International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

A Review on Single Plate Clutch

Shiv Pratap Singh Yadav, Sandeep G M
Assistant Professors
Nitte Meenakshi Institute of Technology
Bengaluru, India

Aditya Kedilaya, Arjun B Curam ,
C V Srihari Raghavan, Kalyan Chilakamarri
UG students
Nitte Meenakshi Institute of Technology
Bengaluru, India

***Abstract*— The purpose of this paper is to review the design and analyze the single plate clutch; this is achieved by using the commercially available modeling software CATIA V5. A program is coded in C language in order to accommodate the input parameters, and correspondingly get a resultant clutch design. Here, one of the problems which are commonly risen while designing clutches was addressed as a case study, and those parameters were taken into account while input to the program. The input data is also used to design the single plate clutch on CATIA-V5, of required material and required analysis was carried out.**

Keywords*— CATIA V5, Single Plate Clutch, C language, Analysis.

I. INTRODUCTION

The dynamism necessary for the motion of a vehicle is transmitted by the engine to the wheels through the flywheel, the clutch arrangement and the driveline. The clutch draws the energy from the flywheel and transmits it to the driveline.

During the engagement process, the frictional torque acts upon the resistance surfaces of the clutch as an engaging force for the driveline. It is disengaged by operating the clutch pedal, drawing the clutch towards the handle in case of a bike, or forcing it down towards the floor of a car.

In this review paper of a single plate clutch, the most commonly used clutch is designed and modeled using CATIA V5 modeling software, and a program was written on C that accepted values of power, speed, co-efficient of friction to name of a few, and gives an output for the required parameters.

The model on CATIA V5 gave an accurate design of what might the clutch plate look like, and what load it can withstand, based on the chosen material. The C program intended to work just like any calculator, except that a program was written with required formulae for one particular problem. This program would then provide answers for diameters, axial force, torque transmitted and number of discs. Accordingly, a material can be chosen on CATIA V5 to portray what the deformation may look like.

II. METHODOLOGY

A. Program Approach

The following are the steps involved in obtaining the output through a C Program

- Input the values of inner and outer diameters of the clutch plate.
- Input the values of co-efficient of friction, speed in rpm and permissible pressure
- Select the required theory of the two, namely, the Uniform Pressure Theory and Uniform Wear Theory to obtain the torque capacity
- By giving in the right formulae, we get values of Axial Force, Mean diameter, Power and Torque.

B. THEORETICAL APPROACH

Steps and Equations:

Step 1: Consider inner diameter of the friction plate as 160 mm and outer diameter as 300 mm.

Step 2: Consider speed as 1000 rpm, co-efficient of friction as 0.2 and allowable maximum pressure as 0.08Mpa.

Step 3: Consider Uniform Wear theory

a. Mean Diameter $D_m = \frac{D_1+D_2}{2}$ (1)

b. Axial Force $F_a = 0.5\times\pi\times p\times D_1\times(D_2-D_1)$ (2)

c. Torque $= 0.5\times u\times F_a\times D_m\times i$ (3)

d. Power $= \frac{T\times n}{(9550\times1000)}$ (4)

Step 4: Consider Uniform Pressure theory

a. Mean Diameter $D_m = \frac{2({D_2}^3-{D_1}^3)}{3({D_2}^2-{D_1}^2)}$ (5)

b. Axial Force $F_a = \frac{\pi\times p\times[{D_2}^2-{D_1}^2]}{4}$ (6)

