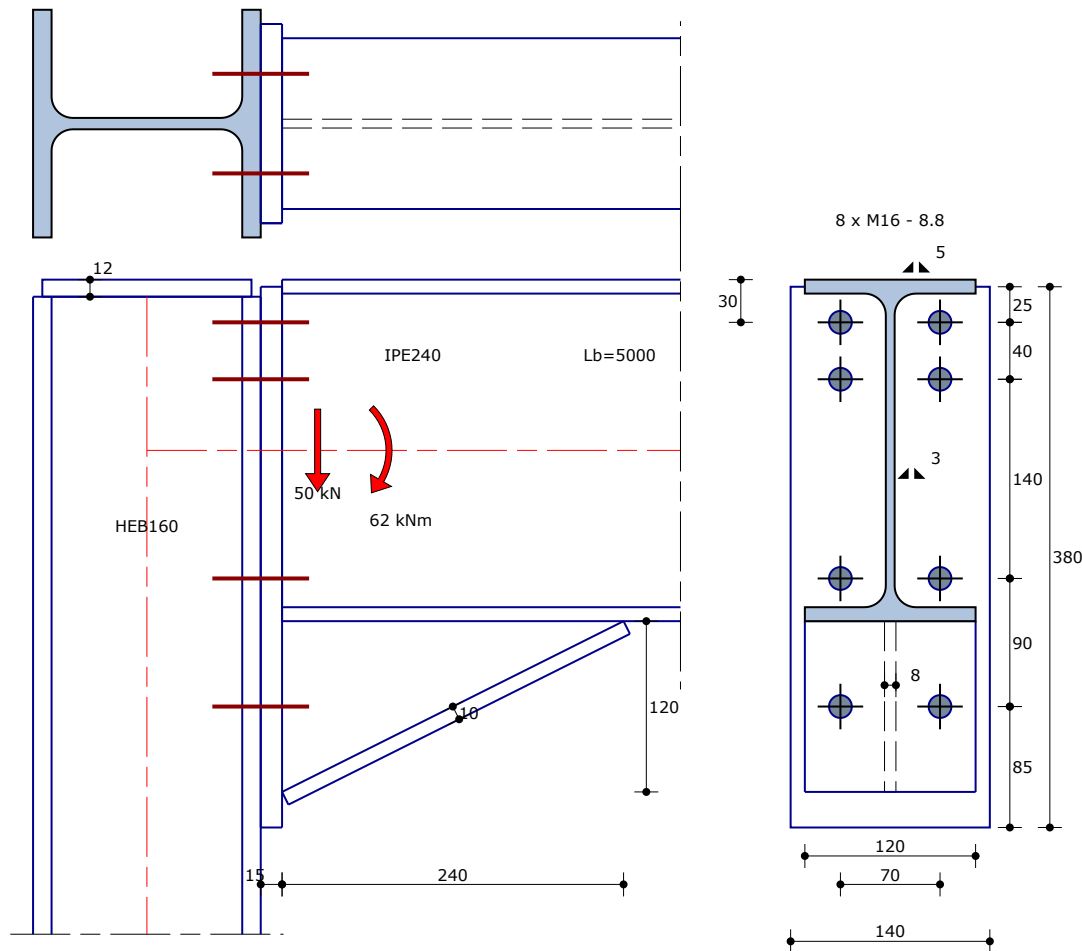


**ALGEMEEN**

Bestand : ....Struct4U\website\voorbeeld uitdraai\XConstructVoorbeeldenDutch.xcst

Gevolgklasse : CC2

**MOMENTVERBINDING: Momentverbinding****INVOERGEGEVENS**

Classificatie constructie  
 Staalsoort  
 Grootste drukspanning in de langsrichting  $\sigma_{com,Ed}$

