201111T430

higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T2280(**E**)(N17)T
NOVEMBER 2011

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N6

(8060076)

17 November (X-Paper)
09:00 – 12:00

REQUIREMENTS: **Hot-rolled structural steel sections BOE 8/2**

Calculators may be used.

This question paper consists of 4 pages and a 3-page information sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
STRENGTH OF MATERIALS AND STRUCTURES N6
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.

QUESTION 1

A torque of 40 kNm is transmitted by a hollow shaft which is subjected to a bending moment of 20 kNm. The maximum tensile stress under these conditions must not exceed 100 MPa. The outside diameter of the shaft is 150 mm.

1.1 Calculate the following:

1.1.1 The inside diameter of the shaft (6)

1.1.2 The maximum shear stress in the shaft (4)

1.2 If a sleeve with a length of 200 mm is shrunk onto the above-mentioned shaft, calculate the interface pressure, if the coefficient of friction is 0,7 between the sleeve and the shaft when a torque of 40 kNm is transmitted. (3)

[13]

QUESTION 2

A concrete slab, simply supported, having a span of 3 metres, is 300 mm thick. The reinforcing consists of 15 mm diameter steel bars placed with their centres at 50 mm from the base of the slab. The allowable stresses in the steel and concrete are 120 MPa and 6 MPa respectively and the modular ratio is 15.

Calculate the following:

2.1 The distance between the adjacent reinforcing bars (8)

2.2 The distributed load per square metre, including the weight of the concrete, that the slab can carry (5)

[13]

QUESTION 3

A retaining wall with a trapezium cross section supports soil with a density of 1 800 kg/m^3 against its vertical face. The wall is 6 metres high, the width at the top is 1 metre and the base is 3 metres. The wall is made of concrete with a density of 2 400 kg/m^3. The angle of repose for the soil is 34°.

Calculate the following:

3.1 The allowable height of the soil if the factor of safety against overturning is 3,5 (10)

3.2 The factor of safety for sliding if the wall friction angle is 0,8 of the angle of repose (5)

[15]

QUESTION 4

A suspension bridge has a span of 120 metres and carries a mass of 3 000 metric tons evenly distributed over the span. It is supported by cables that sag 8 metres at mid-point. The supports are equal and on the same level.

Calculate the following:

4.1 The minimum tension in a cable (4)

4.2 The maximum tension in a cable (3)

4.3 The maximum slope of a cable (2)

4.4 The position on a cable where the tension is 56 MN (3)

[12]

QUESTION 5

A round concrete column is 3 metres in diameter and is subjected to a wind pressure of 3 kPa acting on 0,7 of the projected area. The concrete has a density of 2 800 kg/m^3.

Calculate the height to which the column can be built if no tension is to occur. **[8]**

QUESTION 6

A thick cylinder is subjected to an internal pressure of 80 MPa. The outside diameter is 250 mm and the maximum tensile stress in the cylinder material is 130 MPa. Young's modulus for the material is 210 GPa. Posion's ratio for the material is 0,33.

Calculate the following:

6.1 The maximum permissible inside diameter of the cylinder (9)

6.2 The longitudinal stress in the cylinder (2)

6.3 The hoop stress at the mean radius (2)

6.4 The radial stress at the mean radius (2)

6.5 The change in diameter at the inner diameter of the cylinder (2)

6.6 The strain at the outer diameter of the cylinder (2)
[19]

QUESTION 7

A beam consists of two hot rolled channels that are placed back to back. A point load of 60 kN is placed at mid-point and a uniformly distributed load of 10 kN/m is placed on the full length of the beam (including the weight of the beam). The maximum allowable bending stress in the beam must not exceed 100 MPa and the deflection is limited to 25 mm. The length of the beam is 8 metres and Young's modulus for the steel is 200 GPa.

7.1 Select TWO hot-rolled section channels to be used so that the stress and the deflection is not exceeded. (12)

7.2 Calculate the distance between the back of the TWO channels selected in QUESTION 7.1 so that the moment of inertia about the XX-axis is equal to the moment of inertia about the YY-axis. (8)
[20]

TOTAL: 100

STRENGTH OF MATERIALS AND STRUCTURES N6

INFORMATION SHEET

Any applicable equation or formula may be used.

$$\sigma_R = a + \frac{b}{d_1^2} \qquad \sigma_H = a - \frac{b}{d_1^2} \qquad F_\mu = \mu\, p_o\, \pi\, D_c\, L$$

$$p_i \frac{\pi}{4} d^2 = \sigma_L \frac{\pi}{4}(D^2 - d^2) \qquad d = \frac{d_1}{E}[\sigma_H - \nu\, \sigma_R]$$

$$\in = \frac{\sigma_H - \nu\, \sigma_R}{E} \qquad \Delta d = \frac{D_c}{E}[\sigma_{H1} - \sigma_{H2}]$$

$$\Delta d = D_c \left[\left(\frac{\sigma_{H1} - \nu_1 \sigma_{RC}}{E_1}\right) - \left(\frac{\sigma_{H2} - \nu_2 \sigma_{RC}}{E_2}\right)\right]$$

