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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N6

(8060076)

25 November 2014 (Y-Paper)
13:00 – 16:00

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

This question paper consists of 6 pages and 1 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

TWO cylinders of the same material are shrunk together to form a compound cylinder. The inside diameter is 120 mm and the contact diameter is 200 mm with the outside diameter equal to 260 mm. The radial stress at the contact diameter is 25 MPa. Young's modulus is 200 GPa and Poisson's ratio is 0,3.

Calculate the following:

1.1	The minimum hoop stress in the inner cylinder	(6)
1.2	The maximum hoop stress in the outer cylinder	(6)
1.3	The change in diameter of the inner cylinder at the contact diameter	(1)
1.4	The change in diameter of the outer cylinder at the contact diameter	(1)
1.5	The shrinkage allowance	(1) **[15]**

QUESTION 2

A cantilever with a length of 5 m carries a point load of 10 kN at 3 m from the fixed end. The cantilever is made up of TWO unequal-leg angles, 150 x 90 x 26,6 kg/m which are placed back to back to form a 'T'-shape.
Young's modulus is 200 GPa for the material.

Calculate the following:

2.1	The maximum bending moment on the beam (include the weight of beam)	(2)
2.2	The maximum and minimum bending stresses in the beam	(4)
2.3	The maximum deflection of the beam	(5) **[11]**

QUESTION 3

A 30 m high chimney is made of a material with a density of 7 500 kg/m^3. It has an outside diameter of 2 m and an inside diameter of 1,9 m. A wind with a force of 30 kN blows against the vertical side of the chimney.

Calculate the following:

3.1	The direct stress at the base of the chimney due to its own weight	(3)
3.2	The bending stress due to the wind force	(3)
3.3	The maximum and minimum resultant stresses at the chimney base	(4)
3.4	The position of the neutral axis from the centroid	(2)
3.5	Sketch the stress distribution diagram of the base	(2) **[14]**

QUESTION 4

The retaining wall in FIGURE 1 supports water with a depth of 4 m. The density of the wall material is 2 100 kg/m^3.