Ongeschoord  
 S235  
 0 N/mm<sup>2</sup>

**BEREKENING volgens Eurocode 3**

Gehanteerde normen: : NEN-EN 1993-1-8 + C2:2011/NB:2011 (nl)

$$M_{j,b1,Ed} = 62,00 \text{ kNm}$$

$$V_{j,b1,Ed} = 50,00 \text{ kN}$$

**Kolomflens in dwarsbuiging**

art. 6.2.6.4

**Boutrij 1**

Eindboutrij naast een verstijving; Boutrij als onderdeel van een groep boutrijen

$$e = 0,5(b - w) = 0,5 \times (160 - 70) = 45 \text{ mm}$$

$$m = 0,5w - 0,5t_w - 0,8r = 0,5 \times 70 - 0,5 \times 8 - 0,8 \times 15 = 19 \text{ mm}$$

$$m_2 = dy - 0,5t - 0,8a_{ef} \sqrt{2} = 24 - 0,5 \times 12 - 0,8 \times 5 \times \sqrt{2} = 12,3 \text{ mm}$$

$$\lambda_1 = \frac{m}{m + e} = \frac{19}{19 + 45} = 0,297 \quad \lambda_2 = \frac{m_2}{m + e} = \frac{12,3}{19 + 45} = 0,193 \quad \alpha = 10,296 \quad (\text{Fig. 6.11})$$

$$I_{eff,cp} = 2 \pi m = 2 \times \pi \times 19 = 119,4 \text{ mm} \quad (\text{T6.5})$$

**Trekweerstand**

(T3.4)

$$F_{t,Rd} = \frac{k_2 f_{ub} A_s}{\gamma_{M2}} = \frac{0,9 \times 800 \times 157}{1,25} \times 10^{-3} = 90,4 \text{ kN}$$

$$M_{pl,Rd} = \frac{1}{4} I_{eff} t_{fc}^2 f_y = \frac{1}{4} \times 119,4 \times 13^2 \times 235 \times 10^{-6} = 1,185 \text{ kNm}$$

$$F_{T,1,Rd} = \frac{4 M_{pl,Rd}}{m} = \frac{4 \times 1,185}{19 \times 10^{-3}} = 249,537 \text{ kN}$$

$$F_{T,2,Rd} = \frac{2 M_{pl,Rd} + n \Sigma F_{t,Rd}}{m + n} = \frac{2 \times 1,185 + 23,8 \times 10^{-3} \times 2 \times 90,4}{(19 + 23,8) \times 10^{-3}} = 155,933 \text{ kN} \quad (\text{maatgevend})$$

$$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 90,4 = 180,864 \text{ kN}$$

**Boutrij 2**

Eindboutrij; Boutrij als onderdeel van een groep boutrijen

$$e = 0,5(b - w) = 0,5 \times (160 - 70) = 45 \text{ mm}$$

$$m = 0,5w - 0,5t_w - 0,8r = 0,5 \times 70 - 0,5 \times 8 - 0,8 \times 15 = 19 \text{ mm}$$

$$I_{eff,cp} = 2 \pi m = 2 \times \pi \times 19 = 119,4 \text{ mm} \quad (\text{T6.4})$$

$$I_{eff,nc} = 4m + 1,25e = 4 \times 19 + 1,25 \times 45 = 132,3 \text{ mm}$$

$$I_{eff,cp} = \pi m + p = \pi \times 19 + 40 = 99,7 \text{ mm}$$

$$I_{eff,nc} = 2m + 0,625e + 0,5p = 2 \times 19 + 0,625 \times 45 + 0,5 \times 40 = 86,1 \text{ mm}$$

$$M_{pl,Rd} = \frac{1}{4} I_{eff} t_{fc}^2 f_y = \frac{1}{4} \times 86,1 \times 13^2 \times 235 \times 10^{-6} = 0,855 \text{ kNm}$$

$$F_{T,1,Rd} = \frac{4 M_{pl,Rd}}{m} = \frac{4 \times 0,855}{19 \times 10^{-3}} = 180,024 \text{ kN}$$

$$F_{T,2,Rd} = \frac{2 M_{pl,Rd} + n \Sigma F_{t,Rd}}{m + n} = \frac{2 \times 0,855 + 23,8 \times 10^{-3} \times 2 \times 90,4}{(19 + 23,8) \times 10^{-3}} = 140,485 \text{ kN (maatgevend)}$$

$$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 90,4 = 180,864 \text{ kN}$$

