



**higher education  
& training**

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

# **NASIENRIGLYN**

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

**6 AUGUSTUS 2018**

**Hierdie nasienriglyn bestaan uit 8 bladsye.**

## VRAAG 1

- 1.1
- $$\text{at } 80 \text{ mm} : a - \frac{b}{0,08^2} = -54 \times 10^6 \dots\dots\dots (1) \checkmark$$
- $$\text{at } 120 \text{ mm} : a + \frac{b}{0,12^2} = 0 \dots\dots\dots (2) \checkmark$$
- $$(1) - (2) : 156,25b - 69,444b = -54 \times 10^6$$
- $$b = 239,262 \times 10^3 \checkmark$$
- $$a = -16,615 \times 10^6 \checkmark$$
- $$\text{at } 80 \text{ mm} : \sigma_R = a + \frac{b}{0,08^2}$$
- $$= -16,615 \times 10^6 - \frac{239,262 \times 10^3}{0,08^2}$$
- $$\sigma_R = 20,769 \text{ MPa} \checkmark \quad (5)$$
- 1.2
- $$W = p \times A = 20,769 \times 10^6 \times \pi \times 0,04^2 = 104,398 \text{ kN} \checkmark$$
- $$m = \frac{W}{g} = \frac{104,398 \times 10^3}{9,81} = 10641,951 \text{ kg} \checkmark \quad (2)$$
- 1.3
- $$\sigma_L = \frac{pd^2}{D^2 - d^2} = \frac{20,769 \times 10^6 \times 0,08^2}{0,12^2 - 0,08^2} \checkmark = 16,615 \text{ MPa} \checkmark \quad (2)$$
- 1.4
- $$\epsilon = \frac{(\sigma_H - \nu \times \sigma_R)}{E} = \frac{-54 \times 10^6 - 0,29 \times 20,769 \times 10^6}{200 \times 10^9} \checkmark = -300,115 \times 10^{-6} \checkmark \quad (2)$$
- 1.5
- $$\Delta d = \epsilon \times d = -300,115 \times 10^{-6} \times 0,08 \checkmark = 24,009 \times 10^{-6} \text{ m} \checkmark \quad (2)$$

**[13]**

**VRAAG 2**2.1 *Consider the deflection limit*

$$\Delta = \frac{wl_1^4}{8EI} + \frac{wl_1^3 \times l_2}{6EI}$$

$$0,013 = \frac{10 \times 10^3 \times 4^4}{8 \times 200 \times 10^9 \times I} + \frac{10 \times 10^3 \times 4^3 \times 3}{6 \times 200 \times 10^9 \times I} \checkmark$$

$$I = 246,154 \times 10^{-6} \text{ m}^4 \checkmark$$

Select  $457 \times 191 \times 67,1 \text{ kg/m} \checkmark$ *Consider the stress limit*

$$M = \frac{wl^2}{2} = \frac{10 \times 10^3 \times 4^2}{2} = 80 \text{ kNm} \checkmark$$

$$Z = \frac{M}{\sigma} = \frac{80 \times 10^3}{90 \times 10^6} = 888,889 \times 10^{-6} \text{ m}^3 \checkmark$$

Select  $406 \times 178 \times 53,8 \text{ kg/m} \checkmark$ Correct profile =  $457 \times 191 \times 67,1 \text{ kg/m} \checkmark$ This profile will satisfy both limits  $\checkmark$ 

(8)

2.2

$$\Delta = \frac{wl_1^4}{8EI} + \frac{wl_1^3 \times l_2}{6EI}$$

$$= \frac{10 \times 10^3 \times 4^4}{8 \times 200 \times 10^9 \times 294,1 \times 10^{-6}} + \frac{10 \times 10^3 \times 4^3 \times 3}{6 \times 200 \times 10^9 \times 294,1 \times 10^{-6}} \checkmark$$

$$\Delta = 10,88 \text{ mm} \checkmark$$

$$\sigma = \frac{M}{Z} = \frac{80 \times 10^3}{1297 \times 10^{-6}} \checkmark = 61,681 \text{ MPa} \checkmark$$

