higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N5

9 APRIL 2014

This marking guideline consists of 6 pages.

QUESTION 1

1.1 Tensile strength $= \frac{\max load}{A_O}$

$\frac{48,6\times10^3}{\pi\times0,0111^2}\times4$

502,23 MPa√√ (2)

1.2 $\sigma = \frac{Yield\ load}{A_O}$

$= \frac{20,5\times10^3\times4}{\pi\times0,0111^2}$

= 211,84 MPa√√ (2)

1.3 Percentage elongation $= \frac{72,9-56,3}{56,3} \times 100 = 29,48\%$√√ (2)

1.4 Percentage reduction in area $= \frac{A_O - A_1}{A_O} \times 100$

$= \frac{11,1^2 - 7,98^2}{11,1^2} \times 100$

= 48,32%√√ (2)
[8]

QUESTION 2

$F_1 = F_2$

$\sigma_1 A_1 = \sigma_2 A_2$

$\sigma_1 = \frac{0,0026}{0,0042} \times 64$√

= 39,62 MPa√

$X_1 = \frac{\sigma_1 \ell_1}{E} = \frac{39,62\times0,8}{200\times10^3}$√

$= 1,585 \times 10^{-4}$ m√

$X_2 = \frac{\sigma_2 \ell_2}{E} = \frac{64\times1,3}{200\times10^3}$√

$= 4,16 \times 10^{-4}$ m√

Gain is strain energy = Loss in potential energy

$\frac{\sigma^2 V_1}{2E} + \frac{\sigma_2 V_2}{2E} = W\ (h_1 + X_1 + X_2)$

$$\frac{1}{2 \times 200 \times 10^9}[(39{,}62 \times 10^6)2 \times 0{,}0042 \times 0{,}8 + (64 \times 10^6)2 \times 0{,}0026 \times 1{,}3]\surd\surd\surd\surd$$
$$= 1{,}7 \times 10^3\,(h + 1{,}585 \times 10^{-4} + 4{,}16 \times 10^{-4})\surd\surd$$

= 27,54 mm√ (13)
[13]

QUESTION 3

$I_{XX} = I_{YY}$
$I_{XX} = [3{,}129 \times 10^{-6} + 2{,}318 \times 10^{-3} \times (0{,}2 - 0{,}0331)2]4$
$= 270{,}793 \times 10^{-6}$ m^4√√√√√

$$K = \sqrt{\frac{I}{A}} = \sqrt{\frac{270{,}793 \times 10^{-6}}{2{,}318 \times 10^{-3} \times 4}}$$
= 0,1709 m√√

$$F = \frac{\sigma \times A}{1 + a\left(\frac{\ell}{k}\right)2}$$

$$= \frac{245 \times 10^6 \times 4 \times 2{,}318 \times 10^{-3}}{1 + \frac{1}{7500}\left(\frac{10}{0{,}1709}\right)2}$$
= 1 559,62 kN√√√√
∴ safe load = $\frac{1559{,}62}{5}$ = 311,92 kN√√ **[12]**

QUESTION 4

4.1 $F_b = F_a$
$\sigma_b \times (2 \times 50 \times 5) = \sigma_a \times (50 \times 15)$
$\sigma_b = 1{,}5\ \sigma_a$√√

$$\frac{\sigma_b \ell}{E_h} + \frac{\sigma_a \ell}{E_a} = \ell \times \Delta t\,(\alpha_a - \alpha_b)$$
$$\frac{1{,}5\sigma_a}{108 \times 10^9} + \frac{\sigma_a}{80 \times 10^9} = 70\,(22 \times 10^{-6} - 16 \times 10^{-6})\surd\surd\surd\surd$$

σ_a = 15,92 MPa
σ_b = 15,92 × 1,5√
= 23,87 MPa√ (8)

4.2 Final length = $\ell + \Delta\ell_b + X_b$

$$= 630 + 630 \times 16 \times 10^{-6} \times 70 + \frac{23{,}87 \times 630}{108 \times 10^3}\surd\surd$$
= 630,8448 mm√ (4)
[12]

