ALGEMEEN

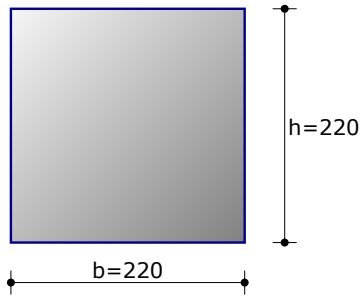
Bestand : C:\Users\Rob\Dropbox\Struct4U\helpdesk\2025\2709\2709a.xcst

Gevolgklasse : CC2

FUNDERINGSPAAL: Funderingspaal

Paal 1

Type paal	Betonpaal
Specificatie	Geprefabriceerd, met constante dwarsafmeting.
Wijze van installeren	Geheid (grondverdringend)
Paallengte	11,1 m
Factoren	α_p=0,70 α_s=0,01 α_t=0,007 Lastzakkingslijn:1



Paalknopniveau	-0,50 m
Paalpuntniveau	10,60 m
Waterniveau	0,50 m
Ontgravingsniveau	0,00 m
Niv. negatieve/positieve kleef	5,00 m

Geen paalgroep

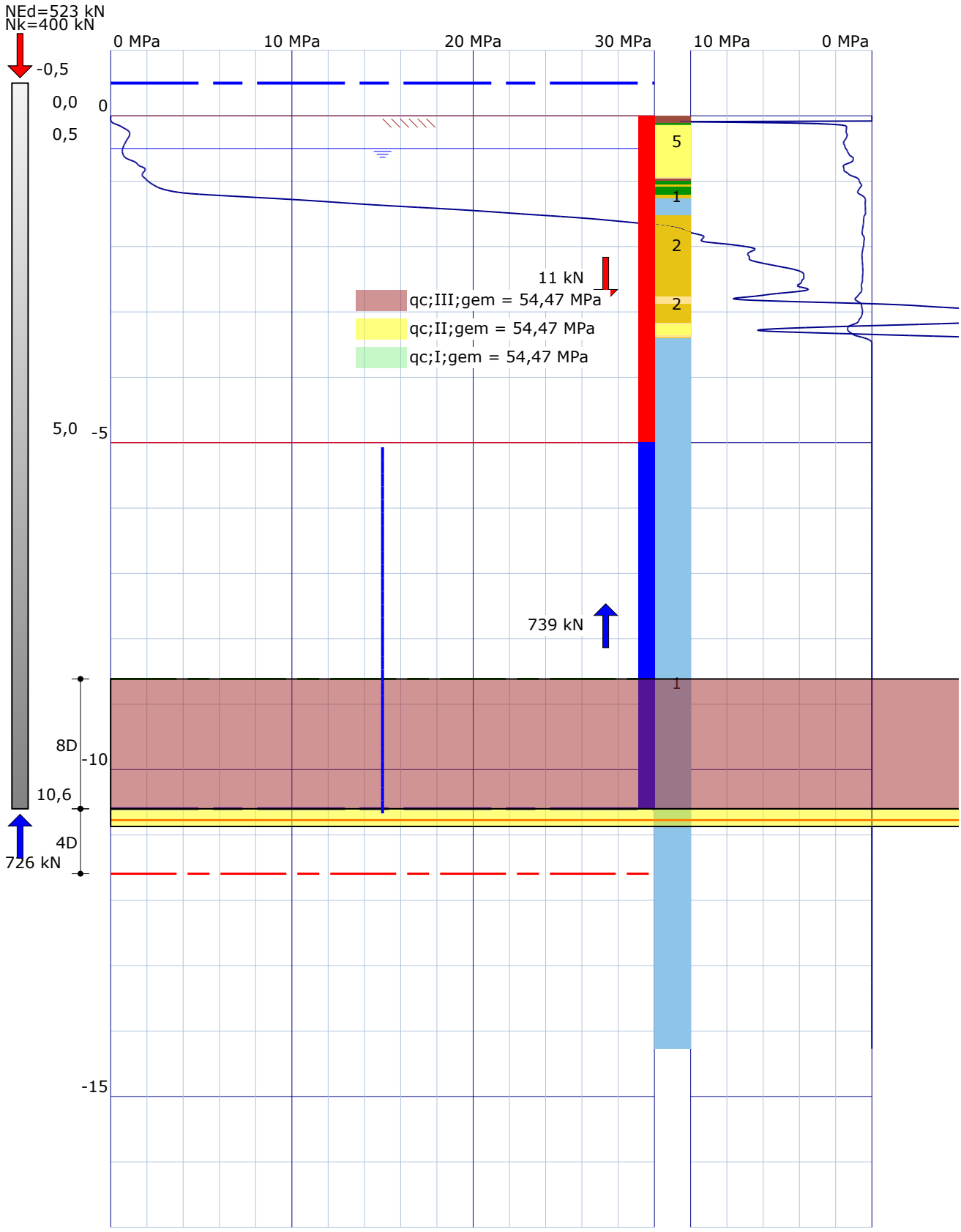
Grondsoorten

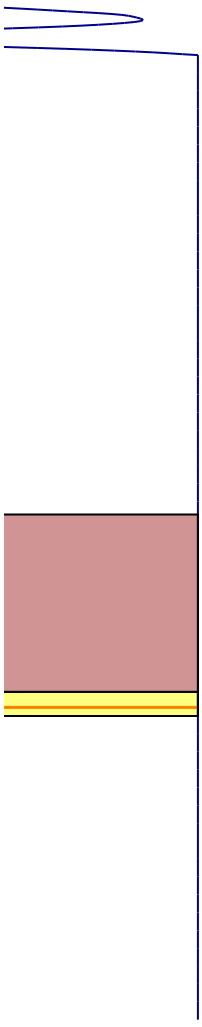
		Grondsoort	γk;min [kN/m3]	γk;max [kN/m3]	γsat;k;min [kN/m3]	γsat;k;max [kN/m3]
1		Grind; Zwak siltig; Los	17	17	19	19
2		Zand; Schoon; Los	17	17	19	19
3		Zand; Schoon; Vast	19	20	21	22
4		Zand; Sterk siltig kleiig	18	19	20	21
5		Zand; Zwak siltig kleiig	18	19	20	21
7		Klei; Schoon; Vast	19	20	19	20
8		Klei; Schoon; Matig	17	17	17	17
9		Klei; Schoon; Slap	14	14	14	14
10		Klei; Schoon; Slap	14	14	14	14
12		Veen; Niet voorbelast; Slap	10	12	10	12

