higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

STRENGTH OF MATERIALS AND STRUCTURES N5

27 November 2014

This marking guideline consists of 8 pages.

QUESTION 1

1.1 $\sigma = \frac{F}{A} = \frac{165\times10^3\times4}{\pi\times462}\surd$

$= 99{,}28$ MPa$\surd$ (3)

1.2 $E = \frac{\Delta\ell}{\ell} = \frac{0{,}074}{180}\surd$

$= 4{,}11\times10^{-4}\ \surd$ (2)

1.3 $E = \frac{\sigma}{E} = \frac{99{,}28\times10^6}{4{,}11\times10^{-4}}\surd$

$= 241{,}49$ GPa$\surd$ (2)
[7]

QUESTION 2

2.1 $P = \frac{2\pi NT}{60}$

$\therefore T = \frac{1350\times10^3\times60}{2\pi\times170}\surd$

75 832,65 Nm$\surd$

$T_{max} = 75832{,}65\times1{,}4\surd$

$= 106165{,}71$ Nm$\surd$

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

$106165{,}71 = \frac{\pi}{16}\times190\times10^6\left(\frac{(1{,}5^4d^4)-d^4}{1{,}5d}\right)\surd\surd$

d = 101,66 mm$\surd$

D = 152,49 mm$\surd$ (8)

2.2 $T = \frac{\pi}{16}\tau d^3$

$106165{,}71\surd = \frac{\pi}{16}\times190\times10^6\times d^3\surd$

d = 141,71 mm$\surd$ (3)

2.3 percentage savings $= \frac{A_S-A_h}{A_S}\times100$

$= \frac{141{,}71^2-[152{,}49^2-101{,}66^2]\times100}{141{,}71^2}\surd\surd$

$= 35{,}67\ \%\surd$ (3)

2.4 $\frac{\theta_h}{\theta_S} = \frac{D_h^4}{D_S^4} = \frac{152,49^4 - 101,66^4}{141,71^4}$√

= 1,076√ (3)

[17]

QUESTION 3

$CM_b = ACM_b$

$3.8 \times 14 \times 5 = 4 \times 2 + C(12 - X)$

$C = \frac{258}{12-X}$ .....(1)√

$BM\ at\ D = 0$

$-4 \times 7 - \frac{3.8 \times 7^2}{2} + 5B = 0$ √

$B = 24.22kN$ √

$-3.8 \times \frac{7^2}{2} + C(7 - X) = 0$ √

$C = \frac{93.1}{(7-X)}$ .....(2)√

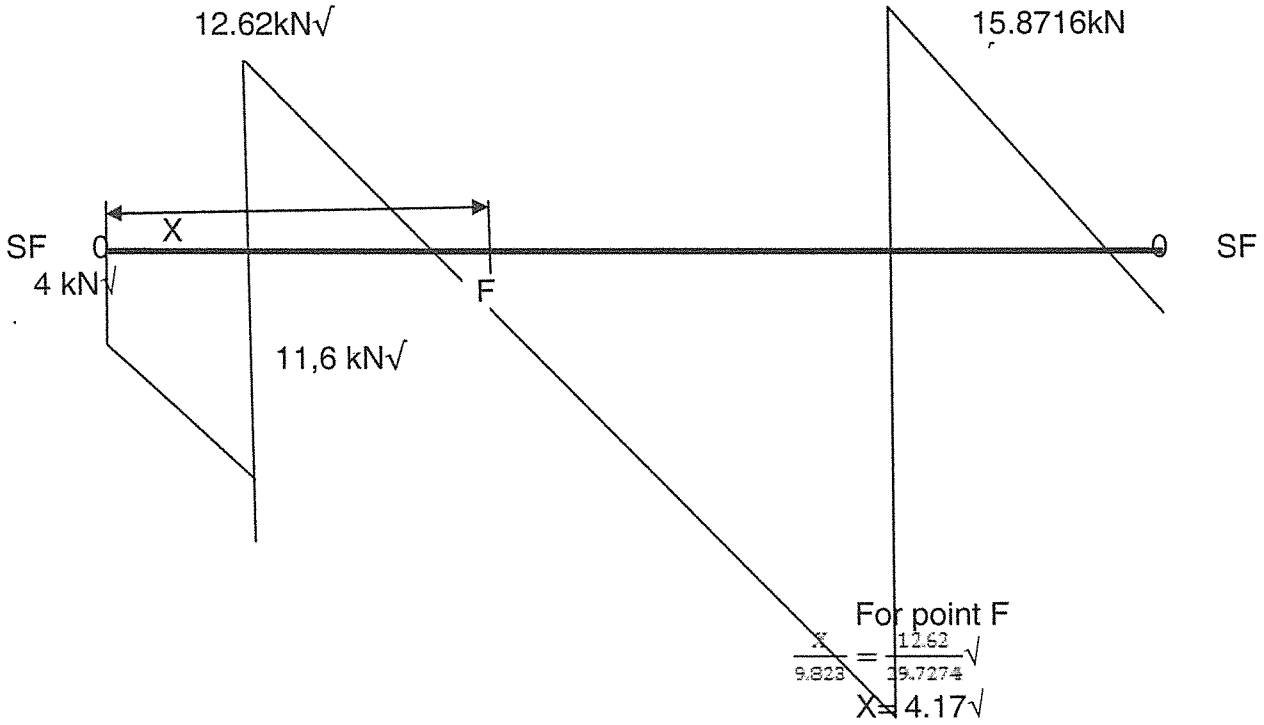
Equation (1) = equation (2)

