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DESIGN EVALUATION OF TWO WHEELER PISTON USING ALUMINUM POWDER METALLURGY

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ABSTRACT

The main aim of the paper is to design a piston for a two wheeler for materials Brass, Cast Iron and Aluminum Powder Metallurgy. The designs of the piston are modeled using 3D modeling software SolidWorks. Design Evaluation is a technique used for validating the Design. In Mechanical Engineering Design Evaluation plays major role in Design. Design Evaluation can be done mainly in three steeps

a. *Constraints*
b. *Variables*
c. *Goals*

In this project Design evaluation is conducted by specifying constraints as stresses, variables as thickness of piston head and goal, minimizing mass of the material. From design Evaluation we will take best design result. Analysis is done in COSMOS.

INTRODUCTION

The piston is the single, most active and very critical component of the automotive engine. The Piston is one of the most crucial, but very much behind-the-stage parts of the engine which does the critical work of passing on the energy derived from the combustion within the combustion chamber to the crankshaft. Simply said, it carries the force of explosion of the combustion process to the crankshaft.

FUNCTIONS OF THE PISTON

To receive the impulse from the expanding gas & transmit the energy to the crank shaft through the connecting rod,It transmits the force of combustion gases to the crank shaft.It controls the opening & closing of parts in a 2-stroke engine.It acts as a seal to escape of high pressure gases into the crank case.

A powder metallurgy with at least two constituent parts, one being a metal. The other material may be a different metal or another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. The metallurgy is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the reinforcement. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common.

PRESSURE

Indicated power IP $= \frac{P_m \times l \times A \times n}{60} = \frac{P_m \times l \times \pi \times D^2 \times n}{60} = \frac{1.12 \times 58.6 \times 3.14 \times 57^2 \times 4}{4 \times 60} = 11217.05\ kw$

Brake power BP $= \frac{2\pi NT}{60} = \frac{2\pi \times 6000 \times 13.4}{60} = 8415.2$

Mechanical efficiency $\eta_{mech} = \frac{BP}{IP} = \frac{8415.2}{11217.05} = 0.75 = 75\%$