Berekening

D_{eq} = 248 mm

Sondering: 01





Negatieve kleef art. 7.3.2.2 (d)

$\Delta L_{nk} = 5$ m

$$F_{nk;rep} = O_{s;gem} . K_0 \tan(\delta) . \Sigma \left(\frac{\sigma_{v,i-1} + \sigma_{v,i1}}{2} . h_i \right) = 0,88 \times 0,25 \times 52 = 11 \text{ kN}$$

$$F_{nk;d} = \gamma_{f,nk} . F_{nk;rep} = 1,00 \times 11 = 11 \text{ kN}$$

Puntdraagvermogen art. 7.6.2.3 (e)

$$q_{b;max;1} = \frac{1}{2} . \alpha_p . \beta . s. \left(\frac{q_{c;I;gem} + q_{c;II;gem}}{2} + q_{c;III;gem} \right) =$$

$$= \frac{1}{2} \times 0,70 \times 1,0 \times 1,0 \times \left(\frac{54,47 + 54,47}{2} + 54,47 \right) = 38,13 \text{ MPa} > 15,00 \text{ MPa}$$

$$R_{b;cal;max;1} = A_b . q_{b;max;1} = 48400 \times 15,00 \times 10^{-3} = 726 \text{ kN}$$

Maximumschachtwrijving art. 7.6.2.3 (c)

$\Delta L = 5,6$ m

$$R_{s;cal;max;1} = O_{s;gem} . \alpha_s . \Sigma \left(q_{c;j;gem} . h_j \right) = 0,88 \times 0,01 \times 84000 = 739 \text{ kN}$$

Maximum gronddraagvermogen van de paal art. 7.6.2.3 (3)

$$R_{c;cal;1} = R_{b;cal;max;1} + R_{s;cal;max;1} = 726 + 739 = 1465 \text{ kN} \quad ...(7.6)$$

Berekening van de zakking van de paal art. 7.6.4.2 (4)

$$F_{c;tot;1} = N_k + F_{nk;1} = 400 + 11 = 411 \text{ kN}$$

Lastzakkingslijn 1:

$$\frac{s_{b;1}}{D_{eq}} \times 100 = \frac{0,6}{248} \times 100 = 0,2\% \rightarrow R_{b;1} = 25\% R_{b;cal;max;1} = \frac{25}{100} \times 726 = 164 \text{ kN} \quad ...(\text{Figuur 7.n})$$

$$s_{b;1} = 0,6 \text{ mm} \rightarrow R_{s;1} = 33\% R_{s;cal;max;1} = \frac{33}{100} \times 739 = 247 \text{ kN} \quad ...(\text{Figuur 7.o})$$

$$F_{gem;1} = \frac{l.F_{c;tot;1} + 0,5 . \Delta L.(F_{c;tot;1} - R_{b;1})}{L} = \frac{5,5 \times 411 + 0,5 \times 5,6 \times (411 - 164)}{11,1} = 266 \text{ kN}$$

$$s_{el;1} = \frac{L.F_{gem;1}}{EA} = \frac{11,1 \times 266 \times 10^3}{1742400} = 1,7 \text{ mm} \quad \text{art. 7.6.4.2 (j)}$$

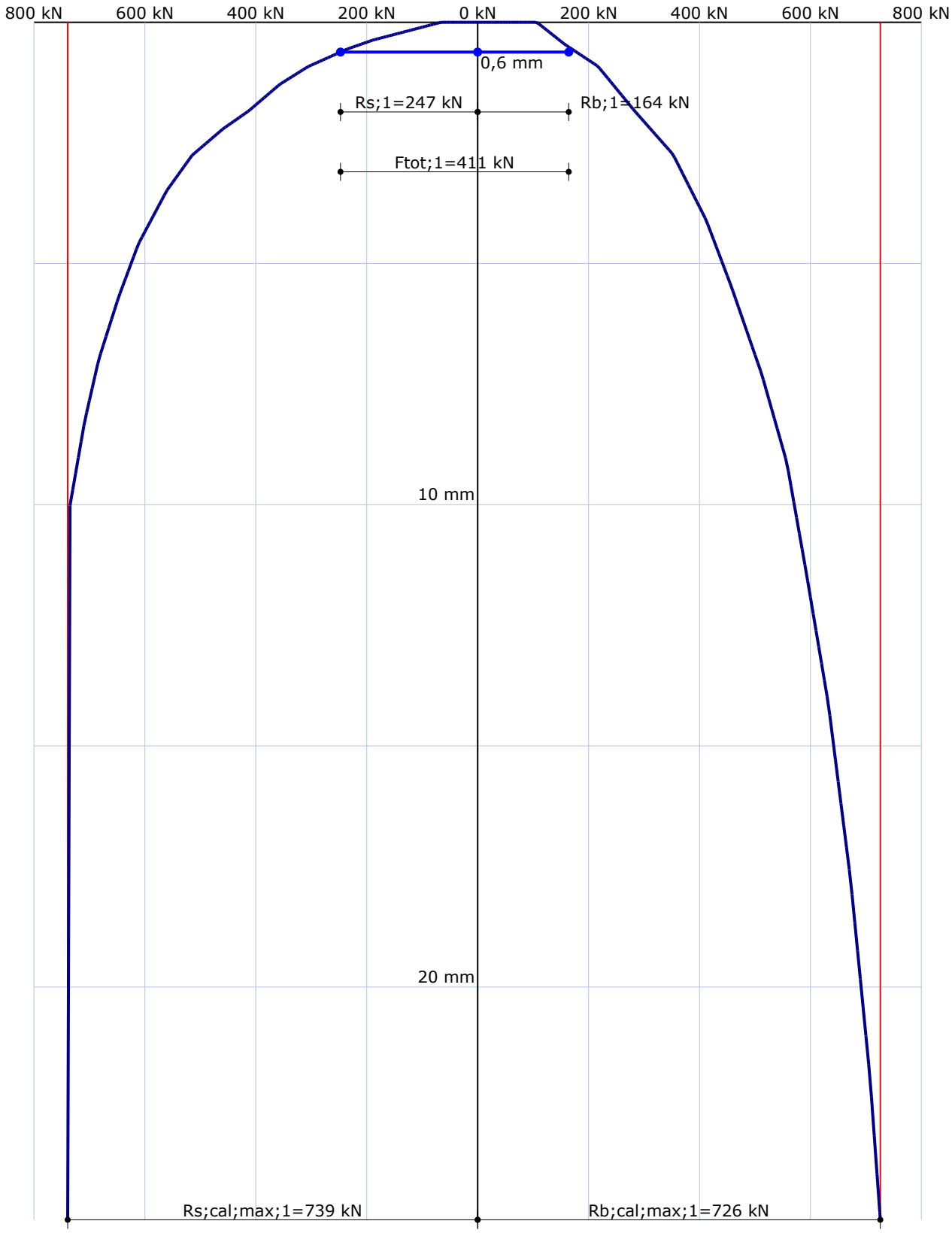
$$s_{1;1} = s_{b;1} + s_{el;1} = 0,6 + 1,7 = 2,3 \text{ mm}$$

