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education

Department:
Education
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N6

(8060076)

29 March (X-Paper)
09:00 – 12:00

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

Calculators may be used.

This question paper consists of 8 pages and a 3-page formula sheet.

DEPARTMENT OF EDUCATION
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 jib crane, as shown in FIGURE 1 below, is used to lift a load.
AB = 6 m; EB = DB = 7,151 m; EA = DA = 9,334 m

Determine the following graphically:

1.1 The load that is lifted when the compressive force in the crane arm BC is 8 kN when the angle with the horizontal is 65° and 100° with the support EB (7)

1.2 The force in DA and DB (3)

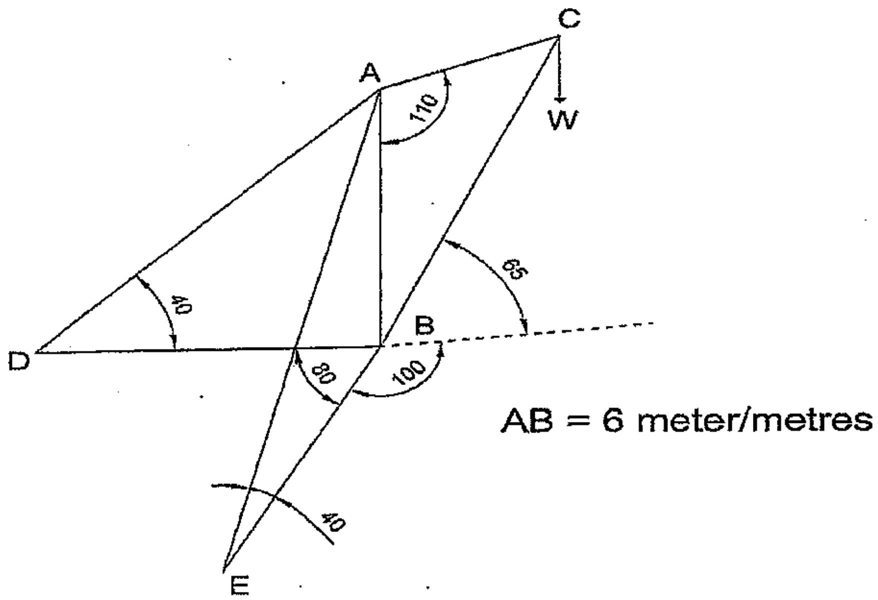

FIGURE 1

[10]

QUESTION 2

A hub with an outside diameter of 200 mm is shrunk on to a hollow shaft with an outside diameter of 100 mm and an inside diameter of 50 mm. The hoop stress of the shaft is limited to 160 MPa. Both the shaft and the hub are of the same material and E = 210 GPa and Poison's ratio is 0,3.

Calculate the following:

2.1 The hoop stress of the hollow shaft at the contact surface (6)

2.2 The radial stress at the contact surface (1)

2.3 The change in diameter of the shaft at contact surface (2)

2.4 The maximum hoop stress in the hub (6)

2.5 The change in diameter for the hub at contact surface (2)

2.6 The shrinkage allowance for the shaft and the hub at contact surface (1)
[18]

QUESTION 3

The stresses in the T-beam shown in FIGURE 2 is 160 MPa for the steel and 10 MPa for the concrete.

As m = 12 calculate the following:

3.1 The position of the neutral axis (2)

3.2 The area of the steel reinforcement (3)

3.3 The actual moment of resistance of the steel (2)

3.4 The stress at the bottom of the flange (2)

3.5 The actual moment of resistance for the concrete (4)

3.6 The maximum moment of resistance for the beam (1)

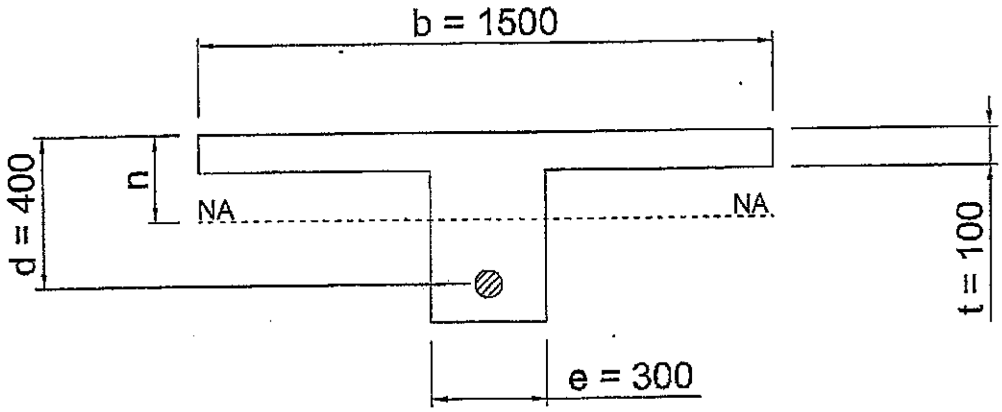

FIGURE 2

[14]

