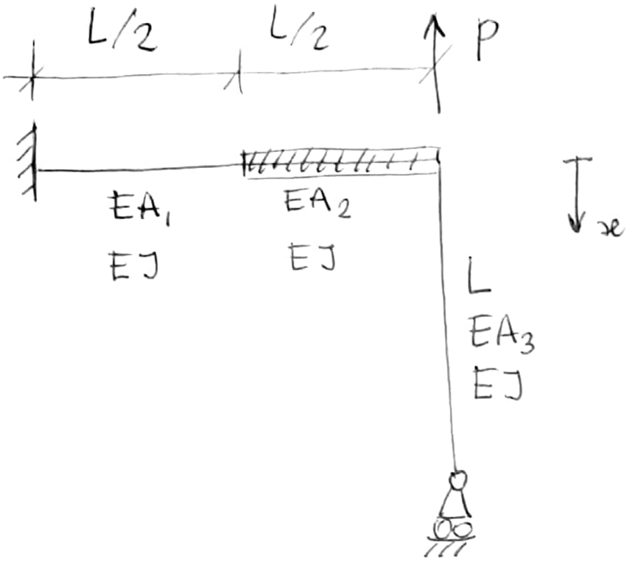


Determine the axial force at $x = L/2$

Data

$L = 1200\ (1 + D/10)$ mm

$EA_1 = 2.0 \cdot 10^4$ N

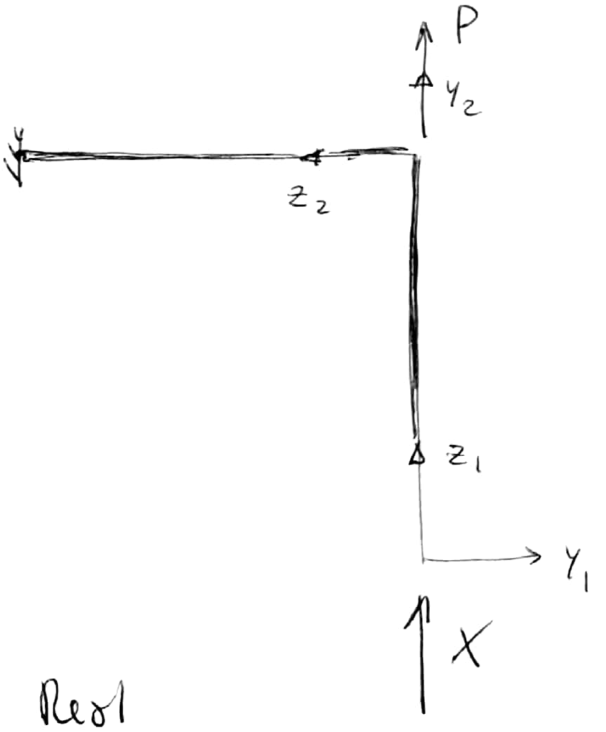
$EA_2 = 1.0 \cdot 10^4$ N

$EA_3 = 2.9 \cdot 10^4$ N

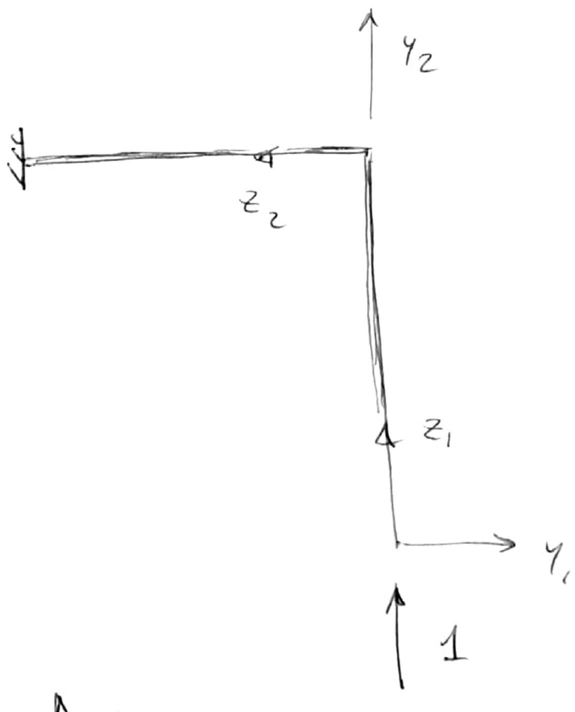
$EJ = 1.5 \cdot 10^{10}$ N mm^2

$P = 1200\ (1 + F/10)$ N

Solution (D = F = 0)



