

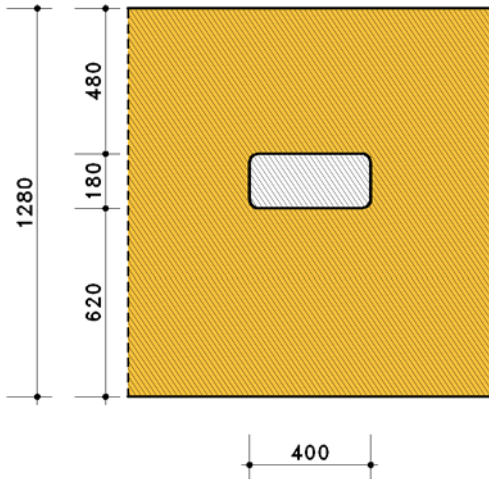
1. Input parameters

1.1. girder opening rectangular unreinforced acc. to DIN EN 1995-1-1/NA:2013-08, NCI NA.6.7

1.2. beam

beam of glue laminated timber EC, GL24h 200/1280 mm, $\rho_k = 385 \text{ kg/m}^3$, NKL 2
 $h_{ro} = 480 \text{ mm}$, $h_{ru} = 620 \text{ mm}$, $a = 400 \text{ mm}$ (expressions acc. to NA:2013-08, NCI NA.6.7 figure NA.7)
 $f_{m,k} = 24.00 \text{ N/mm}^2$, $f_{t,k} = 19.20 \text{ N/mm}^2$, $f_{c,k} = 24.00 \text{ N/mm}^2$, $f_{v,k} = 3.50 \text{ N/mm}^2$, $f_{t90,k} = 0.50 \text{ N/mm}^2$
 filleting of opening edges with $r \geq 15 \text{ mm}$ $r \geq \#\#\# \text{ mm}$
 $f_{m,k}$ increased with $k_h = 1.000$

elevation scale 1:250, unit of length [mm]



1.3. internal forces and moments

Nr.	name	left edge			right edge			KLED	k _{mod}	γ
		N _d kN	V _d kN	M _d kNm	N _d kN	V _d kN	M _d kNm			
1	g+t+s	0.00	50.00	336.00	0.00	30.00	352.00	sh.-term	0.900	1.30

2. results

2.1. tension stress perpendicular to grain in opening area

$h_r = 480 \text{ mm}$, $l_{t,90} = 730 \text{ mm}$, $f_{t,90k} = 0.500 \text{ N/mm}^2$

Nr	f _{t90,d} N/mm ²	zul	left edge				u _l	right edge				u
			F _{t90,d} kN	F _{tV,d} kN	F _{tM,d} kN	F _{t90,d} kN		F _{tV,d} kN	F _{tM,d} kN	F _{t90,d} kN	u _r	
1	0.346	14.983	5.24	5.60	10.84	0.723	3.14	5.87	9.01	0.601	0.723	

$u_{max} = 0.723 \leq 1 \Rightarrow \text{ok.}$

2.2. bending at the opening area cross-section

$I_{nz} = 3465007 \text{ cm}^4$, $z_s = 651 \text{ mm}$, $W_{no} = 53189 \text{ cm}^3$, $W_{nu} = 55127 \text{ cm}^3$, $W_o = 7680 \text{ cm}^3$, $W_u = 12813 \text{ cm}^3$

Nr	f _{m,d} N/mm ²	f _{t,d} N/mm ²	f _{c,d} N/mm ²	σ _{N,d} N/mm ²	σ _{M,o,d} N/mm ²	σ _{M,u,d} N/mm ²	Δσ _{M,o,d} N/mm ²	Δσ _{M,u,d} N/mm ²	σ _{u,d} N/mm ²	σ _{o,d} N/mm ²	u _{o,d}	u _{u,d}	u

$u_{max} = 0.417 \leq 1 \Rightarrow \text{ok.}$

2.3. shear at the reduced cross section

beam width = 200 mm, beam height = 1100 mm, $k_{cr} = 0.714 \Rightarrow A_{ef} = 157143 \text{ mm}^2$, $\kappa_{max} = 1.631$

Nr	f _{v,d} N/mm ²	left edge			right edge			u
		V _d kN	τ _{m,d} N/mm ²	u	V _d kN	τ _{m,d} N/mm ²	u	
1	2.42	50.00	0.779	0.321	30.00	0.467	0.193	0.321

$u_{max} = 0.321 \leq 1 \Rightarrow \text{ok.}$

3. Summary

total utilization all verifications $u_{\max, \text{Ges}} = 0.723 \leq 1 \Rightarrow \text{ok.}$