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EXPERIMENTAL ANALYSIS OF SINGLE PLATE FRICTION CLUTCH

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ABSTRACT:

A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft. In the simplest application, clutches connect and disconnect two rotating shafts (drive shafts or line shafts). In these devices, one shaft is typically attached to an engine or other power unit (the driving member) while the other shaft (the driven member) provides output power for work. While typically the motions involved are rotary, linear clutches are also possible. The aim of the project is to design a Single Plate Clutch for an IC Engine using at different speeds and to analyze to get better results. A 2D drawing is drafted using the calculations. A parametric model of the clutch is designed using 3D modeling software CATIA. The forces acting on the Clutch are also calculated. The strength of the Clutch is validated by applying the forces on the Clutch in analysis software Ansys. This paper shows the design of Single Plate Clutch in automobile. This type of Clutch is a Dry Friction Clutch. The stress of clutch disc is analyzed to observe the stress, displacement and strain during applying pressure on clutch disc face. CATIA is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design. ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements.

I.INTRODUCTION

In the transmission system, the system by which power develops by the engine transmits to road wheels to propel the vehicle. In automobiles, the power develops by the engine which uses to turn wheels. Therefore, the engine is to connect to the transmission systems for transmitting power to wheels.

Also, there should be a system using which the engine could be engaged and disengaged with the transmission system smoothly and without shock so that the vehicle mechanism is not damaged and passengers do not feel inconvenience. A clutch is employed in automobiles for this purpose.

A Clutch is a mechanism used to connect or disconnect the engine from the rest of the transmission elements. It is located between the engine and gearbox. The clutch disengages for starting, changing gears, stopping, and idling. The function of the Clutch is to permit the engagement or disengagement of gear when the vehicle is stationary and the engine is running without damaging gear wheels. So, we come back to our point of Single Plate Clutch and let us

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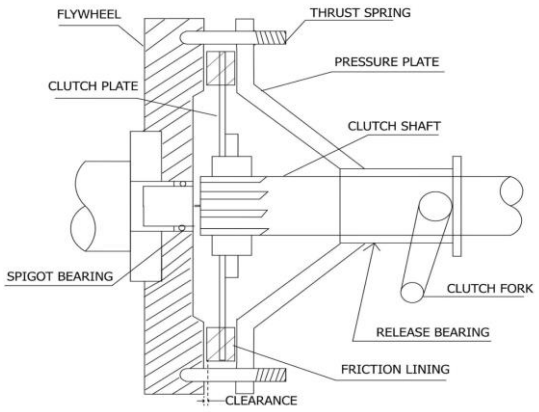
start.

Single Plate Clutch



A single plate clutch has one clutch plate. This clutch works on the principle of friction. It is the most common type of clutch used in motor vehicles. The clutch primarily consists of two members, one mounted on the driving shaft and the other on the drive shaft.

These two shafts are parallel and concentric with each other; one shaft is fixed to its housing while the other is splined so that it can move axially.

The driving torque can increase by increasing the effective radius of contact.

Construction of Single Plate Clutch

A single plate clutch consists of different parts for proper working. They are arranged in a systematic order.

Mainly it consists of a clutch plate with both side friction lining and some other parts which help in the proper functioning of a clutch like a flywheel, pressure plate, thrust bearing, hub, springs, and input mechanism for engagement and disengagement of the clutch.

The clutch plate attaches to the hub between the flywheel and the pressure plate, it moves axially on the drive shaft.

In a single plate clutch, the clutch plate should have both side friction lining because it mounts between the pressure plate and flywheel, friction is responsible for the torque transmission.

The pressure plate engages with the flywheel and springs. Pressure plate helps to push the clutch plate with the flywheel.

A lever attaches to thrust bearings with some mechanism on the drive shaft which transmits input and output motion from the clutch pedal.