$$s_1 = s_{1;1} + s_{2;1} = 2,3 + 0,0 = 2,3 \text{ mm}$$

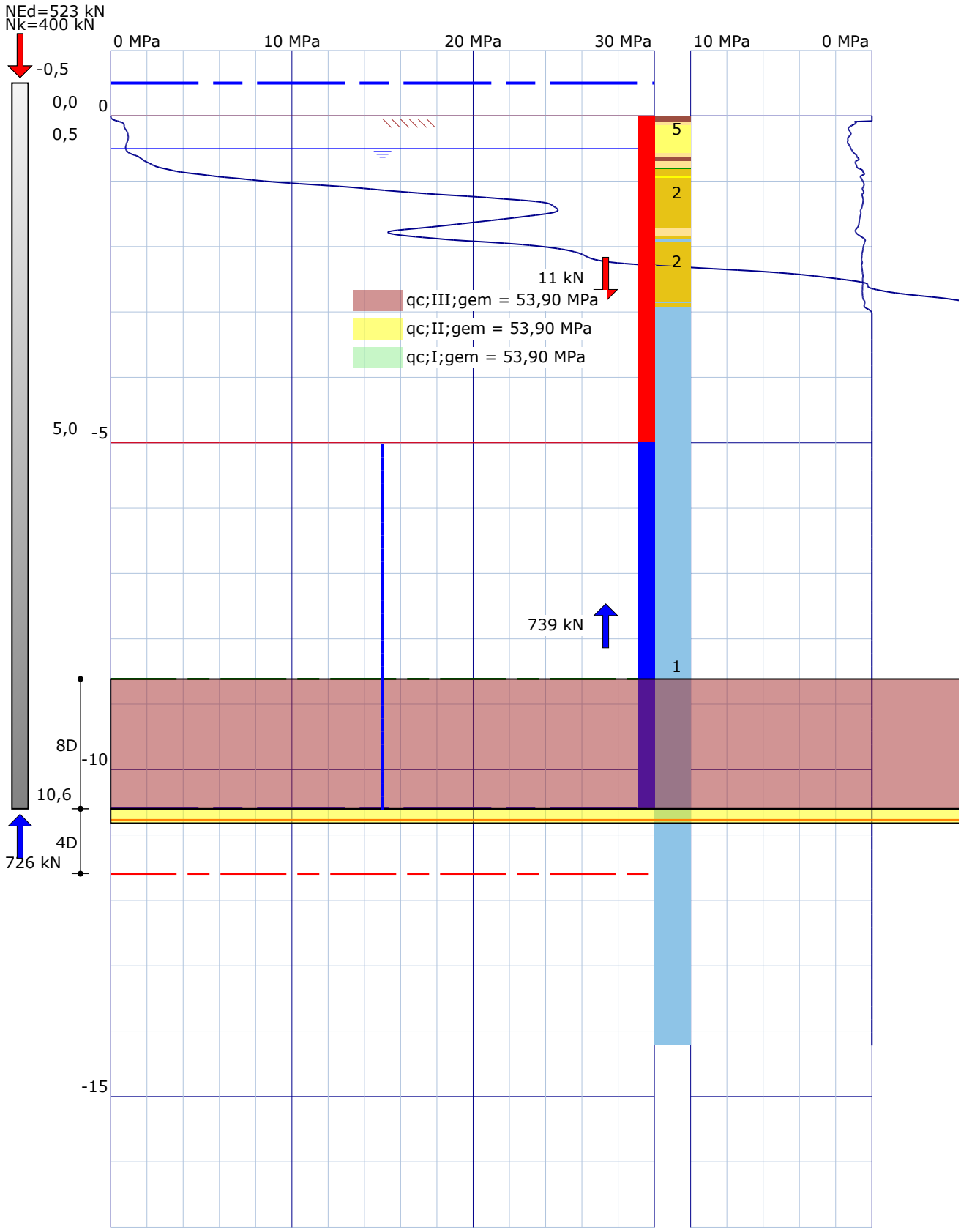
Veerwaarde

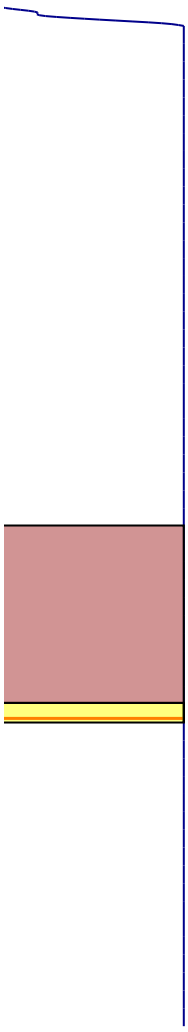
$$k_1 = \frac{F_{c;tot;1}}{s_1} = \frac{411 \times 10^3}{2,3} = 177852 \text{ kN/m}$$

$$k_{min;1} = \frac{k_1}{\sqrt{2}} = \frac{177852}{\sqrt{2}} = 125761 \text{ kN/m} \qquad k_{max;1} = k_1 . \sqrt{2} = 177852 \times \sqrt{2} = 251521 \text{ kN/m}$$


800 kN
600 kN
400 kN
200 kN
0 kN
200 kN
400 kN
600 kN
800 kN
0,6 mm
Rs;1=247 kN
Rb;1=164 kN
Ftot;1=411 kN
10 mm
20 mm
Rs;cal;max;1=739 kN
Rb;cal;max;1=726 kN

Sondering: 02





Negatieve kleef art. 7.3.2.2 (d)

