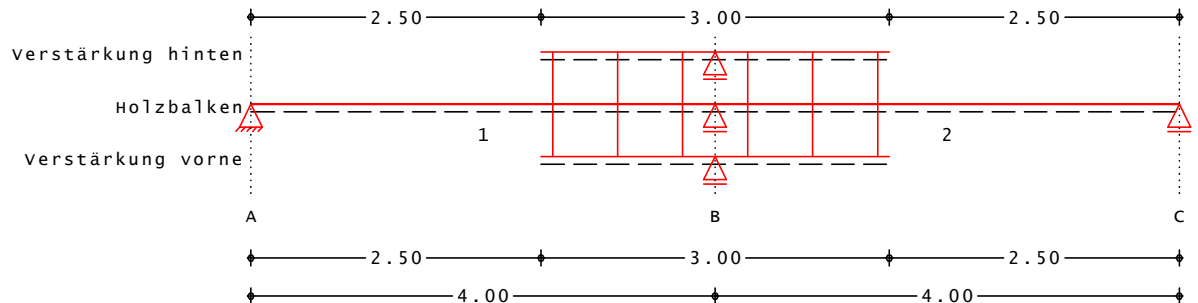


Pos. B341 Holz-Durchlaufträger, mit Verstärkungen über dem Auflager
System Holz-Zweifeldträger
M 1:65

**Abmessungen /
Nutzungsklassen**

| Feld | L [m] | NKL |
|------|----------|-----|
| 1 | 4.00 | 1 |
| 2 | 4.00 | 1 |

Auflager

| Aufl. | x [m] | b [cm] | Balken gelag. | Verst. gelag. | Transl. [kN/m] | Rotat. [kNm/°] |
|-------|----------|-----------|------------------|------------------|-------------------|-------------------|
| A | 0.00 | 30.00 | x | | starr | frei |
| B | 4.00 | 30.00 | x | x | starr | frei |
| C | 8.00 | 30.00 | x | | starr | frei |

Holzbalken

| Feld | a [m] | s [m] | b [cm] | h [cm] | Material |
|------|----------|----------|-----------|-----------|----------|
| 1 | 0.00 | 8.00 | 10.0 | 24.0 | NH C24 |

Verstärkung

| Feld | a [m] | s [m] | Seite | Profil | Material |
|------|----------|----------|--------|--------|----------|
| 1 | 2.50 | 3.00 | beids. | U 140 | S 235 |

Verbundstellen

| QS | Art | Abmessung | Fk1 | K _{ser} [N/mm] | e [cm] |
|----|--------|-----------|-----|----------------------------|-----------|
| V1 | Bolzen | M22 | 5.8 | 7203 | 10.0 |
| | Bolzen | M16 | 5.8 | 5238 | 56.0 |
| | Bolzen | M16 | 5.8 | 5238 | 56.0 |
| | Bolzen | M16 | 5.8 | 5238 | 56.0 |
| | Bolzen | M16 | 5.8 | 5238 | 56.0 |
| | Bolzen | M22 | 5.8 | 7203 | 56.0 |

Einwirkungen

 ständig
Nutz
Schnee

 ständige Einwirkung
Nutzlast, Kategorie A
Schnee-/Eislast <= 1000 m

fw

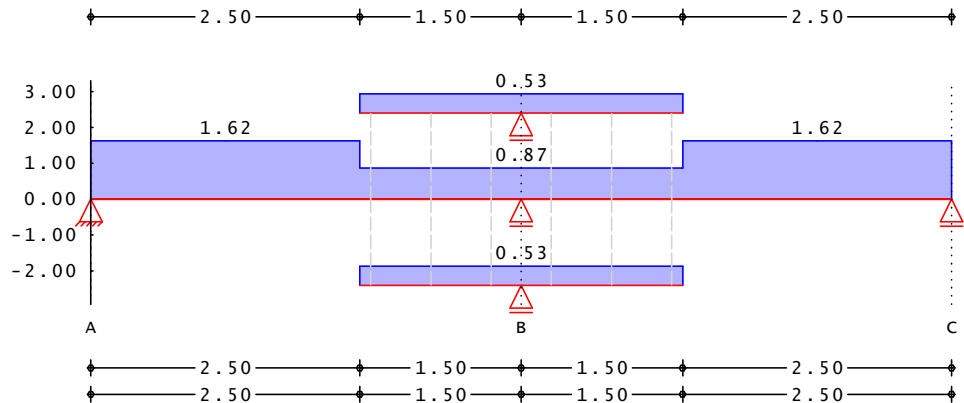
Erläuterungen

 feldweise (fw)
Die Lasten der Einwirkung werden als feldweise
wirkend aufgeteilt.

Belastung

Einwirkung ständig

M 1:70


Eigengewicht

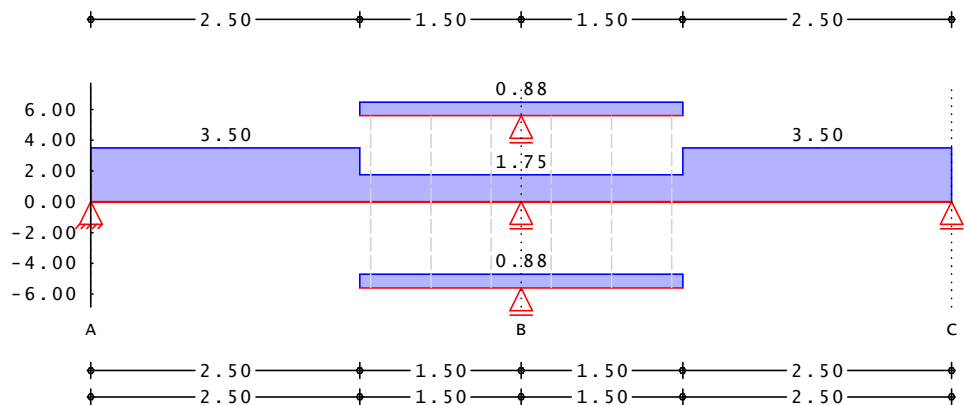
| Bauteil | A [cm ²] | γ [kN/m ³] | g [kN/m] |
|-----------|-------------------------|----------------------------------|-------------|
| Balken | 240.0 | 5.0 | 0.12 |
| verstärk. | 20.4 | 78.5 | 0.16 |

Gleichlasten

| | F _{anf} | a | F _{end} | a | s | auf | Ant. | q |
|---|------------------|------|------------------|------|------|---------|------|--------|
| | | [m] | | [m] | [m] | | [%] | [kN/m] |
| 1 | 1 | 0.00 | 1 | 2.50 | 2.50 | Balken | 100 | 1.50 |
| 2 | 1 | 2.50 | 2 | 1.50 | 3.00 | Balken | 50 | 0.75 |
| 3 | 1 | 2.50 | 2 | 1.50 | 3.00 | Vst.vo. | 25 | 0.38 |
| 4 | 1 | 2.50 | 2 | 1.50 | 3.00 | Vst.hi. | 25 | 0.38 |
| 5 | 2 | 1.50 | 2 | 4.00 | 2.50 | Balken | 100 | 1.50 |

Einwirkung Nutz

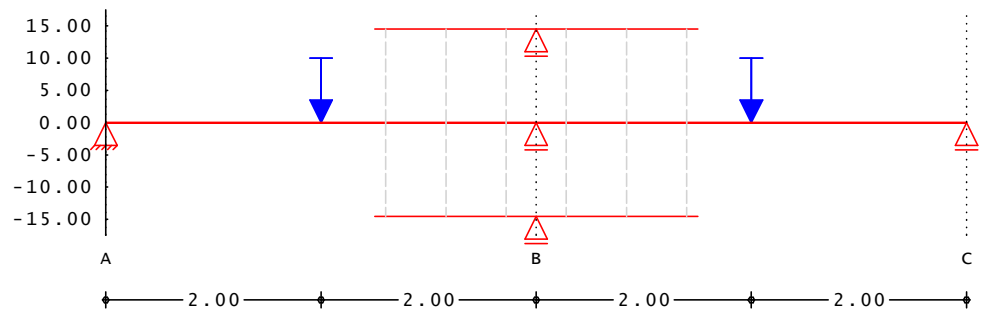
M 1:70


Gleichlasten

| | F _{anf} | a | F _{end} | a | s | auf | Ant. | q |
|---|------------------|------|------------------|------|------|---------|------|--------|
| | | [m] | | [m] | [m] | | [%] | [kN/m] |
| 1 | 1 | 0.00 | 1 | 2.50 | 2.50 | Balken | 100 | 3.50 |
| 2 | 1 | 2.50 | 2 | 1.50 | 3.00 | Balken | 50 | 1.75 |
| 3 | 1 | 2.50 | 2 | 1.50 | 3.00 | Vst.vo. | 25 | 0.88 |
| 4 | 1 | 2.50 | 2 | 1.50 | 3.00 | Vst.hi. | 25 | 0.88 |
| 5 | 2 | 1.50 | 2 | 4.00 | 2.50 | Balken | 100 | 3.50 |

