higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1480**(E)**(A6)T

AUGUST EXAMINATION

NATIONAL CERTIFICATE

STHRENGTH OF MATERIALS AND STRUCTURES N5

(8060065)

6 August 2014 (Y-Paper)

13:00–16:00

Requirements:
1. Hot rolled structural steel sections BOE8/2
2. Calculators may be used.

This question paper consists of 5 pages, 3 diagrams pages and a formula sheet of 3 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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STHRENGTH 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 the question paper.
4. Keep ALL the subsections of questions together.
5. Show ALL the calculation steps where calculations should be done.
6. Write neatly and legibly.

QUESTION 1

Draw neat sketches to show the steel reinforcements as applied in:

1.1 a simply supported beam (2)

1.2 a cantilever (2)
[4]

QUESTION 2

FIGURE 1(attached) shows a compound bar consisting of aluminium section withan outside diameter of 45 mm and a 35 mm diameter hole is drilled into the aluminium section for a length of L. The maximum tensile stress for aluminium is 150MPa and E_{al} is 72GPa. The middle section consists of steel pipe with an outside diameter of 30 mm and an inside diameter of 22mm. The maximum tensile stress for steel is 450 MPa and E_{steel} = 200 GPa. The third section is a solid copper rod with a diameter of 95 mm. The maximum tensile stress for copper is 240 MPa and E_{copper} is 110GPa.

Use a factor of safety of 2 and calculate:

2.1 The maximum allowable stress for each material. (3)

2.2 The maximum allowable force that can be applied to the compound rod (7)

2.3 The actual stress in each material (3)

2.4 The depth 'L' of the hole in the aluminium section if the total extension of the bar is 0,128 mm (6)
[19]

QUESTION 3

Two steel plates, each 14 mm thick, are joint by a double riveted lap joint with chain riveting. The stresses are:

tensile stress = 54 MPa
shear stress = 48 MPa
and crushing stress = 60MP.
Assume rivet diameter equals = 6,05 $\sqrt{t}$

Calculate:

3.1 The pitch for the rivets (4)

3.2 Check if the joint is safe against crushing (8)

3.3 The joint efficiency (2)
[14]

QUESTION 4

A simply supported beam with a length of 8 m supports a point load of 70 kN, 2.5m from the left support. The weight of the beam is 11kN/m. The beam is a symmetrical hollow section (see FIGURE 2 attached) with wall thickness of 15 mm. The outside dimensions are 600 mm× 200 mm.

Calculate:

4.1 The reactions at the supports (4)

4.2 Draw a shear force and bending moment (8)

4.3 The maximum stress in the beam (6)

4.4 The stress in the beam 150 mm from the neutral axis (2)
[20]

QUESTION 5

A hollow shaft transmits 3,6 MW at 210 rpm and the shear stress in the shaft must not exceed 70 MPa and the angle of twist must not exceed $1{,}3^0$. The length of the shaft is 840 mm and the outside diameter is 1,4 d.

G = 85 GPa.

Calculate the diameters of the shaft to be used so that no limit is exceeded.
(Assume mean torque equals maximum torque). **[10]**

QUESTION 6

Determine graphically the magnitude and nature of forces in each member of the structure shown in FIGURE 3 (attached). **[15]**

QUESTION 7

A 16 mm diameter steel rod passes centrally through a copper pipe 54 mm external diameter and 38 mm internal diameter. The length of the assembly is 800mm long. The pipe is closed at each end with flat washes with a thickness of 20 mm. The nuts are tightened until the copper pipe is reduced in length by 0,5 mm and the whole assembly is then subjected to a temperature rise of 80^0C. Assume the thickness of the flat washers remain unchanged throughout the process.

E_{steel} = 210GPa; $\alpha_{steel} = 12\times10^{-6}/^0C$;$E_{copper}$ = 100 GPa and $\alpha_{copper} = 18\times10^{-6}/^0C$
[HINT: The effect of the flat washer's thickness is on the length of the steel rod only.]

