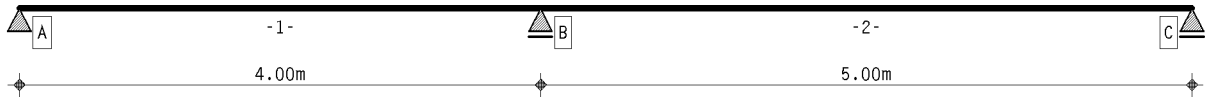


1. Options for Calculations

calculation DIN EN 1995:2010, Germany

service class 1

2. Structural system



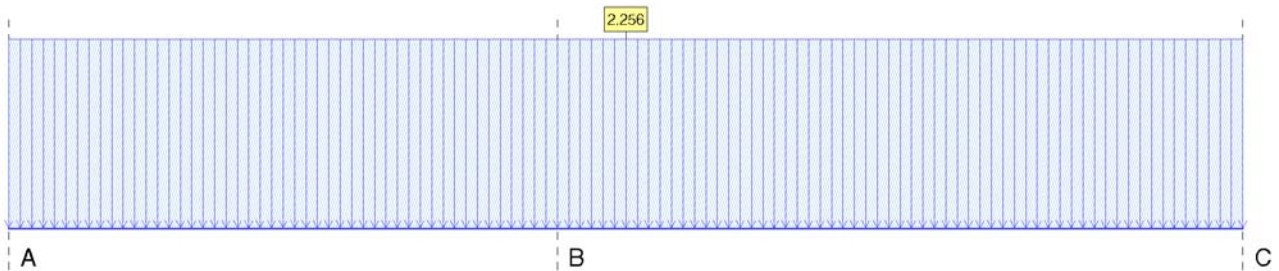
main beam

3. Loading

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

load case 1, beam: dead load (1)

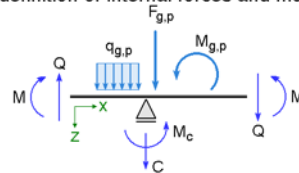
action effect 1: permanent loads



4. material parameters

beam of timber grade: **solid coniferous timber C24**
 service class: **1**
 beamwidth/-height: **70 / 240 mm**
 bar spacing: **a = 625 mm**
 coeff. therm.expan. timber: $0.500 \cdot 10^{-5} / ^\circ\text{K}$
 coeff. thermal expan. steel: $1.200 \cdot 10^{-5} / ^\circ\text{K}$
 char. bend. strength $f_{m,k}$: **24.00 N/mm²**
 char. shear strength $f_{v,k}$: **4.00 N/mm²**
 modulus of elast. $E_{0,mean}$: **11000 N/mm²**
 k_{cr} : **0.50 mm²/N**
 panelling with: **solid coniferous timber C14, thickness = 0 mm, $\rho = 290 \text{ kg/m}^3$**

definition of internal forces and moments:

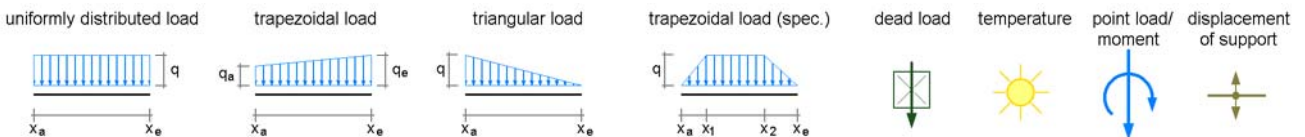


5. Supports

coordinates of supports

supp. name	x m	width mm	depth mm	c _F kN/m	c _M kNm/ -	restraint (F) (M)
A	0.00	4	70	fix	----	X -
B	4.00	4	70	fix	----	X -
C	9.00	4	70	fix	----	X -

6. Action effects



Permanent action effect: permanent loads

1. additive load case: dead load (1)

→ equal area load (beam): $q = 2.26 \text{ kN/m}^2$ from $x_a = 0.00 \text{ m}$ to $x_e = 9.00 \text{ m}$

7. verifications

1: EC 5 load-carrying capacity

buckling analysis of compression flange acc. to DIN EN 1995, 6.3.2 will be executed
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: $a = 1.50 \text{ mm/kN} \Rightarrow b = 100.00$

modal damping ratio $\xi = 0.03$

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 $\nu = 0.00$, torsionstiffness = 0.0 %

