# DESIGN AND STUDY OF A MULTI PLATE CLUTCH

[1]Dr. Karthikeyan P., [2]Dr. V. Venugopal, [3]Mr. J. Chandrasekhar, [4]Ms. L. Priyanka ,
[1]Associate Professor, Dept. of Mechanical Engineering, Malla Reddy College of Engineering, Sec-100
[2]Associate Professor, Department of Mechanical Engineering, Malla Reddy College of Engineering, Sec-100
[3]Asst. Professor, Department of Mechanical Engineering, Malla Reddy College of Engineering, Sec-100
[4]Asst.Professor, Department of Mechanical Engineering, Malla Reddy College of Engineering, Sec-100

**Abstract— Clutch is a mechanism which transfers the rotary motion of one shaft to the other shaft when desired. In automobiles friction clutches are widely used in power transmission applications. To transmit maximum torque in friction clutches selection of the friction material is one of the important tasks.**

**In this thesis, the general introduction to the arrangement, design and some basic concept of multi plate wet type clutch. Fluid plays an important role in this type of clutch so some of their properties are discussed. Some losses due to design parameters are also discussed. To meet the requirements of low fuel consumption, good driving performance and manufacturing feasibility. This paper will provide a design overview of the transmission architecture, main characteristics, key subsystems and control strategies. This gives a better understanding about working principle of clutch, material used for making the clutch plates. Effect of design consideration can be further studied during its application in various conditions.**

**In this paper, we design a multi plate clutch by using empirical formulas. A 2D drawing is drafted for multi plate clutch from the calculations & a 3D model is created in the modeling Software CREO for Automobile Applications. Analysis done in ANSYS with different materials.**

**Static analysis to determine the deformation, stress and strain for the single plate clutch. Modal analysis is to determine the deformations with respect to frequencies.**

**Keywords: 2d 3d design, materials, stress, strain, friction, power transmission.**

## CHAPTER:1
## INTRODUCTION:

The clutch is a mechanical device, which is used to connect or disconnects the source of power from the remaining parts of the power transmission system at the will of operator. The clutch can connect or disconnect the driving shaft and driven shaft. An automotive clutch can permit the engine to run without driving the car. This is desirable when the engine is to be started or stopped, or when the gears to be shifted. Clutch is a mechanism for transmitting rotation, which can be engaged and disengaged. 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. 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. Generally there are two types of clutches based on type of contact Positive clutch− Friction clutch− Single plate comes under the category of friction clutch. Desirable properties for friction materials for clutches: The two materials in contact must have a high− coefficient of friction.

**INTERLOCKING PARTS CLUTCHES:**

This type of clutch has protruding circular edge and a hole for them that engages and disengages during operation. This type is less effective since human foot or hand power on clutching reaches about 10 KN or 1,000 kg.

**FRICTION CLUTCHES :**

A friction clutch The vast majority of clutches ultimately rely on frictional forces for their operation. The purpose of friction clutches is to connect a moving member to another that is moving at a different speed or stationary, often to synchronize the speeds, and/or to transmit power. Usually, as little slippage (difference in speeds) as possible between the two members is desired.

**CHAPTER:2**
**APPLICATIONS:**
**MACHINERY:**

This type of clutch is used in some lawnmowers, copy machines, and conveyor drives. Other applications include packaging machinery, printing machinery, food processing machinery, and factory automation.

**AUTOMOBILES:**

When the electromagnetic clutch is used in automobiles, there may be a clutch release switch inside the gear lever. The driver operates the switch by holding the gear lever to change the gear, thus cutting off current to the electromagnet and disengaging the clutch. With this mechanism, there is no need to depress the clutch pedal. Alternatively, the switch may be replaced by a touch sensor or proximity sensor which senses the presence of the hand near the lever and cuts off the current. The advantages of using this type of clutch for automobiles are that complicated linkages are not required to actuate the clutch, and the driver needs to apply a considerably reduced force to operate the clutch. It is a type of semi-automatic transmission.

**LOCOMOTIVES :**

Electromagnetic clutches have been used on diesel locomotives, e.g. by Hohenzollern Locomotive Works.

