MEASUREMENT OF THE SPRING CONSTANT OF A HELICAL COMPRESSION SPRING

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August 19, 2002

Abstract

A coil spring from the rear suspension of a Volvo automobile was tested in compression in order to measure its spring constant. This test was conducted using a 50 kN capacity testing machine, at a crosshead speed of 10 cm/min and to a maximum deflection of -xx%. Data was collected during both the loading and unloading phases of the experiment. The measured value of the spring constant was xx kN/cm. This was very close to the value (xx kN/cm) one calculates using standard spring design equations. In these calculations Young's modulus was the only parameter considered. Other materials properties must also be considered in the design and manufacture of a spring.

Introduction

- The properties of a helical compression spring is a function of its design and the materials used. The design parameters for these springs are well known and can be used design a helical coil spring for practically any application. The material's properties are also well known and offer many options for the designer.

- In this investigation a helical compression was tested in order to measure its spring constant. The results were then compared to what one would expect using standard design equations.

Procedure

- The spring tested was a coil spring from the rear suspension of a 1968 Volvo sedan (model 142s).

- It was a left hand helical compression spring, had open ground ends, and was made of steel. The dimensions of the unloaded spring, the outside diameter, the total number of coils of turns and the wire diameter are listed in the attached spreadsheet printout.

- The equipment used was an Instron model 4202 universal tester (serial number xxxx). This system was rated to loads up to 50 kN load capacity and had a maximum crosshead travel of over a meter.

- Testing consisted of pre-loading the sample to 10 N followed by compression at a rate of 10 cm/min until 30% compression of the spring was obtained.

Results

- The results of this test are shown in the attached spreadsheet printout.

- The measured spring constant was determined by least squares fit of the data after compensating for the stiffness of the testing machine. Its value was xx kN/cm. The coefficient of correlation was better than 0.999.

- The calculated spring constant was done per the equations given in reference 1 and using the typical elastic modulus for steel. The value obtained was yy kN/cm.

- The maximum stress in the steel when the spring is fully compressed was also calculated. The value obtained was yy MPa.

Discussion

- The close agreement between measured and calculated spring constants is reassuring and demonstrates our ability to design and test our own springs.

- The maximum stress the spring is likely to experience, when fully compressed, is considerably lower than the yield stress for typical high-carbon spring steels (i.e., ASTM A229, 0.55-0.85%C, oil tempered, tensile strength from 1140 to 1220 MPa, design strength is 45% of minimum tensile strength [2]) and so we were in no danger of over-loading, and permanently deforming, the spring.

- Fatigue failures, even at these low loads, can still be a factor after many loading and unloading cycles, especially in high strength steels typically used in springs.

Conclusions

- The spring constant was found to be xx kN/cm during both the loading and unloading of the spring.

- The measured and calculated values are in excellent agreement.

- Other materials issues need to be considered in the design of a spring, including fatigue life, corrosion resistance and effect of temperature.

References

1. Machinery's Handbook, 23rd Edition, eds. E.Oberg, F.Jones, H.Holbrook and H.Ryffel, Industrial Press Company, New York, page 331, (1988).

2. Properties and Selection: Irons and Steels, Metals Handbook, 9th Edition, eds. , ASM, Metals Park, Ohio, volume 1, page 284, (1986).