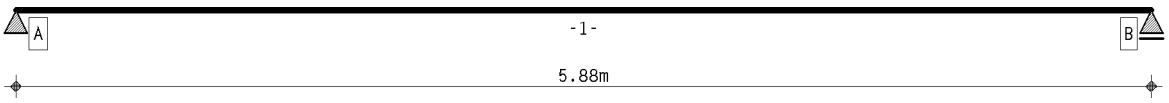
1. Options for Calculations

calculation DIN EN 1995:2010, Germany
service class 1

2. Structural system



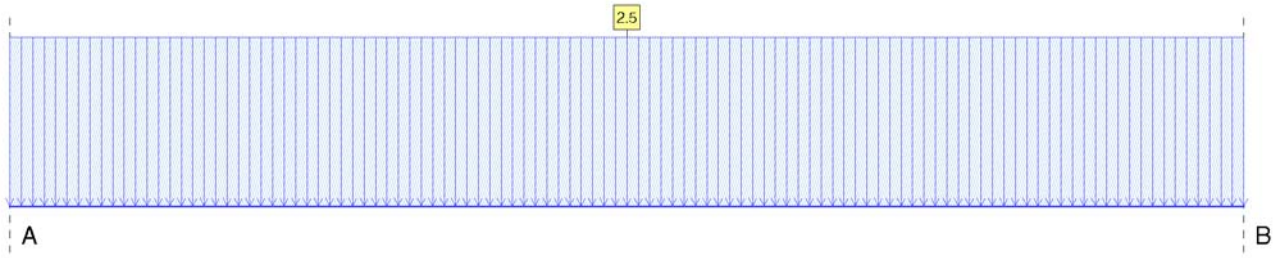
main beam

3. Loading

The load images are displayed separately according to the load application.

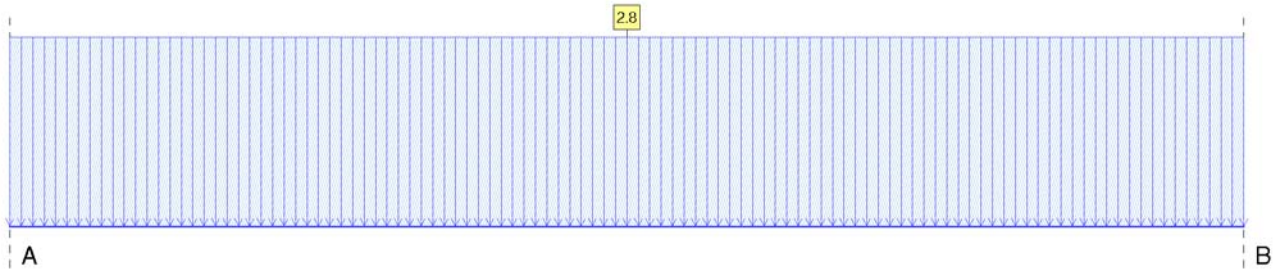
load case 1, beam: dead load (1)

action effect 1: permanent loads



load case 2, beam: live loads (1/1)

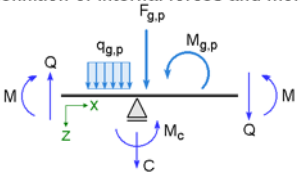
action effect 2: live loads (1)



4. material parameters

beam of timber grade		**solid coniferous timber C24**
service class		**1**
beamwidth/-height		200 / 240 mm
bar spacing		a = **600 mm**
coeff. therm.expan. timber:		0.500 *10^{-5} /°K
coeff. thermal expan. steel:		1.200 *10^{-5} /°K
char. bend. strength	$f_{m,k}$:	24.00 N/mm^2
char. shear strength	$f_{v,k}$:	4.00 N/mm^2
modulus of elast.	$E_{0,mean}$:	11000 N/mm^2
k_{cr}	:	0.50 mm^2/N
panelling with	:	**solid coniferous timber C14**, thickness = 0 mm, ρ = 290 kg/m³

definition of internal forces and moments:

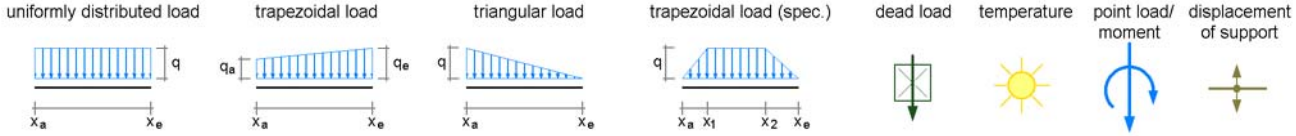


5. Supports

coordinates of supports

supp.name	x m	width mm	depth mm	cF kN/m	cM kNm/-	restraint (F)	restraint (M)
A	0.00	4	200	fix	----	X	-
B	5.88	4	200	fix	----	X	-

6. Action effects



Permanent action effect: permanent loads
1. additive load case: dead load (1)
⇒ equal area load (beam): q = 2.50 kN/m² from x_a = 0.00 m to x_e = 5.88 m

2. Transient action effect: live loads (1)
2. additive load case: live loads (1/1)
⇒ equal area load (beam): q = 2.80 kN/m² from x_a = 0.00 m to x_e = 5.88 m

7. verifications

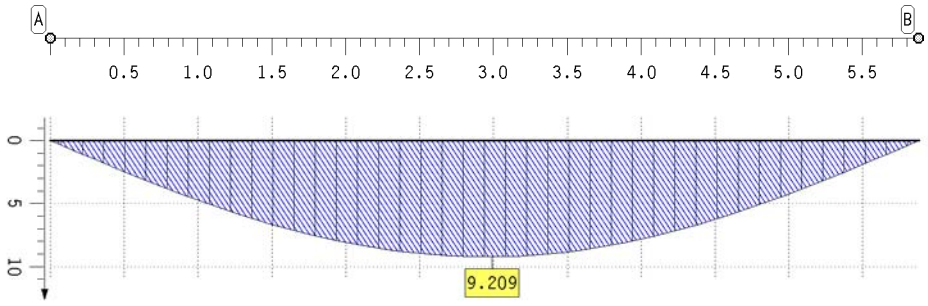
1: EC 5 load-carrying capacity
buckling analysis of compression flange acc. to DIN EN 1995, 6.3.2 will be executed
verification of bearing stress DIN EN 1995, 6.1.5 will be executed
Extreme rule 1

2: EC 5 Verification of vibration
verification of vibration acc. to DIN EN 1995-1-1, 7.3
value acc. to DIN EN 1995-1-1, 7.3.3, figure 7.2: a = 1.50 mm/kN ⇒ b = 100.00
modal damping ratio ξ = 0.03
numeric calculation with Fourier series
Attention! Joints are not taken into account
Springs are only taken into account in the interim storage facilities
Without consideration of shear deformation
Poisson's ratio ν = 0.00, torsionstiffness = 0.0 %
Screed is not taken into account
Contributing width for deflection criterion 600 mm

8. Results of load cases

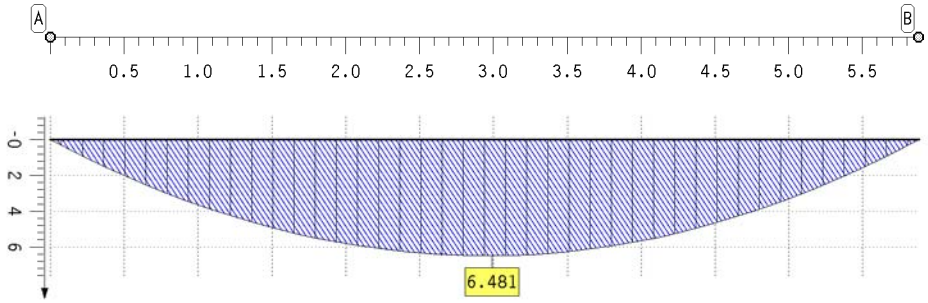
8.1. Action effect 1: load case 1: dead load (1)

deflections of main beam (characteristic)



