

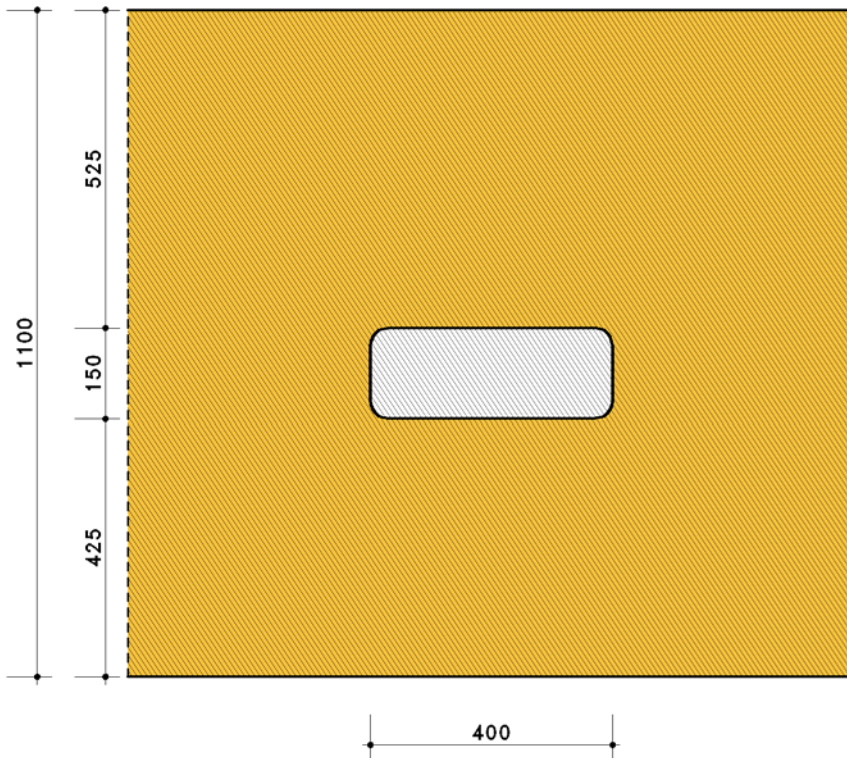
### 1. Input parameters

#### 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, GL28h 220/1100 mm,  $\rho_k = 425 \text{ kg/m}^3$ , NKL 1  
 $h_{ro} = 525 \text{ mm}$ ,  $h_{ru} = 425 \text{ mm}$ ,  $a = 400 \text{ mm}$  (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  $r \geq 15 \text{ mm}$   $r \geq \text{###} \text{ mm}$   
 $f_{m,k}$  increased with  $k_h = 1.000$

elevation scale 1:125, unit of length [mm]



#### 1.3. internal forces and moments

Nr.	name	left edge			right edge			KLED	k <sub>mod</sub>	$\gamma$
		N <sub>d</sub> kN	V <sub>d</sub> kN	M <sub>d</sub> kNm	N <sub>d</sub> kN	V <sub>d</sub> kN	M <sub>d</sub> kNm			
1	g+t+w+s	0.00	42.00	436.90	0.00	18.00	448.90	sh.-term	0.900	1.30

### 2. results

#### 2.1. tension stress perpendicular to grain in opening area

$h_r = 425 \text{ mm}$ ,  $l_{t,90} = 625 \text{ mm}$ ,  $f_{t,90k} = 0.500 \text{ N/mm}^2$

Nr	f <sub>t90,d</sub> N/mm <sup>2</sup>	zul	F <sub>t90,d</sub> kN	left edge			u <sub>l</sub> -	right edge			u <sub>r</sub> kN	u -
				F <sub>tv,d</sub> kN	F <sub>tM,d</sub> kN	F <sub>t90,d</sub> kN		F <sub>tv,d</sub> kN	F <sub>tM,d</sub> kN	F <sub>t90,d</sub> kN		
1	0.346		15.221	4.27	8.22	12.49	0.821	1.83	8.45	10.28	0.675	0.821

$U_{max} = 0.821 \leq 1 \Rightarrow \text{ok.}$

#### 2.2. bending at the opening area cross-section

$I_{nz} = 2424427 \text{ cm}^4$ ,  $z_s = 542 \text{ mm}$ ,  $W_{no} = 44722 \text{ cm}^3$ ,  $W_{nu} = 43457 \text{ cm}^3$ ,  $W_o = 10106 \text{ cm}^3$ ,  $W_u = 6623 \text{ cm}^3$

Nr	f <sub>m,d</sub> N/mm <sup>2</sup>	f <sub>t,d</sub> N/mm <sup>2</sup>	f <sub>c,d</sub> N/mm <sup>2</sup>	$\sigma_{N,d}$ N/mm <sup>2</sup>	$\sigma_{M,o,d}$ N/mm <sup>2</sup>	$\sigma_{M,u,d}$ N/mm <sup>2</sup>	$\Delta\sigma_{M,o,d}$ N/mm <sup>2</sup>	$\Delta\sigma_{M,u,d}$ N/mm <sup>2</sup>	$\sigma_{u,d}$ N/mm <sup>2</sup>	$\sigma_{o,d}$ N/mm <sup>2</sup>	u <sub>o,d</sub> -	u <sub>u,d</sub> -	u -
1	19.38	15.44	19.38	0.000	-9.903	10.192	-0.328	0.405	-10.23	10.597	0.528	0.547	0.547

$U_{max} = 0.547 \leq 1 \Rightarrow \text{ok.}$

### 2.3. shear at the reduced cross section

beam width = 220 mm, beam height = 950 mm,  $k_{cr} = 0.714 \Rightarrow A_{ef} = 149286 \text{ mm}^2$ ,  $\kappa_{max} = 1.684$

Nr	$f_{v,d}$ N/mm <sup>2</sup>	left edge			right edge			u -
		$V_d$ kN	$\tau_{m,d}$ N/mm <sup>2</sup>	u -	$V_d$ kN	$\tau_{m,d}$ N/mm <sup>2</sup>	u -	
1	2.42	42.00	0.711	0.293	18.00	0.305	0.126	0.293

$u_{max} = 0.293 \leq 1 \Rightarrow \text{ok.}$

### 3. Summary

total utilization all verifications  $u_{max,Ges} = 0.821 \leq 1 \Rightarrow \text{ok.}$