Design and Analysis of Friction Clutch Plate

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Abstract—The main purpose of a clutch is to initiate motion or increase the velocity of a body generally by transferring kinetic energy from one to another moving body. This paper is represent a general study of design and analysis of friction clutch plate. In which we design a clutch plate model by CATIA software and then static structural analysis has to be done by using ANSYS software. An experimental work is also performed to observe the strength and deformations of clutch plate.

Key words: Friction clutch plate, CATIA software, ANSYS software

I. INTRODUCTION

The clutch is a mechanical device, which is used to connect or disconnect the source of power from the remaining parts of the power transmission system. 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 are to be shifted. The clutch can connect or disconnect the driving and driven shafts, as and when required by the operator. There is a basic difference between initial and final conditions in clutch operation.

A. CATIA Software:

CATIA (Computer Aided Three Dimensional Interactive Application) developed by Dassault Systems, is one of the world’s leading CAD/CAM/CAE packages. Being a solid modelling tool, it not only unites the 3D parametric features with 2D tools, but also addresses every design-through-manufacturing process. CATIA V5 serves the basic design tasks by providing different workbenches.

B. ANSYS Software:

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. The software implements equations that govern the behavior of these elements and solves them all creating a comprehensive explanation of how the systems act as a whole. These results then can be presented in tabulated or graphical form. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations. ANSYS is the standard FEA teaching tool within the Mechanical Engineering Department at many colleges.

Rajesh Purohita, Poona Khitoliyab and Dinesh Kumar Koli(4) a clutch is to initiate motion or increase the velocity of a body generally by transferring kinetic energy from another moving body. Solid Works Office Premium software. The assembly comprises of the clutch plate, the pressure plate and a diaphragm spring. Static structural analysis was done using ANSYS software. The plots for equivalent stress, total deformation and factor of safety were obtained and the design was continuously optimized till a safe design was obtained. Uniform wear theory was used for the analysis. The material assignment is as follows: clutch plate-structural steel, pressure plate- cast iron GS-70-02 and diaphragm spring- spring steel. Muhammad Zahir Bin Hassan(3) Finite element analysis is use to predict the maximum stress can be apply to the disc. structure analysis of cast iron for dry clutch disc of amphibious vehicle. The main focus that needs to be considered is the torque produced from the engine. Finite element analysis is use to predict the maximum stress can be apply to the disc. Kong Guolong Zhong Zaimin, Yu Zhuoping(1) Torque transfer feature is the is the inherent characteristic of clutch, which determines the performance of clutch, acquisition of accurate torque transfer feature of clutch will provide active role for launch and shift control of clutch. A new method of calibration of clutch torque transfer feature based on constant engine speed launch control is proposed in this paper, and this control algorithm is validated through the simulation, and the results show excellent performance of the calibration of the clutch feature.

V Mani Kiran Tipirineni, P. Punna Rao (6) The 3D model of clutch plate was drafted using Solid works software and analysis of the plate was done for static loading condition. This project finds the maximum stress in failure region during operation. This project also suggests three design modifications to the company to improve the life time of the clutch plate. P. Naga Karna, Tippa Bhimasankara Rao(7) observe the stress distribution and the temperature distribution of the clutch plate by changing the material. And for that we are taken one existing clutch plate dimensions and modeled it by using Pro-e after analysis is done by using Ansys. Here we have done two types of analyses on clutch plate namely static analysis and thermal analysis.

II. DESIGN AND ANALYSIS WORK

We design a clutch plate modeled in CATIA V5R16 and imported in ANSYS 14.0 workbench. The structural analysis has been carried out of structural steel material clutch plate. We analyzed the three factors equivalent von-Mises stress, Total Deformation and factor of safety clutch plate. table 1 shows that the dimensions of clutch plate.

<table>
<thead>
<tr>
<th>S no</th>
<th>Parts name</th>
<th>No of parts</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Spline hub</td>
<td>1</td>
<td>Outer diameter 60 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inner diameter 25 mm</td>
</tr>
<tr>
<td>2</td>
<td>Ms sheet</td>
<td>1</td>
<td>Outer diameter 150 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inner diameter 60 mm</td>
</tr>
<tr>
<td>3</td>
<td>Rivets</td>
<td>16</td>
<td>Diameter 5 mm</td>
</tr>
<tr>
<td>4</td>
<td>spring</td>
<td>6</td>
<td>Pitch 5 mm</td>
</tr>
</tbody>
</table>
### Table 1: Dimensions of Clutch Plate

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>20 mm</td>
</tr>
<tr>
<td>Length</td>
<td>40 mm</td>
</tr>
</tbody>
</table>

**III. Procedure of Software Work**

A Mesh was created (Dividing the model into small elements). Material property and geometry data were defined. The Environment (a combination of loads and supports) was defined follows: Loads: Moment: 176.3 N-m (each side); Pressure: 0.7 MPa. The Model was submitted to the ANSYS solver and the solutions for the Equivalent von-Mises stress, Total Deformation and Stress Tool were obtained.

**Fig. 1:** The Equivalent Von-Mises Stress Plot For The Clutch Plate

Fig 1 shows the statically structure analysis, in which the maximum value of von mises stress of clutch plate is $3.0671 \times 10^8$ and the minimum value is $1.4072 \times 10^5$.

**Fig. 2:** Total Deformation Plot For The Clutch Plate

Fig 2 shows the statically structure analysis in which the maximum value of Total Deformation of clutch plate is $0.001776$ and the minimum value is $0$.

**Fig. 3:** The Factor Of Safety (Stress Tool) Plot For The Clutch Plate

The figure 1 shows the distribution of equivalent von-Mises stress over the clutch plate. The figure 2 shows the distribution of total deformation over the clutch plate. The figure 3 shows the distribution of Factor of Safety (Stress Tool) over the clutch plate which shows that the minimum factor of safety for the clutch plate is greater than 10.

**IV. Experimental Work**

In experimentally observe the clutch plate strength and deformations are present in clutch plate.

<table>
<thead>
<tr>
<th>TEST CARRIED OUT</th>
<th>OBSERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample-1</td>
</tr>
<tr>
<td>Tensile strength in MPa</td>
<td>501.58</td>
</tr>
<tr>
<td>Yield stress in MPa</td>
<td>361.90</td>
</tr>
<tr>
<td>Elongation in %</td>
<td>32.85</td>
</tr>
</tbody>
</table>

**V. Conclusion**

1) The following are the main conclusions of this software investigation:
   - The maximum value of von mises stress of clutch plate found is $3.0671 \times 10^8$, and the minimum value is $1.4072 \times 10^5$.
   - The maximum value of Total Deformation of clutch plate is $0.001776$ and the minimum value is $0$.
   - Maximum deformation found in outer area of plate. Minimum deformation found in centre position of the plate.
   - And Software analysis showed that the designed friction clutch assembly is safe.

2) In experimentally observation we found that the strength and deformation of clutch plate.
REFERENCES


[4] Rajesh Purohita, Pooja Khitoliyab and Dinesh Kumar Kolic, “a,cDepartment of Mechanical Engineering, MANIT- Bhopal (MP) India. manufacturing Process and Automation Engineering Department, Netaji Subhas Institute of Technology, (NSIT), Dwarka, New Delhi, India”


