higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

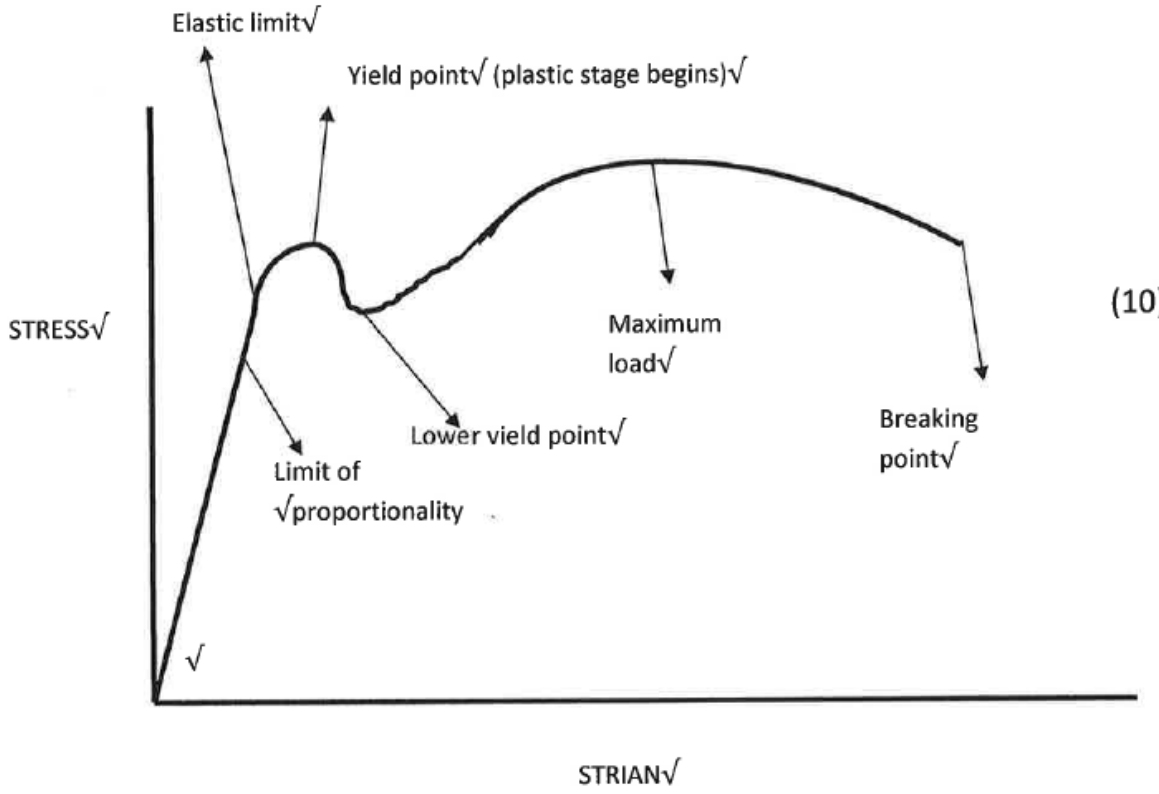
APRIL EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N5

6 APRIL 2016

This marking guideline consists of 7 pages.

QUESTION 1



(10)

[10]

QUESTION 2

2.1 $$d = \sqrt{\frac{F\times 4}{\sigma\times\pi}} = \sqrt{\frac{125\times10^{3}\times4}{215\times10^{6}\times\pi}}\surd = 27.2\ mm^{2}\surd$$ (2)

2.2 $$0{,}29^{-3}\surd = \frac{125\times10^{3}(0.09+0.05)\surd}{\pi\times0.05^{2}\times210\times10^{9}\surd} + \frac{125\times10^{3}\times x\times4\surd}{\pi\times0.0272^{2}\times210\times10^{9}\surd} =$$
$$241.67mm\surd$$ (6)

2.3 $$X_T = X_1 + X_2 + X_3$$

$$X_1 = \frac{125\times10^{3}\times4\times90\times10^{-3}\surd}{0.05^{2}\times\pi\times210\times10^{9}} = 0.027283mm\surd$$

$$X_2 = \frac{125\times10^{3}\times4\times241.67\times10^{-3}}{\pi\times0.0272^{2}\times210\times10^{9}}\surd = 0.2469mm\surd$$

$$X_3 = \frac{125\times10^{3}\times4\times0.05\times10^{-3}}{\pi\times0.05^{2}\times210\times10^{9}}\surd = 0.015157mm\surd$$ (6)

2.4 $$U_T = \frac{125\times10^{3}}{2}\times0.29\times10^{-3}\surd = 18.125\ J\surd$$ (2)

[16]

