

Computational Modeling and FEA Analysis of Multi Plate Clutch for Improved Strength and fabricating by Rapid prototyping process

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Abstract— In this present paper, we design Wet clutch by Computational Modelling and 2-D drawings are designed for multiplate clutch from computational calculations. 3D model is created in the CATIA modeling software for duke bike. Structural Analysis is performed for multi plate clutch by finite element analysis (FEA) software package Ansys. Materials used for liner are Cork, Copper Powder metal, SF001 composite Material. Comparison will be performed between existing design and newly designed clutch profile to validate better design under the different load conditions while changing the design of gears (clutch plate) with low cost and reduction in stresses. Finally modified designed multi plate clutch prototype is to be manufactured by Rapid prototyping process. (Fused Deposition Modeling-FDM)

Keywords— Ansys, CATIA, Copper, Cork, SF00, SF-BU, Wet-Clutch plate, Vonmises stress, Vonmises strain, Total Deformation.

I. INTRODUCTION

It is an instrument for transmitting pivot, which can be locked in and withdrawn. Gears are valuable in gadgets that have two turning shafts. In these gadgets, one pole is commonly determined by an engine or pulley, and the other shaft drives another gadget. Gives us a chance to take an occurrence where one pole is driven by an engine and other drives a drill toss. The grip associates the two poles so that they can either be bolted together or twisted at the same rate (drew in), or be decoupled and turn at diverse paces

A. Friction Clutches:

The contact friction clutch is an imperative part of any car machine. It is a connection in the middle of motor and transmission framework which directs power, in type of torque, from motor to the apparatus gathering At the point when vehicle is begun from halt grasp is locked in to exchange torque to the transmission; and when vehicle is in movement grip is initially separated of the drive to consider rigging determination and afterwards again connected so as the vehicle is easily controlled.

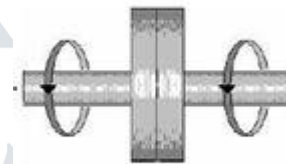


Fig.1. Engaged position of Wet-Clutch Plate

II. MATERIAL SELECTION FOR MULTI-PLATE CLUTCH

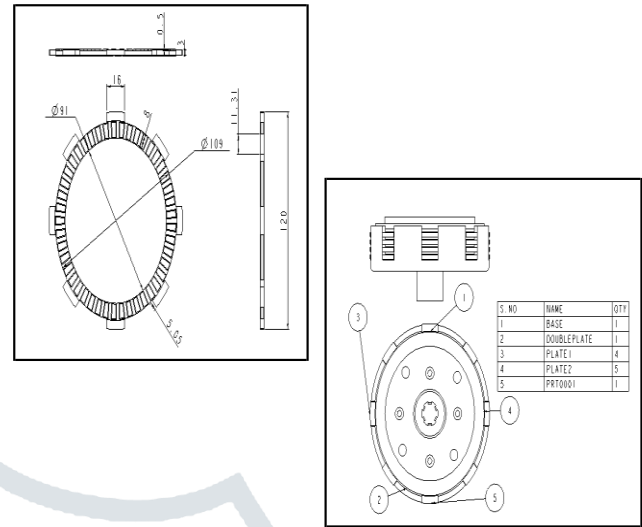
The materials utilized for the covering of grating surface of a grip called rubbing material grinding coating materials, Qualities of the grating covering are as taking as follows:

1. It should have a high and uniform coefficient of grating under working conditions
2. It should not be influenced by dampness and oil
3. It must be able to withstand high temperatures brought about because of slipping.
4. It should have high imperviousness to wear impacts, for example, scoring, irking and removal.
5. It should have less push and strains.
6. It should withstand load with less aggregate displacement.
7. It has to support erosion properties amidst whole living up to expectations life.

TABLE I Material Properties

S.No	Properties	Young's Modulus (Mpa)	Poisson's Ratio	Density (kg/m ³)
1	Cork	32	0.25	180
2	Copper Powder Metal	135e ³	0.35	8300
3	Sf001	7000	0.49	1350

Fig.3. 2-D representation of Friction-Plate and Assembly of Clutch.



III. MODELING OF WET CLUTCH

CATIA is a software which is used for creation and modification of the objects. In CATIA, design and modeling features are available. Design means the process of creating a new object or modifying the existing one. Drafting means the representation of idea of the object. Modeling means conversion of 2D model to 3D.

This is mostly progressive geometric demonstration in three measurements. This regularly utilizes strong geometry shapes called picture to build the article. Another element of the CATIA framework is shading design capacity. By method of shading, it is conceivable to show more data on the representation screen. Hue pictures help to illuminate parts of a gathering or highlight measurements or host for different purposes.

By utilizing the basic capacities of the product as to the single information source standard, it gives a rich arrangement of apparatus in the assembling environment as tooling plan and recreated CNC machining and yield. Tooling choices spread forte instruments for embellishment; pass on throwing and dynamic tooling outline.

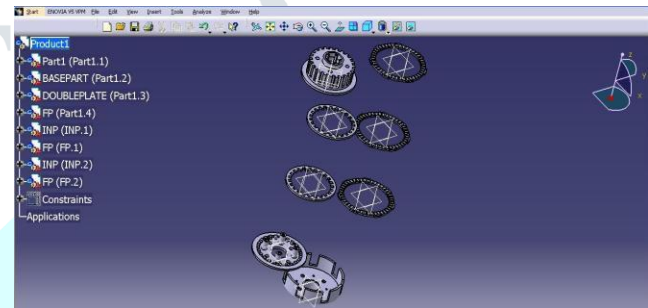


Fig.4. 3-D representation of Exploded View of Wet Multi-plate Clutch.