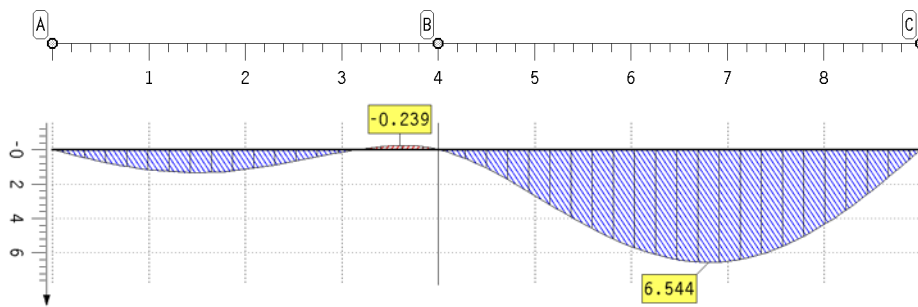
Screed is not taken into account

Contributing width for deflection criterion 625 mm

8. Results of load cases

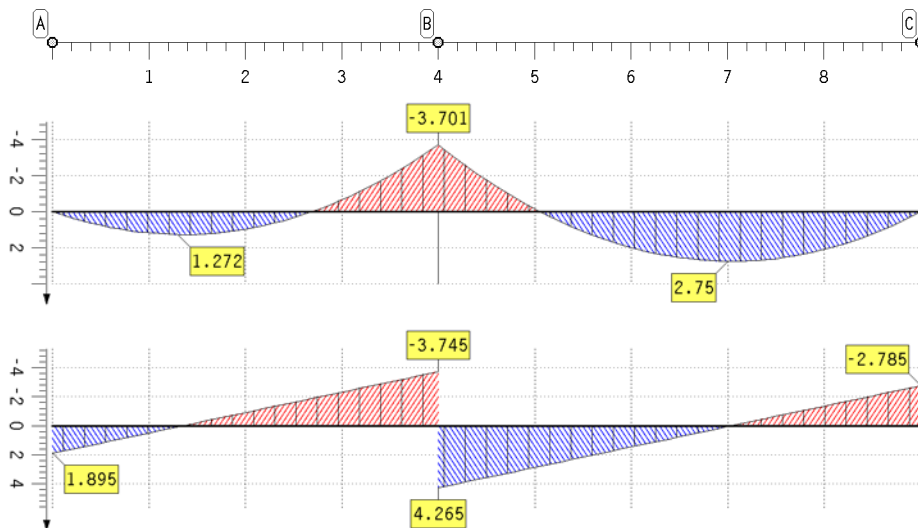
8.1. Action effect 1: load case 1: dead load (1)

deflections of main beam (characteristic)