Einwirkung Schnee

M 1:70



Einzellasten

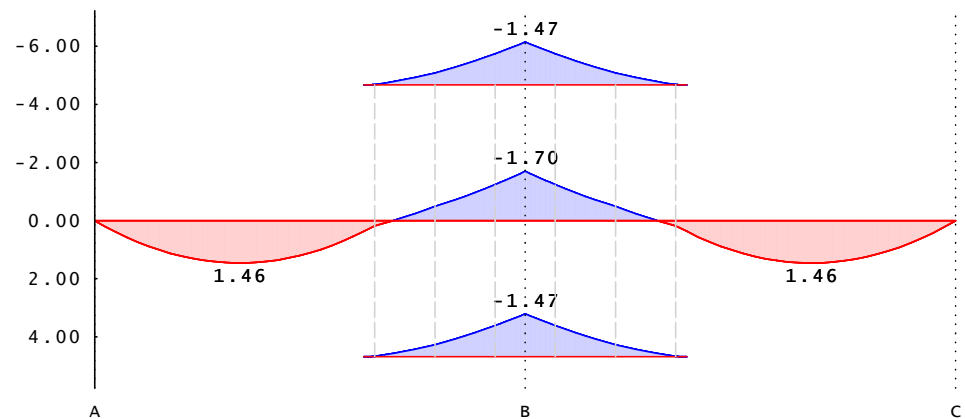
| Feld | a [m] | auf | Ant. [%] | F [kN] |
|------|--------|--------|----------|--------|
| 1 | 1 2.00 | Balken | 100 | 10.00 |
| 2 | 2 2.00 | Balken | 100 | 10.00 |

char. Schnittgrößen

Einwirkung ständig

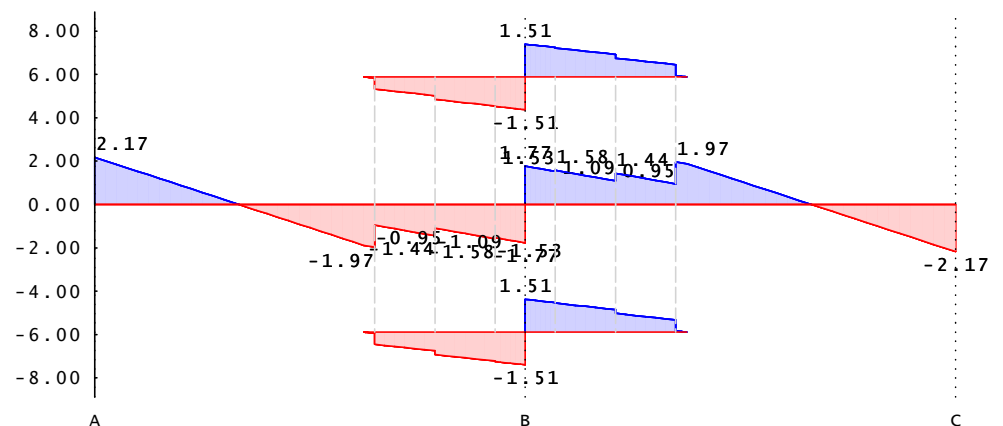
M 1:70

Moment M_k [kNm]

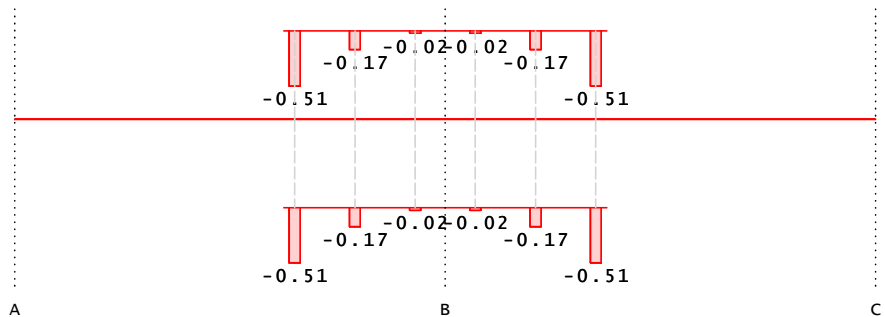


M 1:70

Querkraft V_k [kN]



M 1:70

 Schubkraft in Verbindungsmitteln V_k [kN]

 Holzbalken
Schnittgrößen

| Feld | x [m] | M_k [kNm] | V_k [kN] |
|------|-------|-------------|------------|
| 1 | 0.00 | 0.00 | 2.17* |
| | 1.34 | 1.46* | -0.00 |
| | 2.60 | 0.17 | -1.97 |
| | 2.60 | 0.17 | -0.95 |
| | 4.00 | -1.70 | -1.77 |
| 2 | 0.00 | -1.70 | 1.77 |
| | 1.40 | 0.17 | 0.95 |
| | 1.40 | 0.17 | 1.97* |
| | 2.66 | 1.46* | -0.00 |
| | 4.00 | 0.00 | -2.17 |

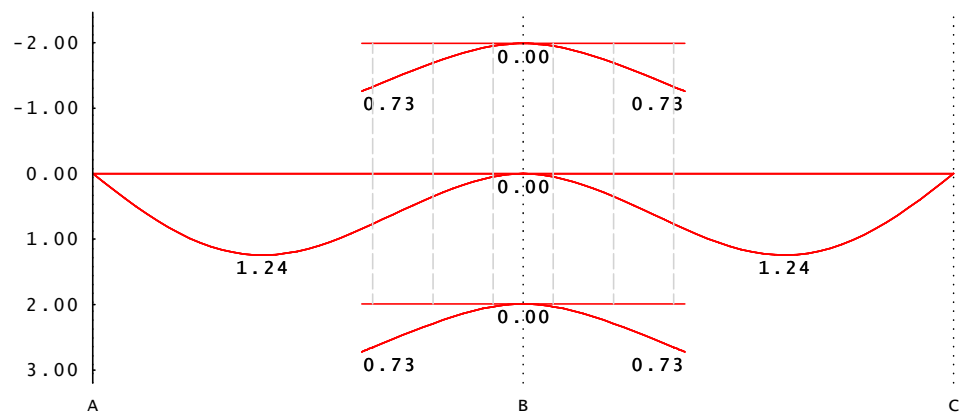
 Verstärkung
Schnittgrößen

| Feld | x [m] | M_k [kNm] | V_k [kN] |
|------|-------|-------------|------------|
| 1 | 2.50 | 0.00* | 0.00 |
| | 4.00 | -1.47 | -1.51 |
| 2 | 0.00 | -1.47 | 1.51* |
| | 1.50 | 0.00* | 0.00 |

 Verbindungsmittel
Schubkräfte

| Feld | x [m] | Verstärkung vorne V_k [kN] | Verstärkung hinten V_k [kN] |
|------|-------|------------------------------|-------------------------------|
| 1 | 2.60 | -0.51 | -0.51 |
| | 3.16 | -0.17 | -0.17 |
| | 3.72 | -0.02 | -0.02 |
| 2 | 0.28 | -0.02 | -0.02 |
| | 0.84 | -0.17 | -0.17 |
| | 1.40 | -0.51 | -0.51 |

M 1:70

 Verformung w_k [mm]


**Holzbalcken
Verformungen**

| Feld | x [m] | W_k [mm] |
|------|----------|---------------|
| 1 | 0.00 | 0.00 |
| | 1.57 | 1.24* |
| | 4.00 | 0.00 |
| 2 | 0.00 | 0.00 |
| | 2.43 | 1.24* |
| | 4.00 | 0.00 |

**Verstärkung
Verformungen**

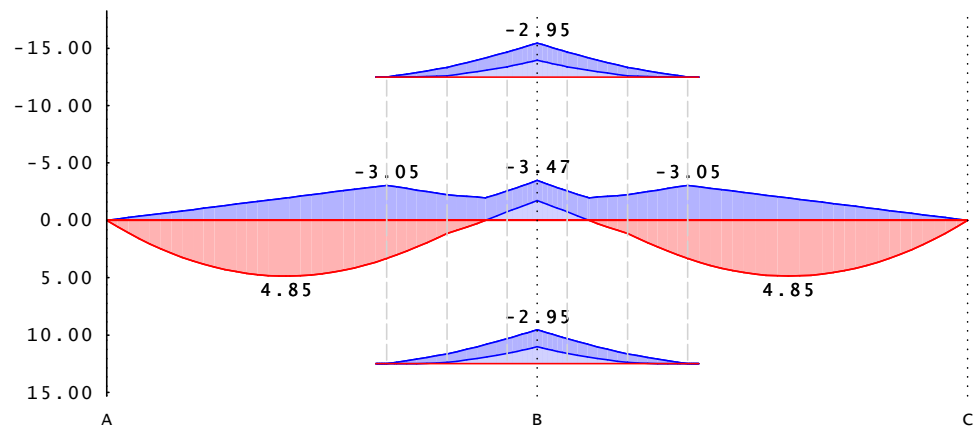
| Feld | x [m] | W_k [mm] |
|------|----------|---------------|
| 1 | 2.50 | 0.73* |
| | 4.00 | 0.00 |
| 2 | 0.00 | 0.00 |
| | 1.50 | 0.73* |

Auflagerkräfte

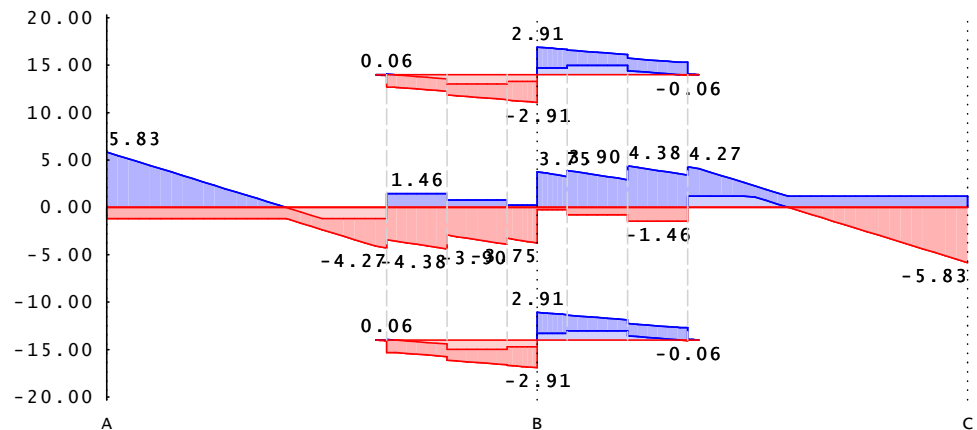
| Aufl. | x [m] | M_k [kNm] | F_k [kN] |
|-------|----------|----------------|---------------|
| A | 0.00 | 0.00 | 2.17 |
| B | 4.00 | 0.00 | 9.58 |
| C | 8.00 | 0.00 | 2.17 |

