



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT STERKTE- EN STRUKTUURLEER N5

8 AUGUST 2018

Hierdie nasienriglyn bestaan uit 9 bladsye.

VRAAG 1

1.1

$$X_T = F \cdot \left(\frac{L_1}{A_1 \cdot E_1} + \frac{L_2}{A_2 \cdot E_2} + \frac{L_3}{A_3 \cdot E_3} \right)$$

$$0,201 \times 10^3 = F \cdot \left[\frac{0,1}{(1,59 \times 10^3) \cdot (200 \times 10^9)} + \frac{0,08}{(7,069 \times 10^4) \cdot (80 \times 10^9)} + \frac{0,08}{(3,801 \times 10^4) \cdot (70,5 \times 10^9)} \right]$$

□ $F = 42634,426 \text{ N}$ ✓ (4)

1.2

$$X_{\text{sin gle}} = \frac{F \cdot L}{A \cdot E}$$

$$0,201 \times 10^3 = \frac{42634,426 \cdot (0,26)}{A \cdot (200 \times 10^9)}$$

□ $A = 2,7575 \times 10^4 \text{ m}^2$ ✓

$$A = 2,7575 \times 10^4 = \frac{\pi}{4} \cdot [(1,2^2) \cdot d^2 + d^2]$$

□ $d = 28,248 \text{ mm}$ ✓

$D = 33,897 \text{ mm}$ ✓ (6)

[10]

VRAAG 2

2.1

$$\eta_{\text{joint}} = \left(\frac{p - d}{p} \right) \cdot 100$$

$$= \left(\frac{90 - 25}{90} \right) \cdot 100$$

$$= 72,22\%$$

(2)

2.2

$$\sigma_T = \frac{\sigma_{T_{\text{MAX}}}}{SF}$$

$$= \frac{280}{5}$$

$$= 56 \text{ MPa}$$

$$\sigma_T = \frac{P_i \cdot D}{2 \cdot t \cdot \eta_j}$$

$$56 \times 10^6 = \frac{P_i \cdot (2)}{2 \cdot (0,015) \cdot (0,7222)}$$

∴ $P_i = 606,665 \text{ kPa}$ ✓ (5)

$$\begin{aligned}
 2.3 \quad F_{Tensile} &= \sigma_{Tensile} \cdot (p - d) \cdot t \quad \checkmark \\
 &= 56 \times 10^6 \cdot (0,09 - 0,025) \cdot 0,015 \quad \checkmark \\
 &= 54600 \text{ N} \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 F_{Tensile_{Coverstraps}} &= \sigma_{Tensile_{cov\ erstraps}} \cdot (p - d) \cdot t_{cov\ erstraps} \cdot n \quad \checkmark \\
 54600 &= \sigma_{Tensile_{cov\ erstraps}} \cdot (0,09 - 0,025) \cdot (0,01) \cdot (2) \quad \checkmark \\
 \therefore \sigma_{Tensile_{cov\ erstraps}} &= 48 \text{ MPa} \quad \checkmark \quad (6)
 \end{aligned}$$

$$\begin{aligned}
 2.4 \quad F_{Shear} &= \tau \cdot \frac{\pi}{4} \cdot (d)^2 \cdot n \cdot x \quad \checkmark \\
 54600 &= \tau \cdot \left(\frac{\pi}{4}\right) \cdot (0,025)^2 \cdot (2) \cdot (1,75) \quad \checkmark \\
 \therefore \tau &= 31,780 \text{ MPa} \quad \checkmark \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 2.5 \quad F_{Crushing} &= \sigma_{Crushing} \cdot (d) \cdot (t) \cdot n \quad \checkmark \\
 54600 &= \sigma_{Crushing} \cdot (0,025) \cdot (0,015) \cdot (2) \quad \checkmark \\
 \therefore \sigma_{Crushing} &= 72,8 \text{ MPa} \quad \checkmark \quad (3)
 \end{aligned}$$

2.6 Aantal klinkjnaels per ry = silinderlengte/steek

$$\begin{aligned}
 &= \frac{4,215}{0,09} \quad \checkmark \\
 &= 46,833 \text{ klinkjnaels per silinderlengte} \quad \checkmark \quad (2)
 \end{aligned}$$

2.7 Aantal klinkjnaels per meter = 1000/steek

$$\begin{aligned}
 &= \frac{1000}{90} \quad \checkmark \\
 &= 11,111 \text{ klinkjnaels per meter} \quad \checkmark \quad (2)
 \end{aligned}$$

[23]

