

# Structural and Thermal Analysis of Single Plate Clutch using CAE Tools

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**Abstract**— The clutch plate is a device use while shifting the gears(while engaging and disengaging).Repetitive use of clutch plate leads to heat generation. Transient thermal and structural analysis of Clutch plate is aimed to evaluate the performance of clutch plate under severe conditions. Clutch plate modeled in SOLID WORKS 2015 and its analysis is done using ANSYS workbench v11. The objective of this analysis or study is to analysis the thermo mechanical behavior of the dry contact of clutch plate during shifting the gears. The coupled thermal structural analysis is uses to determine the heat flux, deformation and the von Mises stress produce in plates with two different materials to increase the performance of clutch plate. A comparison results is shown for both of the materials using FEM.

**Key words:** Solid works, AnsysWorkbench, thermal and structural analysis, clutch plate

## I. INTRODUCTION

In this 21st century technologies are increasing very rapidly. Moreover the completion among the people has increased. Taking the case of automobile sector, technology is changing every days and comfort and safety has taken care by the worker while implementing them. Clutch Plate is one of those revolutionary change inventions which has changed the face of automobile. A clutch is a device that engages and disengages the power transmission, especially from driving shaft to drive shaft.Clutches are used whenever the transmission of power or motion is be controlled either in amount or over time .A clutch plate generally made of compound copper wires or ceramics.Ceramics is generally used in heavy applications such as heavy-duty hauling, though the harder ceramic increase flywheel and pressure plate wear. Two basic types of Clute plates are coil-spring clutch and the diaphragm-spring clutch. The clutch plates causes easier and smoother shifting of gears, thus assuring a jerk free ride and optimum power transmission. Ganesh Raut et.al. [1] Presented the analysis of multidisc clutch plate using FEA in which they have compared different materials to find out the material best for the lining of friction surfaces. MVasundaraet. al. [2] presented the structural analysis on multi plate clutch using Ansys, compared friction material based on the total deformation of the clutch plate to find the better lining material.P Uma Mahesh et.al.[3]presentedFEM analysis of wet multi plate clutch by varying friction surface materialin which Structural and Thermal analysis is done on the wet friction plates (materials used are Cork and Copper Powder Metal.) to verify the strength. Tippa Bhimasankara Rao ET. At. [4] worked on Analysis (static and thermal) of Friction Clutch plate using FEA in which they have observe the stress distribution and the temperature distribution of the clutch plate by changing the material.

## II. MODEL OF CLUTCH PLATE

The solid model of clutch plate constructed for the dimensions as shown in fig.2 radius.068m and flange

thickness of the plate .004m-.002m structural steel and aluminum alloy respectively.

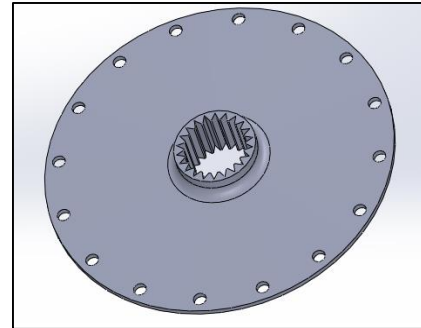


Fig. 1: Model of clutch plate

### A. Finite Element Analysis:

The finite element analysis [FEA] has become most powerful tool for the numerical solutions of a wide range of problems. It has done by increasing the use latest technologies which are really helpful in getting the best solution of the both engineering and non-engineering. In this step it defines the analysis type and options, apply loads and initiate the finite element solution. This involves three phases: Pre-processor phase, Solution phase, Post-processor phase. The ANSYS Workbench, with the Workbench projects and tabs, provides a unified working environment for developing and managing a variety of CAE information and makes it easier for set up and work with data at a high level. Workbench includes the following modules "ANSYS Design Space" is referred to as Simulation "ANSYS AGP" is referred to as Design Modeler and "ANSYS Design explorer" referred to as Design explorer. Workbench provides enhanced interoperability and control over the flow of information between these task modules. Various tools and techniques are incorporated for efficiently manage to large models. Like tree filtering tagging tree Objects, connections worksheet, object generator, sub modeling. Data can be transferred from a 2D coarse model [Full Model] to a 3D sub model. Sub modeling is available for structural and thermal analysis types with solid geometry.

