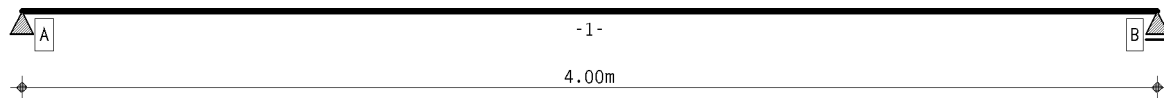


1. Options for Calculations

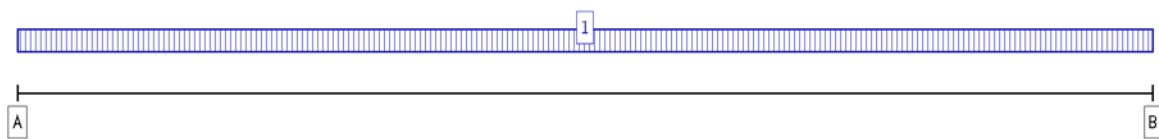
calculation acc. to DIN 1052:2008
service class 1

2. Structural system

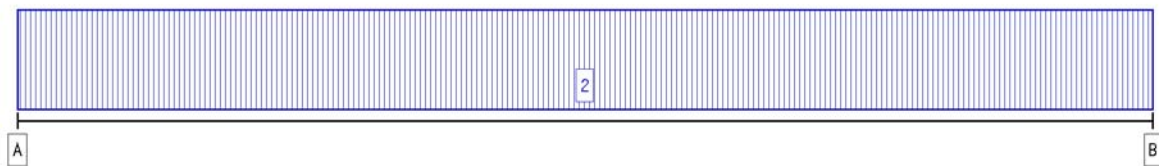


main beam

3. Loading



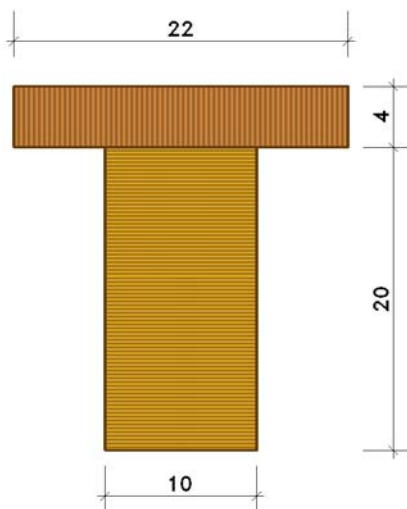
action effect 1: permanent loads (permanent, 1 load cases)



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

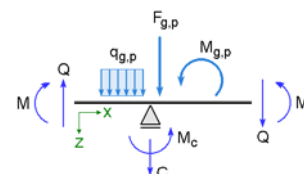
4. main beam

section scale 1: 5



timber grade top flange	solid coniferous timber, C24 (S10)
char. bend. strength $f_{m,k}$	: 24.0 N/mm ²
char. shear strength $f_{v,k}$	: 2.0 N/mm ²
char. ten. strength $f_{t,k}$	: 14.0 N/mm ²
char. compr. strength $f_{c,0,k}$	: 21.0 N/mm ²
char. compr. strength $f_{c,90,k}$	: 2.5 N/mm ²
modulus of elasticity $E_{0,mean}$	: 11000 N/mm ²
Dichte ρ_k/ρ_m	: 350 / 420 kg/m ³
deformation factor k_{def}	: 0.60 -
area A_{flange}	: 88.000 cm ²
moment of inertia I_{flange}	: 117.333 cm ⁴
timber grade web	solid coniferous timber, C24 (S10)
char. bend. strength $f_{m,k}$	: 24.0 N/mm ²
char. shear strength $f_{v,k}$	: 2.0 N/mm ²
char. ten. strength $f_{t,k}$	: 14.0 N/mm ²
char. compr. strength $f_{c,0,k}$	: 21.0 N/mm ²
char. compr. strength $f_{c,90,k}$	: 2.5 N/mm ²
modulus of elasticity $E_{0,mean}$	: 11000 N/mm ²
Dichte ρ_k/ρ_m	: 350 / 420 kg/m ³
deformation factor k_{def}	: 0.60 -
area A_{flange}	: 200.000 cm ²
moment of inertia I_{flange}	: 6666.667 cm ⁴