QUESTION 5

5.1 $\bar{Y}=\frac{A_1Y_1+A_2Y_2+A_3Y_3}{A_T}$

$=\frac{(150\times20\times330)+(300\times20\times170)+(250\times20\times10)}{(150\times20)+(300\times20)+(250\times20)}$√√√

$=147.14mm$√ (5)

5.2 $I_{xx}=\frac{20^3\times150}{12}+(150\times20\times182.36^2)+\frac{300^3\times(20)}{12}+(300\times20\times22.36^2)+\frac{20^3\times(250)}{12}+(20\times250\times137.14^2)=242.752\times10^{-6}m^4$

√√√√√√ (7)

5.3 $Z=\frac{I_{xx}}{Y_{max}}=\frac{242.752\times10^{-6}}{192.86\times10^{-3}}=1258.7\times10^{-6}m^3$√√ (2)

5.4 $\frac{M}{I}=\frac{\sigma}{Y}$

$m=\frac{60\times10^6\times242,752\times10^{-6}}{192,86\times10^{-3}}$

= 75,52 kN/m√√√

$\ell=\sqrt{\frac{m\times8}{w}}=\sqrt{\frac{75,52\times10^3\times8}{5,6\times10^3}}$√

= 10,39 m√ (5)

[19]

QUESTION 6

6.1 $P=\frac{2\pi NT}{60}$

$T=\frac{P\times60}{2\pi N}$

$=\frac{1300\times60}{2\pi\times118}$ = 105 204,149 Nm√√

$T_{max}=1,34\times105204,1149$

= 140 973,51 Nm√

$T=\frac{\pi}{16\sigma}\tau\left(\frac{D^4-d^4}{D}\right)$

$140\,973,51=\frac{\pi}{16}\times56\times10^6\left(\frac{(2d)^4-d^4}{2d}\right)$√√√

d = 119,57 mm√

D = 239,14 mm√ (9)

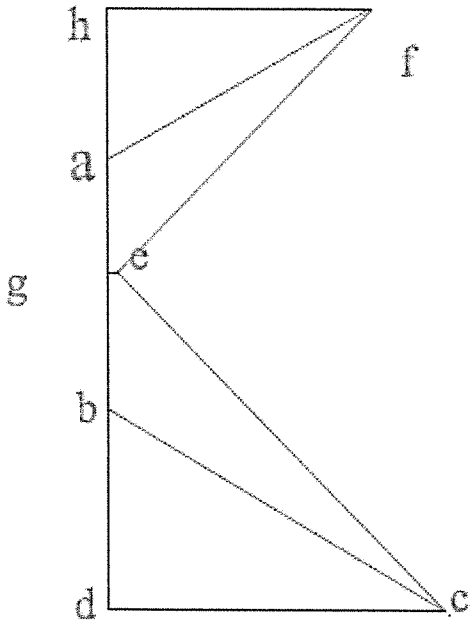
6.2 $\theta = \frac{10,2\ T\ell}{G(D^4 - d^4)} \times \frac{180}{\pi}$

$= \frac{10,2 \times 140973,51 \times 2,5}{80 \times 10^9 (0,2391^4 - 0,11957^4)}$ √√√

$= 0,84^0$√

(4)
[13]

QUESTION 7



(8)

hf=5,448 kN(S)√
af=6,22 kN(t)√
eve =7,438 kN(s)√
ec = 9,532 kN(s)√
bc = 8 kN(t) √
dc= 6,928 kN (s)√ (6)

$CM = ACM$
$(5 \times 10) + (4 \times 25) = (3 \times 5) + (20R)$
$R = 6.75kN$√√ (2)

$CM = ACM$
$(4 \times 5) + (20L) = (5 \times 10) + (3 \times 25)$
$L = 5,25kN$√√ (2)
[16]

√

(8)

√

√

QUESTION 8

Circumferential stress = $\frac{PD}{2t\eta}$

$120 \times 10^6 = \frac{2,6 \times 10^6 \times D}{2 \times 0,02 \times 0,82}$

D = 1,5138 m √√

Longitudinal stress = $\frac{PD}{4t\eta}$

$120 \times 10^6 = \frac{2,6 \times 10^6 \times D}{4 \times 0,02 \times 0,04}$ √√

D = 1,6246 m

∴ use D = 1,6246 m√ (7)
[7]

TOTAL: 100