4H-HLZ79 Version: 2/2017-1d

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

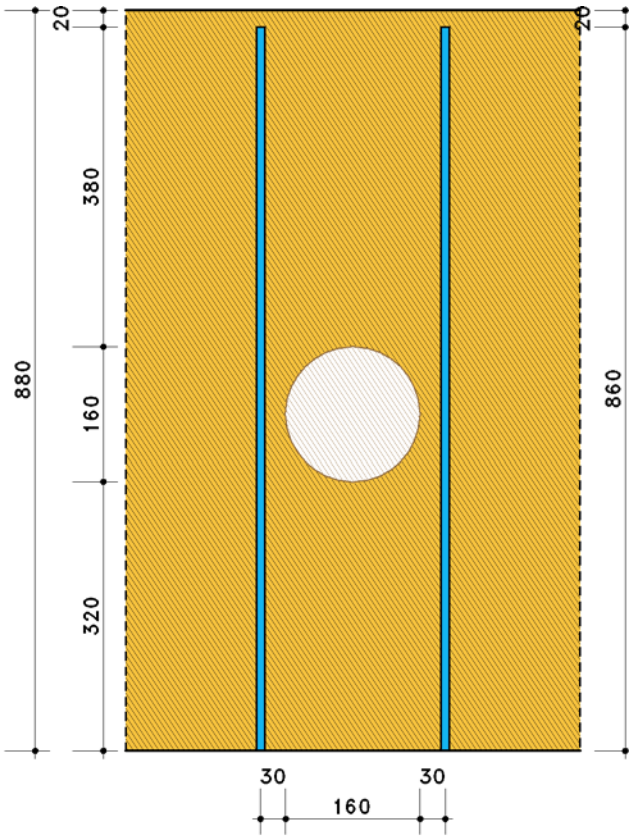
1.2. beam

beam of glue laminated timber EC, GL28h **220/880 mm**, ρ_k = 425 kg/m³, NKL 1
h_{ro} = 400 mm, h_{ru} = 320 mm, a = 160 mm (expressions acc. to NA:2013-08, NCI NA.6.7 figure NA.7)
$f_{m,k}$ = 28.00 N/mm², $f_{t,k}$ = 22.30 N/mm², $f_{c,k}$ = 28.00 N/mm², $f_{v,k}$ = 3.50 N/mm², $f_{t90,k}$ = 0.50 N/mm²
$f_{m,k}$ increased with k_h = 1.000

1.3. reinforcement by 3 glued in steelbars

d_r = 10 mm, d_{ef} = 10.0 mm, l_e = 860 mm, BST500A/B, $a_{3,c}$ = 30 mm, a_2 = 30 mm, $a_{4,c}$ = 30 mm

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



1.4. internal forces and moments

Nr.	name	left edge N_d kN	left edge V_d kN	left edge M_d kNm	right edge N_d kN	right edge V_d kN	right edge M_d kNm	KLED	k_{mod} -	γ -
1	g+w+s	0.00	409.50	798.53	0.00	392.70	734.35	sh.-term	0.900	1.30

2. results

2.1. tension stress perpendicular to grain in opening area

h_r = 344 mm, $l_{t,90}$ = 496 mm, $f_{t,90k}$ = 0.500 N/mm², $f_{k1,k}$ = 3.530 N/mm², l_{ad} = 344 mm

Nr					left edge				right edge				
	$f_{t90,d}$ N/mm²	$f_{k1,d}$ N/mm²	$F_{t90R,d}$ 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 kN	u -
1	0.346	2.444	26.411	31.42	38.88	18.57	57.45	0.725	37.28	17.08	54.36	0.686	0.725

u_{max} = 0.725 ≤ 1 ⇒ ok.

2.2. bending at the opening area cross-section

I_{nz} = 1234972 cm⁴, z_s = 431 mm, W_{no} = 28646 cm³, W_{nu} = 27512 cm³, W_o = 5867 cm³, W_u = 3755 cm³

Nr	$f_{m,d}$ N/mm²	$f_{t,d}$ N/mm²	$f_{c,d}$ N/mm²	$\sigma_{N,d}$ N/mm²	$\sigma_{M,o,d}$ N/mm²	$\sigma_{M,u,d}$ N/mm²	$\sigma_{u,d}$ N/mm²	$\sigma_{o,d}$ N/mm²	$u_{o,d}$ -	$u_{u,d}$ -	u -
1	19.38	15.44	19.38	0.000	-26.755	27.859	-26.76	27.859	1.380	1.437	1.437

u_{max} = 1.437 > 1 ⇒ not ok. !!

2.3. shear at the reduced cross section in circlemitte

beam width = 220 mm, beam height = 720 mm, k_{cr} = 0.714 ⇒ A_{ef} = 113143 mm², κ_{max} = 1.546

Nr	$f_{v,d}$ N/mm²	V_d kN	$\tau_{m,d}$ N/mm²	u -
1	2.42	401.10	5.318	2.195

u_{max} = 2.195 > 1 ⇒ not ok. !!

3. Summary

total utilization all verifications $u_{max,Ges}$ = 2.195 > 1 ⇒ not ok. !!