and designers are still facing a lot of challenges especially, stress concentration and effect of loading, mechanical, thermal behavior and other factors like weight/density of the rocker. Hence comparing the material properties and selecting superior material grade based on strength and wear resistance. Also increase strength and durability by finding best material for rocker arm.

4. METHODOLOGY

The rocker arms are an oscillating lever in the combustion engine in the condition of cyclic load. Due to frequent failure of rocker arm it is necessary to revisit the existing simulation of rocker arm and also it is recommended to have alternate material grade of ferrous casting instead of nonferrous (ALUMINIUM) by combination of following trials to reduce occurrence of failure in the engine.

Identify the most suitable material to increase performance of rocker arm.

Evaluate different material characteristics on casting with help of metal analysis software and material test equipment's

Experimental analysis of the different grades of rocker arm and obtain results.

Compare the result obtained from experimental analysis.

The number of rocker arms is prepared for testing its property is 4, the 4 samples are grouped into 2 categories Grey iron casting, SG iron casting. All the 5 samples of rocker arms are tested for different properties like chemical composition, hardness, tensile strength, yield strength, elongation, microstructure and hardened depth. The effect of chemical composition decides the properties of rocker arm material strength. The below table depicts details of change in chemistry and manufacturing method for each trail, to optimize and propose better quality of rocker arm.

5. TESTINGS

BRINELL HARDNESS TEST
TENSILE TEST
FATIGUE TEST
MICROSTRUCTURE

5.1 BRINELL HARDNESS TEST

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance of indentation, and it is determined by measuring the permanent depth of the indentation. The hardness is one of the most important properties of materials through which the strength, wear resistance, and interface bonding strength between the matrix and reinforcement can be estimated. The Micro hardness test was performed in accordance with ASTM E10-07astandard at room temperature condition (the diameter and length of the test specimen were 20 mm and 30mm, respectively). The Brignell test uses a 10mm diameter steel ball as an indenter with a 3000kg.For softer materials, a smaller force is used; for a harder material, a tungsten carbide ball is substituted for the steel ball. The indentation is measured and hardness is calculated as; $BHN=2P/\pi D(D-(D^2-d^2)^{1/2})$

Where,

P =applied force

D =diameter other indentor (mm)

d =diameter of the indentation (mm)

5.2 TENSILE TEST

Tensile test is one of the simplest and most widely used mechanical tests. Tensile testing also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements the following properties also can be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics.

5.3 FATIGUE TEST

Failure testing is a specialized form of mechanical testing that is performed by applying cyclic loading to a coupon or structure. These tests are used to generate fatigue life and crack growth data, identify critical locations or demonstrate the safety of a structure that may be susceptible to fatigue. Fatigue tests are used on range components from coupons through to full size test articles such as automobiles and aircrafts. Failure of metal can take place at much lower stress as compared to tensile strength when it is subjected to repetitive or fluctuating load. Such a failure is referred to as fatigue failure which always results in brittle fracture It takes place instantaneously without any warning Many components such as crank shafts, gears, connecting rods, springs and blades of power driven machines, which are subjected to cyclic loading, are prone to failure by fatigue. Such failure has been observed to be promoted mainly by application of sufficiently high tensile stresses, large fluctuation or variation in the applied stress and a large number of cycles of applied stress.

5.4 MICROSTRUCTURE

Microscopic examination is generally performed using optical or scanning electron microscopes to magnify features of the material under analysis. The amount or size of these features can be measured and quantified, and compared to acceptance criteria. These examinations are often used in failure analysis to help identify the type of material in question and determine if the material received the proper processing treatments. Metallurgical examinations may evaluate:

Extent of decarburization and carburization, grain size, intergranular attack or corrosion
Depth of alpha case in titanium alloys
Percent spheroidization
Inclusion ratings
Volume fraction of various phases or second phase particles in metals

6. RESULTS AND COMPARISON

6.1 CHEMICAL PROPERTIES

The analysis of chemistry was made in various grades and the experimental results are accumulated. The chemistry was confirmed by optical emission spectroscope.

Table 1: Comparison of chemical composition

	Grey cast ironGG25	**SG Iron 600/3**	**SG Iron 500/6**	**SG Iron 500/7**
CHEMICAL COMPOSITION				
Carbon %	3.28	3.55	3.44	3.47
Silicon %	1.87	2.09	2.16	2.14
Manganese %	0.867	0.477	0.476	0.272
Copper %	0.456	0.553	0.472	0.557
Sulphur %	0.0866	0.0116	0.0133	0.00846
Phosphorus %	0.0472	0.0251	0.0230	0.0232
Nickel %	0.0986	0.0229	0.0162	0.0199

Changes are made only in the major elements of chemical composition which is influence to change mechanical and physical properties, from the data available in table 6.1 could be seen grey iron GG25 consisting les amount of copper and carbon than the other but the percentage of silicon content of SG 500/6 and SG 500/7 is higher than the other will lead to lower the hardness and manganese percent is higher amount in grey cast iron.

6.2 MECHANICAL PROPERTIES

The mechanical properties are obtained from different categories of material after various experiments. The results of hardness, tensile strength, yield strength and elongations of grey cast iron, SG iron and compacted graphite iron are obtained and compared. GG25 reveals that there is no deformation in that particular material category since absence of yield strength and elongation in grey iron. Found more tensile strength which belongs to spheroidal cast iron grade 600/3 and it's expected to withstand impact and cyclic load.

Table 2: Comparison of hardness and tensile strength

SAMPLE	MATERIAL/CATEGORY	HARDNESS	TENSILE STRENGTH in N/mm^2
1	Grey cast iron GG25	205	270.5
2	SG Iron 600/3	240	757.7
3	SG Iron 500/6	225	572.6
4	SG Iron 500/7	215	539.7

In experiment, SG 600/3 exhibits moderate amount of hardness and tensile strength. The yield strength and elongation was not able to record in GG25 since the material grade not consisting sufficient ductility.

Table 3: Comparison of yield strength and elongation

SAMPLE	MATERIAL/CATEGORY	YIELD STRENGTH in N/mm^2	ELONGATION %
1	Grey cast iron GG25	Nil	Nil
2	SG Iron 600/3	487.23	7.3
3	SG Iron 500/6	372.61	8.54
4	SG Iron 500/7	368.31	9.2

6.3 TENSILE SAMPLES AFTER TEST

Grey Iron GG25

SG Iron 600/3

SG Iron 500/6

SG Iron 500/7

The above test samples are used to measure tensile, yield and elongation under universal test mechanic for different groups of materials grade, refer figure -- ---- which is belongs to grey iron not having deformation at the fracture end.

7. CONCLUSION

Rocker arm is an important part of an engine, failure of this component makes engine useless. Some of the engine rockers failed (broken) often due to in- adequate design and strength hence comparison of material properties like Chemistry, hardness, tensile strength, yield strength and elongation for different grades of rocker arm castings were investigated. The experimental analysis revealed that gray iron is not suitable for such application, since the material is not having ductility (yield strength and elongation). On the other hand, experimental analysis of Spheroidal graphite iron shows that this material has more ductility, tensile strength, hardness and nodular graphite with predominantly pearlite, which can support for heat treatment, henceforth SG iron grades 600/3 are suitable grade than Gray cast iron for rocker arm application. To overcome the current issue of frequent failures an optimum design with strength, to increase the life of the rocker arm, is proposed by including integral hardened tip in the SG iron grade with free of internal defect, instead of the insert type.

8. REFERENCE S

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