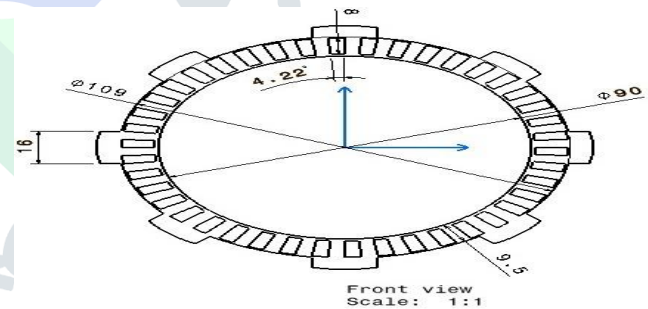


Fig.5. 2-D representation of straight profile Wet Multi-plate Clutch.

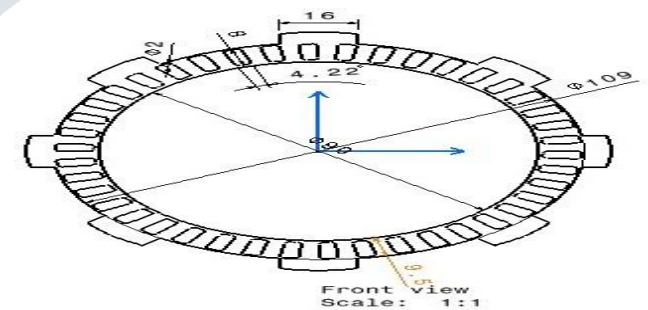


Fig.6. 2-D representation of Fillet profile Wet Multi-plate Clutch

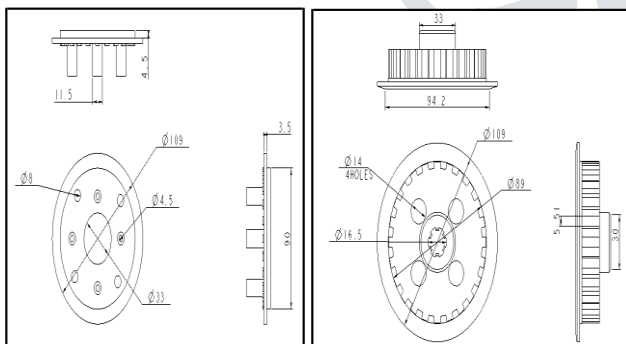


Fig.2 2-D representation of Base-Part and Double plate.

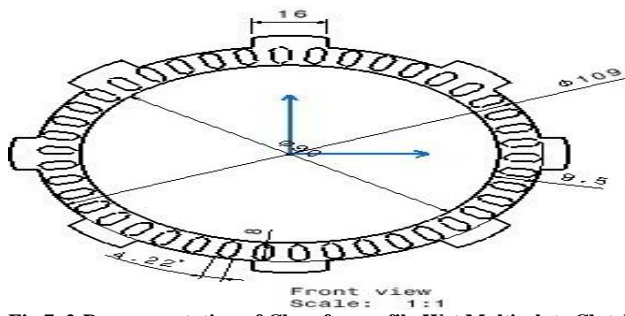


Fig.7. 2-D representation of Chamfer profile Wet Multi-plate Clutch

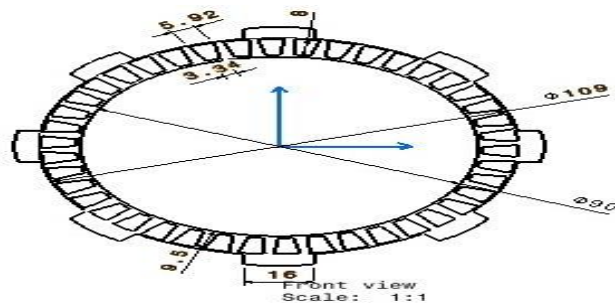


Fig.8. 2-D representation of Tapered profile Wet Multi-plate Clutch

IV. COMPUTATIONAL MODELLING

1. Power produced in Bike = 10000 rpm
2. Twisting Moment = 19.2 N-m @ 8000rpm
3. Co-efficient of friction in between the friction plates, $\mu = 0.3$
4. Operating temperature in between plates = 150 – 250°C
5. Maximum pressure applied = 0.4 N/mm²
6. r_1 and r_2 outer and inner radius of friction faces $r_1 = 109\text{mm}$ and $r_2 = 90\text{ mm}$
7. Average Uniform Pressure=0.0070735Mpa.

V. FINITE ELEMENT ANALYSIS

Finite Element Analysis was initially produced for utilization in the aviation and atomic commercial enterprises where the security of the structures is discriminating. Today, the development in use of the strategy is straightforwardly owing to the quick advances in PC innovation lately. Accordingly, business Finite Element bundles exist that are fit for tackling the most advanced issues, not simply in Structural Analysis. In any case, for an extensive variety of utilizations, for example, relentless state and transient temperature appropriations, liquid stream reproductions furthermore recreation of assembling procedures, for example, Injection Molding and Metal framing. The finite element method is a powerful tool to obtain the numerical solution of wide range of engineering.