$\Delta L_{nk} = 5$ m

$$F_{nk;rep} = O_{s;gem} . K_0 \tan(\delta) . \Sigma \left(\frac{\sigma_{v,i-1} + \sigma_{v,i1}}{2} . h_i \right) = 0,88 \times 0,25 \times 51 = 11 \text{ kN}$$

$$F_{nk;d} = \gamma_{f,nk} . F_{nk;rep} = 1,00 \times 11 = 11 \text{ kN}$$

Puntdraagvermogen art. 7.6.2.3 (e)

$$q_{b;max;2} = \frac{1}{2} . \alpha_p . \beta . s. \left(\frac{q_{c;I;gem} + q_{c;II;gem}}{2} + q_{c;III;gem} \right) =$$

$$= \frac{1}{2} \times 0,70 \times 1,0 \times 1,0 \times \left(\frac{53,90 + 53,90}{2} + 53,90 \right) = 37,73 \text{ MPa} > 15,00 \text{ MPa}$$

$$R_{b;cal;max;2} = A_b . q_{b;max;2} = 48400 \times 15,00 \times 10^{-3} = 726 \text{ kN}$$

Maximumschachtwrijving art. 7.6.2.3 (c)

$\Delta L = 5,6$ m

$$R_{s;cal;max;2} = O_{s;gem} . \alpha_s . \Sigma \left(q_{c;j;gem} . h_j \right) = 0,88 \times 0,01 \times 84000 = 739 \text{ kN}$$

Maximum gronddraagvermogen van de paal art. 7.6.2.3 (3)

$$R_{c;cal;2} = R_{b;cal;max;2} + R_{s;cal;max;2} = 726 + 739 = 1465 \text{ kN} \quad ...(7.6)$$

Berekening van de zakking van de paal art. 7.6.4.2 (4)

$$F_{c;tot;2} = N_k + F_{nk;2} = 400 + 11 = 411 \text{ kN}$$

Lastzakkingslijn 1:

$$\frac{s_{b;2}}{D_{eq}} \times 100 = \frac{0,6}{248} \times 100 = 0,2\% \rightarrow R_{b;2} = 25\% R_{b;cal;max;2} = \frac{25}{100} \times 726 = 164 \text{ kN} \quad ...(\text{Figuur 7.n})$$

$$s_{b;2} = 0,6 \text{ mm} \rightarrow R_{s;2} = 33\% R_{s;cal;max;2} = \frac{33}{100} \times 739 = 247 \text{ kN} \quad ...(\text{Figuur 7.o})$$

$$F_{gem;2} = \frac{l.F_{c;tot;2} + 0,5 . \Delta L.(F_{c;tot;2} - R_{b;2})}{L} = \frac{5,5 \times 411 + 0,5 \times 5,6 \times (411 - 164)}{11,1} = 266 \text{ kN}$$

$$s_{el;2} = \frac{L.F_{gem;2}}{EA} = \frac{11,1 \times 266 \times 10^3}{1742400} = 1,7 \text{ mm} \quad \text{art. 7.6.4.2 (j)}$$

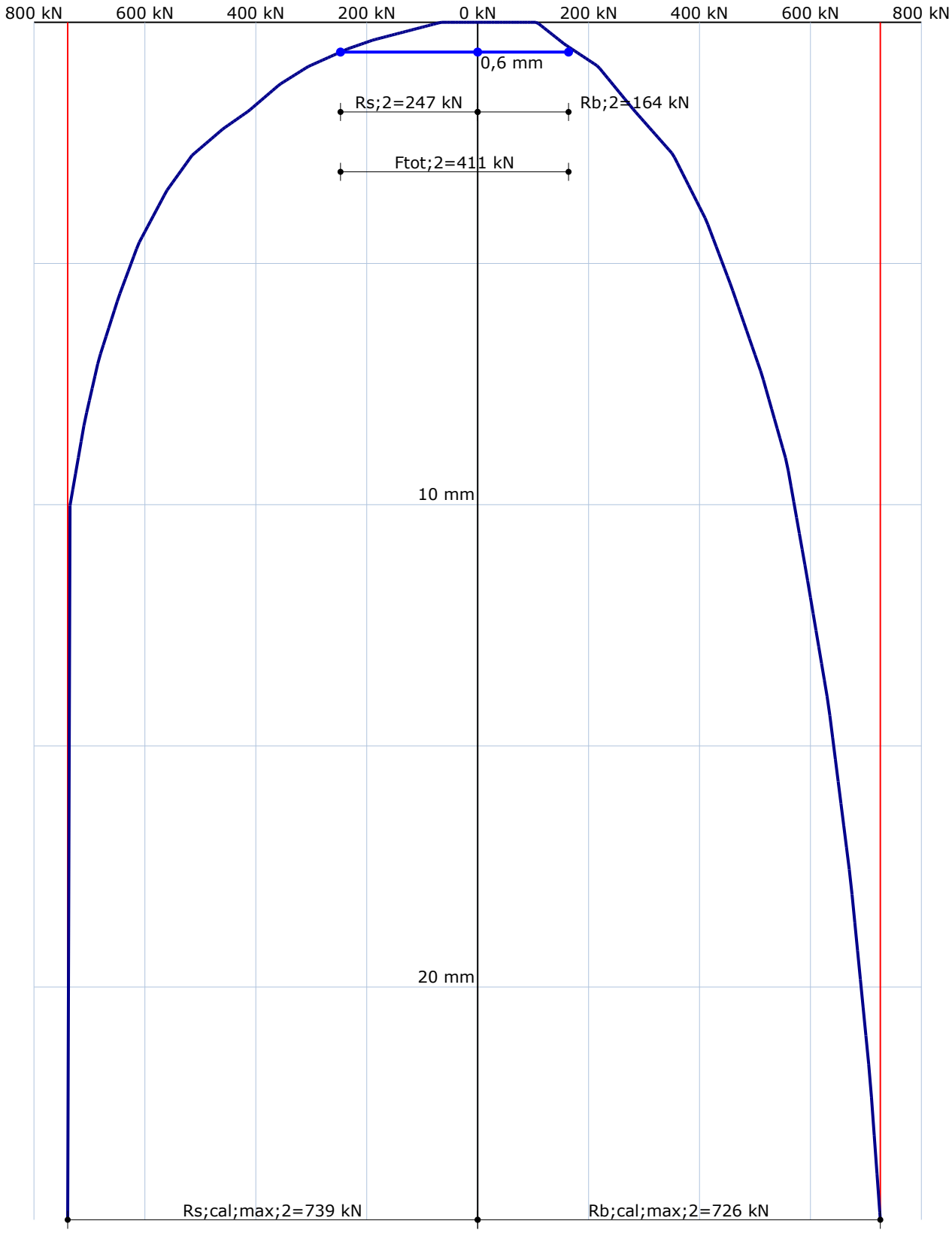
$$s_{1;2} = s_{b;2} + s_{el;2} = 0,6 + 1,7 = 2,3 \text{ mm}$$

