higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1490(E)(A4)T
AUGUST EXAMINATION

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N6

(8060076)

4 August 2014 (Y-Paper)
13:00–16:00

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

This question paper consists of 6 pages and a formula sheet of 3 pages.

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 according to the numbering system used in this question paper.
4. Write neatly and legibly.

QUESTION 1

Each leg of a pair of shear legs is 14 m long and their lower ends are 10 m apart. The length of the backstay is 20 m. A load of 30 kN is lifted and it has an overhang of 3 m.

1.1 Draw a top view and side view of the A-frame. Use a scale of 1 cm = 2 m. (5)

1.2 Determine the forces in the members graphically.
Use a scale of 1 cm = 5 kN. (5)
[10]

QUESTION 2

A closed pipe with an inside diameter of 150 mm and an outside diameter of 200 mm was tested to destruction. The pipe failed at an internal pressure of 48 MPa.

Calculate the following:

2.1 The ultimate hoop stress for the material (6)

2.2 The safe internal pressure for a cylinder of the same material with an internal diameter of 150 mm and an outside diameter of 280 mm.

Use a safety factor of 3. (8)
[14]

QUESTION 3

A solid shaft with a diameter of 230 mm is used as a cantilever with a length of 3 m. The beam carries a point load of 45 kN at the free end. Young's modulus for the material is 197 GPa.

Calculate the following:

3.1 The deflection at the free end (4)

3.2 The load gets replaced by TWO identical loads, ONE at the free end and the other at 2 m from the fixed end.

Calculate the magnitude of the loads so that the deflection remains the same as for the 45 kN load. (5)

3.3 The maximum bending stress in the beam when supporting the TWO loads. (4)
[13]

QUESTION 4

Refer to the steel-press frame shown in FIGURE 1.

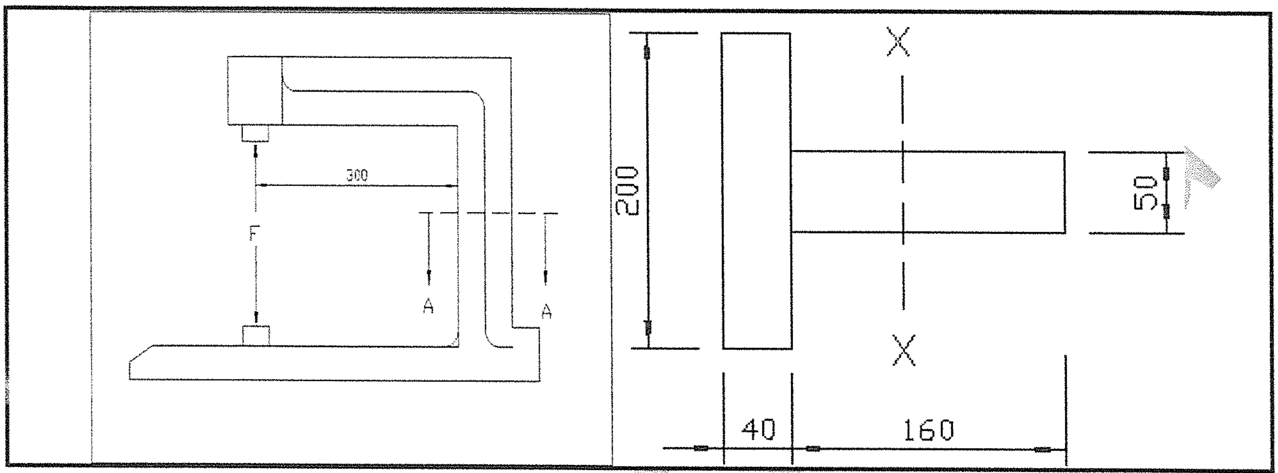

FIGURE 1

Calculate the following:

4.1 The position of the centroid from the top of the flange (3)

4.2 The second moment of area of the profile (5)

4.3 The magnitude and nature of the direct stress in the frame (3)

4.4 The maximum and minimum resultant stresses in the frame (4)
[15]

QUESTION 5

A trapezium-shaped retaining wall retains water to the top of its vertical face with a height of 6 m. The top of the wall is 2 m wide and the base is 5 m wide. The density of the wall material is 2 000 kg/m^3. Consider 1 m length of the wall.

Calculate the following:

5.1 The resultant vertical reaction of the ground (3)

5.2 The weight moments about the TOE (3)

5.3 The force moment about the TOE (3)

5.4 The position of the resultant vertical reaction from the TOE (2)

5.5 The maximum pressure beneath the wall (3)
[14]

QUESTION 6

A short column with a cross-section of 600 mm x 600 mm has a weight of 20 kN. Due to an axial load on the column the stress induced is 500 kPa. The foundation has a weight of 29 kN. The allowable ground-bearing pressure is 180 kPa and the ground has a density of 1 600 kg/m^3 and an angle of repose of 30°.

Calculate the following:

6.1 The length of the sides of the square foundation (4)

6.2 The thickness of the foundation (2)

6.3 The depth of the foundation (2)
[8]

QUESTION 7

A reinforced concrete beam, 400 mm wide with an effective depth of 600 mm is simply supported over a length of 4 m and carries an uniformly distributed load of 30 kN/m over the whole beam as well as a point load in the middle of the beam. The maximum allowable stress in the steel is 115 MPa and in the concrete 5 MPa and these values are reached simultaneously. Take m as 15.

Calculate the following:

7.1 The depth of the neutral axis from the top (3)

7.2 The maximum permissible bending moment (2)

7.3 The magnitude of the point load (2)

7.4 The area of steel reinforcing required (2)

7.5 The number of 25 mm diameter bars required (4)
[13]

QUESTION 8

A solid shaft is supported by TWO bearings 1 m apart. They carry a flywheel with a weight of 7 800 N at 0,6 m from the left-side bearing. The shaft transmits 150 kW at 600 rpm. The maximum torque exceeds the mean torque by 12%. The maximum allowable bending stress in the shaft is 60 MPa and the maximum allowable shear stress is 45 MPa.

Calculate the following:

8.1	The maximum torque on the shaft	(1)
8.2	The maximum bending moment on the shaft	(1)
8.3	The equivalent torque	(2)
8.4	The equivalent bending moment	(2)
8.5	The minimum shaft diameter required by considering BOTH stresses	(5)
8.6	The actual shear stress in the chosen shaft	(2)
		[13]

TOTAL: 100

STRENGTH OF MATERIALS AND STRUCTURES N6

FORMULAE SHEET

Any applicable equation or formula may be used.

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

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

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

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

****

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

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

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

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

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

****

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

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

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

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

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

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

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

****

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

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

****

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

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

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

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

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

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

****

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

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

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

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

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

****

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

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

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