****

$$M = \frac{W\, a\, b}{L}$$

$$\theta = \frac{W\, L^2}{2\, E\, I} \qquad \Delta = \frac{W\, L^3}{3\, E\, I} \qquad M = W\, L$$

$$\theta = \frac{w\, L^3}{6\, E\, I} \qquad \Delta = \frac{w\, L^4}{8\, E\, I} \qquad M = \frac{w\, L^2}{2}$$

$$\theta = \frac{W\, L^2}{16\, E\, I} \qquad \Delta = \frac{W\, L^3}{48\, E\, I} \qquad M = \frac{W\, L}{4}$$

$$\theta = \frac{w\, L^3}{24\, E\, I} \qquad \Delta = \frac{5\, w\, L^4}{384\, E\, I} \qquad M = \frac{w\, L^2}{8}$$

****

$$C_\mu = \frac{1 - Sin\phi}{1 + Sin\phi} \qquad F_w = \frac{1}{2}\rho\, g\, H^2$$

$$F_g = \frac{1}{2} C_\mu\, \rho\, g\, H^2 \qquad F_p = C_\mu\, p\, H$$

$$V\,x + \Sigma F - M = \Sigma W - M \qquad \sigma_r = \frac{V}{B} \pm \frac{6\,V\,e}{B^2}$$

$\sigma_r = \dfrac{2\,V}{3\,x}$ (x = afstand van toon/distance from toe)

$$V.F./\,F.O.S. = \frac{\Sigma W - M}{\Sigma F - M}$$

$$V.F/\,F.O.S. = \frac{\sigma_{Uiterste/Ultimate}}{\sigma_{Mak/Max}}$$

$$V.F./\,F.O.S. = \frac{F_\mu}{\Sigma F - Kragte/Forces}$$

****

$$d = \frac{\sigma_1}{\rho\, g}\left[\frac{1 - Sin\phi}{1 + Sin\phi}\right]^2 \qquad M = \frac{W}{8\,L}[L - l]^2$$

$$M = \frac{W}{8}[L - l] \qquad SF = \frac{W}{2\,L}[L - l]$$

****

$$\frac{\sigma_s}{\sigma_c} = \frac{m(d - n)}{n} \qquad \frac{b\,n^2}{2} = m\,A_s\,(d - n)$$

$$M_c = \frac{1}{2}\sigma_c\, b\, n\, l_a \qquad M_s = \sigma_s\, A_s\, l_a \qquad l_a = d - \frac{n}{3}$$

$$m\,A_s(d - n) = A_1\left(n - \frac{t}{2}\right) + A_2\left(\frac{n - t}{2}\right)$$

$$\sigma_{cl} = \frac{\sigma_c\,(n - t)}{n} \qquad M_s = \sigma_s\, A_s\,(d - n)$$

$$M_c = \left[\frac{1}{2}\sigma_c\, b\, n\left(\frac{2}{3}n\right)\right] - \left[\frac{1}{2}\sigma_{cl}\,(b-e)(n-t)\left\{\frac{2}{3}(n-t)\right\}\right]$$

$$M_{Maks/Max} = M_s + M_c$$

****

$$y^2 = y_0^2 + l_1^2 \qquad l_1 = y_o\, Tan\theta \qquad x = y_o \ln\left[\frac{y+\ell}{y_o}\right]$$

$$F_3^2 = F_H^2 + (wx)^2 \qquad F_H = \frac{w\,L^2}{8\,d} \qquad l = L + \frac{8\,d^2}{3\,L}$$

$$F_H = \frac{w\,x_1^2}{2\,d} \qquad F_H = \frac{w\,(L-x_1)^2}{2\,(d+h)} \qquad Cos\theta = \frac{F_H}{F_t}$$

$$l_1 = x_1 + \frac{2\,d^2}{3\,x_1} \qquad l_2 = (L-x_1) + \frac{2\,(d+h)^2}{3\,(L-x_1)}$$

$$F_{st} = Wx + F_v$$

****

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2+T^2}\right] \qquad M_e = \frac{\pi\,D^3}{32}\sigma_n$$

$$T_e = \sqrt{M^2+T^2} \qquad T_e = \frac{\pi\,D^3}{16}\tau_{maks/\max}$$

$$\frac{Vervang}{Replace}\ D^3\ \frac{met}{with}\ \frac{D^4-d^4}{D}$$