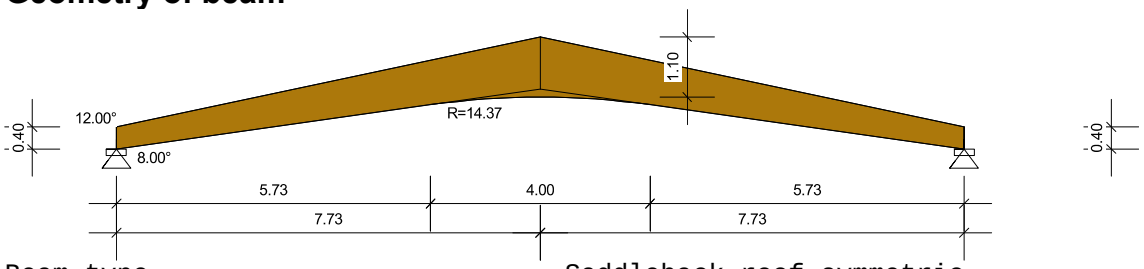
RIB Laminated timber girder (DIN EN 1995-1)

Satteldach_gekrümmt(DGfH S.111).RTbsh

Record of the input

Geometry of beam




```
Beam type                          = Saddleback roof symmetric
Beam length                        = 15.46 m
Roof slope  top                    = 12.00 °
Roof slope bottom                  = 8.00 °
Radius of curvature                = 14.37 m
Straight length before curvature = 5.73 m
Width of beam                      = 0.16 m
Area                               = 10.670 m2
Volume                             = 1.707 m3
Weight                             = 734.09 kg
Length of contour                  = 32.19 m
Surface                            = 5.150 m2
Ridge wedge is mounted
```

Support conditions

```
x  ... [m]   Distance from left end of beam
dx ... Displacement in x-direction
dz ... Displacement in z-direction
rx ... Torsion, x
```

x [m]	Support type	dx	dz	rx	Notch
0.00	Support left	fixed	fixed	fixed	no
15.46	Support right	free	fixed	fixed	no

Material

E [N/mm2]	G [N/mm2]	rho kg/m3	gamma kN/m3	fm,k N/mm2	ft,0,k N/mm2	ft,90,k N/mm2	fc,0,k N/mm2	fc,90,k N/mm2	fv,k N/mm2
13700	850	430.00	5.00	32.00	22.50	0.50	29.00	3.30	2.50

```
Material name      = GL32h
Thickness of rib   = 3.30 cm
Direction of fibre = Parallel with bottom edge
```

Building

```
Height                          = 12.00 m
Depth                           = 20.00 m
Distance of beam                = 1.00 m
Distance to edge of roof:       = 1.50 m
Elevation of building over NN   = 400 m
Speed pressure q                = 0.00 kN/m2
Characteristic snow load sk     = 5.00 kN/m2
```

Usage class

```
UC = 1 ... 20° and 65% rel. Humidity (closed heated buildings)
```

Cross-section values

```
x      ... [m]   Distance from left end of beam
b      ... [cm]  Width of cross-section
h      ... [cm]  Height of cross-section
A      ... [cm2] Area of cross-section b*h
Iy     ... [cm4] Moment of inertia
Wy     ... [cm3] Section modulus
alfa-t ... Face angle of fibre above
alfa-b ... Face angle of fibre below
```

x [m]	b [cm]	h [cm]	A [cm2]	Iy [cm4]	Wy [cm3]	alfa-t [°]	alfa-b [°]
0.00	16.00	39.39	630.28	81503	4138	4.00	0.00
7.73	16.00	109.19	1747.03	1735728	31793	12.00	0.00
15.46	16.00	39.39	630.28	81503	4138	4.00	0.00

Safety

Type	Description	gamma-sup	gamma-inf	psi-0	psi-1	psi-2
G	permanent	1.35	1.00	1.00	1.00	1.00
S	Snow	1.50	0.00	0.50	0.20	0.00

Loading

p1 ... [kN/m2] Load value left
p2 ... [kN/m2] Load value right
x1 ... [m] Load position left
x2 ... [m] Load position right

Load case Ständige Last (Permanent load)

Type	p1	p2	x1	x2
Line load	3.60	3.60	0.00	7.73
Line load	3.60	3.60	7.73	15.46

Load case Snow entire roof (Snow)

Type	p1	p2	x1	x2
Line load	4.00	4.00	0.00	7.73
Line load	4.00	4.00	7.73	15.46

Load case Snow left (Snow)

Type	p1	p2	x1	x2
Line load	4.00	4.00	0.00	7.73
Line load	2.00	2.00	7.73	15.46

Load case Snow right (Snow)

