International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 02 | Feb 2020 www.irjet.net p-ISSN: 2395-0072

Research Review on Analysis of Load- Stress Deflection Characteristics of Modified Diaphragm Spring

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Abstract - *Diaphragm spring washers are elastic washers that have circular shapes. They are flexible axially and deflect like springs when they are compressed. Diaphragm spring washers provide preload between two fastened surfaces and are wont to prevent loose fastening, absorb shocks, and eliminate play and uniform load. Diaphragm spring washers are often employed when space is constrained, and moderate load is applied in the operation. In this paper, a systematic method is presented for designing and analyzing Diaphragm spring washers. In model Diaphragm spring washer, a slanted surface is first utilized to define the axial cross section. Solid model of diaphragm. The spring washer is then generated through rotating the slanted Surface with its central axis. The solid model of a Diaphragm spring washer is totally decided by its four geometric parameters: the internal and external diameters, the thickness of the washer and its height. The design of a Diaphragm washer is systematized during this paper as optimizing its four geometric parameters. The analysis of a Diaphragm washer is conducted based on its solid model. Examples on designing and analyzing Diaphragm spring washers are presented in the paper to verify the effectiveness and demonstrate the procedure of the introduced method.*

Key Words: Belleville Spring, FEA, CATIA, ANSYS, Load deflection curves, h/t ratio

1. INTRODUCTION

The Belleville spring is usually loaded only at its edges by circumferentially uniform loads, axial in direction and with a sense such that they tend to reduce the cone angle. In most cases the edges are completely free to move. However, certain applications require that either the outer edge be restrained from radial expansion, as would be the case if the spring were inserted in a cylinder, or that the inner edge be restrained from radial contraction, as would be the case if a shaft were inserted through the spring. Some applications may require that both of these restrictions be imposed.

1.1Characteristics of Belleville Springs

The simplest type of spring, a prismatic tension specimen, exhibits a characteristic which is typical of structural members in the elastic range: a linear load deflection curve. Accordingly, the helical spring, the volute spring, the ring spring, and most common springs have a straight relationship between load and deflection. On the other hand, Belleville spring usual1y have a nonlinear relationship between load and deflection, and it is possible to design Belleville springs with many differently shaped load deflection curves. By varying the fundamental parameters, it is possible to obtain positive, zero, and even negative spring rates in given portions of the load deflection curve.

The clutch provides a temporary connection between the engine and the gearbox by transmitting engine torque and engine speed in addition to the comfort function of the clutch. One of the com- fort tasks is to damp the vibration while transmitting torque and speed towards the gearbox. The clutch compensates for vibrations through radial and axial springs. The friction force is obtained by a com-press Belleville spring to the disc assembly. Absorption of vibration is a key according to the characteristic of the engine of the vehicle, and the required torque is calculated. In this study, the load calculation of Belleville spring was done and optimized, and then the results were investigated.

Studies on the Belleville spring are limited in the literature and only a few studies have been found about Belleville washer's FEA modeling. No study has been done on the clutch Belleville spring regarding the behavior of stress and deflection compared to the Belleville spring, but the parameter optimization to obtain the required load and stress values.

The performance of the Belleville spring under com- press load was compared between the simulation and experimental results. He investigated Belleville spring stress and deflaction among experimental Method and FEA method. They reduced the deviation between the results by changing the element formation [1]. Friction clutch design was done with dual Belleville Springs and Friction Plates. They reduced the number of components required by using a Belleville spring as a friction plate [2]. The method was developed to predict the deformation behavior of the Belleville spring under axial load using minimum potential energy theory. The classical thin shell theory in a conical coordinate system was used to prepare Belleville Springs by strain energy and function. Their method brings more precise results between the pre-assumptions and the finite element method than the Almen and Lezlo equation [3]. Composite material was applied to Belleville springs instead of steel and the composite material provides similar load and deflection characteristics with steel.

Belleville Spring has been shown to be of little interest as clutch elements, with no studies about the shape adaptation of Belleville Spring to be the target curve under stress constrained. The shape of the Belleville spring has been optimized in this study. Load and stress results were obtained by the finite element method. The design of the experiment was applied to the Latin hypercube sampling method. An evolutionist

1.2 Function of diaphragm spring

The diaphragm spring can be a steel disc with a hole in the middle, and therefore the inner part of the disc is moved sequentially to form a variety of inductive (release-lever) fingers. The outer end of the slotted square measurement is given enlarged blunting holes, which distribute the concentrated stresses created during finger deflection, and in addition provide a way of finding rivets of the body part that pin rings. Controls. Landed, it is a shapely shape. As the pressure plate cowl tightens, it pivots on its pin rings, and the dead set exerts a force on the flat pressure plate, and also the facings. The transmission input shaft passes through the pressure plate. Its parallel splines interact with the internal division of the central disc on the friction disc. With engine rotation, the force current will be transmitted from the regulator disc, through the friction disc, to the central hub and transmission. When the foot lever is depressed, the operation is transferred to the operation fork through the operation mechanism as well as an uncontrollable bearing. The release bearing moves forward and the diaphragm pushes the middle of the spring toward the regulator. The diaphragm on its pin ring stimulates pivots that maneuver incorrectly and act on a pressure-plate retention clip. The pressure plate disintegrates, and the drive is no longer transmitted. Releasing the paddle allows the diaphragm to reapply its clamping force and has a clutch interaction, and the drive is rebuilt.

