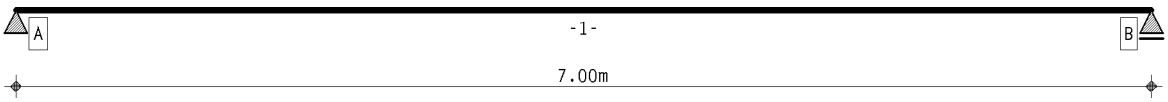
1. Options for Calculations

calculation acc. to DIN 1052:2008

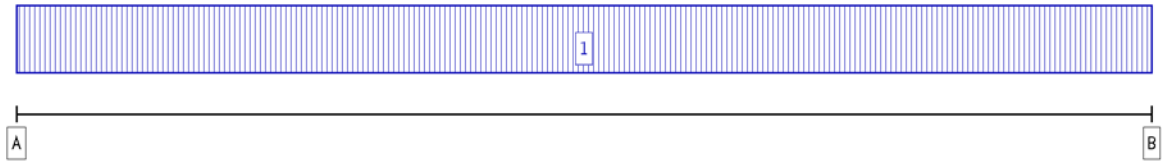
service class 1

2. Structural system

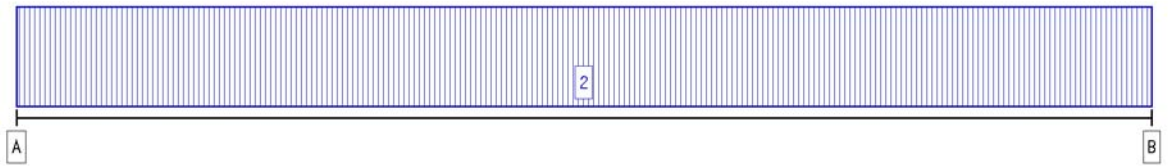


main beam

3. Loading



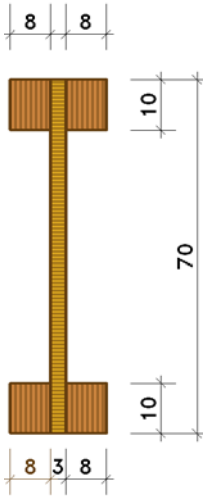
action effect 1: permanent loads (permanent, 1 load cases)



action effect 2: live loads (1) (transient, 1 load cases)

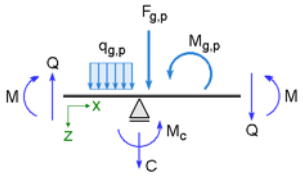
4. main beam

section scale 1:15



timber grade top flange		**solid coniferous timber, C30 (S13)**
char. bend. strength	$f_{m,k}$	: 30.0 N/mm²
char. shear strength	$f_{v,k}$	: 2.0 N/mm²
char. ten. strength	$f_{t,k}$	: 18.0 N/mm²
char. compr. strength	$f_{c,0,k}$	: 23.0 N/mm²
char. compr. strength	$f_{c,90,k}$	: 2.7 N/mm²
modulus of elasticity	$E_{0,mean}$	:12000 N/mm²
Dichte	ρ_k / ρ_m	: 380 / 456 kg/m³
deformation factor	k_{def}	: 0.60 -
area	A_{flange}	: 160.000 cm²
moment of inertia	I_{flange}	: 1333.333 cm⁴
timber grade web (fibre ll)		**plywood F40/30**
d = 30.0 mm (hochkant)		
char. bend. strength	$f_{m,k}$	: 29.0 N/mm²
char. shear strength	$f_{v,k}$	: 9.5 N/mm²
char. ten. strength	$f_{t,k}$	: 29.0 N/mm²
char. compr. strength	$f_{c,0,k}$	: 21.0 N/mm²
char. compr. strength	$f_{c,90,k}$	: 9.0 N/mm²
e-modulus	$E_{0,mean}$ (diaphragm)	: 4400 N/mm²
e-modulus	$E_{0,mean}$ (plate)	: 6000 N/mm²
Dichte	ρ_k / ρ_m	: 600 / 720 kg/m³
deformation factor	k_{def}	: 0.80 -
area	A_{flange}	: 210.000 cm²
moment of inertia	I_{flange}	:85750.000 cm⁴
timber grade bottom flange		**solid coniferous timber, C30 (S13)**
char. bend. strength	$f_{m,k}$	: 30.0 N/mm²
char. shear strength	$f_{v,k}$	: 2.0 N/mm²
char. ten. strength	$f_{t,k}$	: 18.0 N/mm²
char. compr. strength	$f_{c,0,k}$	: 23.0 N/mm²
char. compr. strength	$f_{c,90,k}$	: 2.7 N/mm²
modulus of elasticity	$E_{0,mean}$	:12000 N/mm²
Dichte	ρ_k / ρ_m	: 380 / 456 kg/m³
deformation factor	k_{def}	: 0.60 -
area	A_{flange}	: 160.000 cm²
moment of inertia	I_{flange}	: 1333.333 cm⁴