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	cantilever	s_{ef} mm
1	0.00	4.00	4.00	2.00	28.9000	1.2827	69.2042	1.1788	0.5592	4.00	-	36.0

stiffness values serviceability initial state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_{1r} -	a_1 mm	$E I_{ef,inst}$ Nmm ²	ϕ k_{def} -
1	1.0000	-20.8	1964	0.4775	-99.2	1.2963E12	0.6000

stiffness values load-carrying capacity initial state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_{1r} -	a_1 mm	$E I_{ef,inst}$ Nmm ²	$I_{ef,inst}$ mm ²	$h_{q,inst}$ mm	$A_{q,inst}$ mm
1	1.0000	-17.1	1310	0.3786	-102.9	1.1986E12	108963600.0	11.71	158.83

stiffness values load-carrying capacity final state

section	γ_2 -	a_2 mm	K_1 N/mm	γ_{1r} -	a_1 mm	$E I_{ef,inf}$ Nmm ²	$I_{ef,inf}$ mm ²	$h_{q,inf}$ mm	$A_{q,inf}$ mm
1	1.0000	-17.1	818	0.3786	-102.9	7.4912E11	108963600.0	11.71	158.83

net section properties

section	$A_{n,2}$ cm ²	$W_{n,2}$ cm ³	$I_{n,2}$ cm ⁴	$A_{n,1}$ cm ²	$W_{n,1}$ cm ³	$I_{n,1}$ cm ⁴
1	191.36	666.67	6666.67	83.68	58.67	117.33

6. Fasteners

section 1 from $x_A = 0.00$ m to $x_E = 4.00$

nail, 6.0 x 120.0 mm, $d_k = 0.0$ mm, predrilled

2-row with $a_1 = 72.0$ mm

2 - row with $a_2 = 22.0$ mm, simplified verification acc. to DIN 1052:2008, 12.2(2)

nail ends in timber member 2, penetration depth $t = 80$ mm $> 4 d = 24$ mm, 1 shear plane

$f_{uk} = 600$ N/mm², $M_{yk} = 18987$ Nmm

reduction of R_k with $f = 0.941$ for $\varphi_{orht} < t_{req}$

$K_{ser} = 1964$ N/mm, $\gamma_M = 1.10$, $R_k = 2332.1$ N, all values per shear plane

7. Supports

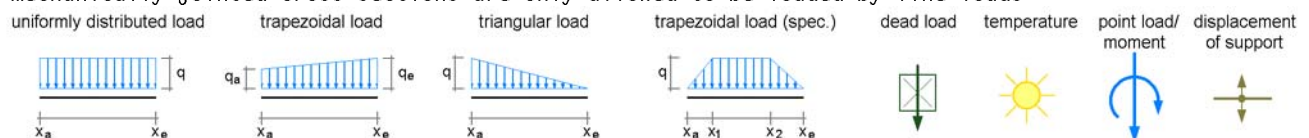
coordinates of supports

supp.name	x m	width mm	depth mm	c_F kN/m	c_M kNm/-	restraint (F) (M)
A	0.00	150	100	fix	----	X -
B	4.00	150	100	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: $q = 0.70$ kN/m from $x_A = 0.00$ m to $x_E = 4.00$ m

2. Transient action effect: live loads (1)

2. additive load case: live loads (1/1)

→ unif.distr.load: $q = 2.45$ kN/m from $x_A = 0.00$ m to $x_E = 4.00$ 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

