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Design and Analysis on Multi Clutch Plate

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ABSTRACT

A clutch is a mechanical device which provides for the transmission of power (and therefore usually motion) from one component (the driving member) to another (the driven member). The opposite component of the clutch is the brake.A multi plate clutch may be used when a large torque is to be transmitted. The inside discs are fastened to the driven shaft to permit axial motion. The outside discs are held by bolts and are fastened to the housing which is keyed to the driving shaft. The multi disc clutches are extensively used in motor cars, motorbikes, machine tools etc.The inside discs are usually made of steel and outside discs are usually made of bronze. The materials used for lining of friction surfaces are Cork, Rubber, Cast iron, Powder metal.The aim of the project is to design a multi plate clutch by using empirical formulas. A 2D drawing is drafted for multi plate clutch from the calculations and a 3D model is created in the 3D modeling software Pro/Engineer. We are conducting structural analysis for above design for validating design. We are conducting analysis by varying the friction surfaces material. By extracting the result we are going to find out which material is best for the lining of friction surfaces. Structural analysis is done for multi plate clutch using the properties of the four materials. Materials used for liner is Cork, rubber, cast iron, Powder metal. Comparison is done for above all materials to validate better lining material for multi plate clutch under the different coefficient of friction conditions while changing the gears.

Analysis is done in ANSYS software

Design is done by pro-e software

INTRODUCTION

Clutch is a mechanism for transmitting rotation, which can be engaged and disengaged. Clutches are useful in devices that have two rotating shafts. In these devices, one shaft is typically driven by a motor or pulley, and the other shaft drives another device. Let us take an instance where one shaft is driven by a motor and the other drives a drill chuck. The clutch connects the two shafts so that they can either be locked together and spin at the same speed (engaged), or be decoupled and spin at different speeds (disengaged). Depending on the orientation, speeds, material, torque produced and finally the use of the whole device, different kinds of clutches are used. The clutch in itself is a mechanism, which employs different configurations and different principles in various models available. In the following lines, we have provided the different kinds of clutches that are available.

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. When vehicle is started from standstill clutch is engaged to transfer torque to the transmission; and when vehicle is in motion clutch is first disengaged of the drive to allow for gear selection and then again engaged smoothly to power the vehicle.

Basic Mechanism of Friction Clutch

There is a rotating shaft from which power is to be transmitted, called as driver shaft; and there is a shaft to which power is transmitted, called driven shaft. To take power from driver to driven shaft clutch is engaged. Engaging the clutch means reducing the physical gap between the rotating parts and forcing the two surfaces to come in contact. Since one part is moving and the other part is stationary, there is a relative motion between them. This creates friction and as a result causes force or torque transfer.

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Friction Clutch Actuation

Clutch actuation means engaging or disengaging the clutch such as to allow for power transmission or cut off the power or torque. Friction Clutches are mainly actuated through four means:

1. **Mechanical**: To actuate clutch mechanically liver or pedal is operated by hand or foot. These livers or pedals are connected to the friction clutch through compound linkages.

2. **Pneumatic**: Air pressure is used to engage the clutch and disengagement is achieved through spring. Compressed air is used through pneumatic pipes and actuation Is controlled through valves and pistons

3. **Hydraulic**: Hydraulic oil is used to exert pressure on the pistons to actuate the clutch. Force is applied hydraulically through pipes and controlled by hydraulic valves and pistons.

4. **Electrical**: For electrical actuation the livers and pedals used in mechanical actuation are replaced by electromagnet or solenoid. Clutch is engaged and disengaged by these electromagnet and solenoid on being triggered by the operator through the electrical wires instead of compound linkages, as in case of mechanical actuation.

The clutches are designed in different forms according to the power transmission requirements and also based on design and space constraints.