**CHAPTER:3**
**OTHER TYPES OF ELECTROMAGNETIC CLUTCHES:**
**MULTIPLE DISK CLUTCHES:**

Introduction – Multiple disk clutches are used to deliver extremely high torque in a relatively small space. These clutches can be used dry or wet (oil bath). Running the clutches in an oil bath also greatly increases the heat dissipation capability, which makes them ideally suited for multiple speed gear boxes and machine tool applications.How it works – Multiple disk clutches operate via an electrical actuation but transmit torque mechanically.

**ELECTROMAGNETIC TOOTH CLUTCHES:**

Of all the electromagnetic clutches, the tooth clutches provide the greatest amount of torque in the smallest overall size. Because torque is transmitted without any slippage, clutches are ideal for multi stage machines where timing is critical such as multi-stage printing presses. Sometimes, exact timing needs to be kept, so tooth clutches can be made with a single position option which means that they will only engage at a specific degree mark. They can be used in dry or wet (oil bath) applications, so they are very well suited for gearbox type drives.

**ELECTROMAGNETIC PARTICLE CLUTCHES:**

Introduction Magnetic particle clutches are unique in their design, from other electro-mechanical clutches because of the wide operating torque range available. Like a standard, single face clutch, torque to voltage is

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-1, 2018
DOI: 10.21276/ijcesr.2018.5.1.17

almost linear. However, in a magnetic particle clutch torque can be controlled very accurately. This makes these units ideally suited for tension control applications, such as wire winding, foil, film, and tape tension control. Because of their fast response, they can also be used in high cycle applications, such as card readers, sorting machines, and labeling equipment.

**AUTOMOBILE POWERTRAIN:**

This plastic pilot shaft guide tool is used to align the clutch disk as the spring-loaded pressure plate is installed. The transmission's drive splines and pilot shaft have a complementary shape. A number of such devices fit various makes and models of drivetrains.

**MOTORCYCLES:**

**A BASKET CLUTCH:**

Motorcycles typically employ a wet clutch with the clutch riding in the same oil as the transmission. These clutches are usually made up of a stack of alternating plain steel and friction plates. Some plates have lugs on their inner diameters that lock them to the engine crankshaft. Other plates have lugs on their outer diameters that lock them to a basket that turns the transmission input shaft. A set of coil springs or a diaphragm spring plate force the plates together when the clutch is engaged.

On motorcycles the clutch is operated by a hand lever on the left handlebar. No pressure on the lever means that the clutch plates are engaged (driving), while pulling the lever back towards the rider disengages the clutch plates through cable or hydraulic actuation, allowing the rider to shift gears or coast. Racing motorcycles often use slipper clutches to eliminate the effects of engine braking, which, being applied only to the rear wheel, can cause instability.

**CHAPTER:4**

**OTHER CLUTCHES AND APPLICATIONS:**

Belt clutch: Used on agricultural equipment, lawn mowers, tillers, and snow blowers. Engine power is transmitted via a set of belts that are slack when the engine is idling, but an idler pulley can tighten the belts to increase friction between the belts and pulleys.

Dog clutch: Utilized in automobile manual transmissions mentioned above. Positive engagement, non-slip. Typically used where slipping is not acceptable and space is limited. Partial engagement under any significant load can be destructive.

Hydraulic clutch: The driving and driven members are not in physical contact; coupling is hydrodynamic.

**SPECIALTY CLUTCHES AND APPLICATIONS:**

**SINGLE-REVOLUTION CLUTCH:**

Single-revolution clutches were developed in the 19th century to power machinery such as shears or presses where a single pull of the operating lever or (later) press of a button would trip the mechanism, engaging the clutch between the power source and the machine's crankshaft for exactly one revolution before disengaging the clutch. When the clutch is disengaged and the driven member is stationary. Early designs were typically dog clutches with a cam on the driven member used to disengage the dogs at the appropriate point.

**CASCADED-PAWL SINGLE-REVOLUTION CLUTCHES:**

Cascaded-pawl single-revolution clutch driving the cam cluster in a Teletype Model 33 that performs fully mechanical conversion of incoming asynchronous serial data to parallel form. The clutch drum, lower left, has been removed to expose the pawls and trip projections.

These superseded wrap-spring single-revolution clutches in page printers, such as teleprinters, including the Teletype Model 28 and its successors, using the same design principles.

