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"DESIGN AND SIMULATION ON PISTON BY USING FEA METHOD"

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ABSTRACT

Piston is the part of engine which converts heat and pressure energy liberated by fuel combustion into mechanical works. Engine piston is the most complex component among the automotives. In this thesis, we will be illustrate design procedure for a piston for diesel engine for water pump and its analysis by its comparison with original piston dimensions used in water pump . The design procedure involves determination of various piston dimensions using analytical method under maximum power condition. In this thesis the combined effect of mechanical and load will be taken into consideration while determining various dimensions. we will be used modeling through a Solidwork and simulation through ANSYS software

Key Words: *Piston, AL 6060, Carbon Fiber ,AL Si 398, Solidwork and ANSYS.*

I. INTRODUCTION

Engine pistons are one of the most complex components of an automobile system. The engine can be called the heart of a vehicle and the piston may be considered the most important part of an engine. Damage mechanisms of the piston have different origins and are mainly wear, temperature, and fatigue related. The fatigue related piston damages play a dominant role mainly due to thermal and mechanical fatigue, either at room or at high temperature. This paper describes the stress distribution and deformation on piston of internal combustion engine by using FEA. The paper describes the FEA technique to predict the higher stress and critical region on the component. With using Creo software the structural model of a piston will be developed. Furthermore, the FEA is performed with using software Abaqus. By applying boundary conditions stress distribution and deformation in piston is calculated.

Fig.1

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The manufacturing of cylinders includes boring, honing and plateau honing which has received much attention by manufacturers in recent times. The process of the surface changes which occurs during running of the engine is related to the wearing action caused by the piston ring on the bore. This action takes place of ―transitional topography‖ where the surface generated exhibits the influence of the piston ring which modifies the machined surface. This has been made possible by improving the design of piston and reducing the failure i.e. scuffing, sculling, seizure of piston etc. The piston is one of the continuous moving parts of engine, is of pivotal importance. Piston has high dynamic loaded speed and heavy reciprocating weight develop high inertia forces, which are undesirable. The following factors may be considered for proper functioning of piston in IC Engine:

1. The piston should have enormous strength and heat resistance properties to withstand gas pressure and inertia forces. They should have minimum weight to minimize the inertia forces.

2. The material of the piston should have good and quick dissipation of heat from the crown to the rings and bearing area to the cylinder walls. It should form an effective gas and oil seal.

3. Material of the piston must possess good wearing qualities, so that the piston is able to maintain sufficient surface-hardness unto the operating temperatures.

4. Piston should have rigid construction to withstand thermal, mechanical distortion and sufficient area to prevent undue wear. It has even expansion under thermal loads so should be free as possible from discontinuities.

Piston should form tribo-pairs and have high reciprocation speed without noise, minimum work of friction and have little or no tendency towards corrosion and pitting-up.

II. PROBLEM FORMULATION

Main problem expected to be found in the design of the large piston is the deformation, due to pressure and temperature. The heat coming from the exhaust gases will be the main reason of deformation.

III. OBJECTIVE OF RESEARCH WORK

Piston rings have been in use for as long as combustion engines themselves. Despite this, ignorance or inadequate knowledge of piston rings is still frequently evident today. No other component is so critical when power loss and oil consumption are at stake. With no other component in the engine is the divide between expectations and utilized capital greater than when replacing piston rings. All too often, confidence in piston rings suffers due to the exaggerated demands made on them. As indicated in earlier, structural designs of piston rings are not studied adequately. Hence, the scope of this project involves following objectives:

A. Selecting appropriate two-wheeler piston rings for carrying out this study.

B. Analytical (structural) design of piston rings using analytical formulations available in literature.

C. Finite Element Analysis of piston rings subjected to various loads acting on it.

D. Compare analytical and FE results.

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IV. MODELLING OF PISTON IN ANSYS SOFTWARE

Single cylinder 4 stroke engine (Kirloskar diesel engine) piston structural analyzing in ANSYS software