II - TYPES OF SINGLE PLATE CLUTCH

Diaphragm Spring Type Single Plate Clutch

The construction of this type of clutch is similar to that of the single plate clutch. In this type of clutch diaphragm springs (also called Belleville springs) are used instead of the ordinary coil springs. In the free condition, the diaphragm spring is of conical form but when assembled, it is constrained to an approximately flat condition because of which it exerts a load upon the pressure plate.

The diaphragm spring is supported on a fulcrum retaining ring so that any section through the spring can be regarded as a simple lever. The pressure plate is axially movable, but it is fixed radically with respect to the cover.

This is done by providing a series of equally spaced lugs cast upon the back surface of the pressure plate. The drive from the engine flywheel is transmitted through the cover, pressure plate and the friction plate to the gearbox input shaft.

The clutch is disengaged by pressing the clutch pedal which actuates the release fingers by means of a

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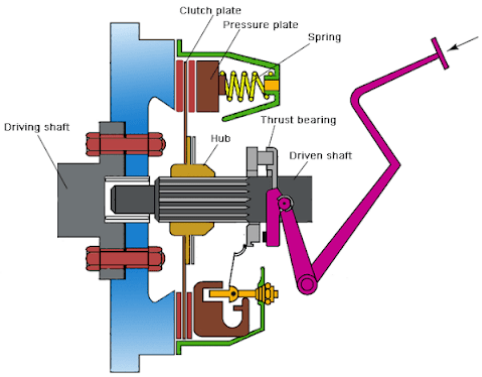
release ring. This pivots the spring about its fulcrum, relieving the spring load on the outside diameter, thereby disconnecting the drive.

III - WORKING OF SINGLE PLATE CLUTCH

In the Clutch the three parts needs. These are the engine flywheel, a friction disc or a clutch plate and a pressure plate.

Some springs give axial force to stay the clutch in the engaged position. When the engine is running and therefore the flywheel is rotating, the pressure plate also rotates because the pressure plate attaches to the flywheel. The friction disc is located between the flywheel and the pressure plate.



When the driving force has pushed down the clutch is released. This action forces the pressure plate to move away from the friction disc against the force of pressure springs. With this movement of the pressure plate, the friction plate is released, and therefore the clutch disengaged.

When your foot is off the pedal, the springs push the pressure plate against the clutch disc, which successively presses against the flywheel. This locks up the engine to the transmission input shaft, causing them to spin at the same speed.

The quantity of force the clutch can hold depends on the friction between the clutch plate and the flywheel, and in this way, much force the spring puts on the pressure plate.

When the clutch presses, the piston pushes on the release fork, which presses the throw-out bearing against the center of the diaphragm spring. As the middle of the diaphragm spring pushes in, a series of pins near the outside surface of the spring causes the spring to pull the pressure plate away from the clutch plate. This releases the clutch from the spinning engine.

Advantages of Single Plate Clutch

- The working of engagement and disengagement is very smooth in a single plate clutch.
- Power losses are very less.
- As sufficient surface area is available for heat dissipation in such clutches, no cooling oil is required. Therefore, single plate clutches are dry type.
- Single plate clutches have a quick operation and respond fast.
- It makes it easier to change gears than a cone type.

Disadvantages of Single Plate Clutch

- Single plate clutches have high wear and tear rate.
- It has less torque transmitting capacity.
- The springs have to be the more stiff hence greater force requires disengaging.
- It requires high maintenance.
- The space required to accommodate the clutch is more as compared to the multi-plate clutch.

Application of Single Plate Clutch

- Single plate clutches are used where large radial space is available.

E.g. cars, buses, and trucks

IV - MAINTENANCE OF SINGLE PLATE CLUTCH

In older vehicles and some economy models the clutch is activated by a cable, but most vehicles now days use a hydraulic system similar to brakes and power steering.

With numerous moving parts, clutches need periodic service and maintenance to avoid big problems and increase the lifespan of your vehicle. You want to make sure your maintenance is performed by a mechanic certified in transmissions, even if it's not bundled in with auto transmission services.

