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ANALYSIS OF POROUS ALUMINUM SINGLE PLATE CLUTCH

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Abstract
Clutch is used to engage and disengaged the engine from transmission system. The clutch permits gradual taking of load when properly operated, thereby it prevent jerky motion of the vehicle and this avoids under strain on the parts of vehicle as well as passengers. A clutch is a device used to transmit the rotary motion of one shaft to another when desired. This research explains the design of Porous Aluminum single plate clutch. Solid works is used for the designing of clutch, and it is also used simulation and analysis of Parts.

Keywords: *Clutch, Porous Aluminum, Shaft, Coefficient of Friction*.

1. Introduction

Clutch plays an important role for engagement or disengagement in transmission system to transmit torque and power from driving to driven shaft(Abdullah and Schlattmann, 2012). 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(Glodová, Lipták and Bocko, 2014). 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 driven shaft. It operates on the principle of friction. When two surfaces are brought in contact and are held against each other due to friction between them, they can be used to transmit power. If one is rotated, then the other also rotates. One surface is connected to engine and other to the transmission system of automobile. Thus, clutch is nothing but a combination of two friction surfaces.

The torque developed by the engine at starting speed is very low(Zhou *et al.*, 2014).Therefore it is not possible to start the engine under load. This requires that the transmission system should provide a means of connecting & disconnecting the engine from rest of the transmission system(Abshire, 2005). Such operations must be smooth and without shock to the occupant of the vehicle .Clutch is used to engage and disengaged the engine from transmission system(Emeerith and Barman, 2017). The clutch permits gradual taking of load when properly operated, thereby it prevent jerky motion of the vehicle and this avoids under strain on the parts of vehicle as well as passengers(Pisaturo and Senatore, 2016). A clutch is a device used to transmit the rotary motion of one shaft to another when desired. The axes of the two shafts are coincident. In friction clutches, the connection of the engine shaft to the gear box shaft is affected by friction between two or more rotating concentric surfaces(Mani, Tipirineni and Rao, 2013). The surfaces can be pressed firmly against one another when engaged and the clutch tends to rotate as a single unit.

When the clutch is engaged the clutch plate is gripped between the flywheel and pressure plate(Warkade and Jain, 2016). Since it is having the friction lining on its both surfaces, due to friction between the flywheel, clutch plate and pressure plate, the clutch revolves with the flywheel(Warkade and Jain, 2016). As such the clutch plate revolves, the clutch also revolves which is connected to the transmission (gear box) also revolves(Journal *et al.*, 2015). The present work is accomplished by carrying out the investigation of mechanical property of Porous Aluminium & Carbon Fibre Composition and to compare the experimental results of deformation & yield strength on the basis of applying pressure.

2. Solid Works

Solid Works mechanical design automation software is a feature-based, parametric solid modeling design tool which takes advantage of the easy to learn Windows™ graphical user interface(Warkade and Jain, 2016). You can create fully associative3-D solid models with or without constraints while utilizing automatic or user defined relations to capture design intent(Dhamecha, Engineering and Group, 2014).

SOLIDWORKS uses a 3D design approach. As you design a part, from the initial sketch to the final result, you create a 3D model. From this model, you can create 2D drawings or mate components consisting of parts or subassemblies to create 3D assemblies(Emeerith and Barman, 2017). You can also create 2D drawings of 3D assemblies. When designing a model using SOLIDWORKS, you can visualize it in three dimensions, the way the model exists once it is manufacture(Idrisi, Deep and Sharma, 2016).