### Kopplaat op buiging

art. 6.2.6.5

#### Boutrij 1

Eerste boutrij onder de getrokken liggerflens; Boutrij als onderdeel van een groep boutrijen

$$e = 0,5(b - w) = 0,5 \times (140 - 70) = 35 \text{ mm}$$

$$m = 0,5w - 0,5t_w - 0,8a_{ew} \sqrt{2} = 0,5 \times 70 - 0,5 \times 6,2 - 0,8 \times 3 \times \sqrt{2} = 28,5 \text{ mm}$$

$$m_2 = dy - 0,5t - 0,8a_{ef} \sqrt{2} = 25,1 - 0,5 \times 9,8 - 0,8 \times 5 \times \sqrt{2} = 14,5 \text{ mm}$$

$$\lambda_1 = \frac{m}{m + e} = \frac{28,5}{28,5 + 35} = 0,449 \quad \lambda_2 = \frac{m_2}{m + e} = \frac{14,5}{28,5 + 35} = 0,229 \quad \alpha = 7,485 \quad (\text{Fig. 6.11})$$

$$I_{eff,cp} = 2 \pi m = 2 \times \pi \times 28,5 = 179,1 \text{ mm} \quad (\text{T6.6})$$

$$I_{eff,nc} = \alpha m = 7,485 \times 28,5 = 213,4 \text{ mm}$$

$$I_{eff,cp} = \pi m + p = \pi \times 28,5 + 40 = 129,6 \text{ mm}$$

$$I_{eff,nc} = 0,5p + \alpha m - (2m + 0,625e) = 0,5 \times 40 + 7,485 \times 28,5 - (2 \times 28,5 + 0,625 \times 35) = 154,5 \text{ mm}$$

$$M_{pl,Rd} = \frac{1}{4} I_{eff} t_{fc}^2 f_y = \frac{1}{4} \times 129,6 \times 15^2 \times 235 \times 10^{-6} = 1,713 \text{ kNm}$$

$$F_{T,1,Rd} = \frac{4 M_{pl,Rd}}{m} = \frac{4 \times 1,713}{28,5 \times 10^{-3}} = 240,307 \text{ kN}$$

$$F_{T,2,Rd} = \frac{2 M_{pl,Rd} + n \Sigma F_{t,Rd}}{m + n} = \frac{2 \times 1,713 + 35,6 \times 10^{-3} \times 2 \times 90,4}{(28,5 + 35,6) \times 10^{-3}} = 153,882 \text{ kN (maatgevend)}$$

$$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 90,4 = 180,864 \text{ kN}$$

#### Boutrij 2

Andere eindboutrij; Boutrij als onderdeel van een groep boutrijen

$$e = 0,5(b - w) = 0,5 \times (140 - 70) = 35 \text{ mm}$$

$$m = 0,5w - 0,5t_w - 0,8a_{ew} \sqrt{2} = 0,5 \times 70 - 0,5 \times 6,2 - 0,8 \times 3 \times \sqrt{2} = 28,5 \text{ mm}$$

$$I_{eff,cp} = 2 \pi m = 2 \times \pi \times 28,5 = 179,1 \text{ mm} \quad (\text{T6.6})$$

$$I_{eff,nc} = 4m + 1,25e = 4 \times 28,5 + 1,25 \times 35 = 157,8 \text{ mm}$$

$$I_{eff,cp} = \pi m + p = \pi \times 28,5 + 40 = 129,6 \text{ mm}$$

$$I_{eff,nc} = 2m + 0,625e + 0,5p = 2 \times 28,5 + 0,625 \times 35 + 0,5 \times 40 = 98,9 \text{ mm}$$

$$M_{pl,Rd} = \frac{1}{4} I_{eff} t_{fc}^2 f_y = \frac{1}{4} \times 98,9 \times 15^2 \times 235 \times 10^{-6} = 1,307 \text{ kNm}$$

$$F_{T,1,Rd} = \frac{4 M_{pl,Rd}}{m} = \frac{4 \times 1,307}{28,5 \times 10^{-3}} = 183,423 \text{ kN}$$