AL Alloy

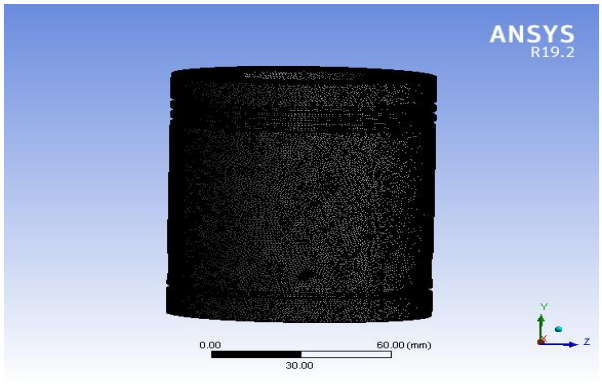

Fig 4.1 3D model meshing on ANSYS

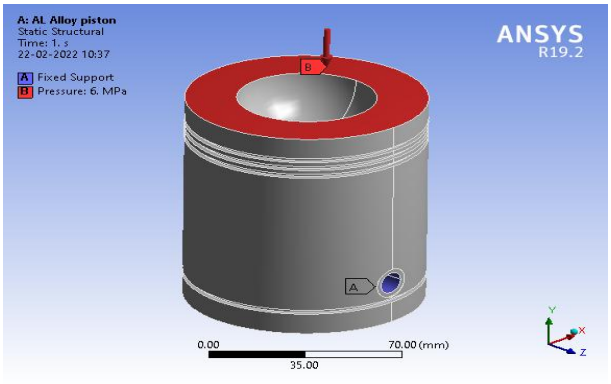

Fig4.2 AL- Alloy applied boundary condition

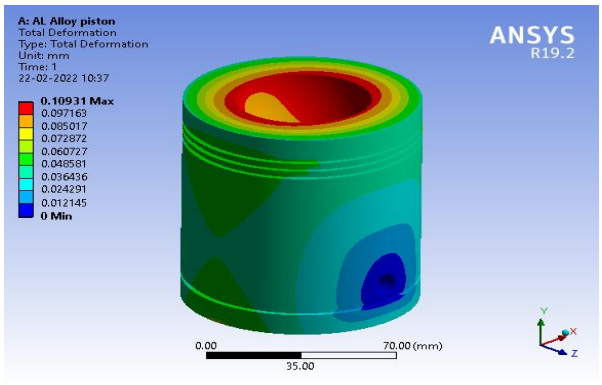

Fig4.3 AL- Alloy Total deformation

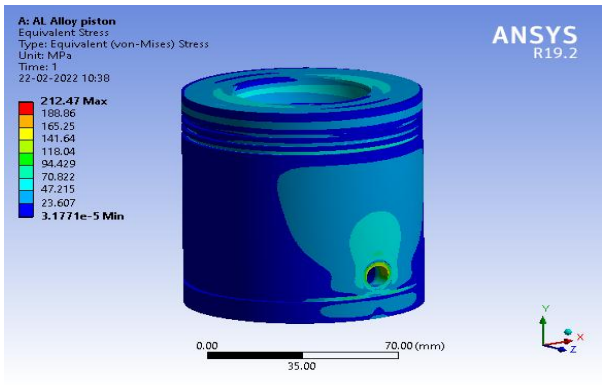

Fig4.4 AL-Alloy stresses

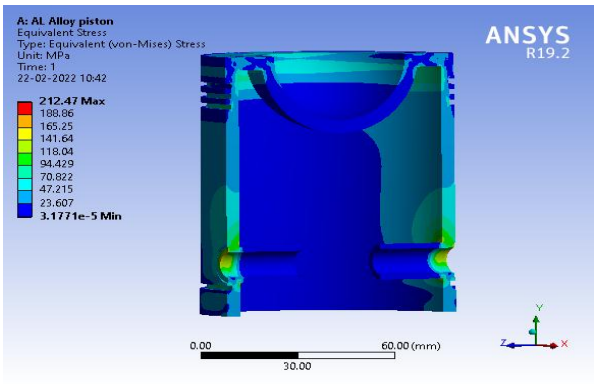

Fig 4.5 AL-Alloy stresses with cutsection of piston

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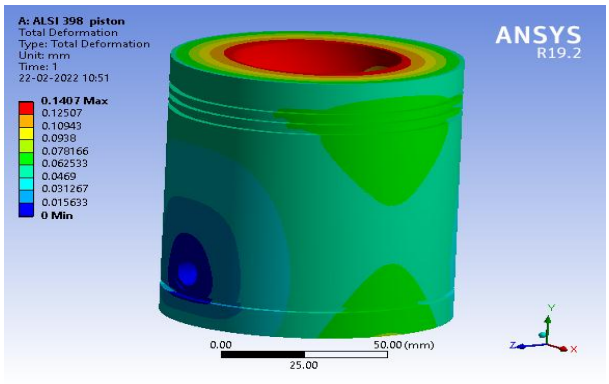
AL-Si398



