



**higher education  
& training**

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

# **NASIENRIGLYN**

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

**12 AUGUSTUS 2019**

**Hierdie nasienriglyn bestaan uit 8 bladsye.**

**VRAAG 1**

1.1 by 200 mm :  $a + \frac{b}{0,2^2} = 30 \times 10^6 \dots\dots\dots (1) \checkmark$

by 140 mm :  $a + \frac{b}{0,14^2} = 0 \dots\dots\dots (2) \checkmark$

(1) – (2) :  $25b - 51,02b = 30 \times 10^6$

$b = -1,153 \times 10^6 \checkmark$

$a = 58,824 \times 10^6 \checkmark$

$\sigma_{Hmin} = a - \frac{b}{0,2^2} = 58,824 \times 10^6 - \frac{(-1,153 \times 10^6)}{0,2^2} \checkmark = 87,647 \text{ MPa} \checkmark$  (6)

1.2 by 200 mm :  $a + \frac{b}{0,2^2} = 30 \times 10^6 \dots\dots\dots (1) \checkmark$

by 250 mm :  $a + \frac{b}{0,25^2} = 0 \dots\dots\dots (2) \checkmark$

(1) – (2) :  $25b - 16b = 30 \times 10^6$

$b = 3,333 \times 10^6 \checkmark$

$a = -53,333 \times 10^6 \checkmark$

$\sigma_{Hmaks} = a - \frac{b}{0,2^2} = -53,333 \times 10^6 - \frac{(3,333 \times 10^6)}{0,2^2} \checkmark = -136,667 \text{ MPa} \checkmark$  (6)

1.3  $\delta d_1 = \frac{D_c}{E} (\sigma_H - \nu \times \sigma_R)$

$= \frac{0,2}{200 \times 10^9} (87,647 \times 10^6 - 0,3 \times 30 \times 10^6)$

$\delta d_1 = 78,647 \times 10^{-6} \text{ m} \checkmark$  (1)

1.4  $\delta d_2 = \frac{D_c}{E} (\sigma_H - \nu \times \sigma_R)$

$= \frac{0,2}{200 \times 10^9} (-136,667 \times 10^6 - 0,3 \times 30 \times 10^6)$

$\delta d_2 = -145,667 \times 10^{-6} \text{ m} \checkmark$  (1)

1.5  $\Delta d = \delta d_1 - \delta d_2$   
 $= 78,647 \times 10^{-6} - (-145,667 \times 10^{-6})$

$\Delta d = 0,224 \text{ mm} \checkmark$  (1)

**[15]**

**VRAAG 2**

$$2.1 \quad M = \frac{wL^2}{8} = \frac{12 \times 10^3 \times 4^2}{8} = 24 \text{ kNm} \checkmark$$

$$Z = \frac{M}{\sigma} = \frac{24 \times 10^3}{80 \times 10^6} = 300 \times 10^{-6} \text{ m}^3 \checkmark$$

*Ligste profiel is 305 × 102 × 28,6 kg/m* ✓ ( $Z = 352,1 \times 10^{-6} \text{ m}^3$ ) (3)

$$2.2 \quad y = \frac{5wL^4}{384EI}$$

$$\frac{4}{360} \checkmark = \frac{5 \times 12 \times 10^3 \times 4^4}{384 \times 207 \times 10^9 \times I}$$

$$I = 17,391 \times 10^{-6} \text{ m}^4 \checkmark$$

*Ligste profiel is 305 × 102 × 24,5 kg/m* ✓ ( $I = 43,64 \times 10^{-6} \text{ m}^4$ ) (3)

2.3 *Korrekte profiel is 305 × 102 × 28,6kg/m* ✓

*Hierdie profiel sal sowel spanning – as defleksiegrense bevredig* ✓ (2)

$$2.4 \quad \sigma = \frac{M}{Z} = \frac{24 \times 10^3}{352,1 \times 10^{-6}} = 68,162 \text{ MPa} \checkmark$$

$$y = \frac{5wL^4}{384EI} = \frac{5 \times 12 \times 10^3 \times 4^4}{384 \times 207 \times 10^9 \times 43,64 \times 10^{-6}} = 4,428 \text{ mm} \checkmark$$