$$F_{T,2,Rd} = \frac{2 M_{pl,Rd} + n \Sigma F_{t,Rd}}{m + n} = \frac{2 \times 1,307 + 35 \times 10^{-3} \times 2 \times 90,4}{(28,5 + 35) \times 10^{-3}} = 140,846 \text{ kN (maatgevend)}$$

$$F_{T,3,Rd} = \Sigma F_{t,Rd} = 2 \times 90,4 = 180,864 \text{ kN}$$

**Kolomlijf op trek in de dwarsrichting**

art. 6.2.6.3

$$\omega_1 = \frac{1}{\sqrt{1 + 1,3(b_{\text{eff,t,wc}} t_{\text{wc}} / A_{\text{vc}})^2}} = \frac{1}{\sqrt{1 + 1,3 \times (205,5 \times 8 / 1762)^2}} = 0,68$$

$$\beta = 1,00 \quad \omega = \omega_1 = 0,68$$

$$F_{\text{t,wc,Rd}} = \frac{\omega b_{\text{eff,t,wc}} t_{\text{wc}} f_{\text{y,wc}}}{\gamma_{\text{M1}}} = \frac{0,68 \times 205,5 \times 8 \times 235}{1,00} = 264,6 \text{ kN} \quad (6.15)$$

$$(F_{\text{t,wc,1,Rd}} = 153,7 \text{ kN} \quad F_{\text{t,wc,2,Rd}} = 110,9 \text{ kN})$$

**Liggerlijf op trek**

art. 6.2.6.8

$$F_{\text{t,wb,Rd}} = \frac{b_{\text{eff,t,wb}} t_{\text{wb}} f_{\text{y,wb}}}{\gamma_{\text{M1}}} = \frac{228,4 \times 6,2 \times 235}{1,00} \times 10^{-3} = 332,8 \text{ kN} \quad (6.22)$$

**Kolomlijf op afschuiving**

art. 6.2.6.1

$$A_{\text{vc}} = A_{\text{a}} - 2 b t_{\text{fc}} + (t_{\text{wc}} + 2 r) t_{\text{fc}} = 5428 - 2 \times 160 \times 13 + (8 + 2 \times 15) \times 13 = 1762 \text{ mm}^2$$

$$V_{\text{wp,Rd}} = \frac{0,90 f_{\text{y,wc}} A_{\text{vc}}}{\sqrt{3} \gamma_{\text{M0}}} = \frac{0,90 \times 235 \times 1762}{\sqrt{3} \times 1,00} \times 10^{-3} = 215,1 \text{ kN} \quad (6.7)$$

**Kolomlijf op druk in de dwarsrichting**

art. 6.2.6.2

$$b_{\text{eff,c,wc}} = t_{\text{fb}} + 2 \sqrt{2} a_{\text{b}} + 5(t_{\text{fc}} + r_{\text{c}}) + s_{\text{p}} = 9,8 + 2 \sqrt{2} \times 5 + 5 \times (13 + 15) + 30 = 193,9 \text{ mm} \quad (6.11)$$

$$\lambda_{\text{p}} = 0,932 \sqrt{\frac{b_{\text{eff,c,wc}} d_{\text{wc}} f_{\text{y,wc}}}{E t_{\text{wc}}^2}} = 0,932 \times \sqrt{\frac{193,9 \times 104 \times 235}{210000 \times 8^2}} = 0,55 \quad (6.13c)$$

$$\lambda_{\text{p}} < 0,72 \quad \rho = 1,0 \quad (6.13a)$$

$$\omega_1 = \frac{1}{\sqrt{1 + 1,3(b_{\text{eff,c,wc}} t_{\text{wc}} / A_{\text{vc}})^2}} = \frac{1}{\sqrt{1 + 1,3 \times (193,9 \times 8 / 1762)^2}} = 0,71$$

$$\beta = 1,00 \quad \omega = \omega_1 = 0,71$$

$$\sigma_{\text{com,Ed}} = 0 \text{ N/mm}^2 < 0,7 f_{\text{y,wc}} \quad k_{\text{wc}} = 1,00$$

$$F_{\text{c,wc,Rd}} = \frac{\omega k_{\text{wc}} \rho b_{\text{eff,c,wc}} t_{\text{wc}} f_{\text{y,wc}}}{\gamma_{\text{M1}}} = \frac{0,71 \times 1,00 \times 1,00 \times 193,9 \times 8 \times 235}{1,00} \times 10^{-3} = 257,3 \text{ kN} \quad (6.9)$$