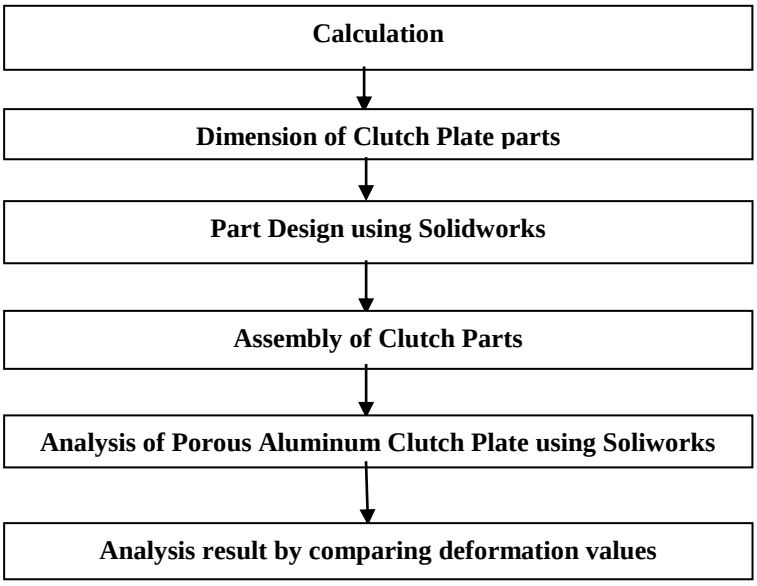
3. Methodology

POROUS ALUMINIUM (6061 T6) is being widely applied for many industrial applications thanks to the unique combination of material properties. Porous aluminium has a high level of volume porosity (cells ratio in the entire volume) of about 55% and homogeneous pores distribution, all pores / cells are open and the material is complete permeable(Mani, Tipirineni and Rao, 2013). Thus, porous aluminium with small pore sizes is applied for vacuum generation in form of vacuum tables / vacuum plates. It is possible to manufacture products of porous aluminium in any shape, thus vacuum forms or press-forms with complex shapes are applied for thermoforming process / production of foam products from expanded polystyrene (EPS), polypropylene (EPP), etc. Porous aluminium has a high specific surface area and is completely permeable. These properties combination make porous aluminium very attractive for the manufacturing of new generation of heat exchangers. Thanks to the open cell structure and high specific surface area, porous aluminium is a very good noice silencing material. Pneumatic silencers / mufflerscan be easily manufactured according to your individual needs and requirements. Silencers made of porous aluminium – an alternative to silencers made of sintered metals. Our silencers have extra strong cast interface between porous and non-porous parts and reduce the noise of pneumatic devices significantly.

Table 1. Properties of Porous Aluminum

Property	**Value**	**Units**
Elastic Modulus	6900	N/mm^2
Poisson's Ratio	.33	N/A
Tensile Strength	310	N/mm^2
Yield Strength	275	N/mm^2
Thermal Expansion	2.4e-005	/K
Mass Density	2700	Kg/m^3
Hardening Factor	.85	N/A

The flow chart showing methodology is shown below, which provides the detailed steps used in present work.



Result and Discussion

4. Design and Calculations

When the driver releases the clutch pedal, power can flow through the clutch. Springs in the clutch force the pressure plate against the friction disc(Deshbhratar and Kakde, 2013). This action clamps the friction disk tightly between the flywheel and the pressure plate(Purohit, Khitoliya and Koli, 2014). Now, the pressure plate and friction disc rotate with the flywheel.

$$T = NfFR \qquad (1)$$

Where,

T - Torque (N-m)

N - Number of frictional discs in contact

F - Coefficient of friction

F - Actuating force (N)

R - Mean or equivalent radius (m)

Note that: $N = n_1 + n_2 - 1$

Where, n_1 = number of driving discs

As both side surfaces of the clutch plate is used for transmitting the torque, a term 'N' is added to include the number of surfaces used for transmitting the torque(Bhandari, 2016).