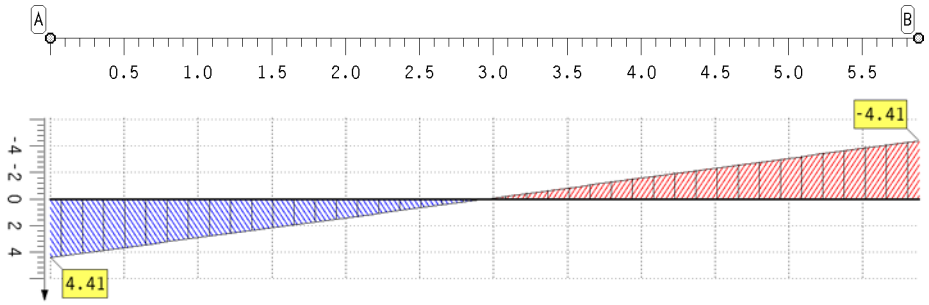
deflection
main beam
characteristic
w in mm
Min: -0.00
Max: 9.21

internal forces and moments



flexural moment
main beam
M in kNm
Min: 0.00
Max: 6.48

internal forces and moments



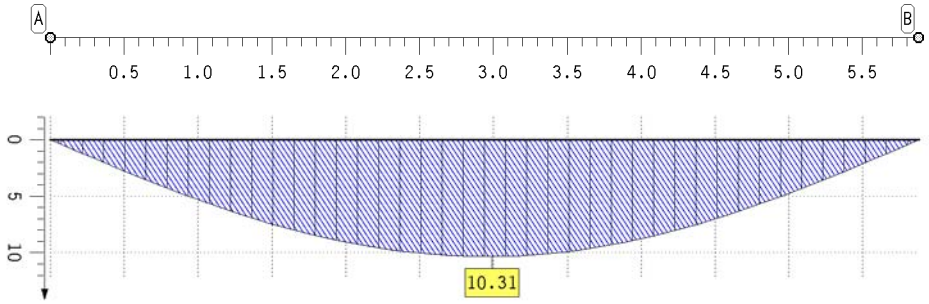
shear force
main beam
V in kN
Min: -4.41
Max: 4.41

support forces

point	x	AP
-	m	kN
A	0.000	-4.41
B	5.880	-4.41

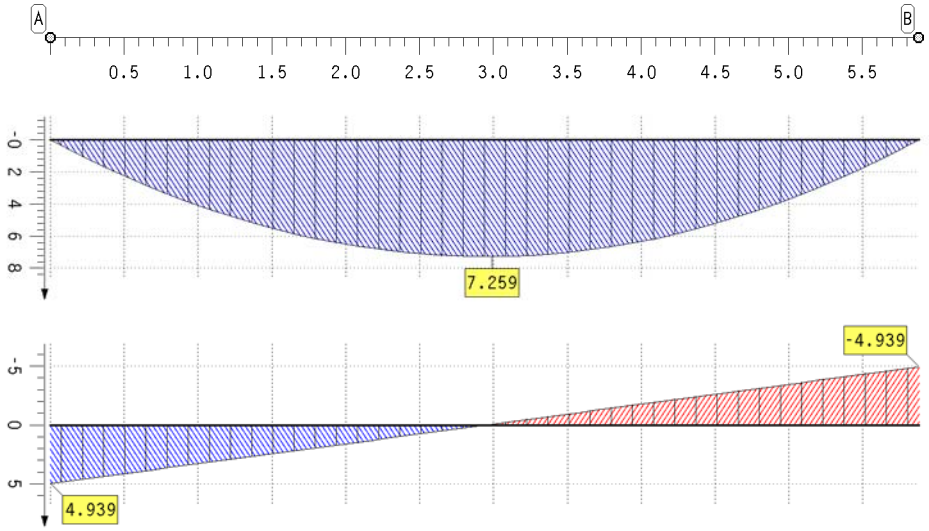
8.2. Action effect 2: load case 2: live loads (1/1)

deflections of main beam (characteristic)