Einwirkung Nutz

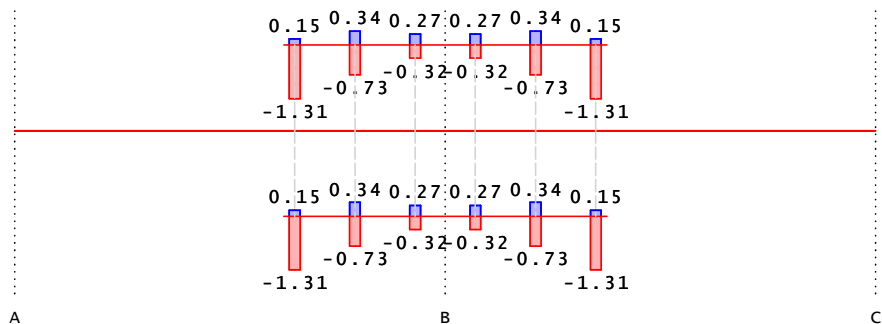
M 1:70

Moment M_k [kNm]


M 1:70

Querkraft V_k [kN]


M 1:70

 Schubkraft in Verbindungsmitteln V_k [kN]

 Holzbalken
Schnittgrößen

| Feld | x [m] | min M_k [kNm] | max M_k [kNm] | min V_k [kN] | max V_k [kN] |
|------|-------|-----------------|-----------------|----------------|----------------|
| 1 | 0.00 | 0.00 | 0.00 | -1.17 | 5.83* |
| | 1.67 | -1.95 | 4.85* | -1.17 | 0.00 |
| | 2.10 | -2.46 | 4.52 | -2.69 | -1.17 |
| | 3.16 | -2.23 | 1.16 | -4.38* | 1.46 |
| | 3.16 | -2.23 | 1.16 | -2.92 | 0.77 |
| | 4.00 | -3.47* | -1.74 | -3.75 | 0.23 |
| 2 | 0.00 | -3.47* | -1.74 | -0.23 | 3.75 |
| | 0.84 | -2.23 | 1.16 | -0.77 | 2.92 |
| | 0.84 | -2.23 | 1.16 | -1.46 | 4.38* |
| | 1.40 | -3.05 | 3.33 | -1.46 | 3.40 |
| | 1.40 | -3.05 | 3.33 | 1.17 | 4.27 |
| | 2.33 | -1.95 | 4.85* | -0.00 | 1.17 |
| | 4.00 | 0.00 | 0.00 | -5.83* | 1.17 |

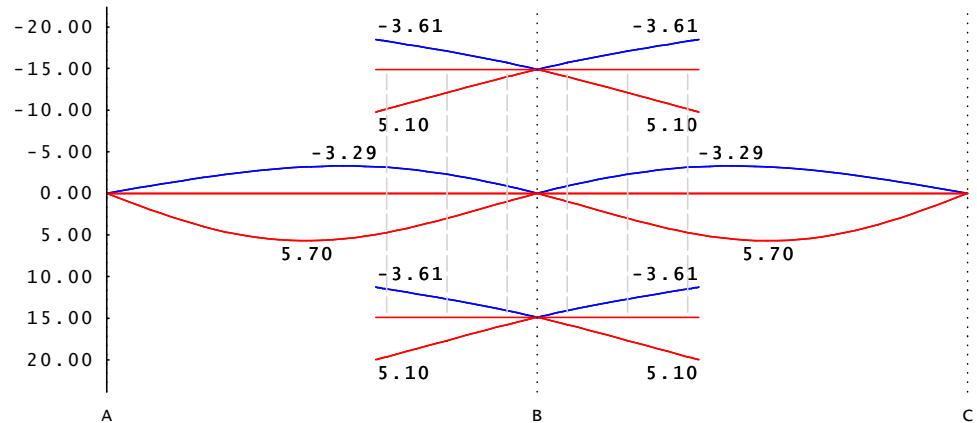
 Verstärkung
Schnittgrößen

| Feld | x [m] | min M_k [kNm] | max M_k [kNm] | min V_k [kN] | max V_k [kN] |
|------|-------|-----------------|-----------------|----------------|----------------|
| 1 | 2.50 | 0.00 | 0.00* | 0.00 | 0.00 |
| | 3.16 | -0.84 | -0.11 | -1.74 | -0.43 |
| | 3.16 | -0.84 | -0.11 | -2.13 | -0.97 |
| | 4.00 | -2.95* | -1.48 | -2.91* | -0.70 |
| 2 | 0.00 | -2.95* | -1.48 | 0.70 | 2.91* |
| | 0.28 | -2.17 | -0.89 | 0.70 | 2.67 |
| | 0.28 | -2.17 | -0.89 | 0.97 | 2.62 |
| | 1.40 | -0.00 | 0.00* | -0.06 | 1.31 |
| | 1.40 | -0.00 | 0.00* | 0.00 | 0.09 |
| | 1.50 | 0.00 | 0.00 | 0.00 | 0.00 |

 Verbindungsmittel
Schubkräfte

| Feld | x [m] | Verstärkung vorne min V_k [kN] | Verstärkung vorne max V_k [kN] | Verstärkung hinten min V_k [kN] | Verstärkung hinten max V_k [kN] |
|------|-------|-------------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|
| 1 | 2.60 | -1.31 | 0.15 | -1.31 | 0.15 |
| | 3.16 | -0.73 | 0.34 | -0.73 | 0.34 |
| | 3.72 | -0.32 | 0.27 | -0.32 | 0.27 |
| 2 | 0.28 | -0.32 | 0.27 | -0.32 | 0.27 |
| | 0.84 | -0.73 | 0.34 | -0.73 | 0.34 |
| | 1.40 | -1.31 | 0.15 | -1.31 | 0.15 |

M 1:70

 Verformung w_k [mm]

 Holzbalken
Verformungen

| Feld | x [m] | min w_k [mm] | max w_k [mm] |
|------|-------|----------------|----------------|
| 1 | 0.00 | 0.00 | 0.00 |
| | 1.85 | -3.17 | 5.70* |
| | 2.20 | -3.29* | 5.47 |
| | 4.00 | 0.00 | 0.00 |
| 2 | 0.00 | 0.00 | 0.00 |
| | 1.80 | -3.29* | 5.47 |
| | 2.15 | -3.17 | 5.70* |
| | 4.00 | 0.00 | 0.00 |

 Verstärkung
Verformungen

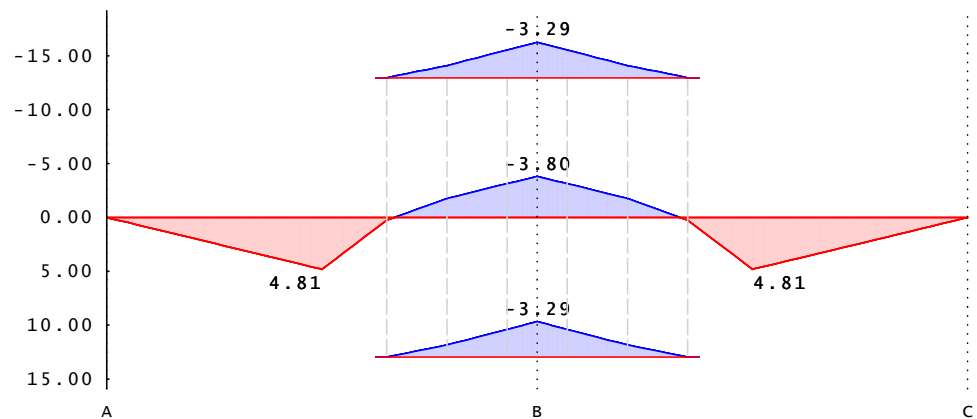
| Feld | x [m] | min w_k [mm] | max w_k [mm] |
|------|-------|----------------|----------------|
| 1 | 2.50 | -3.61* | 5.10* |
| | 4.00 | 0.00 | 0.00 |
| 2 | 0.00 | 0.00 | 0.00 |
| | 1.50 | -3.61* | 5.10* |

Auflagerkräfte

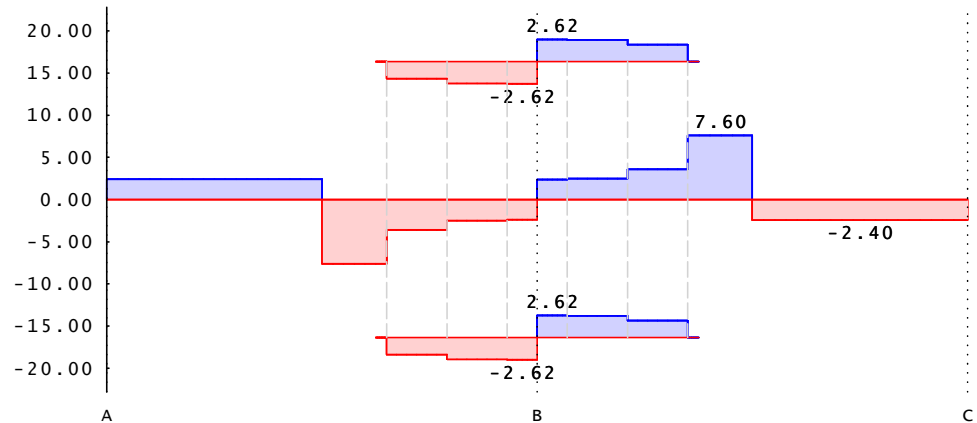
| Aufl. | x [m] | min M_k [kNm] | max M_k [kNm] | min F_k [kN] | max F_k [kN] |
|-------|-------|-----------------|-----------------|----------------|----------------|
| A | 0.00 | 0.00 | 0.00 | -1.17 | 5.83 |
| B | 4.00 | 0.00 | 0.00 | 9.34 | 18.69 |
| C | 8.00 | 0.00 | 0.00 | -1.17 | 5.83 |

Einwirkung Schnee

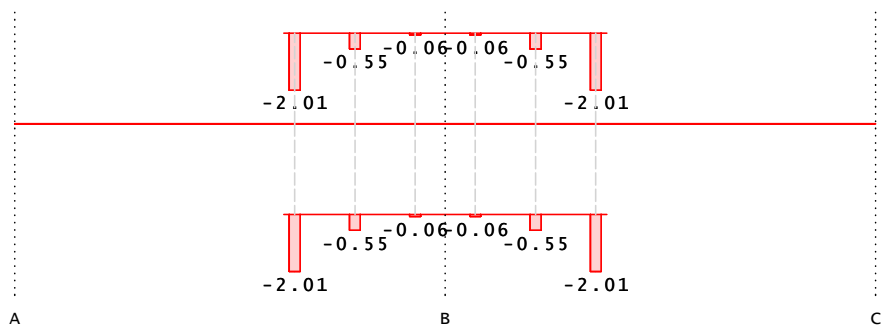
M 1:70

 Moment M_k [kNm]