$$s_2 = s_{1;2} + s_{2;2} = 2,3 + 0,0 = 2,3 \text{ mm}$$

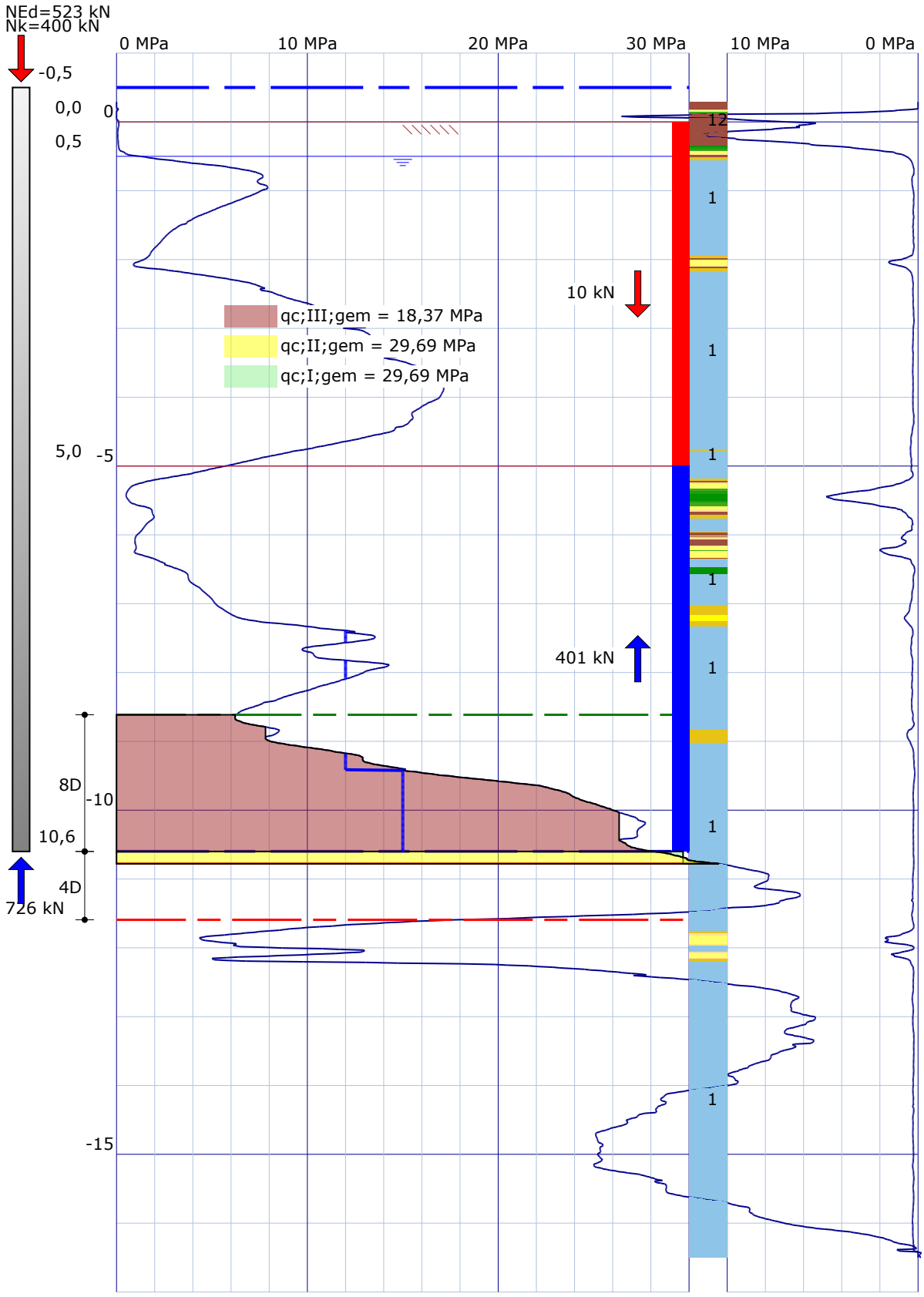
Veerwaarde

$$k_2 = \frac{F_{c;tot;2}}{s_2} = \frac{411 \times 10^3}{2,3} = 177793 \text{ kN/m}$$

$$k_{min;2} = \frac{k_2}{\sqrt{2}} = \frac{177793}{\sqrt{2}} = 125719 \text{ kN/m} \qquad k_{max;2} = k_2 . \sqrt{2} = 177793 \times \sqrt{2} = 251437 \text{ kN/m}$$


800 kN
600 kN
400 kN
200 kN
0 kN
200 kN
400 kN
600 kN
800 kN
0,6 mm
Rs;2=247 kN
Rb;2=164 kN
Ftot;2=411 kN
10 mm
20 mm
Rs;cal;max;2=739 kN
Rb;cal;max;2=726 kN

Sondering: 15854_S01



Negatieve kleef art. 7.3.2.2 (d)

$\Delta L_{nk} = 5$ m

$$F_{nk;rep} = O_{s;gem} . K_0 \tan(\delta) . \Sigma \left(\frac{\sigma_{v,i-1} + \sigma_{v,i1}}{2} . h_i \right) = 0,88 \times 0,25 \times 48 = 10 \text{ kN}$$

$$F_{nk;d} = \gamma_{f,nk} . F_{nk;rep} = 1,00 \times 10 = 10 \text{ kN}$$

Puntdraagvermogen art. 7.6.2.3 (e)

$$q_{b;max;3} = \frac{1}{2} . \alpha_p . \beta . s. \left(\frac{q_{c;I;gem} + q_{c;II;gem}}{2} + q_{c;III;gem} \right) =$$

$$= \frac{1}{2} \times 0,70 \times 1,0 \times 1,0 \times \left(\frac{29,69 + 29,69}{2} + 18,37 \right) = 16,82 \text{ MPa} > 15,00 \text{ MPa}$$

$$R_{b;cal;max;3} = A_b . q_{b;max;3} = 48400 \times 15,00 \times 10^{-3} = 726 \text{ kN}$$

Maximumschachtwrijving art. 7.6.2.3 (c)

$\Delta L = 5,6$ m

$$R_{s;cal;max;3} = O_{s;gem} . \alpha_s . \Sigma \left(q_{c;j;gem} . h_j \right) = 0,88 \times 0,01 \times 45574 = 401 \text{ kN}$$

Maximum gronddraagvermogen van de paal art. 7.6.2.3 (3)

$$R_{c;cal;3} = R_{b;cal;max;3} + R_{s;cal;max;3} = 726 + 401 = 1127 \text{ kN} \quad ...(7.6)$$

