



higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NATIONALE SERTIFIKAAT STERKTE- EN STRUKTUURLEER N6

21 April 2021

Hierdie nasienriglyn bestaan uit 8 bladsye.

VRAAG 1: DIK SILINDERS

1.1 by 100 mm: $a + \frac{b}{0,1^2} = 100 \times 10^6 \dots\dots\dots (1) \checkmark$

by 200 mm: $a + \frac{b}{0,2^2} = 40 \times 10^6 \dots\dots\dots (2) \checkmark$

(1) – (2): $100b - 25b = 60 \times 10^6$

$b = 800 \times 10^3 \checkmark$

$a = 20 \times 10^6 \checkmark$

by 100 mm: $\sigma_H = a - \frac{b}{0,1^2}$
 $= 20 \times 10^6 - \frac{800 \times 10^3}{0,1^2}$

$\sigma_H = -60 \text{ MPa (trek)} \checkmark$

by 200 mm: $\sigma_H = a - \frac{b}{0,2^2}$
 $= 20 \times 10^6 - \frac{800 \times 10^3}{0,2^2}$

$\sigma_H = 0 \checkmark \tag{6}$

1.2 $\delta d_1 = \frac{d}{E} (\sigma_H - \nu \times \sigma_R)$
 $= \frac{0,1}{200 \times 10^9} (-60 \times 10^6 - 0,3 \times 100 \times 10^6)$

$\delta d_1 = -45 \times 10^{-6} \text{ m (toename)} \checkmark$

$d = 100 + 0,045 = 100,045 \text{ mm} \checkmark \tag{2}$

1.3 $\delta d_2 = \frac{D}{E} (\sigma_H - \nu \times \sigma_R)$
 $= \frac{0,2}{200 \times 10^9} (0 - 0,3 \times 40 \times 10^6)$

$\delta d_2 = 12 \times 10^{-6} \text{ m (toename)} \checkmark$

$D = 200 + 0,012 = 200,012 \text{ mm} \checkmark \tag{2}$

$$1.4 \quad t = \frac{D - d}{2} = \frac{200,012 - 100,045}{2} = 49,9835 \text{ mm} \checkmark \quad (1)$$

[11]

VRAAG 2: TREKSPANNING IN DIE KABELS

$$2.1 \quad F_T = \sigma_s A_s + \sigma_a A_a$$

$$= 42 \times 50 + 14 \times 45 \checkmark$$

$$F_T = 8\,400 \text{ N} \checkmark \quad (2)$$

$$2.2 \quad y_2 = \frac{F_T}{w} = \frac{8\,400}{60} = 140 \text{ m} \checkmark$$

$$y_0 = \sqrt{y_2^2 - \ell_2^2} = \sqrt{140^2 - 88^2} = 108,885 \text{ m} \checkmark$$

$$y_1 = \sqrt{y_0^2 + \ell_1^2} = \sqrt{108,885^2 + 62^2} = 125,3 \text{ m} \checkmark$$

$$h = y_2 - y_1 = 14,7 \text{ m} \checkmark \quad (4)$$

$$2.3 \quad x_2 = y_0 \ln \left(\frac{y_2 + \ell_2}{y_0} \right) = 108,885 \times \ln \left(\frac{140 + 88}{108,885} \right) = 80,472 \text{ m} \checkmark \quad (1)$$

$$2.4 \quad y_3 = \frac{F_3}{w} = \frac{7\,800}{60} = 130 \text{ m} \checkmark$$

$$\ell_3 = \sqrt{y_3^2 - y_0^2} = \sqrt{130^2 - 108,885^2} = 71,0211 \text{ m} \checkmark$$

$$x_3 = y_0 \ln \left(\frac{y_3 + \ell_3}{y_0} \right) = 108,885 \times \ln \left(\frac{130 + 71,0211}{108,885} \right) = 66,759 \text{ m (vanaf TP)} \checkmark$$

$$x = x_2 - x_3 = 80,472 - 66,759 = 13,713 \text{ m (vanaf die hoogste steunpunt)} \checkmark \quad (4)$$

