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HYDRAULIC SPRING STIFFNESS TESTING MACHINE

Laxman Paliwal,
Student, BE mechanical Enggt., ICEM, Pune, INDIA
Laxmanpaliwal00@gmail.com
Shankar Padole,
Student, BE mechanical Enggt., ICEM, Pune, INDIA
Shankarpadole996@gmail.com
Akshay Baravkar,
Student, BE mechanical Enggt., ICEM, Pune, INDIA
Akshaybaravkar55@gmail.com
Rushikesh Pataskar
Student, BE mechanical Enggt., ICEM, Pune, INDIA
krishipataskar@gmail.com
Mr. PuspendraUpadhyay
Mechanical Engg. Department, ICEM,Pune,INDIA
Puspendra.upadhyay@indiraicem.ac.in

ABSTRACT

In many engineering machines and mechanisms spring is an essential component used for proper functioning of that machine for maximum efficiency, there are many applications of springs in automobile suspension system, IC engine valves , brakes, clutches, measurements of weights, for storing energy such as in spring type accumulator, in shock absorber, in hydraulic components such as hydraulic cylinders, pressure relief valves, flow control valves etc. But according to the our market survey and observations sometimes spring used in above applications having a many defects such as manufacturing defects, processing defects like defects occurs at the time of hardening sometimes this causes the more hardened spring which has more stiffness value and sometimes causes a less stiffness value of spring, hence this creates a problems on the applications of the springs for proper uses and creates a problems in working of that machine components.By considering this problem we can easily measure spring stiffness by using this machine in low cost.The main objective of this project is to determine the stiffness which is commonly known as spring constant of a compression spring under various load. The kit which has been built into a machine to stretch or compress test springs, while measuring load and displacement is called spring testing kit. It tests springs and finds their properties – good for mechanical workshops use.

Keywords: Spring, Stiffness, Ultrasonic Sensor, Load Cell ,Lcd display

INTRODUCTION

A spring is an elastic machine element, which deflects under the action of the load and returns to its original shape when the load is removed .Before using any spring for different applications it is required to measure stiffness of that spring. The machines available to measure the stiffness are costlier as well as time consuming. So they are not suitable for small scale industries. So it was required to design instrument which can measure stiffness of spring with low cost. For automotive springs, the most relevant performance characteristic is stiffness or "springiness" under load.

LITERATURE REVIEW

Understanding the basic methodology & identifying the various components used in a

spring testing machine, a literature review is carried out & its summary is given below.

A. Literature Survey :

1. **Wang Jian** studied the design of spring load testing & separating system ensuring the quality of the spring. The overall system structure consists of a circular table having six workstations; one of them is the load testing station. In this station, the spring is pressed from the rated position to the maximum position to measure the rated and the maximum pressures. The order of works carried out is the circle table rotating, the spring blanking, the load testing, the value calculating and the spring sorting. One master controller and four slave controllers take the responsibility for all the system functions and the synchronization among each controller is dominated by the master processor through the network communication. The complete debugging function consisting of servomotor control, display of spring parameter, valve switch control, & setting A/D parameter and the convenient operation ensure that the Spring Load Testing and Classification System will run steadily.

2. **Prathamesh D. Belapurkar**developed a working model for obtaining stiffness parameter of helical springs through its frequency. The working principle is that the natural frequency must be 15 or 20 times greater than the operating frequency of the spring, the investigation starts with a master spring whose parameters are known. Then another spring under the same parameters is tested. The machine consists of two plates between which spring is installed and a vibratory mechanism. When the machine is started, vibrating frequency is achieved which is less than the natural frequency of the spring. Displacement sensors record the readings obtained. The stiffness of the test spring is then calculated by comparing results for master spring and test spring. For these tests, the results obtained on UTM are also compared with those of STM.

