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"STATIC AND STRUCTURAL ANALYSIS OF FRICTIONCLUTCH PLATE OF AN ATV"

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Abstract— *Clutch is a mechanical device located between a vehicle engine and its transmission and provides mechanical coupling between the engine and transmission input shaft. Multi plate clutch is one of the important part in the* ***power*** *transmission systems. Good design of clutch provides better engine performance. Multi plate clutch is most widely used in ATV's,racing cars and heavy duty vehicle where high torque transmission required and limited space is available. The multi plate clutch has modelled in NX 9 software and imported in ANSYS Workbench 15. The structural analysis has been carried out for friction material clutch plate. The result of friction materials is based on the static and dynamic analysis, stress and total deformation and temperature variation and heat flux of the friction plate.Uniform wear theory were used for the analysis. The Grey Cast Iron and Kevlar 49 friction material are compared based on the total deformation of the clutch plate to find the better lining material.The Von Mises stress has been determined by varying the friction surfaces material-Grey Cast Iron and Kevlar 49.After that the FEM analysis is done for Kevlar friction material. The stresses & deformation obtained for this friction material is then compared to analysis software result. The analysis is done for worn out friction disc. By extracting the result we found that Kevlar49 as friction material solve this difficulty*.

Key words:*ANSYS, Clutch, friction plate, Grey Cast Iron, Kevlar49, Stress, Strain, VonMisesstress,Deformation.*

1. INTRODUCTION

The clutch is a mechanical device, which is used to connect or disconnects the source of power from the remaining parts of the power transmission system at the will of operator. The friction clutch is an important component of any automotive machine. It is a link between engine and transmission system which conducts power, in form of torque, from engine to the gear assembly. Mainly there are two types of clutches, one is single plate clutch which is used for small duty vehicles and the other is multi plate clutch, which has number of friction plates and steel plate's assembly used for heavy duty vehicles. The clutch principle is based on friction. When two friction surfaces are brought in contact with each other and pressed they are united due to friction between them. If one is revolved the other will also revolve. The friction between the two surfaces depends upon.

2. BACKGROUND

Design and Analysis of Friction Clutch Plate using Ansys by S.Gouse seema begum, and A. Balarajuinvestigated experimentally and numerically friction plate using CATIA V5 R20 software and theoretical calculations and also structural analysis has done by using ANSYS Workbench 14.5. In the study the materials gray cast iron and Kevlar 49 has been selected for friction plate and structural analysis has been done to find the total deformation, equivalent (von mises) stress and equivalent elastic strain and concludes that the material Kevlar 49 is more advantageous than Gray cast iron.

Static And Dynamic Analysis of Clutch Plate With Crack By N.V.Narasimharao, 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 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

Static and Dynamic Analysis of Single Plate Clutch By B.Sreevani ,and M.Murali Mohan explained that present used material for friction disc is Cast Iron and aluminum alloys. In this thesis analysis is performed using composite materials and concluded that by analytical and theoretical results, E Glass Epoxy is better.

Design Modification & Failure Analysis of a Driven Plate/Friction Plate of a Clutch using FEA By Marella. Veerendra, Gowthamtham Reddy, Vudumula, and K. N. D. Malleswara Rao[4] investigated on a Friction plate of a clutch using FEA and from the analysis result it was found that in the actual side plate the maximum value of stress is very near to the theoretical endurance limit. It was proofed experimentally.