definition of internal forces and moments:



5. Beam sections

beam sections

section	x_A m	x_E m	l m	l_{ef} m	i_z mm	k -	λ -	$\lambda_{rel,c}$ -	k_c -	l_v m	cantil.	s_{ef} mm
1	0.00	7.00	7.00	2.33	17.3400	6.3710	134.3714	3.3814	0.0850	7.00	-	50.0

stiffness values serviceability initial state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_{1r} -	a_1 mm	K_3 N/mm	γ_{3r} -	a_3 mm	$EI_{ef,inst}$ Nmm2	ø k_{def} -
1	1.0000	0.0	3130	0.6181	-300.0	3130	0.6181	300.0	2.5456E13	0.6715

stiffness values load-carrying capacity initial state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_1 -	a_1 mm	K_3 N/mm	γ_3 -	a_3 mm	$EI_{ef,inst}$ Nmm2	$I_{ef,inst}$ mm2	$h_{q,inst}$ mm	$A_{q,inst}$ mm
1	1.0000	-0.0	2087	0.5190	-300.0	2087	0.5190	300.0	2.2031E13	1835942272.	35.00	174.01

stiffness values load-carrying capacity final state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_1 -	a_1 mm	K_3 N/mm	γ_3 -	a_3 mm	$EI_{ef,inf}$ Nmm2	$I_{ef,inf}$ mm2	$h_{q,inf}$ mm	$A_{q,inf}$ mm
1	1.0000	0.0	1228	0.5039	-300.0	1228	0.5039	300.0	1.3180E13	1757383680.	35.00	174.71

net section properties

section	$A_{n,2}$ cm2	$W_{n,2}$ cm3	$I_{n,2}$ cm4	$A_{n,1}$ cm2	$W_{n,1}$ cm3	$I_{n,1}$ cm4	$A_{n,3}$ cm2	$W_{n,3}$ cm3	$I_{n,3}$ cm4
1	197.04	2114.48	74006.70	131.92	237.91	1189.57	131.92	237.91	1189.57

6. Fasteners

section 1 from x_A = 0.00 m to x_E = 7.00
nail, 6.0 x 160.0 mm, d_k = 20.0 mm, predrilled
4-row with a_1 = **200.0 mm**
4 - row with a_2 = 20.0 mm, simplified verification acc. to DIN 1052:2008, 12.2(2)
nail ends in timber member 2, 2 shear plane(s), penetration depth t = 50 mm > 4 d = 24 mm
f_{uk} = 600 N/mm², M_{yk} = 18987 Nmm
K_{ser} = 3130 N/mm, γ_M = 1.10, **R_k = 3007.8 N, all values per shear plane**

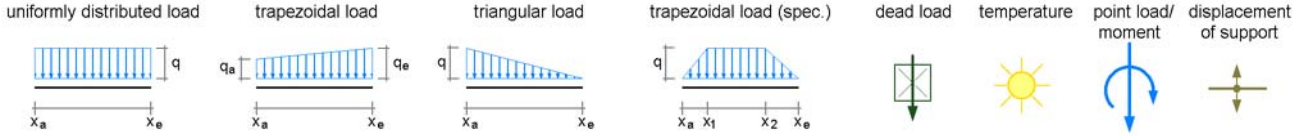
7. Supports

coordinates of supports

supp.name	x m	width mm	depth mm	c_F kN/m	c_M kNm/-	restraint (F)	restraint (M)
A	0.00	150	30	fix	----	X	-
B	7.00	150	30	fix	----	X	-

8. Action effects

Attention! Acc. to DIN 1052, 8.6.2 (2)
mechanically jointed cross-sections are only allowed to be loaded by line loads



