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Design and Fatigue Analysis of a Multi Plate Clutch

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ABSTRACT

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 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 Pro/E for Automobile Applications. We have conducted structural analysis by varying the friction surfaces material. By extracting the results Comparison is done for both materials to validate better lining material for multi plate clutch to find out which material is best for the lining of friction surfaces. Analysis is done in ANSYS software.

I. INTRODUCTION

A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft.

Clutches are used whenever the transmission of power or motion must be controlled either in amount or over time (e.g., electric screwdrivers limit how much torque is transmitted through use of a clutch; clutches control whether automobiles transmit engine power to the wheels).

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.

In a torque-controlled drill, for instance, one shaft is driven by a motor and the other drives a drill chuck. The clutch connects the two shafts so they may be locked together and spin at the same speed (engaged), locked together but spinning at different speeds (slipping), or unlocked and spinning at different speeds.

II. LITERATURE REVIEW

Structural Analysis Of Multi-Plate Clutch

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 Pro/E for Automobile Applications. We have conducted, structural analysis by varying the friction surfaces material. By extracting the results Comparison is done for both materials to validate better lining material for multi plate clutch To find out which material is best for the lining of friction surfaces. Analysis is done in ANSYS software.

III. PROBLEM DESCRIPTION

The objective of this project is to make a 3D model of the multi plate clutch and study the static, modal and thermal behavior of the multi plate clutch by performing the finite element analysis.3D modeling software (PRO-Engineer) was used for designing and analysis software (ANSYS) was used for analysis.
The methodology followed in the project is as follows:

- Create a 3D model of the multi plate clutch assembly using parametric software pro-engineer.
- Convert the surface model into Para solid file and import the model into ANSYS to do analysis.
- Perform static analysis on the multi plate clutch assembly for thermal loads.
- Perform modal and fatigue analysis on the existing model of the surface multi plate clutch.

IV. INTRODUCTION TO CAD/CAE

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation.

A. Introduction to Pro-Engineer

Pro/ENGINEER Wildfire is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated Pro/ENGINEER CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products.
Different modules in pro/engineer
Part design, Assembly, Drawing& Sheet metal.

B. Introduction to Finite Element Method:

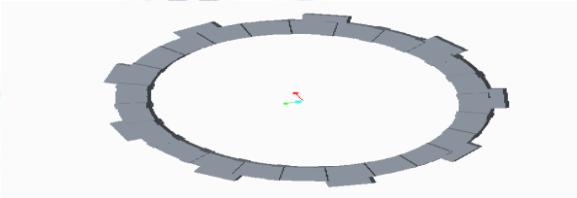
Finite Element Method (FEM) is also called as Finite Element Analysis (FEA). Finite Element Method is a basic analysis technique for resolving and substituting complicated problems by simpler ones, obtaining approximate solutions Finite element method being a flexible tool is used in various industries to solve several practical engineering problems. In finite element method it is feasible to generate the relative results.

V. RESULTS AND DISCUSSIONS

A. Models of multi plate clutchusing pro-e wildfire 5.0:

The multi plate clutchis modeled using the given specifications and design formula from data book. The isometric view of multi plate clutchis shown in below figure. The multi plate clutch outer casing body profile is sketched in sketcher and then it is extruded by using extrude option.

Multi plate clutch 3D model

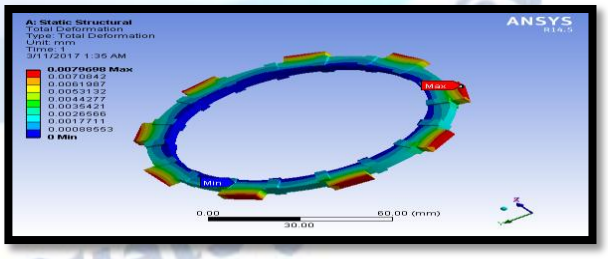


B. Static Analysis of Multi Plate Clutch

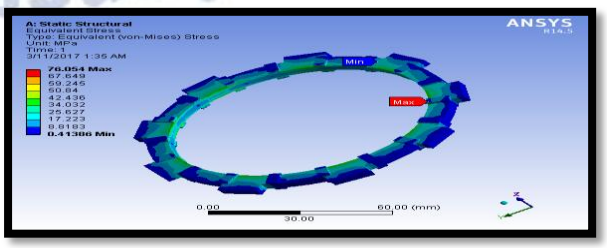
MATERIAL PROPERTIES:

ALUMINUM MMC
Young's modulus = 2.88g/cc
Poisson's ratio = 115GPa
Density = 0.30
Aluminum alloy 7075
Young's modulus = 2.81g/cc
Poisson's ratio = 71.7 GPa
Density = 0.33
E-GLASS EPOXY
Young's modulus = 1.99 g/cc
Poisson's ratio = 27600MPa
Density = 0.34