A. Advantages of FEM

The properties of each element are evaluated separately, so an obvious advantage is that we can incorporate different material properties for each element. Thus almost any degree of non-homogeneity can be included. There is no restriction on the shape of medium; hence arbitrary and irregular shapes cause no difficulty. Like all numerical approximations, FEM is based on the concept of description. Nevertheless as either the variations or residual approach, the technology not only recognizes the multidimensional continuous, but also requires no separate interpolation process to extend the approximate solution to every point within the continuum.

B. Limitations of FEM

FEM reached high level of development as solution technology; however the method yields realistic results only if coefficient or material parameters that describe basic phenomenae are available.

The most tedious aspects of use of FEM are basic processes of sub-division of continuum for generating error free input data for computer.

C. Applications of FEM

Referring to temperature or heat flux distribution in the case of heat transfer problem.

D. Structural Analysis

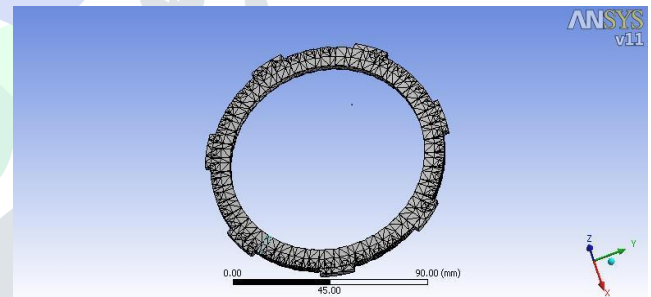


Fig.9. Meshing of Rectangle edge Clutch plate in ANSYS

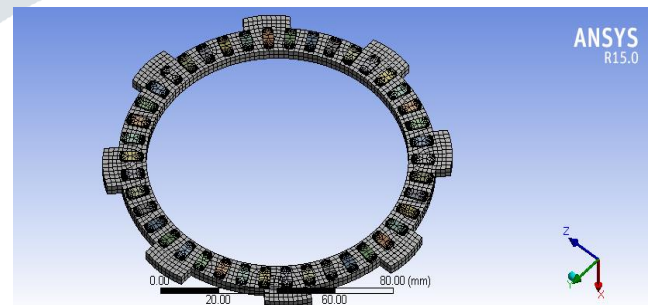


Fig.10. Meshing of Fillet edge Clutch plate in ANSYS

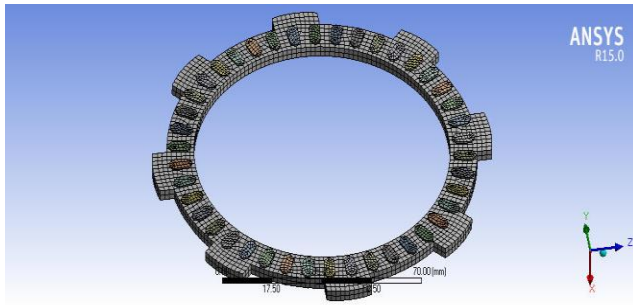


Fig.11.Meshing of Chamfer edge Clutch plate in ANSYS

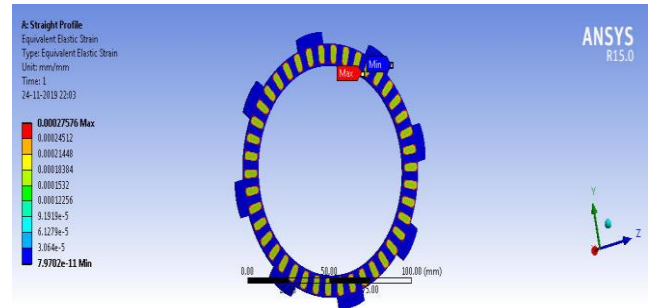


Fig.14.Vonmises Strain of Cork Rectangle Plate

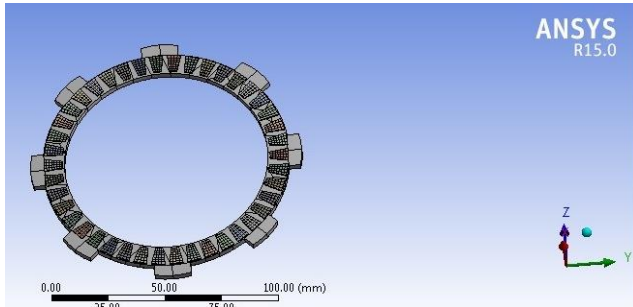


Fig.12.Meshing of Taper edge Clutch plate in ANSYS

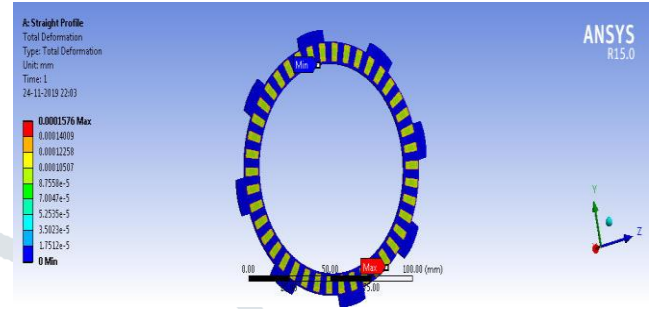


Fig.15. Total Deformation of Cork Rectangle Plate

TABLE II
NODES & ELEMENTS OF CLUTCH PLATES

S.No	Profile	Nodes	Elements
1	Rectangle	29627	4078
2	Fillet	92537	11868
3	Chamfer	38323	5286
4	Taper	20115	2189

