20100T444

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T2360(E)(N18)T
NOVEMBER 2010

NATIONAL CERTIFICATE

STRENGTH OF MATERIALS AND STRUCTURES N5

(8060065)

18 November (X-Paper)
09:00 – 12:00

REQUIREMENTS: Hot-rolled structural steel tables (BOE 8/2)

Calculators may be used.

This question paper consists of 5 pages, 4 diagram sheets and a formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
STRENGTH OF MATERIALS AND STRUCTURES N5
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

During a tensile test on a mild-steel specimen the following results were recorded:

Diameter of test piece = 12,3 mm

Gauge length = 56,5 mm

Load at yield point = 21,6 kN

Maximum load = 49 kN

Distance between gauge marks after fracture = 74 mm

Minimum diameter of fractured test piece = 9 mm

Calculate the following:

1.1 The maximum tensile stress (2)

1.2 The yield stress (2)

1.3 The percentage elongation (2)

1.4 The percentage reduction of area (2)
[8]

QUESTION 2

The stepped round bar shown in FIGURE 1 (DIAGRAM SHEET 1 attached), is fixed securely to a rigid support at its upper-end and has a rigid collar at its lower end. Through what height can a 1,6 kN weight be allowed to fall, if the maximum permissible stress in the bar is 70 MPa?

Take E = 210 GPa **[13]**

QUESTION 3

A compound shaft is formed from a solid shaft with a diameter of 55 mm and fitted bronze sleeve so that the torque in the sleeve is twice the torque in the shaft.

Take: $G_{steel} = 2,6\ G_{bronze}$

HINT: Parallel arrangement and equal length

Calculate the following:

3.1 The outside diameter of the sleeve if the inside diameter is 55 mm (6)

3.2 The torque that can be transmitted if the shear stress in the brass sleeve is limited to 50 MPa (6)

3.3 The shear stress in the steel shaft (3)

3.4 The power that can be transmitted by the compound shaft when rotating at 1 320 r/min (2)

[17]

QUESTION 4

Two 160 mm x 65 mm x 18,8 kg/m channels are joined toe to toe to form a strut with a length of 4 m. See FIGURE 2 (DIAGRAM SHEET 2, attached).

Calculate the following:

4.1 The I_{xx} and I_{yy} values as well as the slenderness ratio (10)

4.2 The safe axial load according to Rankine, if the ultimate stress is 300 MPa and a factor of safety of 3 being adopted, given that the Rankine constant is $\frac{1}{7500}$. Consider BOTH ends being hinged. (5)

[15]

QUESTION 5

A compound bar consists of a copper tube with a cross sectional area of 830 mm^2 and a steel rod with a cross sectional area of 340 mm^2 which fits inside the copper tube. BOTH materials are initially ONE meter long and their ends are rigidly fixed together.

Take: E_{steel} = 200 GPa $\alpha_{steel} = 12 \times 10^{-6}/\,°C$

E_{copper} = 100 GPa $\alpha_{copper} = 18 \times 10^{-6}/\,°C$

Calculate the following:

5.1 The magnitude and nature of the stress in the steel and copper respectively if the temperature is reduced by 60 °C (8)

5.2 The resultant stresses in the steel and copper respectively due to the reduction in temperature and the application of an external axial compressive load of 40 kN (10)

[18]

QUESTION 6

The maximum allowable bending stress of a cantilever shown in FIGURE 3 (DIAGRAM SHEET 3 attached) is 180 MPa. Draw the shear force and bending moment diagrams and choose a suitable channel section from the section tables. What is the actual maximum working stress in the chosen channel section? **[15]**

QUESTION 7

Graphically determine the magnitude and nature of forces in each member of the structure shown in FIGURE 4 (DIAGRAM SHEET 4, attached). The interior angles are 60°. **[14]**

