



**higher education  
& training**

Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

# **NASIENRIGLYN**

## **NASIONALE SERTIFIKAAT STERKTE- EN STRUKTUURLEER N6**

**12 Augustus 2021**

Hierdie nasienriglyn bestaan uit 10 bladsye.

**VRAAG 1**

$$1.1 \quad \text{by 200 mm : } a + \frac{b}{0,2^2} = 25 \times 10^6 \dots \dots \dots (1) \checkmark$$

$$\text{by 200 mm : } a - \frac{b}{0,2^2} = -5 \times 10^6 \dots \dots \dots (2) \checkmark$$

$$(1) + (2) : 2a = 20 \times 10^6$$

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

$$b = 600 \times 10^3 \checkmark$$

$$\text{by 300 mm : } \sigma_R = a + \frac{b}{0,3^2}$$

$$= 10 \times 10^6 + \frac{600 \times 10^3}{0,3^2}$$

$$\sigma_R = 16,667 \text{ MPa } \checkmark \quad (5)$$

$$1.2 \quad \text{by 300 mm : } \sigma_H = a - \frac{b}{0,3^2}$$

$$= 10 \times 10^6 - \frac{600 \times 10^3}{0,3^2}$$

$$\sigma_H = 3,333 \text{ MPa } \checkmark \text{ (druk) } \checkmark \quad (2)$$

$$1.3 \quad \sigma_H = 0 \text{ waar: } a - \frac{b}{D_x^2} = 0$$

$$10 \times 10^6 - \frac{600 \times 10^3}{D_x^2} = 0$$

$$D_x = 244,949 \text{ mm } \checkmark \quad (1)$$

$$1.4 \quad \text{by 300 mm : } a + \frac{b}{0,3^2} = 16,667 \times 10^6 \dots \dots \dots (1) \checkmark$$

$$\text{by 300 mm : } a - \frac{b}{0,3^2} = -65 \times 10^6 \dots \dots \dots (2) \checkmark$$

$$(1) + (2) : 2a = -48,333 \times 10^6$$

$$a = -24,167 \times 10^6 \checkmark$$

$$b = 3,675 \times 10^6 \checkmark$$

$$\text{at } D : \quad a + \frac{b}{D^2} = 0$$

$$-24,167 \times 10^6 + \frac{3,675 \times 10^6}{D^2} = 0$$

$$D = 389,9 \text{ mm } \checkmark$$

(5)  
[13]**VRAAG 2**

$$2.1 \quad y_B = \frac{F_{TB}}{w} = \frac{6000}{40} = 150 \text{ m } \checkmark$$

$$y_A = y_B - h = 150 - 6 = 144 \text{ m } \checkmark$$

$$F_{TA} = wy_A = 40 \times 144 = 5\,760 \text{ N } \checkmark$$

(3)

$$2.2 \quad y_0 = y_A - d = 144 - 4 = 140 \text{ m } \checkmark$$

$$\ell_A = \sqrt{y_A^2 - y_0^2} = \sqrt{144^2 - 140^2} = 33,705 \text{ m } \checkmark$$

$$\ell_B = \sqrt{y_B^2 - y_0^2} = \sqrt{150^2 - 140^2} = 53,852 \text{ m } \checkmark$$

$$\ell_T = \ell_A + \ell_B = 87,556 \text{ m } \checkmark$$

(4)

$$2.3 \quad F_{vc} = w\ell_A = 40 \times 33,705 = 1\,348,184 \text{ N} \checkmark$$

$$F_{va} = F_{TA} \cos \alpha = 5\,760 \times \cos 30 = 4988,306 \text{ N} \checkmark$$

$$F_{va} = F_{va} + F_{vc} = 6336,49 \text{ N} \checkmark \quad (3)$$

$$2.4 \quad F_{Hc} = wy_0 = 40 \times 140 = 5\,600 \text{ N} = F_{Ha} \checkmark$$

$$F_{Ta} = \frac{F_{Ha}}{\sin \theta} = \frac{5\,600}{\sin 30} = 11\,200 \text{ N} \checkmark \quad (2)$$