**Liggerflens en liggerlijf op druk**

art. 6.2.6.7

$$M_{\text{c,Rd}} = M_{\text{pl,Rd}} = \frac{W_{\text{pl}} f_{\text{y}}}{\gamma_{\text{M0}}} = \frac{366897 \times 235}{1,00} \times 10^{-6} = 86,221 \text{ kNm} \quad (6.13)$$

$$F_{\text{c,fb,Rd}} = M_{\text{c,Rd}} / (h - t_{\text{fb}}) = 86,221 / (240 - 9,8) \times 10^3 = 374,5 \text{ kN} \quad (6.21)$$

**Liggerlijf op druk in de dwarsrichting**

art. 6.2.6.2

$$b_{\text{eff,c,wb}} = t_{\text{f,cons}} + 2 \sqrt{2} a_{\text{b}} + 5(t_{\text{fb}} + r_{\text{b}}) = 10 + 2 \sqrt{2} \times 5 + 5 \times (9,8 + 15) = 148,1 \text{ mm} \quad (6.11)$$

$$\lambda_{\text{p}} = 0,932 \sqrt{\frac{b_{\text{eff,c,wb}} d_{\text{wb}} f_{\text{y,wb}}}{E t_{\text{wb}}^2}} = 0,932 \times \sqrt{\frac{148,1 \times 190,4 \times 235}{210000 \times 6,2^2}} = 0,84 \quad (6.13c)$$

$$\lambda_{\text{p}} < 0,72 \quad \rho = (\lambda_{\text{p}} - 0,2) / \lambda_{\text{p}}^2 = (0,84 - 0,2) / 0,84^2 = 0,90 \quad (6.13b)$$

$$\omega_1 = \frac{1}{\sqrt{1 + 1,3(b_{\text{eff,c,wb}} t_{\text{wb}} / A_{\text{vb}})^2}} = \frac{1}{\sqrt{1 + 1,3 \times (148,1 \times 6,2 / 1917)^2}} = 0,88$$

$$\beta = 1,00 \quad \omega = \omega_1 = 0,88$$

$$\sigma_{\text{com,Ed}} = 191 \text{ N/mm}^2 > 0,7 f_{y,\text{wb}} \quad k_{\text{wb}} = 1,7 - \sigma_{\text{com,Ed}} / f_{y,\text{wb}} = 0,89 \quad (6.14)$$

$$F_{\text{c,wb,Rd}} = \frac{\omega k_{\text{wb}} \rho b_{\text{eff,c,wb}} t_{\text{wb}} f_{y,\text{wb}}}{\gamma_{\text{M1}}} = \frac{0,88 \times 0,89 \times 0,90 \times 148,1 \times 6,2 \times 235}{1,00} \times 10^{-3} = 151,8 \text{ kN} \quad (6.9)$$

$$F_{\text{c,wb,Rd,h}} = F_{\text{c,wb,Rd}} \frac{l_{\text{cons}}}{h_{\text{cons}}} = 151,8 \text{ kN} \times \frac{240}{120} = 303,7 \text{ kN}$$

### Liggerkolomverbinding met een geboute kopplaat

art. 6.2.7.2

na herverdeling

Boutrij	Ftr,Rd,c [kN]	Ftr,Rd,e [kN]	Ftr,Rd,c [kN]	Ftr,Rd,e [kN]	Ftr,Rd [kN]	hr [m]	Mj,Rd [kNm]
1	153,7	153,9	153,9	153,9	153,9	0,330	50,781
2	110,9	140,8	110,7	140,8	61,2	0,290	17,754
					215,1		68,535

$$M_{j,b1,Rd} = \sum h_r F_{\text{tr,Rd}} = 68,535 \text{ kNm} \quad (6.25)$$

Moment wordt gelimiteerd door: Kolomlijf op afschuiving

$$\frac{M_{j,b1,Ed}}{M_{j,b1,Rd}} = \frac{62,000}{68,535} = 0,90 < 1,0 \quad \text{voldoet}$$

