



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT STERKTE- EN STRUKTUURLEER N5

23 April 2021

Hierdie nasienriglyn bestaan uit 5 bladsye.

VRAAG 1

$$1.1 \quad \sigma_{max} = \frac{F}{A_{least}} = \frac{70\,000}{\frac{\pi}{4}(0,04^2 - 0,022^2)} = 79,863 \text{ MPa} \quad (4)$$

$$1.2 \quad \sigma_{min} = \frac{F}{A_{max}} = \frac{70\,000}{\frac{\pi}{4}(0,04^2)} = 55,704 \text{ MPa} \quad (3)$$

$$1.3 \quad \varepsilon_H = \frac{\sigma_H}{E} = \frac{79,863 \times 10^6}{190 \times 10^9} = 4,203 \times 10^{-4} \quad \checkmark$$

$$\varepsilon_S = \frac{\sigma_S}{E} = \frac{55,704 \times 10^6}{190 \times 10^9} = 2,932 \times 10^{-4} \quad \checkmark$$

$$\varepsilon_T = \varepsilon_H + \varepsilon_S = 4,203 \times 10^{-4} + 2,932 \times 10^{-4} = 7,135 \times 10^{-4} \quad \checkmark \quad (7)$$

$$1.4 \quad X_H = \frac{\varepsilon_H}{L} = \frac{4,203 \times 10^{-4}}{(0,124 - 0,08)} = 9,552 \times 10^{-3} \quad \checkmark \quad (4)$$

$$1.5 \quad U_H = \frac{1}{2} \cdot F \cdot X_H = \frac{1}{2} \cdot (70\,000) \cdot (9,552 \times 10^{-3}) = 334,32 \text{ J} \quad \checkmark \quad (4)$$

[22]

VRAAG 2

$$2.1 \quad A_S = \frac{\pi}{4} \cdot (0,015^2) \cdot 3 = 5,301 \times 10^{-4} \text{ m}^2$$

$$A_T = \frac{\pi}{4} \cdot (0,15^2) = 17,671 \times 10^{-3} \text{ m}^2$$

$$A_C = A_T - A_S = 17,141 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$F_T = F_C + F_S = 300\,000 \text{ N} \quad \checkmark$$

$$X_C = X_S$$

$$\frac{F_C \cdot L_C}{A_C \cdot E_C} = \frac{F_S \cdot L_S}{A_S \cdot E_S} \quad \checkmark$$

$$\therefore F_C = \left(\frac{17,141 \times 10^{-4} \cdot (18 \times 10^9)}{5,301 \times 10^{-4} \cdot (210 \times 10^9)} \right) \cdot F_S \quad \checkmark$$

$$\therefore F_C = 0,277 \cdot F_S \quad \checkmark$$

$$F_T = 0,277 \cdot F_S + F_S = 300\,000 \text{ N} \quad \checkmark$$

$$\therefore F_S = 234\,896,058 \text{ N} \quad \checkmark$$

$$\therefore F_C = 300\,000 - 234\,896,058 = 65\,103,943 \text{ N} \quad \checkmark$$

$$\therefore \sigma_C = \frac{65\,103,943}{17,141 \times 10^{-3}} = 3,798 \text{ MPa} \quad \checkmark$$

$$\therefore \sigma_S = \frac{234\,896,058}{5,301 \times 10^{-4}} = 443,117 \text{ MPa} \quad \checkmark$$

(14)

$$\begin{aligned}
 2.2 \quad X_C &= X_S \quad \checkmark \\
 \frac{\sigma_c \cdot L_C}{E_C} &= \frac{\sigma_s \cdot L_S}{E_S} \quad \checkmark \\
 \therefore \sigma_s &= \frac{210 \times 10^9 \cdot (6,23 \times 10^6)}{18 \times 10^9} = 72,683 \text{ MPa} \quad \checkmark \\
 F_C + F_S &= 800\,000 \quad \checkmark \\
 \sigma_c \cdot A_C + \sigma_s \cdot A_S &= 800\,000 \\
 6,23 \times 10^6 \cdot (0,0176 - A_S) + 72,683 \times 10^6 \cdot A_S &= 800\,000 \\
 \therefore A_S &= \frac{800\,000 - 109\,648}{66,453 \times 10^6} = 10,389 \times 10^{-3} \text{ m}^2 \quad \checkmark
 \end{aligned}
 \tag{8}$$

$$\begin{aligned}
 2.3 \quad m &= \frac{E_S}{E_C} = \frac{210}{18} = 11,667 \approx 12 \quad \checkmark \\
 &\text{(Staal is 12 x sterker as beton)} \quad \checkmark
 \end{aligned}
 \tag{3}$$

[25]