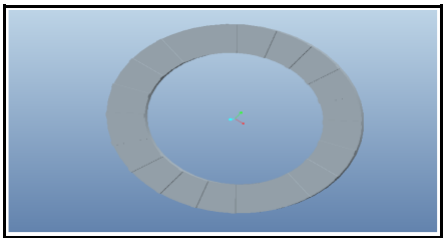
**KICKBACK CLUTCH-BRAKES:**

These mechanisms were found in some types of synchronous-motor-driven electric clocks. Many different types of synchronous clock motors were used, including the pre-World War II Hammond manual-start clocks. Some types of self-starting synchronous motors always started when power was applied, but in detail, their behaviour was chaotic and they were equally

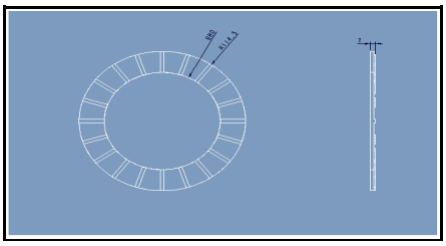
ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-1, 2018
DOI: 10.21276/ijcesr.2018.5.1.17

likely to start rotating in the wrong direction. Coupled to the rotor by one (or possibly two) stages of reduction gearing was a wrap-spring clutch-brake. The spring did not rotate. One end was fixed; the other was free. It rode freely but closely on the rotating member, part of the clock's gear train. The clutch-brake locked up when rotated backwards, but also had some spring action. The inertia of the rotor going backwards engaged the clutch and wound the spring. As it unwound, it restarted the motor in the correct direction. Some designs had no explicit spring as such—but were simply compliant mechanisms. The mechanism was lubricated and wear did not present a problem.

3D MODEL:



2D MODEL:



STATIC ANALYSIS OF SINGLE PLATE CLUTCH:

Materials used

Steel:

Young's modulus = 205000mpa

Poisson's ratio = 0.3

Density = 7850kg/mm$^3$

Cast iron:

Young's modulus = 110000 mpa

Poisson's ratio = 0.28

Density = 7200

Copper :

Young's modulus = 101000mpa

Poisson's ratio = 0.32

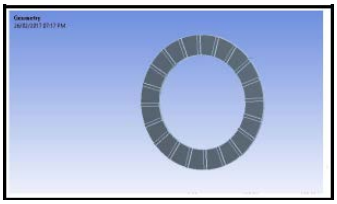
Density = 6800

Save Pro-E Model as .iges format

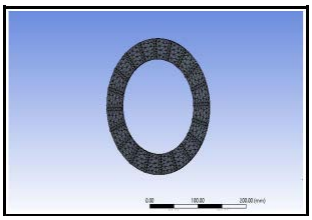
→→Ansys → Workbench→ Select analysis system → static structural → double click

→→Select geometry → right click → import geometry → select browse →open part → ok

→→ Select mesh on work bench → right click → edit Double click on geometry → select MSBR → edit material →



Select mesh on left side part tree → right click → generate mesh →



Select static structural right click → insert → select rotational velocity and fixed support

**5 . RESULTS TABLES:**

**STATIC ANALYSIS RESULT**

| MATERIAL | DEFORMATION(mm) | STRESS (N/MM$^2$) | STRAIN |
|---|---|---|---|
| STEEL | 1.0788E-5 | 0.3023 | 1.6012E-6 |
| CAST IRON | 1.92E-5 | 0.31251 | 2.84E-6 |
| COPPER | 1.54E-5 | 0.32894 | 2.452E-6 |

FATIGUE ANALYSIS RESULT

| MATERIAL | LIFE | DAMAGE | SAFETY FACTOR |
|---|---|---|---|
| STEEL | 1E10 | 0.1 | 4.3094 |
| CAST IRON | 1E10 | 0.1 | 4.4159 |
| COPPER | 1E10 | 0.1 | 4.1953 |

MODAL ANALYSIS RESULTS

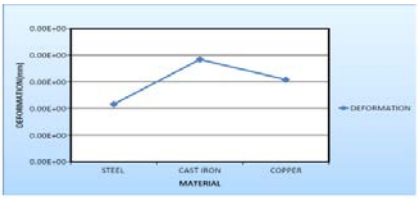
| MATERIAL | frequency | deformation | frequency | Deformation2 | freque | Defor |
|---|---|---|---|---|---|---|