(2)  
**[10]**

**VRAAG 3**

$$3.1 \quad A = \frac{\pi(D^2 - d^2)}{4} = \frac{\pi \times (2,8^2 - 2,6^2)}{4} = 0,848 \text{ m}^2 \checkmark$$

$$I = \frac{\pi(D^4 - d^4)}{64} = \frac{\pi(2^4 - 1,9^4)}{64} = 0,774 \text{ m}^4 \checkmark$$

$$W = \rho Ahg = 2400 \times 0,848 \times h \times 9,81 = 19970,728h \checkmark$$

$$F = p \times A_p = 1,2 \times 10^3 \times 2,8 \times h \times 0,6 = 2016h \checkmark$$

$$\sigma_d = \frac{W}{A} = \frac{19970,728h}{0,848} = 23544h \checkmark$$

$$\sigma_b = \frac{FeY}{I} = \frac{2016h \times 0,5h \times 1,4}{0,774} = 1823,233h^2 \checkmark$$

vir geen spanning  $\sigma_b = \sigma_d$

$$1823,233h^2 = 23544h \checkmark$$

$$h = 14,559 \text{ m} \checkmark$$

(8)

$$3.2 \quad \sigma_d = 23544h = 23544 \times 14,559 = 342,771 \text{ kPa} = \sigma_b \checkmark$$

$$\sigma_{max} = \sigma_d + \sigma_b = 342,771 + 342,771 = 685,543 \text{ kPa} \checkmark \text{ kompressie} \checkmark$$

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

$$4.1 \quad W_1 = \rho g Al = 2000 \times 9,81 \times 1,2 \times 2,5 \times 1 = 58,86 \text{ kN} \checkmark$$

$$V = W_1 + W_2 = 47,677 + 100 = 158,86 \text{ kN} \checkmark \quad (2)$$

$$4.2 \quad C_\mu = \frac{1 - \sin 30}{1 + \sin 30} = 0,333 \checkmark$$

$$F_g = \frac{\rho gh^2}{2} \times C_\mu = \frac{1680 \times 9,81 \times 2,5^2 \times 0,333}{2} = 17,168 \text{ kN} \checkmark \quad (2)$$

$$4.3 \quad W \sim M = W_1 \times x_1 + W_2 \times x_2 = 58,86 \times 0,6 + 100 \times 0,4 = 75,316 \text{ kNm} \checkmark$$

$$F \sim M = F_g \times \frac{h}{3} = 17,168 \times 0,833 = 14,306 \text{ kNm} \checkmark$$

$$V \times x + F \sim M = W \sim M$$

$$158,86 \times x + 14,306 = 75,316 \checkmark$$

$$x = 0,384 \text{ m} \checkmark$$

$$\text{Daar sal spanning wees omdat } x < \frac{B}{3} \checkmark \text{ (val buite middelste derde)} \quad (5)$$

$$4.4 \quad e = 0,5B - x = 0,6 - 0,384 = 0,216 \text{ m} \checkmark$$

$$\sigma_{toe} = \frac{V}{B} + \frac{6Ve}{B^2} = \frac{158,86}{1,2} + \frac{6 \times 158,86 \times 0,216}{1,2^2} = 275,326 \text{ kPa (komp)} \checkmark$$

$$\sigma_{heel} = \frac{V}{B} - \frac{6Ve}{B^2} = \frac{158,86}{1,2} - \frac{6 \times 158,86 \times 0,216}{1,2^2} = -10,559 \text{ kPa (trek)} \checkmark \quad (3)$$

$$4.5 \quad \sigma_{ult} = \sigma_{max} \times FOS = 275,326 \times 3 \checkmark = 825,978 \text{ kPa} \checkmark \quad (2)$$

[14]

**VRAAG 5**

$$5.1 \quad L = \sqrt{\frac{W_T}{p}} = \sqrt{\frac{2,4 \times 10^6 + 300 \times 10^3}{200 \times 10^3}} \checkmark = 3,674 \text{ m} \checkmark$$

$$5.2 \quad M = \frac{W(L-l)}{8} = \frac{2,4 \times 10^6(3,674 - 0,8)}{8} \checkmark = 862,27 \text{ kNm} \checkmark$$

$$5.3 \quad Z = \frac{M}{\sigma \times n} = \frac{862,27 \times 10^3}{110 \times 10^6 \times 5} = 1567,764 \times 10^{-6} \text{ m}^3 \checkmark$$

$$\text{Ligste I - balk is } 457 \times 191 \times 82 \text{ kg/m} \checkmark \text{ (Z = } 1612 \times 10^{-6} \text{ m}^3)$$

$$5.4 \quad l = b \times n + 0,075(n-1) = 0,1913 \times 5 + 0,075 \times 4 \checkmark = 1,2565 \text{ m} \checkmark$$

$$5.5 \quad M = \frac{W(L-l)}{8} = \frac{2,4 \times 10^6(3,674 - 1,2565)}{8} \checkmark = 725,32 \text{ kNm} \checkmark$$

$$5.6 \quad Z = \frac{M}{\sigma \times n} = \frac{725,32 \times 10^3}{110 \times 10^6 \times 10} = 659,382 \times 10^{-6} \text{ m}^3 \checkmark$$

$$\text{Ligste I - balk is } 356 \times 171 \times 44,8 \text{ kg/m} \checkmark \text{ (Z = } 686,1 \times 10^{-6} \text{ m}^3)$$

