DESIGN OF TWO WHEELER PISTON BY USING MATERIALS OF ALUMINUM ALLOYS AND CAST IRON

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Abstract: *A piston is a part of motors, return plimsoll, gas compressors and atmospheric cylinders, among other related devices. It is the changing compositional that is include by a cylinder and is constructed gasoline-handy by piston tingle. The piston transforms the energy of the expanding wind into mechanical energy. The piston container in the fly liner or cover Pistons are usually manufactured of AI or cast hard alloys. This paper's main purpose is to describe a piston for 150cc engine for two materials Cast Iron and Aluminium Alloy. The deigns of the piston are sculptured using PRO-E software. The purpose is evaluated by structural and thermal column analysis by address pressures and temperatures respectively. The rise is evaluated by checking the force, displacement, thermal gradient and warm purge to decide the prime mean of the piston. Structural and Thermal analysis are done in ANSYS software.*

Keywords: *Aluminium Alloy, Piston, ANSYS software, gasoline-handy, piston tingle, cast iron.*

I. INTRODUCTION

The piston in all engines plays an important role in operation and results. The piston bureaucracy is a guide and bearing for the connecting rod's small leakage and transmits the burst pressure inside the cylinder to the crankshaft through the connecting rod. The piston is the most energetic component of an automobile engine. The piston is one of the most important elements in the rear of the engine stage, but it is very important, making the primer pass the force from combustion inside the combustion chamber to the crankshaft. Simply put, it incorporates explosion pressure from thecombustion path to the crankshaft. Apart from the vital work that the piston performs upstairs, there are various positive functions that the piston constantly performs: it acts as a kind of seal between the combustion chambers formed inside the cylinders and the crankcase. Pistons do not allow excessive pressure to accumulate from the combustion chambers to the crankcase [1].

A. Construction of Piston

Its upper part is seen by many names along with the crown, head, or roof and is thicker than the lower. The lower element is called the skirt. There are slots made to house pressed jewelry and oil jewelry. The groove made for the oil ring is broader and deeper than the grooves made for the pressure ring. The oil ring discharges the additional oil that flows into the piston inside through the oil return ports and, as a result, directs it into the combustion chamber. However, it is easy to lubricate the helix screw to a certain extent. Goal. In some designs, an oil ring is provided under the trunnion pinhead. The space between the grooves is called the lands [2].

The piston diameter always remains than the cylinder diameter because the piston reaches a better temperature than the cylinder wall and expands while the engineis running. The space between the cylinder wall and the piston is known as the piston clearance. The diameter of the piston at the crown is slightly smaller than at the skirt due to the difference in operating temperatures. Again, the skirt itself is also slightly tapered to allow for uneven growth due to the temperature distinction as we pass perpendicular to the length of the skirt, and the operating temperature is not always uniform but slightly lower. Cast iron, aluminium alloy, cast steel, etc. It is a common material used for the piston of an

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internal combustion engine. Cast iron pistons are not suitable for high-speed engines due to their extra weight. In addition, these pistons have high electrical and wear resistance. The aluminium alloy piston is lighter and allows for much lower temperatures due to its high thermal conductivity. The growth factor of this type of piston is about 20% lower than that of the pure aluminium piston but higher than that of the cast iron piston and cylinder wall. It is necessary to provide greater clearance for the piston to avoid sticking due to better growth from the cylinder wall. It produces a piston stroke after the engine has started, yet it still heats up and separates the crown from the piston skirt [3].

B. Materials for the Piston:

CI, Al Alloy, and Cast Steel are typical material applications for IC motor pistons.
s. Pistons are not suitable for short engines due to their outsized impact. The aluminium alloy piston allows the flow temperature to be lowered due to its high thermal conductivity. This piston shape enlargement factor is much lower than that of sacred aluminium. Iron regulus is inserted into the groove of its gearbox motors to increase dribbling life and reduce bear [4].

C. Design of Piston:

The piston does the dirty work of drawing most of the explosive electricity from burning gasoline into the crankshaft. It uses a terrible amount of crushing, but the extreme warmth it has to withstand. Weight is a severe problem to find out. However, with a favourable ratio of electricity to energy; If it can be poorly machined, has many thermal conductivities, and most importantly is lifestyle heaviness, then aluminium is the critical choice for today's manufacturingpresses [5].