Permanent action effect: permanent loads
1. additive load case: dead load (1)
⇒ unif.distr.load: q = 4.40 kN/m from x_a = 0.00 m to x_e = 7.00 m
2. Transient action effect: live loads (1)
2. additive load case: live loads (1/1)
⇒ unif.distr.load: q = 5.00 kN/m from x_a = 0.00 m to x_e = 7.00 m

9. verifications

1: DIN 1052:2008 load-carrying capacity
buckling analysis of compression flange acc. to DIN 1052, 10.3.1 will be executed
verification of bearing stress DIN 1052, 10.2.4 will be executed
Extreme rule 1

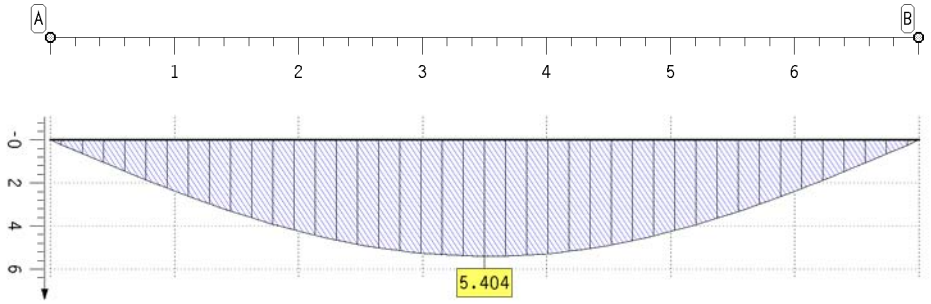
2: DIN 1052:2008 deformations (rarely)
Extreme rule 1

3: DIN 1052:2008 deformations (quasicontinuous)
Extreme rule 1

10. Results of action effects

10.1. Action effect 1: permanent loads

extremal deflections of main beam (characteristic)



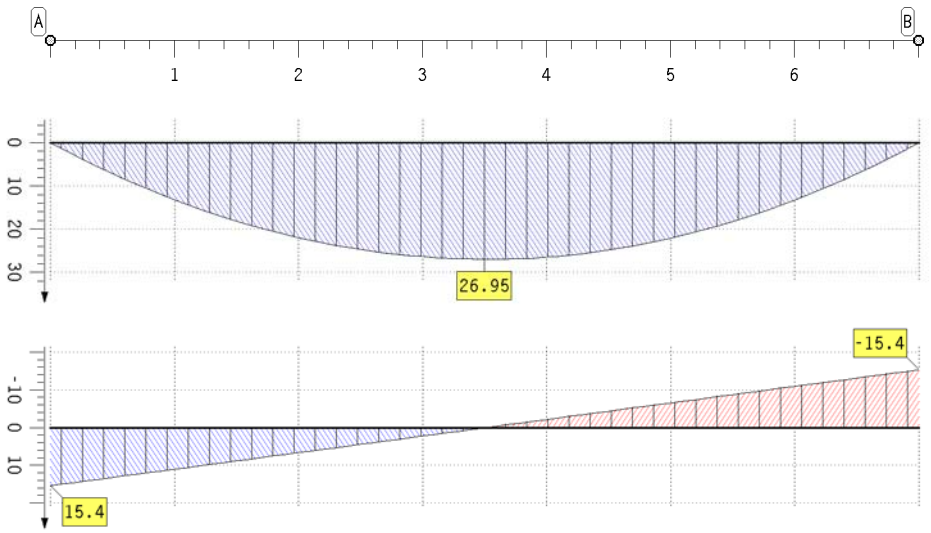
deflection
main beam
characteristic
w in mm
Min: -0.00
Max: 5.40

extremal deflections of main beam (characteristic)

point	x	min w	max w
-	m	mm	mm
A	0.000	0.00	0.00
	1.900	4.10	4.10
	3.500	5.40	5.40
	5.100	4.10	4.10

point	x	min w	max w
-	m	mm	mm
B	7.000	-0.00	-0.00
minimum		**-0.00**	**-0.00**
maximum		**5.40**	**5.40**

extremal internal forces



flexural moment
main beam
M in kNm
Min: 0.00
Max: 26.95

shear force
main beam
V in kN
Min: -15.40
Max: 15.40

extremal internal forces

point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN
A	0.000	0.00	0.00	15.40	15.40
	1.700	19.82	19.82	7.92	7.92
	3.500	26.95	26.95	0.00	0.00
	5.300	19.82	19.82	-7.92	-7.92