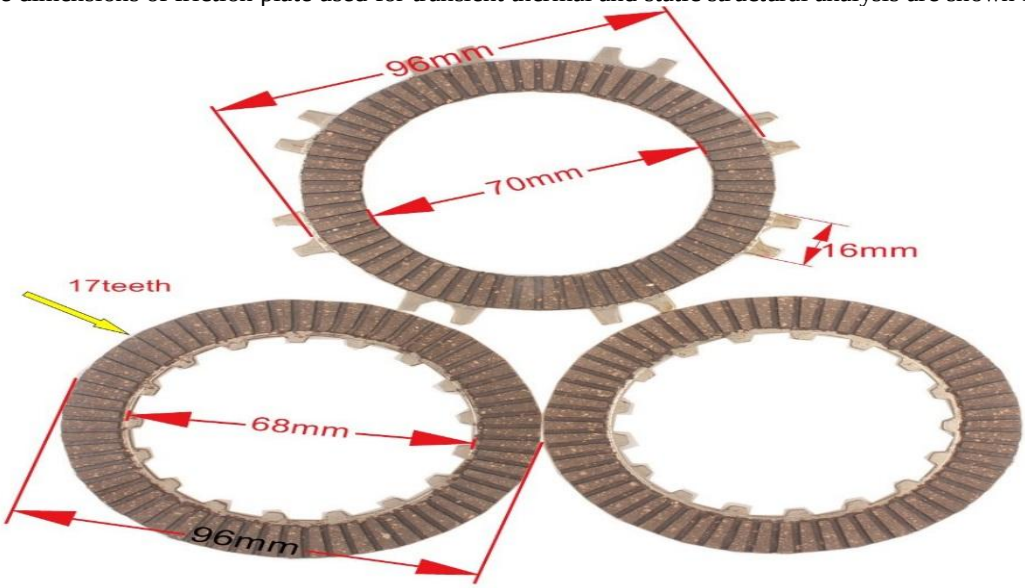
A Literature Review on Failure in Single Plate Clutch System By K.C.Lathiya,N.P.Badola2,C.L.Undhad,and B.D.Dhamecha[5] , studied on failure of single plate clutch system and from results obtained it was concluded that failure of clutch and its damage due to excessive frictional heat and heat fluctuations in the clutch counter-mate disc usually occurs in all type of automotive clutches.

3. DEFINITION OF PROBLEM DOMAIN

Due to the application of clutch on the car clutch plate and friction plate during engagement and disengagement, heat generation takes place due to friction and this thermal flux has to be conducted and dispersed across the friction plate cross section. The condition of clutch engagement and disengagement is very much severe and thus the thermal analysis has to be carried out. The thermal loading as well as structure is axis-symmetric. Hence axis-symmetric analysis can be performed, but in this study we performed 3-D analysis, which is an exact representation for this thermal analysis. Thermal analysis is carried out and with the above load structural analysis is also performed for analyzing the stability of the structure.

4. DIMENSIONS OF FRICTION PLATE

The dimensions of friction plate used for transient thermal and static structural analysis are shown in Fig.



1.