Real



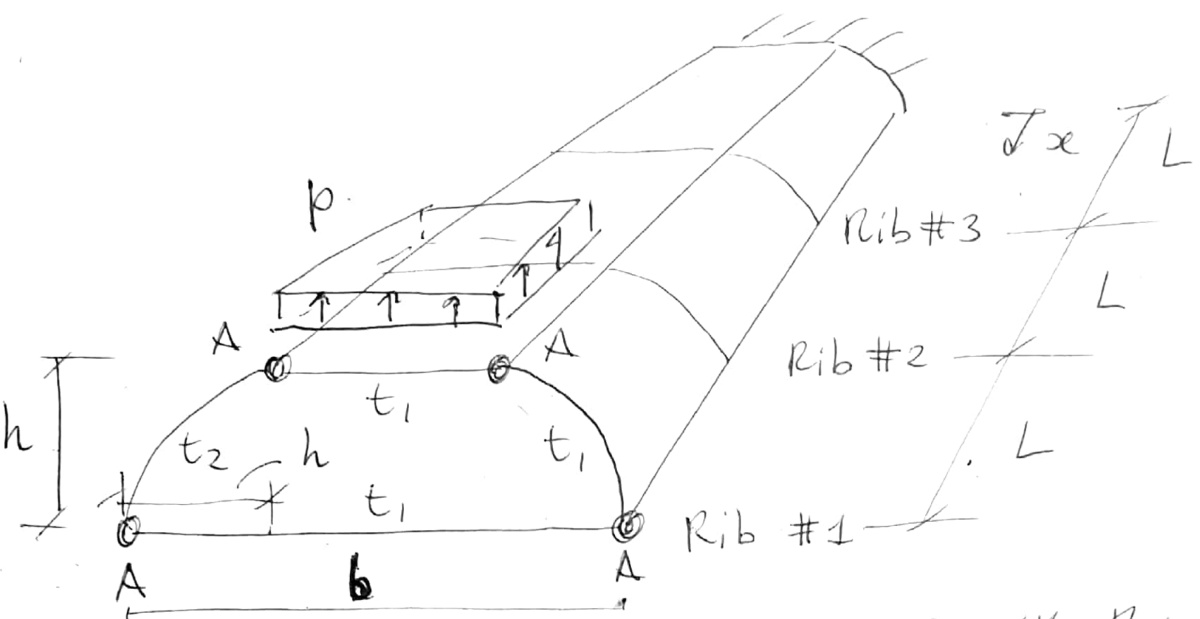
Dummy

$N = -X \qquad \delta N = -1 \qquad$ (beam 1)

$M_x = -(P+X)\, z_2 \qquad \delta M_x = -z_2 \qquad$ (beam 2)

$$\int_0^L \frac{N\,\delta N}{EA_3}\, dz_1 + \int_0^L \frac{M_x\,\delta M_x}{EJ}\, dz_2 = 0$$

$$X = -\frac{PL^2/3}{\frac{EJ}{EA_3} + L^2/3} = -577.59 \text{ N}$$



Evaluate the shear flow in the panel with thickness t_2 at $x = 0$.

Data

$A = 700 \text{ mm}^2$ $\qquad$ $t_2 = 1.5$ mm

$b = 600$ mm $\qquad$ $L = 1800\,(1 + A/10)$ mm

$h = 150$ mm $\qquad$ $p = 2.5 \cdot 10^{-2}\,(1 + B/10)\ \text{N/mm}^2$

$t_1 = 1$ mm

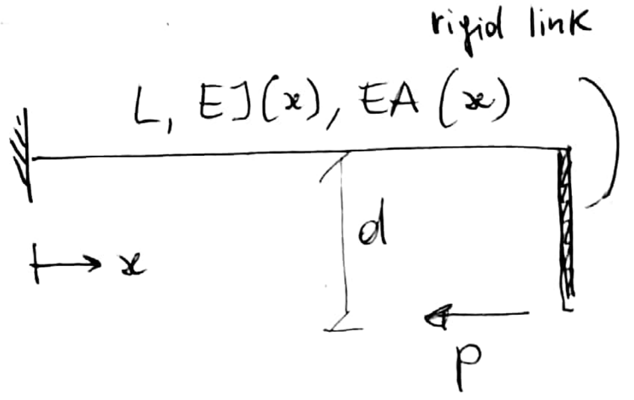
Solution $(A = B = 0)$

The shear at $x = 0$ is

$$T = p \cdot L\,(b - 2h)$$

And from the symmetry of the section

$$q = \frac{T}{2h} = 45 \text{ N/mm}$$



Using the Ritz method and a 1-dof polynomial approximation for any displacement component, determine the strain energy.

