

Seminary exercise Nr. 7

Continuum

1. Define a continuum material point (a differential volume) and describe its properties in x_1, x_2, x_3 coordinate system. For a surface force acting in the direction of selected axis, specify the existing stresses and define the stress subscripts.
2. Define the Hooke's law for direct stress and shear stress. Specify the physical quantities including physical units. Describe the stress-strain curve.
3. A mine shaft elevator is hanging on a steel rope ($E=2.1 \cdot 10^{11} Pa$) with a diameter of $2.5 cm$. The total mass of the cabin and the transported people is $650 kg$. How does the steel rope extend when the lift is at a surface $12 m$ below the motor of the elevator? How does the rope extend when the lift is at the bottom of a shaft $350 m$ deep? Neglect the mass of the rope with respect to the mass of the cabin.
4. A solid copper cube has an edge length of $85.5 cm$. How much stress must be applied to the cube to reduce the edge length to $85.0 cm$? The elastic modulus of copper is $1.4 \cdot 10^{11} Pa$.
5. A tunnel of length $L=150 m$, height $H=7.2 m$, and width $W=5.8 m$ (with a flat roof) is to be constructed at a depth $D=60 m$ beneath the ground. The tunnel roof is to be supported entirely by square steel columns, each with a cross-sectional area of $A=960 cm^2$. The mass of $1.0 cm^3$ of the ground material is $2.8 g$. What is the total mass of the ground material the columns must support? How many columns are needed to keep the compressive stress on each column at one-half of its ultimate strength ($\sigma_E=650 MPa$)?
6. A horizontal aluminium rod with a diameter of $4.8 cm$ exits by $5.3 cm$ from a wall. An object with mass of $1200 kg$ is suspended from the end of the rod. The shear modulus of aluminium is $3 \cdot 10^{10} Pa$. Neglecting the mass of the rod, find the shear stress on the rod and the vertical deflection at the end of the rod.