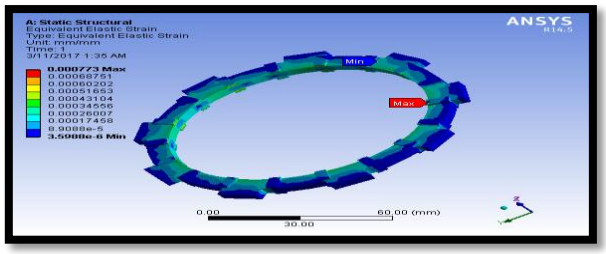
Deformation



Stress

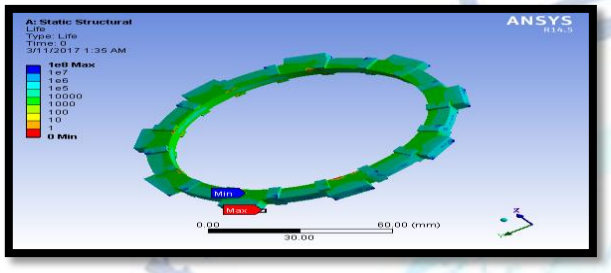


Strain

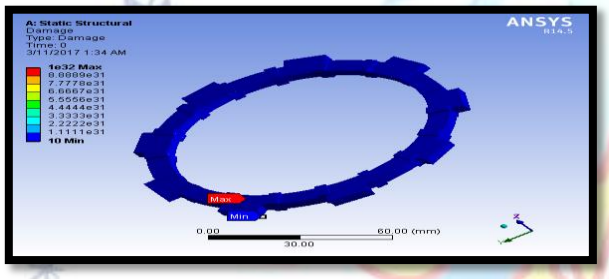


C. Fatigue Analysis of Multi Plate Clutch

Life

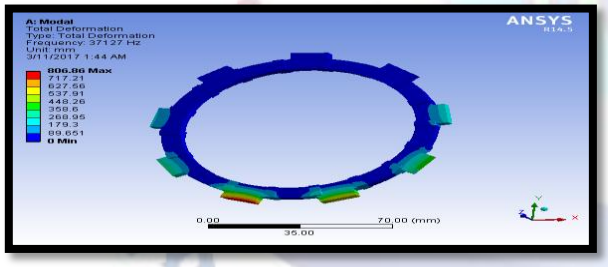


Damage

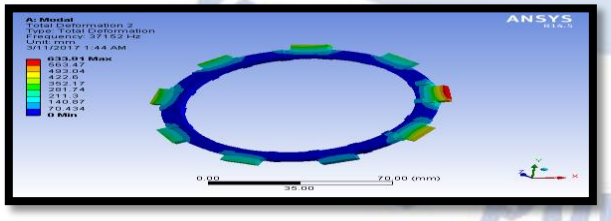


D. Modal Analysis of Multi Plate Clutch

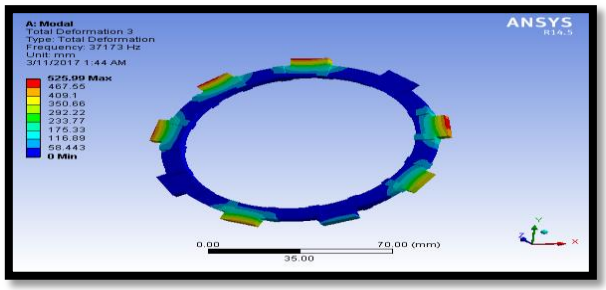
mode shape 1



mode shape 2



mode shape 3



VI. RESULTS AND DISCUSSIONS

Static Analysis Result Table

Material	Deformation(mm)	Stress(MPa)	Strain
Aluminum MMC	0.0079698	76.054	0.000773
Aluminum alloy7075	0.0012704	72.84	0.00011943
E-glass epoxy	0.032919	71.84	0.0030631

Modal Analysis Results

Material	Mode shapes	Deformation (mm)	Frequency (Hz)
Aluminum alloy7075	1	806.86	37127
	2	633.91	37152
	3	525.99	37173
	4	637.42	37191
	5	583.48	37224
Material	Mode shapes	Deformation (mm)	Frequency (Hz)
E-glass epoxy	1	796.76	29758
	2	613.34	29780
	3	542.98	29803
	4	598.25	29822
	5	584.22	29860

Fatigue Analysis Results

Material	life	Damage	Safety factor
Aluminum MMC	1×E8	1×E32	2.0828
Aluminum alloy7075	1×E8	1×E32	2.0953
E-glass epoxy	1×E8	1×E32	2.0994

VII. CONCLUSION

In this thesis the steam flow in multi plate clutchtubes is modeled using PRO-E design software. The thesis will focus on thermal and CFD analysis with different velocities (25, 30, 35& 40m/s). Thermal analysis done for the multi plate clutchby steel, stainless steel& brass at different heat transfer coefficient values. These values are taken from CFD analysis at different velocities. By observing the CFD analysis the pressure drop, velocity, heat transfer coefficient, mass flow rate & heat transfer rate increases by increasing the inlet velocities. By observing the thermal analysis, the

taken different heat transfer coefficient values are from CFD analysis. Heat flux value is more for brass material than steel& stainless steel. So we can conclude the brass material is better for MULTI PLATE CLUTCH.

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