4.2 MODEL GENERATION

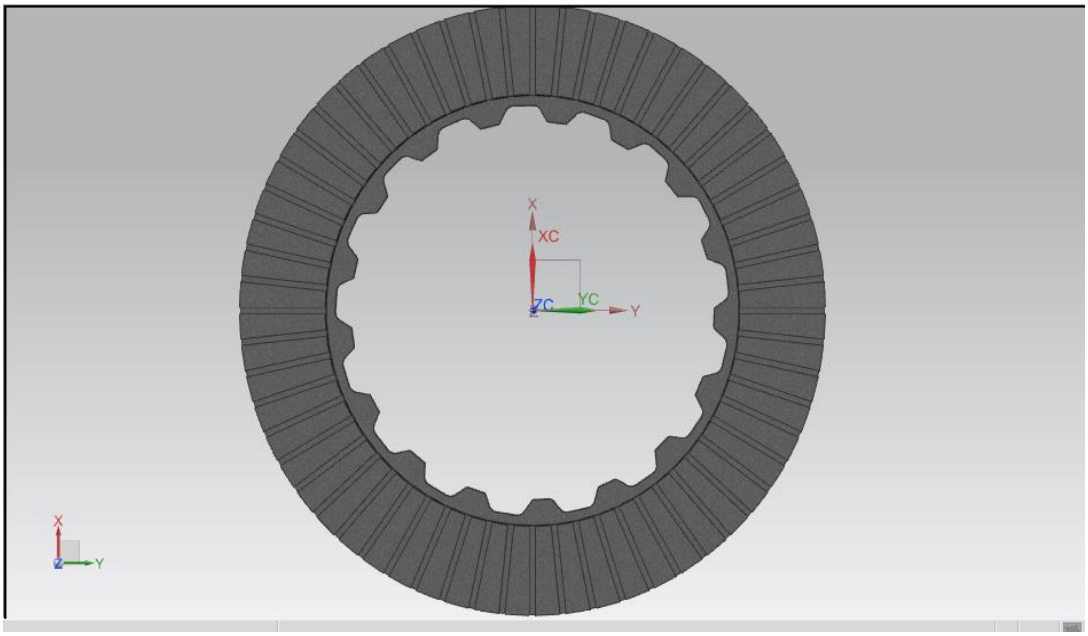


Figure 2Geometry of domain

4.3 MESH GENERATION

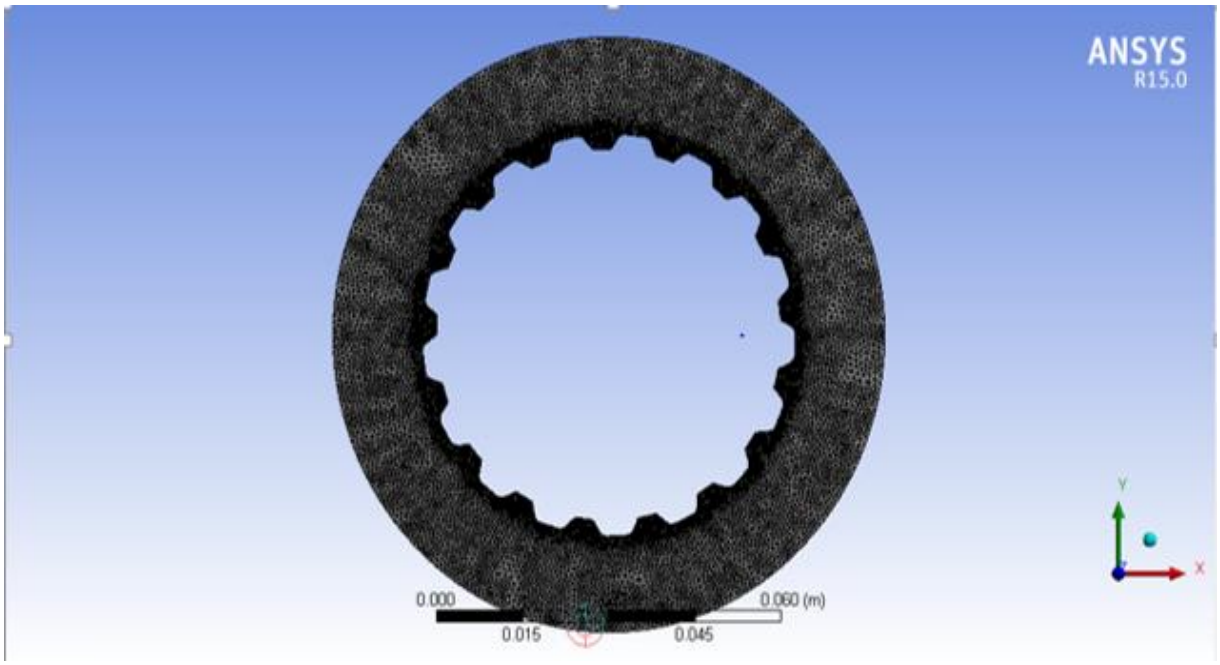


Figure 3 Mesh Generation

4.4 BOUNDARY CONDITIONS & LOADS

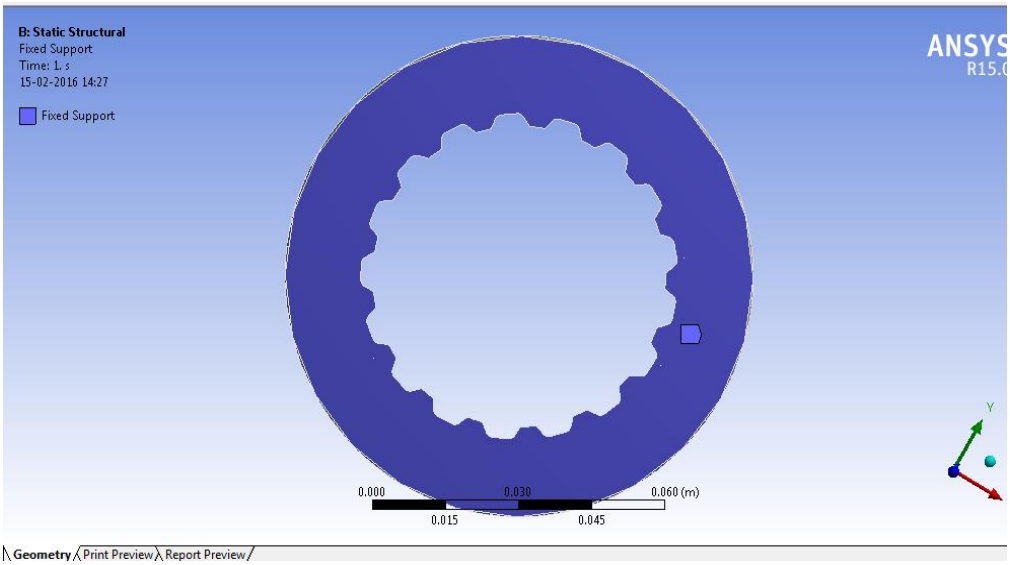


Figure 41Boundary conditions, fixed support