M 1:70

 Querkraft V_k [kN]


M 1:70

 Schubkraft in Verbindungsmitteln V_k [kN]

 Holzbalken
Schnittgrößen

| Feld | x [m] | M_k [kNm] | V_k [kN] |
|------|-------|-------------|------------|
| 1 | 0.00 | 0.00 | 2.40* |
| | 2.00 | 4.81* | 2.40 |
| | 2.00 | 4.81 | -7.60 |
| | 4.00 | -3.80 | -2.36 |
| 2 | 0.00 | -3.80 | 2.36 |
| | 1.40 | 0.25 | 3.58 |
| | 1.40 | 0.25 | 7.60* |
| | 2.00 | 4.81 | 7.60 |
| | 2.00 | 4.81* | -2.40 |
| | 4.00 | 0.00 | -2.40 |

 Verstärkung
Schnittgrößen

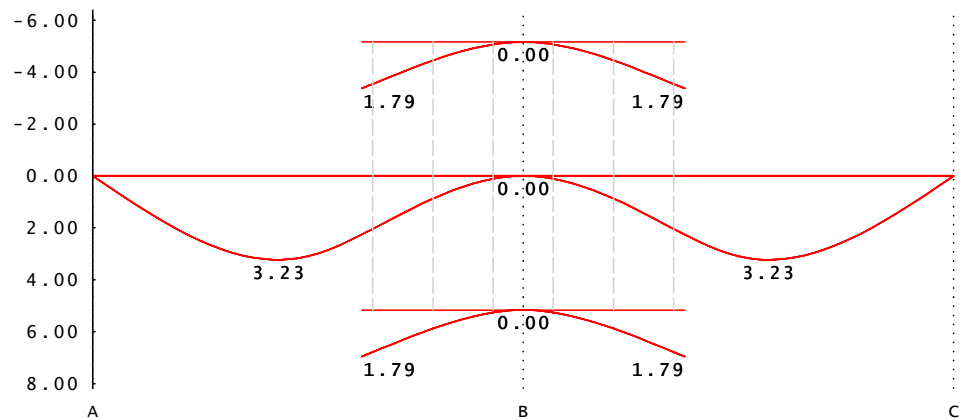
| Feld | x [m] | M_k [kNm] | V_k [kN] |
|------|-------|-------------|------------|
| 1 | 2.50 | 0.00* | 0.00 |
| | 3.72 | -2.56 | -2.56 |
| | 3.72 | -2.56 | -2.62 |
| | 4.00 | -3.29 | -2.62 |
| 2 | 0.00 | -3.29 | 2.62* |
| | 1.40 | 0.00* | 2.01 |
| | 1.40 | 0.00* | 0.00 |

 Verbindungsmittel
Schubkräfte

| Feld | x [m] | Verstärkung vorne V_k [kN] | Verstärkung hinten V_k [kN] |
|------|-------|------------------------------|-------------------------------|
| 1 | 2.60 | -2.01 | -2.01 |
| | 3.16 | -0.55 | -0.55 |
| | 3.72 | -0.06 | -0.06 |

| Feld | x [m] | Verstärkung vorne V_k [kN] | Verstärkung hinten V_k [kN] |
|------|----------|------------------------------------|-------------------------------------|
| 2 | 0.28 | -0.06 | -0.06 |
| | 0.84 | -0.55 | -0.55 |
| | 1.40 | -2.01 | -2.01 |

M 1:70

 Verformung w_k [mm]

 Holzbalken
Verformungen

| Feld | x [m] | w_k [mm] |
|------|----------|---------------|
| 1 | 0.00 | 0.00 |
| | 1.72 | 3.23* |
| | 4.00 | 0.00 |
| 2 | 0.00 | 0.00 |
| | 2.28 | 3.23* |
| | 4.00 | 0.00 |

 Verstärkung
Verformungen

| Feld | x [m] | w_k [mm] |
|------|----------|---------------|
| 1 | 2.50 | 1.79* |
| | 4.00 | 0.00 |
| 2 | 0.00 | 0.00 |
| | 1.50 | 1.79* |

Auflagerkräfte

| Aufl. | x [m] | M_k [kNm] | F_k [kN] |
|-------|----------|----------------|---------------|
| A | 0.00 | 0.00 | 2.40 |
| B | 4.00 | 0.00 | 15.19 |
| C | 8.00 | 0.00 | 2.40 |

Kombinationen
ständige und vorübergehende Bemessungssituation

| Ek | Σ EW (Felder: 1 .. n) | | |
|----|------------------------------|-------------------|--------------|
| 3 | 1.35*ständig | +1.50*Nutz (1) | |
| 4 | 1.35*ständig | +1.50*Nutz (2) | |
| 7 | 1.35*ständig | +1.50*Nutz (1) | +0.75*Schnee |
| 8 | 1.35*ständig | +1.50*Nutz (2) | +0.75*Schnee |
| 10 | 1.35*ständig | +1.05*Nutz (1) | +1.50*Schnee |

| Ek | Σ EW (Felder: 1 .. n) | | |
|----|------------------------------|---------------------|--------------|
| 11 | 1.35*ständig | +1.05*Nutz (2) | +1.50*Schnee |
| 25 | 1.35*ständig | +1.05*Nutz (1,2) | +1.50*Schnee |

quasi-ständige Bemessungssituation

| Ek | Σ EW (Felder: 1 .. n) | | |
|----|------------------------------|-------------------|--|
| 31 | 1.00*ständig | +0.30*Nutz (1) | |
| 32 | 1.00*ständig | +0.30*Nutz (2) | |

Die kombinierten Verformungen enthalten schon die Kriechanteile k_{def} .

Bemessung Materialien

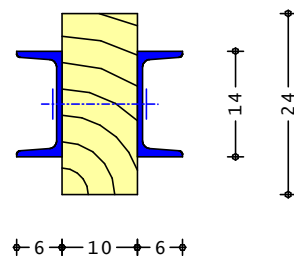
| QS | Holz | $f_{m,k}$ | f_{t0k} | f_{c0k} | f_{c90k} | f_{vk} | E_{0mean} |
|----|--------|-----------|-----------|----------------------|------------|----------|-------------|
| | | | | [N/mm ²] | | | |
| B1 | NH C24 | 24.0 | 14.0 | 21.0 | 2.5 | 2.0 | 11000 |
| QS | Stahl | $f_{u,k}$ | | $f_{y,k}$ | | E_s | |
| | | | | [N/mm ²] | | | |
| V1 | S 235 | 360.0 | | 240.0 | | 210000 | |

Querschnittswerte

| QS | | b | h | A | I_y | |
|----|--------|--------------------|--------------------|--------------------|--------------------|------|
| | | [cm] | [cm] | [cm ²] | [cm ⁴] | |
| B1 | | 10.0 | 24.0 | 240.0 | 11520.0 | |
| QS | Profil | A | I_y | W_y | S_y | s |
| | | [cm ²] | [cm ⁴] | [cm ³] | [cm ³] | [cm] |
| V1 | U 140 | 20.4 | 605.0 | 86.4 | 51.3 | 0.70 |

Schnitt M 1:10

Verstärkung 1
2*U 140, Bolzen M22(5.8)



Verbindungsmittel

| QS | Art | Abmessung | F _{k1} | R _k [kN] |
|----|--------|-----------|-----------------|---------------------|
| V1 | Bolzen | M22 | 5.8 | 14.66 |
| | Bolzen | M16 | 5.8 | 9.92 |
| | Bolzen | M16 | 5.8 | 9.92 |
| | Bolzen | M16 | 5.8 | 9.92 |
| | Bolzen | M16 | 5.8 | 9.92 |
| | Bolzen | M22 | 5.8 | 14.66 |

Nachweise Grenzzustand der Tragfähigkeit

Holzbalcken

Biegebemessung
DIN 1052, Gl.(55),
Gl.(67)

| F | x [m] | Ek | k_{mod} [-] | M_{yd} [kNm] | σ_{myd} [N/mm ²] | f_{myd} [N/mm ²] | η [-] |
|----------------|----------|----|------------------|-------------------|--|-----------------------------------|---------------|
| 1 (L = 4.00 m) | | | | | | | |
| | 0.00 | - | - | 0.00 | 0.00 | - | 0.00 |
| | 2.00 | 10 | 0.90 | 13.59 | 14.16 | 16.62 | 0.85* |
| | 4.00 | 25 | 0.90 | -11.64 | 12.12 | 16.62 | 0.73 |
| 2 (L = 4.00 m) | | | | | | | |
| | 0.00 | 25 | 0.90 | -11.64 | 12.12 | 16.62 | 0.73 |
| | 2.00 | 11 | 0.90 | 13.59 | 14.15 | 16.62 | 0.85* |
| | 4.00 | - | - | 0.00 | 0.00 | - | 0.00 |

Querkraftbemessung
DIN 1052, Gl.(59)

| F | x [m] | Ek | k_{mod} [-] | V_{zd} [kN] | τ_{zd} [N/mm ²] | f_{zd} [N/mm ²] | η [-] |
|---|----------|----|------------------|------------------|-------------------------------------|----------------------------------|---------------|
| 1 | | | | | | | |
| | 0.34 | 7 | 0.90 | 10.95 | 0.68 | 1.38 | 0.49 |
| | 2.60 | 25 | 0.90 | -18.53 | 1.28 | 1.38 | 0.93* |
| | 3.61 | 10 | 0.90 | -9.60 | 0.60 | 1.38 | 0.43 |
| 2 | | | | | | | |
| | 0.39 | 11 | 0.90 | 9.60 | 0.60 | 1.38 | 0.43 |
| | 1.40 | 25 | 0.90 | 18.53 | 1.28 | 1.38 | 0.93* |
| | 3.66 | 8 | 0.90 | -10.95 | 0.68 | 1.38 | 0.49 |

