International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in; editorijoer@gmail.com

Vol.5., Issue.1., 2017
January-February

RESEARCH ARTICLE

ISSN: 2321-7758

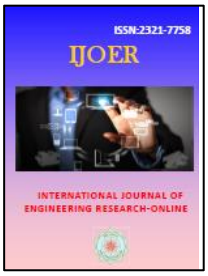
STRUCTURAL ANALYSIS OF FRICTION CLUTCH PLATE BY CHANGING FILLET RADIUS

SYAMBABU NUTALAPATI[1],Dr. D. AZAD[2],Dr. G. SWAMI NAIDU[3]

[1]Research Scholar, M.E (Machine Design), (Ph.D), Jntuk, India

[2]Professor, AitamTekali, Srikakulam District, India

[3]Professor and Vice-Principal (Administration), Department of Metallurgical Engineering, JNTUK-UCEV, India.



ABSTRACT

The clutch is one of the main components in automobiles. The engine power transmitted to the system through the clutch. The failure of such a critical component during service can stall the whole application. The driven mainplate failed normally during its operation due to cyclic loading. This project explains the structural analysis of the clutch plate by changing fillet radius. This project finds the maximum stress in failure region during operation. It also suggests design modifications to improve the life time of the clutch plate.

Key Words: Friction clutch plate, Fillet radius, ANSYS 12.0, CATIA V5.

1. INTRODUCTION

A clutch is a mechanical device that engages and disengages the power, transmission, especially from driving shaft to drivenshaft.Clutches are used whenever the transmission of power or motion must be controlled either in amount or over time (e.g., electric screwdrivers limit how much torque is transmitted through use of a clutch; clutches control whether automobiles transmit engine power to the wheels).

In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts). In these devices, one shaft is typically attached to an engine or other power unit (the driving member) while the other shaft (the driven member) provides output power for work. While typically the motions involved are rotary, linear clutches are also possible.

In a torque-controlled drill, for instance, one shaft is driven by a motor and the other drives a drill chuck. The clutch connects the two shafts so they may be locked together and spin at the same speed (engaged), locked together but spinning at different speeds (slipping), or unlocked and spinning at different speeds (disengaged).

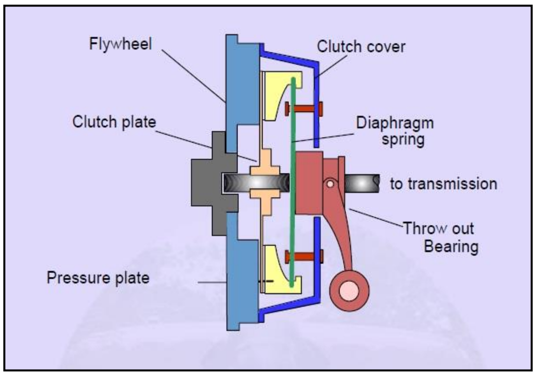


Figure 1: clutch plate with mountings.

1.1 Requirements of clutch

- Transmit maximum torque of the engine
- Engage gradually to avoid sudden jerks
- Dissipate maximum amount of heat
- Damp the vibrations and noise
- Dynamically balanced
- As small as possible
- Easy to operate

1.2 Clutch material

Table 1.1

<table>
<tr><th>Clutch components</th><th>Material</th></tr>
<tr><td>Cover plate</td><td rowspan="6">Mild steel</td></tr>
<tr><td>Damper spring retainer plate</td></tr>
<tr><td>Cushion spring</td></tr>
<tr><td>Clutch hub</td></tr>
<tr><td>Diaphragm spring</td></tr>
<tr><td>Retainer spring</td></tr>
<tr><td>Damper spring</td><td rowspan="2">Spring steel</td></tr>
<tr><td>Coil spring</td></tr>
<tr><td>Pressure plate</td><td>Cast iron</td></tr>
<tr><td>Bolts to fasten flywheel and cover plate</td><td>Steel</td></tr>
<tr><td>Clutch plate</td><td>Structural Steel</td></tr>
<tr><td>Rivets on cushion spring</td><td>Brass</td></tr>
<tr><td>Friction facing</td><td>Asbestos base</td></tr>
<tr><td>Rivets on facing</td><td>Aluminum brass</td></tr>
</table>

1.3 Clutch plate material properties

Table: 1.2

Properties	Sintered-iron	Gray Cast Iron	Structural Steel
Young's modules	275.79Mpa	120Gpa	200Gpa
Shear modules	53Gpa	44-45Gpa	76.9Gpa
Density	6200kg/m3	7200kg/m3	7850kg/m3
Passion ratio	0.34	0.29	0.3

2. THEORETICAL ANALYSIS ON DRIVEN PLATE

2.1 Design of a Disc or Plate Clutch

When the pressure is uniformly distributed over the entire area of the friction face then the intensity of pressure,

$P = (W)/ \Pi [r_1^2 - r_2^2]$

P=intensity of pressure,

(From the table or data book given for various materialsi.e. 0.25 -0.4 Mpa for cast iron or steel)