deflection
main beam
characteristic
w in mm
Min: -0.24
Max: 6.54

internal forces and moments



flexural moment
main beam
M in kNm
Min: -3.70
Max: 2.75

shear force
main beam
V in kN
Min: -3.75
Max: 4.27

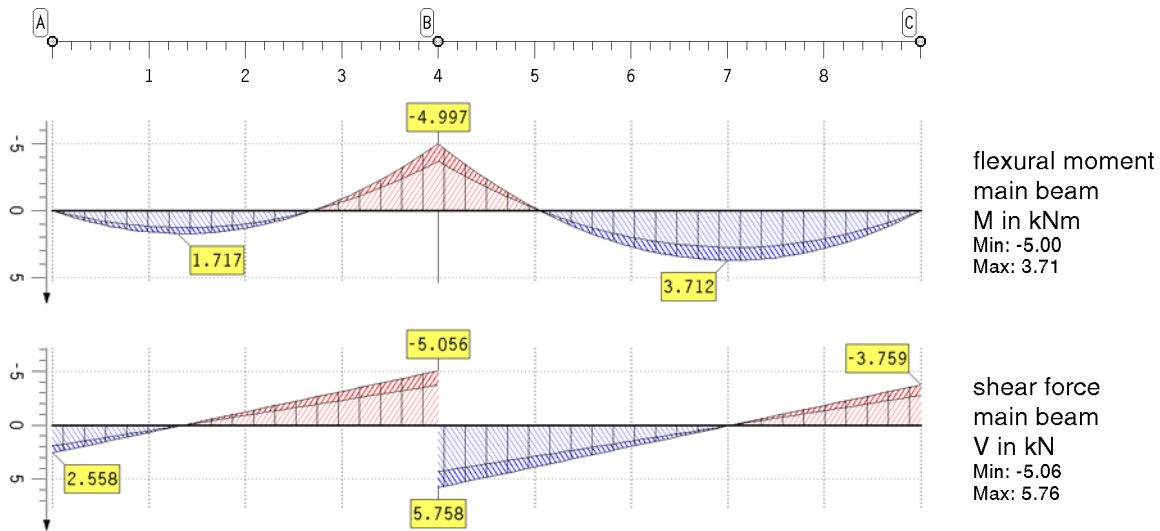
support forces

point	x m	AP kN
A	0.000	-1.89
B	4.000	-8.01
C	9.000	-2.78

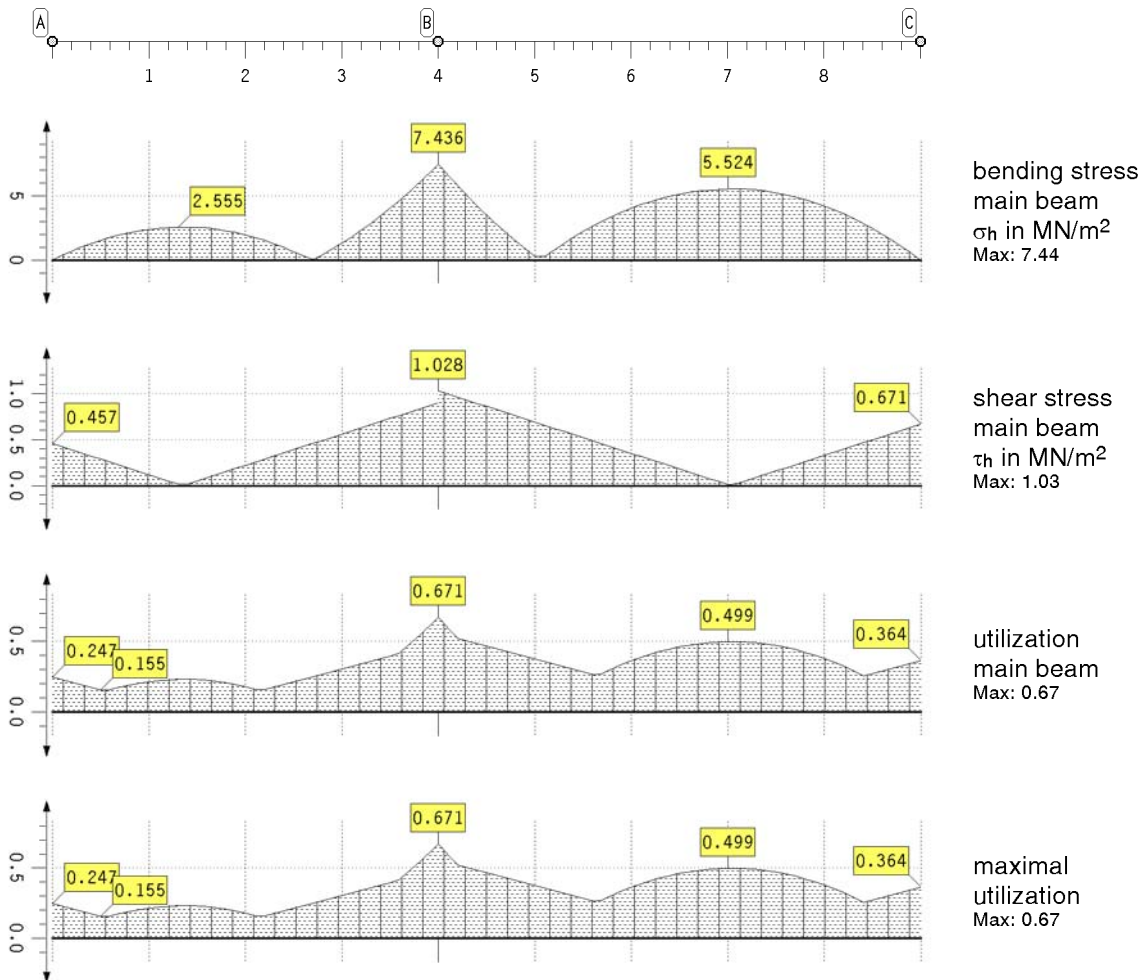
9. Results of verification of ultimate limit state