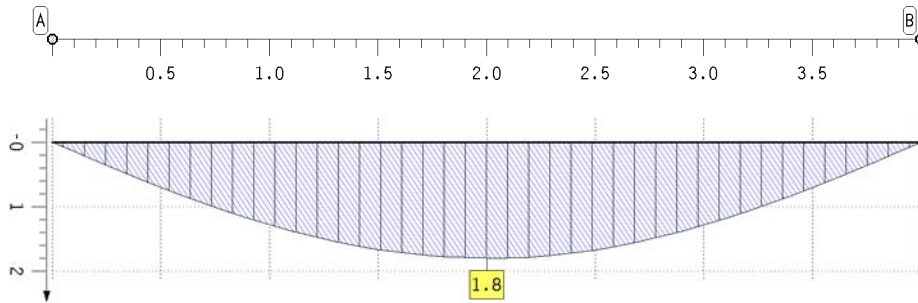
2: DIN 1052:2008 deformations (rarely)

3: DIN 1052:2008 deformations (quasicontinuous)

10. Results of action effects

10.1. Action effect 1: permanent loads

extremal deflections of main beam (characteristic)

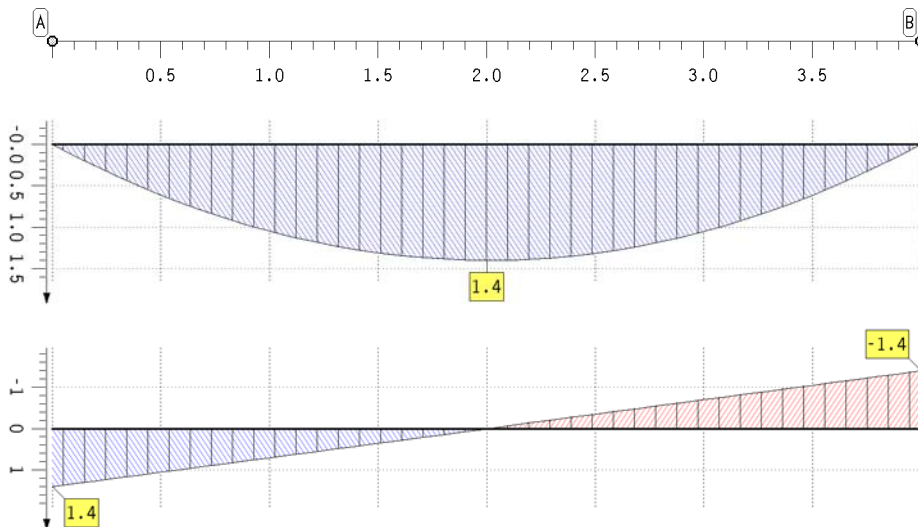


deflection
main beam
characteristic
w in mm
Min: 0.00
Max: 1.80

extremal deflections of main beam (characteristic)

point	x	min w	max w	point	x	min w	max w
-	m	mm	mm	-	m	mm	mm
A	0.000	0.00	0.00	B	4.000	0.00	0.00
	1.100	1.38	1.38	minimum		0.00	0.00
	2.000	1.80	1.80	maximum		1.80	1.80
	2.900	1.38	1.38				

extremal internal forces



flexural moment
main beam
M in kNm
Min: -0.00
Max: 1.40

shear force
main beam
V in kN
Min: -1.40
Max: 1.40

extremal internal forces

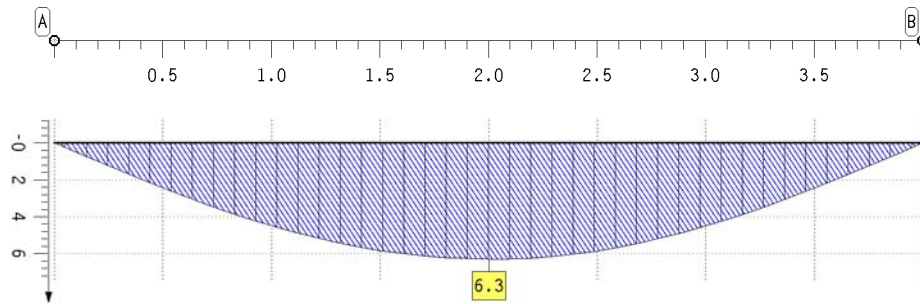
point	x	min M	max M	min V	max V	point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN	-	m	kNm	kNm	kN	kN
A	0.000	-0.00	-0.00	1.40	1.40	B	4.000	0.00	0.00	-1.40	-1.40
	1.000	1.05	1.05	0.70	0.70	minimum		-0.00	-0.00	-1.40	-1.40
	2.000	1.40	1.40	0.00	0.00	maximum		1.40	1.40	1.40	1.40
	3.000	1.05	1.05	-0.70	-0.70						

extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-1.40	-1.40
B	4.000	-1.40	-1.40