P = Taking average 0.32 Mpa

W=Axial thrust

R_1= Outer Radius (55mm)

R_2= Inner Radius (16mm)

Therefore W = 2.7 kN

2.2 Max Pressure

Since the intensity of pressure is max at the inner radius (r_2) therefore

P max, (r_2)= C (Constant)

C= 16 P max

We also know that total force on the constant surface (W)

$2.7\ KN = 2\ \Pi C\ [r_1^2 - r_2^2]$

Note: {[P=C/r] Let P be the Normal Intensity Of pressure at a distance "r"from the AXIS OF THE CLUTCH. Since the intensity of pressure varies inversely with the distance, thereforethat is the reason why intensity of pressure is Maximum at inner radius (r2) which causes propagation of crack.}

$2.7\ KN = 2\ \Pi(16\ P\ max)\ [55^2 - 16^2]$

$P\ max = 0.68 N/mm^2$

2.3 Min Pressure

Since the intensity of pressure is min at the outer radius (r_1), therefore

Pmin (r_1)= C (Constant)

C= 55 P min

$2.7\ KN = 2\ \Pi(55\ P\ min)\ [55^2 - 16^2]$

$P\ min = 0.2\ N/mm^2$

2.4 Average Pressure

Pavg = Total Normal Force/ Area

$Pavg = W/ \Pi\ [r_1^2 - r_2^2]$

$Pavg = 0.31\ N/mm^2$

3. DESIGN OF CLUTCH PLATE IN CATIA V5 SOFTWARE

3.1 Model of Clutch Plate

Open CATIA V5 software, select X-Y plane and draw the 2D diagram of the clutch plate

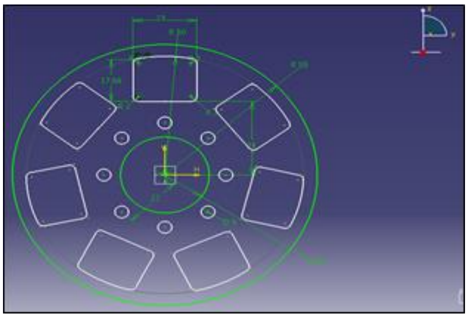


Figure 3.1 Dimensions of Clutch plate

Dimensions of the clutch plate

Outer diameter: 110mm

Inter Diameter: 32mm

Hole Diameter: 5mm
No of Holes: 6
Clutch plate thickness: 3mm
Rectangle dimensions: 23mm×17.66mm×3mm
Fillet radius:0mm, 1.5mm, 2mm, 2.5mm, 3mm
Clutch plate material: Structural steel

3.2 DESIGN OF CLUTCH PLATE

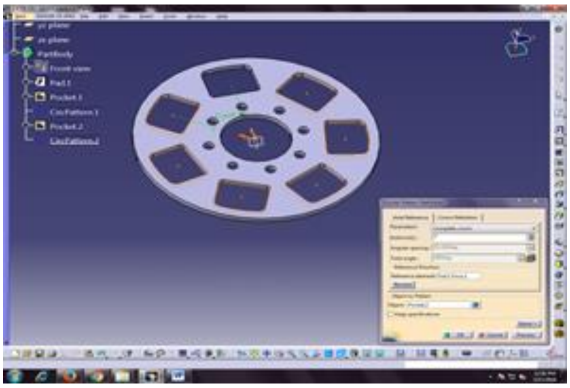


Figure 3.2 Solid Model of Clutch Plate

4. CLUTCH PLATE ANALYSIS USING ANSYS WORKBENCH

To analyzing this product the ansys work bench is required. So after design completed, the model is imported into the ansys work bench

The Material For Clutch (Structural Steel)