<u>Data</u>

$L = 1200$ mm

$d = 45$ mm

$EA_0 = 1.15 \cdot 10^6$ N

$EA_1 = 6.5 \cdot 10^5 (1 + B/10)$ N

$EJ_0 = 1.5 \cdot 10^9$ N mm^2

$EJ_1 = 7.5 \cdot 10^9$ N mm^2

$P = 800$ N

Note, EA and EJ varie linearly with x from EA_0 / EJ_0 to EA_1 / EJ_1.

<u>Solution</u> $(B = 0)$

$u = q_1 x \, ; \quad w = q_2 x^2$

$EJ(x) = \alpha + \beta x$

$EA(x) = \delta + \gamma x$

$\alpha = EJ_0 \qquad \beta = \dfrac{EJ_1 - EJ_0}{L}$

$\delta = EA_0 \qquad \gamma = \dfrac{EA_1 - EA_0}{L}$

$$\int_0^L \left(\delta u_{/x}\, EA(x)\, u_{/x} + \delta w_{/xx}\, EJ(x)\, w_{/xx} \right) dx =$$

$$= - \delta u(L)\, P - \delta w_{/x}(L)\, Pd$$

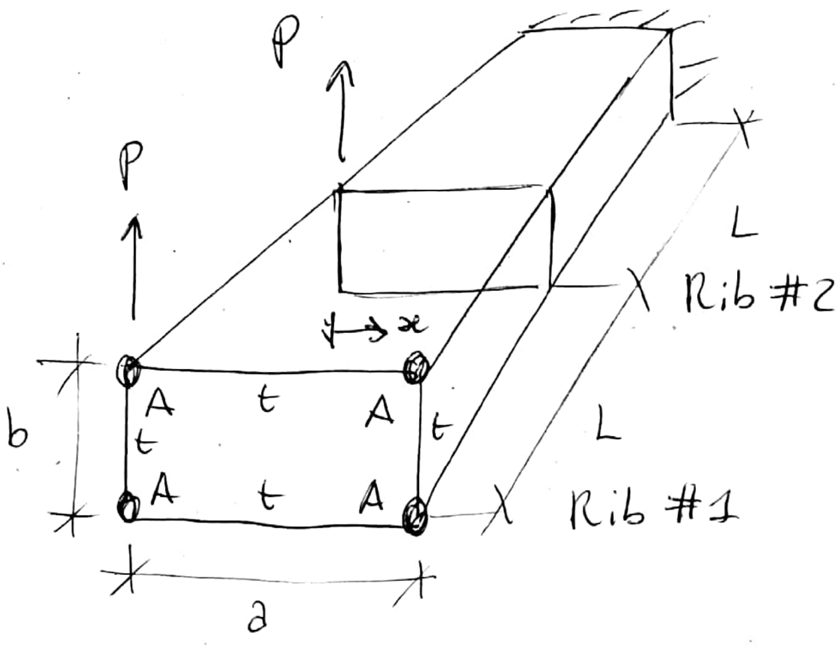
After substitution of the approximations:

$$\begin{bmatrix} \delta L + \gamma L^2/2 & 0 \\ 0 & 4(\alpha L + \beta L^2/2) \end{bmatrix} \begin{Bmatrix} q_1 \\ q_2 \end{Bmatrix} = \begin{Bmatrix} -PL \\ -2LPd \end{Bmatrix}$$

$$\underline{\underline{K}} \; \underline{q} = \underline{f}$$

Solving for $\underline{q}$ and evaluating U provides:

$$U = \frac{1}{2} \underline{q}^T \underline{\underline{K}} \, \underline{q} = 599.47 \text{ Nmm}$$