10.2. Action effect 2: live loads (1)

extremal deflections of main beam (characteristic)

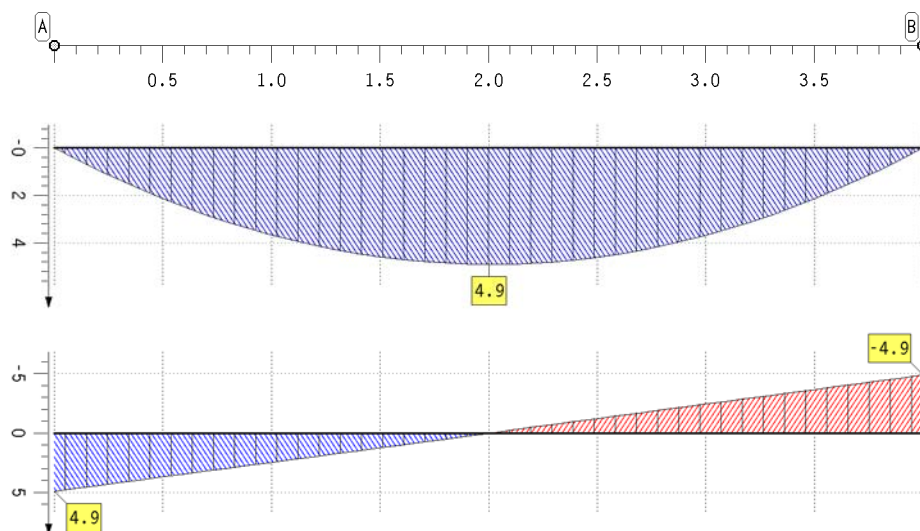


deflection
main beam
characteristic
w in mm
Min: 0.00
Max: 6.30

extremal deflections of main beam (characteristic)

point	x	min w	max w	point	x	min w	max w
-	m	mm	mm	-	m	mm	mm
A	0.000	0.00	0.00	B	4.000	0.00	0.00
	1.100	0.00	4.82	minimum		0.00	0.00
	2.000	0.00	6.30	maximum		0.00	6.30
	2.900	0.00	4.82				

extremal internal forces



flexural moment
main beam
M in kNm
Min: 0.00
Max: 4.90

shear force
main beam
V in kN
Min: -4.90
Max: 4.90

extremal internal forces

point	x	min M	max M	min V	max V	point	x	min M	max M	min V	max V
-	m	kNm	kNm	kN	kN	-	m	kNm	kNm	kN	kN
A	0.000	0.00	0.00	0.00	4.90	B	4.000	0.00	0.00	-4.90	-0.00
	1.000	0.00	3.67	0.00	2.45	minimum		0.00	0.00	-4.90	0.00
	2.000	0.00	4.90	0.00	0.00	maximum		0.00	4.90	0.00	4.90
	3.000	0.00	3.67	-2.45	-0.00						