Auflagerpressung
DIN 1052, Gl.(47)

| | Ek | k_{mod} [-] | F_d [kN] | A_{ef} [cm ²] | k_{c90} [-] | σ_{c90d} [N/mm ²] | f_{c90d} [N/mm ²] | η [-] |
|---|----|------------------|---------------|--------------------------------|------------------|---|------------------------------------|---------------|
| A | 7 | 0.90 | 13.48 | 330.0 | 1.50 | 0.41 | 2.60 | 0.16 |
| B | 25 | 0.90 | 19.24 | 360.0 | 1.50 | 0.53 | 2.60 | 0.21 |
| C | 8 | 0.90 | 13.48 | 330.0 | 1.50 | 0.41 | 2.60 | 0.16 |

Verstärkung

Spannungen
DIN 18800

| F | x [m] | Ek | M_{yd} [kNm] | V_{zd} [kN] | σ_{myd} [N/mm ²] | τ_{zd} [N/mm ²] | σ_{vd} [N/mm ²] | η [-] |
|---|----------|----|-------------------|------------------|--|-------------------------------------|---------------------------------------|---------------|
| 1 | | | | | | | | |
| | 2.50 | - | 0.00 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 |
| | 4.00 | 25 | -10.02 | -9.02 | 115.9 | 10.9 | 116.8 | 0.54* |
| 2 | | | | | | | | |
| | 0.00 | 25 | -10.02 | 9.02 | 115.9 | 10.9 | 116.8 | 0.54* |
| | 1.50 | - | 0.00 | 0.00 | 0.0 | 0.0 | 0.0 | 0.00 |

Verbindungsmitel
DIN 1052

werte pro Scherfuge

| QS | x [m] | Ek | k_{mod} [-] | γ_M [-] | Abst. | F_d [kN] | R_d [kN] | η [-] |
|----|----------|----|------------------|-------------------|-------|---------------|---------------|---------------|
| v1 | | | | | | | | |
| | 0.10 | 11 | 0.90 | 1.30 | ok | -5.08 | 5.07 | 1.00 |
| | 0.66 | 10 | 0.90 | 1.10 | ok | -1.83 | 4.06 | 0.45 |
| | 1.22 | 3 | 0.80 | 1.10 | ok | -0.51 | 3.61 | 0.14 |
| | 1.78 | 4 | 0.80 | 1.10 | ok | -0.51 | 3.61 | 0.14 |
| | 2.34 | 11 | 0.90 | 1.10 | ok | -1.83 | 4.06 | 0.45 |
| | 2.90 | 10 | 0.90 | 1.30 | ok | -5.08 | 5.07 | 1.00 |

Grenzzustand der Gebrauchstauglichkeit

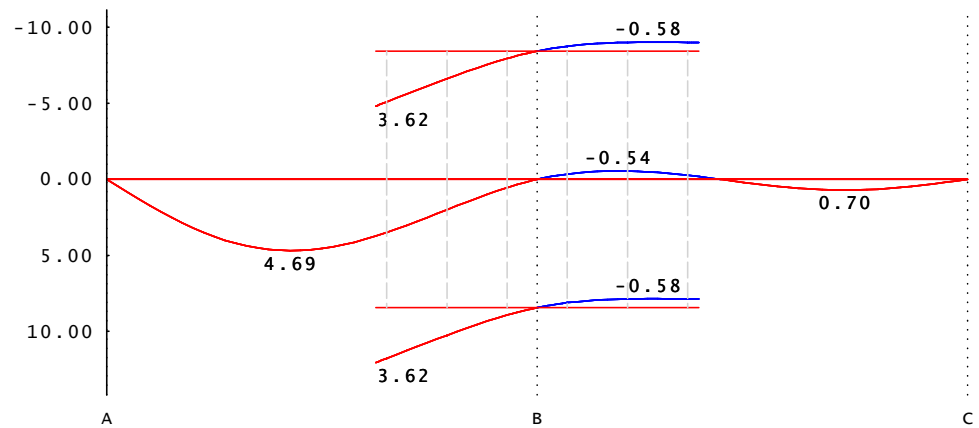
Holzbalcken

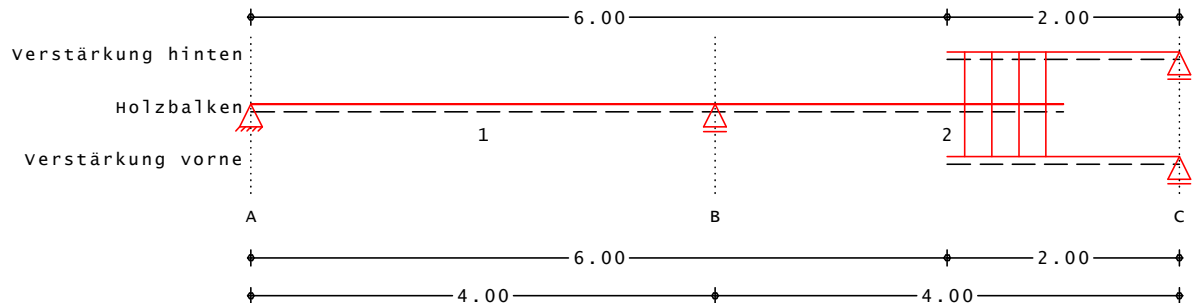
max. Verformungen
DIN 1052, 9.2

| | x [m] | Ek | vorhw [mm] | zulw [mm] | η [-] |
|---|----------|----|---------------|--------------|---------------|
| Feld 1 (L = 4.00 m, NKL 1, $k_{def} = 0.60$) | | | | | |
| Gl(42) | 1.70 | 31 | 4.7 | 20.0 | 0.23 |
| Feld 2 (L = 4.00 m, NKL 1, $k_{def} = 0.60$) | | | | | |
| Gl(42) | 2.28 | 32 | 4.7 | 20.0 | 0.23 |

M 1:70

Durchhang [mm] (Gleichung 42: $w_{fin} - w_0$)



Pos. B341a Austausch des Querschnitts am Auflager
System Holz-Zweifeldträger
M 1:65

**Abmessungen /
Nutzungsklassen**

| Feld | L [m] | NKL |
|------|-------|-----|
| 1 | 4.00 | 2 |
| 2 | 4.00 | 2 |

Auflager

| Aufl. | x [m] | b [cm] | Balken gelag. | Verst. gelag. | Transl. [kN/m] | Rotat. [kNm/°] |
|-------|-------|--------|---------------|---------------|----------------|----------------|
| A | 0.00 | 24.00 | x | | starr | frei |
| B | 4.00 | 24.00 | x | | starr | frei |
| C | 8.00 | 24.00 | | x | starr | frei |

Holzbalken

| Feld | a [m] | s [m] | b [cm] | h [cm] | Material |
|------|-------|-------|--------|--------|----------|
| 1 | 0.00 | 7.00 | 10.0 | 24.0 | NH C24 |

Verstärkung

| Feld | a [m] | s [m] | Seite | b/h | Material |
|------|-------|-------|--------|------|----------|
| 2 | 2.00 | 2.00 | beids. | 6/24 | NH C24 |

Verbundstellen

| QS | n [-] | Art | Abmessung | Fkl | K _{ser} [N/mm] |
|----|-------|-------------------------|----------------|-----|-------------------------|
| V1 | 4 | Ringdübel Typ A1 Bolzen | dc = 65 mm M12 | 4.8 | 13650 |

Abstände Verbundst.

| QS | e _{0,1} [cm] | e [cm] | e _{0,r} [cm] |
|----|-----------------------|-----------|-----------------------|
| V1 | 15.00 | 3 * 23.33 | 115.00 |

Einwirkungen

 ständig
Nutz

 ständige Einwirkung
Nutzlast, Kategorie A

fw

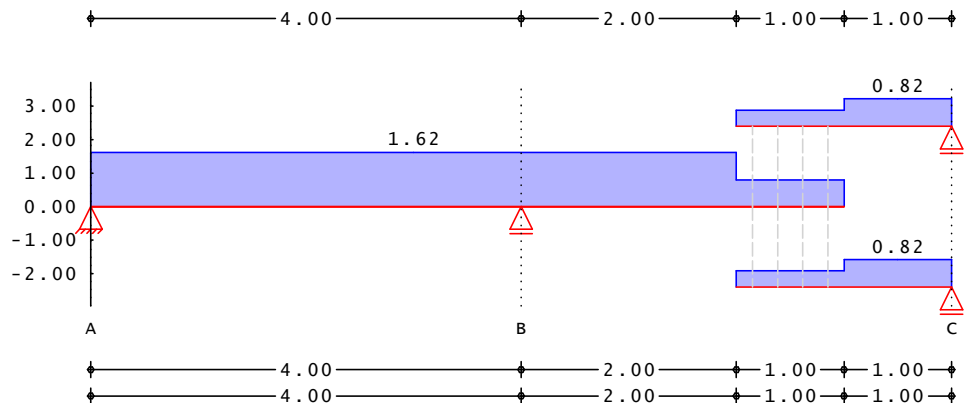
Erläuterungen

 feldweise (fw)
Die Lasten der Einwirkung werden als feldweise wirkend aufgeteilt.

