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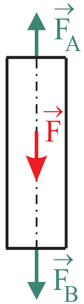
Analysis:

Objectives: check of the limit state of elasticity.

Classification of the bar: straight bar, supported, loaded by forces.

Free body diagram:

Resultants consisting of three force and three moment components can be created in the (fixed in 3D space) support A.



If we ensure a sufficient coaxiality and alignment of the supports, the components without any significant external loads in their direction will be negligible, and the only one significant component of the support resultant will be the force parallel to the bar centreline and thus also to the external loads.

Statical analysis:

1. $\Delta l < \delta \quad \Rightarrow$ statically determinate system
2. $\Delta l > \delta \quad \Rightarrow \nu = 1, \qquad \mu = 2$ (system of forces acting in the same line)
   $s = \mu - \nu = 1 \quad \Rightarrow$ the problem is **circumstantially** onefold statically indeterminate

Applicable conditions of static equilibrium: $F_x: \quad F_A - F - F_B = 0$

limit state of elasticity
supported bar
supports
statical analysis
circumstantial conditions

1. We assume that $\Delta l < \delta$

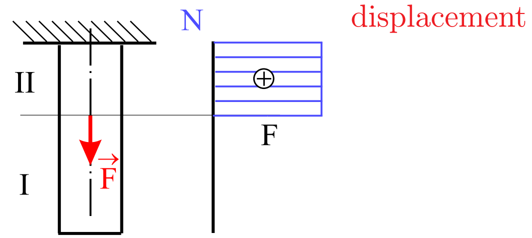
   Distribution of the inner resultant:

   $x \in (0,b): \quad N_I = 0$

   $x \in (0,a): \quad N_{II} = F$

   Elongation of the bar: $\quad \Delta l = \frac{F}{ES} a$

   If the assumption $\Delta l < \delta$ is satisfied, the safety factor against the limit state of elasticity is: $k_K = \frac{\sigma_K S}{F}$



2. We assume that $\Delta l > \delta$

   Released structure:

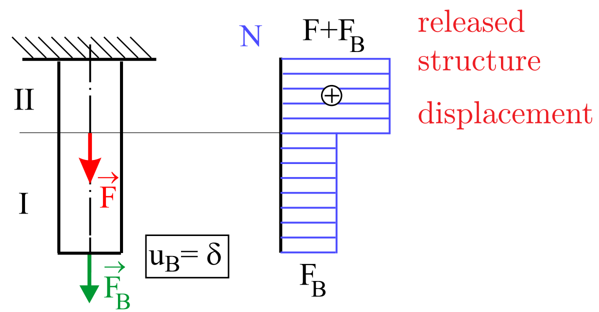
   Distribution of the inner resultant:

   $x \in (0,b): \quad N_I = F_B$

   $x \in (0,a): \quad N_{II} = F + F_B$

   Formulation of the compatibility equations:

$$u_B = \frac{F_B}{ES} b + \frac{F + F_B}{ES} a = \delta$$



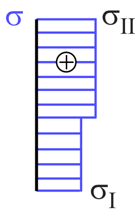
Set of equations and their solution:

$$F_A - F - F_B = 0$$

$$\frac{F_B}{ES} b + \frac{F + F_B}{ES} a = \delta$$

$$F_B = \frac{\delta ES - Fa}{a + b}, \qquad F_A = F + F_B = \frac{Fb + \delta ES}{a + b}.$$

Distribution of stresses: stress



Since the bar is loaded in simple tension (compression), the stress is constant across the section and can be calculated using the following formula:

$$\sigma(x) = \frac{N(x)}{S(x)} : \qquad \sigma_I = \frac{N_I}{S} = \frac{F_B}{S}, \quad \sigma_{II} = \frac{N_{II}}{S} = \frac{F_A}{S}$$

Check for the limit state of elasticity: limit state

We determine the section with extreme stress (dangerous section) from the stress distribution and calculate the safety factor against the limit state of elasticity:

$$k_K = \frac{\sigma_K}{\sigma_{\max}}.$$