Plate friction material

Different special friction materials are available for wet and dry running clutches and brakes. The friction material used represents the most important part of each friction combination, which effectively consist of, in addition, the counter frictional surface and, in the case of wet-running, the oil. The friction combination influences the behavior of the clutch or brake when being engaged and disengaged, the permissible thermal loading, the behavior in terms of wear and thereby the required size of the clutch or brake. Only when these important properties are known can the optimum friction combination for a given application be selected in order to give the desired behavior and service life. In order to provide understanding of the application selection of friction combinations, the following sections will describe the characteristic properties and main areas of use of our different standard friction combinations, namely steel/steel, steel/sintered lining and steel or cast iron/organic friction lining, all of which

have proved themselves in use over many years. Should you have special requirements with regard to the dynamic torque, the static torque or the lubricant to be used, please contact us. For such cases, special friction materials such as plates coated with molybdenum are available.

STRUCTURAL ANALYSIS USING CORK AS FRICTION MATERIAL ANSYS PROCESS:-

IMPORTING THE COMPONEENT FROM ***CAD*** **(**CREO) *TOOL TO* ***CAE*** *TOOL* (ANSYS*):*

STRUCTURAL ANALYSIS:-

1. Click on Ansys workbench

Static structural

FOR

Mild steel

Ex: - 213*10^9 Pa
Poison ratio: 0.29
Density: 7870 Kg/m^3

Bronze

Ex: 137*10^9 Pa
Poison ratio: 0.346
Density: 9250 kg/m^3

Cork

Ex: - 20*10^6 pa
Poison ratio: 0.064
Density: 2400 kg/m^3

Cu powder metal

Ex: - 117*10^9 pa
Poison ratio: 0.32
Density: 8900 kg/m^3

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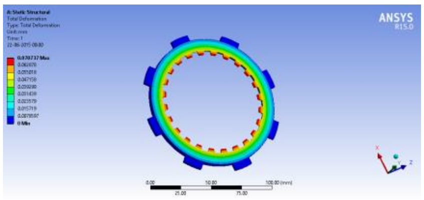
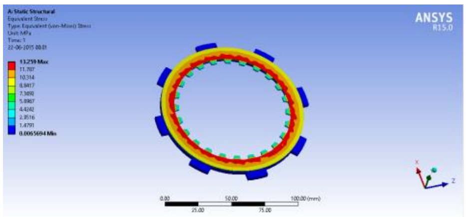
Results

For
0.1 Friction
Cork as friction material

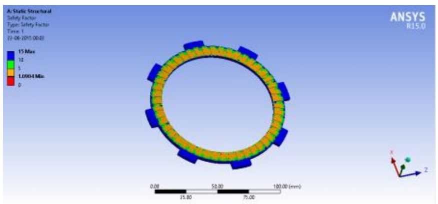
Deformation



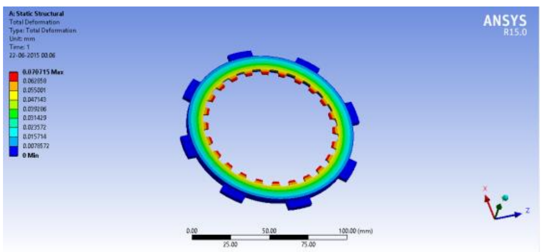
Stress



Fos



0.15 Friction
Deformation



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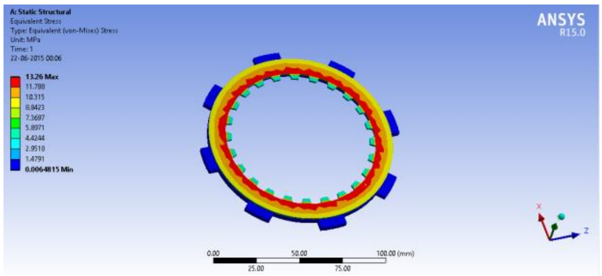