Berekening van de zakking van de paal art. 7.6.4.2 (4)

$$F_{c;tot;3} = N_k + F_{nk;3} = 400 + 10 = 410 \text{ kN}$$

Lastzakkingslijn 1:

$$\frac{s_{b;3}}{D_{eq}} \times 100 = \frac{1,1}{248} \times 100 = 0,4\% \rightarrow R_{b;3} = 32\% R_{b;cal;max;3} = \frac{32}{100} \times 726 = 231 \text{ kN} \quad ...(\text{Figuur 7.n})$$

$$s_{b;3} = 1,1 \text{ mm} \rightarrow R_{s;3} = 45\% R_{s;cal;max;3} = \frac{45}{100} \times 401 = 179 \text{ kN} \quad ...(\text{Figuur 7.o})$$

$$F_{gem;3} = \frac{l.F_{c;tot;3} + 0,5 . \Delta L.(F_{c;tot;3} - R_{b;3})}{L} = \frac{5,5 \times 410 + 0,5 \times 5,6 \times (410 - 231)}{11,1} = 249 \text{ kN}$$

$$s_{el;3} = \frac{L.F_{gem;3}}{EA} = \frac{11,1 \times 249 \times 10^3}{1742400} = 1,6 \text{ mm} \quad \text{art. 7.6.4.2 (j)}$$

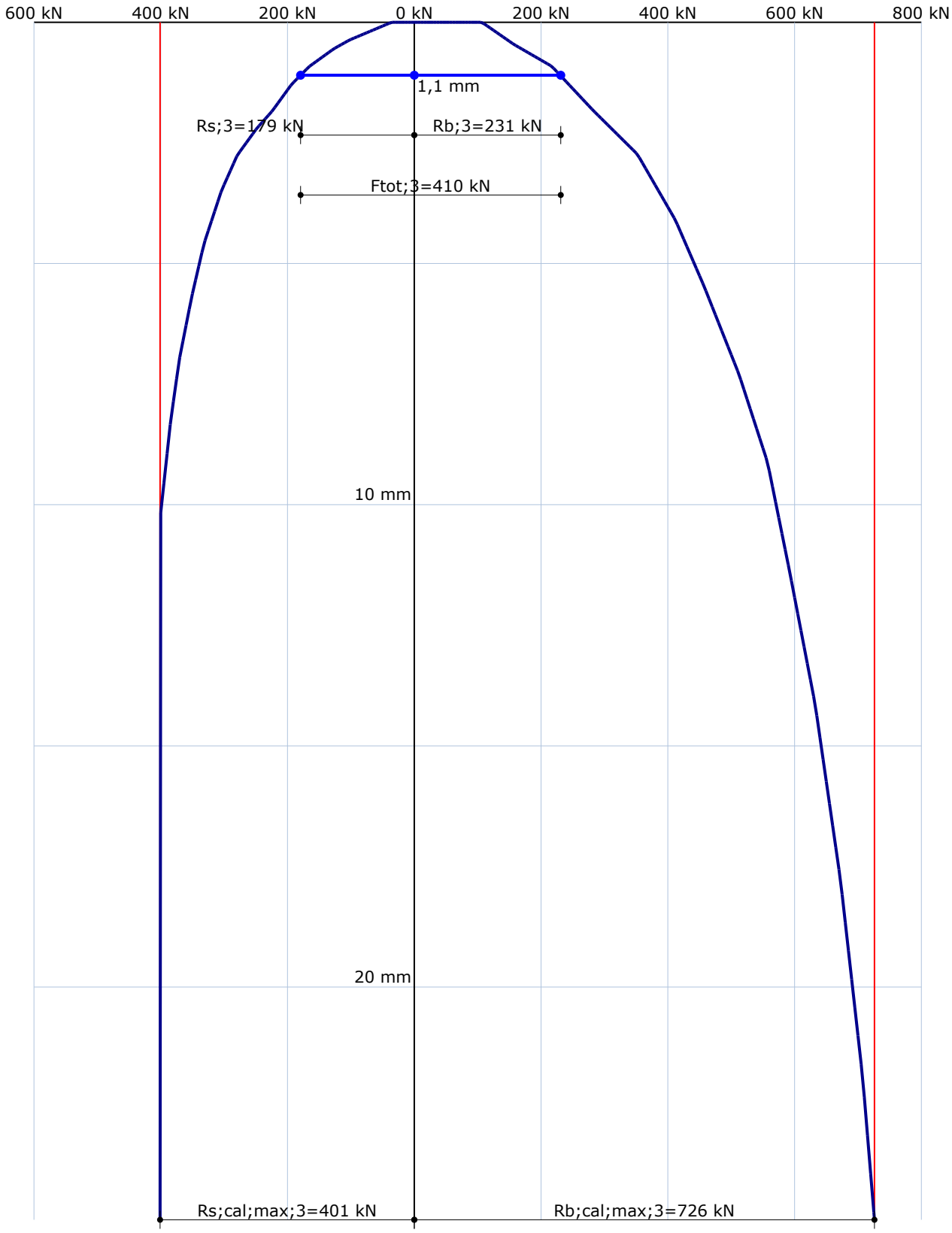
$$s_{1;3} = s_{b;3} + s_{el;3} = 1,1 + 1,6 = 2,7 \text{ mm}$$