deflection
main beam
characteristic
w in mm
Min: 0.00
Max: 10.31

internal forces and moments



flexural moment
main beam
M in kNm
Min: -0.00
Max: 7.26

shear force
main beam
V in kN
Min: -4.94
Max: 4.94

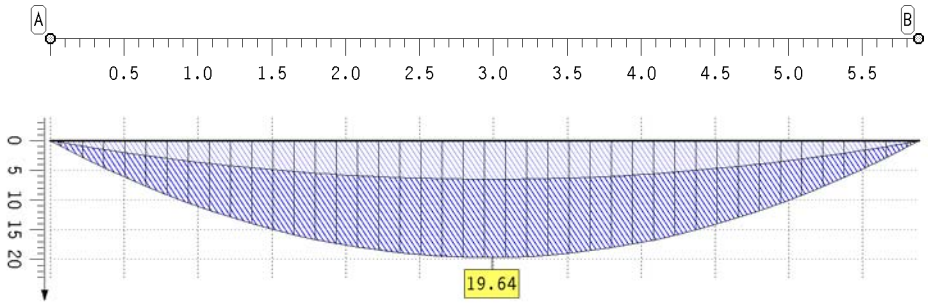
support forces

point	x	AP
-	m	kN
A	0.000	-4.94
B	5.880	-4.94

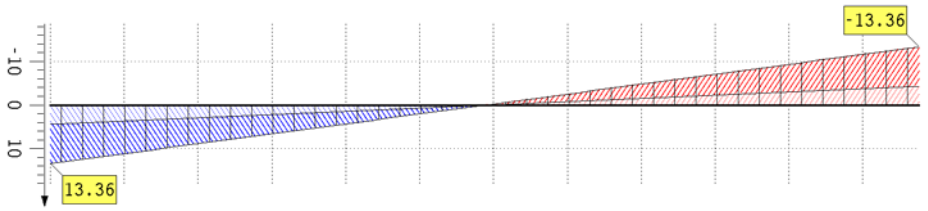
9. Results of verification of ultimate limit state

9.1. Verification of ultimate limit state

extremal internal forces

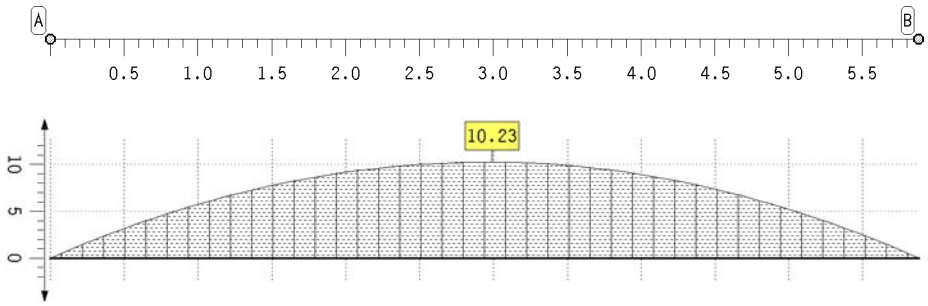


flexural moment
main beam
M in kNm
Min: 0.00
Max: 19.64

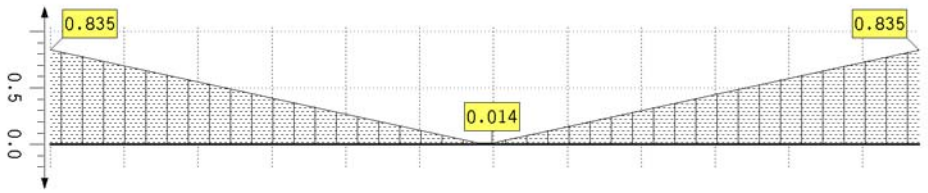


shear force
main beam
V in kN
Min: -13.36
Max: 13.36

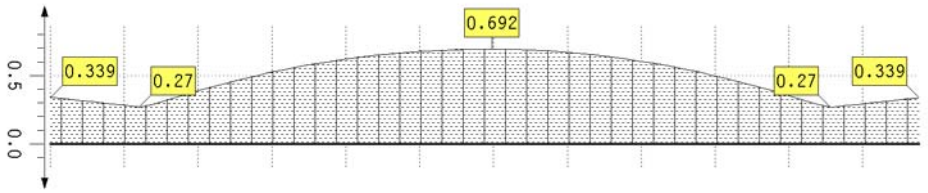
results of verification of ultimate limit state



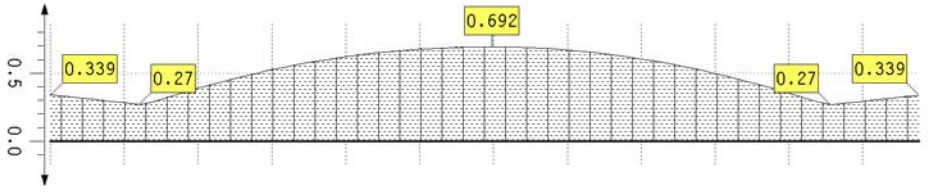
bending stress
main beam
σ_h in MN/m²
Max: 10.23



