

1. Input parameters

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

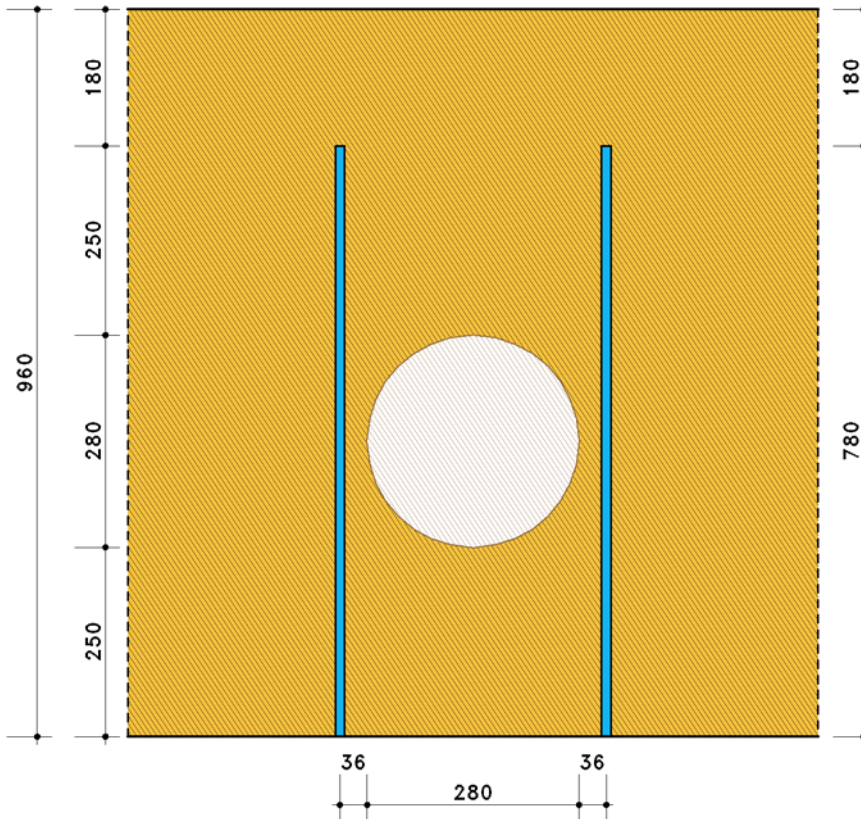
1.2. beam

beam of glue laminated timber EC, GL32h 220/960 mm, $\rho_k = 440 \text{ kg/m}^3$, NKL 1
 $h_{ro} = 430 \text{ mm}$, $h_{ru} = 250 \text{ mm}$, $a = 280 \text{ mm}$ (expressions acc. to NA:2013-08, NCI NA.6.7 figure NA.7)
 $f_{m,k} = 32.00 \text{ N/mm}^2$, $f_{t,k} = 25.60 \text{ N/mm}^2$, $f_{c,k} = 32.00 \text{ N/mm}^2$, $f_{v,k} = 3.50 \text{ N/mm}^2$, $f_{t90,k} = 0.50 \text{ N/mm}^2$
 $f_{m,k}$ increased with $k_h = 1.000$

1.3. reinforcement by 3 glued in steelbars

$d_r = 12 \text{ mm}$, $d_{ef} = 10.4 \text{ mm}$, $l_e = 780 \text{ mm}$, FK 5.8, $a_{3,c} = 36 \text{ mm}$, $a_2 = 36 \text{ mm}$, $a_{4,c} = 36 \text{ mm}$

elevation scale 1:100, unit of length [mm]



1.4. 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+w+s	0.00	374.40	486.75	0.00	329.60	585.31	med.-term	0.800	1.30

2. results

2.1. tension stress perpendicular to grain in opening area

$h_r = 292 \text{ mm}$, $l_{t,90} = 579 \text{ mm}$, $f_{t,90k} = 0.500 \text{ N/mm}^2$, $f_{k1,k} = 3.790 \text{ N/mm}^2$, $l_{ad} = 292 \text{ mm}$

Nr	left edge							right edge				u	
	f _{t90,d} N/mm ²	f _{k1,d} N/mm ²	F _{t90R,d} kN	N _{R,d} kN	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
1	0.308	2.332	25.674	33.72	56.53	13.34	69.87	0.907	49.77	16.04	65.80	0.854	0.907

$u_{max} = 0.907 \leq 1 \Rightarrow \text{ok.}$

2.2. bending at the opening area cross-section

$I_{nz} = 1511329 \text{ cm}^4$, $z_s = 443 \text{ mm}$, $W_{no} = 34120 \text{ cm}^3$, $W_{nu} = 29229 \text{ cm}^3$, $W_o = 6780 \text{ cm}^3$, $W_u = 2292 \text{ cm}^3$

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	$\sigma_{u,d}$ N/mm ²	$\sigma_{o,d}$ N/mm ²	$u_{o,d}$ -	$u_{u,d}$ -	u -
1	19.69	15.75	19.69	0.000	-15.710	18.339	-15.71	18.339	0.798	0.931	0.931

$u_{max} = 0.931 \leq 1 \Rightarrow \text{ok.}$

2.3. shear at the reduced cross section in circlemitte

beam width = 220 mm, beam height = 680 mm, $k_{cr} = 0.714 \Rightarrow A_{ef} = 106857 \text{ mm}^2$, $\kappa_{max} = 1.858$

Nr	$f_{v,d}$ N/mm ²	V_d kN	$\tau_{m,d}$ N/mm ²	u -
1	2.15	352.00	4.941	2.294

$u_{max} = 2.294 > 1 \Rightarrow \text{not ok. !!}$

3. Summary

total utilization all verifications $u_{max,Ges} = 2.294 > 1 \Rightarrow \text{not ok. !!}$