



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Theory of Structures

PAPER NO: 578/15/S02

DURATION: 3 hours

MARCH/APRIL 2020 EXAMINATION

REQUIREMENTS

1. Scientific calculator
2. Answer booklet

INSTRUCTIONS TO CANDIDATE

1. Answer any four (4) questions within 3 hours.
2. Show all working and formulae.
3. Each question carries 25 marks.
4. Start each question on a fresh page.

This paper consists of 4 printed pages.

QUESTION 1

- a) State any three (3) statically indeterminate beams that cannot be analysed by the equations of statics alone. (3 marks)
- b) i) A uniform cantilever is $5m$ long and carries a point load of $50kN$ at a point $3m$ from the support. Determine the vertical deflection of the free end of the cantilever of $EI = 65MNm^2$. Use Moment Area Method. (10 marks)
- ii) How would this value change if the same total load were applied but uniformly distributed over the portion of the cantilever $3m$ from the support? (10 marks)
- c) Prescribe two ways of minimising the disadvantages associated with encastre beams. (2 marks)

QUESTION 2

- a) State any five (5) main causes of bending in columns. (5 marks)
- b) A beam is fixed at both ends is loaded transversely by total uniformly distributed load of $32kN$. It is found that deflection at centre is $1/325$ of span. Now if this transverse load is removed and beam is loaded axially, find out safe axial for the condition such that it fails by buckling only.
Take factor of safety = 4 and $E = 200GPa$ (14 marks)
- c) A steel rod having a cross-sectional area of $300mm^2$ and a length of $150m$ is suspended vertically from one end. It supports a tensile load of $20kN$ at the lower end. If the unit mass of steel is $7850kg/m^3$ and $E = 200GPa$, find the total elongation of the rod. (6 marks)

QUESTION 3

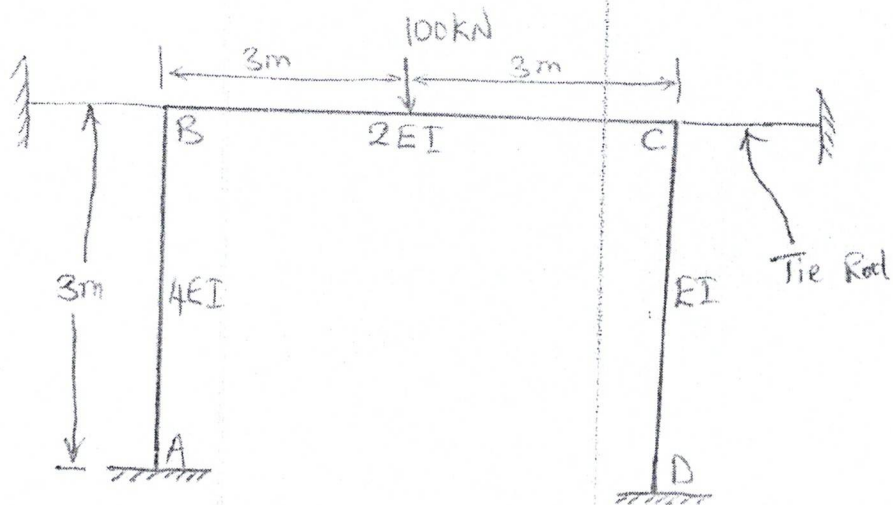


Fig. Q3

Analyse the frame in Fig. Q3 by Hardy Cross method. Hence, draw the SFD and BMD. (25 marks)

QUESTION 4

a) Define the following terms:

- i) Shear centre
- ii) Shear stress

(2 marks)

(2 marks)

b) Find the principal stress at a point A in a uniform rectangular beam 20mm deep and 100mm wide, simply supported at each end over a span of 3m and carrying a uniformly distributed load of 15kN/m. Point A is 1m from the left support. (13 marks)

- c) Determine the location of the shear centre of the channel section in Fig. Q4(c). (8 marks)

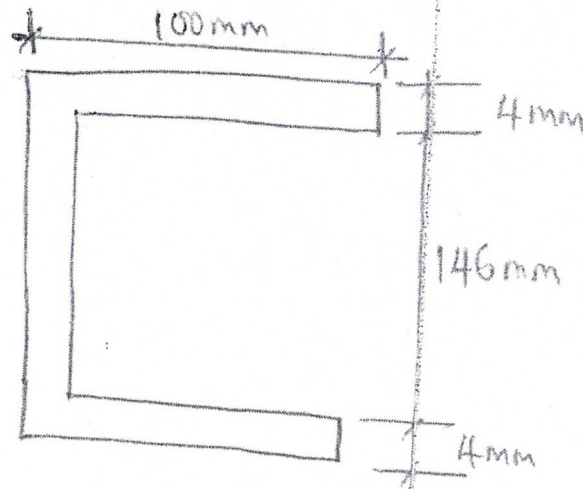


Fig. Q4(c)

QUESTION 5

- a) State any three (3) methods of analysing continuous beams. (3 marks)
- b) Use any of the methods stated in 5(a) to analyse the continuous beam in Fig. Q5(b), hence draw the shear force and bending moment diagrams. (22 marks)

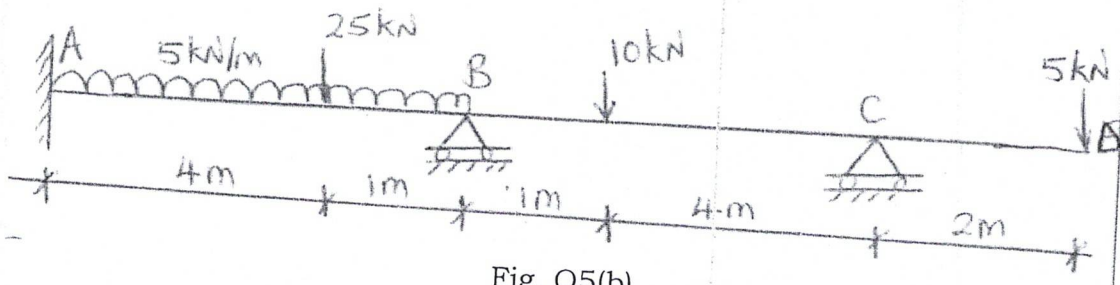


Fig. Q5(b)