Analysis of New Invented Design of Grooves Made on Dry Friction Clutch Plate

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Abstract— In this we have compare the reference grooves of friction plate that is the 23˚inclined friction plate and the suggested new grooves friction plate that is having the different design of the grooves and have proved by comparing both the grooves friction plates by checking the phenomenon like stresses, deformations and the heat flux through the grooves which we have invented and also compare the models in Ansys and Catia V5 models. And also have compared theoretically concepts of clutch plates.

Key words: 23˚ Inclined Grooves, Sunburst Grooves, Single Plate Clutch, Stresses, Deformation, Heat Flux

I. INTRODUCTION

In general there are the types of grooves of frictional plate that is single circular grooved friction plate , double circular frictional grooves, spiral grooves, spiral circular grooves, radial grooves and 23˚ inclined grooves frictional plate these are in the existence many more than this all we have taken here the design of the new invented grooves that is the sunburst grooves friction plate and more than this in paper we have compare the 23˚ inclined grooves friction plate with the new invented grooved frictional plate. And also have made the models in Catia V5 version and also gets analyzed in the Ansys Workbench 15 and also gets compared the von misses stresses and the deformations and the more heat transfer rate throughout the grooved made on the friction plates.

II. LITERATURE REVIEW

In this Research the new numerical technique i.e. the Finite element Analysis have been taken and compute the natural frequencies and the mode shape have been taken by using the various parameters and gets investigated for the vibrational characteristics. And also get verified by the numerical calculations also takes the modelling in Catia software and takes analysis in the ANSYS WORKBECH 14.5 Prashil M. Mhaiskar, Nitin D. Bhusale, Mayur D. Pastapure.[1]

This paper shows the design of single-plate clutch in automobile. This type of clutch is a dry friction clutch. The design of single plate clutch is drawn by using theoretical calculation results. A 2D drawing of clutch disc is drafted. The comparison result is done for using three materials to define the best material for friction plate. The stress of clutch disc is analyzed to observe the stress, displacement and strain during applying pressure on clutch disc face by using Solid Works software. The result of this paper, using cast iron as friction material is advantageous than using alloy steel and copper as friction material. The cast iron using as friction material is the best for single plate clutch. May Thin Gyan, Hla Min Htun, Htay Htay Win, [2].

Clutch plays fundamental role for engagement/ disengagement in transmission system to transmit torque and power from driving to drive shaft. Disengage clutch Change gear, gradually engage clutch thus three operations are to be performed while moving from one gear to another as in conventional transmission system. Paper describes principle of operation of single plate automatic clutch is that of the ordinary friction plate clutch, with its friction and pressure plates (and springs), but instead of using a foot pedal. So human effort to operate clutch will be reduced. The auto-disengagement single plate automatic clutch employs only one set of compression springs instead of the usual two sets, with this arrangement it is possible to reduce the weights of the centrifugal member's .When the clutch is disengaged and the engine is running at idling speed the hinged bob-weights rest against the lower or inward sides of holes in the flywheel. Upward movement of bob weight is responsible to engagement of clutch and further torque and power gets transmitted to drive shaft. ANSYS is used for the calculation of stresses, demo model built up for testing performance of clutch at various speed. This clutch may reduce jerk, transmission losses and increase performance of automatic clutch. Mr. Nilkanth G. Badhe, Prof. S. V. Patil, [3].

The clutch engages the transmission gradually by allowing a certain amount of slippage between the flywheel and the transmission input shaft. However, the slipping mechanism of the clutch generates heat energy due to friction between the clutch disc and the flywheel. At high sliding velocity, excessive frictional heat is generated which lead to high temperature rise at the clutch disc surface, and this causes thermo-mechanical problems such as thermal deformations and thermo-elastic instability which can lead to thermal cracking, wear and other mode of failure of the clutch disc component. In this project, the modeling of clutch is done in detailed using modeling software. After that the FEM analysis is done for sintered iron 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. Mamta G. Pawar, Monarch K. Warambhe, Gautam R. Jodh, [4].