**[12]****VRAAG 3**

$$3.1 \quad \Delta_1 = \frac{w\ell_1^4}{8EI} + \frac{w\ell_1^3 \times \ell_2}{6EI}$$

$$= \frac{10 \times 10^3 \times 2,5^4}{8 \times 200 \times 10^9 \times I} + \frac{10 \times 10^3 \times 2,5^3 \times 1,5}{6 \times 200 \times 10^9 \times I} \checkmark$$

$$\Delta_1 = \frac{439,453 \times 10^{-9}}{I} \checkmark$$

$$\Delta_2 = \frac{FL^3}{3EI} = \frac{20 \times 10^3 \times 4^3}{3 \times 200 \times 10^9 \times I} = \frac{2,133 \times 10^{-6}}{I} \checkmark$$

$$\Delta_T = \Delta_1 + \Delta_2$$

$$11 \times 10^{-3} = \frac{439,453 \times 10^{-9}}{I} + \frac{2,133 \times 10^{-6}}{I} \checkmark$$

$$I = 233,89 \times 10^{-6} \text{ m}^4 \checkmark$$

$$I = \frac{\pi(D^4 - d^4)}{64}$$

$$233,89 \times 10^{-6} = \frac{\pi((2d)^4 - d^4)}{64} \checkmark$$

$$d = 133,502 \text{ mm} \checkmark$$

$$D = 267,004 \text{ mm} \checkmark$$

(8)

$$3.2 \quad \text{Vir } I = 233,89 \times 10^{-6} \text{ m}^4 \text{ kies } 305 \times 305 \times 118 \text{ kg/m} \checkmark \quad (1)$$

$$3.3 \quad M = FL + \frac{w\ell^2}{2}$$

$$= 20 \times 10^3 \times 4 + \frac{10 \times 10^3 \times 2,5^2}{2} \checkmark$$

$$M = 111,25 \text{ kNm} \checkmark$$

$$\sigma = \frac{M}{Z} = \frac{111,25 \times 10^3}{1755 \times 10^{-6}} = 63,39 \text{ MPa} \checkmark$$

(3)  
[12]**VRAAG 4**

$$4.1 \quad A = \frac{\pi(D^2 - d^2)}{4} = \frac{\pi(3^2 - 2,5^2)}{4} = 2,16 \text{ m}^2 \checkmark$$

$$W = \rho g Ah = 2500 \times 9,81 \times 2,16 \times 15 = 794,553 \text{ kN} \checkmark$$

$$\sigma_D = \frac{W}{A} = \frac{794,553 \times 10^3}{2,16} = 367,875 \text{ kPa (druk)} \checkmark$$

(3)

$$4.2 \quad I = \frac{\pi(D^4 - d^4)}{64} = \frac{\pi(3^4 - 2,5^4)}{64} = 2,059 \text{ m}^4 \checkmark$$

$$M = F \times e = 60 \times 10^3 \times 7,5 = 450 \text{ kNm} \checkmark$$

$$\sigma_b = \frac{MY}{I} = \frac{450 \times 10^3 \times 1,5}{2,059} = 327,892 \text{ kPa} \checkmark$$

(3)

$$4.3 \quad \sigma_{max} = \sigma_d + \sigma_b = 695,767 \text{ kPa} \checkmark \text{ (druk)} \checkmark$$

$$\sigma_{min} = \sigma_d - \sigma_b = 39,983 \text{ kPa} \checkmark \text{ (druk)} \checkmark$$

(4)

$$4.4 \quad Y_0 = \frac{\sigma_d \times I}{M} = \frac{367,875 \times 10^3 \times 2,059}{450 \times 10^3} = 1,683 \text{ m (van sentroïed)} \checkmark$$

$$Y = 1,683 + 1,5 = 3,183 \text{ mm (buite profiel)} \checkmark$$

OR

$$\frac{\sigma_{max}}{x} = \frac{\sigma_{min}}{x - D}$$

$$\frac{695,767}{x} = \frac{39,983}{x - 3} \checkmark$$

$$x = 3,183 \text{ mm (buite profiel)} \checkmark$$

(2)  
[12]**VRAAG 5**

$$5.1 \quad W_1 = \rho g A \ell = 2200 \times 9,81 \times 0,5 \times 5 \times b \times 1 = 53,955b \text{ kN} \checkmark$$

$$W_2 = \rho g A \ell = 2200 \times 9,81 \times 2 \times 5 \times 1 = 215,82 \text{ kN} \checkmark$$

