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Tips and Tricks - Modelling Helical Springs

Helical springs are a common component in a wide range of engineering disciplines, from general machinery to automotive and railway vehicles. SIMPACK offers several different possibilities for modelling helical springs in order to enable users to choose the correct amount of detail for a particular analysis.

Helical springs are actually more complicated than they appear at the first glance. Often helical springs act not only in the axial direction but also in the shear, bending and torsional directions (fig. 1). To complicate matters, the behaviour in the different directions is not independent.

FORCE ELEMENTS 001 AND 004 – POINT TO POINT (PTP)

These Force Elements are the simplest ones for simulating helical springs. As PtP ele-ments they exert only an axial force along the (variable) line of action. Thus they must not be used for springs that are intended for shear, bending or torsional action! Non-linear stiffness and damping characteristics can be easily modelled by way of Input Functions.

FORCE ELEMENTS 003, 005 AND BUSHING 043 – COMPONENT (CMP)

These elements enable axial and shear forces. With force element 043, bending and torsion moments can also be taken into account. The directions are defined with respect to the FROM Marker frame. As with every Cmp Force Element, reaction moments, which result from forces with a perpendicular displacement (r x F moments), are taken into consideration. These moments are applied at the FROM Body (fig. 2 and SIMREF manual in the documentation), and are therefore not symmetrically dis-tributed as they would be in reality.

A practical solution, when necessary, is to define two equal elements in opposite directions with each using half the stiffness and damping. For force element 043, a nominal length can be entered. Similar to the PtP element, non-linear characteristics can also be easily included.

SHEAR SPRING FORCE ELEMENT 079 – COMPONENT

This element is designed for modelling helical springs with shear contribution. The reaction moments are distributed equally between the FROM and TO Body. Moreover, the shear and bending are coupled – a shear movement causes also a bending moment and vice versa. The element is recommended when bending and reaction moments are important, for example in secondary springs of railway vehicles.

FLEXICOIL FORCE ELEMENT 081 – COMPONENT

When in "Geometric Data" mode, this element considers all forces and torques including the shear–bending coupling and the symmetric reaction moments. Moreover, other internal dependencies between the single directions according to the findings of Krettek and Sobczak (see documentation) are included. With this mode the user enters the geometric data of the spring. (The other mode of the element, "Stiffness Matrix", does not consider the symmetry of the reaction moments.)

DYNAMIC SPRING GENERATION

The module "Dynamic Spring Generation" is available for easily generating highly detailed helical springs based upon material and geometric properties. Internal mass and contact between the individual windings is also taken into account (fig. 3). Two different levels of model detail may be generated using the same input files, a one-dimensional multi-mass spring and a three-dimensional SIMBEAM spring.

For further information download the 2004 User Meeting presentation "The New module SIMPACK Engine", from the SIMPACK website.

These features are generally used for modelling highly dynamical valve springs.

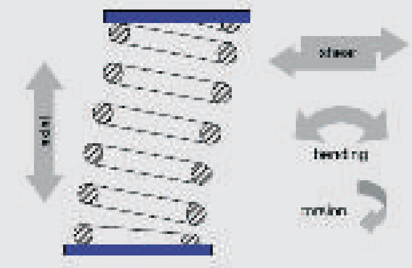

Fig. 1: Helical Spring with Directions of Action

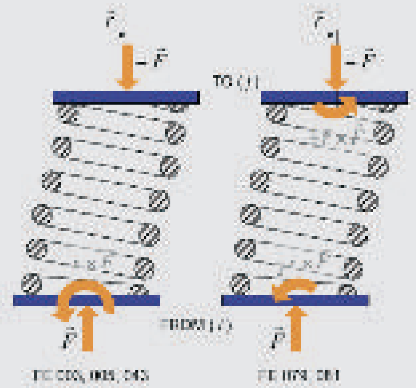

Fig. 2: Reaction (r x F) Moments Acting upon the Spring

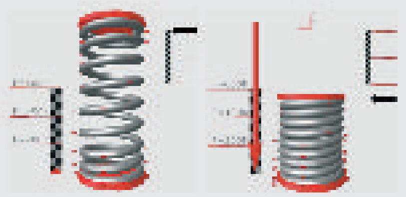

Fig. 3: Dynamic Spring with Coil Contact