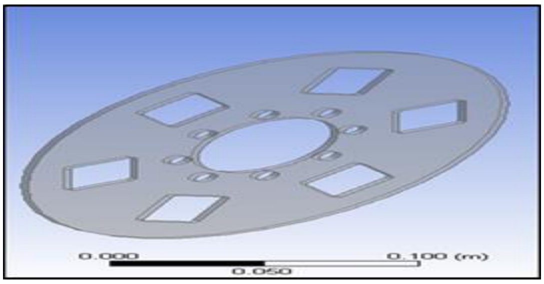


Figure 4.1: After importing

After importing the model into ansys work bent, meshing is required

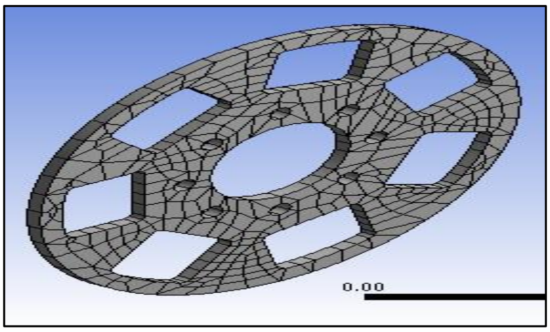


Figure 4.2 After meshing

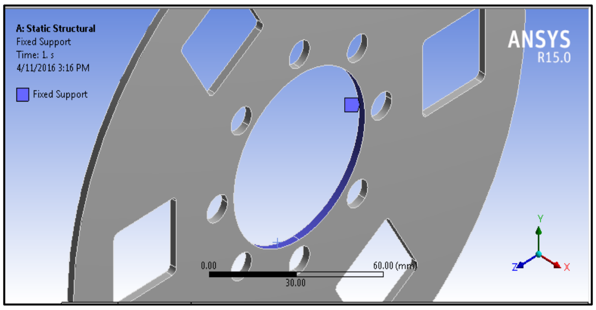


Figure 4.3Fixed Support

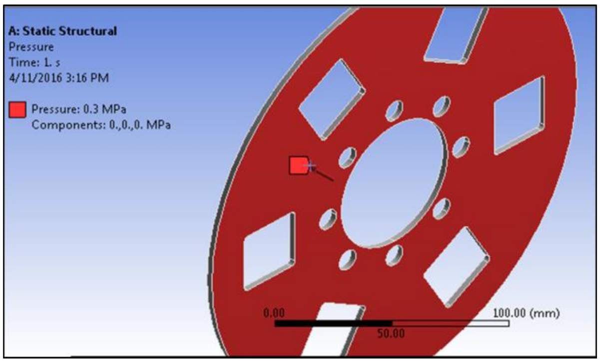


Figure 4.4: Pressure force

4.1 Without Fillet:

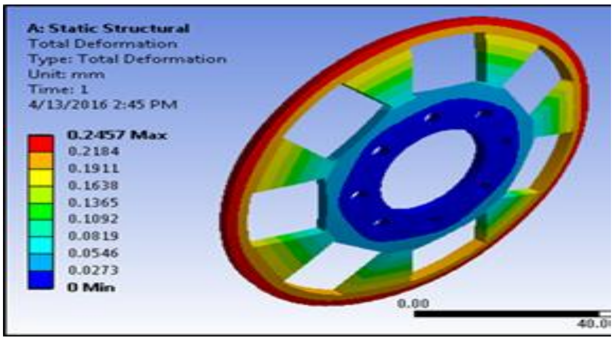


Figure4.5:Total Deformation

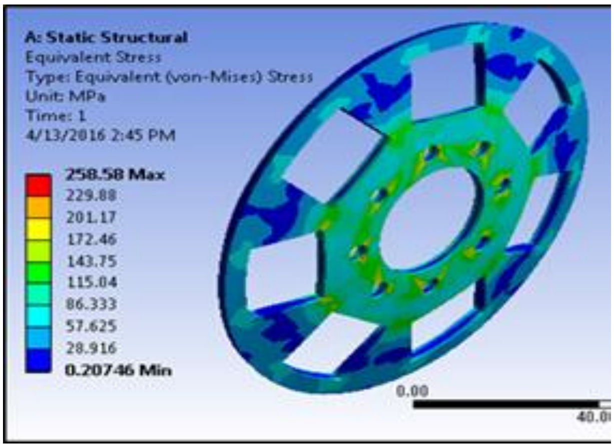


Figure 4.6: Equivalent Stress

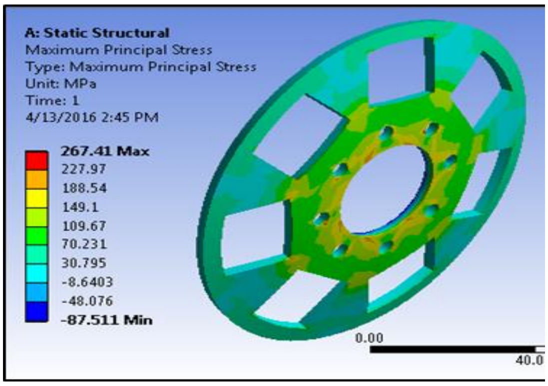


Figure4.7: Maximum Principal Stress

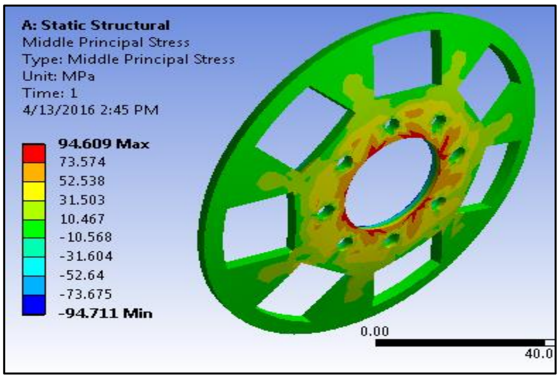


Figure4.8: Middle Principal Stress

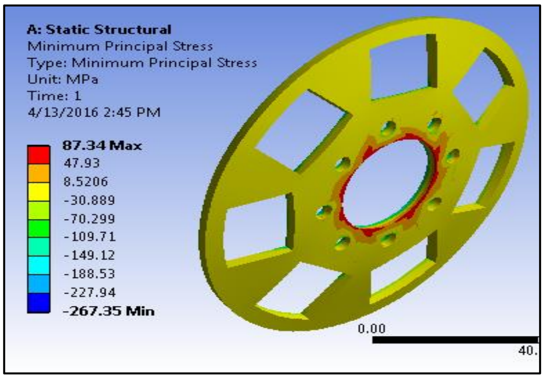


Figure 4.9: Minimum Principal Stress

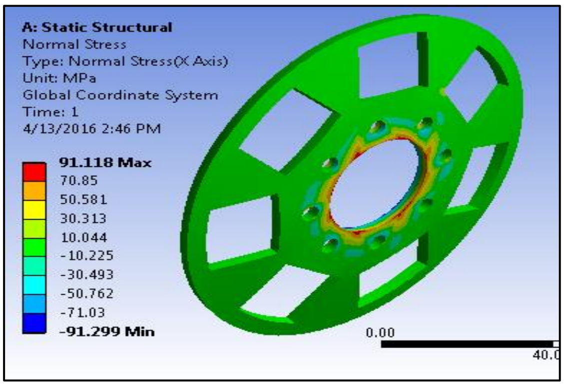


Figure4.10: Normal Stress

4.2 With 1.5mm Fillet

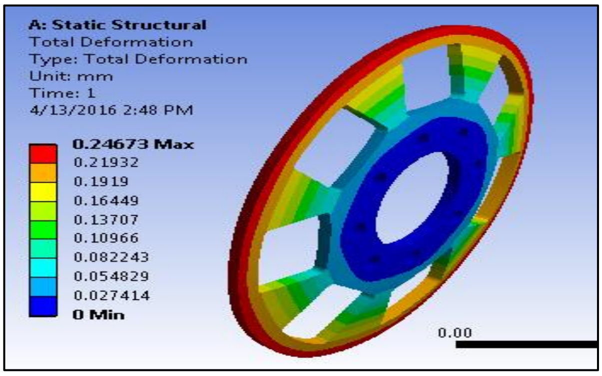