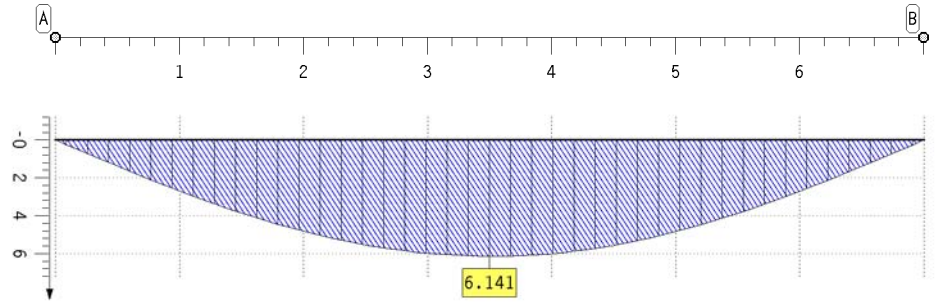
point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN
B	7.000	0.00	0.00	-15.40	-15.40
minimum		**0.00**	**0.00**	**-15.40**	**-15.40**
maximum		**26.95**	**26.95**	**15.40**	**15.40**

extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-15.40	-15.40
B	7.000	-15.40	-15.40

10.2. Action effect 2: live loads (1)

extremal deflections of main beam (characteristic)



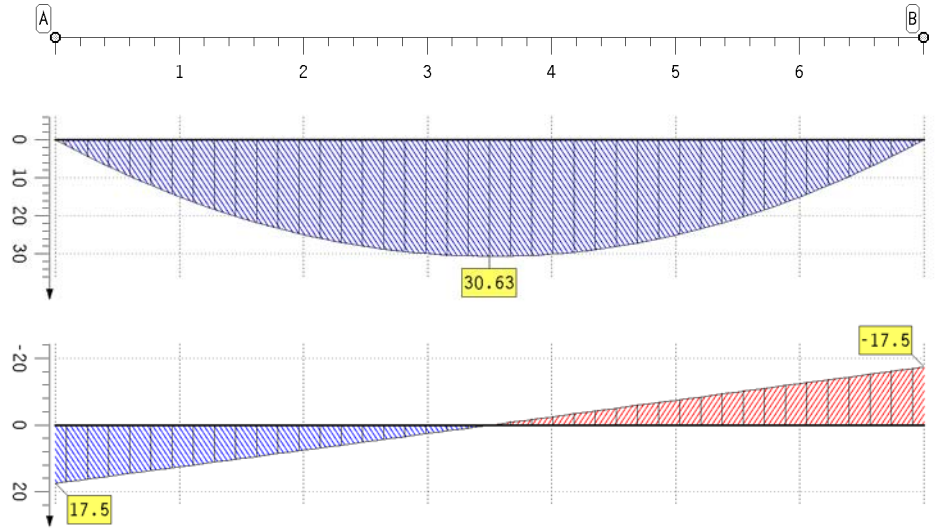
deflection
main beam
characteristic
w in mm
Min: -0.00
Max: 6.14

extremal deflections of main beam (characteristic)

point	x	min w	max w
-	m	mm	mm
A	0.000	0.00	0.00
	1.900	0.00	4.65
	3.500	0.00	6.14
	5.100	0.00	4.65

point	x	min w	max w
-	m	mm	mm
B	7.000	-0.00	-0.00
minimum		**-0.00**	**0.00**
maximum		**0.00**	**6.14**

extremal internal forces



flexural moment
main beam
M in kNm
Min: 0.00
Max: 30.62

shear force
main beam
V in kN
Min: -17.50
Max: 17.50

extremal internal forces

point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN
A	0.000	0.00	0.00	0.00	17.50
	1.800	0.00	23.40	0.00	8.50
	3.500	0.00	30.62	0.00	0.00
	5.300	0.00	22.52	-9.00	-0.00

point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN
B	7.000	0.00	0.00	-17.50	-0.00
minimum		**0.00**	**0.00**	**-17.50**	**0.00**
maximum		**0.00**	**30.62**	**0.00**	**17.50**