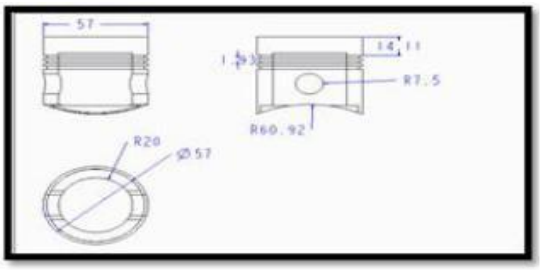

Fig.1 2D model

II. RELATED WORK

Gudimetal et al. [2009] The piston is a component of reciprocating motors. This is to change the force of expansion of the gasoline inside the cylinder to thecrankshaft through the piston rod and the connecting rod. It is one of the most complex components of a car. On some engines, the piston also acts as a valve through the protection and detection ports within the cylinder wall. As a gift, make a powerful 3D piston model with a piston pin designed with the help of CATIA and SOLIDWORKS software. Thermal stresses, mechanical stresses, torque, thermal, mechanical stress distribution, and strains are calculated. After this fatigue analysis, it was performed to check the protection aspects and lifespan of the piston, consistent with the use of ANSYS workbench software. Aluminium-silicon composite is used as piston material. The pressure analysis results also help improve the design of things at the initial stage and help reduce the manufacturing time and value of the piston problem [6].

Wilfried Wunderlich et al.[2012]The 11% aluminium piston for alloy SC100, ACA8, and A4032 was collectively screened with A2618-T6 for its mechanical properties and thermal behaviour. Alloy A2618 proposes a higher failure elongation and higher production pressure than alternative alloys by maintaining a low coefficient of thermal expansion (CTE). Heat stress experiments were confirmed using the Coffin-Manson equation to predict thetime of lifestyles with coefficients of CP = 0.0385, KP = -0.377 similar to A2618,
while Kp = -0.45 was obtained for ACA8 and SC100. The activation electricity derived from the temperature dependence of the lifestyle time was predicted to be Q
= 0.5 eV, as is typical for aluminium alloys.

Dallwoo Kim et al.[2012] The use of iron pistons is increasing due to the increasing electricity requirements of diesel truck

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engines. As a result, iron piston dilation is the typical situation. The reason for this observation is to clarify the lubrication conditions for iron and steel pistons. The friction of steel iron and metal pistons was measured using the float coating technique. The friction of conventional aluminium pistons has also been measured for variation in this appearance. The secondary movement of each piston was scaled to implement a piston friction check, and subsequent results were received. The wrought iron piston showed limited lubrication at the top dead centre (TDC). This is probably due to the perspective of the larger piston inclination caused by, the larger piston clearance. Due to the excellent oil supply, the steel pistons confirmed the hydrodynamic lubrication conditions of TDC and BDC at each cycle.

Piotr Szurgott et al.[2011] The main objective of the preliminary analysis presented in the paper was to examine the behavior of a combustion engine piston made from different types of materials under convection. FE thermo mechanical analysis of a composite piston has been demonstrated. A specific motor is installed in one of the popular polishing tanks. The proposed new material is characterized by low hysteresis: the differences in the thermal growth coefficient of heating and cooling are not enormous. The results obtained for a press made of a new fabric were compared with those of today's standard fabrics. The piston is loaded through a temperature zone inside it. Appropriate mean thermal boundary states, such as temperatures and heat flow, were determined on different surfaces of the EF model. FE analyses were performed using MSC.Marc software. A development version of FE is also provided. The piston engineering CAD model was developed based on the actual engine piston scanned with a 3D laser scanner. A point cloud received from the scanner is processed and directly converted into a powerful 3D model. The 1/4 FE version of the piston part was developed for the initial review presented in the document. The 4-node tetrahedral finite factors were implemented due to the lack of axial symmetry of the element being considered. The temperature range inside the piston changed to a specific and displayed in the form of contour bands. The displacement and pressure lines are also shown in a radial path.

Esfahanian et al. [2006] In this aspect, the heat switch is calculated to the crown of the engine piston. Three unique strategies are used for the combustion limit case. The results of different treatments for specific conditions on the combustion side and their effects on the thermal behavior of the piston are compared. It has been proven that the use of boundary conditions for combustion aspects with meantime and space is a suitable solution method within engineering methods. An interface between KIVA-3V and NASTRAN codes has been developed.