Figure 4.11: Total Deformation

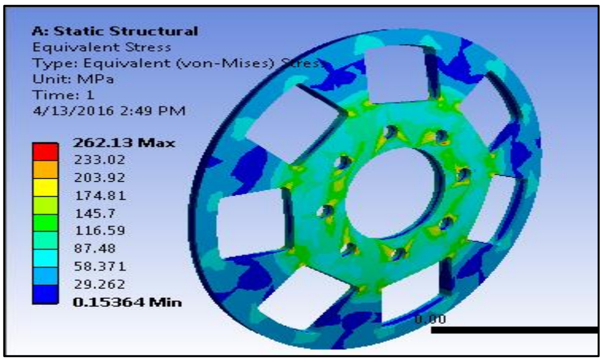


Figure 4.12: Equivalent Stress

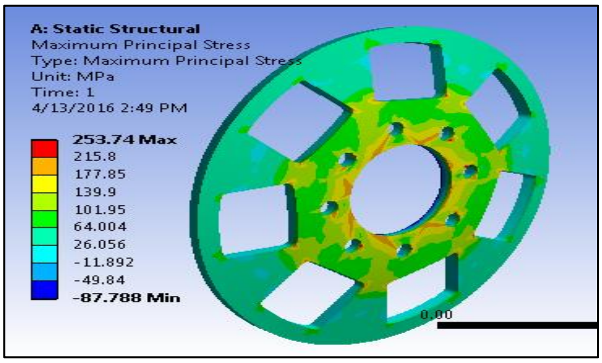


Figure4.13: Maximum Principal Stress

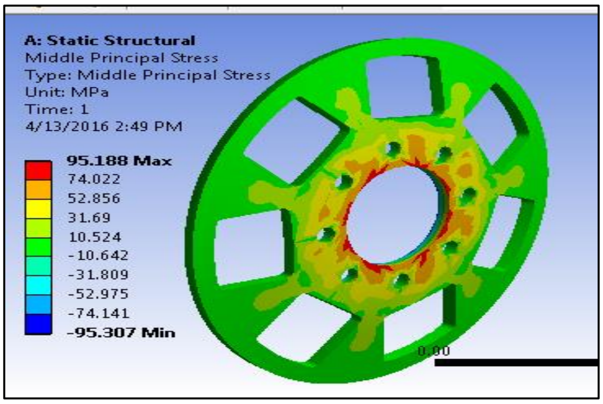


Figure4.14: Middle Principal Stress

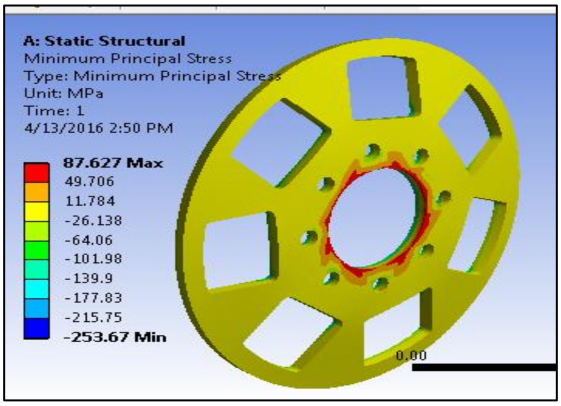


Figure 4.15: Minimum Principal Stress

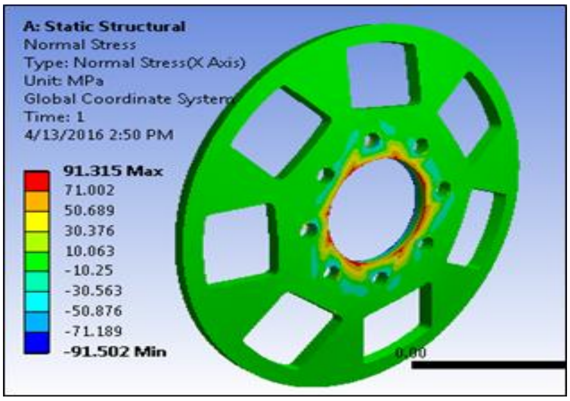


Figure 4.16: Normal Stress

4.3 with 2mm fillet

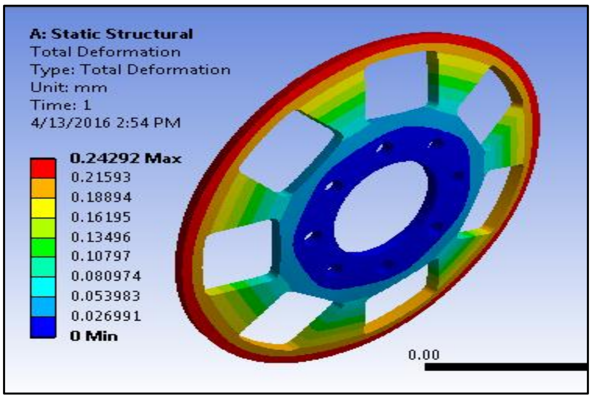


Figure 4.17: Total Deformation

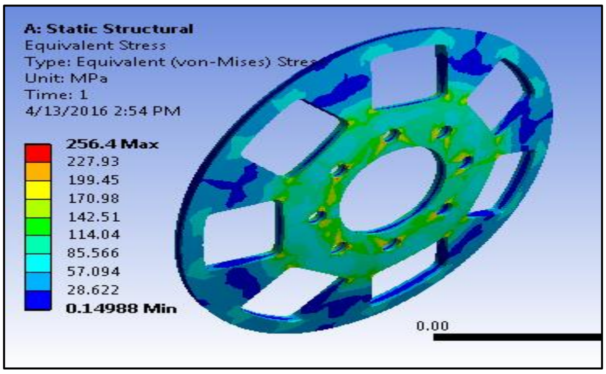


Figure 4.18: Equivalent Stress

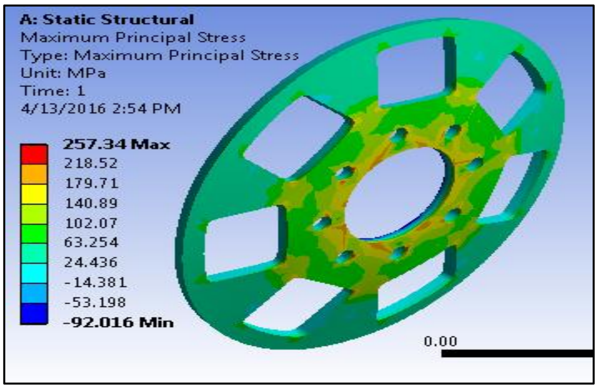


Figure4.19: Maximum Principal Stress

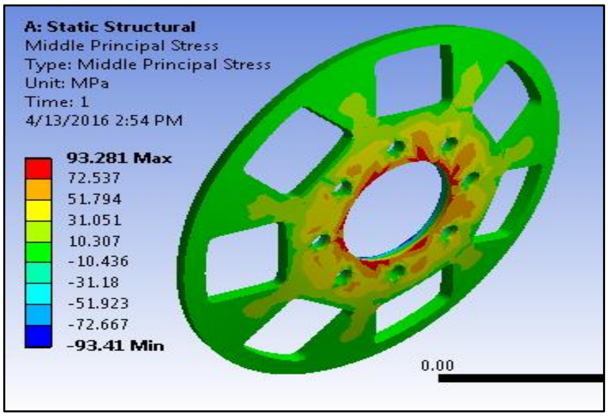


Figure 4.20: Middle Principal Stress

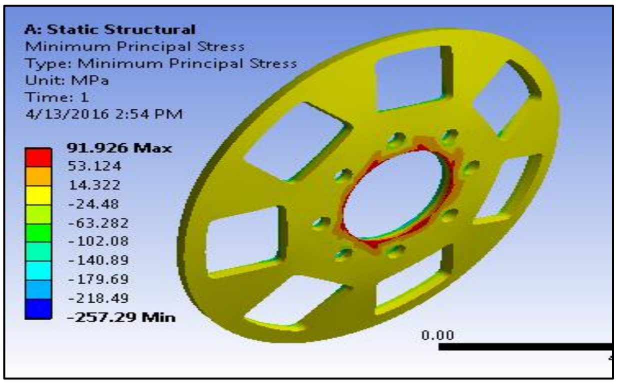


Figure4.21: Minimum Principal Stress

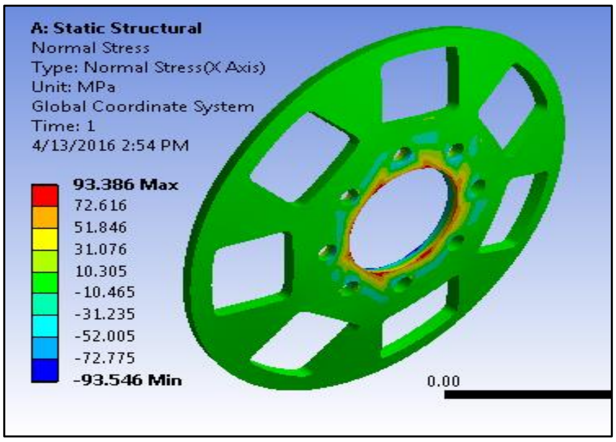


Figure4.22: Normal Stress

