higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

STRENGHT OF MATERIALS AND STRUCTURES N5

18 November 2020

This marking guideline consists of 5 pages.

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QUESTION 1

1.1 $$\sigma_{LoP} = \frac{F_{LoP}}{A_o} = \frac{70\,000}{\frac{\pi}{4}.(0{,}022^2)} = 184{,}146\ MPa$$ ✓ ✓ (2)

1.2 $$E = \frac{F_{LoP}.L_o}{A_o.X_{LoP}} = \frac{70\,000.(0{,}18)}{\frac{\pi}{4}.(0{,}022^2).(190 \times 10^{-6})} = 174{,}454\ GPa$$ ✓ ✓ (2)

1.3 $$\sigma_y = \frac{F_y}{A_o} = \frac{100\,000}{\frac{\pi}{4}.(0{,}022^2)} = 263{,}066\ MPa$$ ✓ ✓ (2)

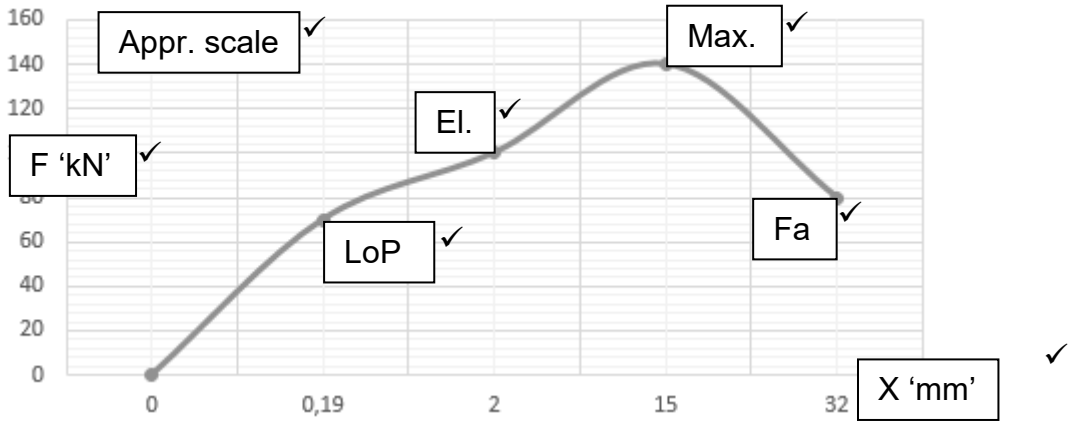
1.4 $$\sigma_y = \frac{F_y}{A_o} = \frac{140\,000}{\frac{\pi}{4}.(0{,}022^2)} = 368{,}292\ MPa$$ ✓ ✓ (2)

1.5 $$\sigma_y = \frac{F_y}{A_o} = \frac{80\,000}{\frac{\pi}{4}.(0{,}0089^2)} = 1\,285{,}938\ MPa$$ ✓ ✓ (3)

1.6 $$\%\,\Delta X = \left(\frac{L_o - L_f}{L_o}\right).100 = \left(\frac{32}{180}\right).100 = 17{,}78\ \%$$ ✓ ✓ ✓ (3)

1.7 $$\%\,\Delta A = \left(\frac{A_o - A_f}{A_o}\right).100 = \left(\frac{22^2 - 8{,}9^2}{22^2}\right).100 = 83{,}63\ \%$$ ✓ ✓ ✓ (3)

1.8



(7)

[24]

QUESTION 2

2.1 $F_C = F_B$

$\Delta t.(\alpha_C.L_C + \alpha_B.L_B) = F.\left(\frac{L_C}{A_C.E_C} + \frac{L_B}{A_B.E_B}\right)$

$60.\left(18 \times 10^{-6}.(0{,}2) + 22 \times 10^{-6}.(0{,}14)\right)$ ✓

$= F.\left(\frac{0{,}2}{380 \times 10^{-6}.(100 \times 10^{9})} + \frac{0{,}14}{500 \times 10^{-6}.(80 \times 10^{9})}\right)$

$F = 45\,736{,}937\ N$✓

$\sigma_C = \frac{F}{A_C} = \frac{45\,736{,}937}{380 \times 10^{-6}} = 120{,}36\ MPa$✓

$\sigma_B = \frac{F}{A_B} = \frac{45\,736{,}937}{500 \times 10^{-6}} = 91{,}474\ MPa$✓

(14)