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VRAAG 3: BUIGING EN DEFLEKSIE VAN BALKE

$$3.1 \quad I_{XX} = 2 \times I_{xx} = 2 \times 19,11 \times 10^{-6} = 38,22 \times 10^{-6} \text{ m}^4 \checkmark$$

$$I_{YY} = 2 \times (I_{yy} + Ar^2)$$

$$= 2 \times (1,478 \times 10^{-6} + 3,218 \times 10^{-3} \times 0,0499^2) \checkmark$$

$$I_{YY} = 18,982 \times 10^{-6} \text{ m}^4 \checkmark \quad (3)$$

3.2 Oorweeg die spanningsperk:

$$M = \sigma z = 80 \times 10^6 \times 2 \times 191,1 \times 10^6 = 30,576 \text{ kNm} \checkmark$$

$$M = \frac{WL}{4} + \frac{wL^2}{8}$$

$$30\,576 = \frac{W \times 4}{4} + \frac{496,386 \times 4^2}{8}$$

$$W = 29,583 \text{ kN} \checkmark$$

Oorweeg die defleksieperk:

$$\Delta = \frac{WL^3}{48EI} + \frac{5wL^4}{384EI}$$

$$10 \times 10^{-3} = \frac{W \times 4^3}{48 \times 200 \times 38,22 \times 10^3} + \frac{5 \times 496,386 \times 4^4}{384 \times 200 \times 38,22 \times 10^3} \checkmark$$

$$W = 56,089 \text{ kN} \checkmark$$

⇒ Maksimum toegelate las is 29,583 kN \checkmark (5)

3.3 $\sigma = 80 \text{ MPa}$ aangesien dit die beperkende faktor was \checkmark

$$\Delta = \frac{29\,583 \times 4^3}{48 \times 200 \times 38,22 \times 10^3} + \frac{5 \times 496,386 \times 4^4}{384 \times 200 \times 38,22 \times 10^3} = 5,377 \text{ mm} \checkmark \quad (2)$$

3.4

$$\Delta = \frac{FL^3}{48EI}$$

$$(5,377 - 2) \times 10^{-3} \checkmark = \frac{F \times 4^3}{48 \times 200 \times 38,22 \times 10^3}$$

$$F = 19,359 \text{ kN} \checkmark \quad (2)$$

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VRAAG 4: DIREKTE EN BUIGPANNINGS

$$4.1 \quad Y_t = \frac{a_1 y_1 + a_2 y_2}{a_T} = \frac{8 \times 10^{-3} \times 0,02 + 8 \times 10^{-3} \times 0,12}{16 \times 10^{-3}} \checkmark$$

$$Y_t = 0,07 \text{ m} \checkmark \text{ and } Y_c = 0,13 \text{ m} \quad (3)$$

$$4.2 \quad I_1 = \frac{bd^3}{12} + Ah^2 = \frac{0,2 \times 0,04^3}{12} + 8 \times 10^{-3} \times 0,05^2 = 21,1 \times 10^{-6} \text{ m}^4 \checkmark$$

$$I_2 = \frac{bd^3}{12} + Ah^2 = \frac{0,05 \times 0,16^3}{12} + 8 \times 10^{-3} \times 0,05^2 = 37,1 \times 10^{-6} \text{ m}^4 \checkmark$$

$$I_{XX} = I_1 + I_2 = 21,1 \times 10^{-6} + 37,1 \times 10^{-6} = 58,2 \times 10^{-6} \text{ m}^4 \checkmark \quad (3)$$

$$4.3 \quad \sigma_d = \frac{F}{A} = \frac{40 \times 10^3}{16 \times 10^{-3}} = 2,5 \text{ MPa} \checkmark \text{ (trek)} \checkmark \quad (2)$$

