2705/103 2709/103
2707/103 2710/103
STRUCTURES I AND
CONSTRUCTION MATERIALS
June/July 2020
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN BUILDING CONSTRUCTION
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN ARCHITECTURE
MODULE I

STRUCTURES I AND CONSTRUCTION MATERIALS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examinations:
Mathematical table/scientific calculator;
Answer booklet.
*This paper consist of **EIGHT** questions in **TWO** sections **A** and **B**.*
*Answer **FIVE** questions choosing at least **TWO** question from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A: STRUCTURES I

*Answer at least **TWO** questions from this section.*

1. (a) Define the following terms as used in construction materials:

(i) toughness;
(ii) modulus of rigidity;
(iii) poisson's ratio.

(6 marks)

(b) A tensile test was conducted on a mild steel bar and the following data obtained from the test:

Diameter of steel bar = 35 mm
Gauge length of the bar = 300 mm
Load at elastic limit = 300 kN
Extension at the load of 200 kN = 0.50 mm
Maximum load = 500 kN
Load of failure = 460 kN
Total extension = 100 mm
Diameter of load at the fracture = 23 mm

Determine:

(i) the Young's modulus;
(ii) the stress at elastic limit;
(iii) the percentage elongation;
(iv) the percentage decrease in area;
(v) ultimate stress;
(vi) failure stress.

(14 marks)

2. (a) **Figure 1** shows a loaded frame. Using the method of joint resolution, determine the force and its nature in all the members of the frame. (10 marks)

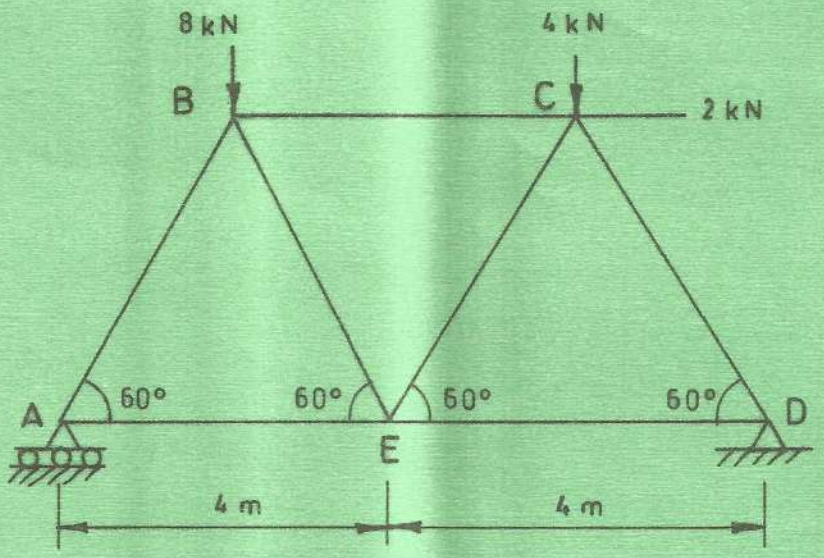


Fig. 1

(b) **Figure 2** shows a section of a loaded beam which is simply supported over a span of 5 metres. If the permissible stress is 120 N/mm^2.
Determine the uniformly distributed load that the beam can carry over the entire span. (10 marks)