QUESTION 4

4.1 Briefly explain what a *bill of quantities* is. (2)

4.2 What is the purpose of a bill of quantities? (1)

4.3 Explain the following terms:

4.3.1 Contract drawings (1)

4.3.2 Working drawings with respect to buildings (1)

4.4 Name FOUR types of foundations and what they are used for. (2)

4.5 Name FOUR tests carried out on soil samples for a site inspection. (2)

4.6 Which THREE factors will influence the covering of steel in reinforced concrete? (3)

[12]

QUESTION 5

A grillage foundation consists of 3 I-sections in the top tier and 6 I-sections in the bottom tier and supports a column of a pier. The support rests on a square base plate of 1 metre by 1 metre, which is NOT FIXED to the I-sections of the top tier.
The support carries a load of 3 MN and the allowable ground bearing pressure for the soil is 220 kPa. The maximum bending stress for the beams is 160 MPa.

5.1 Calculate the size of the I-sections in the top tier. (7)

5.2 Check if the sections chosen in QUESTION 5.1 will fit in on the given dimension of 1 metre for the base plate if the distance between the flanges must be 75 mm. (2)

5.3 If the dimension calculated in QUESTION 5.2 is more than 1 metre, then this dimension must be adjusted. Select suitable I-sections for the bottom tier. (3)
[12]

QUESTION 6

A hollow shaft with a length of 5 metres supports a pulley with a weight of 4 kN at the centre of the shaft between two bearings. The shaft transmits 50 kW at 200 r/min. The outside diameter of the shaft is 1,5 times the inside diameter and the maximum torque is 1,3 times the mean torque. The maximum allowable tensile stress for the shaft is 130 MPa.

Calculate the following:

6.1 Maximum bending moment for the shaft (1)

6.2 Maximum torque transmitted by the shaft (2)

6.3 Dimensions for the shaft (5)

6.4 Shear stress for the shaft (3)
[11]

QUESTION 7

A flat spring steel strip, 30 mm by 8 mm and 800 mm long, is supported between pegs as shown in FIGURE 3 below. The diameter of the pegs is 10 mm each. Consider the strip as a simply supported beam between point A and C.

E = 210 GPa

Calculate the following:

7.1 Deflection at B (3)

7.2 Force on the middle peg B due to the deflection of the strip (5)

7.3 Reaction at peg A and peg C (2)

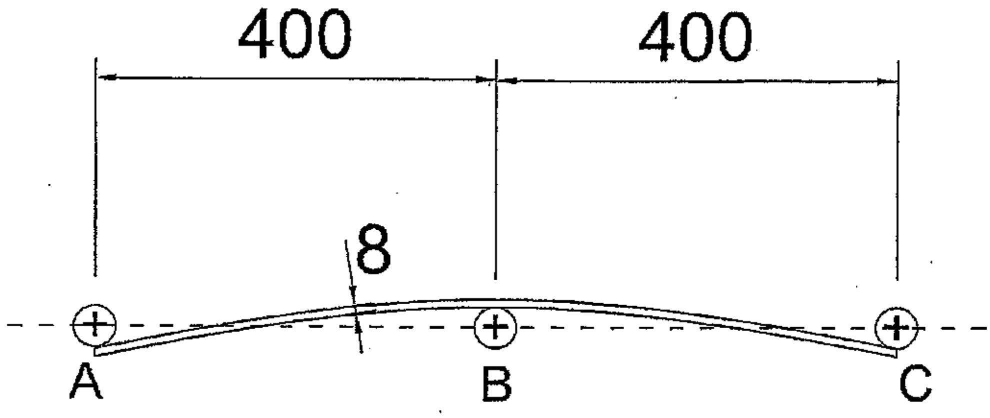

FIGURE 3

[10]

QUESTION 8

A brickwall with a breadth of 800 mm is 3 metres high and is built on a solid base. The density of the bricks is 2 000 kg/m^3. Calculate the maximum wind pressure which the wall can resist per metre length so that the resultant ground reaction is at the middle third of the wall's breadth. **[6]**

QUESTION 9

The main cables of a suspension bridge stretched over 180 metres between two supports which differ 6 metres in height. The turning point of the cables is 72,49 metres from the shortest support, which is 5 metres lower than the top of this support. Each cable carries a load of 500 N/m.

Calculate the following:

9.1 Maximum tension in a cable (3)

9.2 Maximum slope for a cable (2)

9.3 Tension in an anchor cable if the angle between the support and the anchor cable is 60° and the cable is supported by frictionless rollers on the supports (2)

[7]

TOTAL: 100

STRENGTH OF MATERIALS AND STRUCTURES N6

INFORMATION SHEET

Any applicable equation or formula may be used.

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

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

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

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

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

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

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

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

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

****

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

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

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

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

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

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

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

****

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

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

****

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

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

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

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

PTO

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

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

****

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

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

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

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

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

****

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

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

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