4.4 With 2.5mm fillet

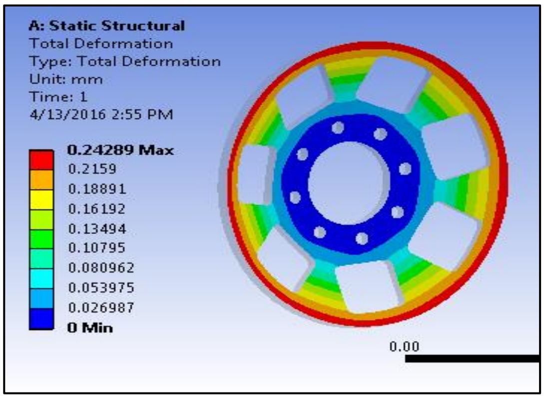


Figure4.23: Total Deformation

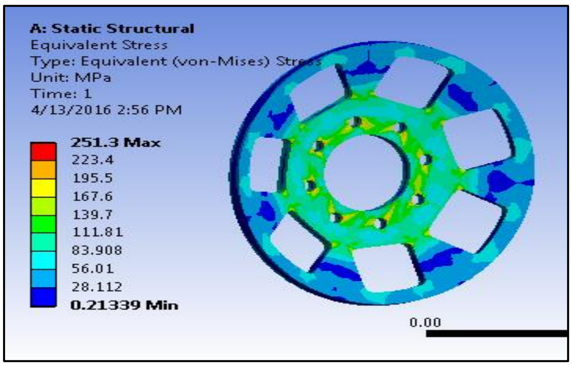


Figure4.24: Equivalent Stress

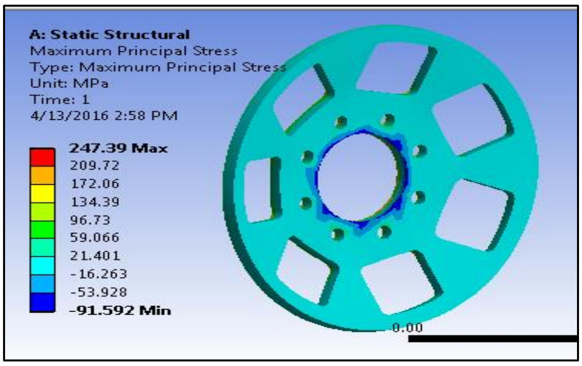


Figure4.25: Maximum Principal Stress

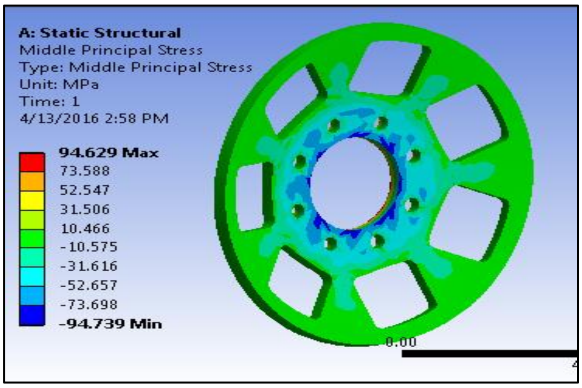


Figure4.26: Middle Principal Stress

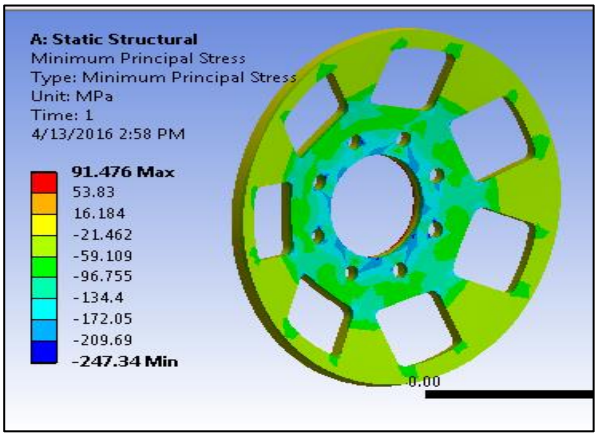


Figure4.27: Minimum Principal Stress

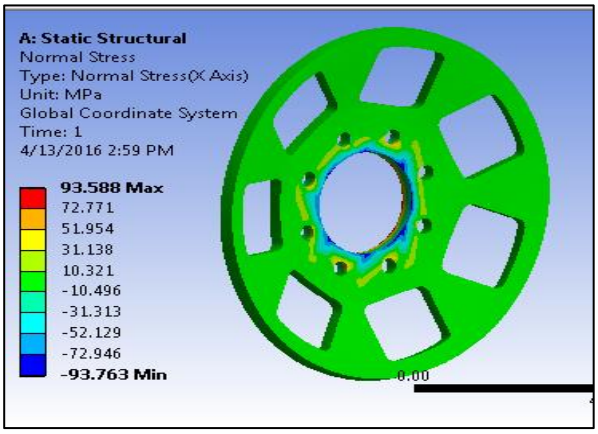


Figure4.28: Normal Stress

4.5 with 3mm fillet

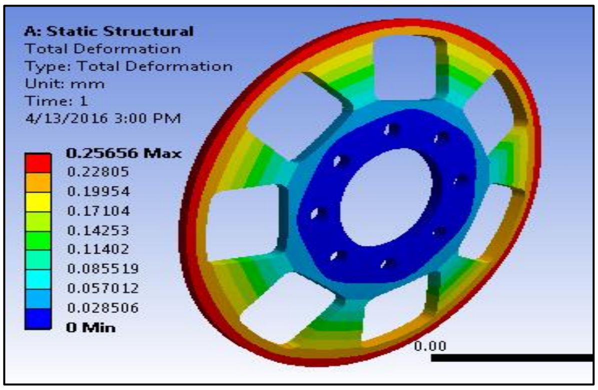


Figure 4.29: Total Deformation

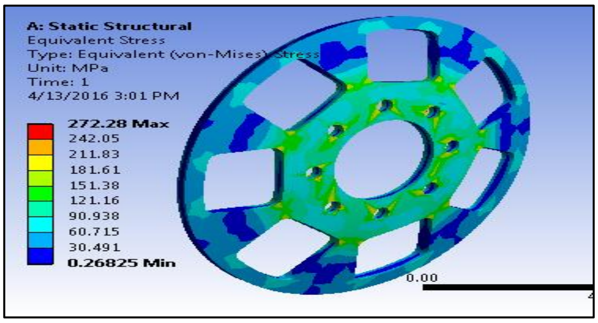


Figure 4.30: Equivalent Stress

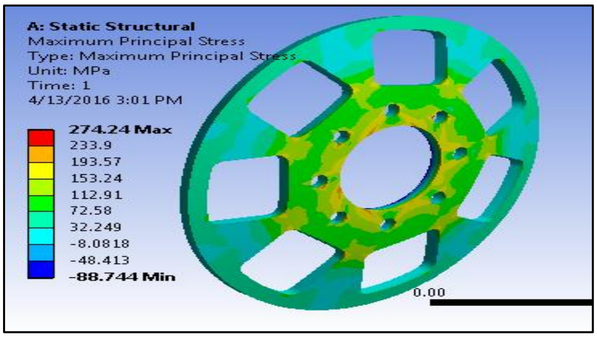


Figure 4.31: Maximum Principal Stresses

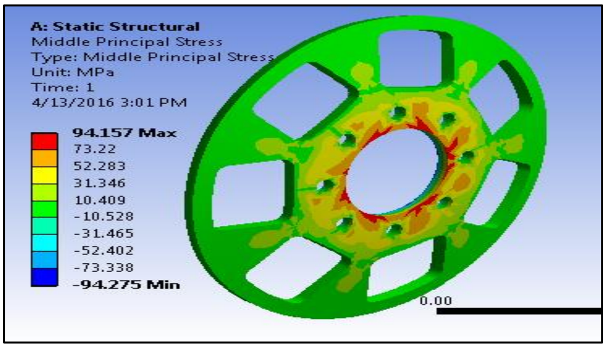


Figure4.32: Middle Principal Stress

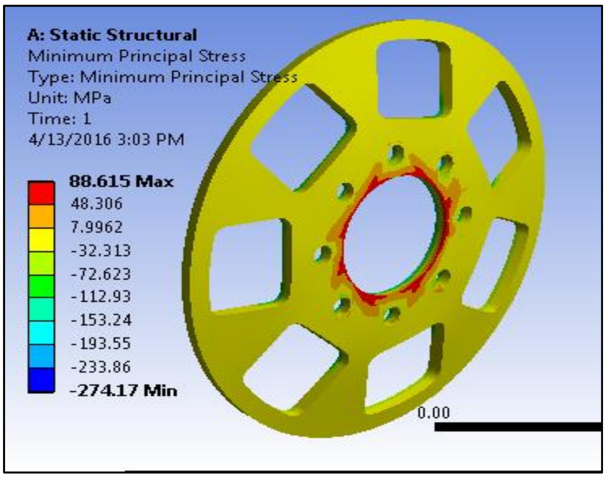


Figure 4.33: Minimum Principal Stress