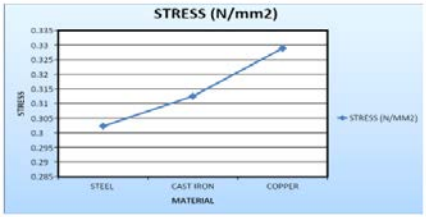
ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-1, 2018
DOI: 10.21276/ijcesr.2018.5.1.17

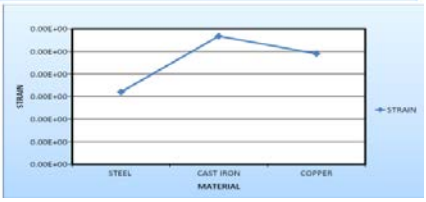
| | | 1 | | | ncy | mation 3 |
|---|---|---|---|---|---|---|
| STEEL | 1.3133E+05 | 589.73 | 1.314E+05 | 655.2 | 1.31E | 626.29 |

| MATERIAL | frequency | deformation 1 | frequency | Deformation2 | frequency | Deformation 3 |
|---|---|---|---|---|---|---|
| STEEL | 1.3133E+05 | 589.73 | 1.314E+05 | 655.2 | 1.31E | 626.29 |

**GRAPHS**




## 6 . CONCLUSION:

Static Structural, modal and fatigue analysis is done for multi plate clutch using the properties of the three materials. Outer material is steel and Materials used for friction plate are varied Cast iron, Cork and Asbestos. Comparison is done for above materials to validate better friction material for multi plate clutch. By observing static analysis results, the stress values for all materials are less than that of their respective yield stress values. The deformation and stress values are less for Cast Iron and Asbestos is used. By observing modal analysis results, the deformation is less for Cast Iron but the frequencies are less when Cork is used. Since the frequencies are lesser, the vibrations in the clutch will be reduced when cork is used. By observing fatigue analysis results, the life is more for Cast Iron but the damage is more for Cork and Asbestos. The clutch will be failed if the applied load is multiplied with the damage value. Since the damage value is more for Cork and Asbestos, the clutch when both the materials are used will fail at very larger loads. So it can be concluded that using Cork for friction plate is better.

## 6 . REFERENCES:

[1] Mr.P.V.Narasimha Rao.L, Ch.Chandrarao ―Static and Dynamic Analysis of Clutch Plate With Crack‖, IJRMET, Volume 4, Issue Spl - 1, Nov 2013

[2] Mr.Ganesh Raut, Anil Manjare, P Bhaskar ―Analysis of Multidisc Clutch Using FEA‖ IJETT, Volume 6, Dec 2013

[3] Prof.P.Baskar, Anil Jadhav, Gauri Salvi, Santosh Ukamnal, ―Static Structural Analysis of Multi plate Clutch with Different Friction Materials‖ IJERT, Volume 2, Issue 11, November 2013

[4] Dr. J. P. Modak, Shrikant V.Bhoyar, Dr. G. D. Mehta, ―Dynamic Analysis Of Single Plate Friction Clutch‖, IJERT, Vol. 2, Issue 7, July – 2013

[5] Mr.Prashil M. Mhaiskar, Nitin D. Bhusale, Mayur D. Pastapure ―Vibration Analysis of Dry Friction Clutch Disc by Using Finite Element Method‖, IJERT, Volume 3, Issue 1, January – 2014

[6] Mr.Rajesh Purohit, Pooja Khitoliya and Dinesh Kumar Koli, ―Design and Finite Element Analysis of an Automotive Clutch Assembly‖, ScienceDirect, Procedia Materials Science 6, 2014

[7] Mr.Monarch K. Warambhe, Gautam R. Jodh, Mamta G. Pawar, ―Design and Analysis of Clutch Using Sintered Iron as a Friction Material‖ ,IJITEE, Volume-3, Issue-7, December 2013

[8] Mr. P.Naga Karna, Tippa Bhimasankara Rao, ―Analysis of Friction Clutch plate using FEA‖ ,IJERD, Volume 6, Issue 2, March 2013

[9] Mr. B. Nivas, M. Nithiyanandam, S. Tharaknath, A. AvinashKumar, ―Design and Analysis of Clutch Plate Using Steel Material [En –Gjs-400 -15steel]‖, IOSR-JDMS, Volume 13, Issue 5, May. 2014