It usually takes about an hour for a clutch adjustment and inspection and includes checking and filling the hydraulic fluid level. It should be performed according to the service schedule for your make and model. As with other automotive fluids, clutch hydraulic fluid should also be replaced at longer scheduled service intervals.

Clutch maintenance is an oft overlooked part of keeping industrial vehicles in good running order. One of the main ways to keep a clutch in good condition is to operate the vehicle with its constant maintenance in mind. Operating your clutch with care is the best way to ensure that a vehicle with a manual transmission keeps performing at its maximum capacity.

MATERIALS PROPERTIES USED

1- Cast Iron

Composition

Carbon	0.16 – 0.18
Manganese	0.70 – 0.90
Silicon	0.40
Sulfur	0.04
Phosphorous	0.04

Physical Properties

Density (kg/m^3)	7870
Melting Point (ºC)	1370

Mechanical Properties

Tensile Strength (Mpa)	440
Yield Strength (Mpa)	340
Shear Modulus (GPa)	80
Modulus of Elasticity (GPa)	205
Hardness (Brinell)	126
Elongation at break (in 50 mm)	15%

2- Aluminum 6061

Composition

Silicon	0.4 – 0.8
Iron	0.7
Copper	0.15 – 0.40
Manganese	0.15
Magnesium	0.80 – 1.20
Chromium	0.04 – 0.35
Zinc	0.25
Titanium	0.15
Other	0.05 – 0.15

Mechanical Properties

Density (kg⁄m3)	2700
Yield Strength (Mpa)	55
Ultimate Strength (MPa)	210
Possions Ratio	0.33

Physical Properties

Young's modulus (E) (GPa)	69

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Tensile strength (σ_t) (MPa)	290
Melting temperature (T_m) (°C)	585
Thermal conductivity (k) (W/(m·K))	202

V - DESIGN METHODLOGY OF SINGLE PLATE CLUTCH

5.1 Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

The 3D CAD system CATIA V5 was introduced in 1999 by Dassault Systems. Replacing CATIA V4, it represented a completely new design tool showing fundamental differences to its predecessor. The user interface, now featuring MS Windows layout, allows for the easy integration of common software packages such as MS Office, several graphic programs or SAPR3 products (depending on the IT environment).

The concept of CATIA V5 is to digitally include the complete process of product development, comprising the first draft, the Design, the layout and at last the production and the assembly. The workbench Mechanical Design is to be addressed in the Context of this CAE training course.

Modeling of Single Plate Clutch in CATIA V5

This Single Plate Clutch is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

The same CATIA V5 R20 3d model and 2d drawing model is shown below for reference. Dimensions are taken from. The design of 3d model is done in CATIA V5 software, and then to do test we are using below mentioned software's.

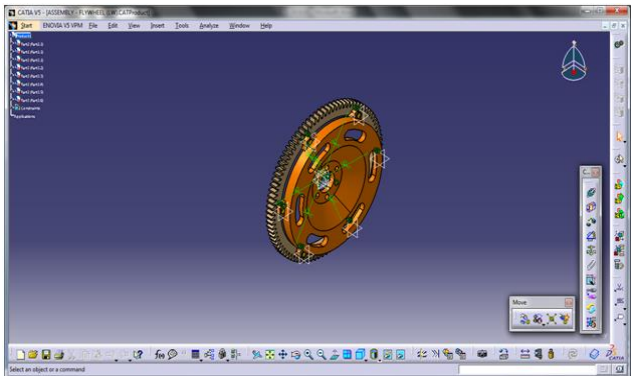

Fig: 5.2: Model design of Single Plate Clutch in CATIA-V5

VI - ANALYSIS OF SINGLE PLATE CLUTCH

6.1 Procedure for FE Analysis Using ANSYS:

The analysis of the Single Plate Clutch is done using ANSYS. For compete assembly is not required, is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