Gray cast iron friction lining

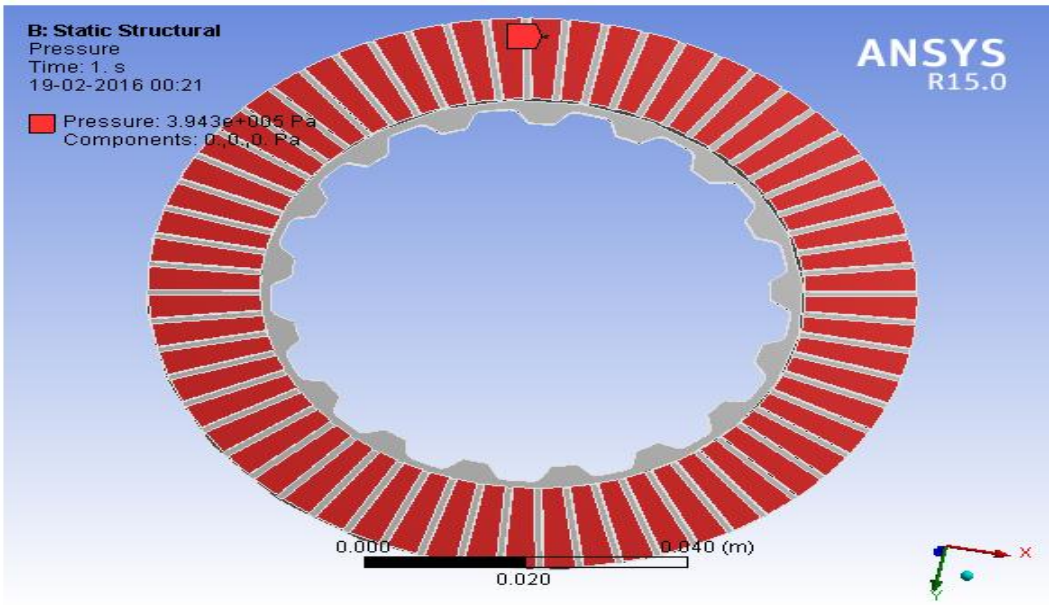


Figure 5Pressure load applied on the Gray cast iron friction lining

Kevlar friction lining

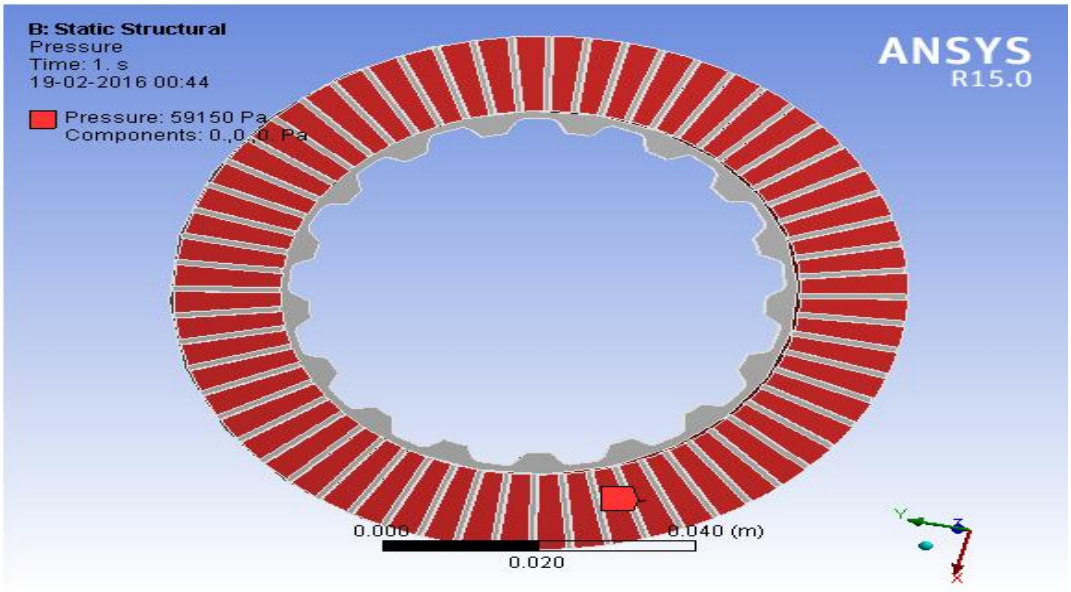


Figure 6Kevlar friction lining