3. **Avdhut R Jadhav**designed a digital spring stiffness testing machine. It consists of two hydraulic cylinders of different diameters interconnected by same liquid. The larger cylinder has a ram and the smaller has a plunger. When force is applied by lever it gets multiplied to many times and that multiplied force acts on the plunger. Due to this force the plunger compresses the liquid transmitting compressive force to the spring thereby compressing it. A load gauge is used to measure the force and the ruler scale to measure the deflection of spring. The ratio of this force to the corresponding deflection gives the spring constant (stiffness) of the spring under test. From this study we come to know the versatility of a spring testing machine.

4. **Muhammad Abu Rahat** presented a technology for measuring the stiffness of springs (tensile & compressive). The testing model consists of a frame, load cell & a scale; a spring is placed on the angled plate bar. When a mass hanger is directly attached to the bottom of the spring, the position of the bottom of the mass relative to a

meter stick is recorded. Masses are added to the spring and the position of the bottom of the mass hanger is then noted. A load cell shows the force applied to the spring. By moving freely with the load cell, scale behind spring directly measures the spring compression. The results are obtained in the form of time history plot for force and displacement of the spring. And thus by getting the load and displacement, spring constant of the compression spring can be measured. The procedure is repeated for various masses thus getting different samples of readings. These samples are then compared with the theoretical formula based calculations of spring constant.

5. **ChandgudeViresh V** carried out the CAD modeling and preparation of test setup of digital spring stiffness testing machine. The main components used are Frame (outer & inner), Cantilever Load Cell, Hydraulic jack, LM guide and Magnetic scale. Load cell used in this setup has a capacity of 500 kg. i.e. 4905 N of force and it gives quick response to change in load magnitude, and load cell used in this setup is cantilever type, and is also attached to the electronic circuit and display which is well calibrated and shows the correct reading of the load at any instant. Load cell has a very good least count for load i.e. 10 gm. Hydraulic jack used in this setup is single acting type of cylinder and it has a capacity to exert 2 tons of force i.e. 2000 kg. A linear guide ways (LM Guide) allows a type of linear motion that utilizes rolling balls. The linear encoder used is based on the magneto resistive sensing principle. Using the hydraulic jack‟s lever, load is applied gradually to compress the spring and the readings of load and displacement are noted.

B. Summary of Literature Review :

Different literature have been studied and analyzed in great detail. After analyzing and understanding the various aspects of coil springs, testing and their applications particularly in automotive valves it can be concluded that there is a need for spring testing systems which are adaptive in nature. It is important that a spring testing setup be designed for further analysis and comparison of the results with analytical to validate the design before actual fabrication.

PROBLEM DEFINITION:

1. We can proposed to measure stiffness of spring of different diameter of different material at various load.
2. Spring stiffness measurement consumes a lot of time.
3. It also requires proper maintenance and operating cost.
4. Achieving the accuracy is difficult and time consuming

Problem Formulation

- Based on the literature review, the machine is designed in such way that it will test the stiffness ofspring having different diameters of different materials under various loads for higher accuracy and precision.

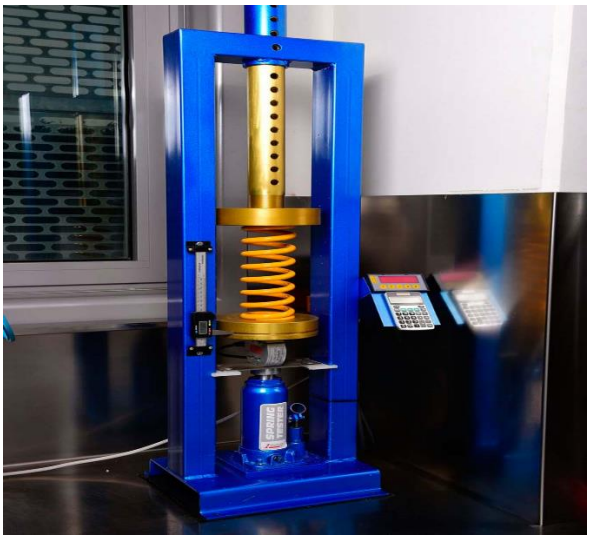
HYDRAULIC SPRING TESTING MACHINE:

There are many types of spring testing machine manufactured by foreign companies. This includes: SF1240 series spring testers is commonly used to test stiffness of all types of coil springs, disc springs and ware springs and spring-types components. This series features a robust dual column design with 40mm lead screw and two 50mm precision guide column for maximum stiffness. Spring testing machine by FSA Canada conduct compression, shear, bending and hardness tests. It comes in two models, STM for helical coil springs and FST for leaf springs. The leaf spring testing machine model FST is used to test wide range of leaf/laminated springs for load rate as per IS 1.155 -1984 while the helical compression spring testing machine model STM is used to test wide range of helical compressions spring and disc springs. Other types of testers are : Asphalt tensile designed to measure the strain at failure for asphalt binders at very low temperature and Creep and stress rupture tester for testing application of metallic materials.

DEVELOPMENT OF HYDRAULIC SPRING TESTING MACHINE

Hydraulic Spring stiffness testing machine mainly consist of following elements :

1. Hydraulic Jack
2. Microcontroller
3. Load Cell
4. Ultrasonic Sensor
5. Lcd display



WORKING PRINCIPLE

Working principle of this machine is based on the hooks law and Pascal‘s law, because for the application of load on the spring i.e. to compress the spring hydraulic jack is used. Hydraulic jack has a lever on it and force is applied by that lever and this force is also multiplied by many times and hence it requires less effort.Force required to produce deflection in spring is generated by using hydraulic jack. Circular platform is attached to rod of hydraulic jack, on which spring rest. As load is applied, spring start to deflect. Function of load cell is to measure applied load. Itis firmly mounted on rod of hydraulic jack. According to Newton’s third law, every action has equal and opposite reaction. Thus, as piston rod moves up, compresses spring with some force, reactive force acts on load cell which measures the magnitude of applied force. Ultrasonic sensor is used to measure deflection of spring. It is fixed to steel platform mounted on load cell. HX - 711 Module is the 24 – bit analog to digital converter (ADC) for weigh scales and industrial control applications to interface directly with a Module sensor. At the end, inputs of load cell and ultrasonic sensor are supplied to microcontroller (Atmega16 or Arduino).Microcontroller which performs arithmetic operations on

inputs supplied to it and output is directly displayed on display.

OBJECTIVES

1. Main objectives of this machine is to check the stiffness of spring with higher accuracy and precision.

2. Designing and constructing a spring stiffness test rig that is capable of testing a various types of springs of different height, diameters and of materials.

3. To reduce the time required for testing and increase the profit of small scale industries and also to reduce inventory and investment cost.

4. Low initial cost of machine and easily operated.

ADVANTAGES

- Spring of different diameters can be checked.
- Spring can be check without damaging the spring.
- The testing is carried out in very less time, so production rate is very high.
- Semi-skilled and unskilled labour can operate this machine easily.
- The system is self-lubricating.
- The system is noiseless.

DISADVANTAGES

1. External power supply (electrical supply) is required to calculate the spring stiffness because the results are shown on alcd display.
2. As in this setup hydraulic jack is used there may be a chances of hydraulic leakages hence the periodic inspection, maintenance and refilling of oil is necessary.
3. Proper reading of load and displacement is necessary.

APPLICATION

- The spring stiffness testing machine is used for measuring stiffness of different spring.
- Spring testing machine used in spring manufacturing industries in quality control department.
- It is used in educational institute to compare the theoretical design and practical spring stiffness.
- Spring testing machine is used in garages also for checking suspension of various automobile.

CONCLUSION

The result which will obtained from this machine will be verified with standard value.Purpose of this work is to make a low cost instrument which must be capable of calculating stiffness of spring well satisfied keeping the accuracy. Combination of mechanical plus electronic component makes it easy to operate, compact mainly faster and accurate. Both input and output modules are easily integrated with microcontroller which forms complete system. A display is provisioned so that real time values of influence parameters (displacement, force) and result as stiffness is displayed which makes it user friendly. The compactness and accuracy makes it suitable for industrial use. With some more work on it can make it ready for commercial use.

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