

**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N5

15 APRIL 2015

This marking guideline consists of 7 pages.

QUESTION 1

$$1.1 \quad \sigma_1 = \frac{F}{A} = \frac{190 \times 10^3 \times 4}{\pi(50^2 - 30^2)} \sqrt{\quad}$$

$$= 151,2 \text{ MPa} \sqrt{\quad} \quad (2)$$

$$\sigma_2 = \frac{190 \times 10^3 \times 4}{\pi \times 50^2} \sqrt{\quad}$$

$$= 96,77 \text{ MPa} \sqrt{\quad} \quad (2)$$

$$1.2 \quad X_T = X_1 + X_2$$

$$= \frac{F \ell_1}{A_1 E} + \frac{F \ell_2}{A_2 E}$$

$$X_T = \frac{190 \times 10^3}{180 \times 10^3 \times \pi} \left(\frac{40 \times 4}{50^2 - 30^2} \right) + \frac{60 \times 4}{50^2} \sqrt{\quad} \sqrt{\quad}$$

$$= 0,06585 \text{ mm} \sqrt{\quad} \quad (4)$$

$$1.3 \quad U_T = U_1 + U_2$$

$$= \frac{1}{2} F X_T$$

$$= \frac{1}{2} \times 190 \times 10^3 \times 0,06585 \times 10^{-3} \sqrt{\quad} \sqrt{\quad}$$

$$= 12,51 \text{ J} \sqrt{\quad}$$

(3)
[11]

QUESTION 2

$$2.1 \quad F_S = F_C$$

$$\sigma_S A_S = \sigma_C A_C$$

$$\sigma_S = \frac{A_C}{A_S} \sigma_C \sqrt{\quad}$$

$$= \frac{850}{340} \sigma_C$$

$$= 2,5 \sigma_C \sqrt{\quad}$$

$$\frac{\sigma_C}{E_C} + \frac{\sigma_S}{E} = \Delta t (\alpha_C - \alpha_S)$$

$$\frac{\sigma_C}{100 \times 10^9 \sqrt{\quad}} + \frac{2,5 \sigma_C}{210 \times 10^9 \sqrt{\quad}} = 80 (18 \times 10^{-6} - 12 \times 10^{-6}) \sqrt{\quad}$$

$$2,19047619 \times 10^{-11} \sigma_C = 48 \times 10^{-5}$$

$$\sigma_C = 21,91 \text{ MPa (T)} \sqrt{\quad}$$

$$\sigma_S = 2,5 \times 21,91 \sqrt{\quad}$$

$$= 54,78 \text{ MPa (C)} \sqrt{\quad}$$

(7)

$$2.2 \quad F_T = F_S + F_C$$

$$X_S = X_C$$

$$\frac{\sigma_S}{E_S} = \frac{\sigma_C}{E_C}$$

$$\sigma_S = \frac{E_S}{E_C} \sigma_C$$

$$= \frac{210}{100} \sigma_C$$

$$= 2,1 \sigma_C \sqrt{\quad}$$

$$F_T = \sigma_S A_S + \sigma_C A_C$$

$$25 \times 10^3 \sqrt{\quad} = 2,1 \sigma_C \times 340 \sqrt{\quad} + 850 \times \sigma_C$$

$$\sigma_C = 15,98 \text{ MPa (C)} \sqrt{\quad}$$

$$\sigma_S = 2,1 \times 15,98 \text{ MPa (C)} \sqrt{\quad}$$

Resultant stresses

$$\begin{aligned} \sigma_{RC} &= 21,91 - 15,98 \sqrt{\quad} \\ &= 5,93 \text{ MPa (T)} \sqrt{\quad} \end{aligned}$$

$$\begin{aligned} \sigma_{RS} &= 54,78 + 33,56 \sqrt{\quad} \\ &= 88,34 \text{ MPa (C)} \sqrt{\quad} \end{aligned}$$

(10)
[17]

