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STEADY STATE STATIC AND DYNAMIC ANALYIS OF A SINGLE PLATE CLUTCH

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ABSTRACT:
A Clutch is a machine member used to connect the driving shaft to a driven shaft, so that the drivenshaft may be started or stopped at will, without stopping the driving shaft. A clutch thus provides an interruptibleconnection between two rotating shafts. The present used material for single plate clutch is Cast Iron and aluminum alloys. In this thesis analysis is performed using composite materials. The composite materials are considered due to their high strength to weight ratio. A single plate clutch is designed and modeled using CATIA software. Static analysis and Dynamic analysis is done on the clutch to determine stresses and deformation. Analysis is done in Ansys. Theoretical calculations are also done to determine stresses.
Keywords: Clutch, Structural Analysis, ANSYS and CATIA.

INTRODUCTION

A clutch is a mechanical device which provides driving force to another mechanism, typically by connecting the driven mechanism to the driving mechanism. Its opposite component is a brake, which inhibits motion. Clutches are useful in devices that have two rotating shafts. In these devices, one shaft is typically attached to a motor or other power unit (the driving member), and the other shaft (the driven member) provides output power for work to be done. In a drill, for instance, one shaft is driven by a motor, and the other drives a drill chuck. The clutch connects the two shafts so that they can either be locked together and spin at the same speed (engaged), or be decoupled and spin at different speeds (disengaged).A Clutch is a machine member used to connect the driving shaft to a driven shaft, so that the driven shaft may be started or stopped at will, without stopping the driving shaft. A clutch thus provides an interruptible connection between two rotating shafts. Clutches allow a high inertia load to be stated with a small power.

SINGLE PLATE CLUTCH:

A much more power type of clutch is the single-plate clutch as shown in which a single flat circular plate is gripped between the inside face of the flywheel and a clamping plate which is made to grip the clutch plate by means of clamping levers actuated by strong spring. The amount of

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pressure put on the clamping plate can be varied by adjusting pins on which the end of the clamping levers pivot. The inside face of the flywheel and a clamping plate which is made to grip the clutch plate by means of clamping levers actuated spring.

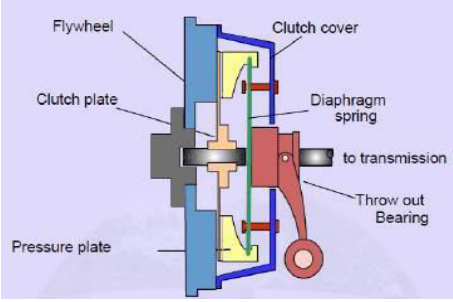

Figure 1.1 single plate clutch

OPERATING OF SINGLE PLATE CLUTCH:

A single plate clutch consists of a clutch plate whose both sides are faced with a frictional material. It is mounted on the hub which is free to move axially along the spline of the driven shaft. The pressure plate and flywheel rotate with the engine crankshaft or driving shaft. The pressure plate pushes the clutch plate towards the flywheel by a set of strong springs which are arranged radially inside the body. When the clutch is engaged, the power is flows from the engine to the rear wheels through the transmission system and the vehicle moves. When the clutch isdisengaged, the power is nottransmitted to the rear wheels and thevehicle stops while the engine is stillrunning. The clutch is disengagedwhen starting the engine, whenshifting the gears, when stopping thevehicle and when idling the engine.The clutch permits the gradual takingup of the load. It prevents jerkymotion of the vehicle. The axialpressure exerted by the springprovides a frictional force in thecircumferential direction when therelative motion between the drivingand driven members tends to takesplace. If the torque due to thisfrictional force exceeds the torque tobe transmitted, then no slipping takesplace and the power is transmittedfrom the driving shaft to the drivenshaft.

By rearranging the terms the equations can be modified and a more general form of the equation can be written as

T N.f.F.Ra m =

T is the torque (Nm).