By rearranging the terms the equations can be modified and a more general form of the equation can be written as:

n_2 = number of driven discs

SPECIFICATIONS

Power	:	73 hp @ 4700 rpm
Torque	:	202.5 N-m @ 2800 rpm
Material used is Porous Aluminum	:	μ -0.3
Maximum operating temperature	:	150˚-250˚ C
Maximum pressure (P)	:	300 kN/m^2

Outer (r_o) and inner (r_i) radius of friction faces

r_o= 0.1145 m, r_i = 0.0802 m

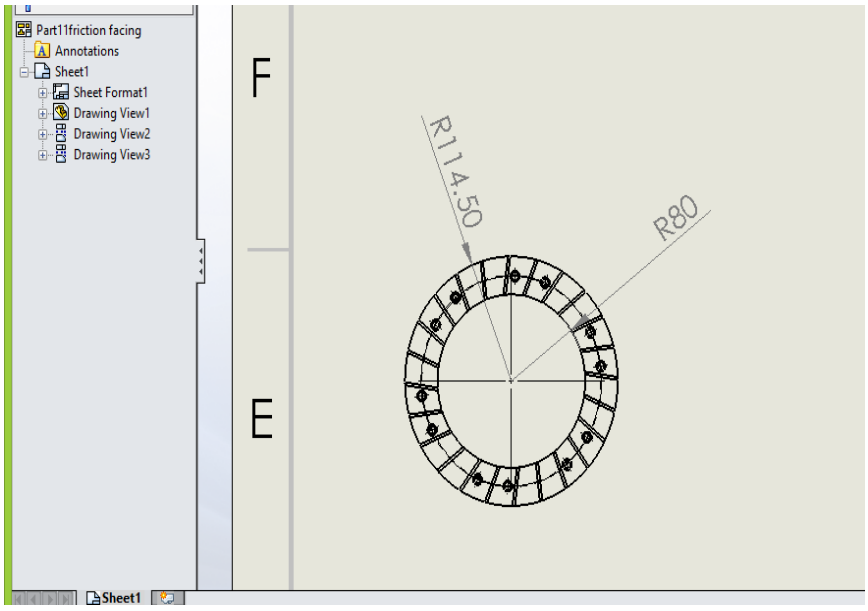


Figure1. 2-D Sketch of Friction facing

This part is drawn using 2-d theoretical calculation in Solid Works .It has similar construction to that of the multi coil spring unit, but it uses a single dished diaphragm-type spring to apply the clamping thrust. The diaphragm spring is a steel disc having hole at the center and the inner portion of the disc is radially slotted so that a number of actuating fingers are formed.

CALCULATIOS: For uniform pressure :

$$R = 2/3[(r_o^3 - r_i^3)/(r_o^2 - r_i^2)] \quad (2)$$

$$R = 0.09896\ m$$

For Uniform Wear :

$$R = (r_o + r_i)/2 \quad (3)$$

ASSEMBLY OF CLUTCH PLATE:

The parts of clutch plate drawn in Solid Works by using some specified calculations and different operations .Clutch Cover is an automated part that allows and prevents the transmission of power from engine to the transmission .The clutch disc is sandwiched between flywheel which is attached to the unit, and the clutch cover. A torsional damper with a hub assembly and a disc assembly has coil springs disposed there between. The coil springs are disposed in pockets defined in part by apertures in opposed cover plates.

