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Design, Analysis and Fabrication of the Piston Using Aluminum Alloy 7475and Comparison with Cast Iron

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ABSTRACT

The main aim of the project is to design a piston for 150cc engine for two materials AL &cast iron . The design of the piston is modeled using CREO parametric software.

The designs are evaluated by structural and thermal analysis by applying pressures and temperatures respectively.

The result is evaluated by checking the stress, displacement, thermal gradient and thermal flux to decide the best design of the piston.

Structural and Thermal analysis are done in ANSYS software.

1. INTRODUCTION

1.1 Internal combustion engines

the connecting rod is attached to the piston by way of a swiveling gudgeon pin (US: wrist pin). This pin is hooked up within the piston: no longer just like the steam engine, there is not any piston rod or crosshead (besides huge two stroke engines).

The pin itself is of hardened metal and is steady within the piston, nevertheless free to maneuver inside the connecting rod. A couple of designs use a 'utterly floating' design that's unfastened in each add-ons. All pins ought to be prevented from relocating sideways and the ends of the pin digging into the cylinder wall, in most cases with the aid of circlips.

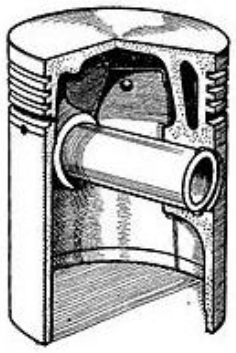


Fig: **piston**

Pistons are cast from aluminium alloys. For greater force and fatigue lifestyles, some racing pistons could even be solid rather. Billet pistons are additionally utilized in racing engines considering they do not rely on the size and constitution of readily available forgings, enabling for ultimate-minute design changes.

2.LITERATUREREVIEW

The solid iron pistons had been old-fashioned Haque M.M and younger J.M. (2001) referred the low expansion team of workers of aluminum–silicon alloy as piston alloy, due to the fact this crew of alloy grants the satisfactory complete balance of residences. Close eutectic aluminum silicon pis-ton alloy show off intricate fatigue habits seeing that of their multi aspect microstructure (Moffat et al 2005) A ceramic insert is custom-made on the highest component to the piston and related to the equal by the use of mechanical locking. The ceramic insert is furnished with pores at the least on the aspect appealing the piston head. The pores have sizes which enable them to be filled with the sunshine alloy during the manufacture of the piston via the squeeze casting system (Mahrus 1988). Piston can be fashioned in two elements. The important part is usual with the aid of utilizing gravity die casting from aluminum or aluminum alloy and a 2d part of the piston is fashioned by way of a squeeze casting procedure to supply a material which is healthier and more resistant than the gravity die solid aluminum or aluminum alloy. The two ingredients are then electron beam welded together to sort the complete piston. The squeeze strong element could also be reinforced with whiskers or fibers to additional improve its houses. This system of building has the advantage that simplest a smaller aspect to piston is formed by way of the extra costly and time-consuming squeeze casting method. This is the advance in colossal diesel pistons (Avezou 1987). David. J (1985) labored on the provision of a put on resistant insert for pistons of light weight alloys. The insert entails an annular ring of damage resistant fabric which has a cylindrical peripheral aspect. The annular ring has at least one projection or A ceramic insert is tailored on the head a part of the piston and linked to the identical through mechanical locking. The ceramic insert is offered with pores at the least on the detail enticing the piston head. The pores have sizes which permit them to be filled with the sunshine alloy all through the manufacture of the piston via utilizing the squeeze casting procedure (Mahrus 1988). is used for doing finite element analysis.

3. PROBLEM DESCRIPTION:

The methodology followed in the project is as follows:

- Create a 3D model of the piston assembly using parametric software pro-engineer.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis.
- Perform thermal analysis on the piston assembly for thermal loads.
- Perform CFD analysis on the existing model of the surface piston for Velocity inlet to find out the mass flow rate, heat transfer rate, pressure drop.

4. INTRODUCTION TO CAD/CAE:

Computer-aided design (**CAD**), also known as **computer-aided design and drafting** (**CADD**), is the use of computer technology for the process of design and design-documentation.