$$s_3 = s_{1;3} + s_{2;3} = 2,7 + 0,0 = 2,7 \text{ mm}$$

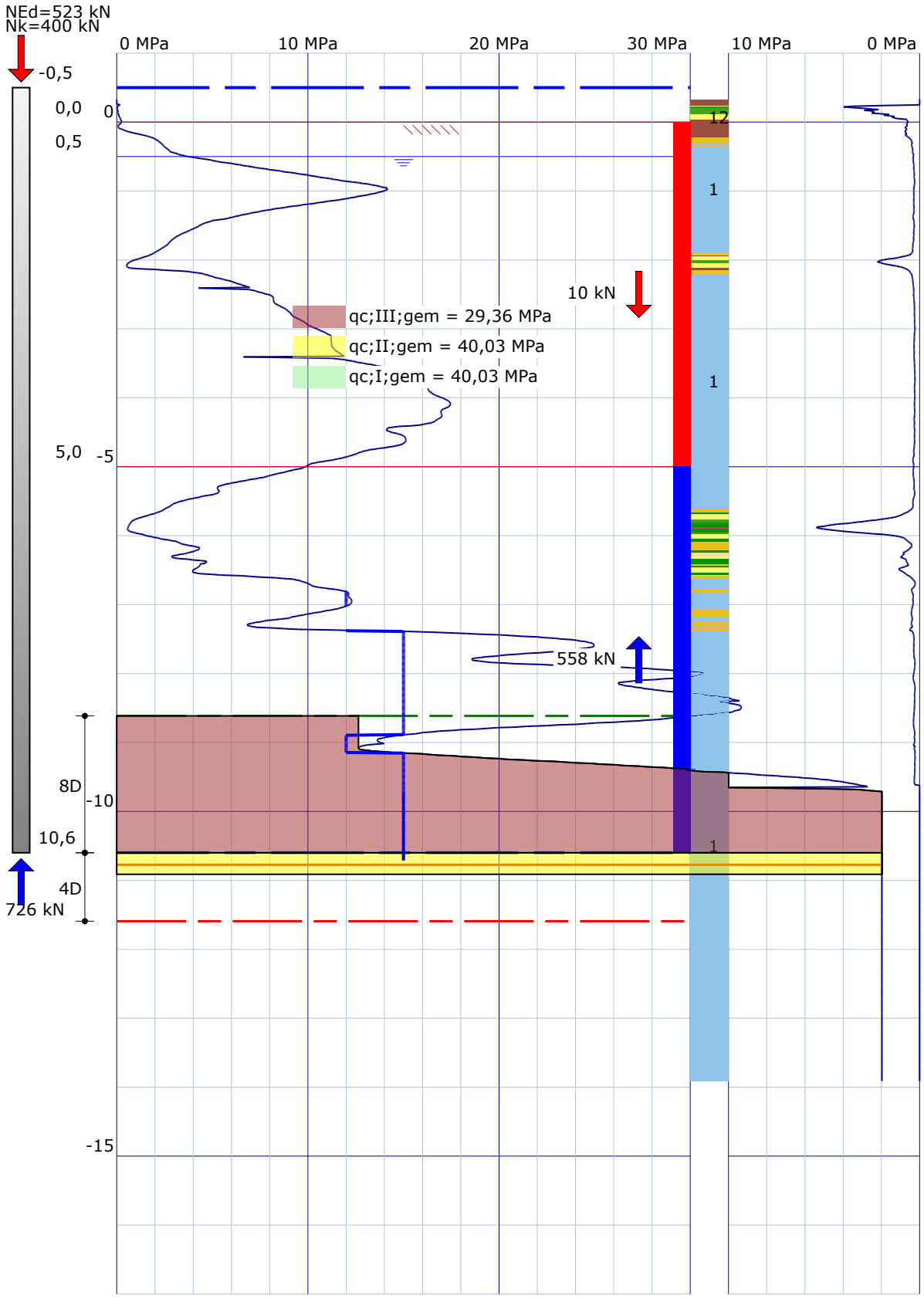
Veerwaarde

$$k_3 = \frac{F_{c;tot;3}}{s_3} = \frac{410 \times 10^3}{2,7} = 153082 \text{ kN/m}$$

$$k_{min;3} = \frac{k_3}{\sqrt{2}} = \frac{153082}{\sqrt{2}} = 108245 \text{ kN/m} \qquad k_{max;3} = k_3 . \sqrt{2} = 153082 \times \sqrt{2} = 216490 \text{ kN/m}$$


600 kN
400 kN
200 kN
0 kN
200 kN
400 kN
600 kN
800 kN
1,1 mm
Rs;3=179 kN
Rb;3=231 kN
Ftot;3=410 kN
10 mm
20 mm
Rs;cal;max;3=401 kN
Rb;cal;max;3=726 kN

Sondering: 15854_S02



Negatieve kleef art. 7.3.2.2 (d)

$\Delta L_{nk} = 5$ m

$$F_{nk;rep} = O_{s;gem} . K_0 \tan(\delta) . \Sigma \left(\frac{\sigma_{v,i-1} + \sigma_{v,i1}}{2} . h_i \right) = 0,88 \times 0,25 \times 47 = 10 \text{ kN}$$

$$F_{nk;d} = \gamma_{f,nk} . F_{nk;rep} = 1,00 \times 10 = 10 \text{ kN}$$

Puntdraagvermogen art. 7.6.2.3 (e)

$$q_{b;max;4} = \frac{1}{2} . \alpha_p . \beta . s. \left(\frac{q_{c;I;gem} + q_{c;II;gem}}{2} + q_{c;III;gem} \right) =$$

$$= \frac{1}{2} \times 0,70 \times 1,0 \times 1,0 \times \left(\frac{40,03 + 40,03}{2} + 29,36 \right) = 24,29 \text{ MPa} > 15,00 \text{ MPa}$$

$$R_{b;cal;max;4} = A_b . q_{b;max;4} = 48400 \times 15,00 \times 10^{-3} = 726 \text{ kN}$$

Maximumschachtwrijving art. 7.6.2.3 (c)

$\Delta L = 5,6$ m

$$R_{s;cal;max;4} = O_{s;gem} . \alpha_s . \Sigma \left(q_{c;j;gem} . h_j \right) = 0,88 \times 0,01 \times 63452 = 558 \text{ kN}$$

Maximum gronddraagvermogen van de paal art. 7.6.2.3 (3)

$$R_{c;cal;4} = R_{b;cal;max;4} + R_{s;cal;max;4} = 726 + 558 = 1284 \text{ kN} \quad ...(7.6)$$

Berekening van de zakking van de paal art. 7.6.4.2 (4)

$$F_{c;tot;4} = N_k + F_{nk;4} = 400 + 10 = 410 \text{ kN}$$

Lastzakkingslijn 1:

$$\frac{s_{b;4}}{D_{eq}} \times 100 = \frac{0,8}{248} \times 100 = 0,3\% \rightarrow R_{b;4} = 27\% R_{b;cal;max;4} = \frac{27}{100} \times 726 = 203 \text{ kN} \quad ...(\text{Figuur 7.n})$$

$$s_{b;4} = 0,8 \text{ mm} \rightarrow R_{s;4} = 37\% R_{s;cal;max;4} = \frac{37}{100} \times 558 = 207 \text{ kN} \quad ...(\text{Figuur 7.o})$$

$$F_{gem;4} = \frac{l.F_{c;tot;4} + 0,5 . \Delta L.(F_{c;tot;4} - R_{b;4})}{L} = \frac{5,5 \times 410 + 0,5 \times 5,6 \times (410 - 203)}{11,1} = 256 \text{ kN}$$

$$s_{el;4} = \frac{L.F_{gem;4}}{EA} = \frac{11,1 \times 256 \times 10^3}{1742400} = 1,6 \text{ mm} \quad \text{art. 7.6.4.2 (j)}$$