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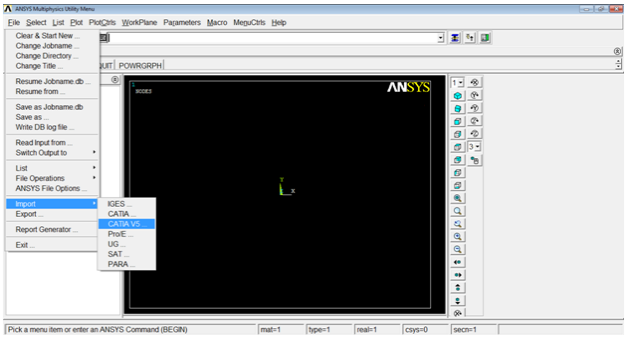

Fig.6.1: Import panel in Ansys.

6.2.1 Meshing:

Mesh generation is the practice of generating a polygonal or polyhedral mesh that approximates a geometric domain. The term "grid generation" is often used interchangeably. Typical uses are for rendering to a computer screen as finite element analysis or computational fluid dynamics. The input model form can vary greatly but common sources are CAD, NURBS, B-rep and STL (file format). The field is highly interdisciplinary, with contributions found in mathematics, computer science, and engineering.

Meshing is an integral part of the computer-aided engineering (CAE) simulation process. The mesh influences the accuracy, convergence and speed of the solution. Furthermore, the time it takes to create a mesh model is often a significant portion of the time it takes to get results from a CAE solution. Therefore, the better and more automated the meshing tools, the better the solution. From easy, automatic meshing to a highly crafted mesh, ANSYS provides the ultimate solution. Powerful automation capabilities ease the initial meshing of a new geometry by keying off physics preferences and using smart defaults so that a mesh can be obtained upon first try. Additionally, users are able to update immediately to a parameter change, making the handoff from CAD to CAE seamless and aiding in up-front design. Once the best design is found, meshing technologies from, ANSYS provide the flexibility to produce meshes that range in complexity from pure hex meshes to highly detailed Hybrid meshes.

It has a range of meshing tools that cater to nearly all physics. While the meshing technologies were developed to meet specific needs in the areas of solid, fluid, electromagnetic, shell, 2-D and beam models, access to these technologies is available across all physics.