III. ANALYTICAL MODELING

In Analytical modelling there is the selection of the friction al material takes p-lace more than this there is the theoretical calculation have been takes place for the pressure and the various analysis which we have been taken that is for stress and the deformation and the heat flux have been taken for the study purpose.

A. Material properties for frictional plate

1) Grey Cast Iron

Young' s modulus	120 GPa
Poisson's ratio	0.29
Density	7200 Kg/m3
Tensile strength	450 Mpa

Thermal conductivity	310W/m.K
Specific heat	450 J/kg.K

Table 1: Material properties for gray cast iron

The clutch disc is generally made from grey cast iron this is because grey cast iron has a good wear resistance with high thermal conductivity and the production cost is low compare to other clutch disc materials

2) Sintered iron

Young's modulus	275.79GPa
Poisson's ratio	0.34
Density	6.2gm/cm^3
Thermal conductivity	220W/m.K
Specific heat	50J/Kg.K

Table 2: Material properties for sintered iron

Friction plates are manufactured by sintering blend of powders consisting of heat absorption material along with friction generating & lubricating materials. The powders are blended in optimized proportions & compacted to form a solid flat button of predetermined shape. The quality of materials used along with the sintering parameter play an important role in providing the required performance.

B. Calculations for the pressure analysis

We know torque transmission capacity of dry friction clutches is given by,

$$T = n \times \mu \times w \times r$$

Here,

- T= 69Nm @ 3500RPM
- n= 2
- μ= 0.2
- r_o= 0.085m
- ri= 0.060m

r=2/3 × (.085)³ - (0.06)³/ (0.085)² - (0.06)²……By uniform pressure theory

= 0.07321

Hence W=T/n =69/2×.33×.0732

Hence W=1428N

Average pressure (P) =$\frac{W}{2\pi r(ro-ri)}$=124176.07 Pa

Average pressure (P) = 0.1 MPa.

C. Calculation for the stresses and the deformations for reference and the invented plate

- a= radius of plate =0.085m
- r_o = radius of central loaded area =0.060m
- P= uniform load per unit area
- V= poissons ratio = 0.34
- h =thickness of plate = 0.004m

D. Calculations of the reference friction clutch plate for the stresses

$$\sigma max = \frac{3(1+v)}{2\pi h^2} p\left(\frac{1}{v+1} + In\frac{a}{r_o} - \frac{1-v^2 r_o^{\,2}}{1+v4a^2}\right)$$

= 424.22 N/mm²

1) For deformation,

$$Wmax = \frac{3(1-v)(3+v)pa^2}{4\pi Eh^3}$$

=2.28mm

E. Calculations for the sunburst grooves friction plate,

1) Calculation for stress

$$\sigma max = \frac{3(1+v)}{2\pi h^2} p\left(\frac{1}{v+1} + In\frac{a}{r_o} - \frac{1-v^2 r_o^{\,2}}{1+v4a^2}\right)$$

=377.092 N/mm^2

2) Calculation for deformation

$$Wmax = \frac{3(1-v)(3+v)pa^2}{4\pi Eh^3}$$

=2.02mm

As we see the above results the sunburst grooves friction plate gives better result than that of the reference one.

IV. FINITE ELEMENT FORMULATIONS

Here we have taken the analysis for the referred one grooves friction plate and the invented grooves friction plate hence have taken the 2D model and 3D models in Catia V5 and the analysis in the Ansys workbench 15.