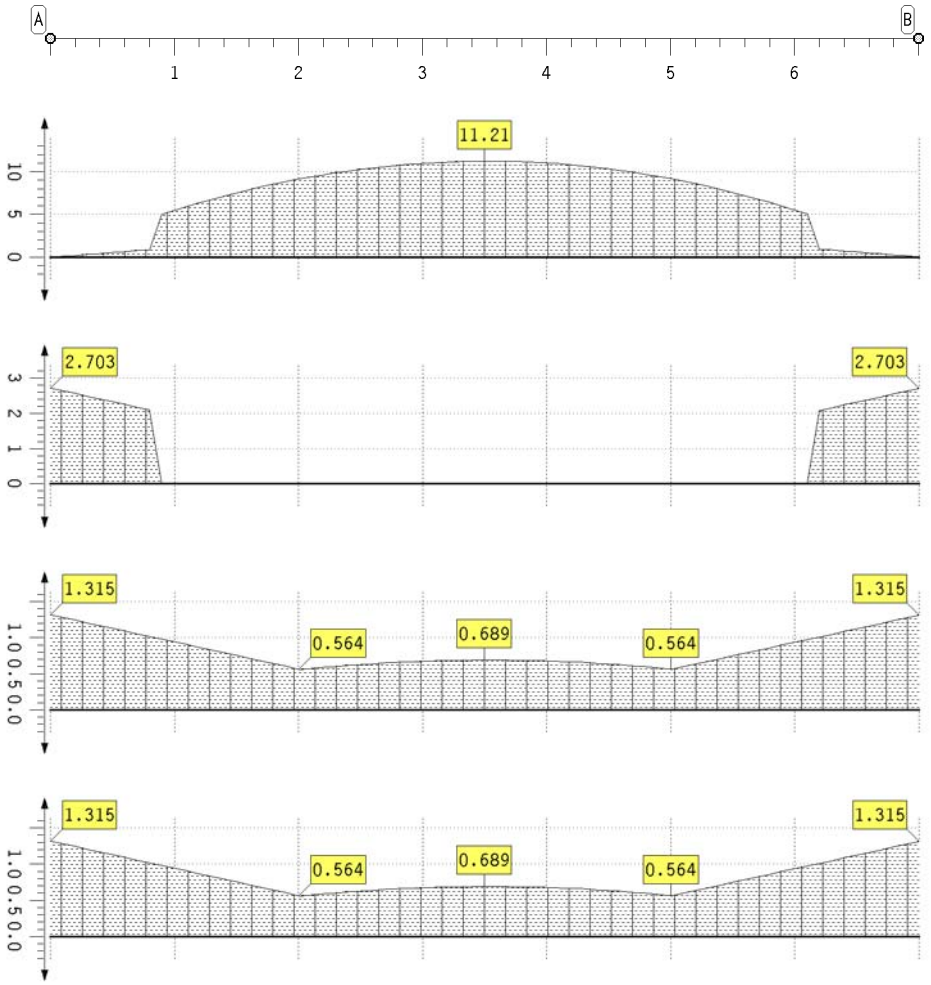
extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-17.50	-0.00
B	7.000	-17.50	-0.00

11. Results of verification of ultimate limit state

11.1. Verification of ultimate limit state

results of verification of ultimate limit state



bending stress
main beam
σ_h in MN/m²
Max: 11.21

shear stress
main beam
τ_h in MN/m²
Max: 2.70

utilization
main beam
Max: 1.32

maximal
utilization
Max: 1.32

maximal utilization

point	x	U
-	m	-
A	0.000	1.315
	2.000	0.564
	3.500	0.689
	5.000	0.564
B	7.000	1.315
minimum		**0.564**
maximum		**1.315**

extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-47.04	-15.40
B	7.000	-47.04	-15.40

verification of bearing stress

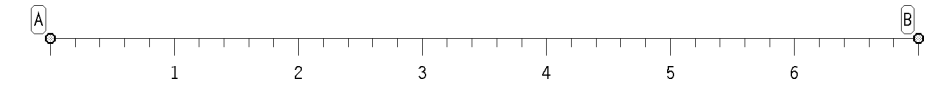
support	l_{ef}	A_{ef}	A_P	k_{c90}	k_{mod}	f_{c90d}	σ_{c90d}	u
	mm	mm²	N		-	N/mm²	N/mm²	-
A	180	5400	47040	1.00	0.90	6.23	8.71	1.40
B	180	5400	47040	1.00	0.90	6.23	8.71	1.40