4.1. INTRODUCTION TO CREO

CREO Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring

compliance with your industry and company standards. Integrated CREO CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.

Different modules in CREO

Part design, Assembly, Drawing& Sheet metal.

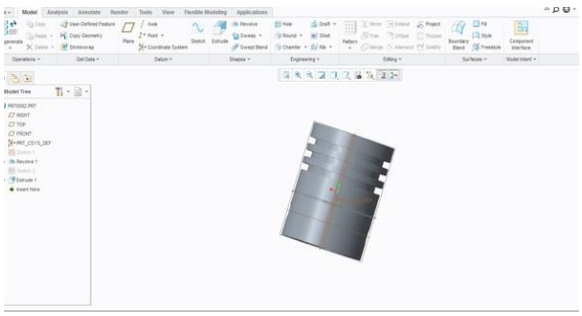
4.2. INTRODUCTION TO FINITE ELEMENT METHOD:

Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

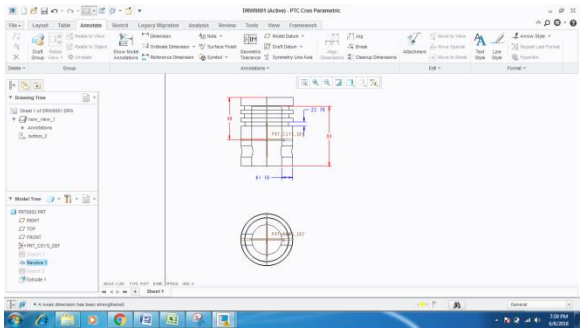
5. RESULTS AND DISCUSSIONS:

5.1. Models of Piston using CREO: The steam boiler is modeled using the given specifications and design formula from data book. The isometric view of steam boiler is shown in below figure. The steam boiler outer casing body profile is sketched in sketcher and then it is revolved up to 360^0 angle using revolve option and tubes are designed and assemble to in steam boiler using extrude option.

Piston 3D model

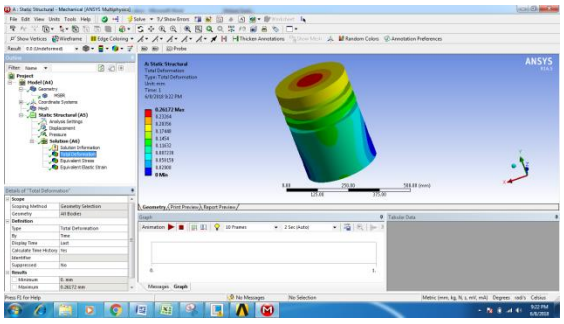


Piston 2D model



5.2. STATIC ANALYSIS OF PISTON

TOTAL DEFORMATION



VON-MISES STRESS

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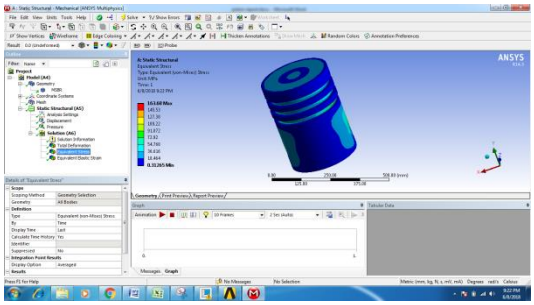
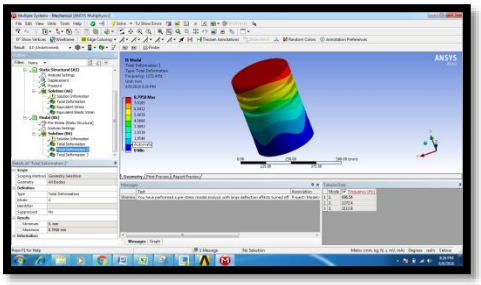
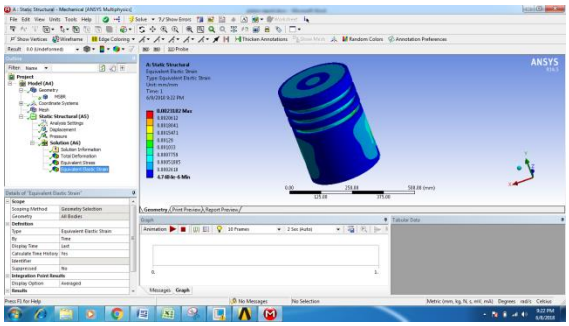