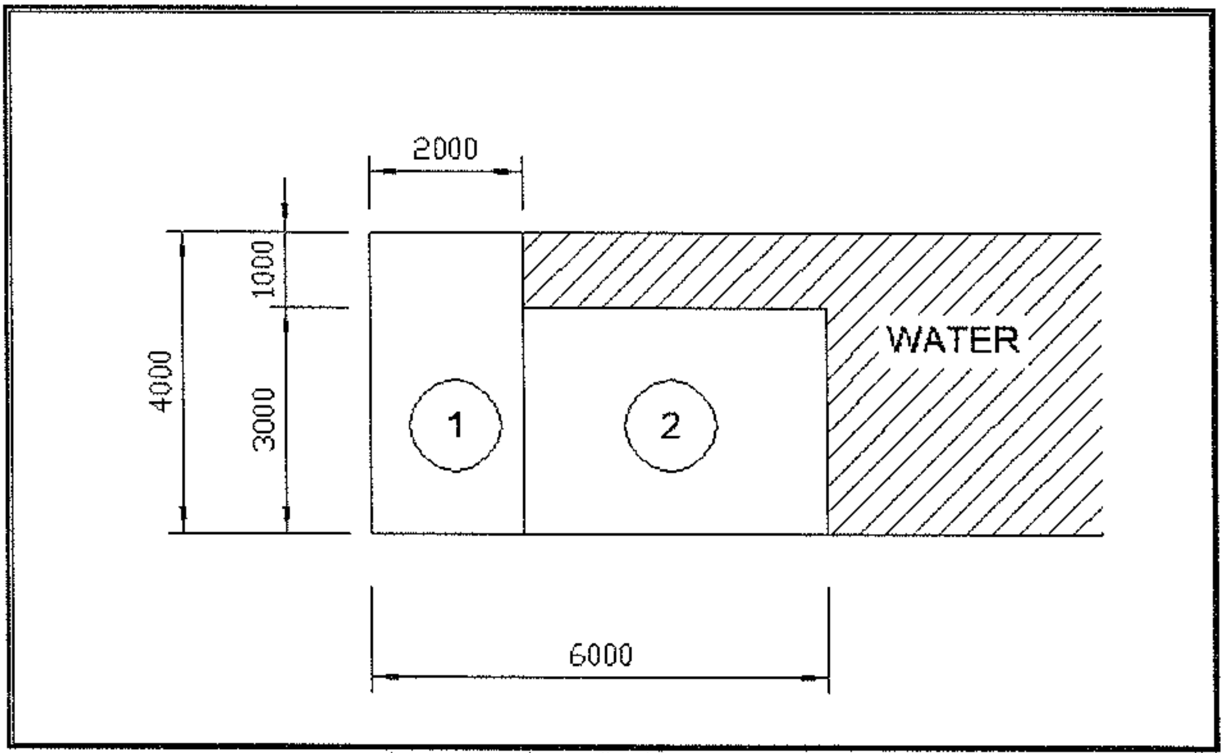

FIGURE 1

Calculate the following:

4.1 The vertical reaction of the ground (4)

4.2 The force-moments about the TOE (3)

4.3 The weight-moments about the TOE (4)

4.4 The factor of safety against overturning (2)

4.5 The factor of safety against sliding if the coefficient of friction is 0,4 (2)
[15]

QUESTION 5

A column supports a load of 2,5 MN on a square base plate of 800 mm x 800 mm and it is NOT FIXED to the top tier of a grillage foundation. The top tier consists out of FOUR parallel flange I-sections and the bottom tier has SIXTEEN parallel flange I-sections. The allowable bending stress in the beams is 100 MPa. The weight of the foundation is 150 kN and the allowable ground bearing pressure is 200 kPa.

Calculate the following:

5.1	The length of the square foundation	(2)
5.2	The bending moment on the top tier	(2)
5.3	Select the LIGHTEST suitable I-sections for the top tier	(3)
5.4	The minimum width needed to space the I-sections in the top tier	(2)
5.5	The bending moment for the bottom tier	(2)
5.6	Select the LIGHTEST suitable I-sections for the bottom tier	(3)

[14]

QUESTION 6

A uniform flexible cable supports its own weight of 25 N/m between TWO supports that differ by 3 m in height. The sag in the cable is 4 m below the shorter support. The maximum tension in the cable is 4 kN.

Calculate the following:

6.1	The tension in the cable at the lower support	(3)
6.2	The total length of the cable	(4)
6.3	The horizontal distance between the supports	(3)
6.4	The vertical reaction in the shorter support if the cable runs over a frictionless pulley and the angle between the anchor cable and the support is 60°	(3)
6.5	The tension in the anchor cable at the higher support if the cable is fixed to a saddle on rollers if the angle between the anchor cable and the support is 70°	(2)

[15]

QUESTION 7

A solid shaft is supported by TWO bearings which are 1 m apart and is used as a drive shaft with a flywheel and a pulley on the shaft. The weight of the shaft is 600 N/m. The mass of the flywheel is 200 kg and is mounted 800 mm from the left bearing. The pulley is mounted 300 mm from the left bearing and transmits power by belt drive. The tight side tension in the belt is 2 000 N and in the slack side it is 600 N. The effective diameter of the pulley is 400 mm. Assume that the belts are vertical and parallel.

Calculate the following:

7.1 The reactions of the bearings (4)

7.2 The maximum bending moment if it occurs at the pulley (2)

7.3 The maximum torque transmitted (2)

7.4 The minimum shaft diameter if the bending stress is limited to 65 MPa (3)

7.5 The diameters of a hollow shaft, made of the same material, if the inside diameter is 60% of the outside diameter (3)

7.6 The percentage saving in weight if the hollow shaft is used (2)

[16]

TOTAL: 100

FORMULA 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)

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

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

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

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

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

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

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

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

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

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

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

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$$y^2 = y_0^2 + l_1^2$$

$$l_1 = y_o\, Tan\theta$$

$$x = y_o \ln\left[\frac{y+\ell}{y_o}\right]$$

$$F_3^2 = F_H^2 + (wx)^2$$

$$F_H = \frac{wL^2}{8d}$$

$$l = L + \frac{8d^2}{3L}$$

$$F_H = \frac{w x_1^2}{2d}$$

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

$$Cos\theta = \frac{F_H}{F_t}$$

$$l_1 = x_1 + \frac{2d^2}{3x_1}$$

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

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

****

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right]$$

$$M_e = \frac{\pi D^3}{32}\sigma_n$$

$$T_e = \sqrt{M^2 + T^2}$$

$$T_e = \frac{\pi D^3}{16}\tau_{maks/\max}$$

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