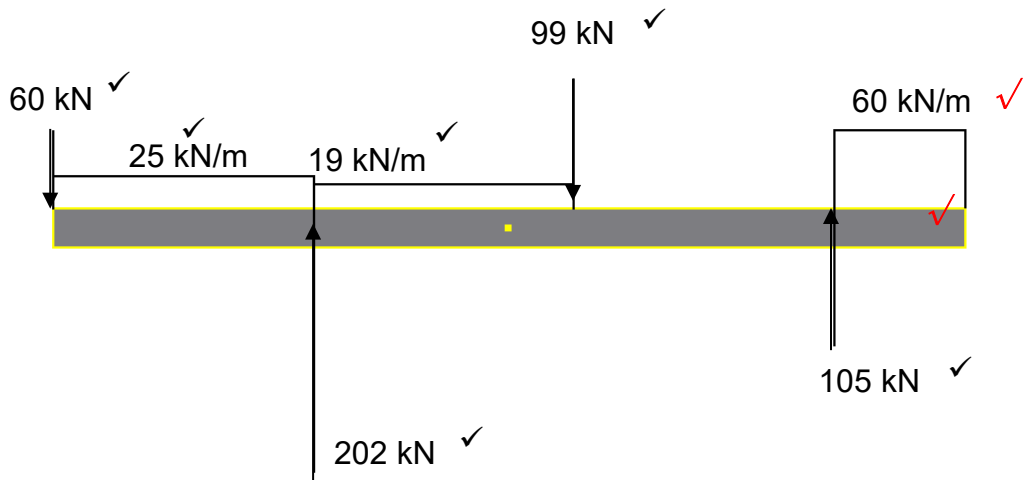
VRAAG 3

$$t = \frac{p_i \cdot D}{2 \cdot \sigma_t \cdot \eta} = \frac{4 \times 10^6 \cdot (3,2)}{2 \cdot (120 \times 10^6) \cdot (0,75)} = 0,071 \text{ m} = 71,111 \text{ mm} \quad \checkmark$$

[4]

VRAAG 4

4.1



FIGUUR 1

(8)

$$\begin{aligned}
 4.2 \quad BM_B &= 60 \cdot (2) + 25 \cdot (2) \cdot \left(\frac{2}{2}\right) = 170 \text{ kN/m} \quad \checkmark \\
 BM_C &= 60 \cdot (4) + 25 \cdot (2) \cdot \left(\frac{2}{2} + 2\right) - 202 \cdot (2) + 19 \cdot (2) \cdot \left(\frac{2}{2}\right) = 24 \text{ kN/m} \quad \checkmark
 \end{aligned}$$

(5)
[13]

VRAAG 5

$$I_{X1} = \frac{1}{12} \cdot (0,1) \cdot (0,006^3) = 18 \times 10^{-9}$$

$$I_{Y2} = 15,13 \times 10^{-6} \checkmark$$

$$I_{XT} = 2 \cdot (18 \times 10^{-9}) + 15,13 \times 10^{-6} = 15,134 \times 10^{-6} \checkmark$$

$$I_{X1} = \frac{1}{12} \cdot (0,006) \cdot (0,1^3) = 0,5 \times 10^{-6}$$

$$I_{Y2} = 1,385 \times 10^{-6} \checkmark$$

$$I_{YT} = 2 \cdot (0,5 \times 10^{-6}) + 1,385 \times 10^{-6} = 2,385 \times 10^{-6} \checkmark$$

$$\therefore I_{least} = 2,385 \times 10^{-6} \checkmark$$

$$A_T = 2 \cdot (0,1 \times 0,006) + 2,73 \times 10^{-3} = 3,93 \times 10^{-3}$$

$$L_E = 12 \times 0,5 = 6 \text{ m} \checkmark$$

$$k = \sqrt{\frac{2,385 \times 10^{-6}}{3,93 \times 10^{-3}}} \neq 0,025 \checkmark$$

$$SR = \frac{6}{0,025} = 243,559 \checkmark$$

$$P_R = \frac{\sigma \cdot A}{1+a \cdot (SR^2)} = \frac{125 \times 10^6 \cdot (3,93 \times 10^{-3})}{1+a \cdot (243,559^2)} = 110\,000 \text{ N} \checkmark \checkmark$$

$$\therefore a = 5,843 \times 10^{-5} \checkmark$$

[19]**VRAAG 6**

Oorweeg die skuifspanningsperk:

$$T = \frac{\pi \cdot D^3 \cdot \tau}{16} = \frac{\pi \cdot (0,063^3) \cdot (55 \times 10^6)}{16} = 2700,314 \text{ Nm} \checkmark$$

Oorweeg die wringhoekperk:

$$T = \frac{\pi \cdot D^4 \cdot G \cdot \theta}{32 \cdot L} = \frac{\pi \cdot (0,063^4) \cdot (70 \times 10^9) \cdot (\frac{1}{57,3})}{32 \cdot (0,6)} = 3\,148,867 \text{ Nm} \checkmark$$

Maksimum wringkrag:

$$T = 2\,700,314 \text{ Nm (verkleinde waarde)}$$

Die kleiner wringkrag sal verseker dat die skuifspanning en die wringhoek binne die gegewe perke is.

[10]

VRAAG 7

7.1	<ul style="list-style-type: none">• Beskermende bedekking• Katodiese beskerming	(Enige ander toepaslike antwoord)	(2)
7.2	<ul style="list-style-type: none">• Elektroplatering• Galvanisering• Anodisering• Verchroming• Metaalspuitverf•	(Enige ander toepaslike antwoord)	(5) [7]
TOTAAL:			100