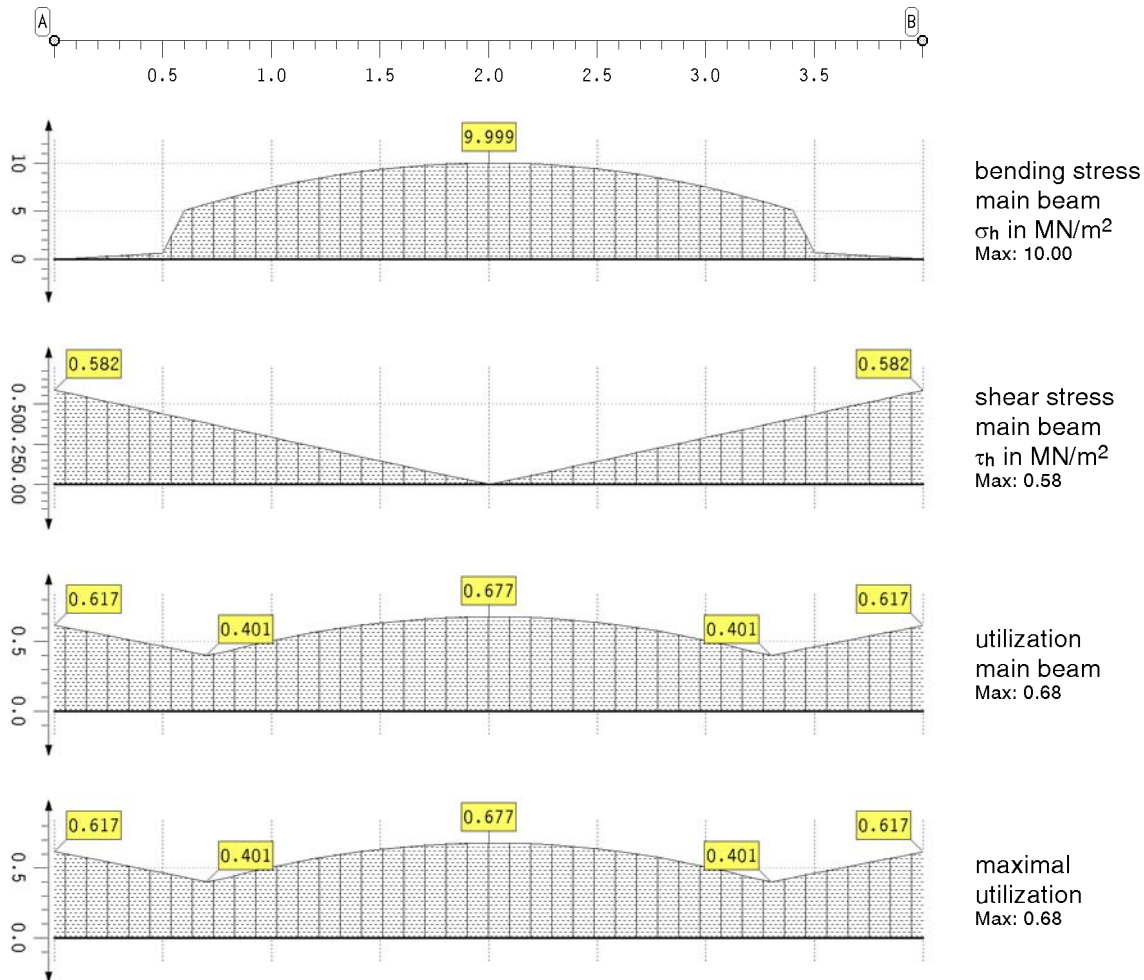
extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-4.90	-0.00
B	4.000	-4.90	-0.00

11. Results of verification of ultimate limit state

11.1. Verification of ultimate limit state

results of verification of ultimate limit state



maximal utilization

point	x	U	point	x	U	point	x	U
-	m	-	-	m	-	-	m	-
A	0.000	0.617		2.000	0.677	B	4.000	0.617
	0.700	0.401		2.600	0.616	minimum		0.401
	1.400	0.616		3.300	0.401	maximum		0.677

extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-9.24	-1.40
B	4.000	-9.24	-1.40

