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

1. Input parameters

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

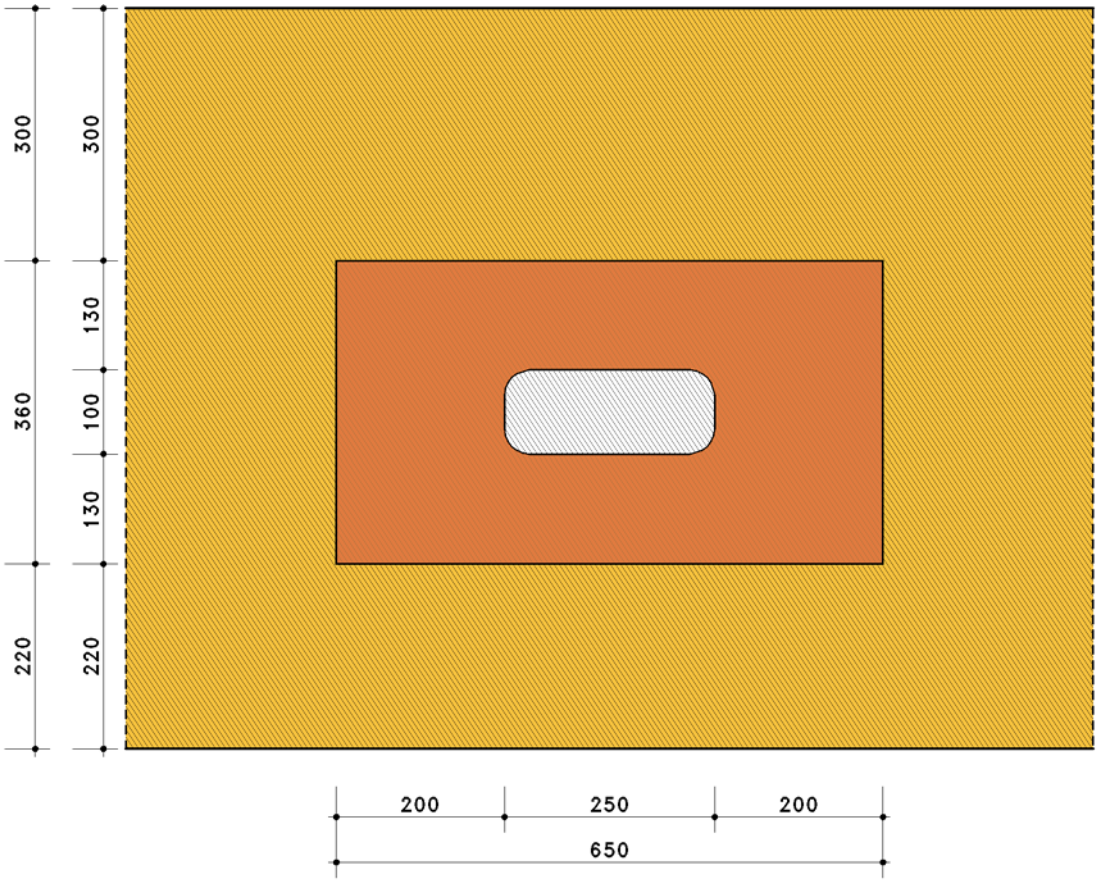
1.2. beam

beam of glue laminated timber EC, GL28h **220/880 mm**, ρ_k = 425 kg/m³, NKL 1
h_{ro} = 430 mm, h_{ru} = 350 mm, a = 250 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
filleting of opening edeges with r ≥ 15 mm r ≥ ### mm
$f_{m,k}$ increased with k_h = 1.000

1.3. reinforcement by glued lugs

plywood F40/30 a_r = 200 mm, h_l = 130 mm, t_r = 10 mm, $f_{t,k}$ = 29.00 N/mm²
parallel to the grain direction of the face grain

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	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

$f_{k2,k}$ = 0.75 N/mm² (table NA.12)

Nr	$f_{t90,d}$ N/mm²	$f_{k2,d}$ N/mm²	$f_{t,d}$ N/mm²	left edge $F_{tV,d}$ kN	$F_{tM,d}$ kN	$F_{t90,d}$ kN	$\tau_{ef,d}$ N/mm²	$\sigma_{t,d}$ N/mm²	$u_{\tau ef,d}$ -	$u_{\sigma,d}$ -	u_l -
1	0.346	0.519	20.08	20.00	6.05	26.05	0.501	6.51	0.965	0.649	0.965

				right edge								
Nr	$f_{t90,d}$ N/mm²	$f_{k2,d}$ N/mm²	$f_{t,d}$ N/mm²	$F_{tV,d}$ kN	$F_{tM,d}$ kN	$F_{t90,d}$ kN	$\tau_{ef,d}$ N/mm²	$\sigma_{t,d}$ N/mm²	$u_{\tau ef,d}$ -	$u_{\sigma,d}$ -	u_r kN	u -
1	0.346	0.519	20.08	17.78	4.78	22.55	0.434	5.64	0.835	0.562	0.835	0.965

$u_{max} = 0.965 \leq 1 \Rightarrow$ ok.

2.2. bending at the opening area cross-section

$I_{nz} = 1243561$ cm⁴, $z_s = 435$ mm, $W_{no} = 28596$ cm³, $W_{nu} = 27937$ cm³, $W_o = 6780$ cm³, $W_u = 4492$ 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	$\Delta\sigma_{M,o,d}$ N/mm²	$\Delta\sigma_{M,u,d}$ 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	-8.280	8.475	-2.263	2.780	-10.54	11.255	0.544	0.581	0.581

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

2.3. shear at the reduced cross section

beam width = 220 mm, beam height = 780 mm, $k_{cr} = 0.714 \Rightarrow A_{ef} = 122571$ mm², $\kappa_{max} = 1.529$

		left edge			right edge			
Nr	$f_{v,d}$ N/mm²	V_d kN	$\tau_{m,d}$ N/mm²	u -	V_d kN	$\tau_{m,d}$ N/mm²	u -	u -
1	2.42	235.73	4.412	1.821	209.48	3.921	1.618	1.821

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

3. Summary

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