(4)

[12]

**VRAAG 3**

3.1

$$\sigma_d = \frac{F}{A} = \frac{180 \times 10^3}{2 \times 1,787 \times 10^{-3}} \checkmark = 50,364 \text{ MPa} \checkmark$$

(2)

3.2

$$M = \frac{wL^2}{2} = \frac{2 \times 137,34 \times 4^2}{2} = 2,197 \text{ kNm} \checkmark$$

$$\sigma_{bmin} = \frac{MY}{I} = \frac{2,197 \times 10^3 \times 0,0241}{2 \times 1,017 \times 10^{-6}} = 26,0365 \text{ MPa} \checkmark \text{ (tensile)} \checkmark$$

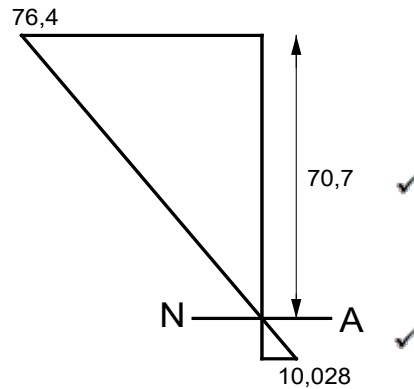
$$\sigma_{bmax} = \frac{MY}{I} = \frac{2,197 \times 10^3 \times 0,0559}{2 \times 1,017 \times 10^{-6}} = 60,392 \text{ MPa} \checkmark \text{ (compressive)} \checkmark$$

(5)

3.3  $\sigma_{max} = \sigma_d + \sigma_b = 50,364 + 26,0365 = 76,4 \text{ MPa} \checkmark \text{ (tensile)} \checkmark$   
 $\sigma_{max} = \sigma_d - \sigma_b = 50,364 - 60,392 = 10,028 \text{ MPa} \checkmark \text{ (compressive)} \checkmark$  (4)

3.4  $\frac{x}{76,4} = \frac{80-x}{10,028} \checkmark$

= 70,7 mm from the top  $\checkmark$



(4)  
[15]

**VRAAG 4**

4.1  $W_1 = \rho g A l = 2200 \times 9,81 \times 0,5 \times 4 \times y \times 1 = 43,164y \text{ kN} \checkmark$   
 $W_2 = \rho g A l = 2200 \times 9,81 \times 1,5 \times 4 \times 1 = 129,492 \text{ kN} \checkmark$   
 $V = W_1 + W_2 = 43,164y + 129,492 \text{ kN} \checkmark$

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

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

(1) + (2):  $91,342 + 38,15 = \frac{2V}{B} \checkmark$

$129,492 = \frac{2(43,164y + 129,492)}{1,5 + y} \checkmark$

$129,492 \times (1,5 + y) = 2(43,164y + 129,492) \checkmark$

$y = 1,5 \text{ m} \checkmark \text{ and } B = 1,5 + 1,5 = 3 \text{ m} \checkmark$

(10)

4.2  $V = 43,164y + 129,492 = 43,164 \times 1,5 + 129,492 = 194,238 \text{ kN} \checkmark$