Calculate:

7.1 The stresses in the steel rod and the copper before the rise in temperature. (7)

7.2 The stresses in the steel and copper after the rise in temperature (resultant stresses) (11)
[18]

TOTAL: [100]

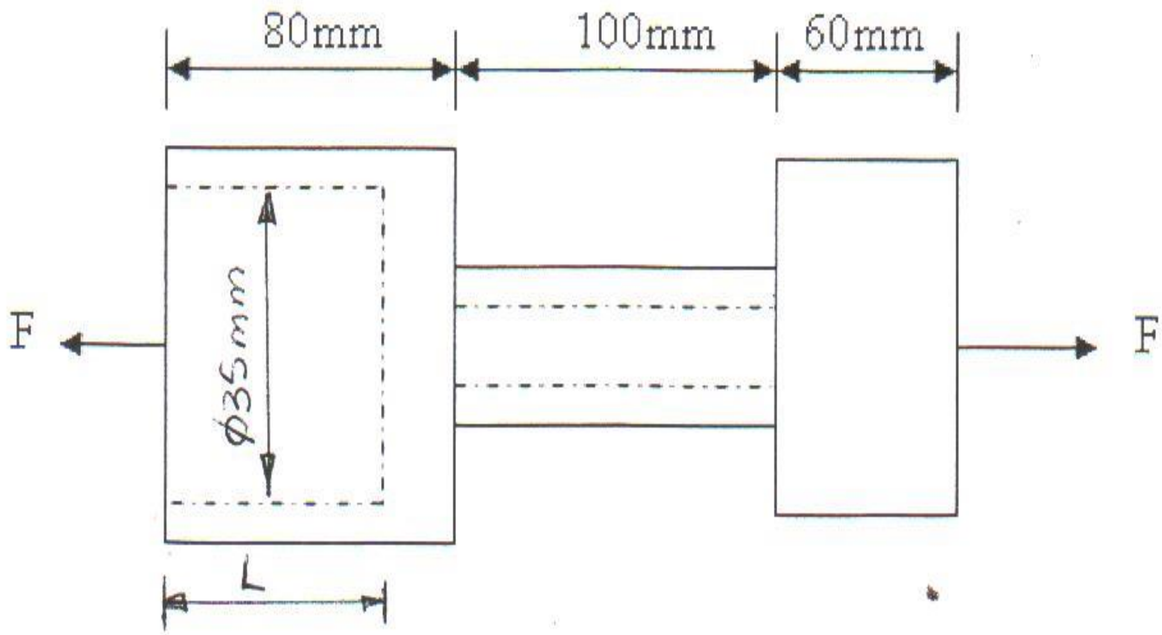

Figure 1

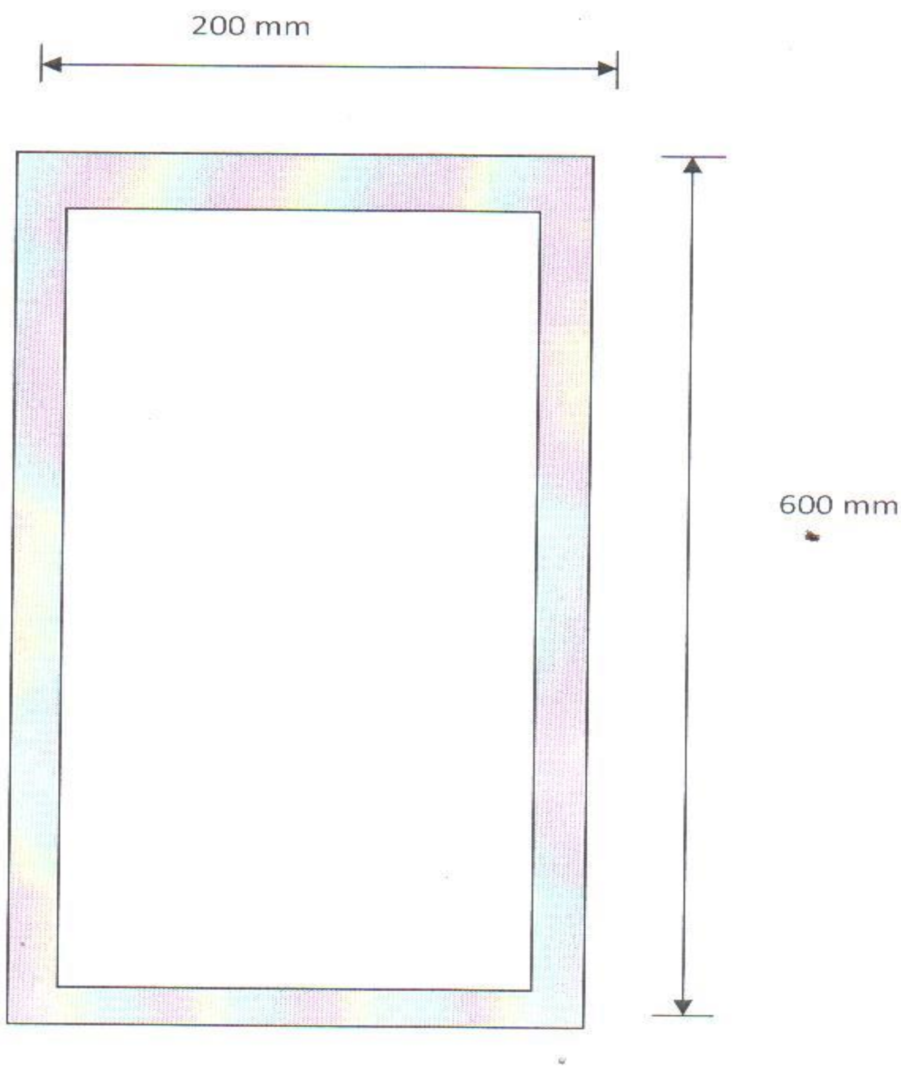

FIGURE 2

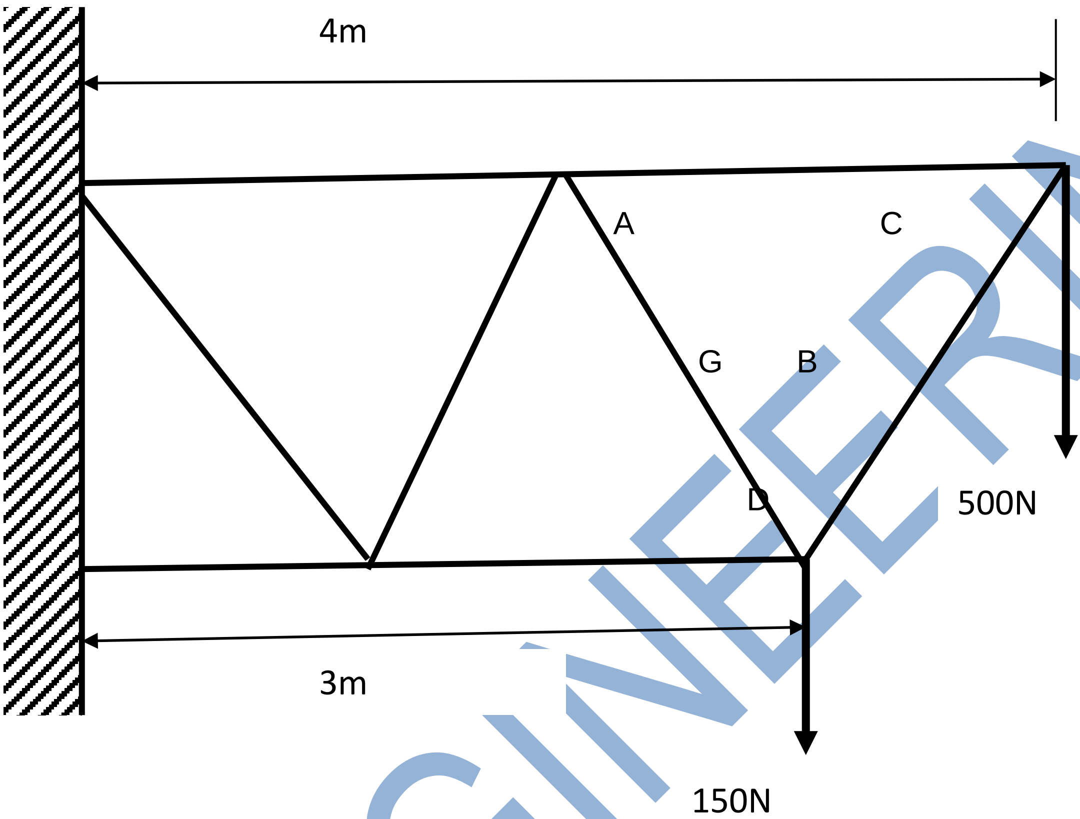

FIGURE 3

STRENGTH OF MATERIALS AND STRUCTURES N5

Any applicable equation or formula may be used.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$M = \sigma Z$$

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

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

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

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

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

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

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

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

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

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

$$P = 2\pi NT$$

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

One end fixed, one end free/

Een ent ingebou, een ent vry $L_e = 2L$

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

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

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

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

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

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

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

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

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

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

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

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

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