VRAAG 3

3.1

$$F \cdot \left[\frac{L_1}{A_1 \cdot E_1} + \frac{L_2}{A_2 \cdot E_2} \right] = \Delta T \cdot [\alpha_2 \cdot L_2 + \alpha_1 \cdot L_1]$$

$$F \cdot \left[\frac{0,21}{2,376 \times 10^{-3} \cdot (31,8 \times 10^9)} + \frac{0,188}{1,134 \times 10^{-3} \cdot (113,8 \times 10^9)} \right] = 80 \cdot [9,2 \times 10^{-6} \cdot (0,21) + 23 \times 10^{-6} \cdot (0,188)]$$

$$F \cdot (4,0184 \times 10^{-9}) = 5,0048 \times 10^{-4}$$

$$\therefore F = 124547,083 \text{ N}$$

$$\sigma_1 = \frac{F}{A_1}$$

$$= \frac{124547,083}{2,376 \times 10^{-3}} = 52,419 \text{ MPa}[C]$$

$$\sigma_2 = \frac{F}{A_2}$$

$$= \frac{124547,083}{1,134 \times 10^{-3}} = 109,83 \text{ MPa}[T]$$

(8)

3.2

$$\delta L_{final_1} = \Delta L_1 - \Delta X_1$$

$$= \alpha_1 \cdot \Delta T \cdot L_1 - \frac{F \cdot L_1}{A_1 \cdot E_1}$$

$$= 23 \times 10^{-6} \cdot (80) \cdot (0,21) - \frac{124547,083 \cdot (0,21)}{2,376 \times 10^{-3} \cdot (31,8 \times 10^9)}$$

$$= (3,864 - 3,462) \times 10^{-4}$$

$$= 0,402 \times 10^{-4} \text{ m}$$

$$L_{final} = L_1 + \delta L_{final_1}$$

$$= 210,0000402 \text{ mm}$$

(5)

3.3

$$\begin{aligned}U_1 &= \frac{F^2 \cdot L_1}{2 \cdot A_1 \cdot E_1} \\&= \frac{124547,083^2 \cdot (0,21)}{2 \cdot (2,376 \times 10^{-3}) \cdot (31,8 \times 10^9)} \checkmark \\&= 21,557 \text{ J} \checkmark\end{aligned}$$

$$\begin{aligned}U_2 &= \frac{F^2 \cdot L_2}{2 \cdot A_2 \cdot E_2} \\&= \frac{124547,083^2 \cdot (0,188)}{2 \cdot (1,134 \times 10^{-3}) \cdot (113,8 \times 10^9)} \checkmark \\&= 11,299 \text{ J} \checkmark\end{aligned}$$

(4)

3.2

$$\begin{aligned}\varepsilon_1 &= \frac{F}{A_1 \cdot E_1} \\&= \frac{124547,083}{2,376 \times 10^{-3} \cdot (31,8 \times 10^9)} \checkmark \\&= 1,648 \times 10^{-3} \checkmark\end{aligned}$$

$$\begin{aligned}\varepsilon_2 &= \frac{F}{A_2 \cdot E_2} \\&= \frac{124547,083}{1,134 \times 10^{-3} \cdot (113,8 \times 10^9)} \checkmark \\&= 9,651 \times 10^{-4} \checkmark\end{aligned}$$

(4)

[21]

VRAAG 4

$$\begin{aligned}
 4.1 \quad I_{XX_{FIX-FIX}} &= \frac{1}{12} \cdot B \cdot D^3 \\
 &= \frac{1}{12} \cdot (0,03) \cdot (0,018^3) \quad \checkmark \\
 &= 1,458 \times 10^{-8} \text{ m}^4 \checkmark
 \end{aligned}$$

$$\begin{aligned}
 I_{YY_{PIN-PIN}} &= \frac{1}{12} \cdot D \cdot B^3 \\
 &= \frac{1}{12} \cdot (0,018) \cdot (0,03^3) \quad \checkmark \\
 &= 4,05 \times 10^{-8} \text{ m}^4 \checkmark
 \end{aligned}$$

$$\begin{aligned}
 P_{E_{YY}} &= \frac{\pi^2 \cdot (E) \cdot (I_{YY})}{L_E^2} \\
 &= \frac{\pi^2 \cdot (210 \times 10^9) \cdot (4,05 \times 10^{-8})}{(0,22)^2} \quad \checkmark \\
 &= 1,734 \text{ MN} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 P_{E_{XX}} &= \frac{\pi^2 \cdot (E) \cdot (I_{XX})}{L_E^2} \\
 &= \frac{\pi^2 \cdot (210 \times 10^9) \cdot (1,458 \times 10^{-8})}{(0,22 \times 0,5)^2} \quad \checkmark \\
 &= 6,937 \text{ MN} \checkmark
 \end{aligned}$$

(10)