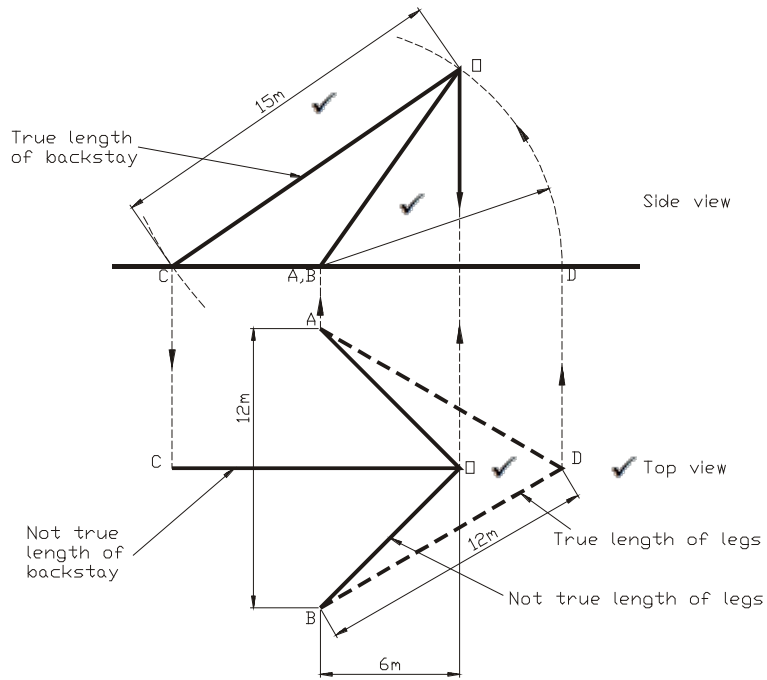
$\sigma_d = \frac{V}{B} = \frac{194,238}{3} = 64,746 \text{ kPa} \checkmark$

$\sigma_b = \sigma_{max} - \sigma_d = 91,342 - 64,746 \checkmark = 26,596 \text{ kPa} \checkmark$

(4)  
[14]

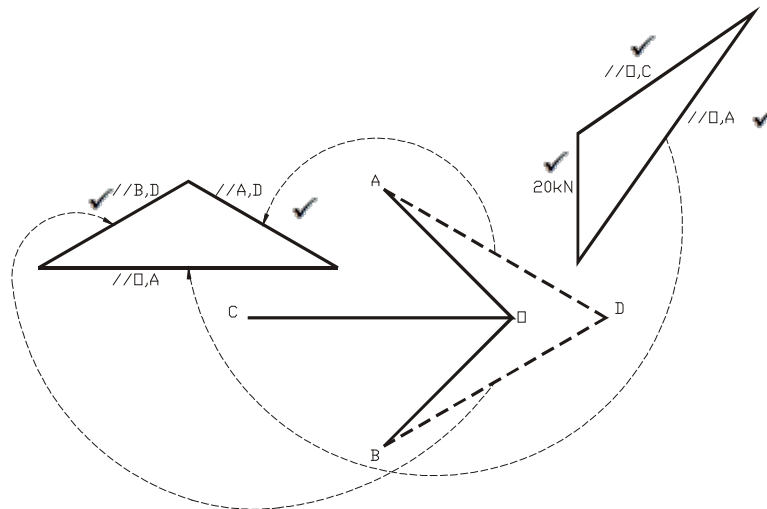
**VRAAG 5**

5.1



(4)

5.2



(5)

5.3

DEEL	OPMANG	AARD
OC	33,3 kN ✓	BIND ✓
OA	27,4 kN ✓	STUT ✓
OB	27,4 kN ✓	STUT ✓

(3)  
[12]

**VRAAG 6**

$$6.1 \quad \frac{\sigma_s}{\sigma_c} = \frac{m(d-n)}{n}$$

$$\frac{140}{7} = \frac{15(0,8-n)}{n} \checkmark$$

$$n = 0,343 \text{ m} \checkmark \quad (2)$$

$$6.2 \quad M = 0,5\sigma_c A_c l_\alpha = 0,5 \times 7 \times 10^6 \times 0,35 \times 0,343 \times 0,686 \checkmark = 288 \text{ kNm} \checkmark \quad (2)$$

$$6.3 \quad M = \sigma_s A_s l_\alpha$$

$$288 \times 10^3 = 140 \times 10^6 \times A_s \times 0,686 \checkmark$$

$$A_s = 3 \times 10^{-3} \text{ m}^2 \checkmark$$

Select 203 × 102 × 25.3 kg/m<sup>3</sup> ✓

$$(3)$$

$$6.4 \quad M = \sigma_s A_s l_\alpha$$

$$288 \times 10^3 = \sigma_s \times 3,226 \times 10^{-3} \times 0,686 \checkmark$$

