Development of a computational software for mechanical flexible machine components design

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Abstract

This project emphasizes the development of computational algorithms to design compression, extension and torsion helicoidal springs. The input parameters for the application are load and deflection, besides some certain hypothesis and a priori decisions like material definition, type of ends, among others. The algorithm will use them to calculate the output parameters, which will be considered to define the spring dimensions, like wire diameter, spring length and diameter, and number of spirals. Other outputs are the stability condition and safety factors for yielding, fatigue and ressonance.

Key words:

Spring Design, computational procedure

Introduction

This project deals with some aspects of spring design like stress, natural frequency, buckling, and others. The first step is a deep bibliographical analysis of machine elements books, comparing the approach adapted for helicoidal spring design. The considered helicoidal springs are compression, extension and torsion springs, which are shown in Figure 1.

The project's objective, at its conclusion, is to use the computational algorithm in the classes of Machine Elements at UNICAMP, to help the students learn more about spring design.

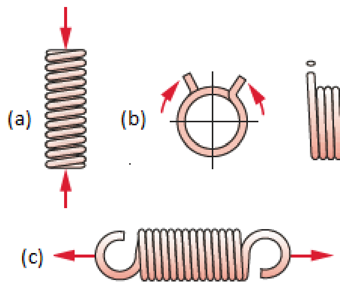

Figure 1. Types of springs this project will work with. a) Compression springs. b) Torsion Springs. c) Extension springs. Norton, 2006.

Results and Discussion

During the bibliographical review, 2 very different methodologies were defined. So, it was decided to make 8 computational algorithms using Fortran 90: 4 for compression springs (for static and dynamic loads), and 2 for extension and torsion springs, considering dynamic loads. Each type of load has the 2 design methods (represented by the identified approach, or methodology). The tests for the algorithms were made following data from examples of the bibliography and comparing the output parameters. First, the example of the first approach was applied to its original methodology (adaptation test). Then, it is solved through the other approach (malleability test). The same is applied for the example of the second approach. In that way, it is possible to verify how the algorithms are robust for different inputs. Each test would give the output parameters, highlighting the buckling stability analysis, resonance safety and the Goodman's diagram for fatigue analysis, which is shown in Figure 2.

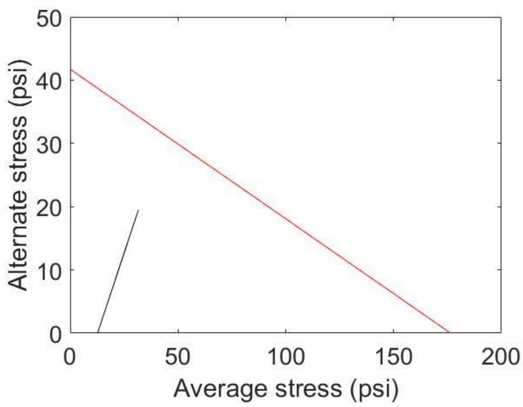

Figure 2. Goodman's Diagram that shows a malleability test of a compression spring design in dynamic load.

Conclusions

For the adaptation tests, it can be concluded that it is possible to simulate the methodology of the books through the selected code language. Through the procedure done for the malleability tests, a satisfactory robustness was reached for the programs. Together with the research team of the Rotating Machinery Laboratory (LAMAR), the programs can be refined for better educational purposes.

Acknowledgement

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[1] Norton, R. Machine Design – An Integrated Approach – 3rd edition. Pearson Prentice Hall, 2006.

[2] Budynas, R. G.; Nisbett, J. K. Shigley's, Mechanical Engineering Design – 9th edition. Mcgraw-Hill, 2011.