$$V = W_1 + W_2 = 53,955b + 215,82 \text{ kN} \checkmark$$

$$\sigma_{max} = \frac{V}{B} + \frac{6Ve}{B^2} \text{ --- (1)} \checkmark$$

$$\sigma_{min} = \frac{V}{B} - \frac{6Ve}{B^2} \text{ --- (2)} \checkmark$$

$$(1) + (2): 107,91 + 35,97 = \frac{2V}{B} \checkmark$$

$$143,88 = \frac{2(53,955b + 215,82)}{2 + b} \checkmark$$

$$143,88 \times (2 + b) = 2(53,955b + 215,82) \checkmark$$

$$b = 4 \text{ m} \checkmark \text{ and } B = 4 + 2 = 6 \text{ m} \checkmark$$

(10)

$$5.2 \quad V = 53,955b + 215,82 = 53,955 \times 4 + 215,82 = 431,64 \text{ kN} \checkmark$$

$$\sigma_d = \frac{V}{B} = \frac{431,64}{6} = 71,94 \text{ kPa} \checkmark$$

$$\sigma_b = \sigma_{max} - \sigma_d = 107,91 - 71,94 \checkmark = 35,97 \text{ kPa} \checkmark$$

(4)

**[14]****VRAAG 6**

$$6.1 \quad A = \frac{W_T}{p} = \frac{3 \times 10^6}{187,5 \times 10^3} = 16 \text{ m}^2 \checkmark$$

$$L = \sqrt{A} = \sqrt{16} = 4 \text{ m} \checkmark$$

(2)

$$6.2 \quad M = \frac{W(L - \ell)}{8} = \frac{2,5 \times 10^6(4 - 0,8)}{8} = 1 \text{ MNm} \checkmark$$

$$Z = \frac{M}{\sigma \times n} = \frac{1 \times 10^6}{100 \times 10^6 \times 5} = 2 \text{ 000} \times 10^{-6} \text{ m}^3 \checkmark$$

ligste I – balkS is  $533 \times 210 \times 92,5 \text{ kg/m} \checkmark$

(3)

$$6.3 \quad \ell = b \times n + 0,075(n - 1) = 0,2093 \times 5 + 0,075 \times 4 = 1,3465 \text{ m} \checkmark$$

Die gegewe basisplaatafmeting van 1,2 m nie voldoende en moet verander na 1,3465 m ✓

(2)

$$6.4 \quad M = \frac{W(L - \ell)}{8} = \frac{2,5 \times 10^6(4 - 1,3465)}{8} = 829,219 \text{ kNm} \checkmark$$

$$Z = \frac{M}{\sigma \times n} = \frac{829,219 \times 10^3}{100 \times 10^6 \times 10} = 829,219 \times 10^{-6} \text{ m}^3 \checkmark$$

ligste I – balk is  $406 \times 178 \times 53,8 \text{ kg/m} \checkmark$

(3)

$$6.5 \quad \sigma_T = \frac{M}{Z \times n} = \frac{1 \times 10^6}{2076 \times 10^{-6} \times 5} = 96,339 \text{ MPa} \checkmark$$

$$\sigma_B = \frac{M}{Z \times n} = \frac{829,219 \times 10^3}{927,4 \times 10^{-6} \times 10} = 89,413 \text{ MPa} \checkmark$$

(2)  
[12]**VRAAG 7**

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

$$\frac{138}{6} = \frac{15(0,6-n)}{n} \checkmark$$

$$23n = 9 - 15n \checkmark$$

$$n = 0,237 \text{ m} \checkmark$$

(3)

$$7.2 \quad l_a = d - \frac{n}{3} = 0,6 - \frac{0,237}{3} = 0,521 \text{ m} \checkmark$$

$$M = \sigma_s A_s l_a = 138 \times 10^6 \times 2 \times 10^{-3} \times 0,521 = 143,811 \text{ kNm} \checkmark$$

(2)

$$7.3 \quad M = \frac{FL}{4} + \frac{wL^2}{8}$$

$$143,811 = \frac{60 \times 4}{4} \checkmark + \frac{w \times 4^2}{8} \checkmark$$

$$w = 41,905 \text{ kN/m} \checkmark$$

(3)

$$7.4 \quad M = 0,5 \sigma_c A_c l_a$$

$$143,811 \times 10^3 = 0,5 \times 6 \times 10^6 \times b \times 0,237 \times 0,521 \checkmark$$

$$b = 0,388 \text{ m} \checkmark$$

(2)

$$7.5 \quad M_c = 0,5 \sigma_c A_c \frac{2}{3} n$$

$$= 0,5 \times 6 \times 10^6 \times 0,388 \times 0,237 \times \frac{2}{3} \times 0,237 \checkmark$$

$$M_c = 43,579 \text{ kNm} \checkmark$$

(2)