$\frac{258}{12-x} = \frac{93.1}{7-x}$√

$C = 4.177$

$C = \frac{93.1}{7-X}$

C = 32,979 kN√



$BM_A = 0$

$BM_B = -4 \times 2 - \frac{3.8 \times 2^2}{2} = -15.6kN.m\sqrt{}$

$BM_f = -4 \times 6.17 - \frac{3.8 \times 6.17^2}{2} + 24.22 \times 4.17 = 3.986kN.m\sqrt{}$

$BM_C = -\frac{3.8 \times 4.17^2}{2} = -33.15kN.m\sqrt{}$

$BM_E = 0$

[20]

QUESTION 4

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

$80(P-24)10 = 75 \times \pi \times \frac{24^2}{4} \times 2\surd$

P = 108,82 mm$\surd$

(2)

$F_t = \sigma_t(P-d)t$

$= 80(108{,}82-24)10\surd$

$= 67{,}856$ kN$\surd$

(2)

$F_C = \sigma_C \times t \times d \times N$

$= 130 \times 10 \times 24 \times 2\surd$

$= 62{,}4$ kN$\surd$

(2)

$F_S = \tau \times \pi\frac{d^2}{4} \times N$

$= 75 \times \pi \times \frac{24^2}{4} \times 2\surd$

$= 67{,}86$ kN$\surd$

(2)

$\eta = \frac{62.4 \times 10^3}{80 \times 10^6 \times 108.82 \times 10^{-3} \times 10 \times 10^{-3}} \times 100\surd$

$= 71{,}68\ \%\surd$

(2)
[10]

QUESTION 5

5.1 $F_S = F_C$

$\sigma_S A_S = \sigma_C A_C$

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

$= \frac{650}{480}\sigma_C$

$= 1{,}354\ \sigma_C\surd$

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

$\frac{1.354\sigma_C}{210 \times 10^9} + \frac{\sigma_C}{E_C} = 70(18 \times 10^{-6} - 12 \times 10^{-6})\surd\surd\surd$

$\sigma_C = 26{,}3$ MPa (C)$\surd$

$\sigma_C = 1354 \times 26{,}3$

$= 36{,}61$MPa (T)$\surd$

(6)

5.2 $X_S = X_C$

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

$\sigma_S = 2\ \sigma_C$√

$F_T = F_C + F_S$

$55 \times 10^3 = \sigma_C A_C + \sigma_S A_S$

$\sigma_C = \times 650 + 2 \times \sigma_C \times 480$√√√

σ_C = 34,16MPa (T)√

σ_C = 2×34,16 = 68,32 MPa (T)√

Resultant stresses

σ_{RS} = 36,61 + 68,32 = 104,93 MPa (T)√

σ_{RC} = 34,16 – 26,3 = 7,86 MPa (T)√ (8)

