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EXPERIMENTAL AND STRUCTURAL SIMULATION OF VIBRATION ABSORPTION SYSTEM OF A SUSPENSION SPRING

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ABSTRACT

This Report presents first results of static tests on Helical Compression Springs which respond to loads with torsional stress. Initially we have to perform an experimental Analysis with a Suspension system of an Automobile. Using the dimensions of the spring a virtual model was created in Pro/E Wildfire 3.0.Then the virtual model was simulated in Ansys Multiphysics by importing the model as IGES file. In that Stress Analysis were carried out with various loads. The Analysis were done in static mode. Then the results were tabulated. After studying the results from the Analysis an optimized model was created by varying various parameters from the model previously developed like diameters, material properties etc., then similar work has to be done with the new optimized model i.e. Stress Analysis. And the results were obtained. Finally the results were compared and necessary steps were taken to control various parameters. The results of this investigation can add an important contribution to the experience of static behavior in a very high cycle regime.

INTRODUCTION

Suspension system for a vehicle is an integration of various machine components designed and assembled in such a manner to absorb all the shocks and vibrations. The objectives of suspension are mentioned in detail. The aim of the work is to analyze various parameters like stresses, stiffness, material etc., of single degrees of freedom, vibrational absorption system of an Automobile. The vibrational absorption system of an Automobile is taken with that experimental analysis was done and various parameters are collected. From the different values are taken and the results are manipulated. Then similar work like this has to be done in Ansys with the given boundary conditions and the results are obtained and compared. Further alterations in the vibrational absorption system are made to improve its lifecycles.

DESCRIPTION ABOUT EXPERIMENTAL ANALYSIS

Helical compression springs are used in numerous applications with high stress amplitudes under simultaneous high mean stress, for example, in valve drives of combustion engines (Fig. 1) or as springs in fuel injection systems. The development of individual types of metal springs has continued during the past years and was aimed by improving technological functionality with as little operating weight as possible. Owing to the requirements of light-weight construction, the mounting spaces for such springs become increasingly smaller so that the helical compression springs are subjected to constantly rising specific stresses. Therefore, a whole variety of expensive measures have to be taken in order to guarantee the required properties, such as, among other things:

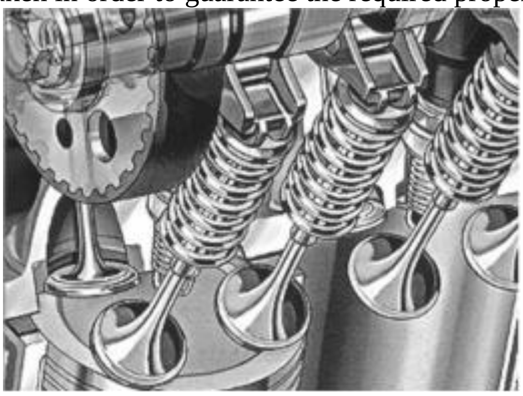


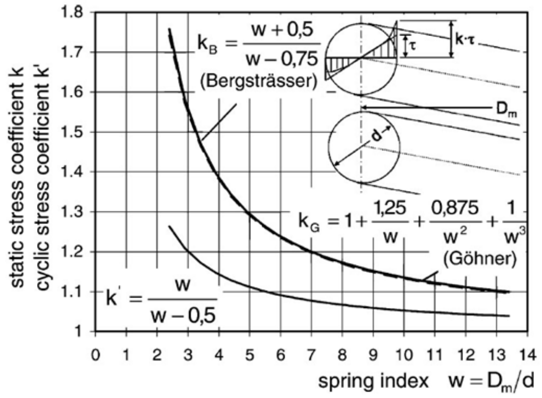
Fig.1.Valve springs in combustion engine

• Use of special valve spring steel wires pursuant to DIN EN 10270 such as Si–Cr- or Si–Cr-V-alloyed, partly in so-called super-clean quality from peeled or ground raw material, crack-tested, or alternatively, from corrosion resistant spring steel wires,

• Careful manufacturing of the springs with special respect to the surface layer, hot presetting, shot-peening (if necessary, at increased temperatures, under pre-stress or in combination with nitriding). The requirements made on the surface quality are extremely high. According to, the surface quality in fact plays a more important part for the operational durability of the springs than the material properties. Helical compression springs respond to external compressive force with torsional stress caused by torsion of the active spring coils which, in a first approximation, may be estimated analogous to a straight torsion bar. Since the shear angle, however, is greater on the inner coil surface than on the outer surface, the peripheral torsional stress on the inner coil surface is higher than on the outer surface. This circumstance is described by using a correction factor k which is dependent on the curvature of the wire (Fig. 2). Fig.2. Correction factor k to describe the static stress concentration on the inner coil surface of a helical compression spring in dependence on the coil ratio w, factor k0 represents the effect of the stress concentration in the case of cyclic load.