VON-MISES STRAIN

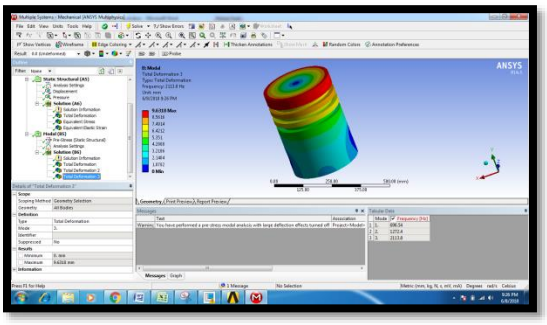


TOTAL DEFORMATION3



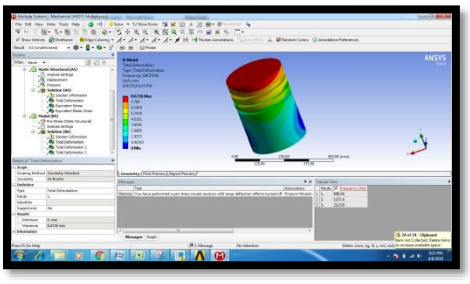
MODAL ANALYSIS OF PISTON

TOTAL DEFORMATION1

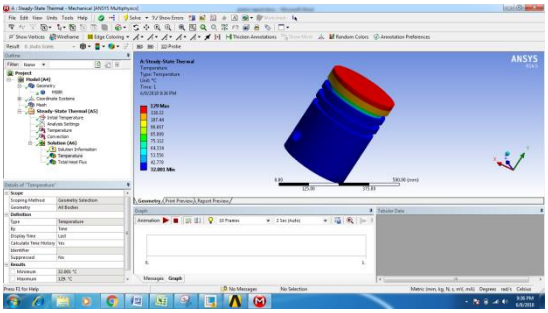


THERMAL ANALYSIS OF PISTON

TEMPERATURE



TOTAL DEFORMATION2



HEAT FLUX

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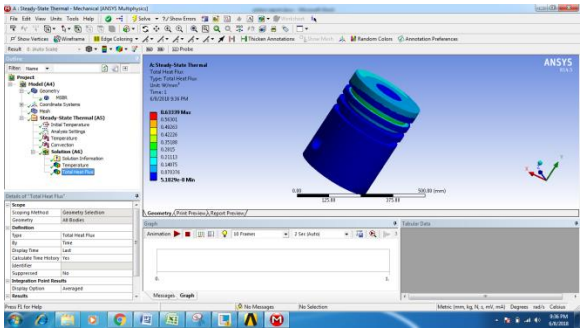


6. RESULTS AND DISCUSSIONS

Static analysis

MATERIAL	DEFORMATION(mm)	STRESS(N/mm2)	Strain
CAST IRON	0.16906	165.57	0.0015047
ALUMINUM ALLOY 7475	0.26172	163.68	0.0023182

Modal analysis

MATERIAL	frequency (hz)	deformationl` (mm)	frequency (hz)	deformation2(mm)	frequency (hz)	deformation 3(mm)
CAST IRON	546.7	5.3919	989.36	5.4786	1655.9	5.946
ALUMINUM ALLOY 7475	696.54	8.6726	1272.4	8.7958	2113.8	9.6318

Thermal analysis

MATERIAL	Temperature (0C)		Heat flux(W/mm^2)
	MIN	MAX	
CAST IRON	31.859	129	0.27468
ALUMINUM ALLOY 7475	32.001	129	0.6339

MANUFACTURING PROCEDURE OF PISTON WITH ALUMINUM ALLOY 7475

EXPERIMENTAL INVESTIGATION

Raw material

Aluminum manufacturers use it to improve the already useful properties of **aluminum**. When used with **aluminum**, **silicon** improves its cast ability, hardness and strength. That said, **silicon** compounds are the **raw material** for a large and growing number of industrial and consumer products such as: **Silicone** rubber parts.