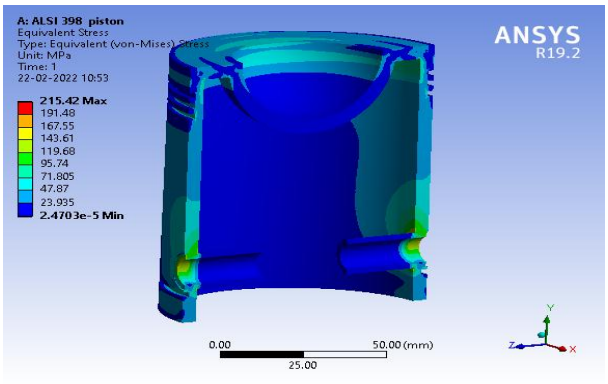
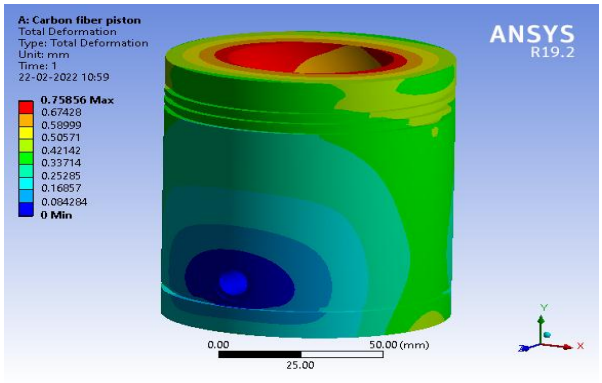


Fig 4.6 AL- 6060 total deformation result **Fig.4.7 AL-SI 398 stresses result with cut section piston model**

Carbon Fiber



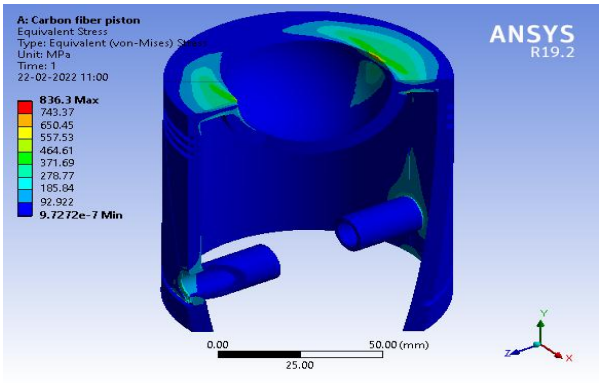


Fig 4.8Carbon fiber total deformation results **Fig.4.9 Carbon fiber thermal stresses results with cutsection**

V. RESULT AND DISCUSSION

We take three different materials3D models of piston are created based on the dimensions obtained. SOLIDWORK 2016 V5R20 is used for creating the 3D model. These models are then imported into ANSYS WORKBENCH 19.2 for analysis. Static structural analysis of pistons is carried out.
Meshing is done with an automatic which gives a fine mesh. For static structural analysis, gas pressure is applied on the top of the piston and frictionless support is applied across the surface of piston and also on the piston pin holes. Then results are obtained for von-misses stress and maximum elastic strain. A comparison is made between these results and the best suited aluminium alloy is selected based on the parameters which shown in Fig 5.1.

The static structural analysis of **AL6060 Aluminium, Carbon fiber, AL-Si 398** are done and results are obtained for Equivalent (Von-Mises) thermal stress, Temperature, deformation and heat flux .

We can observe that in case of **stress**, piston made of **AL 6060** is found to have maximum thermal stress of 224.97 Mpa is observed. When piston made of **Carbon fiber** then thermal stress value maximum 224.53 MPa. when piston made of **AL-Si 398** alloy then maximum thermal stress on is found to be 300 Mpa .