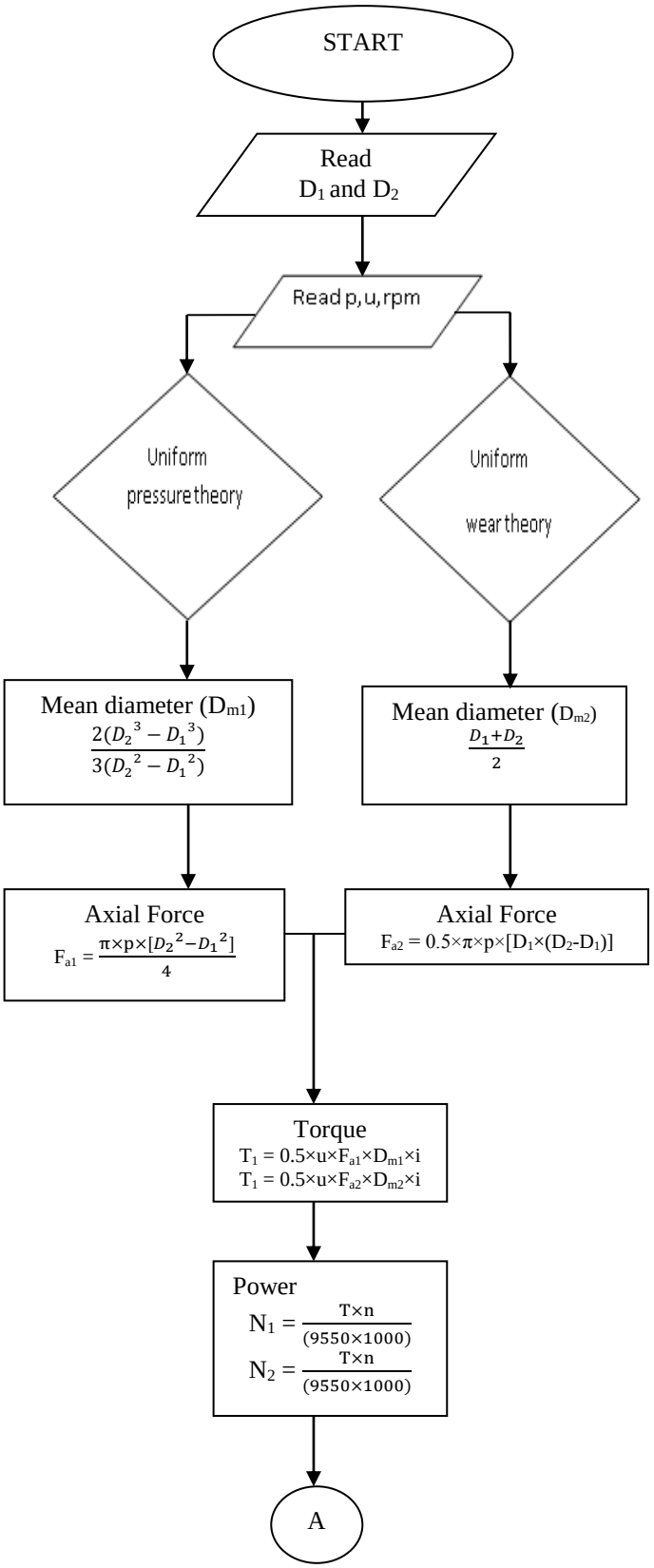
c. Torque $= 0.5\times u\times F_a\times D_m\times i$ (7)

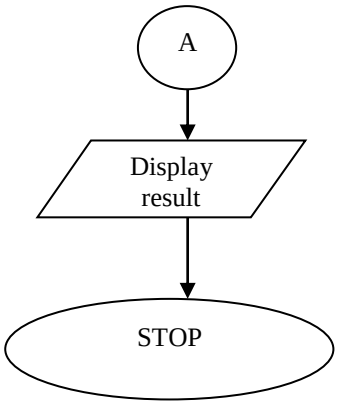
d. Power $= \frac{T\times n}{(9550\times1000)}$ (8)

D_m =Mean diameter
D_1=Inner diameter
D_2=Outer diameter
T=torque
F_a=Axial force

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

C. FLOWCHART





III. RESULTS

After having analyzed the clutch plate design on CATIA V5 and obtaining a result on both analytical and programming approaches, these were the summarized results.

A. Program Approach

Output obtained when D_1= 160 mm and D_2= 300 mm, u = 0.2, p = 0.08MPa

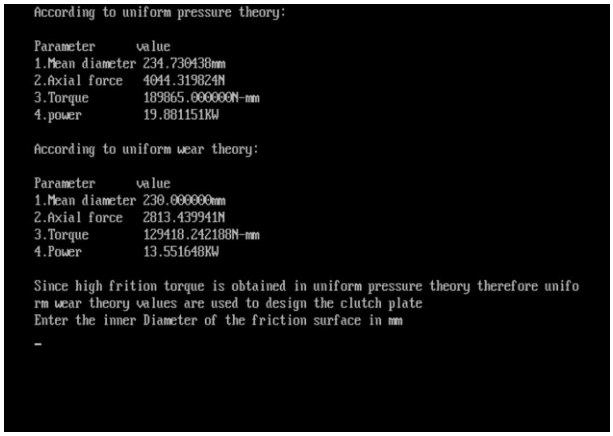


Fig 1: program output

B. Theoretical Approach

Single plate friction clutch of both sides effective has outer diameter 300mm, inner diameter 160mm and coefficient of friction 0.2 runs at 1000rpm find the power transmitted under uniform wear theory and uniform pressure theory and maximum allowable pressure is 0.08Mpa.