### Controle dwarskracht

#### Afschuifweerstand per afschuifvlak

(T3.4)

$$F_{\text{v,Rd}} = \frac{\alpha_v f_{\text{ub}} A_s}{\gamma_{\text{M2}}} = \frac{0,6 \times 800 \times 157}{1,25} \times 10^{-3} = 60,3 \text{ kN}$$

#### Stuikweerstand

(T3.4)

$$k_1 = \min\left[2,8 \frac{e_2}{d_0} - 1,7; 1,4 \frac{p_2}{d_0} - 1,7; 2,5\right] = \min\left[2,8 \times \frac{35}{18} - 1,7; 1,4 \times \frac{70}{18} - 1,7; 2,5\right] = 2,5$$

$$\alpha_d = \frac{e_1}{3 d_0} = \frac{210}{3 \times 18} = 3,889$$

$$\alpha_b = \min\left[\alpha_d; \frac{f_{\text{ub}}}{f_u}; 1,0\right] = \min\left[3,889; \frac{800}{360}; 1,0\right] = 1$$

$$F_{\text{b,Rd}} = \frac{k_1 \alpha_b f_u d t}{\gamma_{\text{M2}}} = \frac{2,5 \times 1 \times 360 \times 16 \times 15}{1,25} \times 10^{-3} = 172,8 \text{ kN}$$

#### Stuikweerstand

(T3.4)

$$k_1 = \min\left[2,8 \frac{e_2}{d_0} - 1,7; 1,4 \frac{p_2}{d_0} - 1,7; 2,5\right] = \min\left[2,8 \times \frac{45}{18} - 1,7; 1,4 \times \frac{70}{18} - 1,7; 2,5\right] = 2,5$$

$$\alpha_d = \frac{e_1}{3 d_0} = \frac{210}{3 \times 18} = 3,889$$

$$\alpha_b = \min\left[\alpha_d; \frac{f_{\text{ub}}}{f_u}; 1,0\right] = \min\left[3,889; \frac{800}{360}; 1,0\right] = 1$$

$$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} = \frac{2,5 \times 1 \times 360 \times 16 \times 13}{1,25} \times 10^{-3} = 149,8 \text{ kN}$$

**Stuikweerstand**

(T3.4)

$$k_1 = \min\left[1,4 \frac{p_2}{d_0} - 1,7; 2,5\right] = \min\left[1,4 \times \frac{70}{18} - 1,7; 2,5\right] = 2,5$$

$$\alpha_d = \frac{p_1}{3 d_0} - \frac{1}{4} = \frac{300}{3 \times 18} - \frac{1}{4} = 5,306$$

$$\alpha_b = \min\left[\alpha_d; \frac{f_{ub}}{f_u}; 1,0\right] = \min\left[5,306; \frac{800}{360}; 1,0\right] = 1$$

$$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} = \frac{2,5 \times 1 \times 360 \times 16 \times 15}{1,25} \times 10^{-3} = 172,8 \text{ kN}$$

**Stuikweerstand**

(T3.4)

$$k_1 = \min\left[1,4 \frac{p_2}{d_0} - 1,7; 2,5\right] = \min\left[1,4 \times \frac{70}{18} - 1,7; 2,5\right] = 2,5$$

$$\alpha_d = \frac{p_1}{3 d_0} - \frac{1}{4} = \frac{300}{3 \times 18} - \frac{1}{4} = 5,306$$

$$\alpha_b = \min\left[\alpha_d; \frac{f_{ub}}{f_u}; 1,0\right] = \min\left[5,306; \frac{800}{360}; 1,0\right] = 1$$

$$F_{b,Rd} = \frac{k_1 \alpha_b f_u d t}{\gamma_{M2}} = \frac{2,5 \times 1 \times 360 \times 16 \times 13}{1,25} \times 10^{-3} = 149,8 \text{ kN}$$

$$V_{1,Ed} = 50,000$$

$$\frac{V_{1,Ed}}{V_{1,Rd}} = \frac{50,000}{241,152} = 0,21 < 1,0 \quad \text{voldoet}$$