Type	p1	p2	x1	x2
Line load	2.00	2.00	0.00	7.73
Line load	4.00	4.00	7.73	15.46

Results

Summary of utilization

	x	actual/perm
ULS:	3.23	1.03*
Bending stress:	3.23	1.03*
Shear stress:	14.88	0.96
Support pressure:	0.00	0.44
SLS:	7.73	1.44*
w,inst:	7.73	1.44*
w,fin seldom:	7.73	1.23*
w,fin qu.st. - w0:	7.73	0.73
Fire protection avail/allow		
ULS:	7.73	0.52
Bending stress:	3.23	0.43
Shear stress:	14.88	0.39

Characteristic support values

x [m]	Type	Ax,min [kN]	Ax,max [kN]	Az,min [kN]	Az,max [kN]
0.00	G	0.00	0.00	28.41	28.41
15.46	G	0.00	0.00	28.41	28.41
0.00	S	0.00	0.00	0.00	30.92
15.46	S	0.00	0.00	0.00	30.92
0.00	Sum	0.00	0.00	28.41	59.33
15.46	Sum	0.00	0.00	28.41	59.33

Characteristic deflections

Fiel	x [m]	w-min [mm]	x [m]	w-max [mm]
1	0.00	0.00	7.73	74.06

Tranverse tension

Transverse tensile stress

```
sigt90  ... Transverse tension stress Gl (6.54)
eta     ... Utilization transverse tension stress Gl (6.53)
eta-lim ... <= 1 -> in UC 1+2 no constc. Bracing neccessary
Myd     ... Design moment at crest point
sig-ul  ... Longitudinal stress at bottom of ridge section GL (6.42)
eta     ... Utilization longitudinal stress of  ridge section Gl(6.41)
```

x [m]	sigt90 [N/mm2]	eta	eta-lim	Myd [kNm]	sig-ul [N/mm2]	eta	kmod
7.73	0.49	4.77	7.95	327.3	14.96	0.68	0.90

Bracing of transverse tension

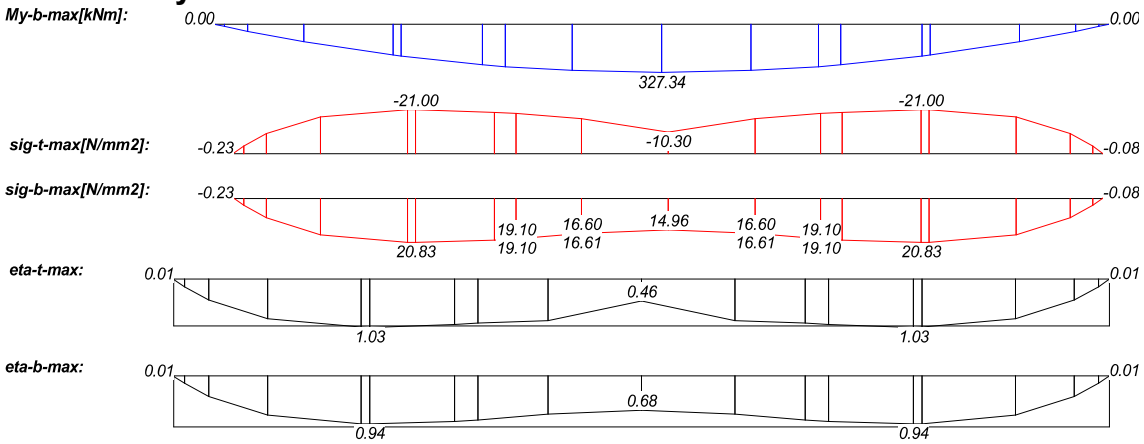
```
Full threaded bolts (SPAX Z-9.1-519)

allow. distance at UE > 25.0 cm and < 82.3 cm
Tensile strength steel ft,d = 1.00 N/mm2

xa,xe  ... area to reinforce, outer and inner quarter
d      ... Diameter of steel
n      ... Total number of bars in the domain
nl     ... Number of bars in longitudinal direction
nq     ... Number of bars in normal direction
a1     ... distance of bar at top edge of beam`s length
a2     ... Minimum distance together cross
a2c    ... Minimum distance to cross edge
```