The curvature can be characterized by the quotient from the mean spring diameter and the wire diameter. This means:

• The maximum stress of helical compression springs occurs on the inner coil surface.
• Accordingly, fatigue fractures of helical compression springs generally originate from this area.



• Therefore, the spring's inner coil surface has to be shotpeened with particular care, which depending on the spring geometry, constitutes a highly fastidious task. Despite a qualitatively high technical state of spring technology, spring fractures were and are being observed after comparatively long periods of operation. In the case of nozzle retaining springs of diesel injection systems, fractures were reported in operation after comparatively extremely high stress cycles. According to, in the 250.106 cycle regime, S–N test results are available for springs manufactured from stainless steels which evidence a distinct fatigue strength decrease in the application of the stainless steels. Thus, in each decade a reduction of the fatigue strength by approximately 30% takes place. The limited data available so far for Si–Cr-alloyed valve spring wires indicate that here the effect is not as strongly pronounced as in the case of the stainless austenitic steels.

RESULT AND DISCUSSION

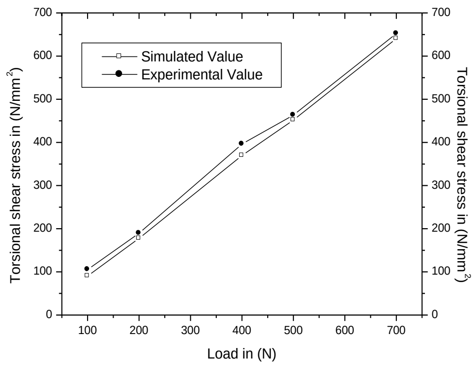


Figure.3 Comparison graph with experimental and simulated values

Table.1. Comparison of experimental and simulated values

Load in N	Torsional Shear Stress in N/mm^2,Simulated	Torsional Shear Stress in N/mm^2,Expermental
100	90.37	105.48
200	177.74	189.5
400	369.48	396.15
500	451.85	463.21

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STRUCTURAL ANALYSIS OF OPTIMIZED MODEL

Finally we have to create a model in which the stress values should improve and with stand for longer lifecycles. We have created many models and simulated it out of which one model showed highest performance than the rest of others from which we can expect better life cycles than others.

The specification of Optimized Model.
Free Length - 192 mm
Wire Diameter- 7 mm
Mean Diameter – 51 mm
Pitch - 16
Density - 6800Kg/m^3

In that model similar tests has been conducted and the results are tabulated.

Table.2.Stress Value of optimized Model

Load in (N)	Torsional stress in N/mm^2	
	Experimental Value	Optimized Value
100	105.48	114.37
200	189.5	197.54
400	396.15	408.45
500	463.21	476.23
700	652.21	661.58

Table 3: Load Vs Torsional Stress

Load in (N)	Torsional stress in N/mm^2		
	Simulated Value	Experimental Value	Optimized Value
100	90.37	105.48	114.37
200	177.74	189.5	197.54
400	369.48	396.15	408.45
500	451.85	463.21	476.23
700	640.59	652.21	661.58

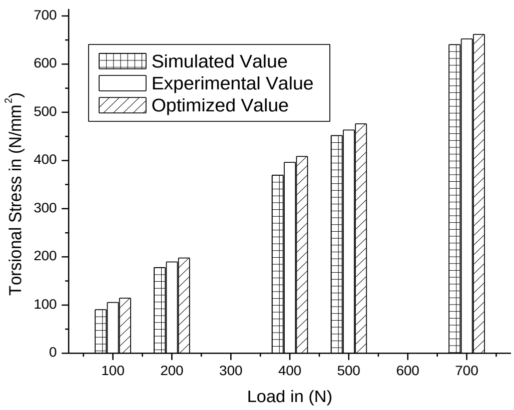

Figure 4: Load Vs Torsional Stress

CONCLUSIONS

The results of this work will help in the spring design and manufacture methodologies. Giving insight in the spring performance under cyclic loads considering as parameters: material type, wire diameter, recommended time and other Specifications It has been shown experimentally as well, that Static limit depends on the Torsional stress field. So far, first insights with regard to these late occurring fractures have been gained, but the exact mechanisms as well as improvement possibilities are not yet known. Thus, there is a considerable requirement for systematically undertaken research on the spring materials, which are of paramount interest. The aim should be to elaborate results about and insights concerning the level of the Static range in the stress should satisfy it fracture limits. Further we have to study about the mechanisms causing failures and we have to find possible remedies or measures of improvement.