verification of bearing stress

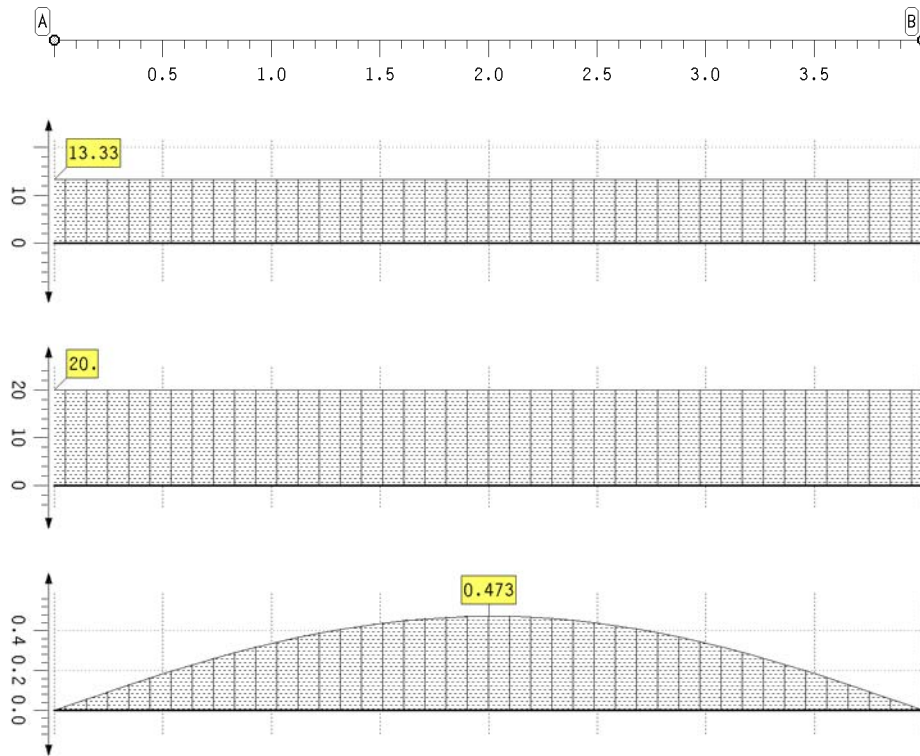
support	l_{ef}	A_{ef}	A_P	k_{c90}	k_{mod}	f_{c90d}	σ_{c90d}	u
	mm	mm^2	N			N/mm^2	N/mm^2	-
A	180	18000	9240	1.25	0.80	1.54	0.51	0.27
B	180	18000	9240	1.25	0.80	1.54	0.51	0.27

verification of bearing stresses für den main beam(u = 0.267) successful!

12. Results of verification of deflections (rarely)

12.1. Verification of deflections (rarely)

results of verification of deflections (rarely)



decisive
deflection
WA,req in mm
Min: 13.33
Max: 13.33

decisive
deflection
WB,req in mm
Min: 20.00
Max: 20.00

maximal
utilization
Max: 0.47

maximal utilization

point	x	U	point	x	U
-	m	-	-	m	-
A	0.000	0.000	B	4.000	0.000
	1.100	0.362	minimum		0.000
	2.000	0.473	maximum		0.473
	2.900	0.362			

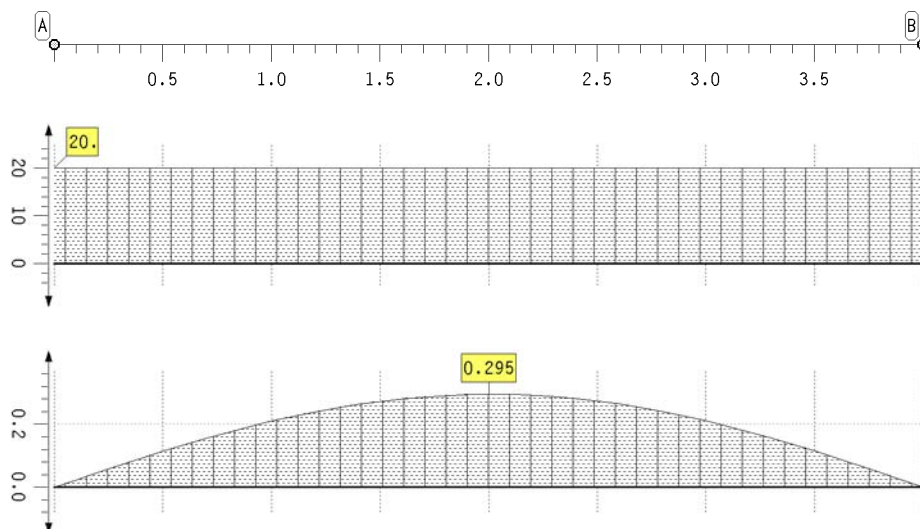
extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-6.62	-0.00
B	4.000	-6.62	-0.00