Belastung

Einwirkung ständig

M 1:70


Eigengewicht

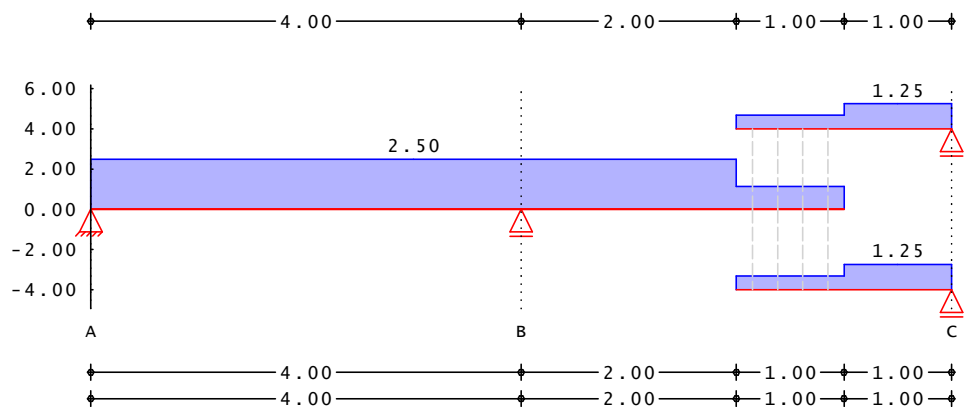
| Bauteil | A [cm ²] | γ [kN/m ³] | g [kN/m] |
|-----------|-------------------------|----------------------------------|-------------|
| Balken | 240.0 | 5.0 | 0.12 |
| verstärk. | 144.0 | 5.0 | 0.07 |

Gleichlasten

| | F _{anf} | a | F _{end} | a | s | auf | Ant. [%] | q [kN/m] |
|---|------------------|------|------------------|------|------|---------|-------------|-------------|
| 1 | 1 | 0.00 | 2 | 2.00 | 6.00 | Balken | 100 | 1.50 |
| 2 | 2 | 2.00 | 2 | 3.00 | 1.00 | Balken | 45 | 0.68 |
| 3 | 2 | 2.00 | 2 | 3.00 | 1.00 | Vst.vo. | 27 | 0.41 |
| 4 | 2 | 2.00 | 2 | 3.00 | 1.00 | Vst.hi. | 27 | 0.41 |
| 5 | 2 | 3.00 | 2 | 4.00 | 1.00 | Vst.vo. | 50 | 0.75 |
| 6 | 2 | 3.00 | 2 | 4.00 | 1.00 | Vst.hi. | 50 | 0.75 |

Einwirkung Nutz

M 1:70


Gleichlasten

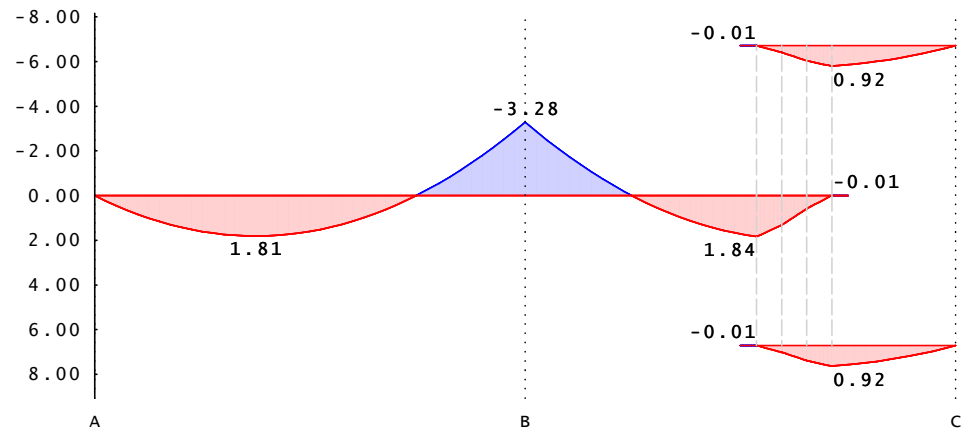
| | F _{anf} | a | F _{end} | a | s | auf | Ant. [%] | q [kN/m] |
|---|------------------|------|------------------|------|------|---------|-------------|-------------|
| 1 | 1 | 0.00 | 2 | 2.00 | 6.00 | Balken | 100 | 2.50 |
| 2 | 2 | 2.00 | 2 | 3.00 | 1.00 | Balken | 45 | 1.14 |
| 3 | 2 | 2.00 | 2 | 3.00 | 1.00 | Vst.vo. | 27 | 0.68 |
| 4 | 2 | 2.00 | 2 | 3.00 | 1.00 | Vst.hi. | 27 | 0.68 |
| 5 | 2 | 3.00 | 2 | 4.00 | 1.00 | Vst.vo. | 50 | 1.25 |
| 6 | 2 | 3.00 | 2 | 4.00 | 1.00 | Vst.hi. | 50 | 1.25 |

char. Schnittgrößen

Einwirkung ständig

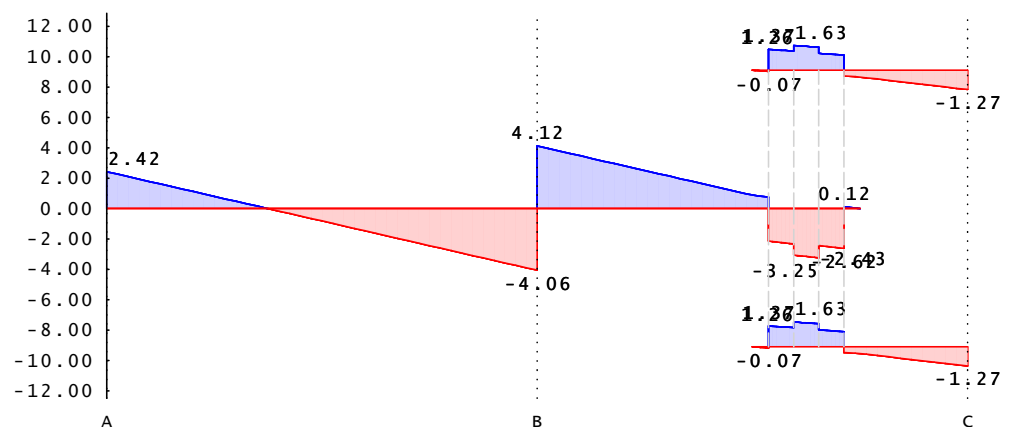
M 1:70

Moment M_k [kNm]



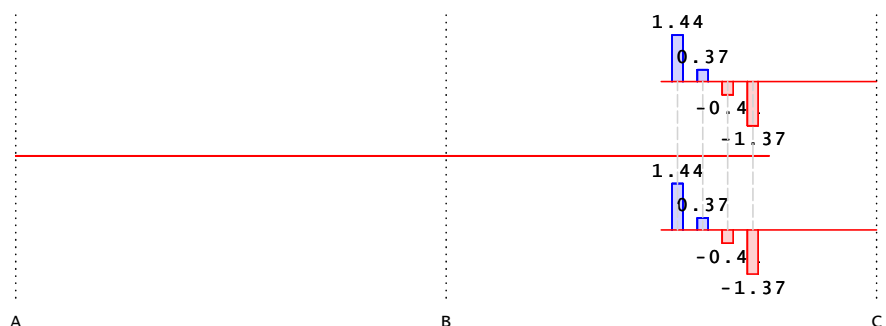
M 1:70

Querkraft V_k [kN]



M 1:70

Schubkraft in Verbindungsmitteln V_k [kN]



Holzbalcken
Schnittgrößen

| Feld | x [m] | M_k [kNm] | V_k [kN] |
|------|-------|-------------|------------|
| 1 | 0.00 | 0.00 | 2.42 |
| | 1.49 | 1.81* | 0.00 |
| | 4.00 | -3.28 | -4.06 |
| 2 | 0.00 | -3.28 | 4.12* |
| | 2.15 | 1.84* | 0.76 |

| Feld | x [m] | M _k [kNm] | V _k [kN] |
|------|----------|-------------------------|------------------------|
| | 2.15 | 1.84 | -2.13 |

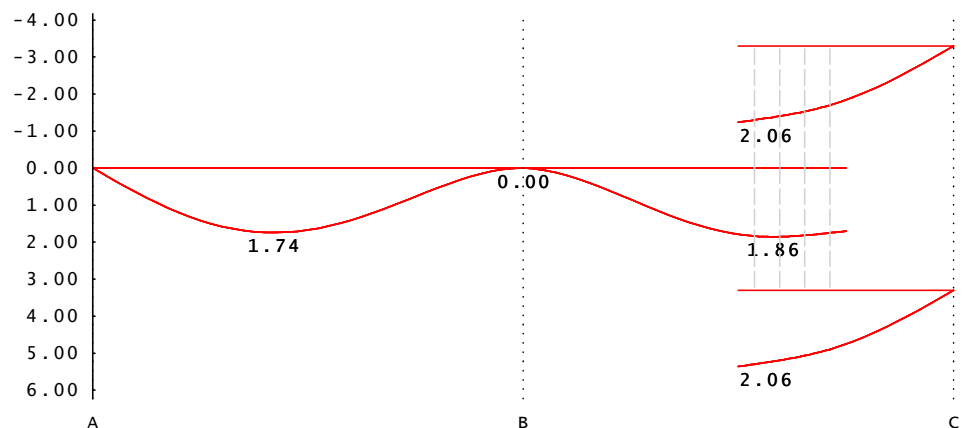
**Verstärkung
Schnittgrößen**

| Feld | x [m] | M _k [kNm] | V _k [kN] |
|------|----------|-------------------------|------------------------|
| 2 | 2.15 | -0.01 | -0.07 |
| | 2.15 | -0.01 | 1.37 |
| | 2.38 | 0.30 | 1.26 |
| | 2.38 | 0.30 | 1.63* |
| | 2.85 | 0.92 | 1.00 |
| | 2.85 | 0.92* | -0.37 |
| | 4.00 | 0.00 | -1.27 |

**Verbindungsmitte
Schubkräfte**

| Feld | x [m] | Verstärkung vorne V _k [kN] | Verstärkung hinten V _k [kN] |
|------|----------|---|--|
| 2 | 2.15 | 1.44 | 1.44 |
| | 2.38 | 0.37 | 0.37 |
| | 2.62 | -0.41 | -0.41 |
| | 2.85 | -1.37 | -1.37 |

M 1:70

Verformung w_k [mm]

**Holzbalcken
Verformungen**

| Feld | x [m] | w _k [mm] |
|------|----------|------------------------|
| 1 | 0.00 | 0.00 |
| | 1.68 | 1.74* |
| | 4.00 | 0.00 |
| 2 | 0.00 | 0.00 |
| | 2.32 | 1.86* |

