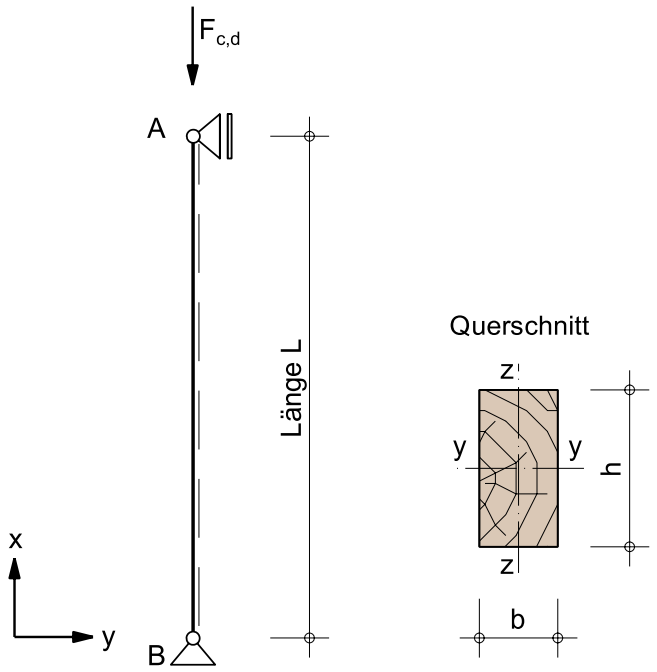
Nachweis Druckstab & Stütze

nach DIN EN 1995-1-1:2010-12 und Nationalem Anhang DIN EN 1995-1-1/NA:2013-08

Anschluss & Geometrie

Pendelstütze

Holzart:	Nadelholz
Festigkeit:	C24
Rohdichte ρ_k:	350 kg/m^3
Breite b:	120 mm
Höhe h:	160 mm
Länge L:	2.80 m

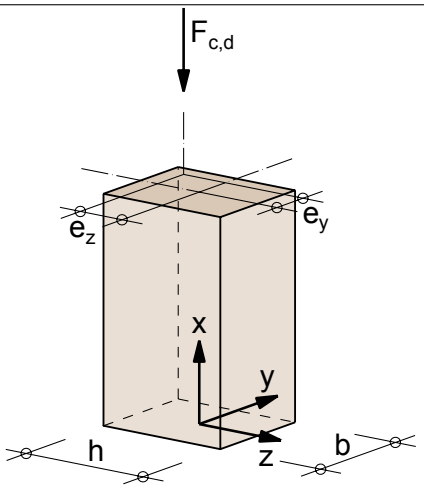


Beanspruchung

$F_{c,d}$:	50.00 kN
Nutzungsklasse:	NKL 1
KLED:	kurz
Ausmitte e_y:	50 mm
Ausmitte e_z:	-50 mm

Das Eigengewicht wurde mit ρ_{mean} = 6.00 kN/m³ (entspricht G_k = 0.32 kN) berücksichtigt.

Nachweis:	0.99 $\leq$ 1.00	**Nachweis erfüllt**



Bemessung

Schnittgrößen

Schnittgrößen am Auflager A (x = L = 2.80 m)

$N_d = -F_{c,d} - 1.35 * G_k = -50.00 - 1.35 * 0.32 = -50.44$ kN

$V_{z,d} = \frac{-F_{c,d} * e_z}{L} = \frac{-50.00 * -50}{2.80} * 10^{-3} = 0.89$ kN

$V_{y,d} = \frac{-F_{c,d} * e_y}{L} = \frac{-50.00 * 50}{2.80} * 10^{-3} = -0.89$ kN

$M_{y,d} = -F_{c,d} * e_z = -50.00 * -50 * 10^{-3} = 2.50$ kNm

$M_{z,d} = -F_{c,d} * e_y = -50.00 * 50 * 10^{-3} = -2.50$ kNm

Festigkeits- und Steifigkeitswerte

$f_{c,0,k}$ =	21.00 N/mm²	$E_{0,mean}$ =	11000 N/mm²	k_{mod} :	0.90
$f_{m,k}$ =	24.00 N/mm²	$E_{0,05}$ =	7400 N/mm²	γ_M :	1.30

$$k_{h,y} = min \begin{cases} \left(\frac{150}{b}\right)^{0.2} = \left(\frac{150}{120}\right)^{0.2} = 1.05 \\ 1.3 \end{cases}$$

$$f_{c,0,d} = k_{mod} * \frac{f_{c,0,k}}{\gamma_M} = 0.90 * \frac{21.00}{1.30} = 14.54 \text{ N/mm}^2$$

$$f_{m,y,d} = k_{mod} * \frac{f_{m,k}}{\gamma_M} = 0.90 * \frac{24.00}{1.30} = 16.62 \text{ N/mm}^2$$

$$f_{m,z,d} = k_{mod} * \frac{k_{h,y} * f_{m,k}}{\gamma_M} = 0.90 * \frac{1.05 * 24.00}{1.30} = 17.45 \text{ N/mm}^2$$