Thickness of piston head

$t_h = \sqrt{\frac{3pD^2}{16\sigma_t}}$ $\mathbf{t_h = 1.57mm}$

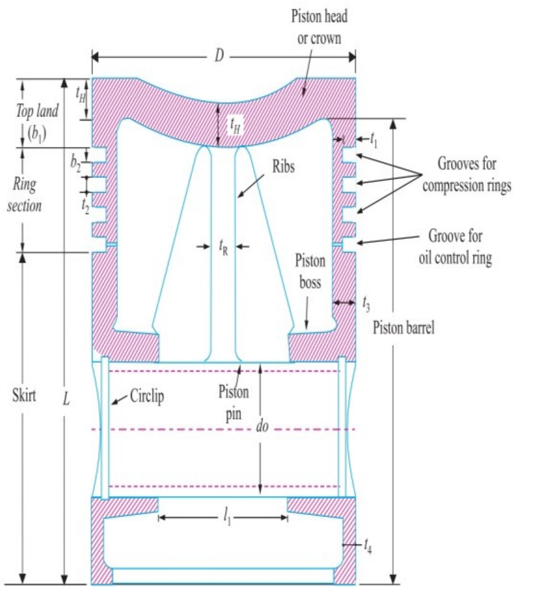
$\mathbf{t_h = 12.03481081mm}$

2.Piston rings

Radial thickness $t_1 = D\sqrt{\frac{3p_w}{\sigma_t}}$

the gap between the free ends of the ring = 3.5t to 4t = 7.72mm

PISTON DESIGN



3. Piston barrel

$t_3 = 0.03D + b + 4.5$

$t_3 = 8.54$mm

The piston wall thickness towards the open end

$t_4 = 0.35t_3$

$t_4 = 2.989$mm

4. Piston skirt

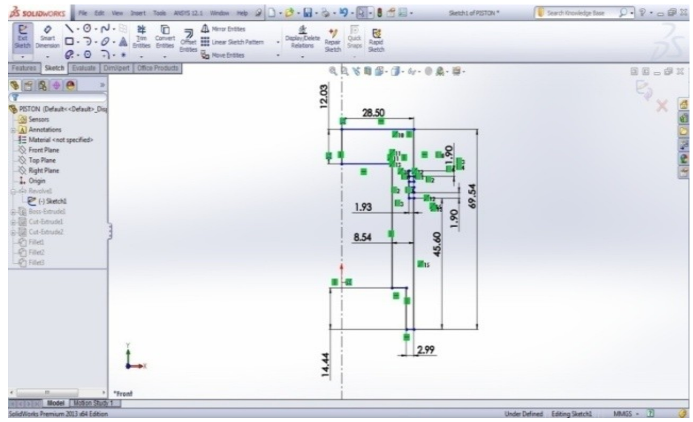
Total length of the piston

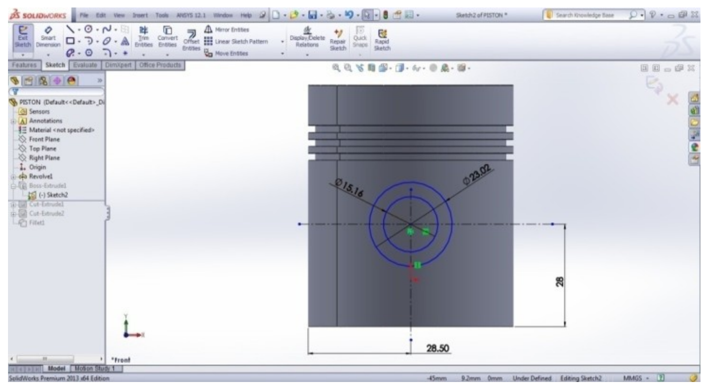
L = length of the skirt   length of ring section + top land

L = 69.54177297mm

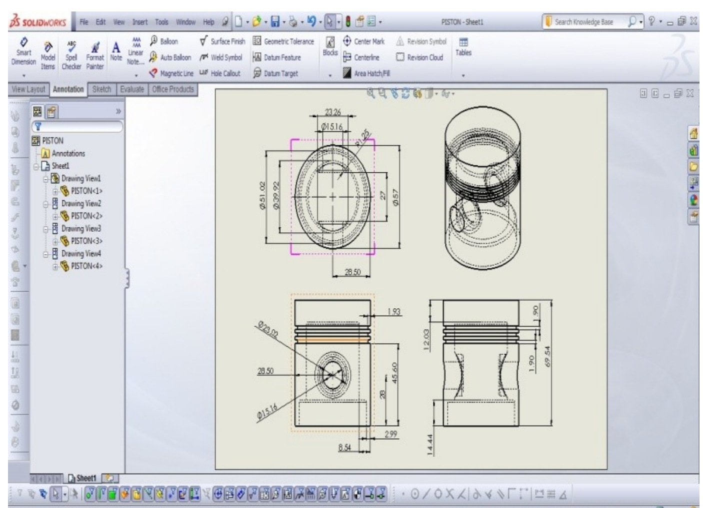
MODEL OF PISTON BY USING SOLID WORKS

SKETCHER:





2D DRAWINGS



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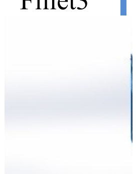
ANALYSIS OF PISTON BY USING COSMOWORKS CAST IRON

MODEL INFORMATION:

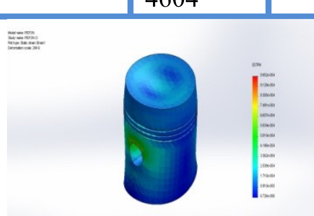
Model name: PISTON
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Fillet3 	Solid Body	Mass:0.645772 kg Volume:9.15989e-005 m^3 Density:7050 kg/m^3 Weight:6.32857 N	C:\Users\VASANTHA\Documents\DESIGN\SW\piston\PISTON.SLDPRT Feb 09 17:31:03 2015

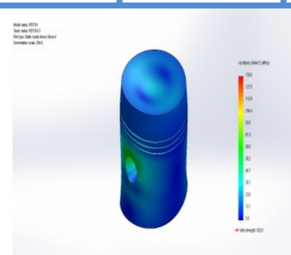
STUDY RESULTS

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



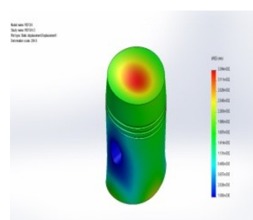
PISTON-PISTON CI-Strain-Strain1

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.512339 N/mm^2 (MPa) Node: 15996	139.006 N/mm^2 (MPa) Node: 17698



PISTON-PISTON CI-Stress-Stress1

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 74	0.0339394 mm Node: 9702



PISTON-PISTON CI-Displacement-Displacement1

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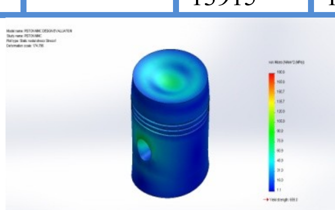
ALLUMINIUM POWDER METALLURGY:MODEL INFORMATION

Model name: PISTON MMC DESIGN EVALUATION
Current Configuration: Default

Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Fillet3 	Solid Body	Mass:0.249261 kg Volume:8.65488e-005 m^3 Density:2880 kg/m^3 Weight:2.44275 N	C:\Users\VASANTHA\Documents\DESIGN\SW\piston\PISTON MMC DESIGN EVALUATION.SLDPRT Feb 09 18:29:35 2015

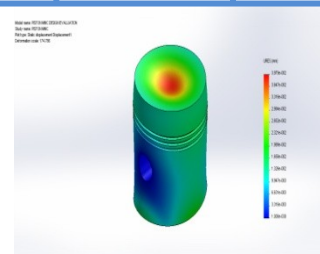
STUDY RESULTS

Name	Type	Min	Max
Stress1	VON: von Mises Stress	1.06347 N/mm^2 (MPa) Node: 13915	180.598 N/mm^2 (MPa) Node: 16663