**Verstärkung
Verformungen**

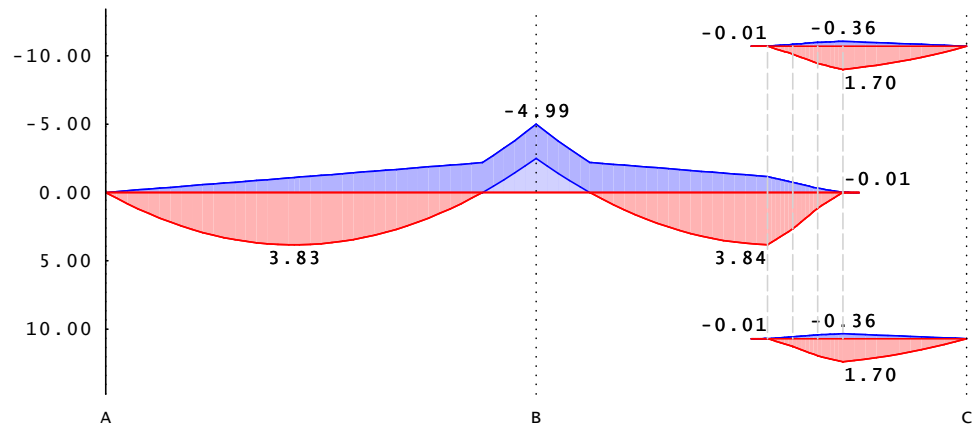
| Feld | x [m] | w _k [mm] |
|------|----------|------------------------|
| 2 | 2.00 | 2.06* |
| | 4.00 | 0.00 |

Auflagerkräfte

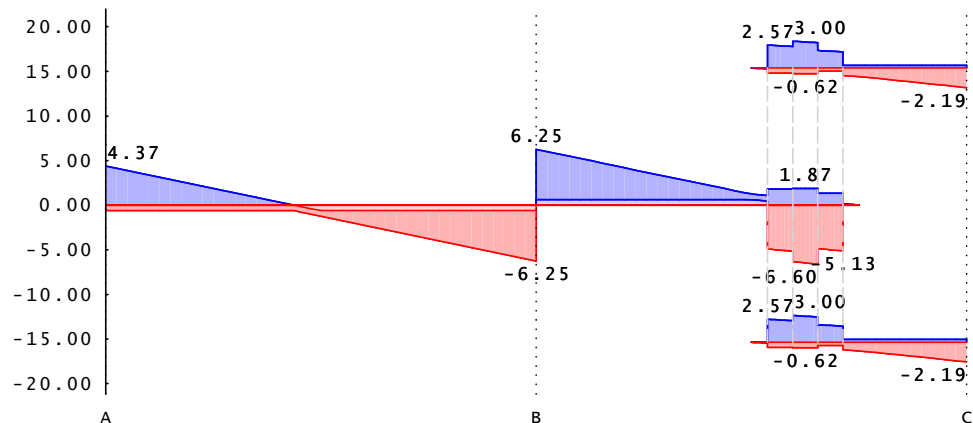
| Aufl. | x [m] | M _k [kNm] | F _k [kN] |
|-------|----------|-------------------------|------------------------|
| A | 0.00 | 0.00 | 2.42 |
| B | 4.00 | 0.00 | 8.18 |
| C | 8.00 | 0.00 | 2.53 |

Einwirkung Nutz

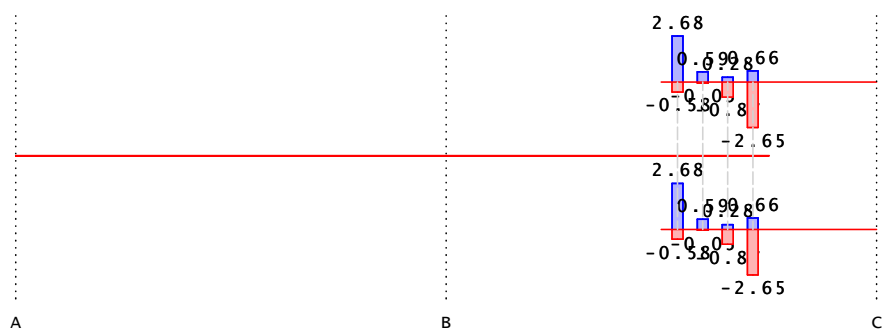
M 1:70

 Moment M_k [kNm]


M 1:70

 Querkraft V_k [kN]


M 1:70

 Schubkraft in Verbindungsmitteln V_k [kN]

 Holzbalken
Schnittgrößen

| Feld | x [m] | min M_k [kNm] | max M_k [kNm] | min V_k [kN] | max V_k [kN] |
|------|-------|-----------------|-----------------|----------------|----------------|
| 1 | 0.00 | 0.00 | 0.00 | -0.62 | 4.37 |
| | 1.75 | -1.09 | 3.83* | -0.62 | -0.00 |
| | 2.00 | -1.24 | 3.75 | -1.25 | -0.62 |
| | 4.00 | -4.99* | -2.49 | -6.25* | -0.62 |
| 2 | 0.00 | -4.99* | -2.49 | 0.63 | 6.25* |
| | 2.15 | -1.16 | 3.84* | 0.45 | 1.08 |
| | 2.15 | -1.16 | 3.84 | -4.90 | 1.78 |

| Feld | x [m] | min M_k [kNm] | max M_k [kNm] | min V_k [kN] | max V_k [kN] |
|------|----------|--------------------|--------------------|-------------------|-------------------|
| | 2.62 | -0.31 | 1.15 | -6.60* | 1.87 |
| | 2.62 | -0.31 | 1.15 | -4.86 | 1.31 |
| | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 |

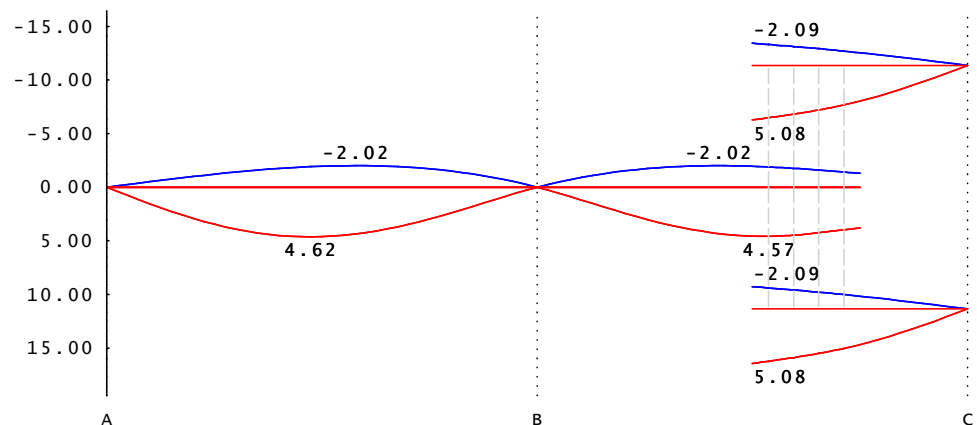
 Verstärkung
Schnittgrößen

| Feld | x [m] | min M_k [kNm] | max M_k [kNm] | min V_k [kN] | max V_k [kN] |
|------|----------|--------------------|--------------------|-------------------|-------------------|
| 2 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 2.38 | -0.13 | 0.57 | -0.58 | 2.42 |
| | 2.38 | -0.13 | 0.57 | -0.62 | 3.00* |
| | 2.85 | -0.36* | 1.70 | -0.34 | 1.81 |
| | 2.85 | -0.36* | 1.70* | -0.84 | 0.31 |
| | 4.00 | 0.00 | 0.00 | -2.19* | 0.31 |

 Verbindungsmittel
Schubkräfte

| Feld | x [m] | Verstärkung vorne | | Verstärkung hinten | |
|------|----------|-------------------|-------------------|--------------------|-------------------|
| | | min V_k [kN] | max V_k [kN] | min V_k [kN] | max V_k [kN] |
| 2 | 2.15 | -0.58 | 2.68 | -0.58 | 2.68 |
| | 2.38 | -0.05 | 0.59 | -0.05 | 0.59 |
| | 2.62 | -0.87 | 0.28 | -0.87 | 0.28 |
| | 2.85 | -2.65 | 0.66 | -2.65 | 0.66 |

M 1:70

 Verformung w_k [mm]

 Holzbalken
Verformungen

| Feld | x [m] | min w_k [mm] | max w_k [mm] |
|------|----------|-------------------|-------------------|
| 1 | 0.00 | 0.00 | 0.00 |
| | 1.89 | -1.92 | 4.62* |
| | 2.31 | -2.02* | 4.36 |
| | 4.00 | 0.00 | 0.00 |
| 2 | 0.00 | 0.00 | 0.00 |
| | 1.69 | -2.02* | 4.32 |
| | 2.15 | -1.90 | 4.57* |
| | 2.15 | -1.90 | 4.57 |

 Verstärkung
Verformungen

| Feld | x [m] | min w_k [mm] | max w_k [mm] |
|------|----------|-------------------|-------------------|
| 2 | 2.00 | -2.09* | 5.08* |
| | 4.00 | 0.00 | 0.00 |

Auflagerkräfte

| Aufl. | x [m] | min M_k [kNm] | max M_k [kNm] | min F_k [kN] | max F_k [kN] |
|-------|----------|--------------------|--------------------|-------------------|-------------------|
| A | 0.00 | 0.00 | 0.00 | -0.62 | 4.37 |
| B | 4.00 | 0.00 | 0.00 | 6.24 | 12.50 |
| C | 8.00 | 0.00 | 0.00 | -0.63 | 4.38 |

Kombinationen
ständige und vorübergehende Bemessungssituation

| Ek | Σ EW (Felder: 1 .. n) |
|----|----------------------------------|
| 3 | 1.35*ständig +1.50*Nutz (1) |
| 4 | 1.35*ständig +1.50*Nutz (2) |
| 9 | 1.35*ständig +1.50*Nutz (1,2) |

seltene Bemessungssituation

| Ek | Σ EW (Felder: 1 .. n) |
|----|--------------------------------|
| 17 | 1.00*ständig +1.00*Nutz (1) |
| 18 | 1.00*ständig +1.00*Nutz (2) |
| 19 | 1.00*ständig +1.00*Nutz (1) |
| 20 | 1.00*ständig +1.00*Nutz (2) |

Die kombinierten Verformungen enthalten schon die Kriechanteile k_{def} .

quasi-ständige Bemessungssituation

| Ek | Σ EW (Felder: 1 .. n) |
|----|--------------------------------|
| 21 | 1.00*ständig +0.30*Nutz (1) |
| 22 | 1.00*ständig +0.30*Nutz (2) |

Die kombinierten Verformungen enthalten schon die Kriechanteile k_{def} .