TOTAL: 100

DIAGRAM SHEET 1

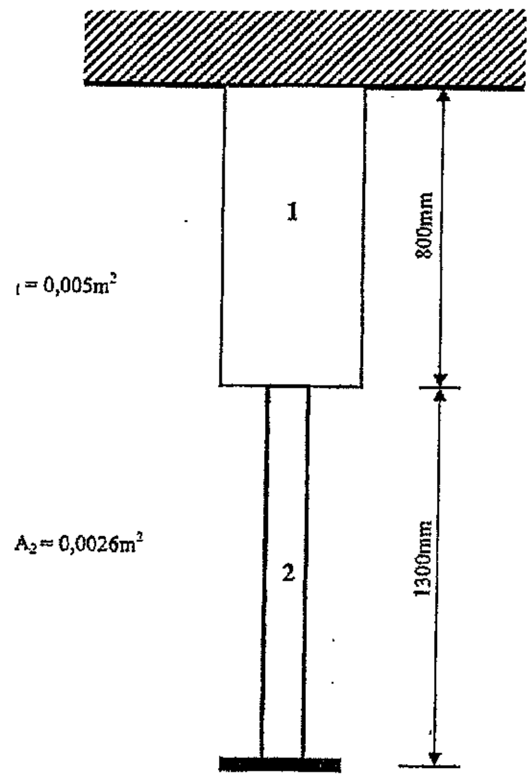

FIGURE 1

DIAGRAM SHEET 2

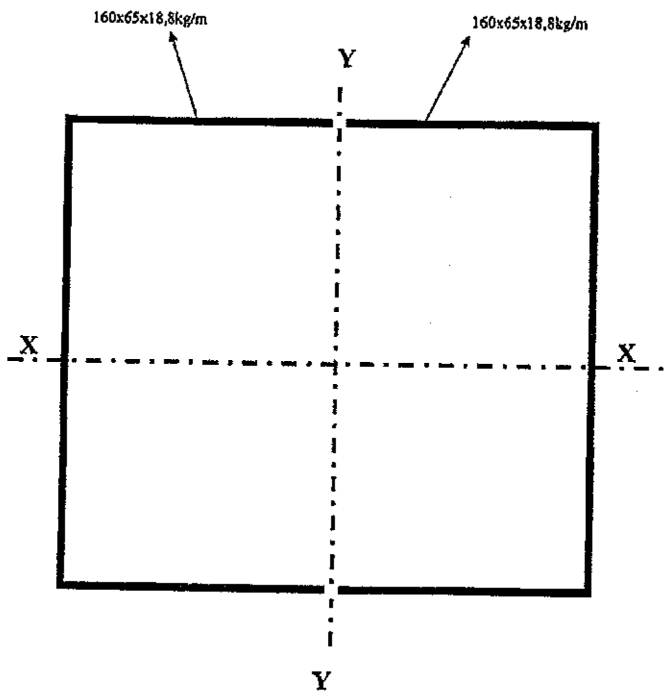

FIGURE 2

DIAGRAM SHEET 3

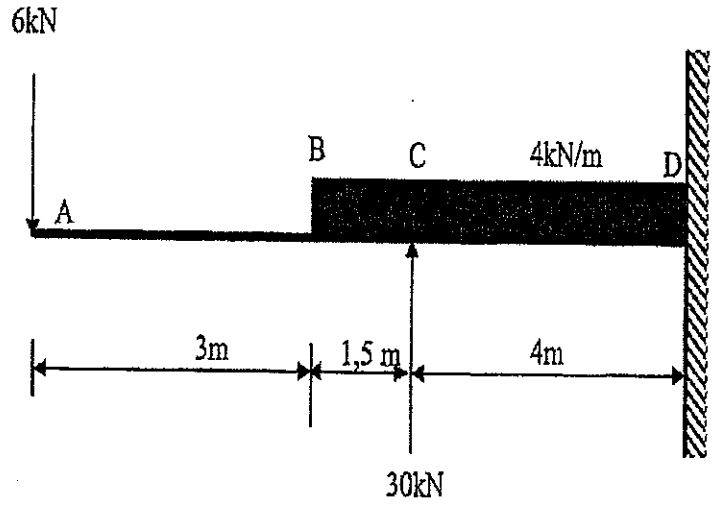

FIGURE 3

DIAGRAM SHEET 4

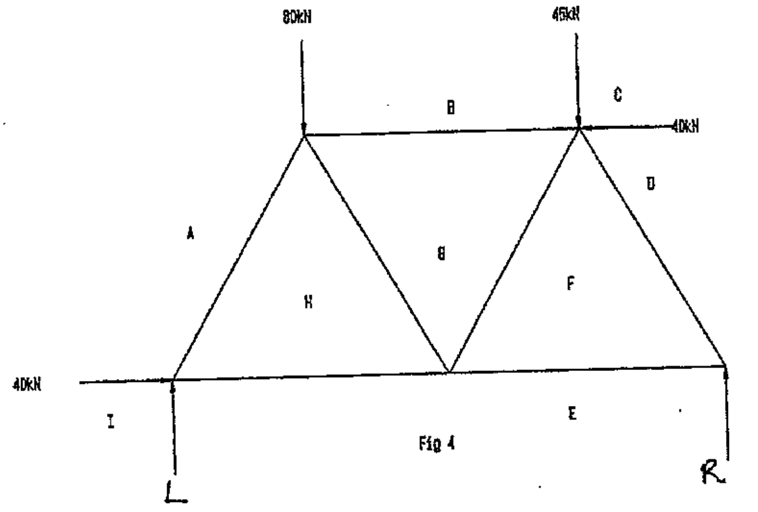

FIGURE 4

Any applicable equation or formula may be used.

$$\sigma = \frac{F}{A}$$

$$\in = \frac{X}{L}$$

$$E = \frac{FL}{Ax}$$

$$F\left(\frac{1}{A_1E} + \frac{1}{A_2E}\right) = \Delta t(\alpha_2 - \alpha_1)$$

$$F\left(\frac{L_1}{A_1E} + \frac{L_2}{A_2E}\right) = L_1\alpha_1\Delta t + L_2\alpha_2\Delta t$$

$$U = \frac{1}{2}Fx$$

$$U = \frac{F^2L}{2AE}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$mg(h + \chi) = \frac{F^2L}{2AE}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{L}$$

$$J = \frac{\pi(D^4 - d^4)}{32}$$

$$T = \frac{\pi}{16}\tau\frac{(D^4 - d^4)}{D}$$

$$T = \frac{\pi}{16}\tau D^3$$

$$\theta = \frac{10,2\,TL}{GD^4}$$

$$\theta = \frac{10,2\,TL}{G(D^4 - d^4)}$$

$$P = 2\pi NT$$

$$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$$