Rax,d ... Capacity of tensile force due to extraction
Ft90,d ... Design tension force
lad ... Effective length of anchorage
eta ... Utilisation from extraction
eta-St ... Utilisation of tensile strength

n = -1: not allowable

xa m	xe m	d mm	n	nl	nq	a1 cm	a2 cm	a2c cm	Rax,d kN	Ft90,d kN	lad cm	eta	eta-St
5.73	6.73	8	4	4	1	27.0	2.0	3.2	17.1	13.4	39.8	0.78	0.99
6.73	8.73	8	12	6	2	35.2	2.0	3.2	19.5	13.4	45.5	0.69	0.99
8.73	9.73	8	4	4	1	27.0	2.0	3.2	17.1	13.4	39.8	0.78	0.99
5.73	6.73	10	3	3	1	36.0	2.5	4.0	21.4	17.9	39.8	0.84	0.80
6.73	8.73	10	8	8	1	26.4	2.5	4.0	24.4	20.1	45.5	0.82	0.90
8.73	9.73	10	3	3	1	36.0	2.5	4.0	21.4	17.9	39.8	0.84	0.80
5.73	6.73	12	3	3	1	36.0	3.0	4.8	25.6	17.9	39.8	0.70	0.59
6.73	8.73	12	6	6	1	35.2	3.0	4.8	29.3	26.8	45.5	0.92	0.88
8.73	9.73	12	3	3	1	36.0	3.0	4.8	25.6	17.9	39.8	0.70	0.59

Stress analysis

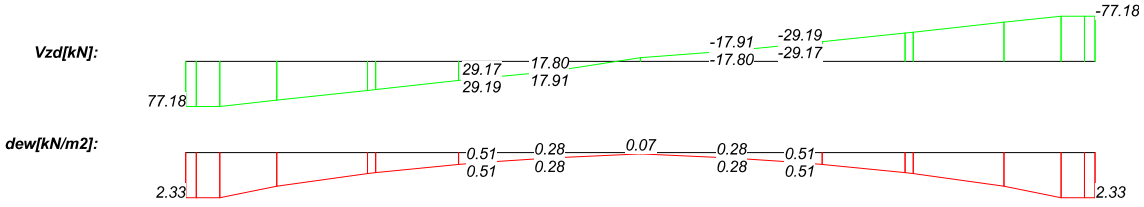


maximum longitudinal stress

```
Myd    ... [kNm] Design moment
sig    ... [N/mm2] Bending stress
allsig ... [N/mm2] permissible shear stress
eta    ... Utilisation level
kmod   ... Modification coefficient
kled   ... Duration of loads
    kled=1 ..permanent, 2 ... long, 3 ... mid, 4 ... short, 5 ... very short
```

x	Myd	sig,o	allSig	eta-0	kled	kmod	sig,u	allsig	eta-b	kled	kmod
3.23	216.58	-21.00	20.35	**1.03***	4	0.90	20.83	22.06	0.94	4	0.90
7.73	327.34	-10.30	22.15	0.46	4	0.90	14.96	22.15	0.68	4	0.90
12.23	216.58	-21.00	20.35	**1.03***	4	0.90	20.83	22.06	0.94	4	0.90

Shear stresses



x	Vd	Mtd	tau	dews	all	eta	kled	kmod
14.88	-77.18	0.00	2.33	0.00	2.42	0.96	4	0.90

Support pressure and safety

Avd ... [kN] Design value of support reaction
alfa ... [°] Angle between force and fibre direction
kc90 ... Coefficient of transverse compression

x	Avd-min	Avd-max	kled	kmod	alfa	kc90	Width	sig-alf	all	eta
0.00	28.41	84.74	4	0.90	82.00	1.75	0.36	1.36	3.08	0.44
15.46	28.41	84.74	4	0.90	82.00	1.75	0.36	1.36	3.08	0.44

Check of deflections

wG,inst ... Initial deformation due to permanent loads
wG,fin ... End deformation due to permanent load
wQ,inst.s ... Initial deformation due to variable loads (rare combination)
wQ,fin.s ... End deformation due to variable loads (rare combination)
wQ,inst.q ... Initial deformation due to variable loads (quasi-permanent combination)
wQ,fin.q ... End deformation due to variable loads (Quasi-permanent combination)
w0 = 0.0 mm ... [mm] given camber
L' ... [m] Length of span
all ... [mm] allowance deflection
L'/w ... relationship between length and deflection
w,inst ... elastic initial deflection under rare action combination
w,inst = wG.inst + wQ,inst.s
w,fin.s ... Total deflection under rare action combination
w,fin.s = w,fin(G+Q).s
w,fin.q ... Total deflection under quasi-permanent action combination
w,fin.q = w,fin(G+Q).q - w0
Camber is already subtracted from deflection wfin.q of main span.

