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Analysis:

Objectives: check of the limit states of elasticity and deformation.

Classification of the bar: straight notched bar, loaded by a distributed volumetric load q_N parallel to the bar centreline. Gravitational forces are negligible,because the centrifugal acceleration is much higher than the gravitational one. The bar assumptions are not satisfied in the support location and in the notch location.

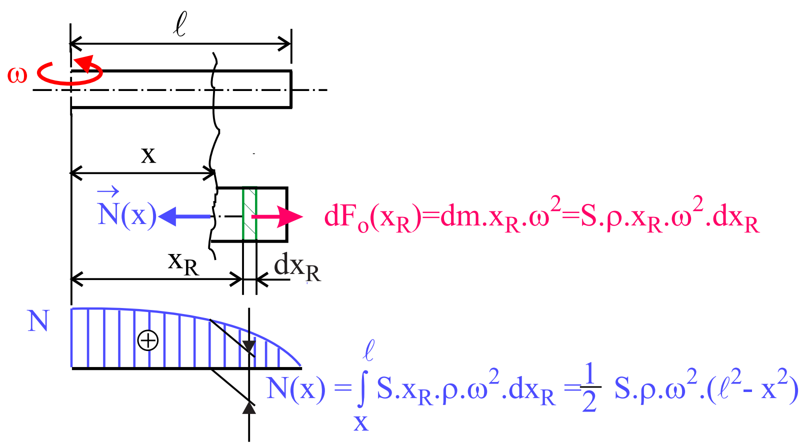
Angular velocity $\omega = 2\pi n = 314,16\,\mathrm{s}^{-1}$

Statical analysis: a system of forces acting in the same line $\Rightarrow \quad \nu = 1, \qquad \mu = 1$

$s = \mu - \nu = 0 \quad \Rightarrow$ statically determinate bearing

Evaluation of inner resultants:

The variability of the $N(x)$ along the centreline caused by the volumetric forces does not create any shear stresses and any warping of the cross sections. The formulas valid for simple tension can be used to evaluate stresses in the cross section and displacements.



Stress distribution: stress

$$\sigma(x) = \frac{N(x)}{S} = \frac{1}{2}\rho\omega^2\left(l^2 - x^2\right)$$

Bar elongation: elongation

$$\Delta l = \int_\gamma \frac{N(x)}{ES}\mathrm{d}x = \int_\gamma \frac{\sigma(x)}{E}\mathrm{d}x = \frac{\rho\omega^2}{2E}\int_0^l \left(l^2 - x^2\right)\mathrm{d}x = \frac{\rho\omega^2 l^3}{3E} = 0,125\,\mathrm{mm}$$

Safety factor against the limit state of elasticity: safety factor

Possible dangerous sections:

1. near the fixed support (maximum normal force N N): $\sigma(0) = \frac{1}{2}\rho\omega^2 l^2 = 81,4\,\mathrm{MPa}$
2. notch notch

   stress concentration factor:

$$\frac{b}{B} = \frac{30}{35} = 0,9 \qquad \frac{r}{t} = \frac{1,5}{2,5} = 0,6 \quad \Rightarrow \quad \alpha = 3,5$$

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$$\sigma_{ex} = \alpha\sigma_{nom} = \alpha\frac{N(v)}{ab} = 200,4\,\mathrm{MPa}$$

$$k_K = \frac{\sigma_K}{\sigma_{\max}} = 1,7$$

Safety factor against the limit state of deformation

safety factor

The limit state of deformation occurs if the bar comes in contact with the case (the deformation becomes inacceptable from the viewpoint of body functions).

$$k_\delta = \frac{\delta}{\Delta l} = \frac{0,5}{0,125} = 4$$

The safety factor against the limit state of elasticity is lower, therefore decissive, the limit state of elasticity would occur as the first of the limit states.