2.2 Using Copper details:

$\delta_C = \alpha_C.\Delta t.L_C - \frac{F_C.L_C}{A_C.E_C}$ ✓

$\delta_C = 18 \times 10^{-6}.(0{,}2).(60) - \frac{45\,736{,}937.(0{,}2)}{380 \times 10^{-6}.(100 \times 10^{9})}$ ✓ ✓

$\delta_C = -0{,}0025\ mm$✓ (5)

[19]

QUESTION 3

Consider the circumferential/tensile stress:

$\sigma_T = \frac{p_i.D}{2.t.\eta_L} = \frac{3 \times 10^{6}.D}{2.(0{,}03).(0{,}7)} = 110 \times 10^{6}$✓

$\therefore D = 1{,}54\ m$✓

Consider the longitudinal stress:

$\sigma_L = \frac{p_i.D}{4.t.\eta_T} = \frac{3 \times 10^{6}.D}{4.(0{,}03).(0{,}55)} = 110 \times 10^{6}$✓

$\therefore D = 2{,}42\ m$✓

Allowable internal diameter:

$\therefore D = 1{,}54\ m$✓ because this will satisfy both the longitudinal and circumferential stress limits.✓ **[10]**

QUESTION 4

4.1 Steel section:

$C_S = \frac{G_S.J_S}{L} = \frac{90 \times 10^9.\frac{\pi}{32}.(0{,}011^4)}{0{,}19} = 680{,}863\ Nm/rad$ ✓✓✓

Aluminium section:

$C_A = \frac{G_A.J_A}{L} = \frac{110 \times 10^9.\frac{\pi}{32}.(0{,}018^4)}{0{,}28} = 4\ 048{,}784\ Nm/rad$ ✓✓✓ (6)

4.2 $C_T = C_S + C_A = 680{,}863 + 4\ 048{,}784 = 4\ 729{,}647\ Nm/rad$ ✓✓ (2)

4.3 $T_T = T_S + T_A$

$\theta_S = \theta_A$ ✓

$T_T = C_S.\theta_S + C_A.\theta_A$ ✓

$60 = 4\ 729{,}647.(\theta)$ ✓

$\therefore \theta = 0{,}0127\ rad = 0{,}73^o$ ✓ (4)

4.4 $\tau_S = \frac{R_S.G_S.\theta}{L_S} = \frac{0{,}0055.(90 \times 10^9).(0{,}0127)}{0{,}19} = 33{,}087\ MPa$ ✓✓✓

$\tau_A = \frac{R_A.G_A.\theta}{L_A} = \frac{0{,}009.(110 \times 10^9).(0{,}0127)}{0{,}28} = 44{,}904\ MPa$ ✓✓✓ (6)

4.5 $T_S = C_s.(\theta) = 680{,}863.(0{,}0127) = 8{,}647\ Nm$ ✓✓

$T_A = C_A.(\theta) = 4\ 048{,}784.(0{,}0127) = 51{,}420\ Nm$ ✓✓ (4)

4.6 $P = 2.\pi.\frac{N}{60}.T_T = 2.\pi.\frac{1750}{60}.60 = 10\ 995{,}574\ kW$ ✓✓ (3)

[25]

QUESTION 5

5.1 $P_E = \frac{\pi^2.E.I}{{L_E}^2} = \frac{\pi^2.(210 \times 10^9).(I)}{12^2} = 280\ 000\ N$ ✓✓✓

$\therefore I = 1{,}945 \times 10^{-5}\ m^4$

$I = \frac{\pi}{64}.(0{,}18^4 - d^4) = 1{,}945 \times 10^{-5}\ m^4$ ✓✓

$d = 159.959 \approx 160\ mm$ ✓ (6)

5.2 $A = \frac{\pi}{4}.(0{,}18^2 - 0{,}16^2) = 5{,}341 \times 10^{-3}\ m^2$

$k = \sqrt{\frac{I}{A}} = \sqrt{\frac{1{,}945 \times 10^{-5}}{5{,}341 \times 10^{-3}}} = 0{,}06\ m^3$ ✓✓✓

$SR = \frac{L_E}{k} = \frac{12}{0{,}06} = 199{,}315$ ✓✓

$P_R = \frac{\sigma_y.A}{1 + a.(SR)^2} = \frac{155 \times 10^6.(5{,}341 \times 10^{-3})}{1 + \left(\frac{1}{7100}\right).(199{,}315^2)} = 125\ 522{,}811\ N$ ✓✓✓ (9)

[15]

QUESTION 6

- Tensile test
- Compressive test
- Shear test
- Creep test
- Hardness test
- Impact test and
- Fatigue test (7 × 1) **[7]**

TOTAL: 100

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