higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N5

10 APRIL 2013

This marking guideline consists of 7 pages.

QUESTION 1

1.1
$$F = 2W$$
$$= 2 \times 300$$
$$= 600N$$

$$x = \frac{F\ell}{AE}$$
$$= \frac{600 \times 4 \times 4}{\pi \times 0,016^2 \times 200 \times 10^9}$$
$$= 0,05968mm$$ (4)

1.2
$$x = \frac{F\ell}{AE}$$
$$x = \frac{\sigma\ell}{E}$$
$$\delta = \frac{Ex}{\ell}$$
$$= \frac{200 \times 10^9 \times 0,05968 \times 10^{-3}}{4}$$
$$= 2,984MPa$$ (2)

1.3
$$U = \frac{F^2\ell}{2AE}$$
$$= \frac{600^2 \times 4 \times 4}{2 \times \pi \times 0,016^2 \times 200 \times 10^9}$$
$$= 0,0179J$$ (2)
[8]

QUESTION 2

2.1

$$\phi_h = \phi_s \qquad (T_h = 2T_s)$$

$$\frac{10,2 \times T_h \times L}{G_b\left(D^4 - d^4\right)} = \frac{10,2 \times T_s \times \ell}{Gd^4}$$

$$\frac{2}{G_b\left(D^4 - d^4\right)} = \frac{1}{Gd^4}$$

$$\frac{2}{82 \times 10^9\left(D^4 - 0,06^4\right)} = \frac{1}{205 \times 10^9 \times 0,06^4}$$

$$D = 93,9mm$$

(7)

2.2 *Hollow shaft*

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

$$= \frac{\pi}{16} \times 50 \times 10^6\left(\frac{0,0939^4 - 0,06^4}{0.0939}\right)$$

$$= 6,6773,2N.m$$

(3)

Solid shaft

$$T = \frac{\pi}{16}\tau d^3$$

$$= \frac{\pi}{16} \times 85 \times 10^6 \times 0,06^3$$

$$= 3604,98N.m$$

$$T_{total} = T_h + T_s$$

$$= 6773,2 + 3604,98$$

$$= 10378,18N.m$$

(4)

2.3

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

$$= \frac{2\pi \times 1450 \times 10378,18}{60}$$

$$= 1575,86kW$$

(2)
[16]

QUESTION 3

$$A_1 = 6 \times 306$$
$$= 1836mm^2$$

$$A_2 = 380 \times 6$$
$$= 2280mm^2$$

$$A_3 = 6 \times 306$$
$$= 1836mm^2$$

$$A_T = 1836 + 2280 + 1836$$
$$= 5952mm^2$$

$$Y = \frac{A_1 y_1 + A_2 y_2 + A_3 y_3}{A_T}$$
$$= \frac{1836 \times 153 + 2280 \times 3 + 1836 \times 153}{5952}$$
$$= 95,54mm$$ (5)

$$\therefore Y_{MAX} = 306 - 95,54$$
$$= 210,46mm$$

$$I_{xx} = \left(\frac{BD^3}{12} + A_1 r_1^2\right) \times 2 + \left(\frac{BD^3}{12} + A_2 r_2^2\right)$$
$$= \left(\frac{0,306 \times 0,006^3}{12} + 1836 \times 10^{-6} \times 0,05746^2\right) \times 2 + \left(\frac{0,38 \times 0,006^3}{12} + A2280 \times 10^{-6} \times 0,09254^2\right)$$
$$= 60,308 \times 10^{-6} m^4$$ (5)

$$\frac{M}{I} = \frac{\sigma}{Y_{MAX}}$$
$$M = \frac{120 \times 10^6 \times 60,308 \times 10^{-6}}{0,21046}$$
$$= 34386,39N.m$$ (3)

$$M = \frac{W_1 \ell_1^{\,2}}{8} + \frac{W_2 \ell_2^{\,2}}{8}$$
$$W_1 = 5952 \times 10^{-6} \times 8000 \times 9,81$$
$$= 467,113N/m$$
$$W_2 = 0,38 \times h \times 1000 \times 9,81$$
$$= 3727,8h$$

$$\therefore 34386,39 = \frac{467,113 \times 12^2}{8} + \frac{3727,8h \times 12^2}{8}$$
$$h = 0,387mm$$ (6)
$$\therefore h = 300mm$$ **[19]**

QUESTION 4

4.1

$$I_{XX} = \left(I_{XX_1} \times 2\right) + \left(I_{XX_2} + Ar^2\right)2$$

$$= \left(9,247 \times 10^{-6} \times 2\right) + \left(\frac{0,24 \times 0,01^3}{12} + 0,01 \times 0,24 \times 0,085^2\right)2$$

$$= 53,214 \times 10^{-6} m$$ (4)

4.2

$$I_{yy} = \left(\frac{0,24^3 \times 0,01}{12} \times 2\right) + \left(0,8505 \times 10^{-6} + 2,401 \times 10^{-3} \times 0,1184^2 \times 10^{-3}\right)2$$

$$= 92,058 \times 10^{-6} m^4$$ (4)

4.3

$$K^2 = \frac{I}{A}$$

$$= \frac{53,214 \times 10^{-6}}{2,401 \times 10^{-3} \times 2 + (0,24 \times 0,01)2}$$

$$= 0,00554$$

$$F = \frac{\sigma_C \times A}{1 + a\left(\frac{L}{K}\right)^2}$$

$$= \frac{\sigma_C \times A}{1 + \frac{1}{7500} \times \left(\frac{6^2}{0,00554}\right)}$$

$$= 1,54MN$$ (7)