(6 × 2) [12]



**VRAAG 7**

$$7.1 \quad \frac{wx_1^2}{2d} = \frac{w(L - x_1)^2}{2(d + h)}$$

$$\frac{x_1^2}{8} = \frac{(160 - x_1)^2}{14} \quad \checkmark$$

$$\frac{160 - x_1}{x_1} = \sqrt{\frac{14}{8}} \quad \checkmark$$

$$x_1 = 68,88 \text{ m} \quad \checkmark \quad (3)$$

$$7.2 \quad F_H = \frac{wx_1^2}{2d} = \frac{15 \times 10^3 \times 68,88^2}{2 \times 8} \quad \checkmark = 4447,944 \text{ kN} \quad \checkmark \quad (2)$$

$$7.3 \quad F_{v2} = wx_2 = 15 \times 10^3 \times 91,12 = 1366,798 \text{ kN} \quad \checkmark$$

$$F_{T2} = \sqrt{F_H^2 + F_{v2}^2} = \sqrt{4447,944^2 + 1366,798^2} = 4653,208 \text{ kN} \quad \checkmark \quad (2)$$

$$7.4 \quad \text{By } 120 \text{ m vaaf laer steunstuk: } x_3 = 120 - x_1 = 51,12 \text{ m} \quad \checkmark$$

$$F_{v3} = wx_3 = 15 \times 10^3 \times 51,12 = 766,798 \text{ kN} \quad \checkmark$$

$$F_{T3} = \sqrt{F_H^2 + F_{v3}^2} = \sqrt{4447,944^2 + 766,798^2} = 4513,556 \text{ kN} \quad \checkmark \quad (3)$$

**[10]****VRAAG 8**

$$8.1 \quad R_L \times 1,2 = 2600 \times 0,8 + 981 \times 0,4 + 600 \times 1,2 \times 0,6 \quad \checkmark$$

$$R_L = 2420,333 \text{ N} \quad \checkmark$$

$$R_R \times 1,2 = 2600 \times 0,4 + 981 \times 0,8 + 600 \times 1,2 \times 0,6 \quad \checkmark$$

$$R_R = 1880,667 \text{ N} \quad \checkmark \quad (4)$$

$$8.2 \quad M = 2420,333 \times 0,4 - 600 \times 0,4 \times 0,2 \quad \checkmark = 920,133 \text{ Nm} \quad \checkmark \quad (2)$$

$$8.3 \quad T = (T_1 - T_2)r = (2000 - 600)0,2 = 280 \text{ Nm} \quad \checkmark \quad (1)$$

$$8.4 \quad M_e = 0,5 \left( M + \sqrt{M^2 + T^2} \right) = 0,5 \left( 920,13 + \sqrt{920,13^2 + 280^2} \right) = 940,963 \text{ Nm} \checkmark$$

$$M_e = \frac{\pi d^3 \sigma}{32}$$

$$940,963 = \frac{\pi \times d^3 \times 70 \times 10^6}{32} \checkmark$$

$$d = 51,542 \text{ mm} \checkmark$$

(3)

$$8.5 \quad M_e = \frac{\pi(D^4 - d^4)\sigma}{32D}$$

$$940,963 = \frac{\pi \times [D^4 - (0,5)^4] \times 70 \times 10^6}{32D}$$

$$940,963 = \frac{\pi \times (0,9375D^4)70 \times 10^6}{32D} \checkmark$$

$$D = 52,662 \text{ mm} \checkmark$$

$$d = 26,331 \text{ mm} \checkmark$$

(3)

$$8.6 \quad \% \text{ besparing} = \frac{d_s^2 - (D^2 - d^2)}{d_s^2} = \frac{51,542^2 - (52,662^2 - 26,331^2)}{51,542^2} \checkmark$$

$$= 21,7\% \checkmark$$

(2)

**[15]****TOTAAL: 100**