FEA Puzzler: *How Confident Are You?*

We are pleased to bring you another FEA puzzler from Professor Barna Szabó of Engineering Software Research and Development Inc. In this challenge we are looking at a coil spring and determining the progression in spring rate as the spring is deformed. Easy you say! But, there is a catch - we want to know how confident you are in your predictions.

Send your responses, in confidence, to Professor Szabó at challenge@nafems.org. Responses of sufficient merit will win an exclusive NAFEMS business card holder. A summary of the responses will be published without attribution in a future issue of Benchmark.

The challenge will close on February 1st 2019 – best of luck!

Problem Statement

The centerline of the coil spring shown in Figure 1 is given by:

$$x = r_c \cos\theta \quad -\pi < \theta < 11\pi$$
$$y = r_c \sin\theta \quad -\pi < \theta < 11\pi$$
$$z = \begin{cases} 0 & -\pi < \theta \leq 0 \\ \theta\, d/(2\pi) & 0 < \theta \leq 10\pi \\ 5d & 10\pi < \theta < 11\pi \end{cases}$$

Where r_c = 50.0 mm is the coil radius, d = 25.0 mm is the pitch. The solution domain is such that any section perpendicular to the centerline is circular with radius r_w = 5.0 mm (the wire radius) however the wire is truncated at the ends so that $0 < z < 5d$. The geometry is available to download in parasolid and step formats from nafems.org at nafe.ms/puzzler

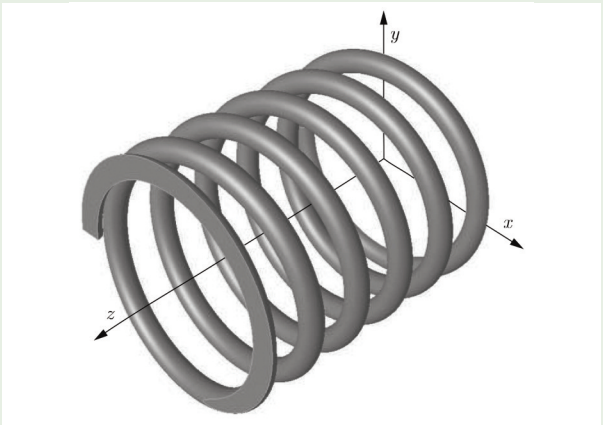

Figure 1: Coil spring used in the challenge

The spring is made of AISI 5160 alloy steel and has the material properties described in Table 1.

Modulus of Elasticity	200 GPa
Poisson's Ratio	0.285
Yield Strength	285 MPa

Table 1: AISI 5160 material properties

Assume that the axial displacement u_z at z = 0 is zero and at $z = 5d$ it is $u_z = \Delta$, $\Delta < 0$.

The Challenge

1. Determine the incremental spring rates in N/mm units for Δ = 0 and Δ = –25 mm.
2. Verify that the errors of approximation in the reported values are not greater than 3 percent. Describe the solution verification procedure followed.
3. Quantify your degree of belief in the correctness of the reported data by selecting a number between 0 and 10. This number represents your subjective assessment of the weight of evidence supporting your claim that the calculated spring rates are within the specified error tolerance. Select 10 if you are certain that the relative error in your reported spring rates is not greater than 3 percent. Select 0 if you are certain that the relative error in the reported data is greater than 3 percent. Provide the assessment of your confidence in the solution results at both Δ = 0 and Δ = –25 mm.
4. If you were asked to sign an engineering report in which the conclusions were based on computed spring rates (or any other computed data), what degree of belief would you expect to have in the correctness of the data before you would sign the report?

Send your responses to challenge@nafems.org by February 1st 2019