PISTON MMC DESIGN EVALUATION-PISTON MMC-Stress-Stress1

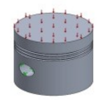
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 74	0.0397868 mm Node: 4923



PISTON MMC DESIGN EVALUATION-PISTON MMC-Displacement-Displacement1

ALUMINUM ALLOY 7075

MODEL INFORMATION



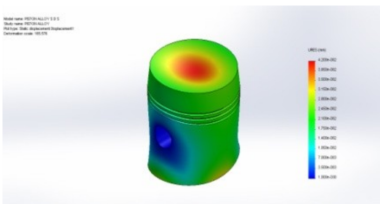
Model name: **PISTON ALLOY S D S**

Current Configuration: **Default**

Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Fillet3 	**Solid Body**	Mass:0.257393 kg Volume:9.15989e-005 m^3 Density:2810 kg/m^3 Weight:2.52245 N	C:\Users\VASANTHA\Documents\DESIGN\SW\piston\PISTON ALLOY S D S.SLDPRT **Feb 09 19:10:38 2015**

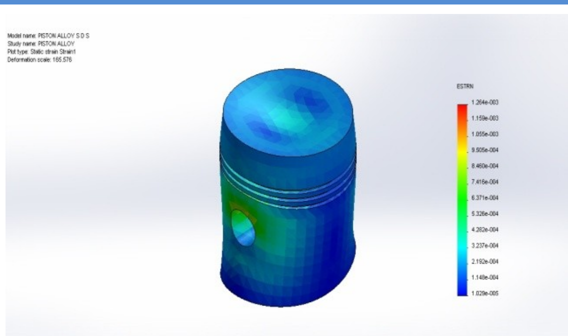
STUDY RESULTS

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 74	0.0420002 mm Node: 3362



PISTON ALLOY S D S-PISTON ALLOY-Displacement-Displacement1

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.02872e-005 Element: 3671	0.00126389 Element: 10894



PISTON ALLOY S D S-PISTON ALLOY-Strain-Strain1

DESIGN OPTIMIZATION OF PISTON

ALUMINUM ALLOY 7075:

MODEL INFORMATION

Document Name	Configuration	Document Path	Date Modified
PISTON 7075	Default	C:\Users\VASANTHA\Documents\DESIGN\SW\piston sw\COSMOS STATIC PISTON\PISTON 7075.SLDPRT	Feb 10 10:17:03 2015

STUDY PROPERTIES:

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

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UNITS:

Sensor name	Condition	Bounds	Units	Study name
Stress1	**is less than**	Max:520	N/mm^2 (MPa)	PISTON CI

Design Study Setup

Design Variables

Name	Type	Values	Units
ALLOY	**Range**	Min:8 Max:12	Mm

Constraints

Sensor name	Condition	Bounds	Units	Study name
Stress1	**is less than**	Max:505	N/mm^2 (MPa)	CI

Goals

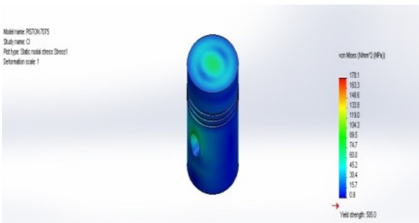
Name	Goal	Properties	Weight	Study name
Mass1	Minimize	Mass	10	-

STUDY RESULTS

Component name	**UNITS**	**CURRENT**	**INITIAL**	**Optimal**	**Iteration 1**	**Iteration2**
ALLOY	Mm	8	12.03481	8	8	12
Stress 1	N/mm^2 (MPa)	178.09	126.43	178.09	178.09	125.01
Mass1		86.5488	91.5989	86.5488	86.5488	91.5553

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

Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.913657 N/mm^2 (MPa) Node: 6637	178.089 N/mm^2 (MPa) Node: 16663



PISTON 7075-CI-Stress-Stress1

RESULTS TABLE

As per the analysis images

	DISPLACEMENT (mm)	STRESS (N/mm^2)	STRAIN	WEIGHT (Kg)
CAST IRON	0.0039	139.006	0.000995247	0.645
ALUMINUM POWDER METALLURGY	0.0397868	180.5	0.00096114	0.249
ALUMINUM 7075	0.042	126.431	0.00126	0.257

CONCLUSION

In this paper,By comparing the three materials, we can conclude that using Aluminum powder metallurgy is better than other two materials since its strength is more and also by using this material its weight is also less.We have also done design optimization by reducing the piston head thickness, the values are 12mm (Original), 10mm and 8mm. By observing the optimization results for all materials, by reducing thickness of piston head from 12mm to 8mm, the results are optimal. So by taking piston head thickness as 8mm, it is the optimal value.

REFERANCES

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