$$4.4 \quad \sigma_{bt} = \frac{FeY_t}{I} = \frac{40 \times 10^3 \times 0,37 \times 0,07}{58,2 \times 10^{-6}} = 22,251 \text{ MPa (trek)} \checkmark$$

$$\sigma_{bc} = \frac{FeY_c}{I} = \frac{40 \times 10^3 \times 0,37 \times 0,13}{58,2 \times 10^{-6}} = 41,323 \text{ MPa (saamdrukkend)} \checkmark$$

$$\sigma_{Rt} = \sigma_d + \sigma_{bt} = 3,125 + 22,251 = 25,376 \text{ MPa} \checkmark \text{ (trek)} \checkmark$$

$$\sigma_{Rc} = \sigma_d - \sigma_{bc} = 3,125 - 41,323 = 38,198 \text{ MPa} \checkmark \text{ (saamdrukkend)} \checkmark \quad (6)$$

[14]**VRAAG 5: KEERMURE**

$$5.1 \quad F_w = \frac{\rho g h^2}{2} = \frac{1\,000 \times 9,81 \times 6^2}{2} = 176,58 \text{ kN} \checkmark$$

$$W_1 = \rho g A l = 2\,100 \times 9,81 \times 0,5 \times 1 \times 6 = 61,803 \text{ kN} \checkmark$$

$$W_2 = \rho g A l = 2\,100 \times 9,81 \times 2 \times 6 = 247,212 \text{ kN} \checkmark$$

$$V = W_1 + W_2 = 61,803 + 247,212 = 309,015 \text{ kN} \checkmark \quad (4)$$

$$5.2 \quad F \sim M = F_w \times \frac{h}{3} = 176,58 \times 2 = 353,16 \text{ kNm} \checkmark$$

$$W \sim M = W_1 x_1 + W_2 x_2 = 61,803 \times 0,667 + 247,212 \times 2 \checkmark = 535,626 \text{ kNm} \checkmark \quad (3)$$

$$5.3 \quad FOS = \frac{W \sim M}{F \sim M} = \frac{535,626}{353,16} = 1,517 \checkmark \text{ (nie veilig nie, behoort } \geq 2 \text{ te wees)} \checkmark \quad (2)$$

5.4 $Vx + F \sim M = W \sim M$

$309,015x + 353,16 = 535,626 \checkmark$

$x = 0,59 \text{ m vanaf toon} \checkmark$

Daar sal trekspanning wees omdat $x < \frac{B}{3} \checkmark$ (val buite die middelste derde) (3)

5.5 $e = 0,5B - x = 1,5 - 0,59 = 0,91 \text{ m} \checkmark$

$\sigma_{max} = \frac{V}{B} + \frac{6Ve}{B^2} = \frac{309,015}{3} + \frac{6 \times 309,015 \times 0,91}{3^2} = 290,474 \text{ kPa} \checkmark$

$\sigma_{ult} = 3 \times \sigma_{max} = 871,422 \text{ kPa} \checkmark$ (3)

[15]

VRAAG 6: FONDASIES

6.1 $W_T = 340 \times 9,81 \times 4 + 50 \times 10^3 = 63,342 \text{ kN} \checkmark$

$L = \sqrt{\frac{W_T}{p_g}} = \sqrt{\frac{63,342}{30}} = 1,453 \text{ m} \checkmark$ (2)

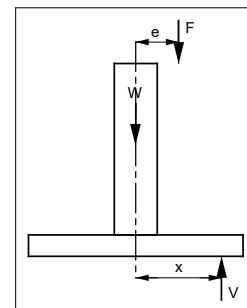
6.2 $\sigma_d = \frac{W_T}{A_c} = \frac{63,342 \times 10^3}{43,27 \times 10^{-3}} \checkmark = 1,464 \text{ MPa} \checkmark$ (2)

6.3 $e = 100 + \frac{h}{2} = 100 + \frac{406,4}{2} = 303,2 \text{ mm} \checkmark$