Model Rib#2 as a beam and evaluate the bending moment at $x = a/3$

Data

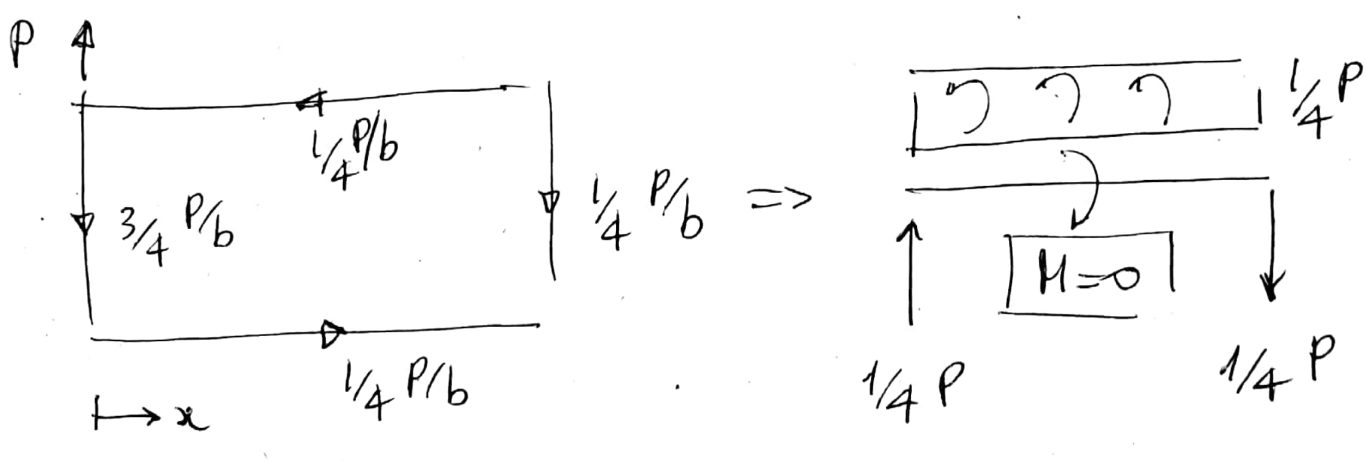
$a = 500\,(1 + A/10)$ mm $A = 500$ mm^2

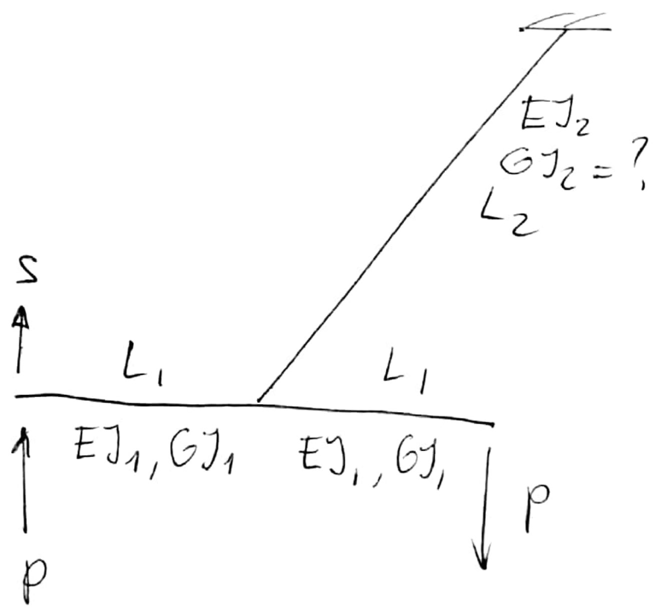
$b = 250$ mm $L = 2000$ mm

$t = 0.6$ mm $P = 1000$ N

Solution ($A = 0$)

the equilibrating shear flows are found as:





Find the value of GJ_2/GJ_1 such that $S = S_{max}$.

Data

$L_1 = 300$ mm

$L_2 = 750$ mm

$EJ_1 = 2 \cdot 10^9$ N mm^2

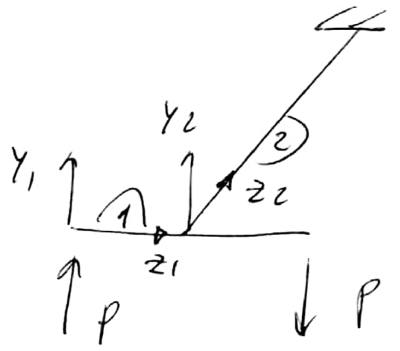
$EJ_2 = 3 \cdot 10^9$ N mm^2

$GJ_1 = 9 \cdot 10^7$ N mm^2

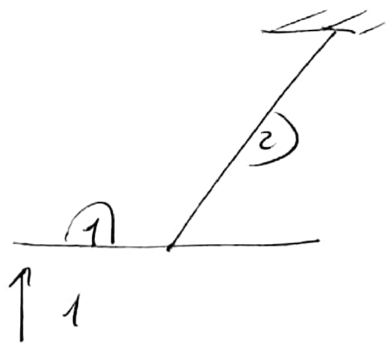
$P = 1200$ N

$S_{max} = 15\,(1 + F/10)$

Solution ($F=0$)