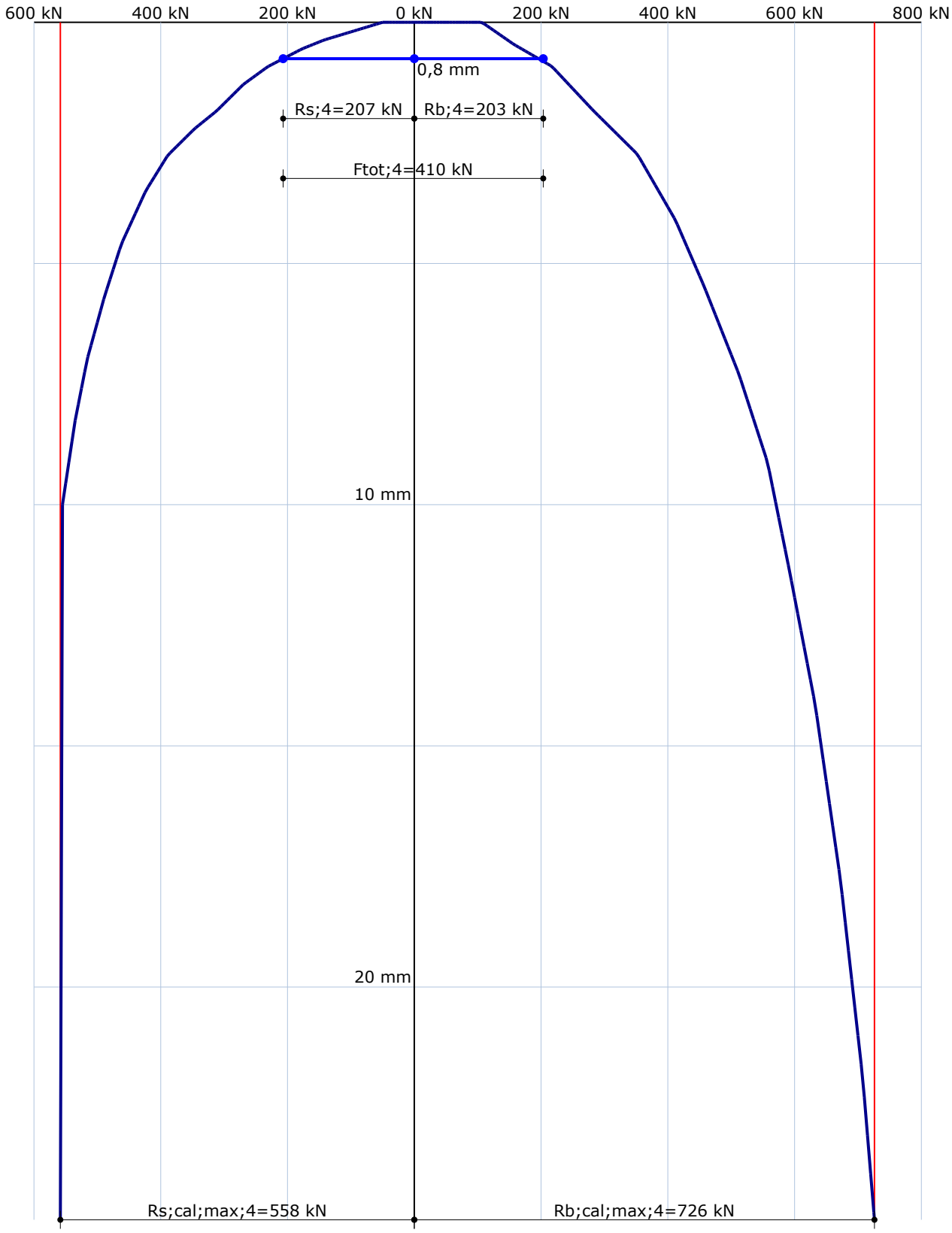
$$s_{1;4} = s_{b;4} + s_{el;4} = 0,8 + 1,6 = 2,4 \text{ mm}$$

$$s_4 = s_{1;4} + s_{2;4} = 2,4 + 0,0 = 2,4 \text{ mm}$$

Veerwaarde

$$k_4 = \frac{F_{c;tot;4}}{s_4} = \frac{410 \times 10^3}{2,4} = 172253 \text{ kN/m}$$

$$k_{min;4} = \frac{k_4}{\sqrt{2}} = \frac{172253}{\sqrt{2}} = 121801 \text{ kN/m} \qquad k_{max;4} = k_4 . \sqrt{2} = 172253 \times \sqrt{2} = 243603 \text{ kN/m}$$


600 kN
400 kN
200 kN
0 kN
200 kN
400 kN
600 kN
800 kN
0,8 mm
Rs;4=207 kN
Rb;4=203 kN
Ftot;4=410 kN
10 mm
20 mm
Rs;cal;max;4=558 kN
Rb;cal;max;4=726 kN

Berekening netto maatgevend paaldraagvermogen art. 7.6.2.3 (5)

Aantal sonderingen n = 4

Type bouwwerk: Niet-stijf

$$\text{Variatiecoëfficient VC} = \frac{\sigma}{(R_{c;cal})_{gem}} \times 100\% = \frac{163}{1335} \times 100\% = 12{,}2\% > 12\% \rightarrow n = 1$$

$\xi_3 = 1{,}39$ $\xi_4 = 1{,}39$ ...(tabel A.10)

$$(R_{c;k})_{gem} = \frac{(R_{c;cal})_{gem}}{\xi_3} = \frac{1335}{1{,}39} = 961 \text{ kN}$$

$$(R_{c;k})_{min} = \frac{(R_{c;cal})_{min}}{\xi_4} = \frac{1127}{1{,}39} = 811 \text{ kN}$$

$$R_{c;d} = \frac{\min\left[(R_{c;k})_{gem}\ ;(R_{c;k})_{min}\right]}{\gamma_m} = \frac{\min\left[961\ ;811\right]}{1{,}20} = 676 \text{ kN} \quad ...(7.8)$$

$R_{c;net;d} = R_{c;d} - F_{nk;d} = 676 - 11 = 664$ kN

$$\frac{N_{Ed}}{R_{c;netto;d}} = \frac{523}{664} = 0{,}79 < 1{,}0 \qquad \text{voldoet}$$

Funderingspaal voldoet