$$7.6 \quad M_s = \sigma_s A_s (d-n)$$

$$= 138 \times 10^6 \times 2 \times 10^{-3} (0,6 - 0,237) \checkmark$$

$$M_s = 100,232 \text{ kNm} \checkmark$$

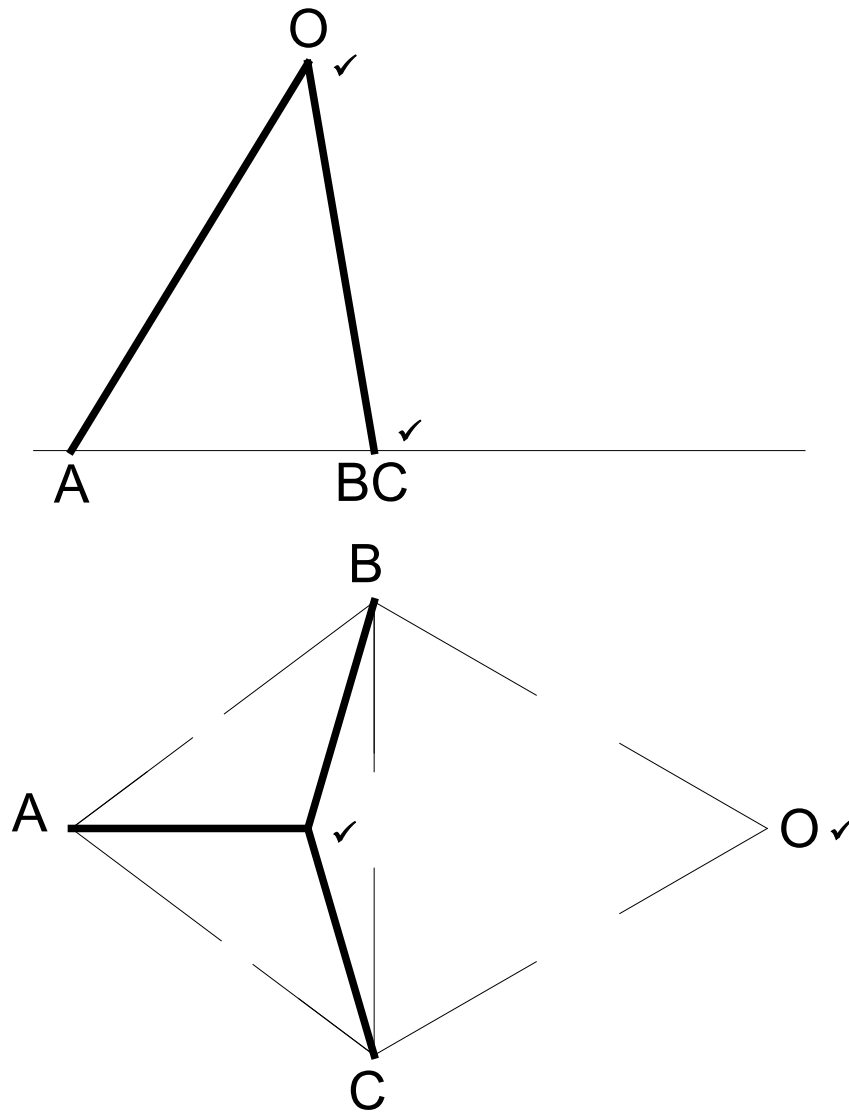
(2)

[14]



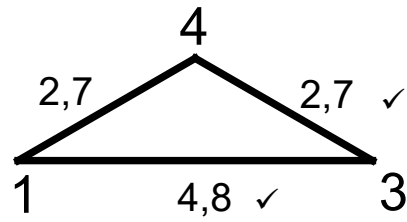
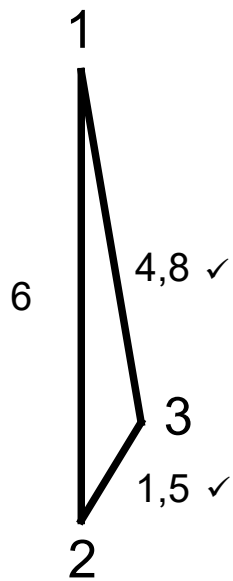
**VRAAG 8**

8.1



(4)

8.2



MEMBER	MAGNITUDE	NATURE
OA (2-3)	9 kN ✓	Strut
OB (3-4)	16,2 kN ✓	Strut
OC (1-4)	16,2 kN ✓	Strut

(7)  
[11]

**TOTAAL: 100**