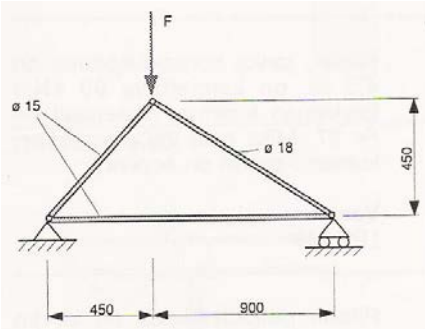


TMKS0600 STATIIKKA JA LUJUUSOPPI

Tehtävä L5-3

Määritä suurin kuorma F , joka kuvan rakenteelle voidaan sallia, kun varmuusluvun on oltava 3.



$$D_1 = 15 \text{ mm}$$

$$D_2 = 18 \text{ mm}$$

$$E = 200 \text{ GPa}$$

$$\tan \alpha = 450/450 \Rightarrow$$

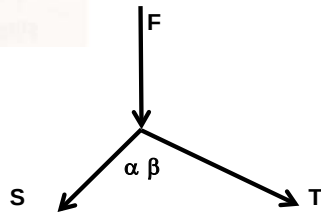
$$\alpha = 45^\circ$$

$$\tan \beta = 900/450 \Rightarrow$$

$$\beta = 63,4^\circ$$

$$\rightarrow \Sigma F_x = 0: -S \sin \alpha + T \sin \beta = 0 \quad (1)$$

$$\uparrow \Sigma F_y = 0: -F - S \cos \alpha - T \cos \beta = 0 \quad (2)$$



$$L_1 = (450^2 + 450^2)^{1/2} = 636,40 \text{ mm}$$

$$L_2 = (900^2 + 450^2)^{1/2} = 1006,23 \text{ mm}$$

$$I_1 = \pi D_1^4 / 64 = 2485,05 \text{ mm}^4$$

$$I_2 = \pi D_2^4 / 64 = 5153,00 \text{ mm}^4$$

$$F_n = \pi^2 EI / L_n^2 \quad L_n = L_i$$

$$F_{n1} = 12112 \text{ N}$$

$$F_{n2} = 10046 \text{ N}$$

Jos T:llä on varmuus 3 nurjahtamiseen $\Rightarrow T = -F_{n2} / 3$

$$T = -3349 \text{ N}$$

Jos S:llä on varmuus 3 nurjahtamiseen $\Rightarrow S = -F_{n1} / 3$

$$S = -4037 \text{ N}$$

$$(1) \Rightarrow S = T \sin \beta / \sin \alpha$$

$$\text{sij. (2)} \Rightarrow -F - T \sin \beta / \sin \alpha \cos \alpha - T \cos \beta = 0$$

$$\Rightarrow F = -T \sin \beta / \sin \alpha \cos \alpha - T \cos \beta = 4492,722827 \text{ N}$$

$$S = -4235,78 \text{ N} \quad \text{ei käy liian suuri}$$

$$(1) \Rightarrow T = S \sin \alpha / \sin \beta$$

$$\text{sij. (2)} \Rightarrow -F - S \cos \alpha - S \sin \alpha / \sin \beta \cos \beta = 0$$

$$\Rightarrow F = -S \cos \alpha - S \sin \alpha / \sin \beta \cos \beta = 4282,177441 \text{ N}$$

Tarkistus:

$$L_n = 636 \text{ mm}$$

$$\lambda = L_n / i = 169,71 > \lambda_{\min}, \text{ nurjahtaa Eulerin mukaisesti}$$

$$i = (I/A)^{1/2} = 3,7500$$

$$A = 176,7146 \text{ mm}^2$$

$$\lambda_{\min} = 105 \text{ taulukosta}$$

$$L_n = 1006 \text{ mm}$$

$$\lambda = L_n / i = 223,61 > \lambda_{\min}, \text{ nurjahtaa Eulerin mukaisesti}$$

$$i = (I/A)^{1/2} = 4,5000$$

$$A = 254,469 \text{ mm}^2$$

$$\lambda_{\min} = 105 \text{ taulukosta}$$