Computer Aided Design and Analysis of Load Deflection Behaviour Of Diaphragm Spring used in Clutch Assembly

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Abstract - *Slotted disc springs, diaphragm springs, and plain diaphragm washers are all specific types of springs used to store mechanical energy in the vehicle clutch assembly. The Diaphragm spring's main purpose is to store a lot of energy in a small amount of area. The Diaphragm spring is a conical-shaped washer with axis symmetry.*

In the current work, a typical diaphragm spring is taken into account for the numerical analysis of force and is first modeled in the CATIA v5r12 simulation programmed before being further examined in ANSYS 14.0. For a good analysis, the top edge of the spring is given the displacement, and at rest all directions for that edge are completely limited.

The base edge of the spring is confined in all directions, while the upper edge is given a displacement equal to twice the height of the spring for all materials taken into consideration. These two boundary conditions are supplied in this work.

Key Words: Diaphragm spring, FEA, CATIA, ANSYS, Load deflection values.

1. INTRODUCTION

1.1. Introduction of Diaphragm Clutch / Slotted Disk Spring

The slotted cone-shaped disc spring is a modification of the regular conical disc spring or Belleville spring in as much as it has regularly arranged slots extending from the inside diameter.

A diaphragm spring undergoes a larger deflection at a smaller load comparing with a regular disc spring or Belleville spring of comparable dimensions, thereby combining some of the advantages of the disc spring and the cantilever type spring in a single unit. It is used, wherever stacking is unsuitable, a relatively large outside diameter of the spring is acceptable, and a regressive loaded deflection characteristic curve is desired, like in clutch applications.

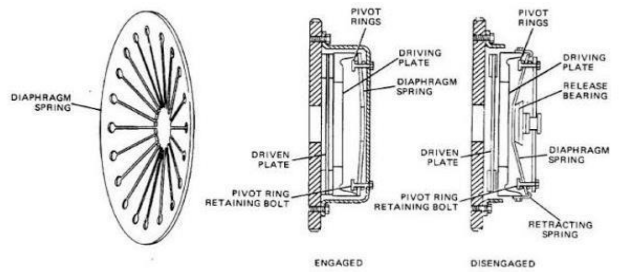

Figure 1.1: The Diaphragm spring used in Clutch Assembly

1.3. The load-displacement behavior of a diaphragm spring: Several analytical studies have been developed specifically to extend the constant applied load within the load-displacement in order to increase the performance of the nonlinear load displacement.

A disc spring's cross-thickness section's profile can be changed to achieve this. Fast growing load exposure can be prevented by maintaining the constant applied load within the intermediate load-displacement region.

1.4. Uses for a Diaphragm Spring

For cars and small commercial vehicles, it is utilized commercially. This specific spring is quite small, only has a few functional parts, and is best suited to light automobiles. In this study, we employ a diaphragm spring clutch load. The approximate formula suggested by Almen-Laszlo for deformation characteristics is commonly adopted.

2. OBJECTIVE OF WORK

2.5. This work's outline:

The diaphragm spring is briefly described in Chapter 1 along with its function, characteristics, and uses.

The various research articles on diaphragm spring clutch are represented in Chapter 2 so that we may obtain an understanding of what has been done and what we might do for our own research.

Chapter 3.The modelling of a diaphragm spring and the formulae required to calculate a diaphragm spring is both shown in

Chapter 4 provides and analyses the simulation findings as they were produced by the ANSYS programmed in terms of load and displacement.

Based on the simulation findings acquired in chapter 4 and the conclusion and future scope presented in chapter 5,

To help with understanding, references and annexure will finally be supplied.

3. SIMULATION AND MODELING OF DIAPHRAGM SPRING

3.1 Diaphragm Spring Modeling: In the current study, a diaphragm spring model is built using the CATIA V5R12 software's part design workbench after initially creating a 2D sketch using the sketching module.

The revolve tool on the CATIA 3D workbench is used to create only a half-side sketch, which is subsequently rotated with respect to the sketch's axis.

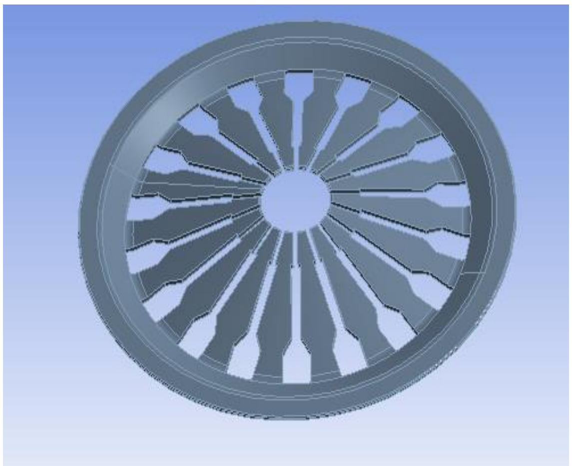

Figure 3.1 CATIA model of Diaphragm spring

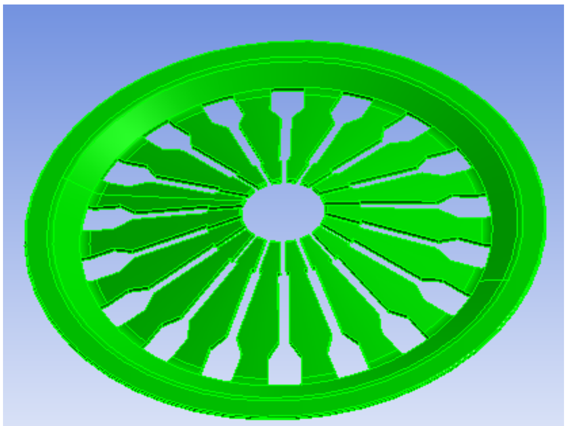

Figure 3.2: CATIA model imported as IGES file

The model is imported, and after that, it meshes into a limited number of elements for the disintegration of the entire part. This is done to make the body malleable so that the model may be analyzed; if it is not done, ANSYS will treat the body as stiff, making further analysis impossible.