4.2

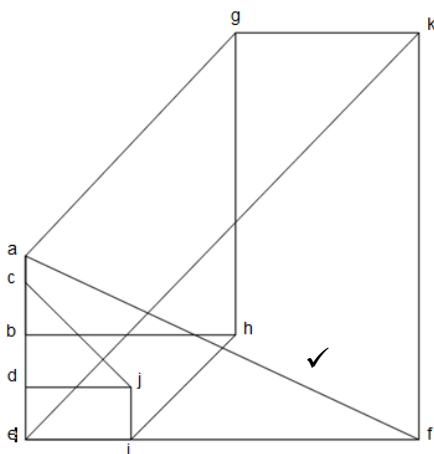
$$\begin{aligned}
 k &= \sqrt{\frac{I_{Least}}{A}} \\
 &= \sqrt{\frac{1,458 \times 10^{-8}}{(0,03) \cdot (0,018)}} \checkmark \\
 &= 5,196 \times 10^{-3} \text{ m} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 SR &= \frac{L_E}{k} \\
 &= \frac{0,22}{5,196 \times 10^{-3}} \checkmark \\
 &= 42,34 \checkmark
 \end{aligned}$$

$$\begin{aligned}
 P_R &= \frac{\sigma_Y \cdot (A)}{1 + \frac{1}{7500} \cdot (SR)^2} \\
 &= \frac{260 \times 10^6 \cdot (0,03) \cdot (0,018)}{1 + \frac{1}{7500} \cdot (42,34)^2} \checkmark \\
 &= 113,315 \text{ kN} \checkmark
 \end{aligned}$$

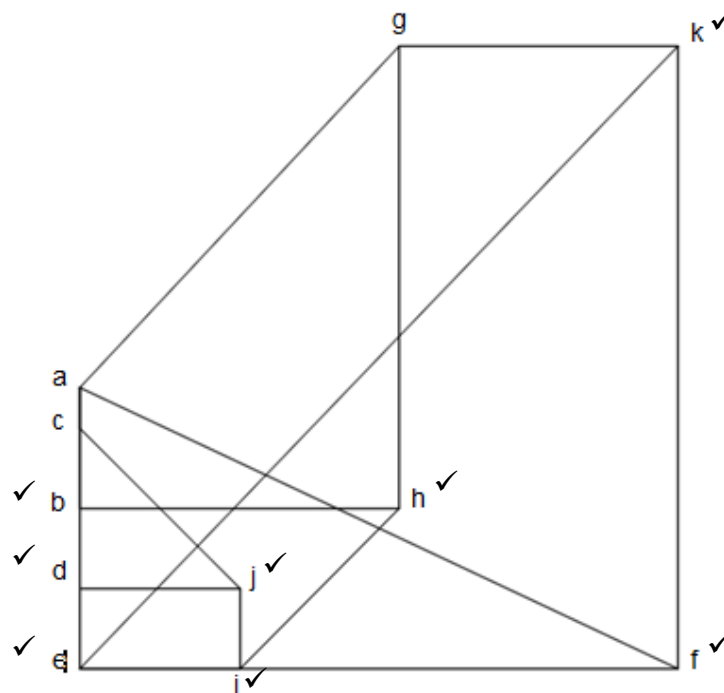
(7)
[17]**VRAAG 5**

5.1 Reaksie by vaste steun = af = 166 N ✓



(2)

5.2



Deel	Krag (N)	Aard
bh	80 ✓	Bind (T) ✓
ij	19 ✓	T ✓
ih	55 ✓	Stut (S) ✓
fk	156 ✓	T ✓
ek	218 ✓	S ✓

(18)
[20]

VRAAG 6

6.1

$$I_{xx} = \frac{\pi}{64} \cdot (D^4 - d^4) = \frac{\pi}{64} \cdot (0,39^4 - 0,35^4) \checkmark$$

$$= 398,99 \times 10^{-6} \text{ m}^4 \checkmark$$

$$M = \frac{1}{8} \cdot \omega \cdot L^2 = \frac{1}{8} \cdot (1819 + 898) \cdot (3^2) \checkmark$$

$$= 3056,625 \text{ N.m} \checkmark$$

$$\sigma = \frac{M \cdot y}{I_{xx}} = \frac{3056,625 \cdot (\frac{0,39}{2})}{398,99 \times 10^{-6}} \checkmark$$

$$= 1,494 \text{ MPa} \checkmark$$

(7)

6.2

$$Z = \frac{I_{xx}}{y} = \frac{399,98 \times 10^{-6}}{\left(\frac{0,39}{2}\right)} \checkmark$$
$$= 2,046 \times 10^{-3} \text{ m}^3 \checkmark$$

(2)

[9]**TOTAAL: 100**