[15]

QUESTION 5

5.1
$$\frac{\sigma_S}{E_S}+\frac{\sigma_C}{E_C}=\Delta t\left(\alpha_C-\alpha_S\right)$$
$$\sigma_C A_C=\sigma_S A_S$$
$$\sigma_S=\frac{A_C}{A_S}\times\sigma_C$$
$$=\frac{640}{500}\times\sigma_C$$
$$=1,28\sigma_C$$
(7)

5.2
$$\frac{1,28\sigma_C}{210\times10^9}+\frac{\sigma_C}{105\times10^9}=50\left(18\times10^{-6}-12\times10^{-6}\right)$$
$$\sigma_C=19,287MPa$$
(7)

5.3
$$\sigma_S=19,2\times1,28$$
$$=24,58MPa$$
(4)
[18]

QUESTION 6

6.1
$$efficiency=\frac{P-D}{P}$$
$$=\frac{0,13-0,04}{0,13}\times100$$
$$=69,2\%$$
(1)

6.2
$$\sigma_t=\frac{P\times D}{t\times2\times efficiency}$$
$$=\frac{1,2\times10^6\times0,15}{0,016\times2\times0,692}$$
$$=81,29MPa$$
(3)

6.3
$$\sigma_t\times\left(P-d\right)\times t=\frac{\pi D^2}{4}\times N\times\tau$$
$$81,29\times10^6\times\left(0,13-0,04\right)\times0,016=\frac{\pi\times0,04^2}{4}\times2\times2\times\tau$$
$$\tau=23,29MPa$$
(3)

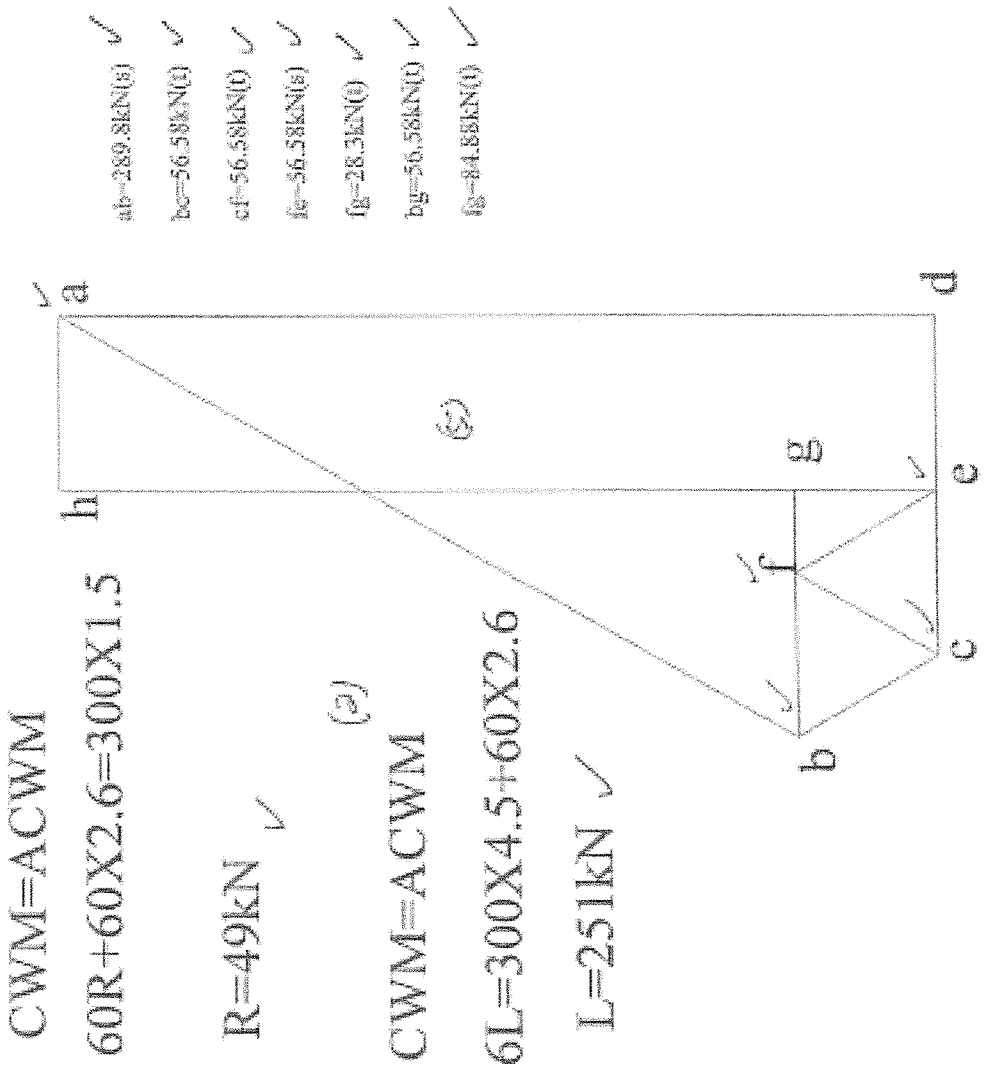
6.4 $\sigma_t \times (P-d) \times t = D \times t \times \sigma_c \times N$

$81,29 \times 10^6 \times (0,13-0,04) \times 0,016 = 0,04 \times 0,016 \times 2 \times \sigma_c$

$\sigma_c = 91,45MPa$ (3)

[10]

QUESTION 7



[14]

TOTAL: 100