1.3 Literature review

Several researchers have performed stress and deflection analysis of a Belleville spring.

Monica Carfagni [1] performed stress and deflection analysis to formulate CAD method for checkout and design Of Belleville Springs. The method eliminates the need to resort to traditional trial and error techniques. In a matter of seconds, it examines fast and correctly and designs Belleville Springs, producing load conversion Attributes in graphic and table formats and can produce a drawn drawing.

Yes. Schraffmer [2] carried out stress and deflection analysis of a slotted Belleville spring to develop an analytical relationship for Deflection and tension of a speckled conical spring.

Anudeep and others [5] designed Belleville Spring washer using a mathematical approach. He built it using CATIA software. They Also analyzed finite elements Belleville Spring Washer was designed. Fixed Structural analysis was performed. Material The chosen was H-13 tool steel.

Dubey and Bhope [6] demonstrated tension and Deflection analysis of a disk spring using finite Element Method. Different combination Ratio of its outer diameter and internal Diameter, (rd) and its height for thickness (h / t) is considered to be investigated Major stresses on internal () i) and external () o) with spring surface Deflection. FE results compared with existing analytical results. Seen it analytical values of principal stress Are greater than the FE value for the outer surface for all ratios of rd and h / t. But as h / t increases Deviation between analytical and FE values Also increases. This trend was also seen For deflection. Also the analytical equation Deflection may be prone to high error For higher loads due to the values of D / D and H / T.

Swieskowski [11] developed an analytic Procedure for the design of Belleville washers for energy efficiency. They set the tension Reduction that is obtained by substituting a single Washer assembly by a nested arrangement. In addition they determined optimal stacking Belleville Spring Arrangement.

Dharan and Bawan [4] demonstrated feasibility Study of replacing steel disc spring Composite material. Design equation for Steels was modified for composite materials. There were many prototype disc springs Built, tested. They were compared with equivalent steel springs. Result indicated that composite materials could replace Steel for making disc spring. Also, there was a lot of collective savings.

Atxaga and others [6] demonstrated failure Analysis of various disc springs Stainless Steel.

Patangalto and others [9] Isotropic and composite analyzed disc springs. An application of the Ritz the method based on energy approach was discussed to predict deformation and load Features of such disc springs.

Analyzed the effects of Ozaki and others [10] Friction limits on static and dynamic The behavior of the cone disk spring. They narrowed Element method for this analysis.

Karkaya [9] examined the effectiveness of the overall Disc springs with different cross-sections and washers are usually round shaped discs that serve Increase the area of contact between the bolt head or nut and Buried parts. A washer bolt is usually used Need to distribute compression load on clamped part on a larger area than what the bolt head or nut can provide. Using a washer also prevents damage to the bearing

Surface adjacent to fastener by tightening nut [12]. Washers are important components in fastening and assembly Operations. In addition to acting as a seat for bolts, nuts, screws and rivets, washers perform many other functions including Insulating, sealing, locking, spacing, improving appearance, Taking spring, aligning, distributing load. Washer Are indispensable for the functions of many machines or Importance for devices and their operation [13].

Spring washers are used to provide offset conditions. To introduce tension, or repetition action of bolted assembly Springs. Even if the duration of their deflection is limited because of their size and especially their height. A Some better performance can be expected pairing multiple washers together. Their stacking capacity, With their compatibility and versatility, spring makes Washers quite advantageous where used in confined places or where a stationary function is required [14].

1.4. CONCLUSIONS

Belleville spring washer's elastic washers and Circular shape their axial cross section is rectangular Shape. A solid model for designing a Belleville spring washer Need to be installed. For a Belleville Spring Washer model, A tidy rectangle is drawn first which is defined by four Design Parameter of Belleville Spring Washer: Interior And outer diameter, washer height and thickness. The inner and outer diameters are measured vertically Belleville spring washer's axle while washer height with washer axis.

Washer thickness the value of the short length of the oblique rectangle. With him made rectangular, solid model of Belleville the spring washer can be installed by rotating the stand Rectangle with respect to the washer axis. Designing a Belleville Spring Washer is organized in this research Optimization of four design parameters for design Belleville spring washer to fulfill your desired performance Requirements. Standard Belleville Spring Washers have been widely used for various applications due to their convenience to construct. However, the standard Belleville spring washers A disadvantage is the amount or weight of their contents. Belleville to reduce the amount or weight of material for spring Washers, five different size modifications (internal slots,) Outer slot, middle hole, mixed hole and inner slot, Mixed holes and external slots) are presented in this research. Belleville spring washers with modified shapes are analyzed and compared with their standard Belleville spring washer. Belleville spring washer with mixed holes And much less material is found in the outer slot than the It's associated standard Belleville spring washer. The maximum stress within a standard Belleville spring washer is Much more than it's associated Belleville spring washer with mixed holes and internal slots when they occur under the same input displacement.

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