### B. Meshing Details:

Meshing in Workbench is generally provided durable and easy specifically that will certainly help to simplify the mesh generation process. The model using must be divided into a number of small pieces known as finite elements. Here we have used "Fine" mesh.A finite element mesh model generated is shown in fig.3.The mesh results are as shown in table No 2.

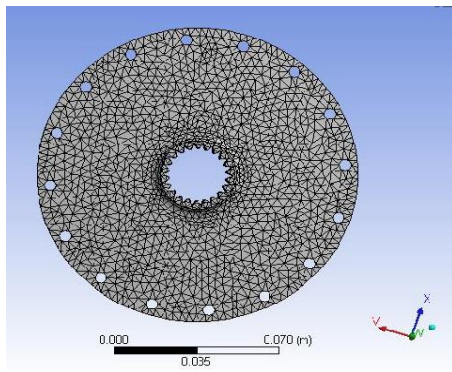


Fig. 2:

Mesh Generation

Materials	No. of Mesh	No. Of nodes
Structural Steel	10208	22071
Aluminum Alloy	10208	22071

Table1: Elements and nodes

Material properties of structural steel and aluminum alloys is shown in table 2

Material properties

Material selected	Structural steel	Aluminum alloy
Young modulus	200 GPa	69 GPa
Poisson ratio	0.3	0.33
Tensile Ultimate Strength	400 MPa	110 MPa
Tensile Yield Strength	250 MPa	95Mpa
Density	7850 kg/m <sup>3</sup>	2770 kg/m <sup>3</sup>

Table 2:

### III. RESULTS AND DISCUSSIONS

Comparing both the material structural steel and aluminum alloy and their properties by applying the same thermal temperature which varies from 22 to 28.5 degree Celsius. Heat flux is the rate of heat energy transfer through a given surface, per unit time. The SI derived unit of heat rate is joule per second, or watt. Heat flux density is the heat rate per unit area. In SI units, heat flux density is measured in W/m<sup>2</sup>. The vonmises and deformation results for the clutch plate as shown below in table 3

