ISSN : 2455-9679
SJIF Impact Factor : 6.008

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INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"THERMAL TRANSIENT ANALYSIS OF A TWO WHEELER PISTON WITH DIFFERENT MATERIALS BY USING FEM"

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ABSTRACT

Piston in the internal combustion (IC) engine is robust, dynamically loaded tribo-pair that reciprocates continuously at varying temperature. Study has been made by various researchers on piston design, dynamics, fatigue and wear at the interface with other element in contact along with their effects on IC engines Fuel pressure is applied to the piston pin and a frictionless guide is applied to the entire piston surface as well as the piston pin holes to evaluate the static transient structure. Then the results of von Misses strain and maximum elastic strain are obtained. These results are compared and the most suitable aluminum alloy is selected according to the parameters. Static structural assessments of cast iron, 6061 aluminum alloy and Ti-Al-4V were performed and results were obtained for stress and deformation . We can confirm that a cast iron piston release a maximum stress of 100.35 MPa under equivalent pressure (von-misses). The maximum stress for 6061 aluminum alloy is calculated as 96.8 MPa, while Ti-Al-4V is calculated as 94.85 MPa.

***Keyword**: Ti-Al-4V, 6061 aluminum alloy, cast iron , piston, IC engine, stress, deformation*

I. INTRODUCTION

The current design of the internal piston fire engines has contributed to improved performance and reliability of the piston-cylinder assembly components. Many research and development centers and sciences at home and abroad conduct studies aimed at increasing net energy and torque and reducing fuel consumption, while meeting EU standards for effective emissions of fire hazards [1, 2]. One of the main objectives of car manufacturers is to ensure the highest durability and reliability of the engine [7, 9]. The piston is a feature of the crankshaft assembly, which participates in the conversion of heat energy into a working machine [6, 10]. The piston head forms the moving part of the fire chamber. Piston grooves hold piston rings that enclose the cylinder working space, while individual piston pin holders have a piston pin bear-mounted on them, which transmits electrical energy to the crankshaft. The main function of the piston is to absorb the piston head-space pressure by the piston head. This force, increased by the inertia force, is transmitted to the piston, the piston pin and, through the connecting rod, to the crankshaft. The design of the piston must withstand high thermal and mechanical loads [8]. It is necessary to: - take heat from the head of the hot piston, heated by high temperature gas, to the walls of the cool cylinders, - lead the piston to the cylinder sleeve and take the pressure of the lateral piston on the cylinder bearing above, - cause very low friction loss, and - confirm the use of engine oil lubricant. The materials used for pistons in internal combustion engines include: - aluminum alloys, - alloy steels, and cast iron. The most commonly used materials for making pistons include: stainless steel, alloy steel and aluminum alloys, aluminum-silicon alloys (Al-Si) and aluminum-copper alloys (Al-Cu) These alloys are characterized by low density, being useful due to the small weight of the piston, and the large coefficient of thermal conductivity [5]. Aluminum alloys are distinguished by good posture during dispersion and mechanical efficiency (machine cutting). The main disadvantages of these alloys include: large coefficient of thermal elasticity, low hardness and low power indicators at high temperatures. Cast-iron pistons are rarely used. They are available in low-speed exercise engines. They are characterized by good slide structures, which maintain good mechanical properties at high temperatures, and a small coefficient of thermal expansion. The main disadvantages of using cast-iron pistons in modern high-speed engines are: the coefficient of low thermal conductivity and high magnitude leading to a large number of pistons and high inertia potential.