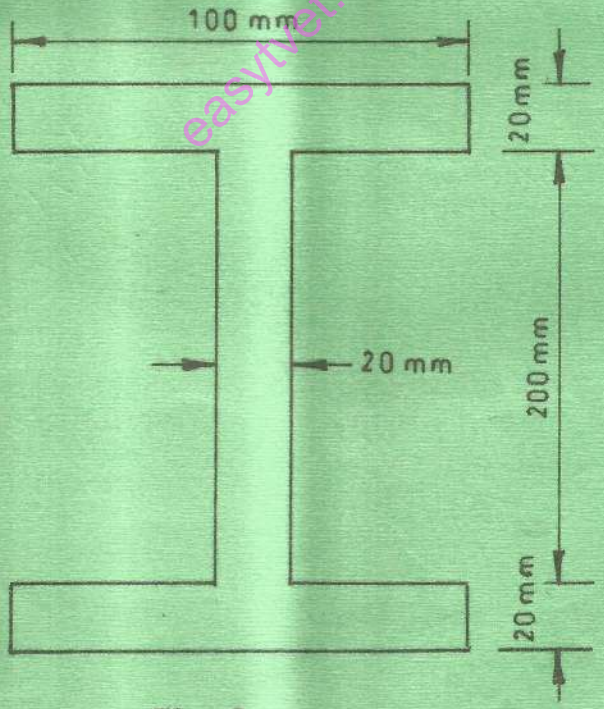
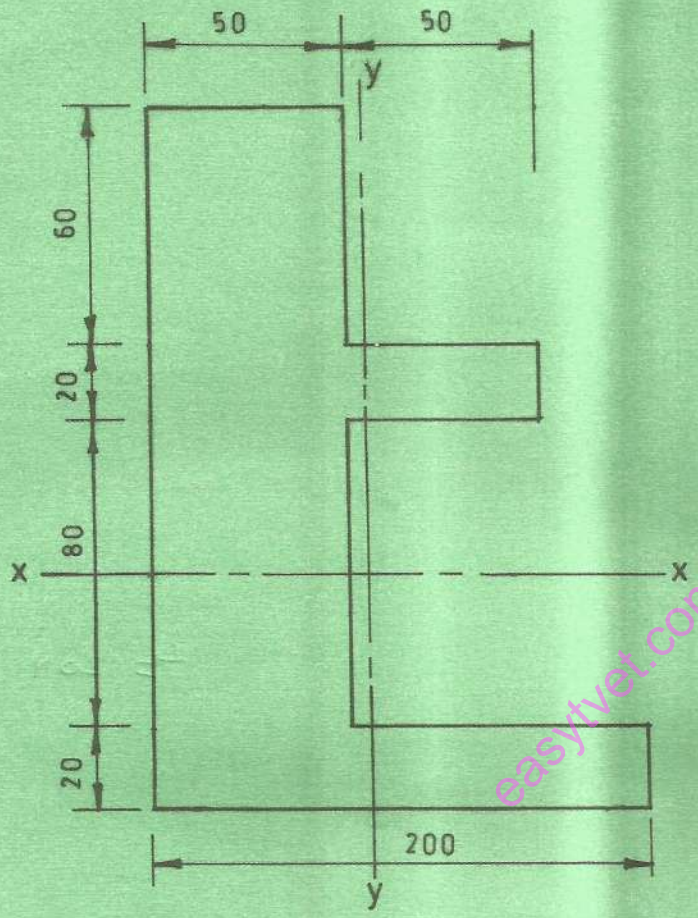


Fig. 2

3. (a) **Figure 3** shows a section of a loaded beam.
Determine:

(i) the position of the centroidal axes
(ii) the second moment of area about both centroidal axes;
(iii) the radius of gyration about both centroidal axes.

(14 marks)



•All dimensions in mm

Fig. 3

(b) A hollow concentric cylindrical cast iron column 5 m long with both ends restrained in position and direction is to support and axial compressive load. Using the following data determine the crippling load.

Data:
Internal diameter = 20 mm
External diameter = 30 mm
Rankines constant = $\frac{1}{1600}$
Ultimate crushing stress = 55 N/mm^2.

(6 marks)

4. (a) List **four** types of loads, applied on structural elements. (2 marks)

dead load, Imposed load, uniform distributed load, vary load

(b) **Figure 4** shows a composite material. If a tensile force F is applied at the two ends, derive the:

(i) compatibility equation; ✓
(ii) equilibrium equation.

(8 marks)

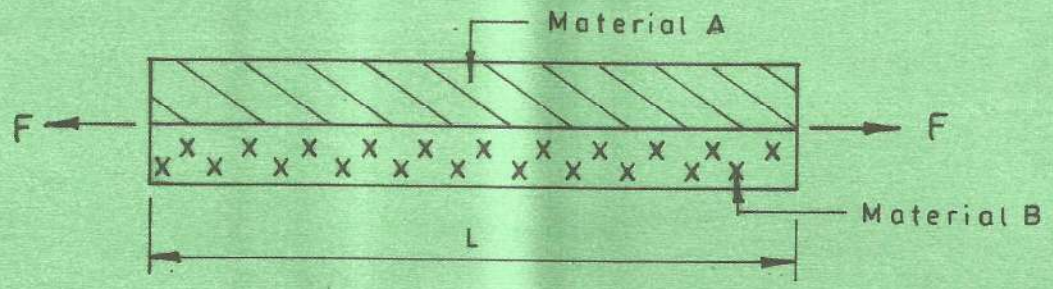


Fig. 4

(c) **Figure 5** shows a loaded beam.