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REFERENCES

Alfredson B, Olsson M. Applying multiaxial fatigue criteria to standing contact fatigue. Int J Fatigue 2001.
Artaraz F, Sa´nchez Beitia S. An unsuitable residual stress state in train springs originated by shot peening. Int J Fatigue 1991.
Bown MW, Miller KJ. A theory for fatigue failure under multiaxial stress–strain conditions. Proc Inst Mech Eng 1973.
Carlson H. Spring designer's handbook. New York: Marcel Dekker Inc.; 1978.
Chen, S. and S. Billings (1989). "Representation of non-linear systems: the NARMAX model," International Journal of Control.
Cullity BD, Stock RS. Elements of X-ray diffraction. Englewood Cliffs, NJ: Prentice-Hall; 2001.
Del Llano-Vizcaya L, Rubio-Gonza´lez C, Mesmacque G, Banderas- erna´ndez A. Stress relief effect on fatigue and relaxation of compression springs. Mater Design [accepted].
Design and failure modes of automotive suspension springs Y. Prawoto, M. Ikeda, S.K. Manville a, A. Nishikawa NHK International Corporation, Varsity Court, Wixom, United States B NHK Spring Corporation, Fukuura Kanazawa-ku, Yokohama, Japan
Faires VM, Design of machine elements. Montaner & Simonl; 1970.
Finite element analysis of super elastic, large deformation behavior of shape memory alloy helical springs Yutaka Toi, Jong-Bin Lee, Minoru Taya Institute of Industrial Science, University of Tokyo, Komaba, Meguro-ku, Tokyo, Japan Center for Intelligent Materials and Systems, University of Washington, Seattle, USA
Han C, Chen X, Kim KS. Evaluation of multiaxial fatigue criteria under irregular loading.
Kim KS, Park JC. Shear strain based multiaxial fatigue parameters applied to variable amplitude loading.
Maximum principal tensile stress and fatigue crack origin for compression springs M.T. Todinov, School of Metallurgy and Materials, The University of Birmingham, Edgbaston Birmingham B15 2TT, UK
Melander A, Larson M. The effect of stress amplitude on the cause of fatigue crack initiation in spring steel. Int J Fatigue 1993.
Multiaxial fatigue and failure analysis of helical Compression springs L. Del Llano-Vizcaya, C. Rubio-Gonza´lez, G. Mesmacque b, T. Cervantes-Herna´ndez a Centro de Ingenierı´a y Desarrollo Industrial, Pie de la cuesta, Desarrollo San Pablo, Quere´taro, Mexicob Laboratoire de Me´chanique de Lille, Universite´ de Lille, Villeneuve d'Ascq, France
Ravi Kumar B, Das Swapan K, Bhattacharya DK. Fatigue failure of helical compression spring in coke oven batteries. Eng Fail Anal 2003.
Shigley J. Mechanical engineering design. New York: McGraw-Hill; 1981.
Shin J, Lee S, Ryu J. Correlation of microstructure and fatigue properties of two high-strength spring steels. Int J Fatigue 1999.
Socie DF, Marquis GB. Multiaxial fatigue. SAE International; 2000.
Stress relief effect on fatigue and relaxation of compression springs L. Del Llano-Vizcaya, C. Rubio-Gonzalez, G. Mesmacque, A. Banderas-Herna´ndez Centro de Ingenierı´a y Desarrollo Industrial, Pie de la cuesta, Desarrollo San Pablo, Quere´taro, Mexico Laboratoire de Me´chanique de Lille, Universite´ de Lille, Villeneuve d'Ascq, France
Todinov MT. Maximum principal tensile stress and fatigue crack origin for compression springs. Int J Mech Sci 1999.
Todinov MT. Residual stresses at the surface of automotive suspension springs. J Mater Sci 2000.