**Controle van de lassen**

$$a_{ef} = 5 \text{ mm} > 0,46 t_f = 0,46 \times 9,8 = 4,5 \text{ mm} \quad \text{voldoet}$$

$$a_{ew} = 3 \text{ mm} > 0,46 t_w = 0,46 \times 6,2 = 2,9 \text{ mm} \quad \text{voldoet}$$

**Rotatiestijfheid**

art. 6.1.2.3

**Boutrij 1**

$$k_3 = \frac{0,7 I_{eff} t_w}{d_c} = \frac{0,7 \times 119,4 \times 8}{134} = 4,99 \text{ mm}$$

$$k_4 = \frac{0,9 I_{eff} t_{fc}^3}{m^3} = \frac{0,9 \times 119,4 \times 13^3}{19^3} = 34,41 \text{ mm} \quad (T6.11)$$

$$k_{10} = \frac{1,6 A_s}{L_b} = \frac{1,6 \times 157}{39,8} = 6,32 \text{ mm}$$

$$k_5 = \frac{0,9 I_{eff} t_p^3}{m^3} = \frac{0,9 \times 129,6 \times 15^3}{28,5^3} = 16,99 \text{ mm}$$

$$\frac{1}{k_{eff,1}} = \frac{1}{k_3} + \frac{1}{k_4} + \frac{1}{k_{10}} + \frac{1}{k_5} = \frac{1}{4,99} + \frac{1}{34,41} + \frac{1}{6,32} + \frac{1}{16,99} = 0,447 \quad k_{eff,1} = 2,24 \text{ mm} \quad (6.30)$$

**Boutrij 2**

$$k_3 = \frac{0,7 I_{eff} t_w}{d_c} = \frac{0,7 \times 86,1 \times 8}{134} = 3,60 \text{ mm}$$

$$k_4 = \frac{0,9 I_{eff} t_{fc}^3}{m^3} = \frac{0,9 \times 86,1 \times 13^3}{19^3} = 24,83 \text{ mm} \quad (T6.11)$$

$$k_{10} = \frac{1,6 A_s}{L_b} = \frac{1,6 \times 157}{39,8} = 6,32 \text{ mm}$$

$$k_5 = \frac{0,9 I_{eff} t_p^3}{m^3} = \frac{0,9 \times 98,9 \times 15^3}{28,5^3} = 12,97 \text{ mm}$$

$$k_{\text{eff},2} = \frac{1}{k_3} + \frac{1}{k_4} + \frac{1}{k_{10}} + \frac{1}{k_5} = \frac{1}{3,60} + \frac{1}{24,83} + \frac{1}{6,32} + \frac{1}{12,97} = 0,553 \quad k_{\text{eff},2} = 1,81 \text{ mm} \quad (6.30)$$

$$Z_{\text{eq}} = \frac{\sum k_{\text{eff},r} h_r^2}{\sum k_{\text{eff},r} h_r} = \frac{2,24 \times 330^2 + 1,81 \times 290^2}{2,24 \times 330 + 1,81 \times 290} = 313 \text{ mm} \quad (6.31)$$

$$k_{\text{eq}} = \frac{\sum k_{\text{eff},r} h_r}{Z_{\text{eff}}} = \frac{2,24 \times 330 + 1,81 \times 290}{313} = 4,03 \text{ mm} \quad (6.29)$$

$$k_1 = \frac{0,38 A_{vc}}{\beta z} = \frac{0,38 \times 1762}{1 \times 310} = 2,16 \text{ mm} \quad k_2 = \frac{0,7 b_{\text{eff}} t_w}{d_c} = \frac{0,7 \times 193,9 \times 8}{134} = 8,11 \text{ mm} \quad (T6.11)$$

$$S_{j,\text{ini}} = \frac{E Z_{\text{eq}}^2}{\frac{1}{k_{\text{eq}}} + \frac{1}{k_2} + \frac{1}{k_1}} = \frac{210000 \times 313^2}{\frac{1}{4,03} + \frac{1}{8,11} + \frac{1}{2,16}} \cdot 10^{-6} = 24713 \text{ kNm/rad} \quad (6.27)$$