4.5 EQUIVALENT STRESS & TOTAL DEFORMATION OF GRAY CAST IRON

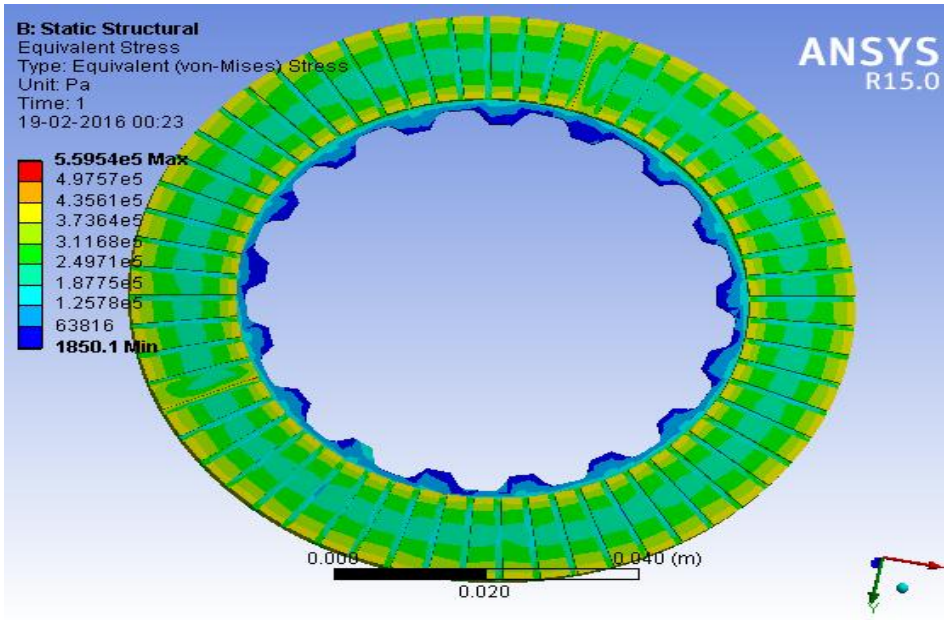


Figure 7Equivalent (von-mises) stress for gray cast iron

The figure 7shows the von mises stress for gray cast iron friction clutch plate, the maximum stress will occur across the edges of the friction plate.