VII - DISCUSSION ON ANALYSYS RESULT

Structural Analysis Results for Single Plate Clutch

7.1 Results of Displacement Analysis

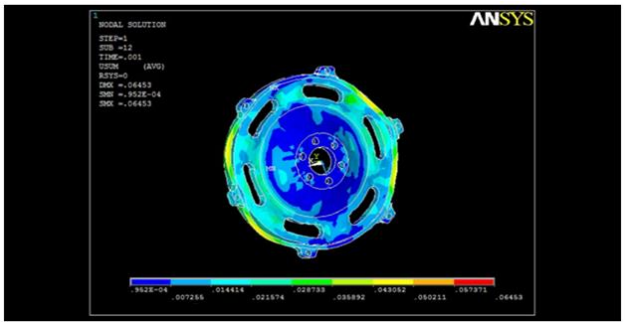

Fig: 7.1: Displacement Analysis CI

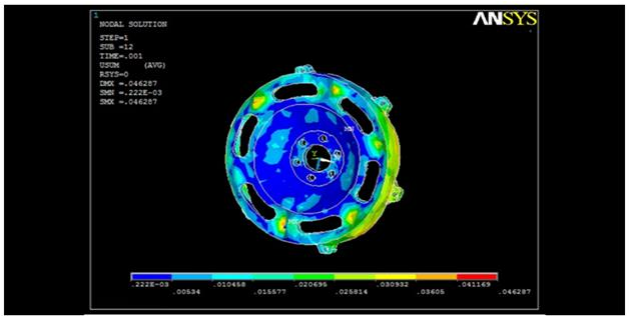

Fig: 7.2: Displacement Analysis AL

7.2 Results of Stress Analysis

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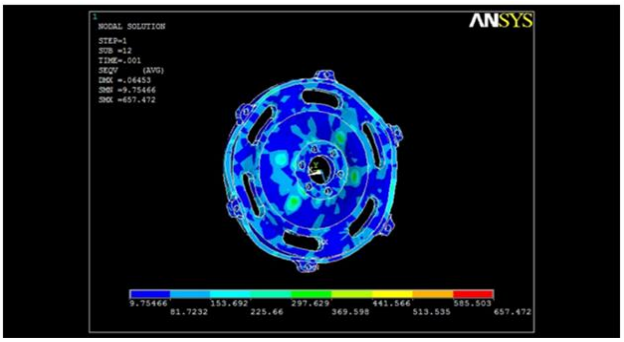

Fig: 7.3: Stress Analysis CI

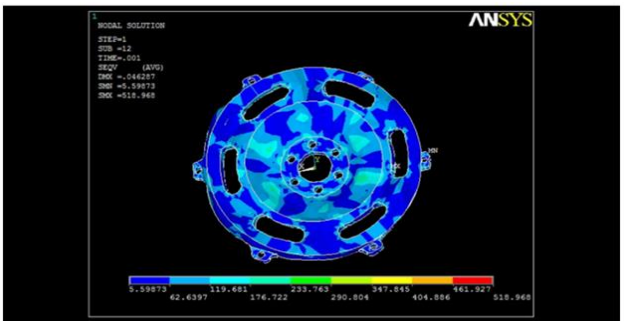

Fig: 7.4: Stress Analysis AL

7.3 Results of Strain Analysis

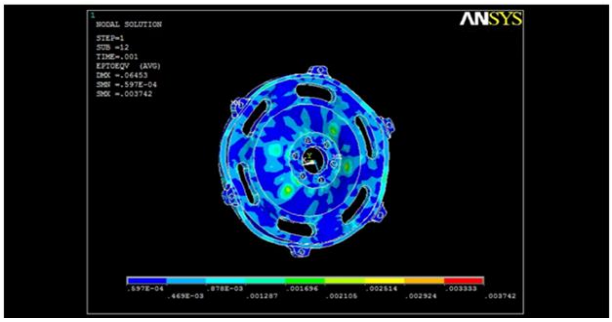

Fig: 7.5: Strain Analysis CI

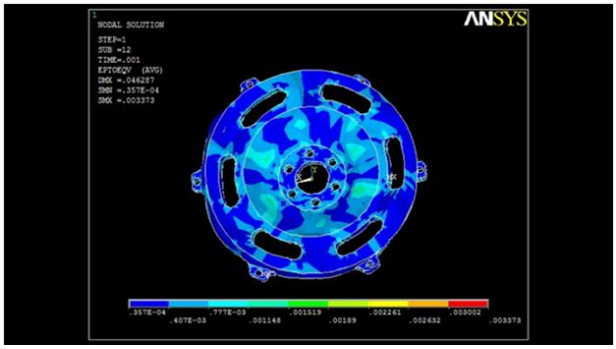

Fig: 7.6: Strain Analysis AL

VIII - CONCLUSION

It can be seen from the above result that, our objective to find out after the loads falling on the Single Plate Clutch. The design has been successful.

As shown above figures the displacement of the complete design assembly is meshed and solved using Ansys and displacement is very less. This is showing us that clearly each component in assembly is having minor displacement.

Stress is at the fixing location (Minimum Stress which is acceptable). The value is very less compared to yield value; this is below the yield point.

The maximum stress is coming, this solution solving with the help of Ansys software so that the maximum stress is very less. So we can conclude our design parameters are approximately correct. Strain acting by the designed model is at the fixing location.

Structural Analysis Results

S. No	Results	CI	AL
01	Displacement (in mm)	0.0645	0.0462
03	Stress (MPa)	657.47	518.96
04	Strain (MPa)	0.0037	0.0033

The design of the Single Plate Clutch with mechanism worked flawlessly in analysis as well. All these facts point to the completion of our objective in high esteem.

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