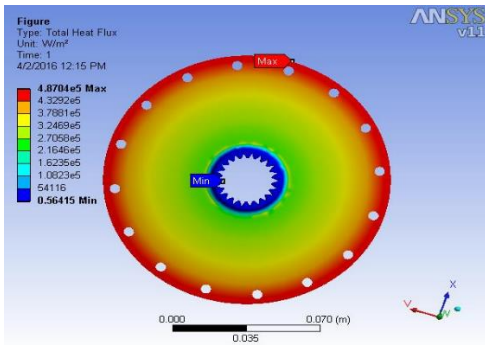


Fig. 3: Total Heat Flux of Aluminum Alloy

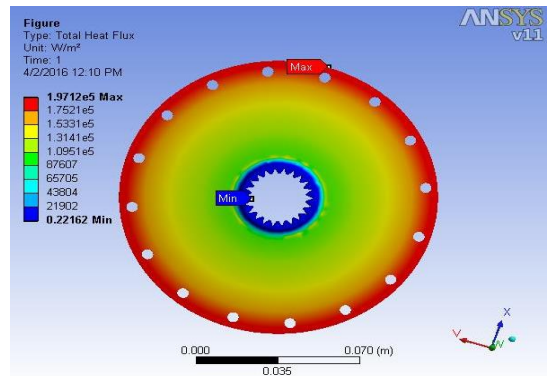


Fig. 4: Total Heat Flux of Structural Steel

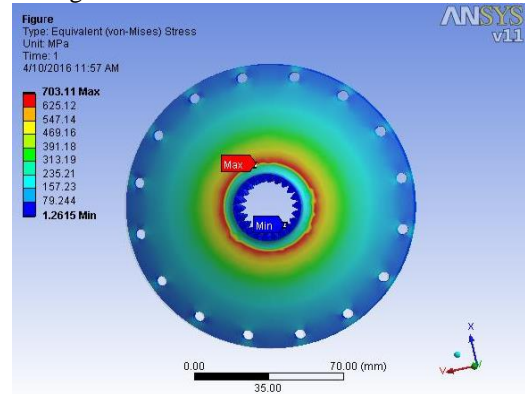


Fig. 5: Von Mises Stress Of Structural Steel

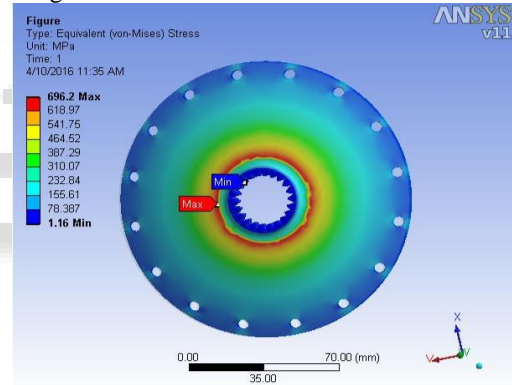


Fig. 6: Von Mises Stress of Aluminum Alloy

Results Parameter	Structural steel		Aluminum Alloy	
	Maxi.	Mini.	Maxi.	Mini.
Heat Flux (W/m <sup>2</sup> )	1.9712e5	0.22162	4.8704e5	0.5641
Von Mises (MPa)	703.11	1.26	696.2	1.16
Deformation (mm)	1.2139	0	3.2946	0

Table 3:

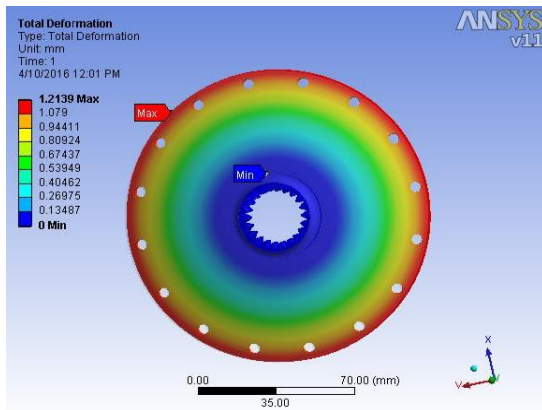


Fig. 7: Total Deformation of Structural Steel

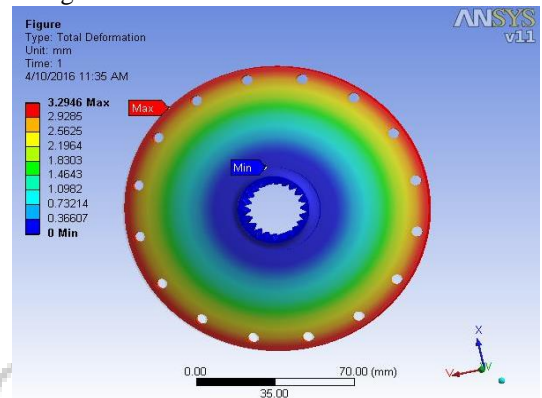


Fig. 8: Total Deformation of Aluminum Alloy

#### IV. CONCLUSION

All the comparison are done and it is observed that the same required output varies with the type of material used. Comparing the results of structural and thermal analysis which includes (Heat Flux, Total Deformation, and Von Mises stress) of structural steel and aluminum alloy, it is cleared that structural steel is far better than aluminum alloy. We come to know that the alloy of aluminum can be replaced by structural steel or by any other composite material or a reinforce material.

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