Beskou momente om senter: $V \times x = F \times e \checkmark$

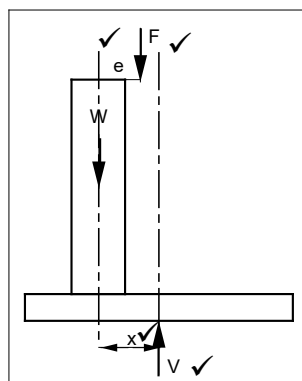
$63,342 \times x = 50 \times 0,3032 \checkmark$

$x = 239,337 \text{ mm} \checkmark$



(4)

6.4



(4)

[12]

VRAAG 7: GEWAPENDE BETON

$$7.1 \quad \frac{\sigma_s}{\sigma_c} = \frac{m(d-n)}{n}$$

$$\frac{140}{7} = \frac{15(d-n)}{n}$$

$$d = 2,333n \dots \dots (1) \checkmark$$

$$M = 0,5\sigma_c A_c \left(d - \frac{n}{3}\right)$$

$$174 \times 10^3 = 0,5 \times 7 \times 10^6 \times 0,4 \times n(d - 0,333n) \dots \dots (2) \checkmark$$

$$(1) \text{ into } (2): 174 \times 10^3 = 0,5 \times 7 \times 10^6 \times 0,4 \times n(2,333n - 0,333n) \checkmark$$

$$n = 0,249 \text{ m} \checkmark$$

$$d = 2,333n = 0,582 \text{ m} \checkmark$$

$$D = d + r + c = 582 + 10 + 30 = 622 \text{ mm} \checkmark$$

(6)

$$7.2 \quad \ell_a = d - \frac{n}{3} = 0,582 - \frac{0,249}{3} = 0,499 \text{ m} \checkmark$$

$$A_s = \frac{M}{\sigma_s \times \ell_a} = \frac{174 \times 10^3}{140 \times 10^6 \times 0,499} = 2,493 \times 10^{-3} \text{ m}^2 \checkmark$$

$$A_r = \pi r^2 = \pi \times 0,01^2 = 314,159 \times 10^{-6} \text{ m}^2 \checkmark$$

$$\text{aantal stawe} = \frac{A_s}{A_r} = \frac{2,493 \times 10^{-3}}{314,159 \times 10^{-6}} = 7,9 \text{ dus } 8 \text{ stawe} \checkmark$$

(4)

$$7.3 \quad M_c = 0,5\sigma_c A_c \times \frac{2}{3}n$$

$$= 0,5 \times 7 \times 10^6 \times 0,4 \times 0,249 \times \frac{2}{3} \times 0,249 \checkmark$$