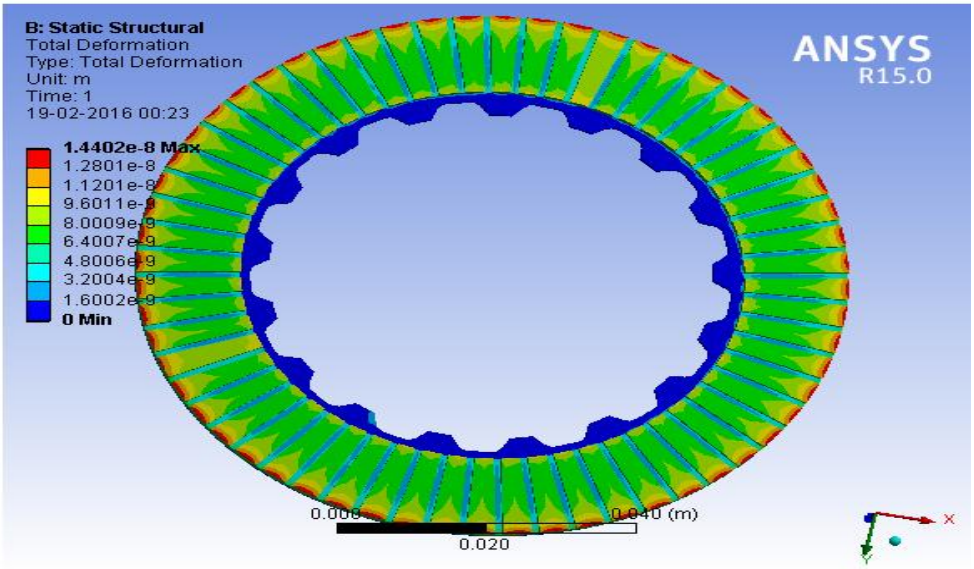


Figure8Total deformation

The total deformation for gray cast iron friction plate occurs at the edges and it is about 1.4402e-8m, which is as shown in the figure 8

4.6 EQUIVALENT STRESS & TOTAL DEFORMATION OF KEVLAR FRICTION MATERIAL

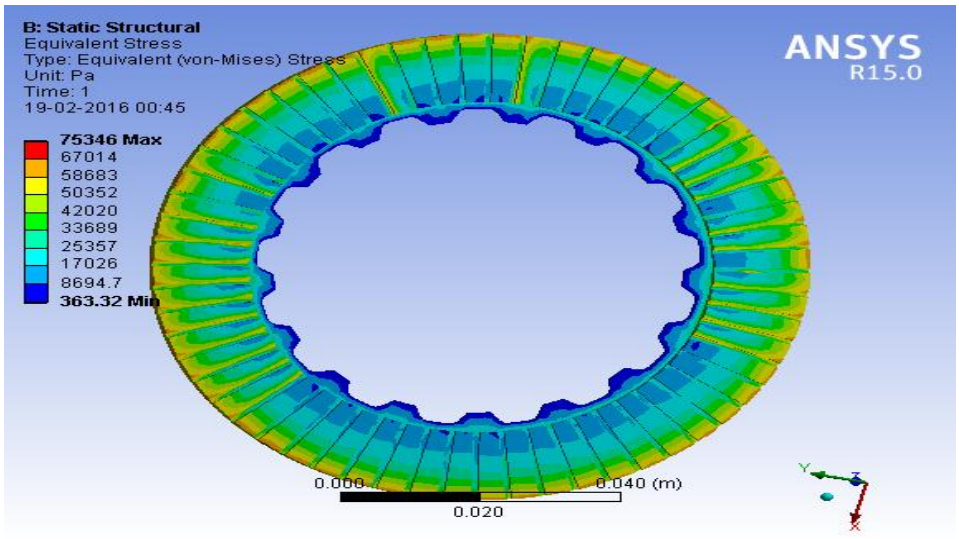


Figure 9Equivalent (von-mises) stress for Kevlar

The above figure shows the von mises stress for Kevlar49 friction clutch plate, the maximum stress will occur across the edges of the friction plate.