III. DESIGN CALCULATIONS OF PISTON

Suzuki GS 150 R specifications

Engine type : air cooled 4-stroke SOHC

Bore

Displacement =149.5CC ×( ) = 57 × 58.6

Maximum power = 13.8bhp @8500rpm

Maximum torque = 13.4Nm @ 6000 rpm

Compression ratio =9.35/1

MODELS OF PISTON AND MESHING OF PISTON

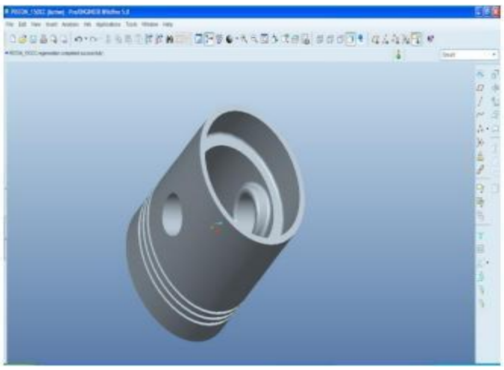

Fig.2 (a)

Fig.2 a & b Aluminium alloy 7475-T761

Introduction to COSMOSWORKS

COSMOSWORKS is useful software for design analysis in mechanical engineering. That’s an introduction for you who would

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like to learn more about COSMOSWORKS. COSMOS WORKS is
a design analysis automation application fully integrated with Solid Works. This software uses the Finite Element Method (FEM) to simulate the working conditions of your designs and predict their behaviour. FEM requires the solution of large systems of equations. Powered by fast solvers, COSMOSWORKS makes it possible for designers to quickly check the integrity of their designs and search for the optimum solution. A product development cycle typically includes the following steps:

- Build your model in the Solid Works CAD system.
- Prototype the design and Test the prototype in the field.
- Evaluate the results of the field tests.
- Modify the design based on the field test result

Analysis Steps: You complete a study by performing the following steps:

- Create a study defining its analysis type and options.
- If needed, define parameters of your study. Parameters could be a model dimension, a material property, a force value, or any other entity that you want to investigate its impact on the design

Cast Iron Metal Matrix Composite

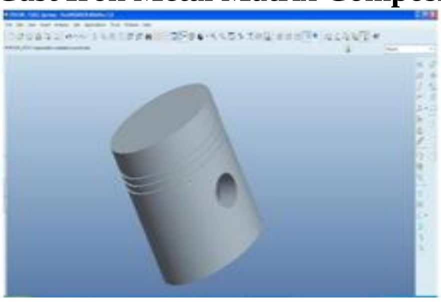


Fig.3 CI metal matrix composite

Aluminium metal matrix composite

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	6.72647e-006 Element: 4604	0.000995247 Element: 7946

Fig.4 Al metal matrix composite

Table.1 Mesh types

Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SolidWorks Flow Simulation	Off
Solver type	FFEPlus
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off
Incompatible bonding options	Automatic
Large displacement	Off
Compute free body forces	On
Friction	Off
Use Adaptive Method:	Off
Result folder	SolidWorks document (C:\ Documents\ DESIGN\S W\piston)

Table.2 Aluminium Alloy 7475-T761 study properties

Study name	PISTON ALLOY
Analysis type	Static
Mesh type	Solid Mesh
Thermal Effect:	On
Thermal option	Include temperature loads
Zero strain temperature	298 Kelvin
Include fluid pressure effects from SolidWorks Flow Simulation	Off
Solver type	FFEPlus
Inplane Effect:	Off
Soft Spring:	Off
Inertial Relief:	Off

Table.3 Material properties

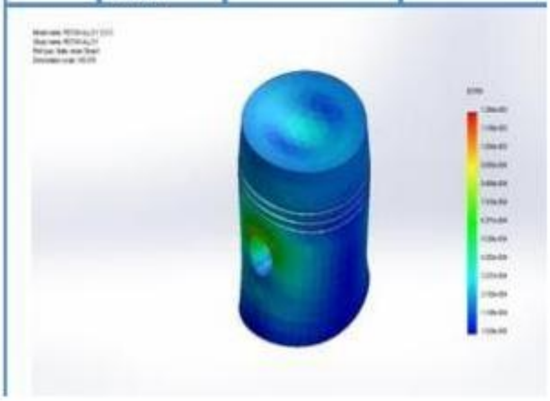
Compogment name	Units	Iteration3
ALLOY	mm	10
Stress1	N/mm^2 (MPa)	153.78
Mass1	g	89.0521

Study name	Design Study 1
Analysis type	Design Study(Optimization)
Design Study Quality	High quality (slower)
Result folder	SolidWorks document(C:\DESIGN\SW\pistor sw\COSMOS STATIC PISTON