QUESTOIN 3

$$3.1 \quad T_1 = T_3$$

$$\frac{\pi}{16} \tau \left(\frac{D^4 - d^4}{D} \right) \sqrt{\quad} = \frac{\pi}{16} \tau d_s^3 \sqrt{\quad}$$

$$\frac{D^4 - d^4}{D} = d_s^3$$

$$\frac{40^4 - 25^4 \sqrt{\quad}}{40} = d_s^3$$

$$d = 37,85 \text{ mm} \sqrt{\quad}$$

(4)

$$3.2 \quad \theta_T = \theta_1 + \theta_2 + \theta_3$$

$$= \frac{10,2 \times T \times \ell_1}{G(D^4 - d^4)} + \frac{10,2 \times T \times \ell_2}{G D^4} + \frac{10,2 \times T \times \ell_3}{G D^4}$$

$$= \frac{10,2 \times 300}{200 \times 10^9} \left[\frac{0,12}{0,04^4 - 0,025^4} + \frac{0,14}{0,04^4} + \frac{0,125}{0,03785^4} \right] \sqrt{\quad} \sqrt{\quad}$$

$$= 26,14878 \times 10^{-4} \text{ rad} \sqrt{\quad}$$

$$= 26,14878 \times 10^{-4} \times 57,3$$

$$= 0,15^0 \sqrt{\quad}$$

(6)

3.3 $T_{max} = 1,25 T_{mean}$

$$\therefore T_{mean} = \frac{300\sqrt{}}{1,25} = 240 \text{ Nm}\sqrt{}$$

$$P = \frac{2\pi NT}{60} = \frac{2\pi \times 800 \times 240}{60}\sqrt{}$$

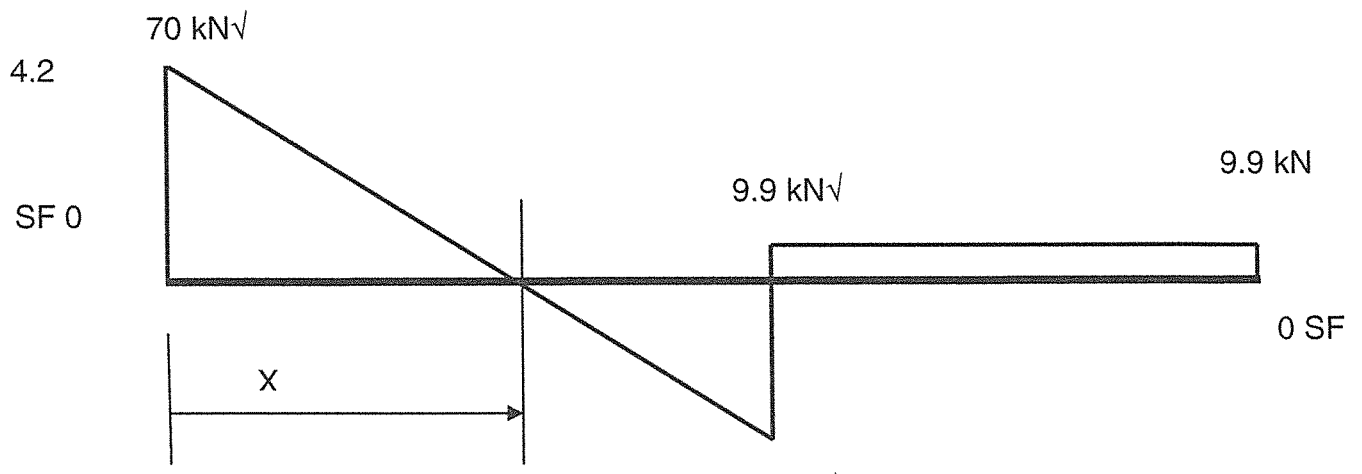
$$= 20,106 \text{ kW}\sqrt{}$$

(4)
[14]

QUESTION 4

4.1 4.1.1 $BM_{2,5} = 70 \times 2,5\sqrt{-\frac{25 \times 2,5^2}{2}}\sqrt{=} 96,875 \text{ kNm}\sqrt{}$ (3)

