

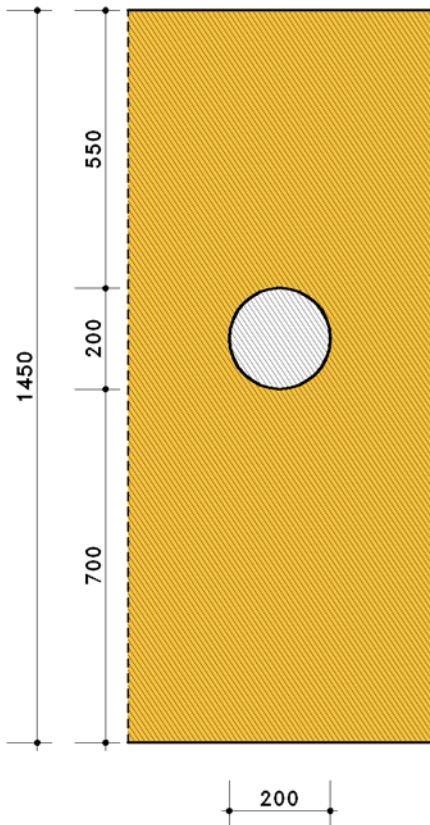
### 1. Input parameters

#### 1.1. girder opening circular 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 200/1450 mm,  $\rho_k = 425 \text{ kg/m}^3$ , NKL 1  
 $h_{ro} = 550 \text{ mm}$ ,  $h_{ru} = 700 \text{ mm}$ ,  $a = 200 \text{ mm}$  (expressions acc. to NA:2013-08, NCI NA.6.7 figure NA.7)  
 $f_{m,k} = 28.00 \text{ N/mm}^2$ ,  $f_{t,k} = 22.30 \text{ N/mm}^2$ ,  $f_{c,k} = 28.00 \text{ N/mm}^2$ ,  $f_{v,k} = 3.50 \text{ N/mm}^2$ ,  $f_{t90,k} = 0.50 \text{ N/mm}^2$   
 $f_{m,k}$  increased with  $k_h = 1.000$

elevation scale 1:150, unit of length [mm]



#### 1.3. internal forces and moments

Nr.	name	left edge			right edge			KLED	k <sub>mod</sub>	γ
		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+s	0.00	100.00	-525.00	0.00	100.00	-505.00	sh.-term	0.900	1.30

### 2. results

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

$h_r = 580 \text{ mm}$ ,  $l_{t,90} = 796 \text{ mm}$ ,  $f_{t,90k} = 0.500 \text{ N/mm}^2$

Nr	f <sub>t90,d</sub> N/mm <sup>2</sup>	zul F <sub>t90,d</sub> kN	left edge				right edge				u
			F <sub>tV,d</sub> kN	F <sub>tM,d</sub> kN	F <sub>t90,d</sub> kN	u <sub>l</sub>	F <sub>tV,d</sub> kN	F <sub>tM,d</sub> kN	F <sub>t90,d</sub> kN	u <sub>r</sub>	
1	0.346	15.342	7.22	7.24	14.46	0.943	7.22	6.97	14.18	0.925	0.943

$u_{max} = 0.943 \leq 1 \Rightarrow \text{ok.}$

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

$I_{nz} = 5041608 \text{ cm}^4$ ,  $z_s = 737 \text{ mm}$ ,  $W_{no} = 68407 \text{ cm}^3$ ,  $W_{nu} = 70710 \text{ cm}^3$ ,  $W_o = 10083 \text{ cm}^3$ ,  $W_u = 16333 \text{ cm}^3$

Nr	$f_{m,d}$ N/mm <sup>2</sup>	$f_{t,d}$ N/mm <sup>2</sup>	$f_{c,d}$ 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>	$\sigma_{u,d}$ N/mm <sup>2</sup>	$\sigma_{o,d}$ N/mm <sup>2</sup>	$u_{o,d}$ -	$u_{u,d}$ -	$u$ -
1	19.38	15.44	19.38	0.000	7.528	-7.283	7.528	-7.283	0.388	0.376	0.388

$u_{max} = 0.388 \leq 1 \Rightarrow \text{ok.}$

## 2.3. shear at the reduced cross section in circle center

beam width = 200 mm, beam height = 1250 mm,  $k_{cr} = 0.714 \Rightarrow A_{ef} = 178571 \text{ mm}^2$ ,  $\kappa_{max} = 1.409$

Nr	$f_{v,d}$ N/mm <sup>2</sup>	$V_d$ kN	$\tau_{m,d}$ N/mm <sup>2</sup>	$u$ -
1	2.42	100.00	0.840	0.347

$u_{max} = 0.347 \leq 1 \Rightarrow \text{ok.}$

## 3. Summary

total utilization all verifications  $u_{max,Ges} = 0.943 \leq 1 \Rightarrow \text{ok.}$