$$\sigma_s = 130,192 \text{ MPa} \checkmark \quad (2)$$

$$6.5 \quad M_c = 0,5\sigma_c A_c \frac{2}{3}n$$

$$= 0,5 \times 7 \times 10^6 \times 0,35 \times 0,343 \times \frac{2}{3} \times 0,343 \checkmark$$

$$M_c = 96 \text{ kNm} \checkmark$$

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

$$= 130,192 \times 10^6 \times 3,226 \times 10^{-6} (0,8 - 0,343) \checkmark$$

$$M_s = 192 \text{ kNm} \checkmark \quad (4)$$

**[13]**

**VRAAG 7**

7.1

$$\frac{x}{L-x} = \sqrt{\frac{d}{d+h}}$$

$$\frac{x}{130-x} = \sqrt{\frac{8}{12}} \checkmark$$

$$x = 58,434 \text{ m} \checkmark \quad (2)$$

7.2

$$F_H = \frac{wx_1^2}{2d} = \frac{12 \times 58,434^2}{2 \times 8} = 2560,87 \text{ kN} \checkmark$$

$$F_{V2} = wx_2 = 12 \times 71,566 = 858,796 \text{ kN} \checkmark$$

$$F_{T2} = \sqrt{F_H^2 + F_{V2}^2} = \sqrt{2560,87^2 + 858,796^2} = 2701,0342 \text{ kN} \checkmark \quad (3)$$

7.3

$$F_{V\alpha} = F_H \tan \theta = 2560,87 \times \tan 40 = 2148,825 \text{ kN} \checkmark$$

$$R = F_{V2} + F_{V\alpha} = 858,796 + 2148,825 = 3007,621 \text{ kN} \checkmark \quad (2)$$

7.4

$$x_3 = 80 - 58,434 = 21,566 \text{ m} \checkmark$$

$$F_{V3} = wx_3 = 12 \times 21,566 = 258,796 \text{ kN} \checkmark$$

$$F_{T3} = \sqrt{F_H^2 + F_{V3}^2} = \sqrt{2560,87^2 + 258,786^2} = 2573,914 \text{ kN} \checkmark \quad (3)$$

**[10]**

**VRAAG 8**

$$8.1 \quad \tau = \frac{\tau_{ult}}{FOS} = \frac{200}{4} = 50 \text{ MPa} \checkmark$$

$$T_e = \frac{\pi(D^4 - d^4)\tau}{16D} = \frac{\pi(0,1^4 - 0,075^4) \times 50 \times 10^6}{16 \times 0,1} \checkmark = 6711,166 \text{ Nm} \checkmark$$

$$T_e = \sqrt{T^2 + M^2}$$

$$6711,166 = \sqrt{(T)^2 + (3T)^2} \checkmark$$

$$T = 2122,257 \text{ Nm} \checkmark$$

$$M = 6366,771 \text{ Nm} \checkmark$$

(6)

$$8.2 \quad M_e = 0,5(M + T_e)$$

$$= 0,5(6366,771 + 6711,166)$$

$$M_e = 6538,968 \text{ Nm} \checkmark$$

$$\sigma = \frac{32 \times M_e \times D}{\pi \times (D^4 - d^4)} = \frac{32 \times 6538,968 \times 0,1}{\pi \times (0,1^4 - 0,075^4)} \checkmark = 97,434 \text{ MPa} \checkmark$$

(3)

$$8.3 \quad d^3 = \frac{D^4 - d^4}{D} = \frac{0,1^4 - 0,075^4}{0,1} = 683,59375 \times 10^{-6} \checkmark$$

$$d = 88,1 \text{ mm} \checkmark$$

(2)

**[11]****TOTAAL: 100**