Model Reference	Properties	
	Name:	7475-T761, Plate (SS)
	Model type:	Linear Elastic Isotropic
	Default failure criterion:	Max von Mises Stress
	Yield strength:	4.05e+008 N/m^2
	Tensile strength:	5.7e+008 N/m^2
	Elastic modulus:	7.2e+010 N/m^2
	Poisson's ratio:	0.33
	Mass density:	2810 kg/m^3
	Shear modulus:	2.79e+010 N/m^2
	Thermal expansion coefficient:	2.2e-005 /Kelvin

IV. RESULTS AND DISCUSSIONS

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.02872e-005 Element: 3671	0.00126389 Element: 1089



Component name	Current	Initial	Optimal	Iteration 1	Iteration 2
ALLOY	8	12.03	8	8	12
Stress1	178.09	126.43	178.09	178.09	125.01
Mass1	86.54	91.59	86.54	86.54	91.55

	CAST IRON	ALUMINUM MMC	ALUMINUM 7475
STRESS (MPa)	139.006	180.6	126.431
DISPLACEMENT (mm)	0.0339	0.039	0.042
STRAIN	0.00099	0.00096114	0.001263

Table.4 Aluminum Alloy 7475-T761: Study Properties:

Table. 4 Study results

Table.5 Results Table

V. CONCLUSION

In my challenge, I designed a piston to be used in a wheeled vehicle. The piston cloth currently in use is LM25 aluminium alloy. However, I'm switching using various aluminium alloys 7475-T761 and 6061. I'm switching to using older materials because they have more power than LM25 aluminium alloy.
Two models of pistons are designed fortwo materials: 7475-T761 and 6061 aluminium alloy. In this document, we will turn to aluminium alloy 7475-T761 and the aluminium metal matrix composite. The advantage of aluminium alloy over cast iron is that it weighs much less. The 7475-T761 aluminium alloy and aluminium metal matrix composite strength is higher than the 7475-T761 aluminium alloy. The structural evaluation ends on the piston for three materials: cast iron, 7475-T761 aluminium alloy, and aluminium composite matrix. When looking at the rating effects, the stress value for each material, aluminium alloy 7475-T761 and aluminium steel matrix composite is lower than their respective yield stress values.

VI. REFERENCES

1. A Method for Optimal Selection of Models in Complex Mechanical Systems of the Means of Transport [in polish], Final Report, Project No. 5 T12C 039 24, Military University ofTechnology, Warsaw 2006.
2. Bordes, C., Numerical Simulation of a Combustion Engine Piston with Surface Coating under Thermo- Mechanical Load, Master Thesis, Ecole Nationale

Supérieured'Ingénieurs des Etudes des Techniques d'Armements 2004.

3. Budzik, G., Jaskólski, J., Thermal Loads of Pistons in Combustion Engines [in polish: ObciąĪenia cieplne táokowych silników spalinowych], Rzeszow University of Technology Publishing House, Rzeszow 2004.

4. P. S. Shenoy and A. Fatemi, "Dynamic Analysis of Loads and Stresses in Connecting Rods", Journal of Mechanical Engineering Science, 2006,Vol. 220, No. 5.

5. P. S. Shenoy and A. Fatemi, "Connecting Rod Optimization for Weight and Cost Reduction", SAE Paper No. 2005-01-0987, SAE 2005 Transactions: Journal of Materials and Manufacturing

6. Gudimetal P, Gopinath C.V, "Finite Element analysis of Reverse Engineered Internal Combustion Engine Piston", AIJSTPME (2009) 2(4): 85-92

7. Wilfried Wunderlich and Morihito Hayashi, "Thermal cyclic fatigue analysis of three aluminium piston alloys", International Journal of Material and Mechanical Engineering, June 2012.

8. Dallwoo Kim, Akemi Ito et.al. "Friction characteristics of steel pistons for diesel engines", Journal of Materials Research and Technology, June 2012.

9. Piotr Szurgott and Tadeusz Niezgoda, "Thermo mechanical FE analysis of the engine piston made of composite material with low hysteresis" Journal of KONES Powertrain and Transport, Vol. 18, No. 1, 2011.

10. Esfahanian, A. Javaheri, M. Ghaffarpour, "Thermal analysis of an SI engine piston using different combustion boundary condition treatments", Applied Thermal Engineering 26 (2006) 277.