N is the number of frictional discs in contact.

f is the coefficient of friction

F is the actuating force (N).
a

R is the mean or equivalent radius (m).
m

Note that N = n1 + n2 -1

Where n1= number of driving discs

n2 = number of driven discs

PROBLEM DESCRIPTION

Previous work has been done onthe sintered iron friction materialclutch plate and dynamic analysis ofcracks in composite materials. Staticand dynamic analysis of clutch platehad also been done to observe theclutch before crack and after crack butthe crack propagation and growthwere not observed.The objective of this project is to make a 3D model of the single plate clutch and study the static, modal and thermal behavior of the multi plate clutch by performing the finite element analysis.3D modeling software (CATIA) was used for designing and analysis software (ANSYS) was used for analysis. The methodology followed in the project is as follows:

- Create a 3D model of the multi plate clutch

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- Assembly using parametric software CATIA.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis.
- Perform static analysis on the Single plate

2.LITERATURE SURVEY

[1] Oday I. abdullah, Michael lytkin (2015)

the accurate computation of the contact pressure distribution is considered the main key to obtain the temperature distribution of the contact surfaces of clutch with high accuracy. High number of researchers in the thermoplastic field assumed that the contact surfaces of the automotive clutches and brakes are flat, and they don't take the actual surface roughness into consideration in the numerical models. In this paper a new model of rough clutch disc has achieved to show the actual contact pressure of the new and used friction facing of clutch disc. The effect of the surface roughness of the used friction facing on the heat generated and the temperature fields are investigated as well

[2] Shaik Mohammad Ali (2014)

Clutch is a mechanical device, which is used to engage or disengage the source of power from the rest of the power transmission system at the operator's will. The clutch can connect or disconnect the driving shaft from the driven shaft when necessary. Clutches are designed to transfer maximum torque with minimum heat generation. During engagement and disengagement the two clutch discs has the sliding motion between them. The research shows that that designing and analysis of two positive multi friction plates. For the designing of the friction plates 3d modeling software used and for the analysis ansys package is used. In the analysis part the two models are analyzed with different materials by conducting two types of analysis which are structural and thermal

[3] Deshbhratar, and Nagnath U. Kakde (2001)

has performed design and Structural Analysis of Single Plate Friction Clutch the values of Equivalent stresses for material loading conditions it is clearly seen that these are less than the allowable stresses for that particular material under applied conditions the part not going to yield and hence the design is safe.

[4] N.V.Narasimharao (1994)

has Done Research Work on Investigate How a Crack Propagates and Grows in a Clutch. A Clutch Plate Is Analyzed For Crack Propagation For Different Materials Aluminum Alloy 6061, Aluminum Alloy 7475, Composite Materials S2 Glass And Kevlar. Theoretical Calculations Are Done To Determine Stress Intensity Factor, Crack Extension Force, Crack Opening Displacement. . From Dynamics And Fracture Mechanics, It Is Well Known That Accelerated Crack Nucleation And Micro-Crack Formation In Components Can Occur Due To Various Reasons, Such As Transient Load Swings, Higher Than Expected Intermittent Loads, Or Defective Component Materials. Normal Wear Causes Configuration Changes That Contribute To Dynamic Loading Conditions That Can A

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Literature Review on Failure in Single Plate Clutch Cause Micro Crack Formation At Material Grain Boundaries In Stress Concentrated Regions (Acute Changes In Material Geometry). So, Finally They Conclude That If The Crack Propagates In The Composite Materials, They Tend To Fail Faster Than Aluminum Alloys Thereby Reducing Their Life. So Care Should Be Taken For Composite Materials Not To Get The Crack.

[5] Ganesh Raut(1996)

presents The Structure Analysis Of Multi Plate By Varying The Friction Surfaces Material And Keeping Base Material Aluminum Same. Structural Analysis Is Done On The Friction Plates To Verify The Strength. Friction Materials Used Are Lo31and Hybrid Sf-Bu. By Observing The Analysis Results, The Maximum Shear Stress, Von-Mises Stress And Total Deformation Values For Hybrid Sf-Bu Are Less Than Lo31 Respective Values. So That For Multi Plate Clutches Using As Hybrid Sf-Bu Friction Material Is Advantageous Than Using Lo31 As Friction Material.