- Consider Uniform Wear theory

Step1: Mean Diameter $D_m = \frac{D1+D2}{2}$

$= \frac{300+160}{2}$

= 230 mm

Step2: Axial Force $F_a = 0.5\times\pi\times p\times [D_1(D_2-D_1)]$

$= 0.5\times3.14\times0.08\times [160(140)]$

= 2814.86 N

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

Step3: Torque = $0.5 \times u \times F_a \times D_m \times i$
$= 0.5 \times 0.2 \times 2814.46 \times 230 \times 2$
$= 129483.56$ N-mm

Step4: Power = $\frac{T \times n}{(9550 \times 1000)}$
$= 13.56$ kW

- Consider Uniform Pressure theory

Step1: Mean Diameter $D_m = \frac{2(D_2^3 - D_1^3)}{3(D_2^2 - D_1^2)}$
$= 237.10$ mm

Step2: Axial Force $F_a = \frac{\pi \times p \times [D_2^2 - D_1^2]}{4}$
$= 4046.37$ N

Step3:Torque$=0.5 \times u \times F_a \times D_m \times i$
$= 0.5 \times 0.2 \times 4046.37 \times 237.10 \times 2$
$= 191878.86$N-mm

Step4: Power = $\frac{T \times n}{(9550 \times 1000)}$
$= 20.09$ kW

C. Analytical Approach

After completing the design of the clutch plate in CATIA, the following analysis was carried out in order to view the deformation plot and view the Von-Mises stresses.

1. Material: Bronze, considering D_1=160 mm, D_2=300 mm, F_a = 2813.43 N

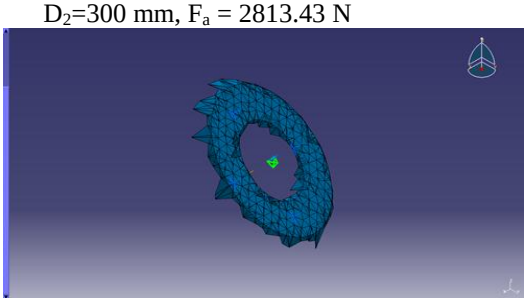


Fig 2. Deformation plot of bronze friction plate

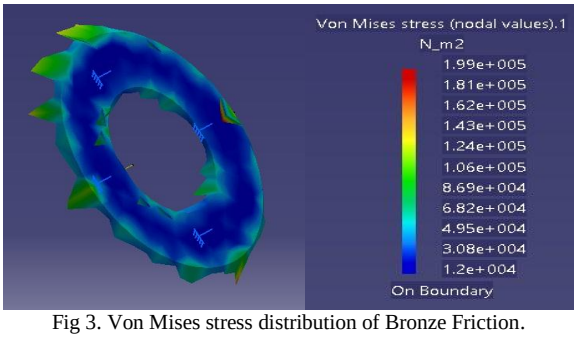


Fig 3. Von Mises stress distribution of Bronze Friction.

The maximum stress obtained on the boundary is 1.99e5 N/m^2.

2. Material: C-40 considering D_1=160 mm, D_2=300 mm, F_a= 2813.43 N

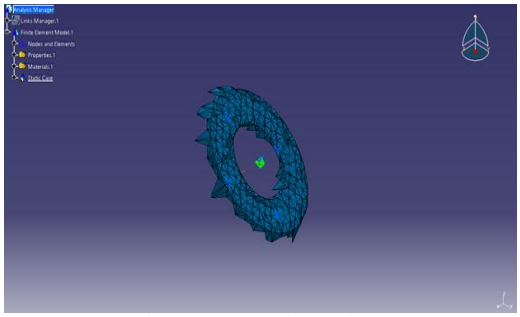


Fig 4. Deformation Plot of C-40 friction plate

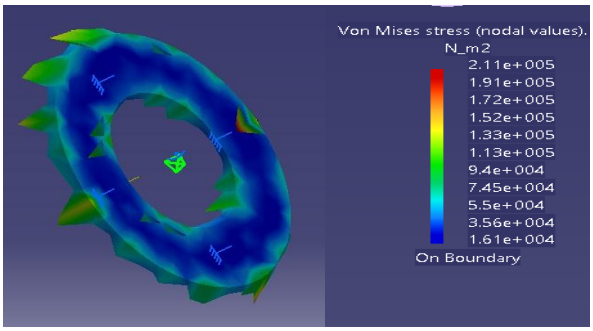


Fig 5. Von Mises stress distribution of C-40 Friction Plate

The maximum stress obtained on the boundary is 2.11e5 N/m^2.