Modeling of Diaphragm Spring:

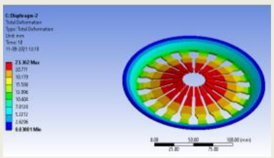

Figure 3.5: Deformation in mm for aluminum alloy.

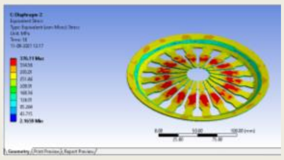

Figure 3.6: Stress in MPa for aluminum alloy.

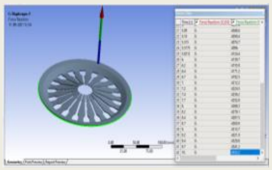

Figure 3.7: Force obtained in Newton for aluminum alloy.

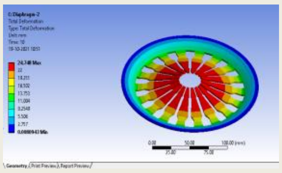

Figure 3.8: Deformation in mm for magnesium alloy.

Modeling of Diaphragm Spring:

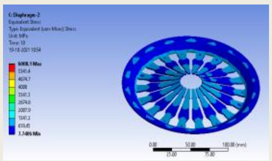

Figure 3.9: Stress in MPa for magnesium alloy

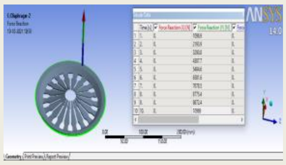

Figure 3.10: Force obtained in Newton for magnesium alloy

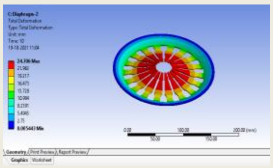

Figure 3.11: Deformation in mm for mild steel

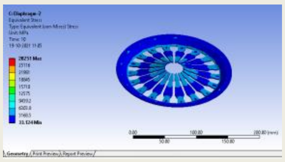

Figure 3.12: Stress in MPa for mild steel

Modeling of Diaphragm Spring:

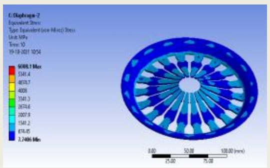

Figure 3.9: Stress in MPa for magnesium alloy

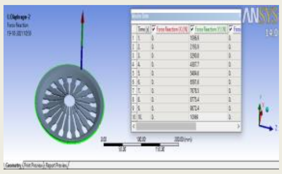

Figure 3.10: Force obtained in Newton for magnesium alloy

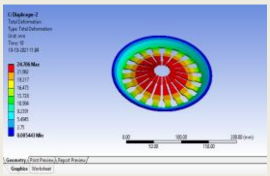

Figure 3.11: Deformation in mm for mild steel

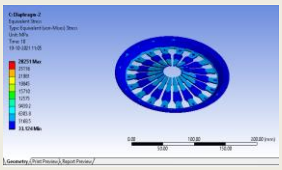

Figure 3.12: Stress in MPa for mild steel

Sr. No.		Displacement	Stress	Reaction Force
1.	Mild Steel	24.706 mm	28251 MPa	48502 N
2.	Magnesium Alloy	24.748 mm	6008.1 MPa	10969 N
3.	Aluminum Alloy	23.362 mm	376.11 MPa	4352.2 N

4. DISCUSSIONS:

Based on the analysis presented here, the following conclusions have been drawn:

1. In practically all of the materials taken into consideration, the displacement obtained is comparable.

2. The stress obtained in the aluminum alloy is found to be minimal for the same value of displacement for the same boundary conditions.

3. The reaction force value in Aluminium alloy is determined to be minimal for the same value of displacement for the same boundary circumstances.

4. When compared to Aluminium alloy, the induced stress and induced reaction force values for the applied loading condition are substantially higher for the magnesium alloy.

5.1 CONCLUSION

The diaphragm spring is used in this work rather than just the Belleville spring, and the impact on clutch operation is determined using the deformation, stress, and response force criteria. Additionally, the animation is viewed in a virtual setting so that viewers may observe the washer in action. Additionally, by plotting the force-displacement curve to view the variations in outcomes of the same, the comparative analysis can be more thoroughly analyzed.

It is necessary to test the capacity of the CATIA modelling and ANSYS analysis software to determine whether or not using the simulation technique is practical.

According to force, stress, and displacement requirements, it has been discovered that the order of the best materials for automobile clutch applications will be as follows: Aluminium alloy, magnesium alloy, and mild steel.

Aluminium alloy > Magnesium alloy > Mild steel

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