A. 2D designs for both the grooves

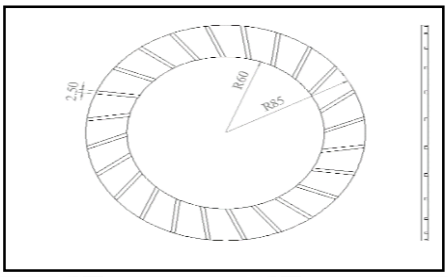

Fig. 1: 2D Friction plate with 23˚Inclined grooves

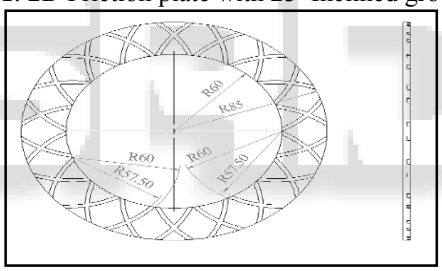

Fig. 2: 2D Friction plate with Sunburst grooves

1) 3D models for both the grooves

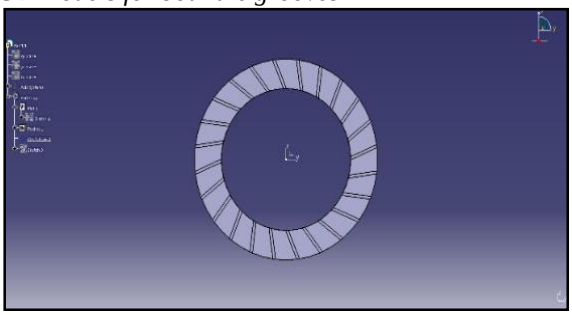

Fig. 3: 3D Friction plate with 23˚Inclined groove

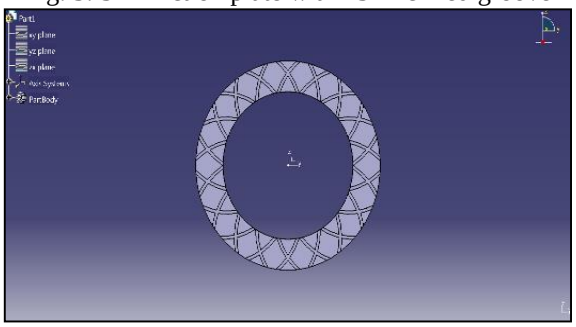

Fig. 4: 3D Friction plate with Sunburst grooves

B. Analysis with 23˚Inclined grooves

1) Von-misses stresses

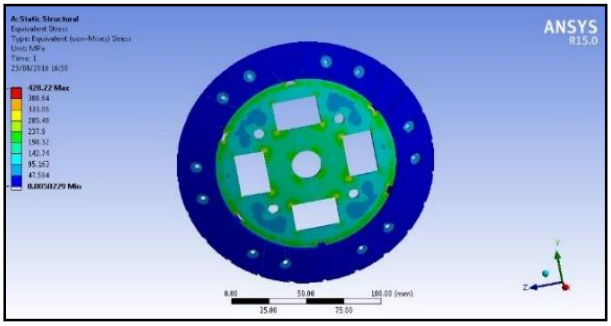

Fig. 5: Von-misses stresses

Stress value for clutch is 428.2 N/mm2 which is below the critical value. Hence, design is safe.

2) Deformation

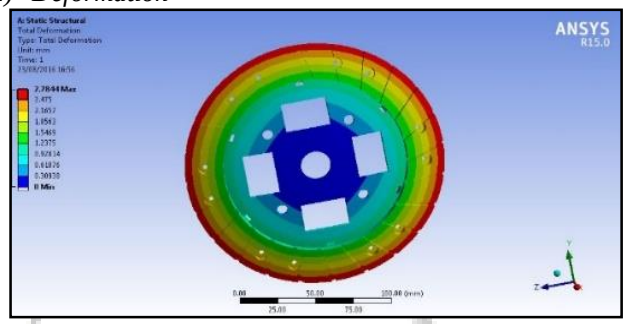

Fig. 6: Deformation for 23°inclined grooves

From fig, deformation for clutch is 2.78 mm.

3) Heat flux

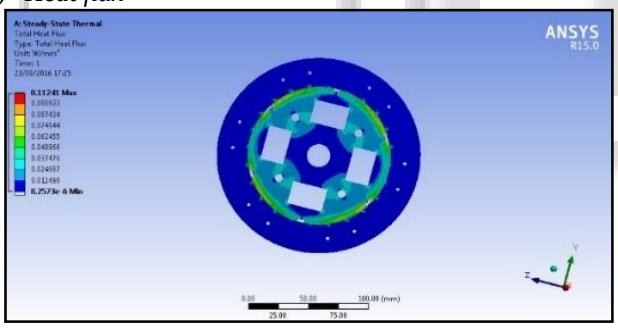

Fig. 7: Heat Flux for 23° inclined grooves

Heat flux in circular clutch is coming as 0.11W/mm2.