This analysis is used to perform and find Structural parameters such as Stresses, Strains, Deformation, Bending Moment and Shear stress. Structural analysis is probably the most common application of the finite element method as it implies bridges and buildings, naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

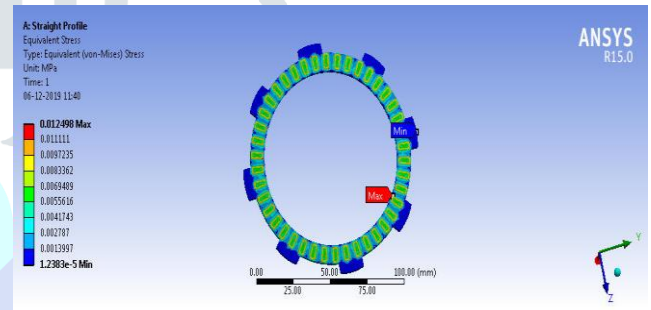


Fig.16. Vonmises Stress of Copper Rectangle Plate

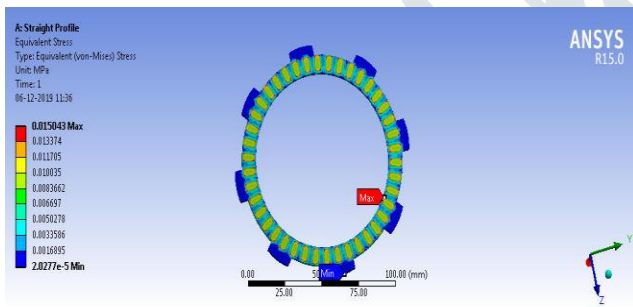


Fig.13.Vonmises Stress of Cork Rectangle Plate

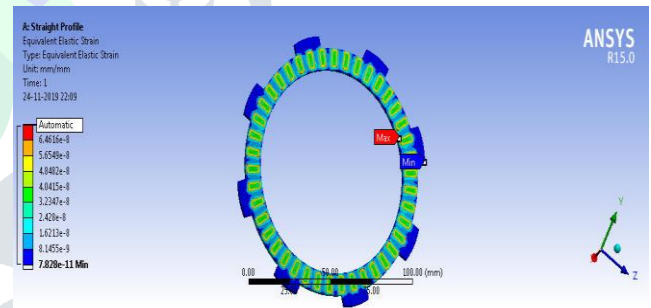


Fig.17. Vonmises Strain of Copper Rectangle Plate

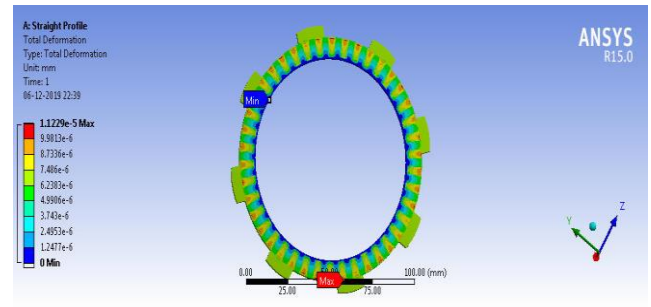


Fig.18. Total Deformation of Copper Rectangle Plate

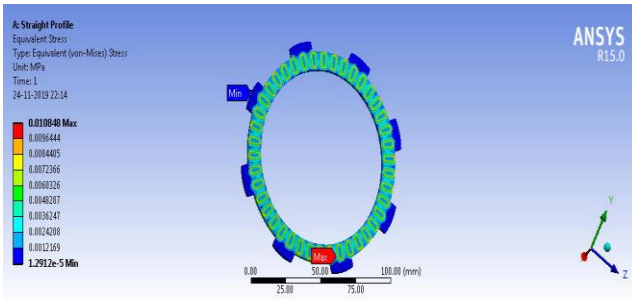


Fig.19. Vonmises Stress of SF001 Rectangle Plate

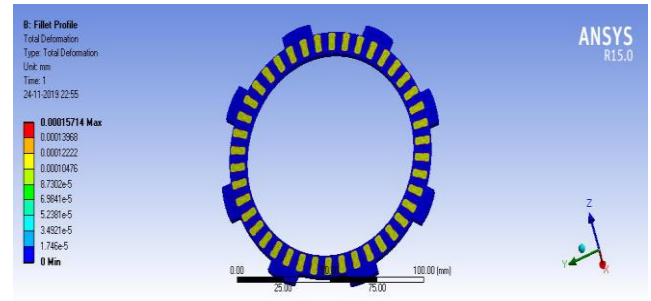


Fig.24. Total Deformation of Cork Fillet Plate

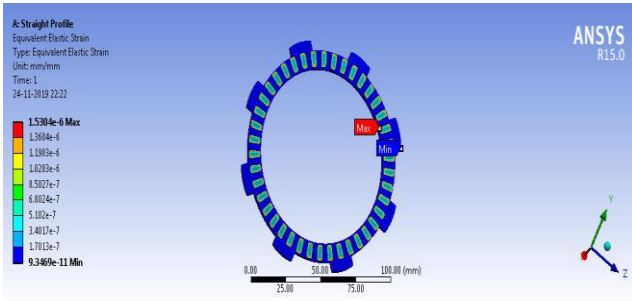


Fig.20. Vonmises Strain of SF001 Rectangle Plate

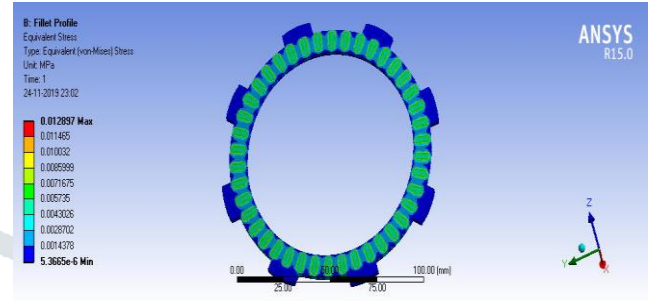