shear stress
main beam
τ_h in MN/m²
Max: 0.84



utilization
main beam
Max: 0.69



maximal
utilization
Max: 0.69

verification of ultimate limit state of main beam

point	x	$k_{mod,h}$	σ_h	τ_h	U_h
-	m	-	MN/m²	MN/m²	-
A	0.000	0.800	0.00	0.84	0.339
	0.598	0.800	3.74	0.67	0.270
	1.794	0.800	8.68	0.33	0.587
	2.890	0.800	10.23	0.01	0.692
	4.086	0.800	8.68	0.33	0.587
	5.282	0.800	3.74	0.67	0.270
B	5.880	0.800	0.00	0.84	0.339
minimum		**0.800**	**0.00**	**0.01**	**0.270**
maximum		**0.800**	**10.23**	**0.84**	**0.692**

maximal utilization

point	x	U	point	x	U	point	x	U
-	m	-	-	m	-	-	m	-
A	0.000	0.339		2.890	0.692	B	5.880	0.339
	0.598	0.270		4.086	0.587	**minimum**		**0.270**
	1.794	0.587		5.282	0.270	**maximum**		**0.692**

verification of bearing stress

supp.	l_{ef} mm	A_{ef} mm²	A_P N	k_{c90}	k_{mod} -	f_{c90d} N/mm²	σ_{c90d} N/mm²	u -
A	8	1600	13362	1.00	0.80	1.54	2.51	1.63
B	8	1600	13362	1.00	0.80	1.54	2.51	1.63

verification of bearing stresses für den main beam(u = 1.629) does not meet the requirements!

10. vibration verification results

10.1. natural frequency

$EI_{lengthwise}$ = 2.534400 MNm²/m, EI_{cross} = 0.000000 MNm²/m, m = 33400.0 kG/m²
f_e = 5.158 Hz < f_{min} = 8 Hz ⇒ special examination

10.2. stiffness criterion

$x_{max\ F}$ = 2.940 m, $x_{max\ w}$ = 2.940 m ⇒ w_{max} = 1.671 mm
w(1kN) = 1.67 mm > w_{grenz} = 1.5 mm ⇒ **criterion not met!!!**

10.3. unit pulse speed

n_{40} = 8.0000
v = 1.673 mm/s ≤ v_{grenz} = 20.394 mm/s ⇒ **criterion met!**

10.4. heel strike

v = 92.014 mm/s ≤ v_{grenz} = 122.365 mm/s ⇒ **criterion met!**

10.5. acceleration/resonance

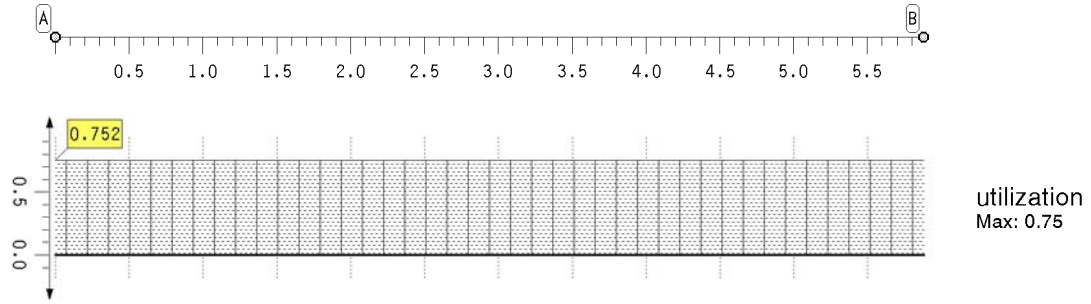
a = 0.709994 m/s² > 0.3 m/s² ⇒ noticeable, not disturbing

verification successful!

11. Summary

11.1. Summary of all verifications

maximal utilization



utilization
Max: 0.75

verification of bearing stress

supp.	l_{ef} mm	A_{ef} mm²	A_P N	k_{c90}	k_{mod} -	f_{c90d} N/mm²	σ_{c90d} N/mm²	u -
A	8	1600	13362	1.00	0.80	1.54	2.51	1.63
B	8	1600	13362	1.00	0.80	1.54	2.51	1.63

verification of bearing stresses für den main beam(u = 1.629) does not meet the requirements!

12. Utilizations of all verifications

verification of load-carrying capacity (u = 1.629) does not meet the requirements!