(i) determine the reactions at the supports;
(ii) sketch the shear force diagram;
(iii) sketch the bending moment diagram.

(10 marks)

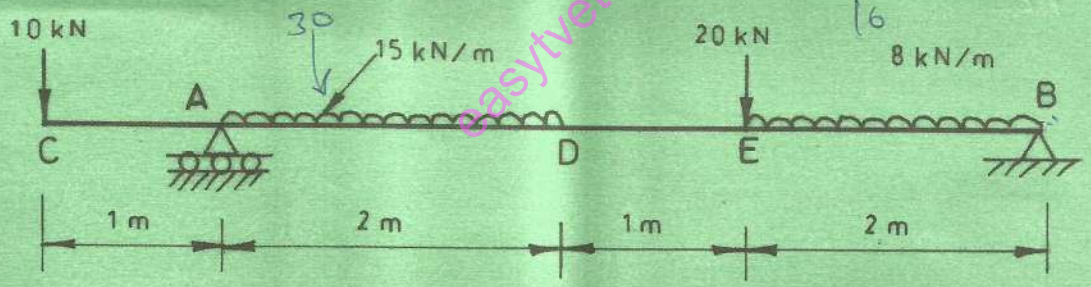


Fig. 5

Reactions

$\sum M_B = 0$

$5R_A - (10 \times 6) - (15 \times 2 \times 4) - (8 \times 2 \times 1) = 20 \times 2$

$5R_A - 60 - 120 - 24 = 40$

$5R_A = 244$ 236 242

$R_A = 48.8$ KN

$R_A = 47.2$

$\sum M_A = 0$

$5R_B - (10 \times 1) - (15 \times 2 \times 4) - (8 \times 2 \times 4) - 20 \times 3 - 15 \times 2 \times 1 + 5(10 \times 1)$

$5R_B - 60 - 60 - 30 + 10$

$R_B = 144/5 = 28.8$ KN

SECTION B: CONSTRUCTION MATERIALS

*Answer at least **TWO** questions from this section.*

5. (a) Outline the following classifications of properties of materials:

(i) physical properties;
(ii) mechanical properties. (3 marks)

(b) Explain the following characteristics of building stones:

(i) appearance;
(ii) strength;
(iii) porosity and absorption;
(iv) weathering.

(8 marks)

(c) State **five** reasons for seasoning timber. (5 marks)

(d) Explain the manufacturing process of the following timber products:

(i) veneer,
(ii) plywood.

(4 marks)

6. (a) With aid of sketches describe the following clay products:

(i) perforated bricks;
(ii) plain roofing tiles. (7 marks)

(b) Outline the following methods of protecting ferrous metals from rusting:

(i) tarring;
(ii) painting;
(iii) galvanising;
(iv) enamelling.

(6 marks)

(c) Describe the following non-ferrous alloys:

(i) brass;
(ii) bronze. (4 marks)

(d) Outline the manufacture of the following thermoplastics:

(i) Cellulose nitrate;
(ii) Polyethylene. (3 marks)

7. (a) Differentiate between water paint and distempers. (4 marks)

(b) Explain the following categories of glass:

(i) Soda lime glass;
(ii) Lead glass;
(iii) Boro-silicate glass.

(6 marks)

(c) Outline the process of the manufacture of glass. (6 marks)

(d) (i) List **four** types of special glasses.

(ii) Describe glazing putty.

(4 marks)

8. (a) State **six** properties of Bituminous products. (6 marks)

(b) Describe the following Bituminous products:

(i) Bitumen,
(ii) Coal tar.

(5 marks)

(c) Describe the following mortars:

(i) cement-plasticizer mortars;
(ii) masonry cement mortars

(6 marks)

(d) State **three** properties of mortar. (3 marks)

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