5.3 $\Delta\ell = \ell\alpha_C\Delta t + \frac{\sigma_{RC}\ell}{E_C}$

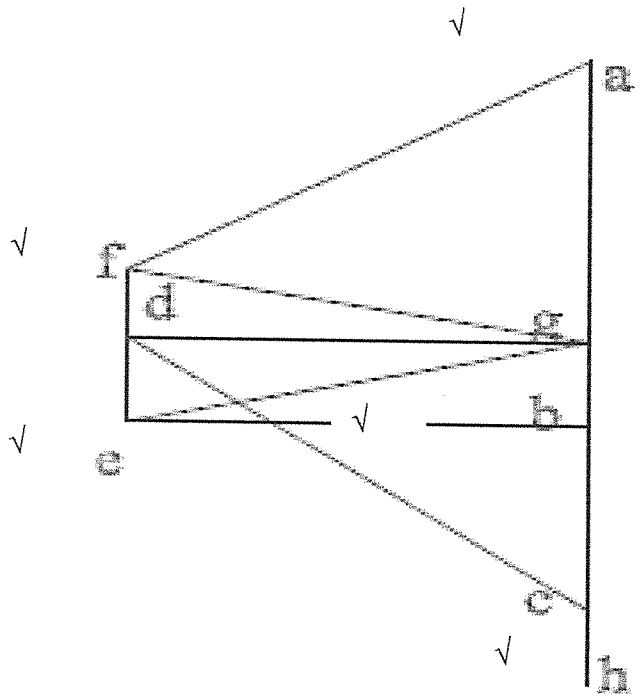
$830 \times 18 \times 10^{-6} \times 70 + \frac{7,86 \times 830}{105 \times 10^3}$√√

1,1079 mm

∴ l_f = 831,1079 mm√ (3)

[17]

6.



(5)

CM=ACM
100 x 5 + 50 x 9 + 20 × 13 = 13R
R = 93,1 N√
CM = ACM
13 L=100 x 8 + 50 x 4
L = 76.9N√ (2)

Magnitude and nature of forces
eg=100.17N(t)√
fg= 99.19 N (t)√
fa=113.66N(S)√
de=23.1N(t)√
fe=41.53N (S)√
eb= 97.47N (S)√
dg=97.47N (t)√
cd=121.83N S)√ (8)
[15]

QUESTION 7

7.1 $$\bar{y} = \frac{(300\times30\times345)+(200\times30\times315)+(300\times30\times150)}{(300\times30)+(200\times30)+(300\times30)}\surd$$
$$= 264.375mm\surd$$

$$I_{YY} = \frac{(300^3\times30)+(200^3\times30)+(30^3\times300)}{12} = 88.175\times10^{-6}m^4\surd\surd$$

$$I_{XX} = \frac{30^3\times300}{12} + (30\times300\times80.625^2) + \frac{30^3\times200}{12} + (200\times30\times50.625^2) + \frac{300^3\times30}{12} + (300\times30\times114.375^2)$$
$$= 193.4156\times10^{-6}m^4\surd\surd\surd$$

$$P = \frac{\pi^2\times E\times I}{l^2}$$
$$P = \frac{\pi^2\times210\times10^9\times88\times10^{-6}}{8.2^2}\surd$$
$$= 2.72MN\surd$$ (9)

7.2 $$P = \frac{\pi^2 \times E \times I_{xx}}{l^2}$$

$$P = \frac{\pi^2 \times 210 \times 10^9 \times 193.4156 \times 10^{-6}}{8.2^2}\surd$$

$$= 5.96MN\surd$$

$$P = \frac{\pi^2 \times E \times I_{yy}}{l^2}$$

$$= \frac{\pi^2 \times 210 \times 10^9 \times 88.175 \times 10^{-6}}{4.1^2}\surd$$

$$= 10.87MN\surd$$

(5)

USE P = 5,96 MN√ **[14]**

TOTAL: 100