Querschnittswerte

$$A = b * h = 120 * 160 * 10^{-2} = 192.00 \text{ cm}^2$$

$$W_y = \frac{b * h^2}{6} = \frac{120 * 160^2}{6} * 10^{-3} = 512.00 \text{ cm}^3$$

$$W_z = \frac{h * b^2}{6} = \frac{160 * 120^2}{6} * 10^{-3} = 384.00 \text{ cm}^3$$

$$i_y = \frac{h}{\sqrt{12}} = \frac{160}{\sqrt{12}} = 46.19 \text{ mm}$$

$$i_z = \frac{b}{\sqrt{12}} = \frac{120}{\sqrt{12}} = 34.64 \text{ mm}$$

Schlankheit und Knicklängenbeiwerte

Stablänge $s = L = 2.80$ m

Knicklängenbeiwert $\beta = 1.00$ (DIN EN 1995-1-1/NA:2013-08, Tabelle NA. 24)

Ersatzstablänge $l_{ef} = \beta * s = 1.00 * 2.80 = 2.80$ m

Knicklänge $s_{ky} = l_{ef} = 2.80$ m

Knicklänge $s_{kz} = l_{ef} = 2.80$ m

Schlankheit

$$\lambda_y = \frac{s_{ky}}{i_y} = \frac{2.80 * 10^3}{46.19} = 60.62$$

$$\lambda_z = \frac{s_{kz}}{i_z} = \frac{2.80 * 10^3}{34.64} = 80.83$$

$$\lambda_{rel,y} = \frac{\lambda_y}{\pi} * \sqrt{\frac{f_{c,0,k}}{E_{0,05}}} = \frac{60.62}{\pi} * \sqrt{\frac{21.00}{7400}} = 1.03 \quad \text{(Gl. 6.21)}$$

$$\lambda_{rel,z} = \frac{\lambda_z}{\pi} * \sqrt{\frac{f_{c,0,k}}{E_{0,05}}} = \frac{80.83}{\pi} * \sqrt{\frac{21.00}{7400}} = 1.37 \quad \text{(Gl. 6.22)}$$

Knickbeiwerte

Imperfektionsbeiwert $\beta_c = 0.20$ (Gl. 6.29)

$$k_y = 0.5\left(1 + \beta_c * (\lambda_{rel,y} - 0.3) + \lambda_{rel,y}^2\right) = 0.5\left(1 + 0.20 * (1.03 - 0.3) + 1.03^2\right) = 1.10 \quad \text{(Gl. 6.27)}$$

$$k_z = 0.5\left(1 + \beta_c * (\lambda_{rel,z} - 0.3) + \lambda_{rel,z}^2\right) = 0.5\left(1 + 0.20 * (1.37 - 0.3) + 1.37^2\right) = 1.55 \quad \text{(Gl. 6.28)}$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{1.10 + \sqrt{1.10^2 - 1.03^2}} = 0.67 \quad \text{(Gl. 6.25)}$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{1.55 + \sqrt{1.55^2 - 1.37^2}} = 0.44 \quad \text{(Gl. 6.26)}$$

Beanspruchung

$$\sigma_{c,0,d} = \frac{N_d}{A} * 10 = \frac{-50.44}{192.00} * 10 = -2.63 \text{ N/mm}^2$$

$$\sigma_{m,y,d} = \frac{M_{y,d}}{W_y} * 10^3 = \frac{2.50}{512.00} * 10^3 = 4.88 \text{ N/mm}^2$$

$$\sigma_{m,z,d} = \frac{M_{z,d}}{W_z} * 10^3 = \frac{-2.50}{384.00} * 10^3 = -6.51 \text{ N/mm}^2$$

Nachweise

Stabilitätsnachweis

Beiwert $k_m = 0.70$

$$\frac{|\sigma_{c,0,d}|}{k_{c,y} * f_{c,0,d}} + \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + k_m * \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \frac{|-2.63|}{0.67 * 14.54} + \frac{|4.88|}{16.62} + 0.70 * \frac{|-6.51|}{17.45} = 0.27 + 0.29 + 0.70 * 0.37 = 0.82 \quad \text{(Gl. 6.23)}$$

$$\frac{|\sigma_{c,0,d}|}{k_{c,z} * f_{c,0,d}} + k_m * \frac{|\sigma_{m,y,d}|}{f_{m,y,d}} + \frac{|\sigma_{m,z,d}|}{f_{m,z,d}} = \frac{|-2.63|}{0.44 * 14.54} + 0.70 * \frac{|4.88|}{16.62} + \frac{|-6.51|}{17.45} = 0.41 + 0.70 * 0.29 + 0.37 = 0.99 \quad \text{(Gl. 6.24)}$$

Stabilitätsnachweis:	$0.99 \leq 1.00$	**Nachweis erfüllt**

verwendete Normen

DIN EN 338:2016-07	Bauholz für tragende Zwecke
DIN EN 1995-1-1:2010-12	Eurocode 5: Bemessung und Konstruktion von Holzbauteilen, Teil 1-1
DIN EN 1995-1-1/A2:2014-07	Änderung A2 zu EC5
DIN EN 1995-1-1/NA:2013-08	Nationaler Anhang (EC5)