QUESTION 3

3.1 $T_{al} = \frac{\pi}{16} \times \tau \times d^3 = \frac{\pi}{16} \times 16 \times 10^6 \times 0.08^3 \surd$

= 1 608,5 N.m$\surd$

$T_b = \frac{\pi}{16} \times \tau \times d^3 = \frac{\pi}{16} \times 27 \times 10^6 \times 0.065^3 \surd$

= 1455,91 N.m$\surd$

The permissible torque is 1455.91N.m$\surd$ (5)

3.2 $\theta_T = \theta_a + \theta_b$

$\frac{0.56 \times \pi \surd}{180} = \frac{10.2 \times 1455.91 \times 0.28 \surd}{30 \times 10^9 \times 0.084^4 \surd} + \frac{10.2 \times 1455.91 \times L_b \surd}{40 \times 10^9 \times 0.065^4 \surd}$

L_b = 307,24 mm$\surd$ (6)

[11]

QUESTION 4

4.1 $U = \frac{\sigma^2 \times V}{2E}$

$68 = \frac{\sigma^2 \times \pi \times 0.028^2 \times 1.2 \surd}{2 \times 4 \times 200 \times 10^9 \surd}$

$\sigma = 191.86 \times MPa \surd$ (3)

4.2 $W = \sigma \times A = 191.86 \times \frac{\pi \times 28^2}{4} \surd$

= 118,14kN.$\surd$ (2)

4.3 $\sigma = \frac{2W}{A}$

$W = \frac{191.86 \times \pi \times 28^2}{2 \times 4} \surd$

= 59,69 kN$\surd$ (2)

4.4 $W\left(h + \frac{\sigma l}{E}\right) = \frac{\sigma^2 \times V}{2E}$

$W\left(0.13 \surd + \frac{191.86 \times 10^6 \times 1.2 \surd}{200 \times 10^9 \surd}\right) = 65 \surd$

W = 495,61 N$\surd$ (5)

[12]

QUESTION 5

5.1

$$F_C = F_S$$
$$\sigma_C \times A_C = \sigma_S \times A_S$$
$$\sigma_C = \sigma_S \frac{A_S}{A_C}$$

$$\sigma_C = \frac{2.5}{734 \times 10^{-2}} \times \sigma_S \surd$$
$$\sigma_C = 0.3401\sigma_S \surd$$

$$\frac{\sigma_S \times l_s}{E_S} + \frac{\sigma_C \times l_c}{E_C} = l_o \times \Delta t(\propto_c - \propto_s)$$
$$\frac{\sigma_S}{210 \times 10^9} \surd + \frac{0.3401 \times \sigma_S \surd}{100 \times 10^9} = 80(18 \times 10^{-6} + 12 \times 10^{-6}) \surd$$
$$\sigma_s = 58.8MPa(T) \surd$$
$$\sigma_C = 0.3401 \times 58.8$$
= 20 MPa(C)√ (7)

5.2 Consider the external force

$$\frac{\sigma_s}{E_S} = \frac{\sigma_c}{E_C}$$
$$\sigma_S = \frac{E_S}{E_C}\sigma_C$$
$$\sigma_S = 2.1\sigma_C \surd$$

$$F_T = F_S + F_C$$
$$40 \times 10^3 = 2.1 \times 2.5 \times 10^{-4} \times \sigma_C + \sigma_C \times 735 \times 10^{-6} \surd$$
$$\sigma_C = 31.75MPa(T) \surd$$
$$\sigma_S = 2.1 \times 31.75$$
= 66.67 MPa$(T)\surd$

Resultant stresses

$$\sigma_{RS} = 58.8 + 66.67 \surd = 125.47MPA(T) \surd$$
$$\sigma_{RC} = 31.75 - 20 \surd = 11.75MPa(T) \surd$$ (8)

[15]

QUESTION 6

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

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

$$M=\frac{\frac{\pi}{64}(1.05^4d^4-d^4)\times\sigma\times 2}{1.05d}\surd$$

$$M=0.0215d^3\sigma\surd$$

$$\omega_1=\frac{\pi}{4}\times d^2\times 880\times 9.81$$

= 6780.185d^2 N/m$\surd$

$$\omega_2=7850\times 9.81\times\frac{\pi}{4}(1.05d^2-d^2)\surd$$

= 6199.439d^2 N.m$\surd$

$$\omega_T=6780.185d^2+6199.439d^2$$

= 12979.62d^2N.m$\surd$

$$0.02015d^3\times 90\times 10^{6\surd}=\frac{12792.62d^2\times 15^2}{8}\surd$$

d = 201.3 mm$\surd$

D = 211.4 mm$\surd$ **[10]**

QUESTION 7

7.1 Longitudinal stress

$$\sigma_t=\frac{P\times D}{4\times t}$$

$$\sigma_t=\frac{5.5\times 10^6\times 0.3}{4\times 0.006}\surd=68.75MPa\surd$$

Circumferential stress

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

$$\sigma_t=\frac{5.5\times 10^6\times 0.3}{2\times 0.006}\surd$$

= 137.5 MPa$\surd$ (4)

