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GROUP TITLE/ABSTRACT

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"Design Optimization of Helical Compression Springs to Mitigate Axial Twist"

Mechanical springs provide key functionality in many mechanisms. A previous IMSM project team quantified the significance of spring forces in a nonlinear spring-mass-damper model of a rocket-mounted acceleration switch. A helical compression spring, which consists of a helical coil of wire that is compressed to generate force, is an effective, compact design for generating spring forces. Therefore, a subsequent IMSM project team investigated how to design helical compression springs to effect optimal forces while meeting a variety of design constraints and performance goals. That team focused on traditional spring performance measures such as spring index, effective stiffness, and dimensional change; however, a subtle, yet significant, aspect of helical compression springs was not considered: a helical compression spring tends to twist about its axis when compressed. This twisting action can cause alignment challenges in assembling springs into high-precision mechanisms, and it can lead to undesired residual stresses in both the springs and the mechanisms. Although the axial twist is recognized by the spring manufacturing industry, it largely does not factor this into their designs. In part, the neglect is due to the complexity of predicting the twist as a function of spring properties. To mitigate the twist, some manufactures have devised novel coil patterns; yet, these require non-standard spring manufacturing processes and are incompatible with industry design software. Optimizing the design of *conventional* helical compression springs to mitigate their axial twist is desired. This project aims to develop design guidelines for twist-mitigated helical compression springs that satisfy multiple performance objectives and constraints. The project's approach is to develop a computational modeling capability and subsequently to study axial twist for varying spring parameters. In support of project development, spring data and specifiable design parameters and constraints will be provided.

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Project Team References

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- K. Michalczyk, "Analysis of Helical Compression Spring Support Influence on Its Deformation," *The Archive of Mechanical Engineering*, **56**(4), pp. 350-362, 2009.