3. Material: Cast Iron, considering D_1=160 mm, D_2=300 mm, F_a = 2813.43 N

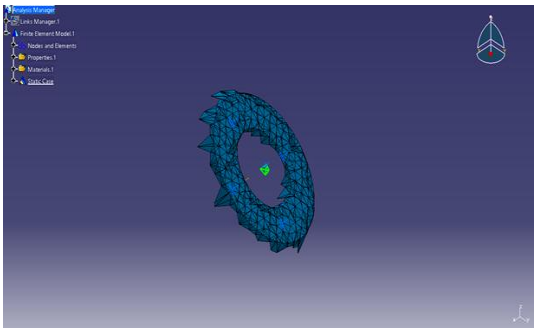


Fig 6. Deformation Plot of Cast Iron friction plate

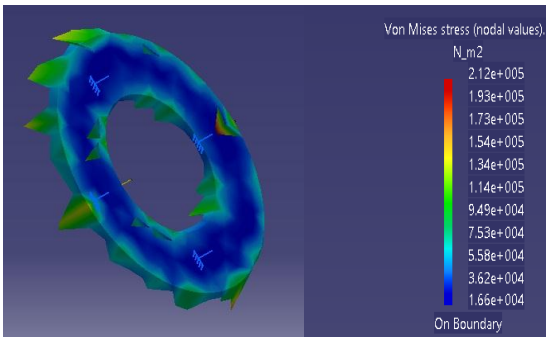


Fig 7. Von Mises stress distribution of Cast iron Friction Plate. The maximum stress obtained on the boundary is 2.12e5 N/m^2.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

Table 1: Comparison of values under Uniform pressure Theory

Parameters	Program Output	Theoretical output
Mean diameter (mm)	234.73	237.10
Axial Force (N)	4044.31	4046.37
Power (kW)	19.88	20.09
Torque (N-mm)	189865.00	191878.00

Table 2: Comparison of values under Uniform Wear Theory

Parameters	Program output	Theoretical output
Mean diameter(mm)	230.00	230
Axial force(N)	2813.439	2814.86
Power(kW)	13.55	13.56
Torque(N-mm)	129418.242	129483.56

Since the value of friction torque is higher in Uniform Pressure theory, Uniform Wear Theory is considered while designing the clutch plate.

IV. CONCLUSION

This Project demonstrates to us how different materials can be analyzed on CATIA V5 in order to view their deformations and their Von Mises stresses. The program written on C conformed to the formulae used to determine various parameters theoretically. It was found that under Uniform

Pressure Theory, the value of power developed was higher than that of Uniform Wear Theory, due to which, the latter was used to design the clutch plate. The results obtained were quite favorable, which was expected. The stresses as well as the deformation plots clear the idea about what parameter should've been taken into account while defining the single plate friction clutch. According to the results obtained, Bronze is preferred to design the Single Plate Clutch.

ACKNOWLEDGMENT

The authors acknowledge, to Dr. H C Nagaraj, Principal. Nitte Meenakshi Institute of Technology for providing the support and infrastructure to carry out our research. We would also like to acknowledge Dr. Kiran Aithal S, HOD, Department of Mechanical Engineering, of Nitte Meenakshi Institute of Technology for their valuable suggestions and support.

REFERENCES

[1] V.B BHANDARI- Design of Machine Elements-II 3rd edition, 448-456.

[2] Design, modeling and analysis of Single Plate Clutch by Ramakrishna Reddy, International Journal & Magazine of Engineering, Technology, Management and Research ISSN No: 2348-4845 Volume No: 2 (2015), Issue No: 8 (August), pp. 2134-2139.

[3] Design and Analysis of Clutch Using Sintered Iron as a Friction Material by Mamta G. Pawar, Monarch K. Warambhe, Gautam R. Jodh, International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume-3, Issue-7, December 2013

[4] A textbook of machine design by R.S.Kurmi and J.K.Gupta – 14th edition (2005), pp. 888-891.