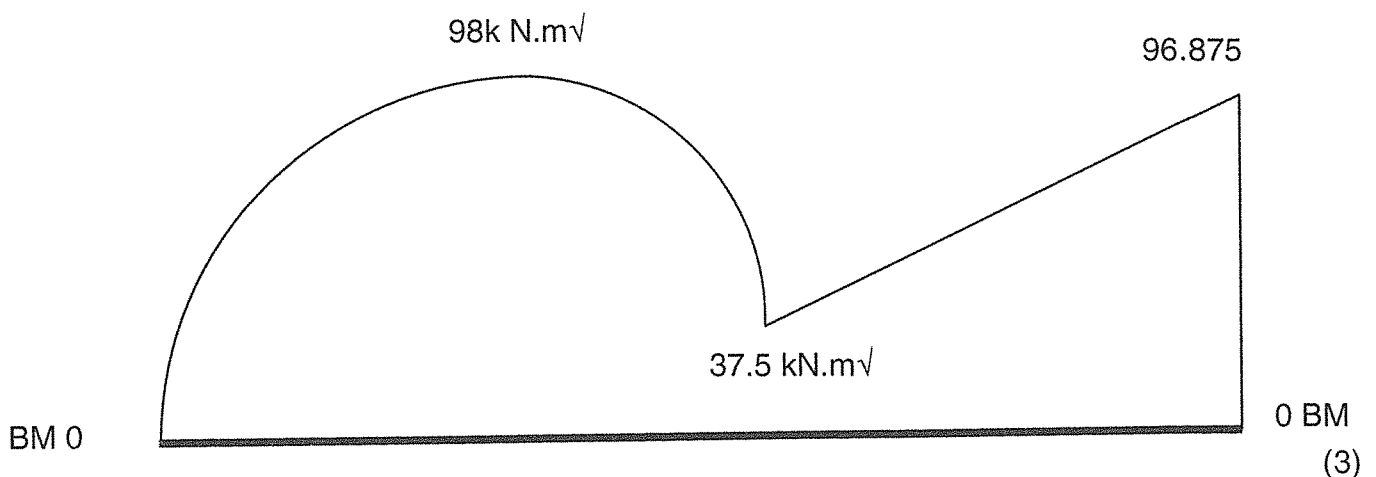
4.1.2 $BM_C = 70 \times 11\sqrt{-25 \times 5 \times 8,5 - F \times 6}\sqrt{}$
 $96,875 = -930 - 6F\sqrt{}$
 $F = -64,9 \text{ kN}\sqrt{}$ (4)



$$\frac{5}{125} = \frac{x}{70}$$

$$x = 2.8 \text{ m}\sqrt{}$$

(4)



(3)

STRENGTH OF MATERIALS AND STRUCTURES N5

$$BM_{2,8} = 70 \times 2,8 - 25 \times \frac{2,8^2}{2} = 98 \text{ kNm} \quad (1)$$

$$BMB = 70 \times 5 - \frac{25 \times 5^2}{2} = 37,5 \text{ kNm} \quad (1)$$

$$4.3 \quad \frac{M}{I} = \frac{\delta}{Y}$$

$$Z = \frac{M}{\delta}$$

$$= \frac{98 \times 10^3}{60 \times 10^6}$$

$$= 16,33,33 \times 10^{-6} \text{ m}^3$$

$$Z = 1775 \times 10^{-6} \text{ m}^3$$

The dimensions are $457 \times 191 \times 89,7 \text{ kg/m}$

$$= \frac{M}{Z} = \frac{98 \times 10^3}{1775 \times 10^{-6}} = 55,2 \text{ MPa} \quad (5)$$