II. PROBLEM FORMULATION

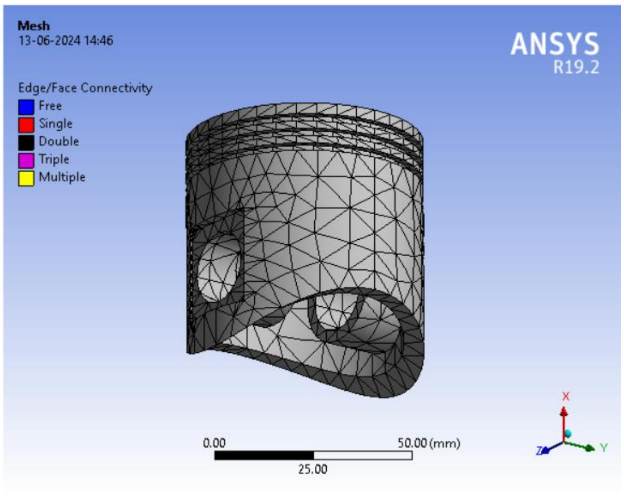
Typical, most frequently found failures of pistons used in four-stroke internal combustion engines. Typical piston failures caused by the poor quality of fuel, the adjustment of the engine feed system or wrong engine operation have been discussed. The most common cause of piston failures is an incorrectly performed repair of the engine or its improper operation.

III. METHODOLOGY

1.1 FINITE ELEMENT MODEL

Establish a balanced and accurate element model that is the most important part of piston finite element analysis, thus marking the grid elements to get accurate results in the end. According to the piston structure symmetry, to facilitate calculation and reduce the workload, cut the established piston model to save 1/4 and import the model into the limited element analysis software to the piston according to good interface between modeling software and limited analytics software. During the import process, some details are left out, such as the chamfer and the snap ring of the piston pin etc. The geometric model of the piston is shown in Figure 1. The Body Structures of the Piston are shown in table1. During the production of piston model space, based on experience.

IV. MODELING & SIMULATION



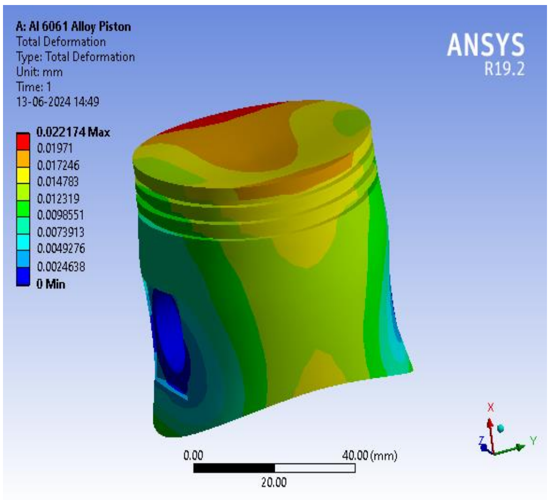


Fig.1 Piston meshing model   Fig. 2 Aluminum alloy piston deformation results

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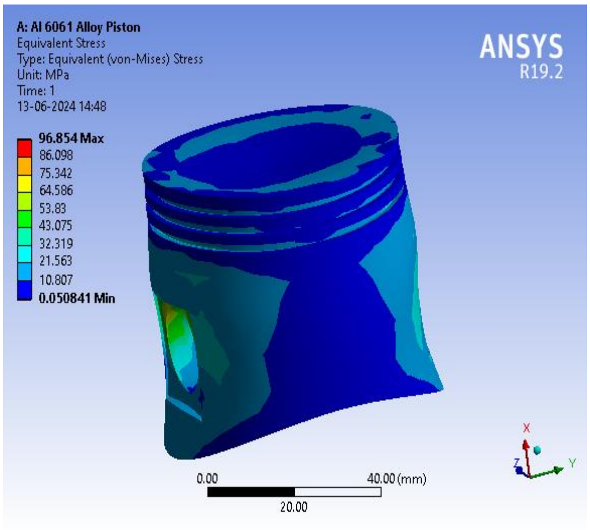