Minimal:

Fiel	L'	x	w,inst	all	L'/w	x	wfin.s	all	L'/w	x	wfin.q	all	L'/w
1	15.46	0.00	0.0	51.5	-	0.00	0.0	77.3	-	0.00	0.0	77.3	-

Maximum:

Fiel	L'	x	w,inst	all	L'/w	x	wfin.s	all	L'/w	x	wfin.q	all	L'/w
1	15.46	7.73	74.1	51.5	209	7.73	95.3	77.3	162	7.73	56.7	77.3	273

Results of load case fire

```
Burnout                ... Trilateral
Fire resistance class  ... F 30 -B
```

Remaining cross-section

```
d(tf)     ... [cm] Depth of combustion
Ar        ... [cm2] Area
Wr        ... [cm3] Section modulus
ur        ... [cm] Flamed Circumference
k,fi      ... Modification coefficient of stiffness (Tab. 75)
kmod,m,fi ... Modification coefficient of bending strength
kmod,E,fi ... Modification coefficient of stiffness
```

x [m]	d(tf) [cm]	ur [cm]	Ar [cm2]	Wr [cm3]	k,fi	kmod,m,fi	kmod,E,fi
0.00	2.80	83.58	380.56	2320.93	1.15	1.00	1.00
0.18	2.80	86.14	393.84	2485.69	1.15	1.00	1.00
0.58	2.80	91.81	423.34	2872.06	1.15	1.00	1.00
1.55	2.80	105.51	494.59	3920.19	1.15	1.00	1.00
3.09	2.80	127.44	608.62	5936.22	1.15	1.00	1.00
3.23	2.80	129.43	618.95	6139.37	1.15	1.00	1.00
4.64	2.80	149.37	722.65	8369.01	1.15	1.00	1.00
5.03	2.80	154.85	751.16	9042.32	1.15	1.00	1.00
6.18	2.80	173.20	846.56	11484.87	1.15	1.00	1.00
7.73	2.80	223.18	1106.45	19619.13	1.15	1.00	1.00
9.28	2.80	173.20	846.56	11484.87	1.15	1.00	1.00
10.44	2.80	154.85	751.16	9042.32	1.15	1.00	1.00
10.82	2.80	149.37	722.65	8369.01	1.15	1.00	1.00
12.23	2.80	129.43	618.95	6139.37	1.15	1.00	1.00
12.37	2.80	127.44	608.62	5936.22	1.15	1.00	1.00
13.91	2.80	105.51	494.59	3920.19	1.15	1.00	1.00
14.88	2.80	91.81	423.34	2872.06	1.15	1.00	1.00
15.28	2.80	86.14	393.84	2485.69	1.15	1.00	1.00
15.46	2.80	83.58	380.56	2320.93	1.15	1.00	1.00

Transverse tensile in case of fire

Transverse tensile stress in case of fire

x [m]	sigt90 [N/mm2]	eta	eta-lim	Myd [kNm]	sig-ul [N/mm2]	eta	kmod
7.73	0.32	0.52	3.16	133.6	9.90	0.27	0.90

Bracing of transverse tensile in case of fire

```
Full threaded bolts (SPAX Z-9.1-519)

allow. distance at UE > 25.0 cm and < 82.3 cm
Tensile strength steel ft,d = 1.00 N/mm2

n = -1: not allowable
```

xa m	xe m	d mm	n	nl	nq	a1 cm	a2 cm	a2c cm	Rax,d kN	Ft90,d kN	lad cm	eta	eta-St
5.73	6.73	8	2	2	1	54.0	0.0	0.0	22.2	0.0	39.8	0.00	0.00
6.73	8.73	8	3	3	1	70.4	0.0	0.0	22.2	0.0	39.8	0.00	0.00
8.73	9.73	8	2	2	1	54.0	0.0	0.0	22.2	0.0	39.8	0.00	0.00
5.73	6.73	10	2	2	1	54.0	0.0	0.0	27.8	0.0	39.8	0.00	0.00
6.73	8.73	10	3	3	1	70.4	0.0	0.0	27.8	0.0	39.8	0.00	0.00
8.73	9.73	10	2	2	1	54.0	0.0	0.0	27.8	0.0	39.8	0.00	0.00
5.73	6.73	12	2	2	1	54.0	0.0	0.0	33.3	0.0	39.8	0.00	0.00
6.73	8.73	12	3	3	1	70.4	0.0	0.0	33.3	0.0	39.8	0.00	0.00
8.73	9.73	12	2	2	1	54.0	0.0	0.0	33.3	0.0	39.8	0.00	0.00

Stress analysis

maximum longitudinal stress in case of fire

x	Myd	sig,o	allSig	eta-0	kled	kmod	sig,u	allsig	eta-b	kled	kmod
3.09	85.55	-14.47	33.87	0.43	4	0.90	14.35	36.74	0.39	4	0.90
7.73	133.59	-6.81	36.80	0.19	4	0.90	9.90	36.80	0.27	4	0.90
12.37	85.55	-14.47	33.87	0.43	4	0.90	14.35	36.74	0.39	4	0.90

Shear stresses in case of fire

x	Vd	Mtd	tau	dews	all	eta	kled	kmod
14.88	-31.51	0.00	1.56	0.00	4.03	0.39	4	0.90