Fig.25. Vonmises Stress of Copper Fillet Plate

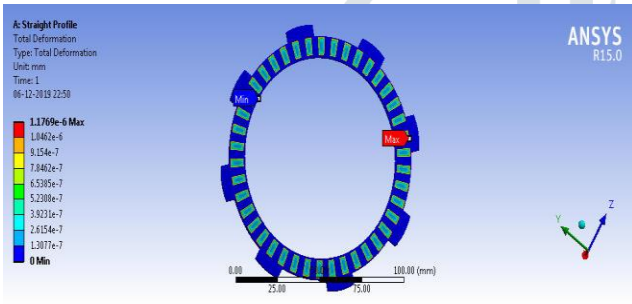


Fig.21. Total Deformation of SF001 Rectangle Plate

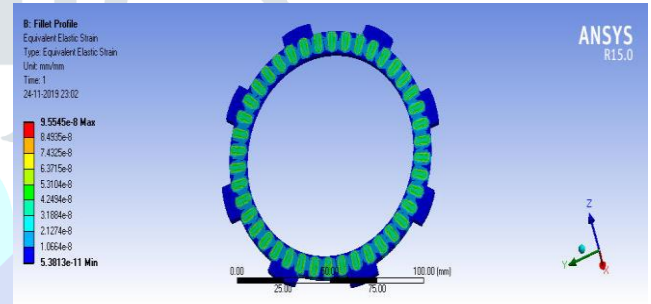


Fig.26. Vonmises Strain of Copper Fillet Plate

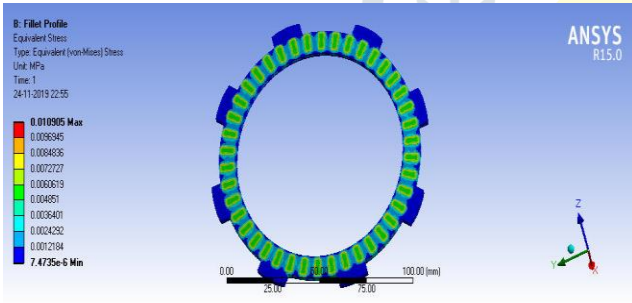


Fig.22. Vonmises Stress of Cork Fillet Plate

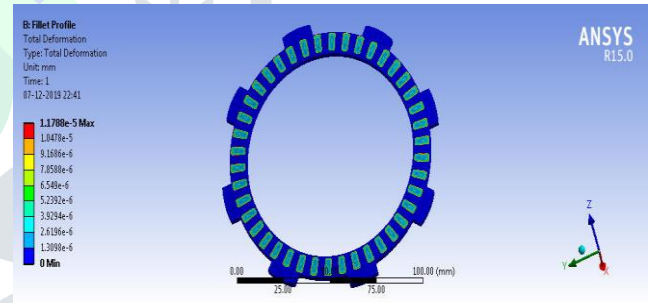


Fig.27. Total Deformation of Copper Fillet Plate

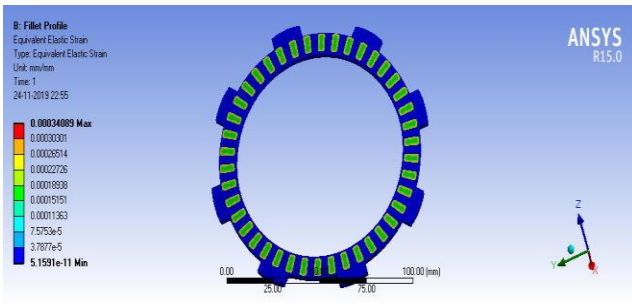


Fig.23. Vonmises Strain of Cork Fillet Plate

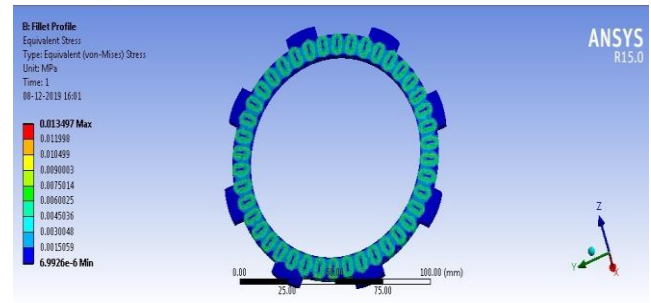


Fig.28. Vonmises stress of SF001 Fillet Plate

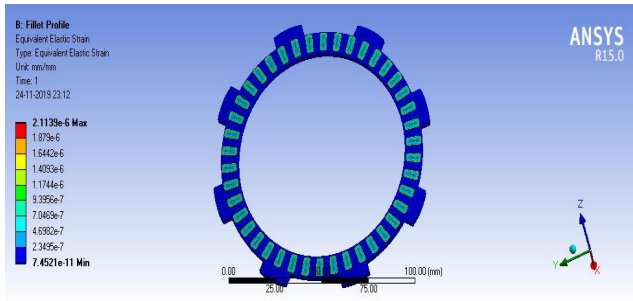


Fig.28. Vonmises strain of SF001 Fillet Plate

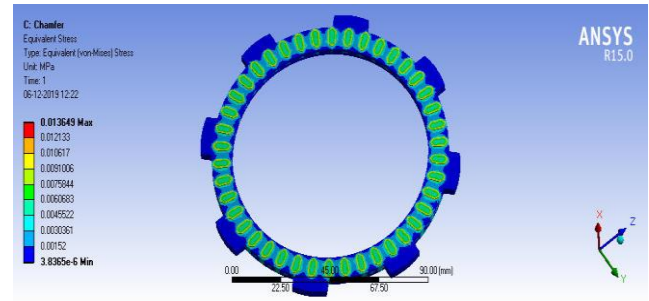


Fig.33. Vonmises Stress of Copper Chamfer Plate

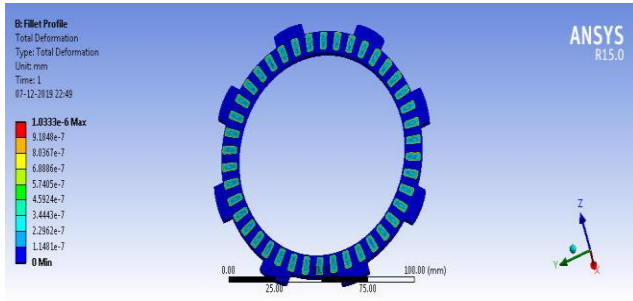


Fig.29. Total Deformation of SF001 Fillet Plate

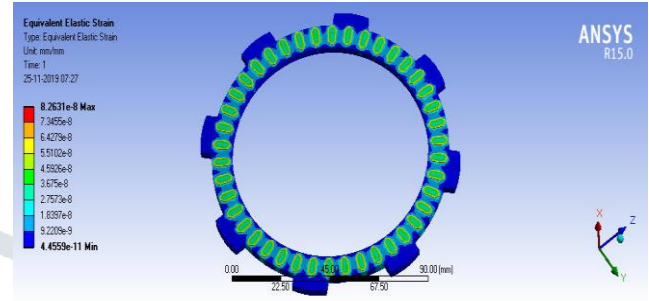


Fig.34. Vonmises Strain of Copper Chamfer Plate

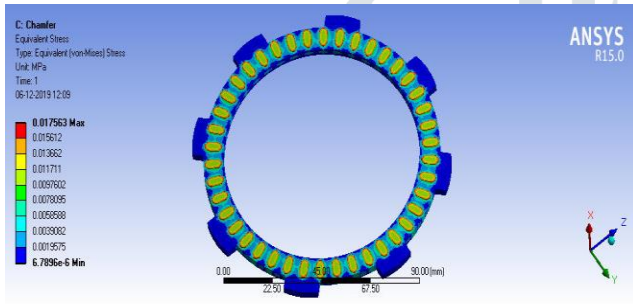


