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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1710(**E**)(N18)T
NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N6

(8060076)

18 November 2013 (X-Paper)
09:00–12:00

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

Calculators may be used.

This question paper consists of 5 pages and 3 information sheets.

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. Draw a line after each part of a question.
5. Show ALL the steps of the calculations.
6. No marks will be given if only the formula and answer are given.
7. Write neatly and legibly.

QUESTION 1

A hollow shaft is subjected to a bending moment of 15 kNm. The length of the shaft is 3 m and it transmits a maximum torque of 36 kNm. The maximum torque is 20 percent more than the mean torque and the shaft transmits 800 kW.

Calculate the following:

1.1 The weight of the flywheel which is mounted in the middle of the shaft between the bearings. Consider the shaft as simply supported. (2)

1.2 The revolutions at which the power is transmitted (2)

1.3 The diameters of the hollow shaft if the inside diameter is 0,6 times the outside diameter and the maximum compressive stress in the shaft is 120 MPa (7)

1.4 The shear stress in the shaft for this condition (2)

[13]

QUESTION 2

2.1 Briefly describe how a link bend test is carried out on a lifting chain. (5)

2.2 State FOUR conditions a lifting chain must comply with to be satisfactory after examination and measurement. (2)

2.3 When is a proof test carried out on a hook? (1)

[8]

QUESTION 3

A reinforced concrete beam is simply supported over a length of 4 m and carries a uniformly distributed load of 12 kN/m over its full length, including its weight. A point load is supported 2,8 metres from the left-hand support. The allowable stress for the steel and the concrete is 140 MPa and 7 MPa respectively and m = 15. The maximum moment of resistance is at the point load.

Calculate the following:

3.1 The maximum moment of resistance of the beam if the reaction in the right-hand support is 80 kN (3)

3.2 The magnitude of the point load (6)

3.3 The effective depth of the steel reinforcement if the width of the beam is 400 mm (5)

[14]

QUESTION 4

A cantilever consists of a flat bar, 20 mm by 150 mm, bending about its XX-axis. Two unequal leg angles, 150 mm by 90 mm by 15 mm, are welded to the flat bar, one at each side to form a 'T' section. The 150 mm will be vertical and the 90 mm horizontal. The length of the cantilever is 4 m and the weight of the flat bar and the two angles are 570 N/m. The deflection of the cantilever must not be more than 1/360 of its length. E = 200 GPa

Calculate the following:

4.1 The point load that can be hoisted at the free end of the cantilever (11)

4.2 The compressive stress in the cantilever (4)
[15]

QUESTION 5

A retaining wall with a trapezium cross section is 1 m wide at the top and 4 m wide at the bottom. The vertical side of the wall that retains the water is 5 m high and the wall material has a density of 2 400 kg/m^3. The ultimate ground bearing pressure of the soil underneath the wall is 213 kPa. The wall is designed with a factor of safety of 3 for ground bearing pressure. The minimum ground bearing pressure must not exceed 79 per cent of the maximum ground bearing pressure beneath the wall.

Calculate the following:

5.1 The maximum and minimum ground bearing pressure beneath the wall (2)

5.2 The weight of the wall (3)

5.3 The position of the resultant ground reaction from the toe of the wall (3)

5.4 The depth of the water for the condition above. State why the wall will be safe against tension in the wall for the calculated water depth. (7)
[15]

QUESTION 6

A solid steel shaft with a diameter of 60 mm is pressed into a bronze sleeve with an outer diameter of 80 mm. Young's moduli for steel and bronze are 210 GPa and 95 GPa receptively. Poisson's ratios for steel and bronze are 0,28 and 0,3 respectively.

Use Lame's equations and calculate:

6.1 The maximum hoop stress in the sleeve if the intermediate pressure in the compound cylinder is 30 MPa (6)

6.2 The shrinkage allowance for the compound cylinder (3)
[9]

QUESTION 7

A suspension bridge is suspended between two supports A and B, 200 m apart and the load on each supporting cable is 10 kN/m. The difference in height of the two supports are 6 m and the turning point of the cable is 5 m below the top of the shortest support A. The anchor cable is supported by frictionless rollers at the top of the supports and form an angle of 60° with the supports.

Calculate the following:

7.1 The maximum and minimum tension at the supports (8)

7.2 The dimensions of a square foundation to support the loads of the bridge for support B which is an H-section (piles) of 356 by 368 by 174 kg/m. The height of support B is 10 m. The allowable ground bearing pressure is 260 kPa. (6)
[14]

QUESTION 8

The legs of a tripod have the following lengths: OA = 5,8 m; OB = 5 m; OC = 6 m. The base of the tripod forms a triangle ABC with AB = AC = 6 m and BC = 5 m.

Determine graphically:

8.1 The forces in the legs OB and OC if the resultant force for these legs may not exceed 25 kN (2)

8.2 The load lifted by the tripod (10)
[12]

TOTAL: 100

STRENGTH OF MATERIALS AND STRUCTURES N6

INFORMATION SHEET

Any applicable equation or formula may be used.

$$\sigma_R = a + \frac{b}{d_1^2}$$

$$\sigma_H = a - \frac{b}{d_1^2}$$

$$F_\mu = \mu \, p_o \, \pi \, D_c \, L$$

$$p_i \frac{\pi}{4} d^2 = \sigma_L \frac{\pi}{4}(D^2 - d^2)$$

$$d = \frac{d_1}{E}[\sigma_H - \nu \, \sigma_R]$$

$$\in = \frac{\sigma_H - \nu \, \sigma_R}{E}$$

$$\Delta d = \frac{D_c}{E}[\sigma_{H1} - \sigma_{H2}]$$

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

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

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

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

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

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

$$C_\mu = \frac{1 - Sin\phi}{1 + Sin\phi}$$

$$F_w = \frac{1}{2} \rho \, g \, H^2$$

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

$$F_p = C_\mu \, p \, H$$

$$V\,x + \Sigma F - M = \Sigma W - M$$

$$\sigma_r = \frac{V}{B} \pm \frac{6\,V\,e}{B^2}$$

$$\sigma_r = \frac{2\,V}{3\,x} \quad (x = \text{distance from toe})$$

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

$$V.F/F.O.S. = \frac{^6\ ultimate}{^6\ \max}$$

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

$$d = \frac{\sigma_1}{\rho\, g}\left[\frac{1 - Sin\phi}{1 + Sin\phi}\right]^2$$

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

$$M = \frac{W}{8}[L - l]$$

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

$$\frac{\sigma_s}{\sigma_c} = \frac{m(d - n)}{n}$$

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

$$M_c = \frac{1}{2}\sigma_c\,b\,n\,l_a$$

$$l_a = d - \frac{n}{3}$$

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

$$M_s = \sigma_s\,A_s\,l_a$$

$$\sigma_{cl} = \frac{\sigma_c\,(n - t)}{n}$$

$$M_s = \sigma_s\,A_s\,(d - n)$$

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

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

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

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

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

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

$$F_H = \frac{w L^2}{8 d}$$

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

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

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

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

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

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

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

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

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

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

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

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