List 3

Task 1

Create a geometric model of a rod with a diameter of 20 mm and a length of 200 mm, made of structural steel (Young's modulus E = 200 GPa; Poisson's ratio υ = 0,3). Then, conduct a uniaxial tensile test, assuming that one end of the rod is fixed, and a force of F = 3 kN is applied to the other end.

a) Determine the values of displacements and stresses occurring in the rod.
b) Knowing that the tensile yield strength of the used steel is R_e = 250 MPa, determine whether the applied tensile force F causes the stresses to exceed the permissible limits for the analyzed rod.
c) How will changing the material of the rod to an aluminum alloy (E = 71 GPa; υ = 0,33; R_e = 280 MPa) and to a titanium alloy (E = 96 GPa; υ = 0,36; R_e = 930 MPa) affect the displacement and stress values?

Task 2

Perform an analogous uniaxial tensile test, as in task 1, for a rod with a length of 200 mm and made of structural steel. Assume that the cross-sectional area of the rod is A = 314,16 mm², and the shape of this cross-section is as follows:

a) A square
b) A rectangle (sides: 2·a = b)
c) A regular hexagon

How does the change in the shape of the rod's cross-section affect the values of displacements and stresses?

Task 3

Based on the uniaxial tensile test of a rod made of structural steel with dimensions Ø20 mm x 200 mm, determine the stress (σ) versus strain (ε) curve. How will the doubling of the tensile yield strength (R_e) affect the change in the σ = f(ε) characteristic curve?