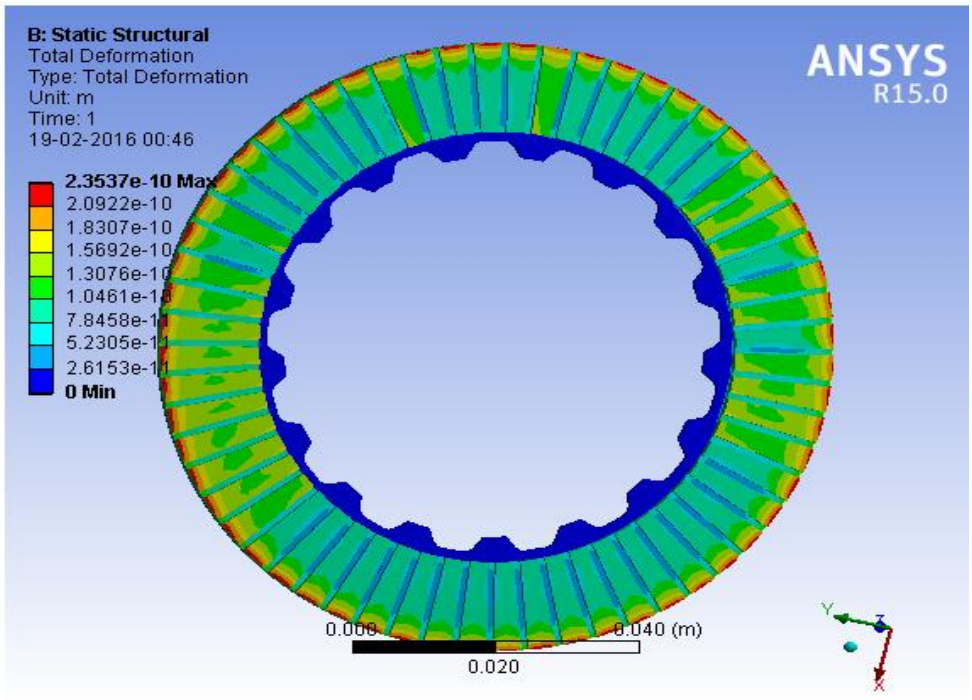


Figure10Total deformation

The total deformation for Kevlar49 friction plate occurs at the edges and it is about 2.3537e-10 m, which is as shown in the above figure 10.

Material	Von-misses Stress (Pas.)	Total Deformation (m)
Gray cast Iron	$5.5954e^{5}$	1.4402 e-8
Kevlar 49	75346	2.3537 -10

5. CONCLUSION AND SCOPE OF FUTURE WORK

In this thesis, a single friction plate clutch is modeled in 3D modeling software Unigraphics 9. Present used material for clutch is Gray cast iron. In this thesis static and thermal analysis is done to find the temperature variation and heat flux of the friction plate. Theoretical calculations are done to determine stress intensity factor, crack extension force, crack opening displacement. By observing the analysis results, the stress values are more for composite materials and when the crack is started the composite materials, stress values increases more than the condition of no crack so the composite materials fails faster once the crack propagates. And it is found that the temperature developed during the engagement and disengagement process is beyond the maximum temperature of the gray cast iron material, i.e. why there is crack and erosion of the friction material of the friction plate that the values of temperature increase linearly with disc radius and the maximum temperature, The highest temperature occurs approximately at half slipping time for all engagements. The outcomes obtained in this work show the effect of neglecting the variation of heat flux with radius in case of uniform pressure on the temperature distribution, maximum temperature.

5.2 FUTURE SCOPE OF WORK

By changing the friction lining material of 125cc ATV life of the clutch plate can be increased.

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