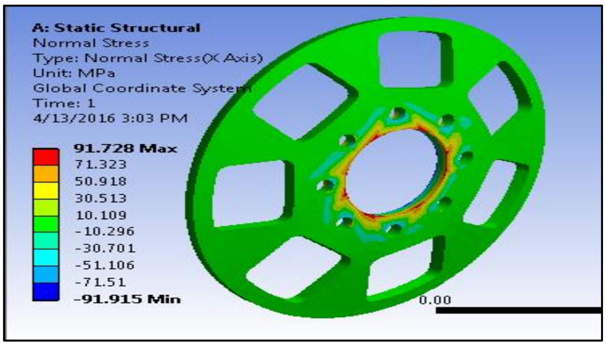


Figure 4.34: Normal Stress

5. Results

- We done the Static structural analysis on driven plate of clutch of structural steel material with different fillet radius on Ansys work bench
- After done the analysis on clutch plate the following results are occurred

Fillet Radius	Total deformation	Equivalent stress	Normal stress
Without	0.2457	258.58	91.11
1.5mm	0.24673	262.13	91.315
2mm	0.24292	256.4	93.386
2.5mm	0.24289	251.3	93.588
3mm	0.25656	272.28	91.728

Fillet Radius	Max. Principle stress	Middle principle stress	Min. Principal stress
Without	267.41	94.609	87.34
1.5mm	253.74	95.188	87.627
2mm	257.34	93.281	91.926
2.5mm	247.39	94.629	91.476
3mm	274.24	94.157	88.615

6. Conclusion

- By reference of above table the stress and the deformation are slow down at the fillet radius of 2.5mm.