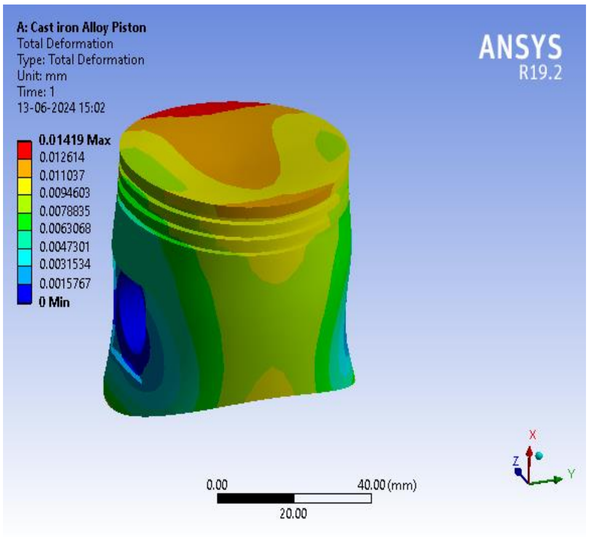


Fig. 3 Aluminum alloy piston stresses results Fig.4 Cast iron alloy piston deformation results

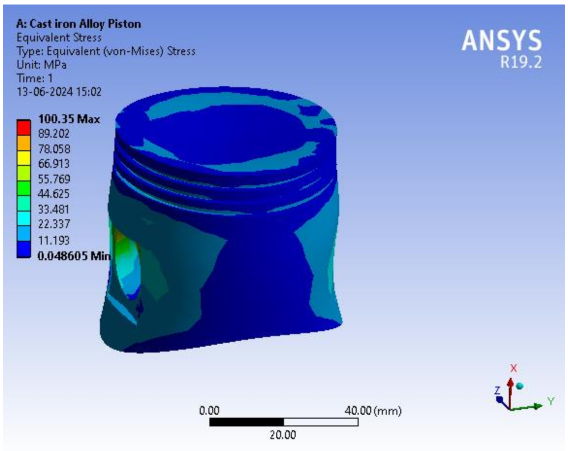
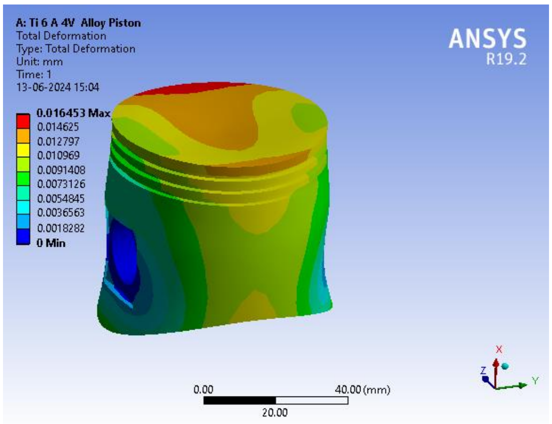


Fig. 5 Cast iron alloy piston stresses results

TI-6A- 4V



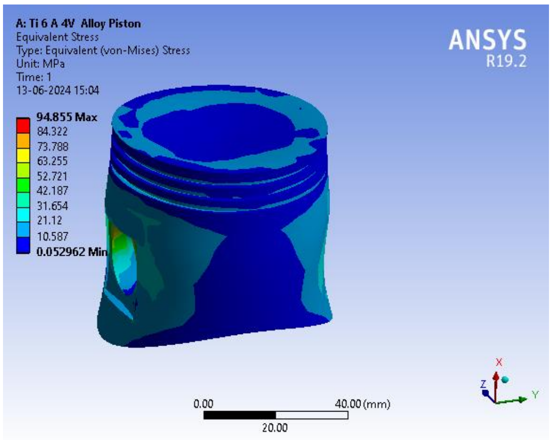


Fig.6 TI-6A- 4V alloy piston deformation results Fig. 7 TI-6A- 4V alloy piston stresses results

