

1. Input parameters

1.1. girder opening rectangular with glued-in steel bars acc. to DIN EN 1995-1-1/NA:2013-08, NCI NA.6.8.4

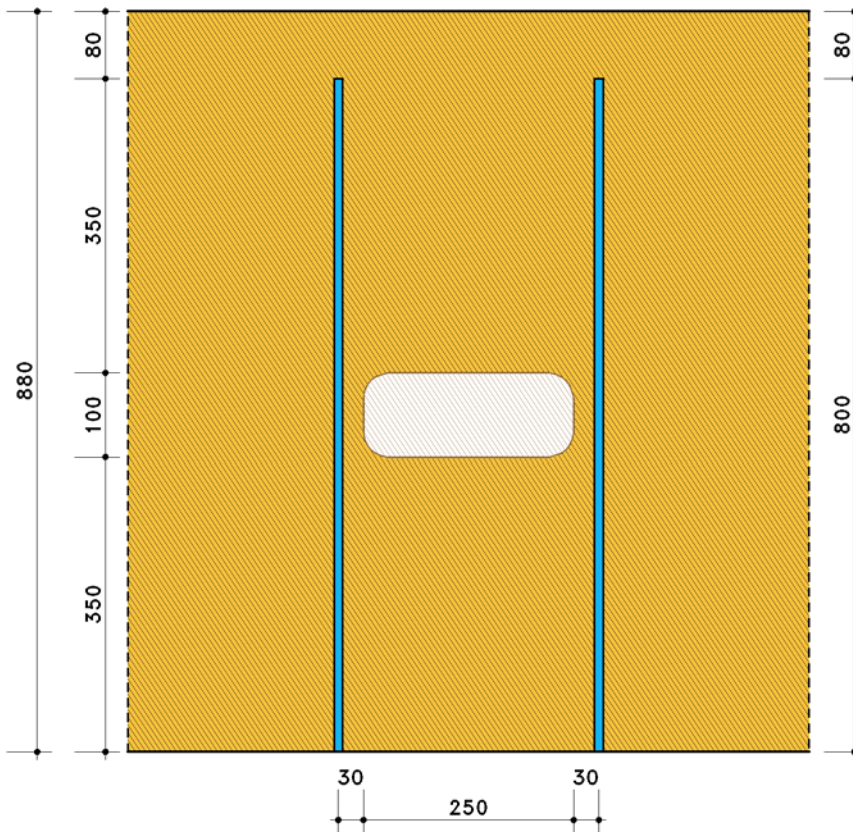
1.2. beam

beam of glue laminated timber EC, GL28h 220/880 mm, $\rho_k = 425 \text{ kg/m}^3$, NKL 1
 $h_{ro} = 430 \text{ mm}$, $h_{ru} = 350 \text{ mm}$, $a = 250 \text{ mm}$ (expressions acc. to NA:2013-08, NCI NA.6.7 figure NA.7)
 $f_{m,k} = 28.00 \text{ N/mm}^2$, $f_{t,k} = 22.30 \text{ N/mm}^2$, $f_{c,k} = 28.00 \text{ N/mm}^2$, $f_{v,k} = 3.50 \text{ N/mm}^2$, $f_{t90,k} = 0.50 \text{ N/mm}^2$
 filleting of opening edges with $r \geq 15 \text{ mm}$ $r \geq \#\#\# \text{ mm}$
 $f_{m,k}$ increased with $k_h = 1.000$

1.3. reinforcement by 1 glued-in steelbar

$d_r = 10 \text{ mm}$, $d_{ef} = 10.0 \text{ mm}$, $l_e = 800 \text{ mm}$, BST500A/B, $a_{3,c} = 30 \text{ mm}$, $a_2 = 30 \text{ mm}$, $a_{4,c} = 30 \text{ mm}$

elevation scale 1:90, unit of length [mm]



1.4. internal forces and moments

Nr.	name	left edge			right edge			KLED	Kmod	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	235.73	264.60	0.00	209.48	208.95	sh.-term	0.900	1.30

2. results

2.1. tension stress perpendicular to grain in opening area

$h_r = 350 \text{ mm}$, $l_{t,90} = 490 \text{ mm}$, $f_{t,90k} = 0.500 \text{ N/mm}^2$, $f_{k1,k} = 3.500 \text{ N/mm}^2$, $l_{ad} = 350 \text{ mm}$

Nr	$f_{t90,d}$ N/mm ²	$f_{k1,d}$ N/mm ²	F _{t90R,d} kN	N _{R,d} kN	left edge				right edge				u
					F _{tV,d} kN	F _{tM,d} kN	F _{t90,d} kN	u _l -	F _{tV,d} kN	F _{tM,d} kN	F _{t90,d} kN	u _r kN	
1	0.346	2.423	26.643	31.42	20.00	6.05	26.05	0.978	17.78	4.78	22.55	0.846	0.978

$u_{max} = 0.978 \leq 1 \Rightarrow \text{ok.}$

2.2. bending at the opening area cross-section

$I_{nz} = 1243561 \text{ cm}^4$, $z_s = 435 \text{ mm}$, $W_{no} = 28596 \text{ cm}^3$, $W_{nu} = 27937 \text{ cm}^3$, $W_o = 6780 \text{ cm}^3$, $W_u = 4492 \text{ cm}^3$

Nr	$f_{m,d}$ N/mm ²	$f_{t,d}$ N/mm ²	$f_{c,d}$ N/mm ²	$\sigma_{N,d}$ N/mm ²	$\sigma_{M,o,d}$ N/mm ²	$\sigma_{M,u,d}$ N/mm ²	$\Delta\sigma_{M,o,d}$ N/mm ²	$\Delta\sigma_{M,u,d}$ N/mm ²	$\sigma_{u,d}$ N/mm ²	$\sigma_{o,d}$ N/mm ²	$u_{o,d}$ -	$u_{u,d}$ -	u -
1	19.38	15.44	19.38	0.000	-8.280	8.475	-2.263	2.780	-10.54	11.255	0.544	0.581	0.581

$u_{max} = 0.581 \leq 1 \Rightarrow \text{ok.}$

2.3. shear at the reduced cross section

beam width = 220 mm, beam height = 780 mm, $k_{cr} = 0.714 \Rightarrow A_{ef} = 122571 \text{ mm}^2$, $\kappa_{max} = 1.529$

Nr	$f_{v,d}$ N/mm ²	left edge			right edge			u -
		V_d kN	$\tau_{m,d}$ N/mm ²	u -	V_d kN	$\tau_{m,d}$ N/mm ²	u -	
1	2.42	235.73	4.412	1.821	209.48	3.921	1.618	1.821

$u_{max} = 1.821 > 1 \Rightarrow \text{not ok. !!}$

3. Summary

total utilization all verifications $u_{max,Ges} = 1.821 > 1 \Rightarrow \text{not ok. !!}$