Fig.30. Vonmises Stress of Cork Chamfer Plate

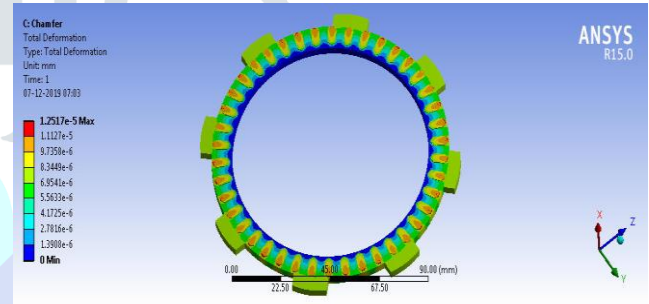


Fig.35. Total Deformation of Copper Chamfer Plate

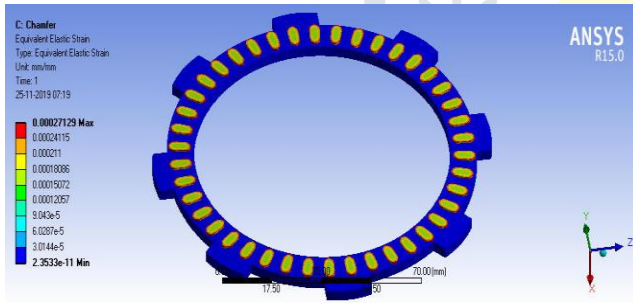


Fig.31. Vonmises Strain of Cork Chamfer Plate

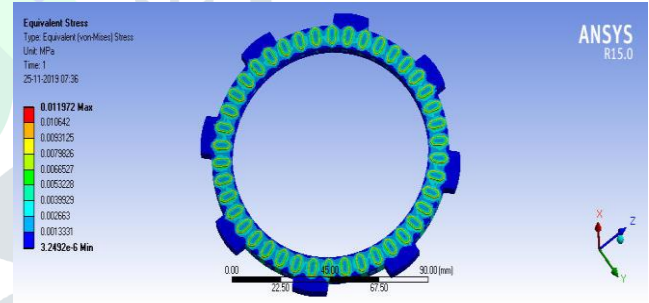


Fig.36. Vonmises Stress of SF001 Chamfer Plate

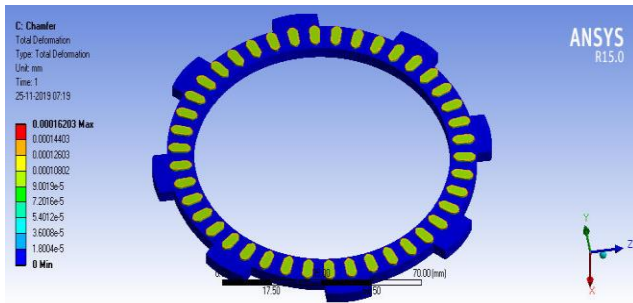


Fig.32. Total Deformation of Cork Chamfer Plate

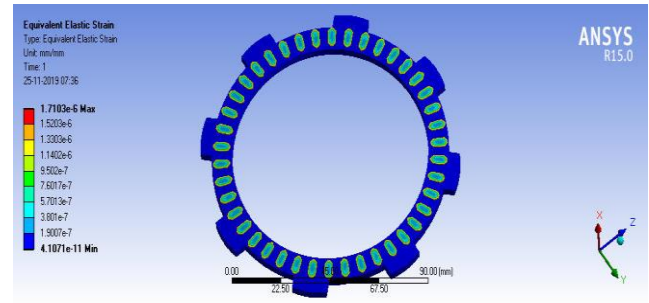


Fig.37. Vonmises Strain of SF001 Chamfer Plate

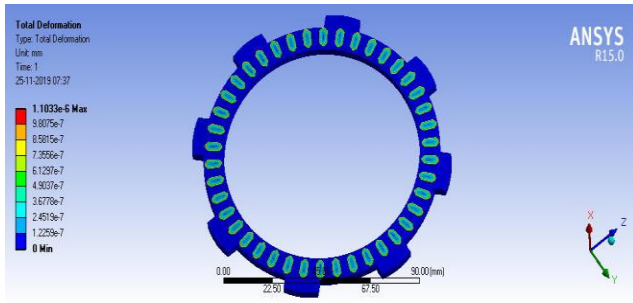


Fig.38. Total Deformation of SF001 Chamfer Plate

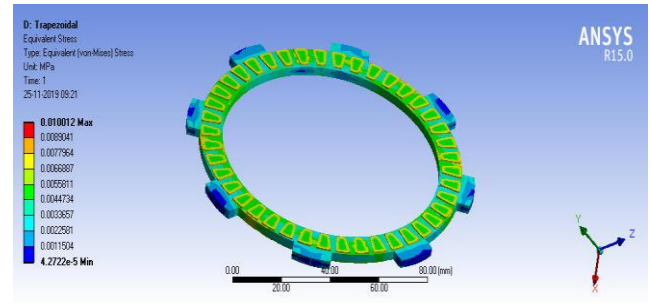


Fig.43. Vonmises Stress of Copper Taper Profile Plate

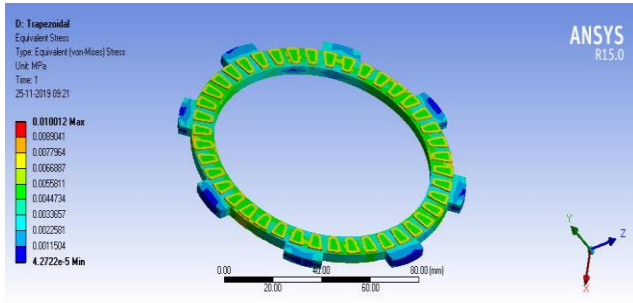


Fig.39. Total Deformation of SF001 Chamfer Plate

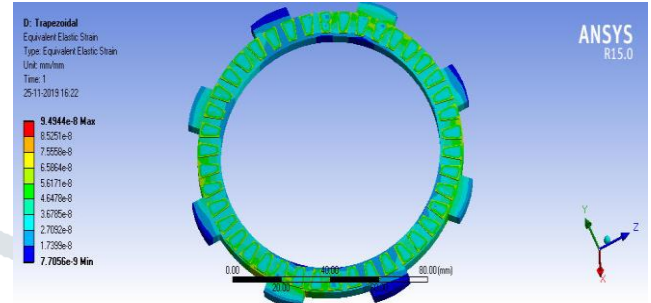


Fig.44. Vonmises Strain of Copper Taper Profile Plate

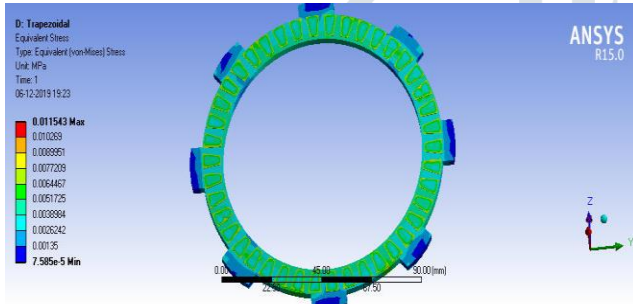


Fig.40. Vonmises Stress of Cork Taper Profile Plate