V. RESULT & DISCUSSION

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Based on the measured dimensions, three-dimensional piston models were created using SOLIDWORKV5R21, a three-dimensional model. Then, for evaluation, these models were imported into ANSYS WORKBNCH 19.2. A check of the static structure of the pistons is carried out. An automatic meshing process is used to produce high quality mesh. Fuel pressure is applied to the piston pin and a frictionless guide is applied to the entire piston surface as well as the piston pin holes to evaluate the static transient structure. Then the results of von Misses strain and maximum elastic strain are obtained. These results are compared and the most suitable aluminum alloy is selected according to the parameters. Static structural assessments of cast iron, 6061 aluminum alloy and Ti-Al-4V were performed and results were obtained for stress and deformation . We can confirm that a cast iron piston release a maximum stress of 100.35 MPa under equivalent pressure (von-misses). The maximum stress for 6061 aluminum alloy is calculated as 96.8 MPa, while Ti-Al-4V is calculated as 94.85 MPa.

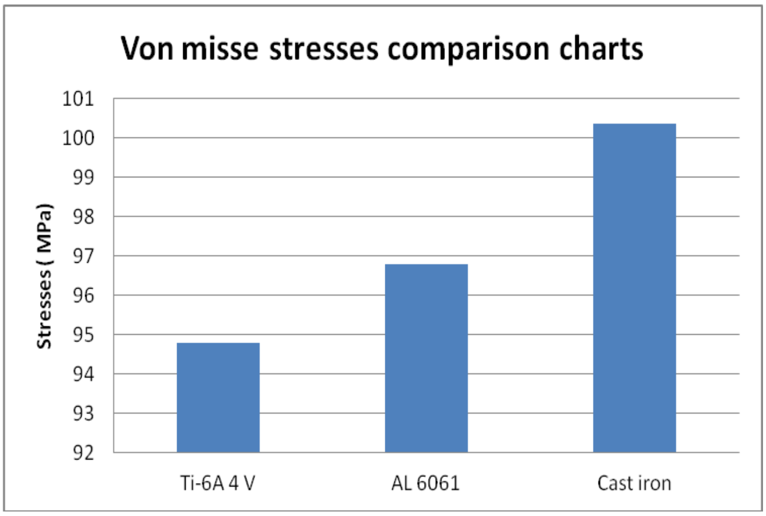

Fig.6.1Von misses thermal stresses comparison charts

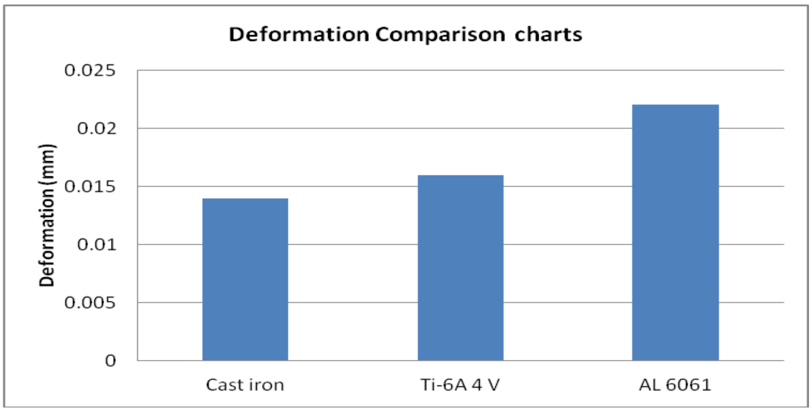

Fig . 6.2 Deformation Comparison charts

VI. CONCLUSION

A piston is a moving disk enclosed in a cylinder which is made gas-tight by piston rings. The disk moves inside the cylinder as a liquid or gas inside the cylinder expands and contracts. For this reason, a piston is inevitable in an internal combustion engine. Set of piston device with their connecting rod and looking at the based on the measured dimensions and here 3D piston model was created using SOLIDWORK 21, a three-dimensional model. Then, for evaluation, these models were imported into ANSYS workbench 19.2. A check of the static structure of the pistons is carried out.

ISSN : 2455-9679
SJIF Impact Factor : 6.008

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