7.2 Axial load$\surd$

$$\sigma=\frac{F}{A}$$

$$F=68.75\times 10^6\times\pi\times 0.3\times 0.006\surd$$

= 388.772 kN$\surd$ (2)

[6]

QUESTION 8

8.1 The least value of I

$$I = \frac{0.03 \times 0.007^3}{12}\surd$$

$$= 8.575 \times 10^{-10}\text{mm}\surd$$

$$F = \frac{n\pi^2 EI}{L^2}$$

$$= \frac{1 \times \pi^2 \times 200 \times 10^9 \times 8.575 \times 10^{-10}}{1.5^2}\surd$$

$$= 752.28\text{N}\surd$$ (4)

8.2

$$F = \frac{n\pi^2 \times EI}{L^2}$$

$$F = \frac{2 \times \pi^2 \times 200 \times 10^9 \times 8.575 \times 10^{-10}}{1.5^2}\surd$$

$$F = 1504.57N = \surd$$ (2)

8.3

$$F = \frac{n\pi^2 \times EI}{L^2}$$

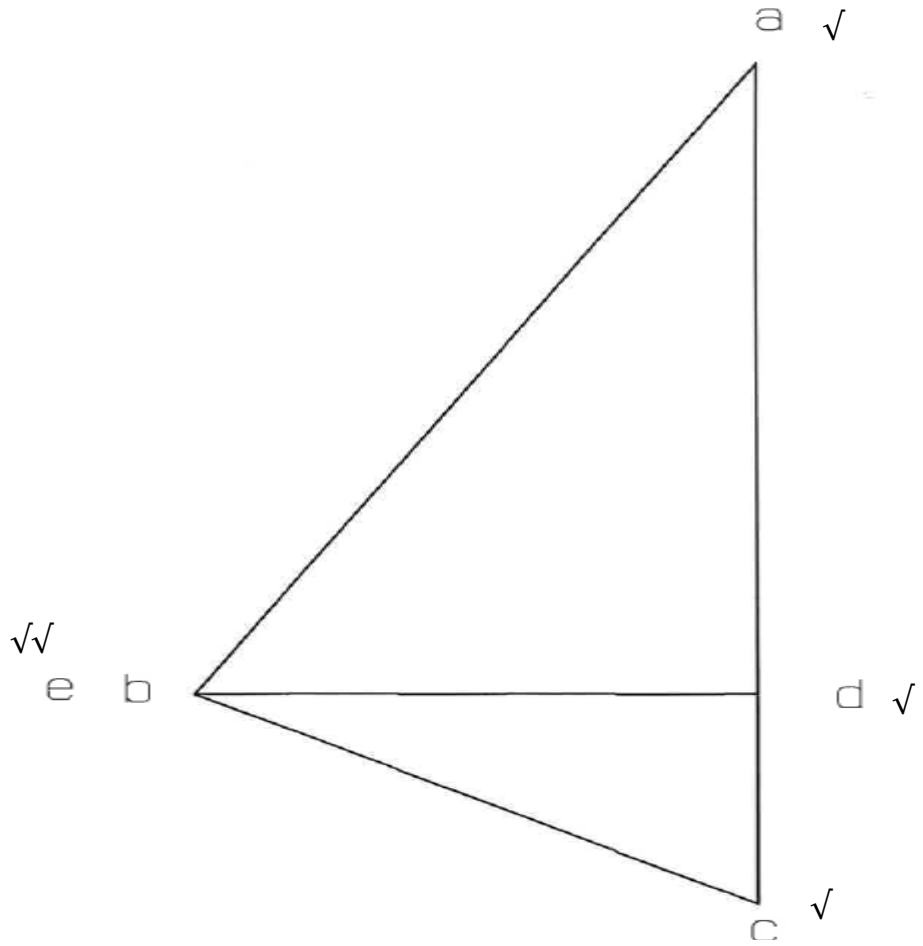
$$F = \frac{4 \times \pi^2 \times 200 \times 10^9 \times 8.575 \times 10^{-10}}{1.5^2}\surd$$

$$F = 3009.13N = \surd$$ (2)

[8]

QUESTION 9

150 x 2.11= 8.44XR
R = 37.5kN✓
8.44L= 150 x 6.33
L = 112.5 kN✓ (2)



(5)

ae = 130kN (S) √
bc = 75kN (S) √
bd = 65kN (T) √
de = 65kN (T) √
be = Redundant √✓

(5)
[12]

TOTAL: 100