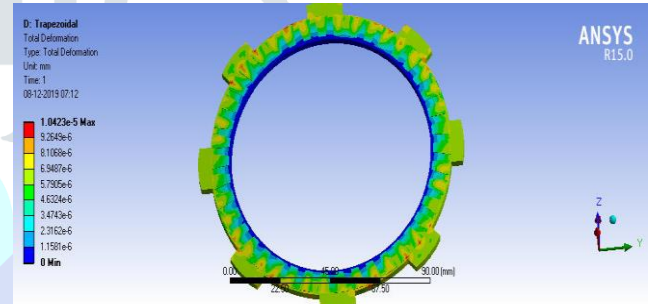


Fig.45. Total Deformation of Copper Taper Profile Plate

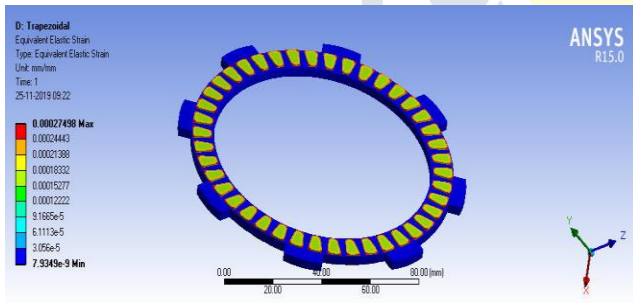


Fig.41. Vonmises Strain of Cork Taper Profile Plate

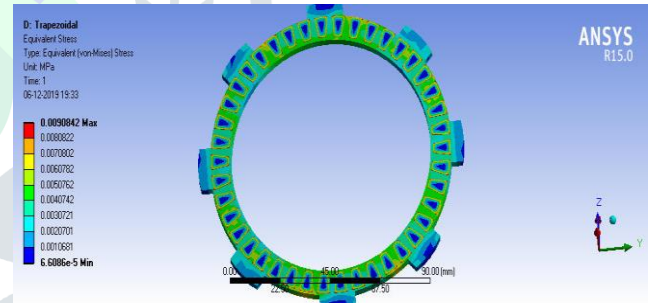


Fig.46. Vonmises stress of SF001 Taper Profile Plate

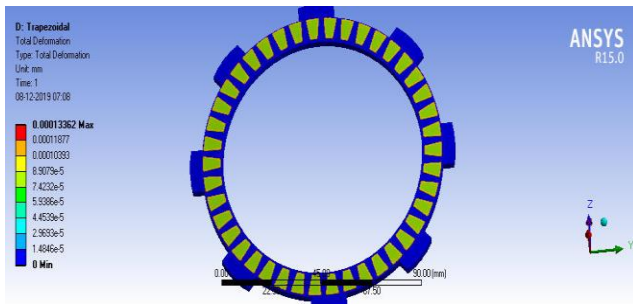


Fig.42. Total Deformation of Cork Taper Profile Plate

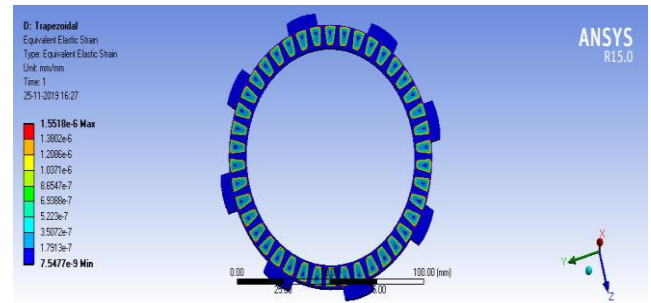


Fig.47. Vonmises strain of SF001 Taper Profile Plate

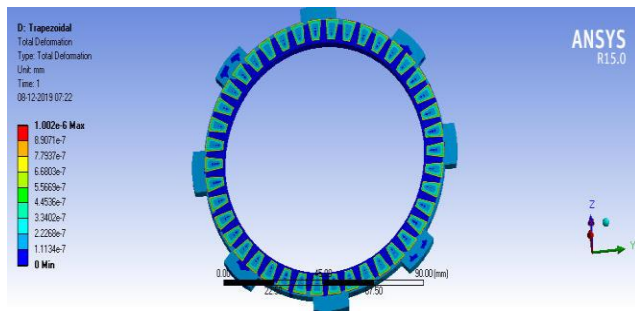


Fig.48. Total Deformation of SF001 Taper Profile Plate



Fig.49. Fusion Deposition Method Taper Profile Plate

TABLE III
VONMISES STRESS FROM STRUCTURAL ANALYSIS

S.NO	PROFILE	Vonnises Stress-Mpa		
		Cork	Copper	SF001
1	Rectangle	0.01504	0.01249	0.010848
2	Fillet	0.010905	0.012897	0.013497
3	Chamfer	0.017563	0.013649	0.011972
4	Taper	0.011543	0.010012	0.0090842

TABLE IV
VONMISES STRAIN FROM STRUCTURAL ANALYSIS

S.NO	PROFILE	Vonnises Strain		
		Cork	Copper	SF001
1	Rectangle	0.0002757	7.2684e-8	1.5304e-6
2	Fillet	0.00034089	9.5545e-8	2.1139e-6
3	Chamfer	0.00027129	8.2631e-8	1.7103e-6
4	Taper	0.00027498	9.4944e-8	1.5518e-6



SF001 material liners.

TABLE V
TOTAL DEFORMATION FROM STRUCTURAL ANALYSIS

S.NO	PROFILE	Total Deformation-mm		
		Cork	Copper	SF001
1	Rectangle	0.000157	1.229e-5	1.1769e-6
2	Fillet	0.0001571	1.1788e-5	1.033e-6
3	Chamfer	0.000162	1.2517e-5	1.1033e-6
4	Taper	0.00013362	1.0423e-5	1.002e-6

VII. CONCLUSION

Computational configuration, analytical investigation and Structural analysis are done on the friction plates to check the quality Friction materials, for Cork, Copper(powder metal) and SF001 Composite materials. By examining the experimental results, Taper profile got better values such as Vonnises stress and Total Deformation than Rectangle, Fillet and chamfer profiles and SF001 Vonnises stress 0.011543Mpa, Total Deformation 1.002e-6. Composite material got better results than Cork and Copper

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