13. Results of verification of deflections (quasicontinuous)

13.1. Verification of deflections (quasicontinuous)

results of verification of deflections (quasicontinuous)



decisive
deflection
Wreq in mm
Min: 20.00
Max: 20.00

maximal
utilization
Max: 0.30

maximal utilization

point	x	U	point	x	U
-	m	-	-	m	-
A	0.000	0.000	B	4.000	0.000
	1.100	0.226	minimum		0.000
	2.000	0.295	maximum		0.295
	2.900	0.226			

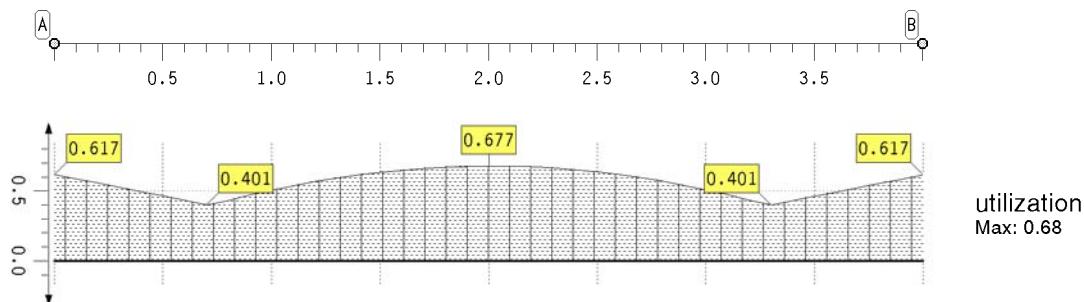
extremal support forces

point	x	min AP	max AP
-	m	kN	kN
A	0.000	-4.59	-2.24
B	4.000	-4.59	-2.24

14. Summary

14.1. Summary of all verifications

maximal utilization



maximal utilization

point	x	U	point	x	U	point	x	U
-	m	-	-	m	-	-	m	-
A	0.000	0.617		2.000	0.677	B	4.000	0.617
	0.700	0.401		2.600	0.616	minimum		0.401
	1.400	0.616		3.300	0.401	maximum		0.677

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	18000	9240	1.25	0.80	1.54	0.51	0.27
B	180	18000	9240	1.25	0.80	1.54	0.51	0.27

verification of bearing stresses für den main beam(u = 0.267) successful!

15. Utilizations of all verifications

all verifications successful!

16. Detailed verification piont

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

internal forces and moments

state	M	V	M ₁	N ₁	M ₂	N ₂
	kNm	kN	Nmm	N	Nmm	N
start,min	-0.00	1.40	-0	0	-0	-0
start,max	0.00	9.24	0	-0	0	0
end,min	-0.00	1.40	-0	0	-0	-0
end,max	0.00	9.24	0	-0	0	0

stresses and utilization

state	$k_{mod,1}$	$\sigma_{m,1}$	$\sigma_{c,1}$	u ₁	$k_{mod,2}$	$\sigma_{m,2}$	$\sigma_{c,2}$	u _{σ,2}	τ_2	u _τ	u ₂
	-	N/mm ²	N/mm ²	-	-	N/mm ²	N/mm ²	-	N/mm ²	-	-
start	0.8	0.00	-0.00	0.00	0.8	0.00	0.00	0.00	0.58	0.47	0.47
end	0.8	0.00	-0.00	0.00	0.8	0.00	0.00	0.00	0.58	0.47	0.47

fastener

state	F _{1,d} N	u _{1,d} -
start	-1046	0.73
end	-1046	0.73

resulting utilization at verification point $u_{res} = 0.473$