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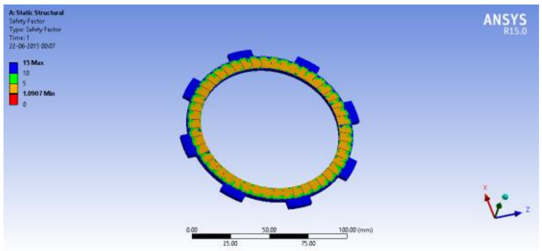
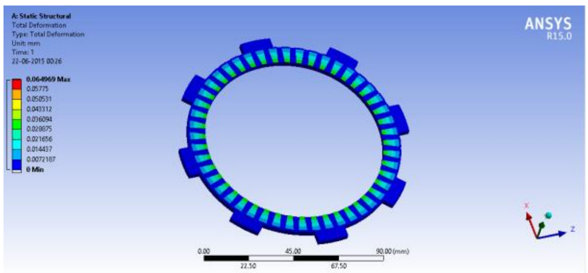
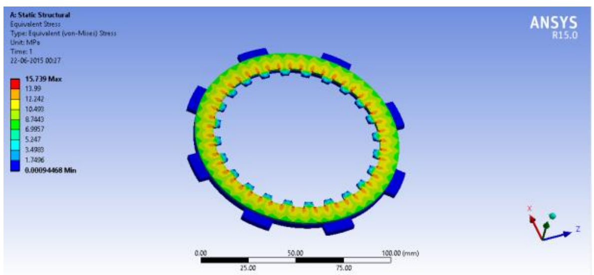


0.2 Friction
Deformation



Stress



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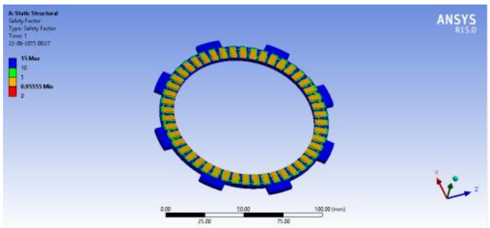
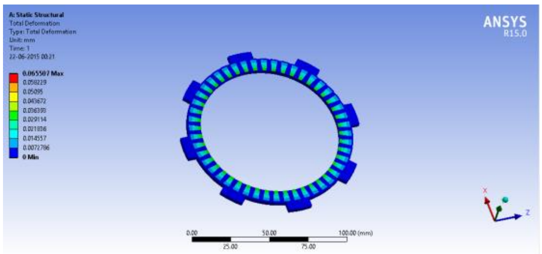
Fos