[6] Anil Jadhav(2013)

Is Concerned The Structure Analysis Of Clutch Plate Is Done Over Cork, Copper And Sa92 As Friction Lining For Pulsar Dtsi Model. The Intensity Of Axial Pressure Was Calculated By Using Uniform Pressure Theory And Uniform Wear Theory. As The Structural Behavior Of The Friction Lining Of Multi Plate Clutch Can Be Studied By Analyzing Just A Single Clutch Plate, Hence In This Study, Structural Analysis Of A Single Clutch Plate Has Been Carried Out In Ansys Workbench. The Von Mises Stress, Von Mises Strain And Total Deformation Values For The Three Materials Obtained From The Analysis Were Compared And The Best Friction Material Was Selected. From Analysis It Can Be Concluded That, On The Strength Basis, Sa92 Is More Suitable And Quite Better Friction Material Than Copper And Cork For Same Rated Torque.

3. METHODOLOGY

The present work is investigate how a crack propagates grows in a clutch. The finite element program ANSYS is used to simulate crack growth and to compute the stresses and the stress intensity factor. A Geometric model of clutch was designed in 3D by using software Catia. The materials of the clutch considered Are ceramic material which can withstand high pressure, temperature, and strength of the material. The main parts of the clutch are theclutch housing diaphragm spring,release bearing, pressure plate and friction plate. The clutch housing which contains the pressure plate and diaphragm spring is bolted to the fly wheel and rotates with the engine.

CLUTCH MATERIALS

This is because grey cast iron has agood wear resistance with high stress conditions and theproduction cost is low compare toother clutch disc materials such asA1-MMC (aluminum-metal matrixcomposite), carbon composites andceramic based composites of like Aluminum alloys 7475,6061 grade grey cast iron is selected as the material for the commercial clutch disc.

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DESIGN OF CLUTCH

The materials of clutch considered are Aluminum alloys 7475.6061 and composite materials S2 Glass and Kevlar. By using the CATIA software the clutch was designed.

The clutch disc is a steel plate, covered with a frictional material that is sandwiched between the flywheel and the pressure plate. The center of the disc is the hub, which fits the spines of the transmission input shaft. When the clutch is engaged, the disc is "squeezed" between the flywheel and pressure plate, and power from the engine is transmitted by the disc's hub to the input shaft of the transmission.There is however, a tendency for cables to gradually stretch and eventually break due to age and wear.