**Bemessung
Materialien**

| QS | Holz | $f_{m,k}$ | f_{t0k} | f_{c0k} | f_{c90k} | f_{vk} | E_{0mean} |
|----|--------|-----------|-----------|-----------|------------|----------|-------------|
| B1 | NH C24 | 24.0 | 14.0 | 21.0 | 2.5 | 2.0 | 11000 |
| V1 | NH C24 | 24.0 | 14.0 | 21.0 | 2.5 | 2.0 | 11000 |

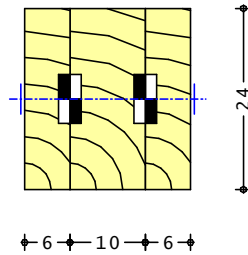
Querschnittswerte

| QS | b [cm] | h [cm] | A [cm ²] | I_y [cm ⁴] |
|----|-----------|-----------|-------------------------|-----------------------------|
| B1 | 10.0 | 24.0 | 240.0 | 11520.0 |
| V1 | 6.0 | 24.0 | 144.0 | 6912.0 |

Schnitt
M 1:10

Verstärkung 1

2*6/24, 2 Ringdübel Typ A1, dc = 65 mm



Verbindungsmittel

| QS | n | Art | Abmessung | Fk1 | Rk [kN] |
|----|---|----------------------------|-------------------|-----|---------|
| V1 | 4 | Ringdübel Typ A1 Bolzen | dc = 65 mm M12 | 4.8 | 13.44 |

Nachweise
Grenzzustand der Tragfähigkeit

Holz balken

Biegebemessung
DIN 1052, Gl.(55),
Gl.(67)

| F | x [m] | Ek | k _{mod} [-] | M _{yd} [kNm] | σ _{myd} [N/mm ²] | f _{myd} [N/mm ²] | η [-] |
|----------------|-------|----|----------------------|-----------------------|---------------------------------------|---------------------------------------|-------|
| 1 (L = 4.00 m) | 0.00 | - | - | 0.00 | 0.00 | - | 0.00 |
| | 4.00 | 9 | 0.80 | -11.92 | 12.41 | 14.77 | 0.84* |
| | 3.00 | - | - | 0.00 | 0.00 | - | 0.00 |

Querkraftbemessung
DIN 1052, Gl.(59)

| F | x [m] | Ek | k _{mod} [-] | V _{zd} [kN] | τ _{zd} [N/mm ²] | f _{zd} [N/mm ²] | η [-] |
|---|-------|----|----------------------|----------------------|--------------------------------------|--------------------------------------|-------|
| 1 | 0.32 | 3 | 0.80 | 7.93 | 0.50 | 1.23 | 0.40 |
| | 3.64 | 9 | 0.80 | -12.72 | 0.79 | 1.23 | 0.65* |
| 2 | 0.36 | 9 | 0.80 | 12.79 | 0.80 | 1.23 | 0.65 |
| | 2.62 | 4 | 0.80 | -14.29 | 1.01 | 1.23 | 0.82* |
| | 3.00 | - | - | 0.00 | 0.00 | - | 0.00 |

Auflagerpressung
DIN 1052, Gl.(47)

| | Ek | k _{mod} [-] | F _d [kN] | A _{ef} [cm ²] | k _{c90} [-] | σ _{c90d} [N/mm ²] | f _{c90d} [N/mm ²] | η [-] |
|---|----|----------------------|---------------------|------------------------------------|----------------------|--|--|-------|
| A | 3 | 0.80 | 9.83 | 270.0 | 1.50 | 0.36 | 2.31 | 0.16 |
| B | 9 | 0.80 | 29.78 | 300.0 | 1.50 | 0.99 | 2.31 | 0.43 |

Verstärkung

Biegebemessung
DIN 1052, Gl.(55),
Gl.(67)

| F | x [m] | Ek | k _{mod} [-] | M _{yd} [kNm] | σ _{myd} [N/mm ²] | f _{myd} [N/mm ²] | η [-] |
|----------------|-------|----|----------------------|-----------------------|---------------------------------------|---------------------------------------|-------|
| 2 (L = 4.00 m) | 2.00 | - | - | 0.00 | 0.00 | - | 0.00 |
| | 2.85 | 4 | 0.80 | 3.78 | 6.60 | 14.77 | 0.45* |
| | 4.00 | - | - | 0.00 | 0.00 | - | 0.00 |

Querkraftbemessung
DIN 1052, Gl.(59)

| F | x [m] | Ek | k _{mod} [-] | V _{zd} [kN] | τ _{zd} [N/mm ²] | f _{zd} [N/mm ²] | η [-] |
|---|-------|----|----------------------|----------------------|--------------------------------------|--------------------------------------|-------|
| 2 | 2.00 | - | - | 0.00 | 0.00 | - | 0.00 |
| | 2.38 | 4 | 0.80 | 6.70 | 0.77 | 1.23 | 0.63* |
| | 3.68 | 4 | 0.80 | -4.04 | 0.42 | 1.23 | 0.34 |

Verbindungsmittel
 DIN 1052

Werte pro Scherfuge

| QS | x [m] | Ek | k _{mod} [-] | γ _M [-] | Abst. | F _d [kN] | R _d [kN] | η [-] |
|----|----------|----|-------------------------|-----------------------|-------|------------------------|------------------------|----------|
| v1 | 0.15 | 4 | 0.80 | 1.30 | ok | 5.96 | 8.27 | 0.72 |
| | 0.38 | 4 | 0.80 | 1.30 | ok | 1.38 | 8.27 | 0.17 |
| | 0.62 | 4 | 0.80 | 1.30 | ok | -1.86 | 8.27 | 0.22 |
| | 0.85 | 4 | 0.80 | 1.30 | ok | -5.82 | 8.27 | 0.70 |

Grenzzustand der Gebrauchstauglichkeit

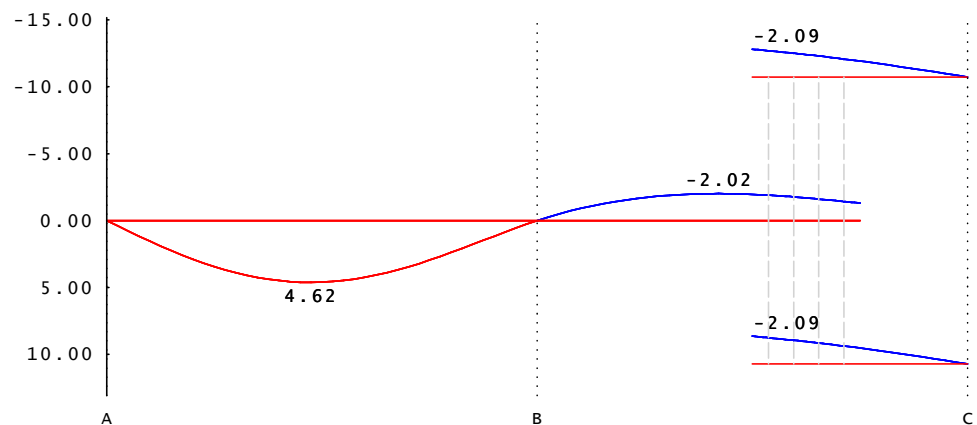
Holzbalken

 max. Verformungen
 DIN 1052, 9.2

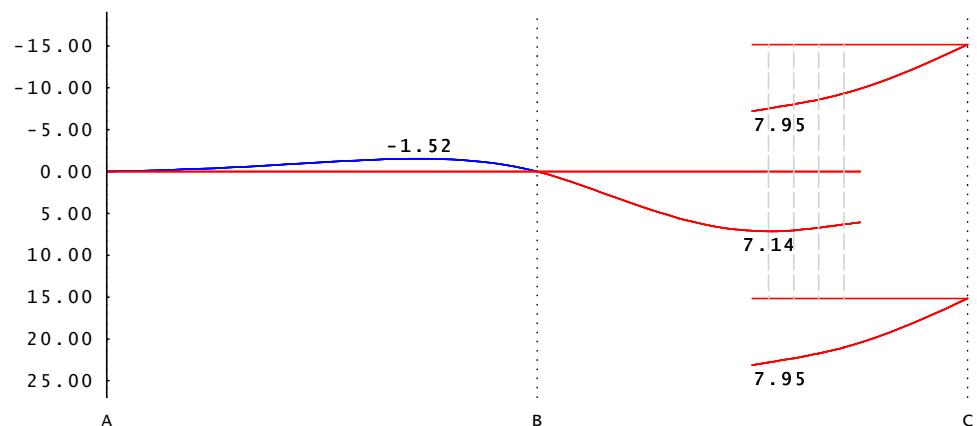
| | x [m] | Ek | vorhw [mm] | zulw [mm] | η [-] |
|---|----------|----|---------------|--------------|----------|
| Feld 1 (L = 4.00 m, NKL 2, kdef = 0.80) | | | | | |
| G1(40) | 1.89 | 17 | 4.6 | 13.3 | 0.35 |
| G1(41) | 1.80 | 19 | 7.1 | 20.0 | 0.35 |
| G1(42) | 1.80 | 21 | 5.6 | 20.0 | 0.28 |
| Feld 2 (L = 4.00 m, NKL 2, kdef = 0.80) | | | | | |
| G1(40) | 2.15 | 18 | 4.6 | 13.3 | 0.34 |
| G1(41) | 2.15 | 20 | 7.1 | 20.0 | 0.36 |
| G1(42) | 2.20 | 22 | 5.8 | 20.0 | 0.29 |

 elastische Durchbiegung [mm] (Gleichung 40: $w_{Q,inst}$)

M 1:70


 Enddurchbiegung [mm] (Gleichung 41: $w_{fin} - w_{G,inst}$)

M 1:70



M 1:70

Durchhang [mm] (Gleichung 42: $w_{fin} - w_0$)