4) Sunburst groove

Model of friction plate with Sunburst grooves is prepared in CATIA V5. The dimensions of this are as follows:

To make this model, normal drafting commands like line, circle, hexagon etc. are used. Some more commands like pad, pocket etc. are also been used.

C. Meshed Model

1) Von-misses stresses

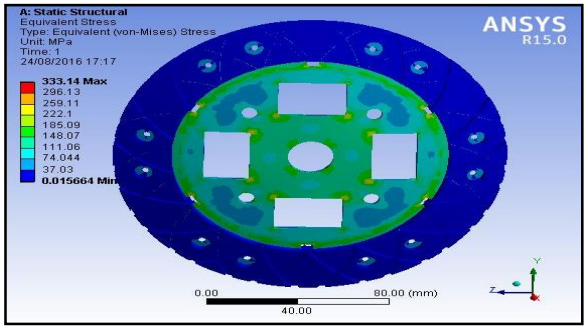

Fig. 8: Von-misses stresses for sunburst grooves

Stress value for clutch is 333.14 N/mm2 which is below the critical value. Hence, design is safe.

2) Deformation

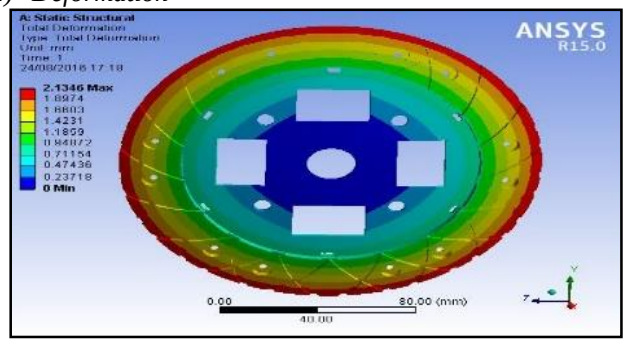

Fig. 9: Deformation for sunburst grooves

From fig, deformation for clutch is 2.13 mm.

3) Heat flux

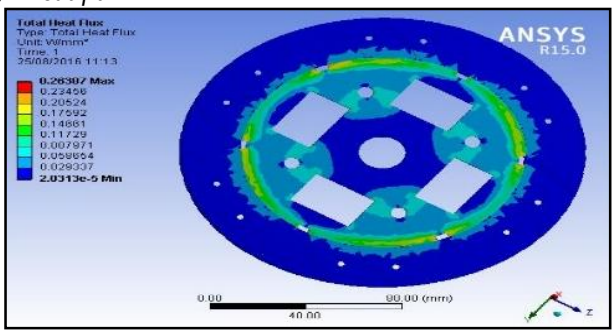

Fig. 10: Heat Flux

Heat flux in Sunburst grooves is coming as 0.263W/mm^2.

Here we have can see that sunburst grooves friction plate is more efficient frictional plate we have get from such analysis which is showing the less deformations and also shows the more heat transfer than the reference frictional plate.

V. RESULT AND DISCUSSION

- In Short we can see the result for the suggested grooves friction plate that have 16.5% less weight than the existence one.
- Again the suggested or sunburst grooves have 12.5% less stress than the existence but it is in acceptable limit.
- Also sunburst groove friction plate have 11.2% less deformation and it's very good.
- The heat transfer that is heat flux is50.9% more than the existence one which is quite more than the accepted.

VI. RECOMMENDATION

In future we can calculate the torque transmission capacity through the modified design of grooves made up on the frictional plate by the torque sensor for more efficiency furthermore can test for the heat transfer practically as it's more expensive so not performed in this project. And also the dynamic analysis can do in future. For appropriate getting work of designed grooved plate

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