

# Implementing Latest Techniques and Tools for Modelling and Analysis of Piston to Enhance the Performance by Using Different Materials

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**ABSTRACT:** The main purpose of presenting this review paper is to discuss the study performed on the piston materials and compare the mechanical properties and their performance. To withstand all the stresses and applied load piston material should possess some properties such as good thermal conductivity, light weight, wear resistance, high strength to weight ratio. After performing the literature survey and study of the research papers we determined to apply thermal and static structural analysis on different materials.

In this study Cast iron, Structural steel, Graphite and Al-alloys will be used and examined as the piston materials. The methodology procedure mentioned in this review paper is inspired by some of research paper followed in literature survey. Designing is completed by using CATIA V5 mechanical software tool and thermal and static structural stress analysis performed on each material under the same condition using ANSYS 14.5 software and FEA analysis.

**KEYWORDS:** Piston material, Cast Iron, Structural Steel, Graphite, Al-Alloy, CATIA V5, ANSYS.

## I. INTRODUCTION

Piston is the most important component of the power engine of the vehicle and supplies energy to the different components after converting it into various forms. Engine consists of various mechanisms and components induced in it for different functioning. Piston is one of them which is connected to the cam shaft is responsible for all the strokes in an engine which includes intake, Compression, Expansion and exhaust. Piston of IC engine is used in today's industry is basically made up of Al-alloy. It is also a moving component that is contained by the cylinder. The main purpose of piston is to transfer force which is generated by expanding gas to crankshaft through the connecting rod. In the thermal analysis the properties of material are studied with the change in temperature where as in static structural analysis stresses are calculated at certain static loading condition. For both the static structural and thermal analysis Finite element method is use.

The efficiency of IC engine is greatly depended on design of piston as well as the material which is used in piston. The piston with the less weight is more efficient than the conventional one. In this study analysis is done on the piston with Cast iron, Al-alloy and graphite, structural steel.

## II. RELATED WORK

**K. S. Mahajan [2016]** carried out the objective of the present work is to focus on the structural analysis of ceramic coated piston, working under thermal and mechanical loads. Thermal analysis was carried out on uncoated and ceramic coated piston to verify the temperature changes at the ceramic coated regions using Hyper-mesh and ANSYS. The study of thermal stresses generated due to temperature differences at different materials junctions used in coating was analysed. The stresses due to the mechanical loads were studied to finally determine the structural behaviour of the partially ceramic coated pistons. The Thermal Stress Distribution for coated and uncoated piston models show that the thermal stress is maximum at the centre for uncoated model and at edges for the coated model.

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**Kancharla Raja Sekhar [2016]** carried out study on piston that 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. Piston that transfer the combustive gases power to the connecting rod. To improve the efficiency of the engine there is a need to study about the piston. Pistons that are usually made up with alloy steels that show the grate resistant against thermal loads and structural loads. In the project we design a piston by using solid works 2016 design software and we did the structural load analysis and thermal analysis by applying various materials such as composites on piston in ansys workbench software.

**Yaohui Lu [2016]** stated that the improvement of the diesel engine power and performance, the piston in the combustion chamber is subjected to higher thermal load and the thermal stress decreases its working life. Therefore, it is necessary to analyse the subsequent thermal stress on the piston during design process to reach the optimum one. They tried to present a new calculation method for the theoretical design of the piston. In his study, the 3D solid model of piston in 16V280 diesel engine was developed and the simulation calculation of the steady-state and the transient-state temperature field is carried out. The results show that the maximum temperature is 354 °C, which appears at the edge of the combustion chamber. The steady-state temperature field of finite element simulation shows a good agreement with the experimental results. The thermal stress obtained from thermal mechanical decoupling method was within the allowable range, since the maximum value is 270 MPa. Danger zone appears at the combustion chamber throat, the contact area of piston head and skirt.

**V G Cioată [2016]** discussed here about the piston is one of the most important components of the internal combustion engine. Piston fails mainly due to mechanical stresses and thermal stresses. In this paper is determined by using the finite element method, stress and displacement distribution due the flue gas pressure and temperature, separately and combined. The FEA is performed by CAD and CAE software. The results are compared with those obtained by the analytical method and conclusions have been drawn.

The results are compared with those obtained by the analytical method and conclusions are drawn. Autodesk Inventor Professional is used to obtain the 3D model of the piston and ANSYS Workbench V.15 is used for the finite element analysis.

**C. Kirnera [2016]** described the piston assembly is the most complex system within the internal combustion engine. In order to fully exploit its optimization potential a high level of system understanding is required. Therefore, in this paper experimental studies of two single cylinder engines are combined with CFD-simulation of the piston ring pack. The introduced measurement and simulation techniques enable a holistic approach to the investigation of the tribological conditions of the piston assembly. The results – like the comparison of crank-angle resolved oil film thickness to the piston assembly friction measurement – illustrate the implications of design parameters of the piston assembly on the functional parameters friction, oil consumption, blow-by, wear and acoustics and thereby permit purposive system optimization.

**Nunna Durga Prasanth [2015]** worked on some composite materials those are framed by the mixing of two or more materials to accomplish properties that are better than those of its constituents. Aluminium metal matrix composites are increasing across the board acknowledgement for vehicles, modern, aviation applications in view of their low thickness, high quality and great structural unbending nature. In the present work a specimen is made to Al-SiC-graphite contained in particulate metal matrix composites by stir casting method. The expansion level of graphite being Varied from 3-5wt% in venture of 1wt% and the rate of SiC is consistent (i.e. 5%). Brinell hardness, tensile properties and impact strength of the composites were tested according to the norms. Sometimes an image may contain text embedded on to it. Detecting and recognizing these characters can be very important, and removing these is important in the context of removing indirect advertisements, and for aesthetic reasons.