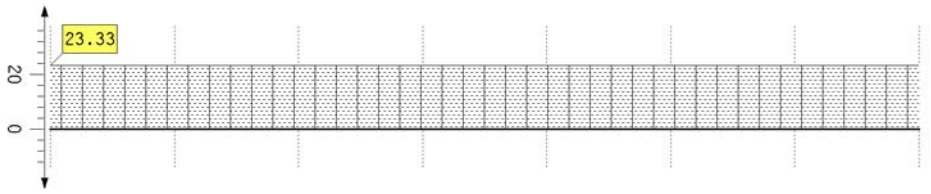
verification of bearing stresses für den main beam(u = 1.398) does not meet the requirements!

12. Results of verification of deflections (rarely)

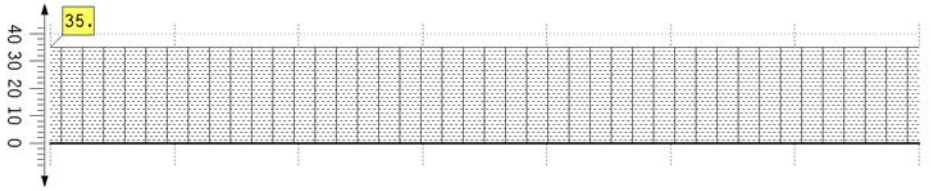
12.1. Verification of deflections (rarely)

results of verification of deflections (rarely)

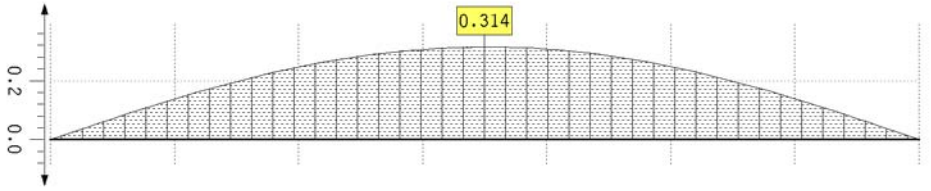




decisive deflection $w_{A,req}$ in mm
Min: 23.33
Max: 23.33



decisive deflection $w_{B,req}$ in mm
Min: 35.00
Max: 35.00



maximal utilization
Max: 0.31

maximal utilization

point	x	U
-	m	-
A	0.000	0.000
	1.900	0.238
	3.500	0.314
	5.100	0.238

point	x	U
-	m	-
B	7.000	0.000
minimum		**0.000**
maximum		**0.314**

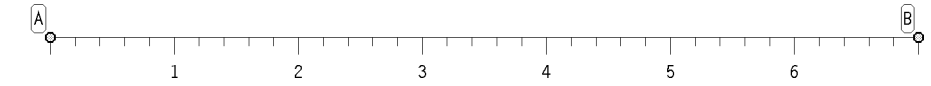
extremal support forces

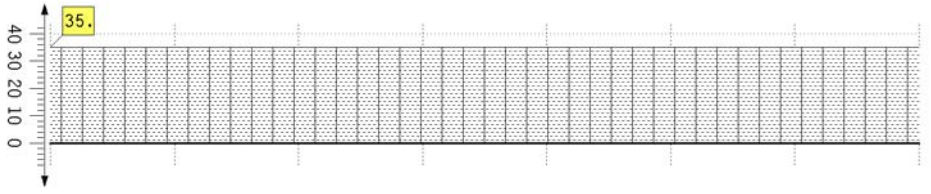
point	x	min AP	max AP
-	m	kN	kN
A	0.000	-31.37	-0.00
B	7.000	-31.37	-0.00

13. Results of verification of deflections (quasicontinuous)

13.1. Verification of deflections (quasicontinuous)

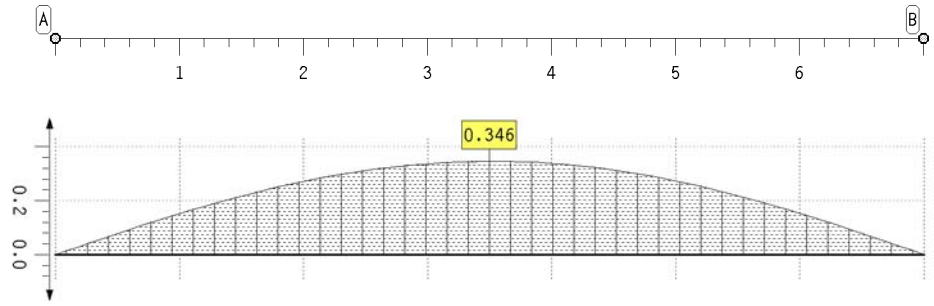
results of verification of deflections (quasicontinuous)