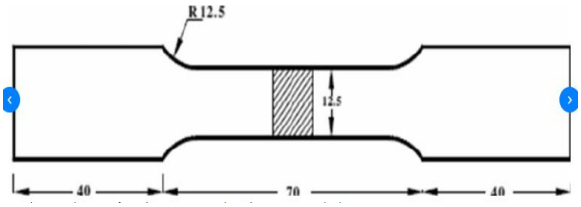
Testing Methods

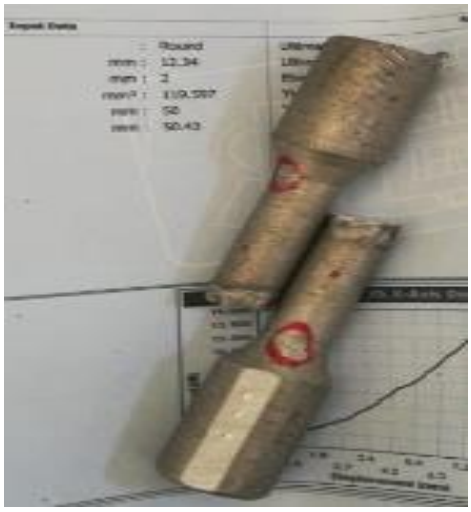
All the mechanical testing methods that were carried out were base on American Standard Testing

Methods (ASTM). There were test performed, namely Tensile Test (ASTM D638),

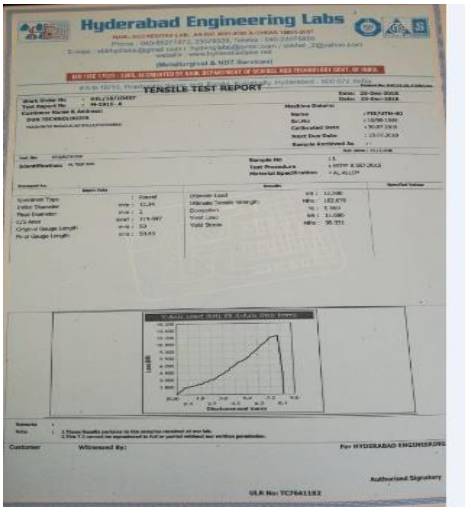
Tensile Test:

In a broad sense, tensile test is a measurement of the ability of a material to withstand forces that tend to pull it apart and to what extent the material stretches before breaking. The stiffness of a material which represented by tensile modulus can be determined from stress-strain diagram. Universal Testing Machine (Zwick / Roell Z010 10KN) was used at cross-head speed of 3mm/min. Figure 5.6 shows the Universal Testing Machine (Zwick / Roell Z010).





Test report



HARDNESS MEASUREMENT

- Brinell hardness is determined by forcing a hard steel or carbide sphere of a specified diameter under a specified load into the surface of the material and measuring the diameter of indentation left after the test.
- The Brinell hardness number or simply the Brinell number,is obtained by dividing the load used in kilograms,by the actual surface area of the indentation in square millimeters.

$$B.H.N = \frac{P}{A} = \frac{P}{\frac{\pi D}{2}[D - \sqrt{D^2 - d^2}]}$$

Test report

Hyderabad Engineering Labs

HARDNESS TEST REPORT

7. CONCLUSION

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. The piston transforms the energy of the expanding gasses into mechanical energy. The piston rides in the cylinder liner or sleeve. Pistons are commonly made of aluminum or cast iron alloys. The main aim of the project is to design a piston for two composite materials cast iron & aluminum 7475. The design of the piston is modeled using CREO parametric software.By observing the static analysis the deformation increase and stress will decrease for aluminum alloy 7475 material. By observing the modal analysis the deformation increases for magnesium aluminum alloy 7475 material and by observing the thermal analysis the heat flux value more for aluminum alloy 7475.So it can be concluded the aluminum alloy 7475 material is the better material for pistion.

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