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QUESTION 5

$$5.1 \quad I_{XX} = (I_{xx1} + A_1 r_1^2) 2 + (I_{xx2})$$

$$= \left(\frac{0,013^3 \times 0,14}{12} \right) 2 + (0,14 \times 0,13 \times 0,1335^2) 2 + \left(\frac{0,254^3 \times 0,013}{12} \right) 2$$

$$= 82,676 \times 10^{-6} \text{ m}^4 \quad (4)$$

$$I_{YY} = (I_{yy1} + A_1 r_1^2) 2 + (I_{yy2})$$

$$= \left(\frac{0,14^3 \times 0,013}{12} \right) 2 + \left(\frac{0,013^3 \times 0,254}{12} \right) 2$$

$$= 5,991 \times 10^{-6} \text{ m}^4 \quad (3)$$

$$F = \frac{\pi^2 \times E \times I}{l^2}$$

$$= \frac{4 \times \pi^2 \times 210 \times 10^9 \times 5,991 \times 10^{-6}}{4^2}$$

$$= 3,1 \text{ MN} \quad (3)$$

$$\sigma = \frac{F}{A} = \frac{3,1 \times 10^6}{(0,14 \times 0,013) 2 + (0,254 \times 0,013)}$$

$$= 446,56 \text{ MPa} \quad (2)$$

5.2

$$SR = \frac{\delta_s}{K} = \sqrt{\frac{I}{A}} = \frac{5,991 \times 10^{-6}}{69,42 \times 10^{-4}}$$

$$= 0,029938 \text{ m}\sqrt{}$$

$$\frac{\delta_s}{K_1} = \frac{\delta_s}{K_2} \sqrt{}$$

Since l_e are the same $K_1 = K_2$

$$29,38 = \sqrt{\frac{X^4}{12}} \times \frac{1}{X^2} \sqrt{}$$

$$29,38 = \sqrt{\frac{X^2}{12}}$$

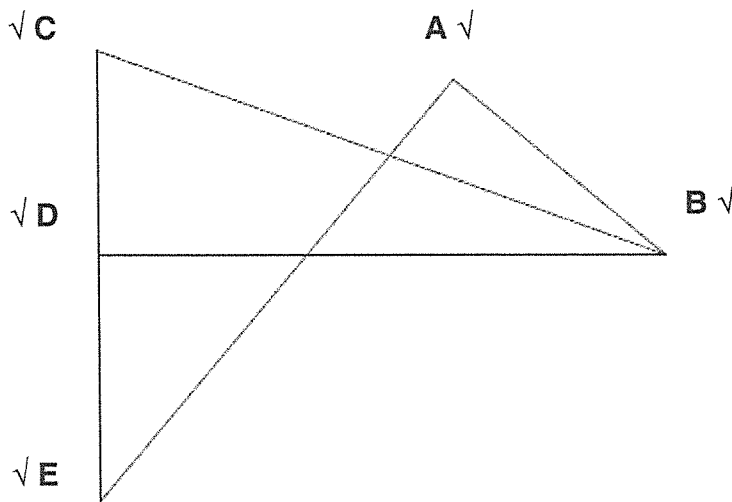
$$29,38^2 = \frac{X^2}{12} \sqrt{}$$

$$X = 101,78 \text{ mm}\sqrt{}$$

Dimensions are $101,78 \text{ mm} \times 101,78 \text{ mm}\sqrt{}$

(6)
[18]

QUESTION 6



- EA = 120,84 kN (S) ✓
- CB = 131,57 kN (t) ✓
- BD = 123,64 kN (S) ✓
- AB = 60 kN (S) ✓

(5)

(4)
[9]

QUESTION 7

$$\sigma = \frac{P \times D}{2t}$$

$$= \frac{160 \times 10^3 \times 1.5}{2 \times 0.022} \sqrt{\sqrt{\quad}}$$

$$= 5.45 \text{ MPa} \sqrt{\quad}$$

$$(P - d) \times t \times \sigma = N \times \frac{\pi \times d^2}{4} \times \tau$$

$$(P - 0.015) \sqrt{\quad} \times 0.022 \times 5.45 \times 10^6 \sqrt{\quad} = 1 \times \frac{\pi \times 0.015^2}{4} \times \frac{340 \times 10^6}{6} \sqrt{\quad}$$

$$P = 98.52 \text{ mm} \sqrt{\quad}$$

Number of rivets

$$N = \frac{1000}{98.52} \sqrt{\quad}$$

$$= 10.15 \sqrt{\quad}$$

say 11 $\sqrt{\quad}$

[10]

TOTAL: 100