decisive deflection w_{req} in mm
Min: 35.00
Max: 35.00

results of verification of deflections (quasicontinuous)



maximal utilization
Max: 0.35

maximal utilization

point	x	U
-	m	-
A	0.000	0.000
	1.900	0.262
	3.500	0.346
	5.100	0.262
B	7.000	0.000
minimum		**0.000**
maximum		**0.346**

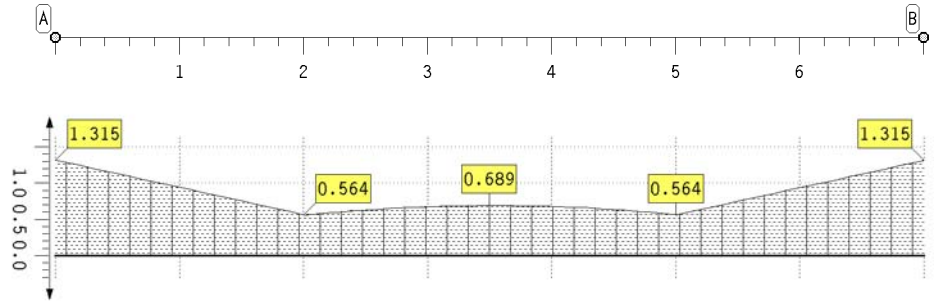
extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-34.52	-25.74
B	7.000	-34.52	-25.74

14. Summary

14.1. Summary of all verifications

maximal utilization



utilization
Max: 1.32

maximal utilization

point	x	U
-	m	-
A	0.000	1.315
	2.000	0.564
	3.500	0.689
	5.000	0.564
B	7.000	1.315
minimum		**0.564**
maximum		**1.315**

verification of bearing stress

support	l_{ef}	A_{ef}	A_P	k_{c90}	k_{mod}	f_{c90d}	σ_{c90d}	u
	mm	mm^2	N		-	N/mm^2	N/mm^2	-
A	180	5400	47040	1.00	0.90	6.23	8.71	1.40
B	180	5400	47040	1.00	0.90	6.23	8.71	1.40

verification of bearing stresses für den main beam(u = 1.398) does not meet the requirements!

15. Utilizations of all verifications

verification of load-carrying capacity (u = 1.398) does not meet the requirements!

16. Detailed verification piont

16.1. Verification of load-carrying capacity at x = 0.00 m

internal forces and moments

state	M kNm	V kN	M_1 Nmm	N_1 N	M_2 Nmm	N_2 N	M_3 Nmm	N_3 N
start,min	0.00	15.40	0	-0	0	0	0	0
start,max	0.00	47.04	0	-0	0	0	0	0
end,min	0.00	15.40	0	-0	0	0	0	0
end,max	0.00	47.04	0	-0	0	0	0	0

stresses and utilization web

state	$k_{mod,2}$ -	$\sigma_{m,2}$ N/mm²	$\sigma_{c,2}$ N/mm²	$u_{\sigma,2}$ -	τ_2 N/mm²	u_τ -	u_2 -
start	0.9	0.00	0.00	**0.00**	2.70	0.41	0.41
end	0.9	0.00	0.00	0.00	2.69	0.41	0.41

stresses and utilization flanges

state	$k_{mod,1}$ -	$\sigma_{m,1}$ N/mm²	$\sigma_{c,1}$ N/mm²	u_1 -	$k_{mod,3}$ -	$\sigma_{m,3}$ N/mm²	$\sigma_{c,3}$ N/mm²	u_3 -
start	0.9	0.00	-0.00	**0.00**	0.9	0.00	0.00	**0.00**
end	0.9	0.00	-0.00	0.00	0.9	0.00	0.00	0.00

fastener

state	$F_{1,d}$ N	$u_{1,d}$ -	$F_{2,d}$ N	$u_{2,d}$ -
start	-3192	1.53	3192	1.53
end	-3237	**1.55**	3237	**1.55**

resulting utilization at verification point u_{res} = 1.315