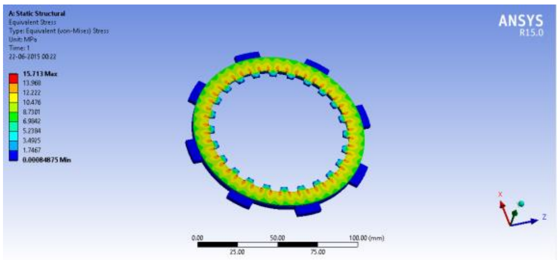


0.25 Friction

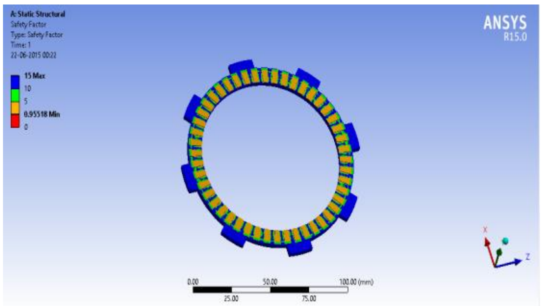
Deformation



Stress

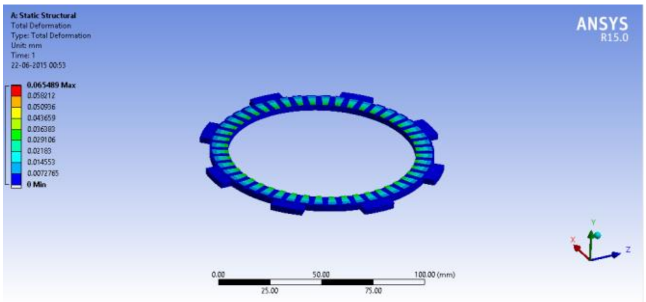


Fos



0.3 Friction

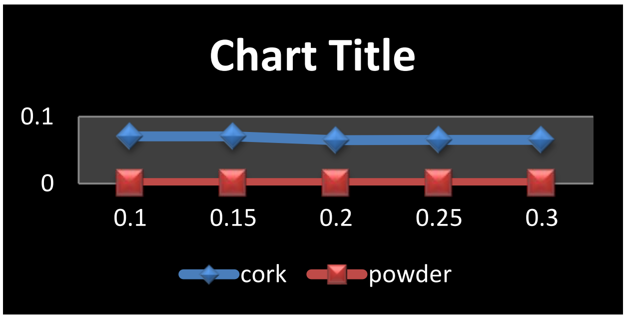
Deformation



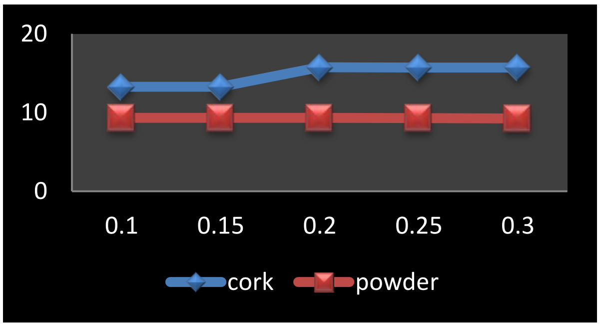
Graphs

For all materials

Deformation



Stress



To improve performance we increasing 0.1mm thickness to the friction plate

And again we analyzing with same boundary conditions and same material properties

Deformation Table
0.5 thick

Co efficient of friction	cork	Cu powder metal
0.1	0.070737	0.00075202
0.15	0.070715	0.0007514
0.20	0.064969	0.0007508
0.25	0.065507	0.00075021
0.30	0.065489	0.00074962

Stress

Co efficient of friction	cork	Cu powder metal
0.1	13.259	9.3192
0.15	13.26	9.3137
0.20	15.739	9.3083
0.25	15.713	9.3038
0.30	15.714	9.2987

Fos

Co efficient of friction	cork	Cu powder metal
0.1	1.0904	1.6096
0.15	1.0907	1.6105
0.20	0.9555	1.6115
0.25	0.95518	1.6123
0.30	0.95519	1.6131

Calculations

From all the above clutch plates they have different weights, when we change material properties the weight will also change and the deformation values and stress and safety factor values also change, and we calculated all values and mention above, now we calculating stiffness of object

For 0.5mm thickness plate when we using cork as friction material it is 134 grams, To calculate stiffness we converting into Newton's

We Know That

1Kgf=9.81N

0.134/9.81= 1 Newton

1 N = 0.013700

Stiffness=weight/deformation
=0.013700/0.070737
= 0.19367 N/mm

For cu powder material

Weight =140 grams
And after converting into Newton's
N=0.014271

Stiffness=0.014271/0.00075202
=18.977 N/mm

Calculation for 0.6mm Plate

Cork weight=183.86grams
N=0.018742
Stiffness=0.018742/0.058863
=0.31840N/mm

Cu powder weight=190.5grams (0.0194281N)
Stiffness = 0.0194281/0.00019881
= 97.72194 N/mm

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CONCLUSION

From this project first we identified one problem with existing material while increasing coefficient of friction the stress value also increased and to avoid this and we chosen copper powder metal and analyzed with same boundary conditions. The changing materials having less stress values compare to existing material and have good safety factor values.To get better results we changing friction material thickness from 0.5mm to 0.6mm. By this changes the stress values are gradually decreased

In generally we know that when we increasing thickness the stress automatically decreased but while selecting one good material we should not go through only stress values we should check its stiffness values also. Finally 0.6mm thick friction material with copper powder material have better results among all models

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