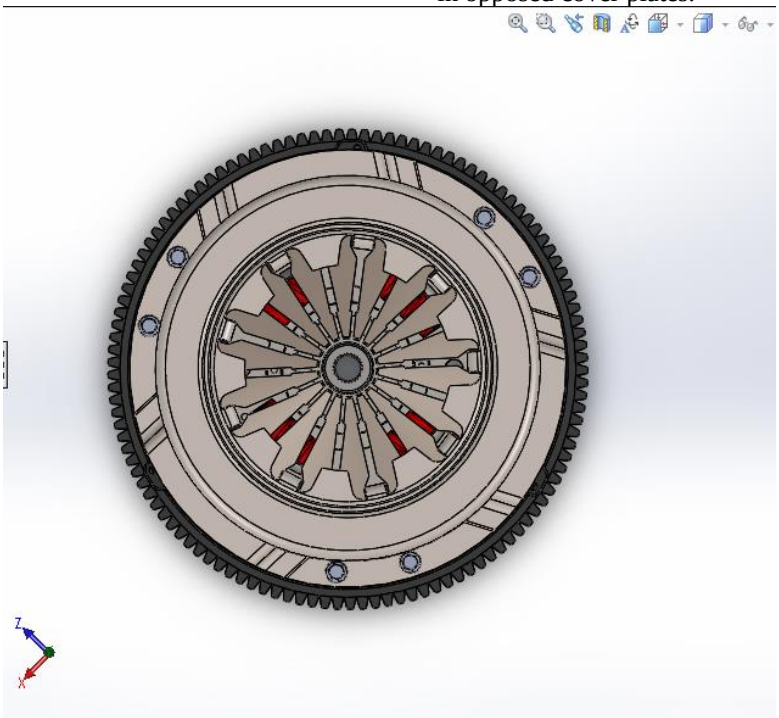


Figure2. Clutch Plate

5. Analysis Using Solid works

Porous Aluminum has taken for analysis of Friction Plate.Stress and Displacement analysis of materials are given below.

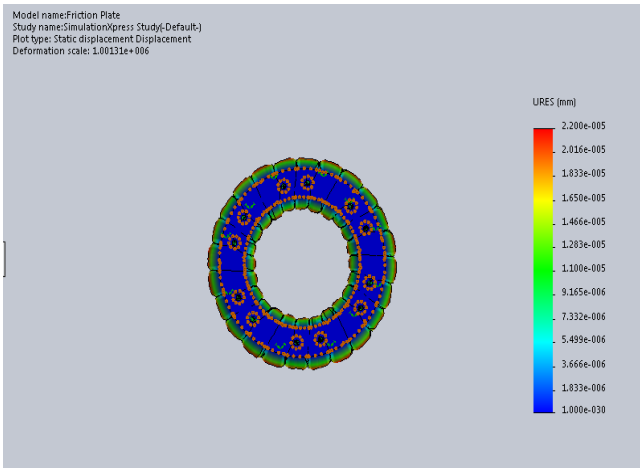


Figure3.Displacement Analysis

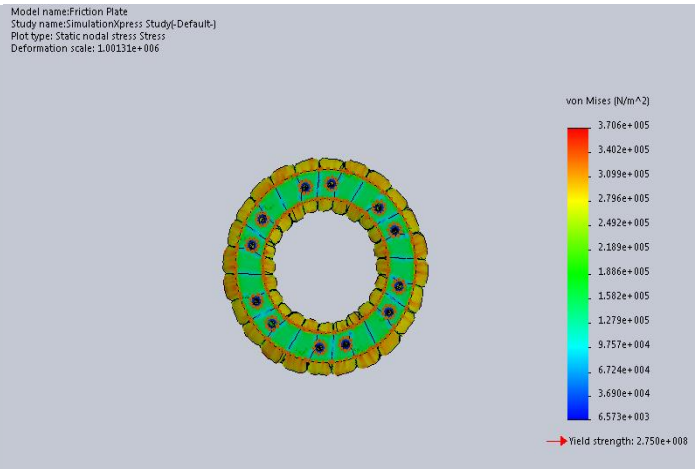


Figure4. Stress Analysis

6. Results

In this table we take Porous Aluminium and with the help of simulation and analysis in Solidwork, it shows different values of deformation and von- mises stress by applying different value of pressure.

Table2. Analysis Results

Materials	Pressure(kN/m^2)	Coefficient of friction	Deformation	Von - misesstresss
Porous Aluminum	280	0.3	1.48e+009	1.825e-004
	300	0.3	1.00131e+006	2.713e-004
	320	0.3	1.2845e+009	1.771e-004
	350	0.3	1.1744e009	1.938e-004

7. Conclusion

The design and assembly of single plate clutch is done on solid works software. Porous Aluminium is taken. Analysis of friction facing is done on Solid works. Material taken, shows different values of deformation and yield strength on different pressures. Since Porous Aluminum has minimum value of deformation and yield strength. Porous aluminum has high heat conductivity, low density, good corrosion resistance; its products are permeable over the whole volume and can be manufactured in up to large size.
Analysis of friction plate by taking different materials would be done. By apply different pressure values there corresponds different values of deformation, yield strength,vonmises stress determine, so we take that material which has low value of deformation in comparison to the other materials.

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