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## III. PROPOSED METHODOLOGY

To fulfil the requirements of efficient piston four types of different materials will be used in this study and the performance will be analysed using Finite Element Analysis and using ANSYS software tool. This study is performed on four different materials which can be used for manufacturing the piston such as Cast iron, Structural steel, Graphite, aluminium alloy. Analysis will be completed on the difference between the performances given by different materials piston and compare the results based on some calculations. Design techniques and procedure for manufacturing the piston will be taken as per standards.

ANSYS is a multi-Physics computing software falls under the category of CAE i.e. Computer Aided engineering analysis software used for providing the approximate solutions to the problems. The designing of piston by using different material will completed by using the software applications using CATIA V5, CAE application, ANSYS. After applying some considerable changes into the graphics standards and displays in the software workstation. The piston is then analysed for making numerical calculation for the temperature distribution in order to control the thermal stresses and deformations. In order to have an efficient piston it is very important to optimize the temperature distribution of the piston designing and the thermal behaviour of all four materials.

## IV. MATERIAL SELECTION

Piston in an IC engine must possess the following characteristics:

- Strength to resist gas pressure.
- Minimum weight.
- Reciprocate with minimum noise.
- Sufficient bearing area to prevent wear.
- Must seal the gas from top and oil from the bottom.
- Resistance to distortion under heavy forces and heavy temperature.

Selection of piston material is determined on the basis of above mentioned characteristics. Structural steel is light in weight and having high yield strength and cast iron is hard more brittle and fusible than the structural steel but weak in tensile property. Al-alloy shows following properties including high strength excellent malleability, corrosion resistance, easy to handling, good machinability and less weight compared to cast iron and steel. Electrical and thermal conductivity of Al-alloy is also great. Graphite has some properties better than the cast iron and the structural steel. It has lowest weight and the thermal and electrical conductivity is good, highest strength and hardness of this material makes it suitable for piston manufacturing. These four materials will be undergone through mechanical tests and analysis in order to find the best suitable piston material among them.

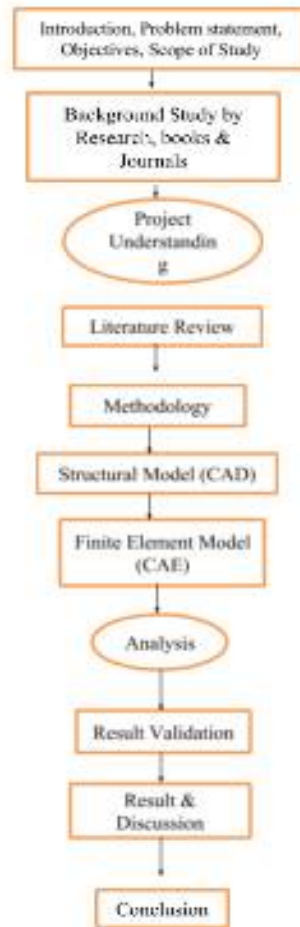
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## Flow Chart of Modelling Process of piston



## V. CONCLUSION

In an automotive system and automobile industries the use and importance of the piston and the terminology has been considered in this study. The different type of piston materials can be used to manufacture the piston such as Graphite, Cast iron, Structural steel & Aluminium alloy. This study is performed on the selection of suitable piston material for having excellent efficiency and mechanical properties in the piston. The detailed methodology behind the fabrication process and designing can be completed by using mechanical software such as ANSYS; CATIA V5 can also be explained by using flow charts. Thermal stresses analysis can be determined by application of thermal load on the piston material and same as the equivalent stresses can also be implied to examine the mechanical strength of the material.

The main objective of this study is to check the variations in stresses and thermal behaviour when replacing the piston material with of graphite material and some other different materials.

## REFERENCES

- [1] K.S.Mahajan and S.H.Deshmukh – “Structural and Thermal Analysis of Piston” International Journal of Current Engineering and Technology E-ISSN 2277 – 4106, P-ISSN 2347 – 5161 ©2016 INPRESSCO.



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Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

- [2] Kancharla Raja Sekhar, G. Vijay Prakash- "Thermal Analysis Of A Piston" Volume 5, Issue 4 OCT 2016.
- [3] Yaohui Lu, Xing Zhang, Penglin Xiang, Dawei Dong – "Analysis of Thermal Temperature Fields and Thermal Stress under Steady Temperature field of Diesel Engine Piston" , Southwest Jiaotong University, Chengdu Sichuan 610031, China, 2016.
- [4] V G Cioatã, I Kiss, V Alexa and S A Rațiu – "Mechanical and thermal analysis of the internal combustion engine piston using Ansys" International Conference on Applied Sciences (ICAS2016).
- [5] C. Kirner, J. Halbhuber, B. Uhlig, A. Oliva, S. Graf, G. Wachtmeister- "Experimental and simulative research advances in the piston assembly of an internal combustion engine" Preprint submitted to Tribology International March 17, 2016.
- [6] Nunna Durga Prasanth , Dr.B Venkataraman – "EXPERIMENTAL INVESTIGATION AND ANALYSIS OF PISTON BY USING HYBRID METAL MATRIX" [Nunna, 4(3): March, 2015] ISSN: 2277-9655 Scientific Journal Impact Factor: 3.449 (ISRA), Impact Factor: 2.114.