$$M = \frac{WL}{8}$$

$$M = \frac{\omega L^2}{8}$$

$$M = \frac{WL}{4}$$

$$Z = \frac{I}{y}$$

$$M = \sigma Z$$

$$I = \frac{\pi}{64}(D^4 - d^4)$$

$$I = \frac{\pi}{64}D^4$$

$$I_{xx} = \frac{bd^3}{12}$$

$$F = \frac{\pi^2 EI}{L_e^2}$$

$$F = \frac{\sigma A}{1 + a\left(\frac{L_e}{k}\right)^2}$$

$$F = \frac{4\pi^2 EI}{L^2}$$

$$F = \frac{\sigma A}{1 + \frac{a}{4}\left(\frac{L}{k}\right)^2}$$

$$k = \sqrt{\frac{I}{A}}$$

$$S.v = \frac{L_e}{k};\ S.R = \frac{L_e}{k}$$

Hinged ends/Geskarnierde ente $L_e = L$

Fixed ends/Ingeboude ente $L_e = \frac{L}{2}$

One end fixed, one end hinged/
Een ent ingebou, een ent geskarnier

$$L_e = \frac{L}{\sqrt{2}}$$

PTO

One end fixed, one end free/
Een ent ingebou, een ent vry $L_e = 2L$

$$\sigma = \frac{PD}{2.t\eta}$$

$$\sigma = \frac{PD}{4t\eta}$$

$$\eta = \frac{(p-d)\,t\sigma_t}{pt\sigma_t} \times 100$$

$$\eta = \frac{\frac{\pi d^2}{4}n\tau}{pt\sigma_t} \times 100$$

$$\eta = \frac{ndt\sigma_c}{pt\sigma_t} \times 100$$

$$\sigma_t(p-d)\,t = \frac{\pi d^2}{4}nt$$

$$(p-d)\,t\sigma_t = dtn\sigma_c$$