Real



Dummy

$M = -Pz_1$ $\delta M = -z_1$ (beam 1)

$M_2 = -2PL_1$ $\delta M_2 = -L_1$ (beam 2)

$$\int_0^{L_1} \frac{\delta M M}{EJ_1} dz_1 + \int_0^{L_2} \frac{\delta M_2 M_2}{GJ_2} dz_2 = S = S_{max}$$

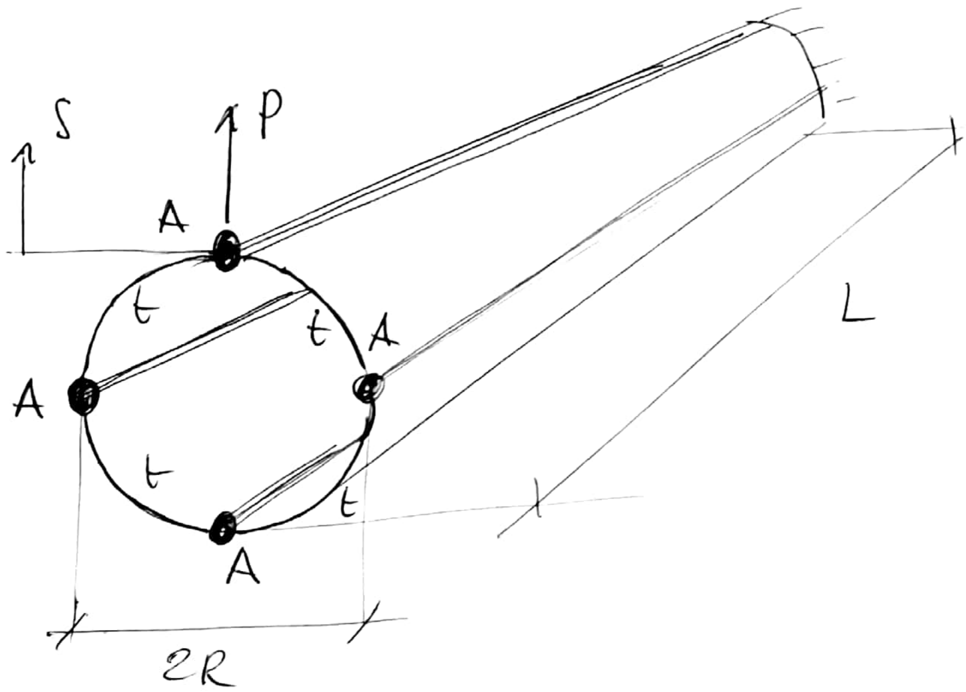
From which:

$$GJ_2 = \frac{2PL_1^2 L_2}{S_{max} - PL_1^3/3EJ_1}$$

and

$$\frac{GJ_2}{GJ_1} = 187.5$$

Scanned by CamScanner



Evaluate the contribution of shear deformability to the displacement S.

Data

$L = 2300$ mm

$R = 150$ mm

$t = 0.8\,(1 + A/10)$ mm

$P = 1700\,(1 + B/10)$ N

$G = 27000$ MPa

Solution (A = B = 0)

$$A^* = \frac{8}{\pi} t R$$

$$S_{shear} = \frac{PL}{GA^*} = 0.4739 \text{ mm}$$

- A beam model cannot be used for evaluating local effects due to load introduction.

  True

- The semi-monocoque approximation provides the exact shear stress distribution along the panels' thickness.

  False

- Essential boundary conditions are more important than natural ones.

  False

- The semi-inverse approach for the De Saint Venant solution for isotropic, homogeneous beams

  leads to the exact solution of the problem.

- The shear center of beam section with one closed cell

  requires application of the compatibility equation theta'=0

- The trial functions in the Ritz method

  must be part of a complete set