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STARTUP LOW COST MECHATRONICS PRODUCT DESIGN OF A SPRING LOAD TESTER

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Abstract

Springs possess an inevitably prominent position in the vast applications of mechanical systems. Springs have its usage in almost everything ranging from small toys, wrist watches to large dies and vehicles. Startup India is a flagship initiative of the Government of India, intended to empower and grow through innovation and design. During innovation, one has to clearly define the problems, needs and specifications of project. Specifications translate the problems and needs into the realization of the project design, subsequent manufacturing, testing and launch of the product in a competitive market. In the present work, a spring load tester has been developed at a much lower than available in the market using mechatronics product design concept. It has no wear and tear, is smaller in size and accuracy is better than other available products in the market. Spring load testing equipment is suitable for use in industry and academic institutions for various practical applications.

Keywords: *Spring, stiffness, innovation, mechatronics product design, startups.*

1.Introduction

Springs are very important mechanical components that find a variety of indispensable applications everywhere including industries, automobiles, educational institutes and many products of day to day use. Springs are elastic bodies which have ability to distort or deflect when a load is externally applied and as soon as the load is removed the spring tends to regain its initial structure. Springs are used to absorb and release the energy as per the application of its use. To ensure a high performance, it is very important to analyze the springs before it is used or incorporated in any assembly or during its replacement. Spring stiffness is indisputably one such prominent aspect that needs to be essentially tested and it differs as per the type of application.

Aouraze et al. (2017) worked on load cells that detect the load applied in form of change in electrical signal which is displayed on digital display unit. The deflection is measured from the pointer scale fixed on the tester. As springs follow Hooke's law of elasticity that states that the load applied will be directly proportional to the deflection caused.

Patil et al. (2018) developed a machine that causes deflection to a stationary spring by load applied through hydraulic jack. This load compresses a piston rod that in turn creates a force on load cell incorporated in the machine and reading of load is taken. An ultrasonic sensor is employed to take the reading of deflection. Readings of sensor and load cell are transmitted to microcontroller and using the proper interface devices, displayed on the digital display.

Praseed K. et al. (2017) created a CAD model of the tester and the model analysis was done by ANSYS. The analyzed model was then manufactured and employed for the purpose of checking the valve springs that find applications in engines.

Belapurkar and Jadhav (2015) adopted a new approach to calculate stiffness of springs. They have used a spring with known dimensions and adjusted it within the machine plates. The stiffness and frequency of master springs is used to give the stiffness of spring at any other random frequency. A ratio is developed. Using the ratio of master springs, other springs are tested for stiffness.

Pathan et al. (2017) also developed a spring stiffness tester. In this machine, a force is transmitted from a large cylinder to a lever after amplification that in turn moves the piston rod that further compresses the test spring seated inside the small cylinder. A load cell incorporated in small cylinder reads the pressure exerted and deflection reading is taken by the scale. Hence, using the Hooke's law of elasticity, deflection and load readings are used to calculate stiffness.

Nagre et al. (2017) developed a hydraulic spring stiffness testing machine. This force applied for compression is measured through a pressure gauge and deflection of spring is read in units of length.

2.Experimental Set Up

Figure 1: Spring load stiffness tester for helical springs

The experimental set up employed has following main components:

1. Frame or structure
2. Base or platform
3. Hand wheel
4. Upper and lower anvil
5. Scale with pointer
6. Digital display unit

The low cost helical spring stiffness tester has been manufactured in the present work. The test spring is placed between the two anvils. Lower anvil is stationary whereas upper anvil is movable. The machine uses left handed screw. Hence, rotating the hand wheel counter clockwise, the upper frame is pushed along with the upper anvil downwards and a clockwise rotation will result in its upward movement. The lower anvil is seated on a load cell element. A scale with a pointer is placed on one of the side frame. The entire frame sits on a rugged base. The digital display unit is provided that gives the reading of load in kgf. The digital display is both battery operated as well electricity operated through electrical cable. The setup is designed to take a load in the range of 1-200 kgf.

3.Methodology

The set up is first switched either on battery power or by connecting the cable to an electrical power source. When the digital display shows 0, the helical spring to be tested is placed on lower anvil. Using counter clock wise movement of hand wheel, the upper movable frame is made to just touch the upper part of the vertical helical spring. The position of pointer on the scale is noted. Then, the hand wheel is further rotated to apply load on the spring through upper anvil to take multiple readings of load from the display unit in order to avoid error. The corresponding readings of deflection are taken in the unit of length from the scale.

Load exerted on the spring is transmitted to lower anvil from where it is detected by load cell resulting in a change in shape of strain gauge incorporated into it. This induces a strain that is converted into an electrical signal.

$$\frac{\Delta R}{R} = G \in$$

Where, R = Resistance
G = Gauge Factor
∈ = Strain
The reading of load obtained in kgf can be converted in Newton and using the readings of load in N and deflection in mm, stiffness can be measured from the Hooke's law:

$$F = kx$$

Where, F= Load in Newton
x = Deflection of spring in mm
k = Stiffness of spring in N/mm
Hence, Stiffness = Load/Deflection

Also, using spring design equations, stiffness can be denoted as:

$$k = \frac{Gd^4}{8ND^3}$$

Where, G = Modulus of rigidity
d = Wire diameter
N = Number of active coils
D = Mean coil diameter

4.Conclusion

This work provides an economical and reliable substitute to costly and complicated spring stiffness machines available at present. This electromechanical system is easy to understand and operate with higher accuracy even by a less skilled operator. The digital display unit gives a direct reading, thereby decreasing the time involved in the process of optimization of parameters of different springs. The provision of battery operation further adds on to the advantages by facilitating the operator to take the reading anywhere, even in absence of proper electrical supply. This set up is extremely beneficial for carrying out the experimental work in educational institutes and industries.

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