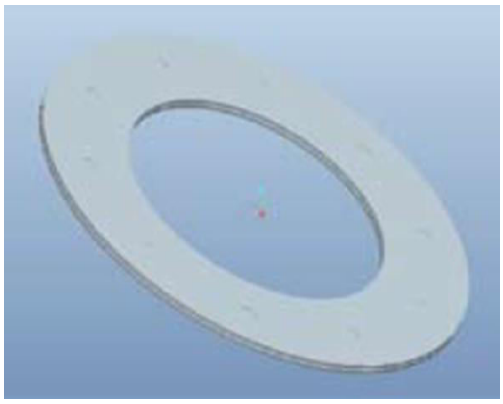

Figure 3.1 Clutch Plate

Figure 3.2 design of single plate clutch

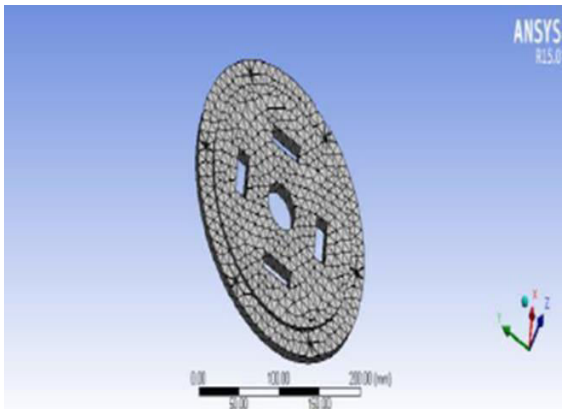

Figure 3.3 meshing of single plate clutch

ANALYSIS

- **Gray cast iron**

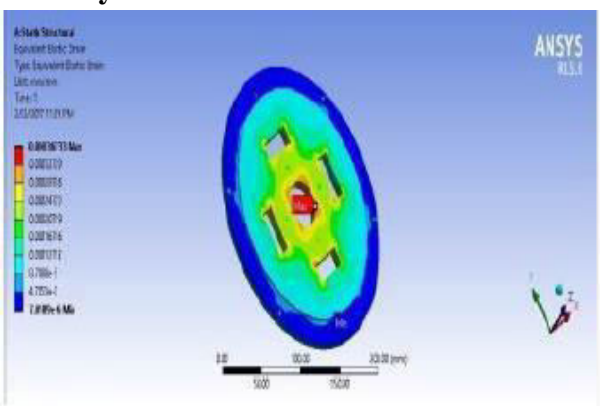

Figure 4.1 Equivalent Elastic Strains

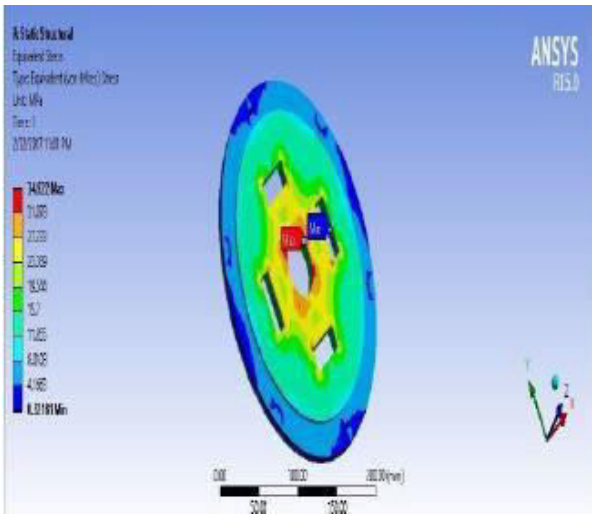

Figure 4.2 Equivalent (Vonmises) Stress

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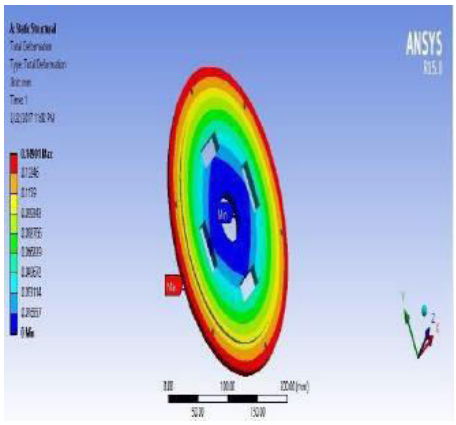

Figure 4.3 Total Deformation

ALUMINUM ALLOY A360:

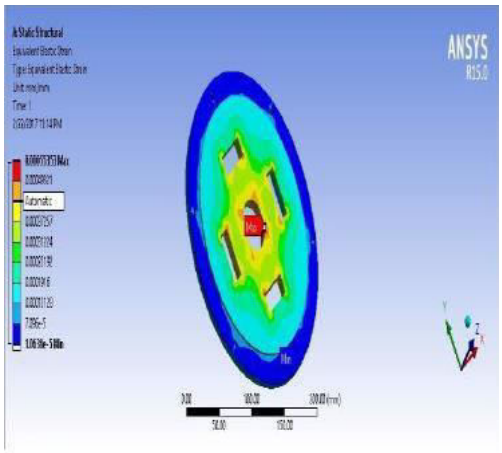

Figure 4.4 Equivalent Elastic Strain

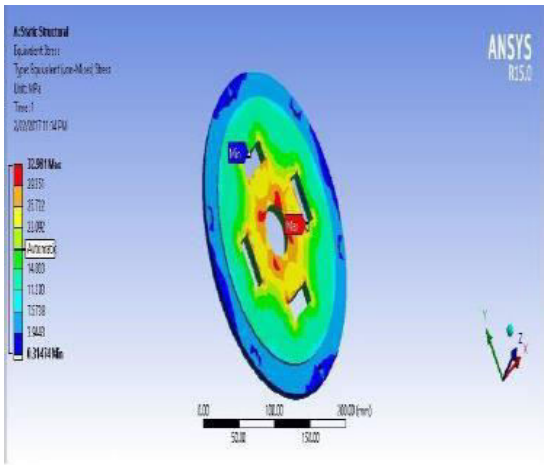

Figure 4.5 Equivalent (Vonmises) Stress

SILICON CARBIDE:

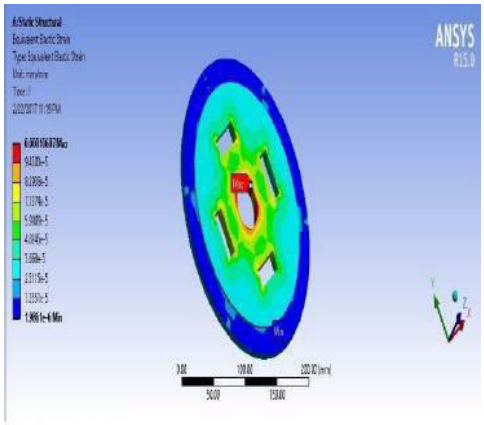

Figure 4.6 Equivalent Elastic Strain

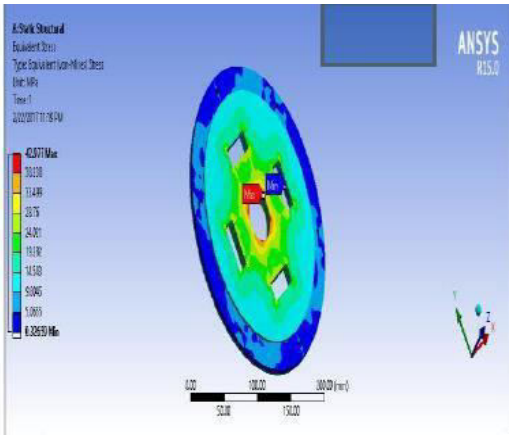

Figure 4.7 Equivalent (Vonmises) Stress

Table 4.1 STATIC ANALYSIS RESULTS

Material	Vonmises Strain	Vonmisses Stress (Mpa)	Total Deformation (mm)
Gray Cast Iron	0.00037	34.922	0.14901
Aluminum Alloy A360	0.00055	32.981	0.22113
Silicon Carbide	0.00011	42.977	0.04421

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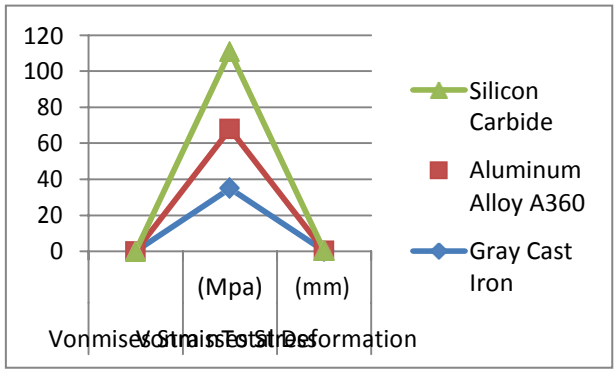

Graph 4.1 Static Analysis Variations

5 CONCLUSION

In this project, a single plate clutch is modeled in 3D modeling software CATIA and theoretical calculations and also static and dynamic analysis has done by using ANSYS Workbench 15.0. Present used material for clutch is Alloy steel. In this project, it is replaced with Gray cast iron, Aluminum Alloy A360, Silicon Carbide Has been selected for friction plate and static and dynamic analysis has been done to find the total deformation, equivalent (vonmises) stress and equivalent elastic strain. By comparing the results it is clear that Aluminum Alloy A360 has less deformation than other materials. So using the materials is safe. By comparing the results between materials, Aluminum Alloy A360 is more advantageous than other materials due to its less weight and high strength.

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