9.1. Verification of ultimate limit state

extremal internal forces



results of verification of ultimate limit state



verification of ultimate limit state of main beam

point	x m	$k_{mod,h}$	σ_h MN/m ²	τ_h MN/m ²	U_h	point	x m	$k_{mod,h}$	σ_h MN/m ²	τ_h MN/m ²	U_h
A	0.000	0.600	0.00	0.46	0.247	B	4.000	0.600	7.44	0.90	0.671
	0.500	0.600	1.55	0.29	0.155	B	4.000	0.600	7.44	1.03	0.671
	1.300	0.600	2.55	0.01	0.231		4.200	0.600	5.78	0.96	0.522
	2.200	0.600	1.52	0.29	0.158		5.000	0.600	0.28	0.69	0.373
	2.700	0.600	0.05	0.46	0.250		5.600	0.600	2.65	0.48	0.262
	3.600	0.600	4.65	0.77	0.420		6.400	0.600	4.97	0.21	0.449

verification of ultimate limit state of main beam

point	x	k _{mod,h}	σ _h	τ _h	U _h	point	x	k _{mod,h}	σ _h	τ _h	U _h
-	m	-	MN/m ²	MN/m ²	-	-	m	-	MN/m ²	MN/m ²	-
	7.000	0.600	5.52	0.01	0.499	C	9.000	0.600	0.00	0.67	0.364
	7.700	0.600	4.88	0.23	0.440	minimum		0.600	0.00	0.01	0.155
	8.400	0.600	2.85	0.47	0.257	maximum		0.600	7.44	1.03	0.671

maximal utilization

point	x	U	point	x	U	point	x	U	point	x	U
-	m	-	-	m	-	-	m	-	-	m	-
A	0.000	0.247		3.600	0.420		5.600	0.262		8.400	0.257
	0.500	0.155	B	4.000	0.671		6.400	0.449	C	9.000	0.364
	1.300	0.231	B	4.000	0.671		7.000	0.499	minimum		0.155
	2.200	0.158		4.200	0.522		7.700	0.440	maximum		0.671

10. vibration verification results

10.1. natural frequency

$EI_{lengthwise} = 0.887040 \text{ MNm}^2/\text{m}$, $EI_{cross} = 0.000000 \text{ MNm}^2/\text{m}$, $m = 22560.0 \text{ kg/m}^2$
 $f_e = 5.818 \text{ Hz} < f_{min} = 8 \text{ Hz} \Rightarrow \text{special examination}$

10.2. stiffness criterion

$x_{max F} = 2.500 \text{ m}$, $x_{max w} = 2.500 \text{ m} \Rightarrow w_{max} = 2.936 \text{ mm}$
 $w(1\text{kN}) = 2.94 \text{ mm} > w_{grenz} = 1.5 \text{ mm} \Rightarrow \text{criterion not met!!!}$

10.3. unit pulse speed

$n_{40} = 10.0000$
 $v = 2.159 \text{ mm/s} \leq v_{grenz} = 22.341 \text{ mm/s} \Rightarrow \text{criterion met!}$

10.4. heel strike

$v = 118.732 \text{ mm/s} \leq v_{grenz} = 134.047 \text{ mm/s} \Rightarrow \text{criterion met!}$

10.5. acceleration/resonance

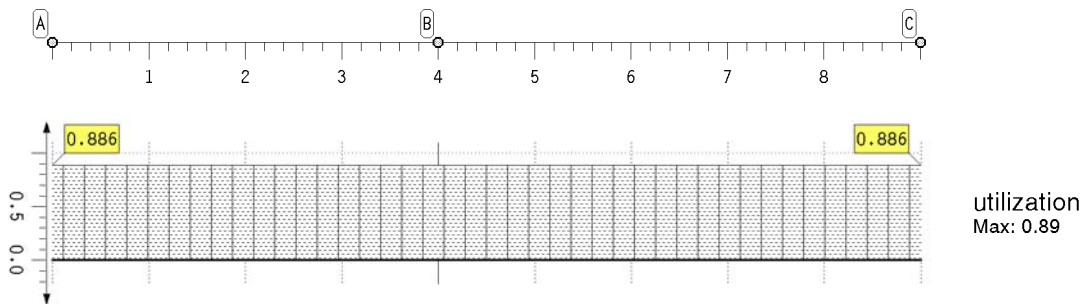
$a = 0.376442 \text{ m/s}^2 > 0.3 \text{ m/s}^2 \Rightarrow \text{noticeable, not disturbing}$

verification successful!

11. Summary

11.1. Summary of all verifications

maximal utilization



12. Utilizations of all verifications

all verifications successful!