$$M_c = 58 \text{ kNm} \checkmark$$

$$M_s = \sigma_s A_s (d - n)$$

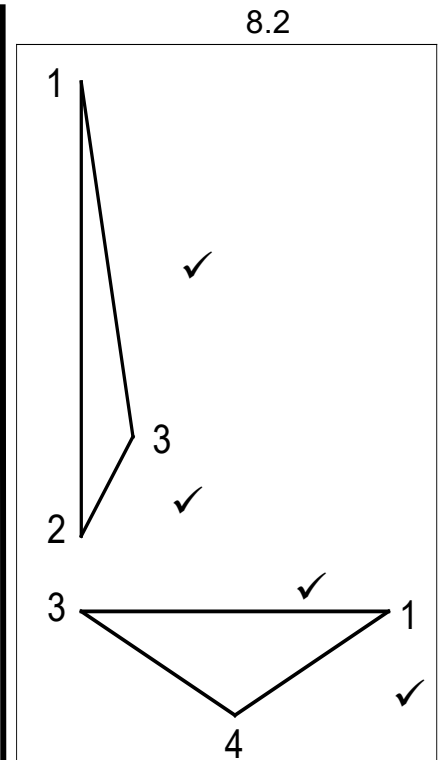
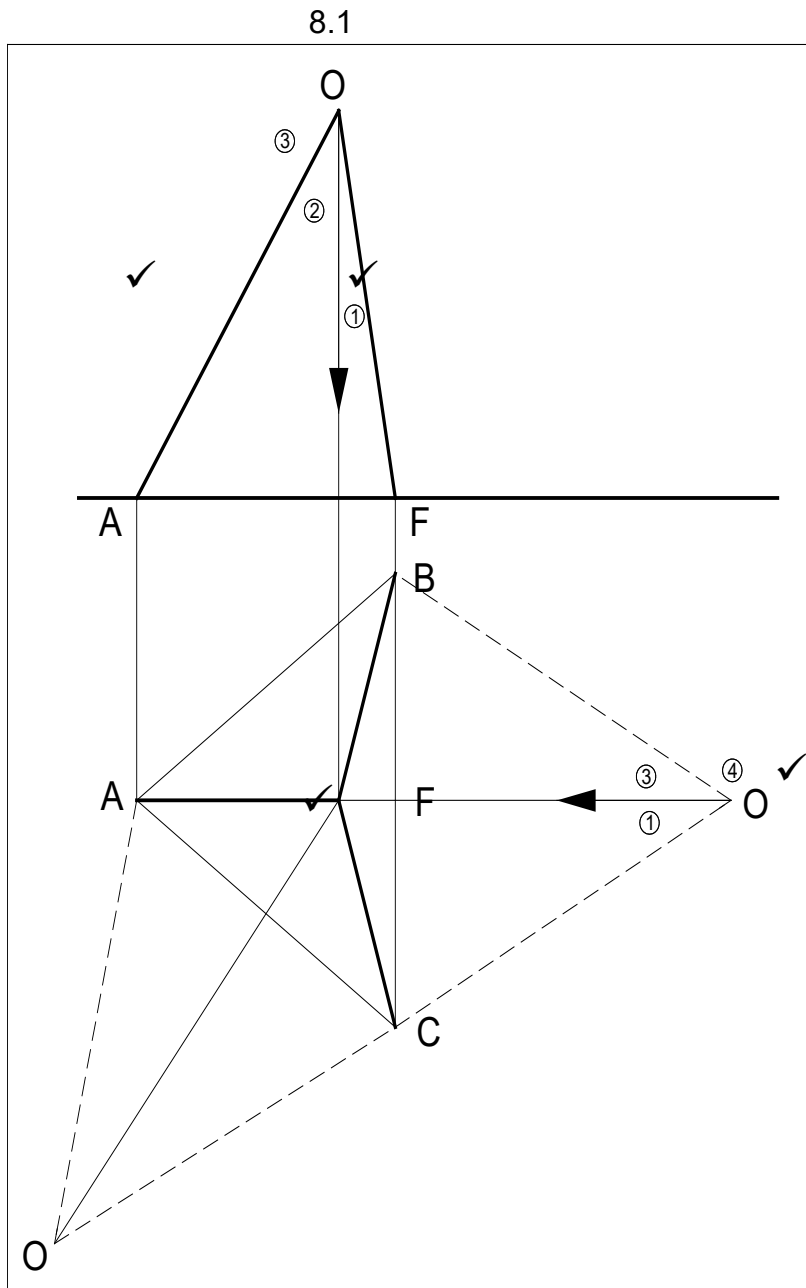
$$= 140 \times 10^6 \times 2,493 \times 10^{-3} (0,582 - 0,249) \checkmark$$

$$M_s = 1\,167 \text{ kNm} \checkmark$$

(4)

[14]

VRAAG 8: STRUKTUURRAAMWERK



- 8.1 Sien skets (4)
- 8.2 Sien skets (4)

8.3

| DEEL | GROOTTE | AARD |
|----------|----------|-------|
| OA (2-3) | 7,7 kN√ | Stut√ |
| OB (3-4) | 13,7 kN√ | Stut√ |
| OC (1-4) | 13,7 kN√ | Stut√ |

(3)
[11]

TOTAAL: 100