We can observe that in case of **deformations**shown in Fig 5.2 , piston made of **AL-Si 398** is found to have minimum deformation of 0.00000023mm is observed. When piston made of **Carbon Fiber** then deformations

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value maximum 0.0439mm. when piston made of **AL 6060** alloy then maximum deformation on is found to be 0.19269 mm

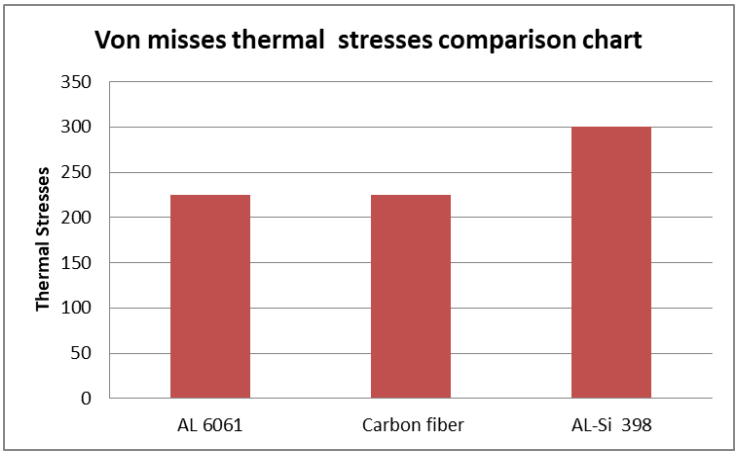

Fig.5.1 Von misses thermal stresses comparison chart

In this graph we can see that diffterent materail vonmisses thermal stresses and this graph is plot bwtween material and Thermal vonmisses stresses.here it is clearly seen that Al 6060 alloy has more value of thermal stress compare to other material like AL Si 398 and Carbon fiber.

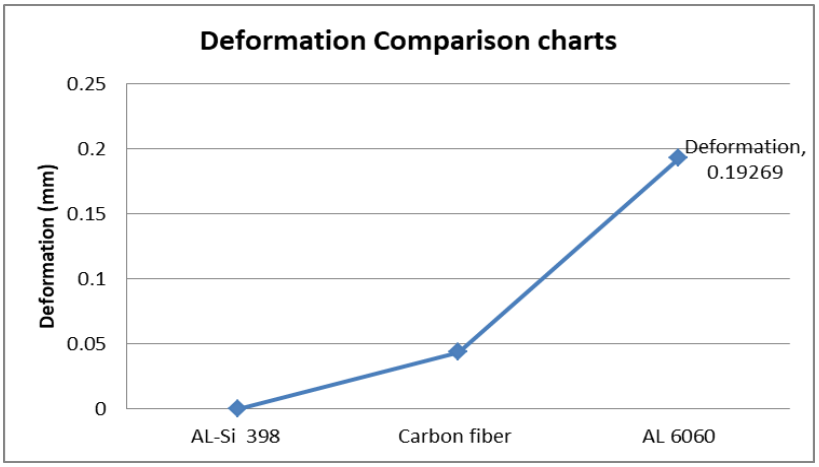

Fig.5.2 Deformation Comparisoncharts

In this graph we can see that diffterent materail deformation and this graph is plot between material and Thermal deformations .here it is clearly seen that Crabon fiber alloy has morevalue of thermal deformation compare to other material.

The fundamental concepts and design methods concerned with single cylinders petrol engine have been studied in this project the thermal results found by the use of this Thermal transient and Thermal transient method are nearly equal to the actual dimensions used now a days. Hence it provides a fast procedure to design a piston which can be further improved by the use of various ANSYS thermal software and methods. The most important part is that very less time is required to design the piston and only a few basic specification of the engine.s. The most critical part is that less time is required to outline the piston and just a couple of essential detail of the engine.

- Pistons made of various aluminum alloy like AL Si 398 , Carbon Fiber, Al 6060 were outlined and investigated effectively.

- We find Piston move even at minimum pressure carried out with help of thermal transient software.

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- In static-auxiliary investigation, the pistons wereexamined to discover the proportional Thermal stress, comparable flexible strain, deformation and thermal heat flux.

- It tends to be seen that greatest stress force is on the base surface of the piston crown in every one of the materials.

Here we discovered Carbon Fiber is good because its has less deformation esteem contrast with different materials of aluminum alloy . So we will be recommended this Carbon Fiber basic of thermal streses ,thermal heat flux ,velocity and turbulence for future work because all thermal parameter are in considerable range.

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