- The stress and deformation are without fillet respectively is 258.58mpa, 0.2457mm.
- The stress and deformation are 2.5mm fillet respectively is 251.3mpa, 0.24289mm.
- By compare with all the data the 2.5mm fillet clutch plate is better than all the clutch plates' models because the stress development and total deformation is low.
- Finally the 2.5mm fillet radius of driven plate is suitable for design of clutch and life of the clutch is increases.

References

[1]. Mr.N.V.Narasimharao.L, Ch.Chandrarao —Static and Dynamic Analysis of Clutch Plate With Crack‖, IJRMET, Volume 4, Issue Spl - 1, Nov 2013

[2]. Dr. J. P. Modak, ShrikantV.Bhoyar, Dr. G. D. Mehta, —Dynamic Analysis Of Single Plate

Friction Clutch‖, IJERT, Vol. 2, Issue 7, July – 2013

[3]. Mr.Prashil M. Mhaiskar, Nitin D. Bhusale, Mayur D. Pastapure ―Vibration Analysis of Dry Friction Clutch Disc by Using Finite Element Method‖, IJERT, Volume 3, Issue 1, January – 2014

[4]. Mr.RajeshPurohit, PoojaKhitoliya and Dinesh Kumar Koli, ―Design and Finite Element Analysis of an Automotive Clutch Assembly‖, ScienceDirect, Procedia Materials Science 6, 2014

[5]. Mr.Monarch K. Warambhe, Gautam R. Jodh, Mamta G. Pawar, ―Design and Analysis of Clutch Using Sintered Iron as a Friction Material‖ ,IJITEE, Volume-3, Issue-7, December 2013

[6]. Mr. P.NagaKarna, TippaBhimasankaraRao, ―Analysis of Friction Clutch plate using FEA‖,IJERD, Volume 6, Issue 2, March 2013

[7]. B. Nivas, M. Nithiyanandam, S. Tharaknath, A. AvinashKumar, ―Design and Analysis of Clutch Plate Using Steel Material [En –Gjs-400 -15steel]‖, IOSR-JDMS, Volume 13, Issue 5, May. 2014

[8]. Automobile engineering by Dr. Kirpal Singh

[9]. Strength of materials by Dr. R.K. Bansal

[10]. Machine design by R.S. Khurmi& S. Chand publications

[11]. Finite element analysis by S.S. Bhavikatti