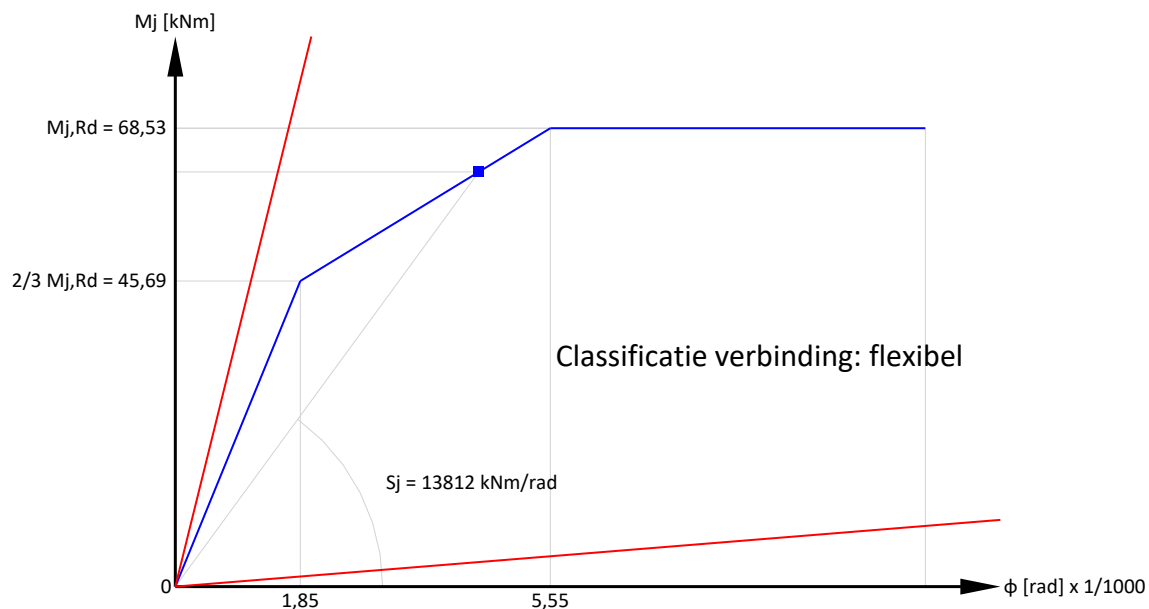
$$S_{j,\text{ini}} > \frac{0,5 E I_b}{L_b} = \frac{0,5 \times 210000 \times 38942643}{5000} = 818 \text{ kNm/rad} \quad (F5.4)$$

$$S_{j,\text{ini}} < \frac{k_b E I_b}{L_b} = \frac{25 \times 210000 \times 38942643}{5000} = 40890 \text{ kNm/rad} \rightarrow \text{Zone 2: flexibel}$$

$$\phi_1 = \frac{2/3 M_{j,\text{Rd}}}{S_{j,\text{ini}}} = \frac{45,69}{24713} = 1,85 \cdot 10^{-3} \text{ rad}$$

$$\phi_2 = \frac{M_{j,\text{Rd}}}{\frac{S_{j,\text{ini}}}{\eta}} = \frac{68,53}{\frac{24713}{2}} = 5,55 \cdot 10^{-3} \text{ rad}$$

$$S_j = \frac{M_{j,\text{Ed}}}{\phi} = \frac{62,00}{4,49 \cdot 10^{-3}} = 13812 \text{ kNm/rad}$$



Te gebruiken rotatiestijfheid in de elastische algemene berekening

**Conclusie: Momentverbinding voldoet.**