



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 2021 EXAMINATION

REQUIREMENTS

1. Scientific calculator.
2. Answer booklet.

INSTRUCTIONS TO CANDIDATE

1. Answer any four (4) questions in 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) i) Why is it important to determine deflection of loaded beams in structural engineering. (3 marks)
- ii) State any two (2) methods of structural analysis that are used to find deflection at any point for statically indeterminate beams. (2 marks)
- iii) What three (3) pieces of advice would you give to an engineer if a reinforced concrete beam fails in deflection during analysis and design? (3 marks)
- b) For the beam shown in Fig Q1b determine.
- i) The support reactions and fixing moments (14 marks)
- ii) The deflection under the 50kN load using any of the methods you specified in (1aii) above. (3 marks)

Use $EI = 14MNm^2$

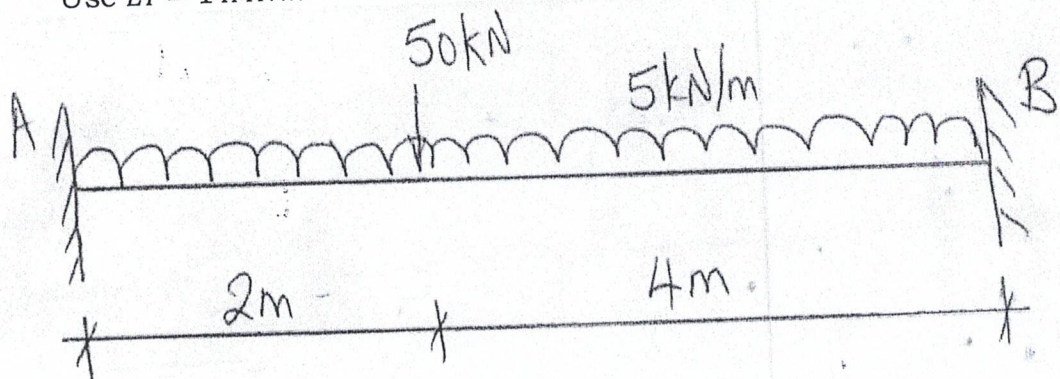


Fig Q1b

QUESTION 2

Analyse the continuous beam shown in Fig Q2 by moment distribution method. Draw the bending moment diagram and the shear force diagram. The beam is prismatic. (25 marks)

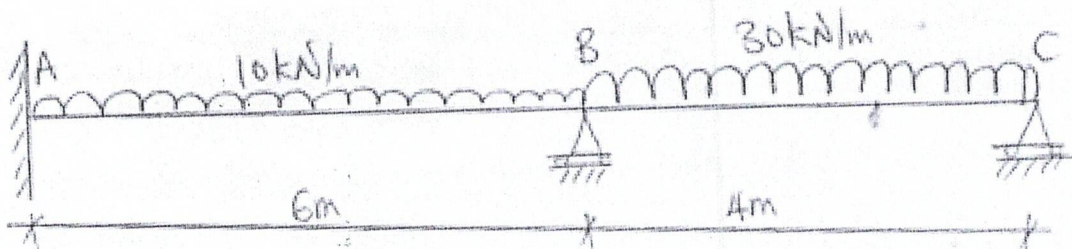
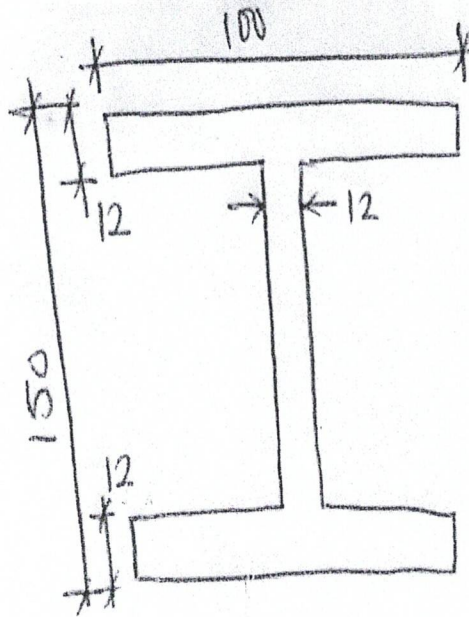


Fig Q2

QUESTION 3

- a) i) Define shear centre of a section. (2 marks)
- ii) For the I-beam shown in Fig Qa11 determine the maximum and the average shear stress if a shear force of 100kN is applied. (13 marks)



All dimensions are in millimetres.

- b) i) State any three (3) software applications that can be used for structural analysis. (3 marks)
- ii) What are the advantages of using computer applications in structural analysis? (5 marks)
- iii) List any two (2) draw backs of using computer software in structural analysis. (2 marks)

QUESTION 4

a) Define the following terms:

- i) Stress (2 marks)
- ii) Strain (2 marks)
- iii) Modulus of elasticity (2 marks)

b) A 10m section of steel [$E = 200\text{GPa}$ and $\alpha = 11,9 \times 10^{-6}/^{\circ}\text{C}$] rail has a cross sectional area of 7500mm^2 . Both ends of the rail are tight against adjacent rails that, for this problem, can be assumed rigid. The rail is supported against lateral movement. For an increase in temperature of 50°C , determine

- i) The normal stress in the rail (6 marks)
- ii) The internal force on a cross section of the rail (4 marks)

c) i) State four (4) major types of end conditions which are considered in Euler's column theory. (4 marks)

ii) What are the assumptions in Euler's column theory? (5 marks)

QUESTION 5

Analyse the rigid frame shown in Fig Q5. Assume EI to be constant for all the members. Draw the bending moment diagram.

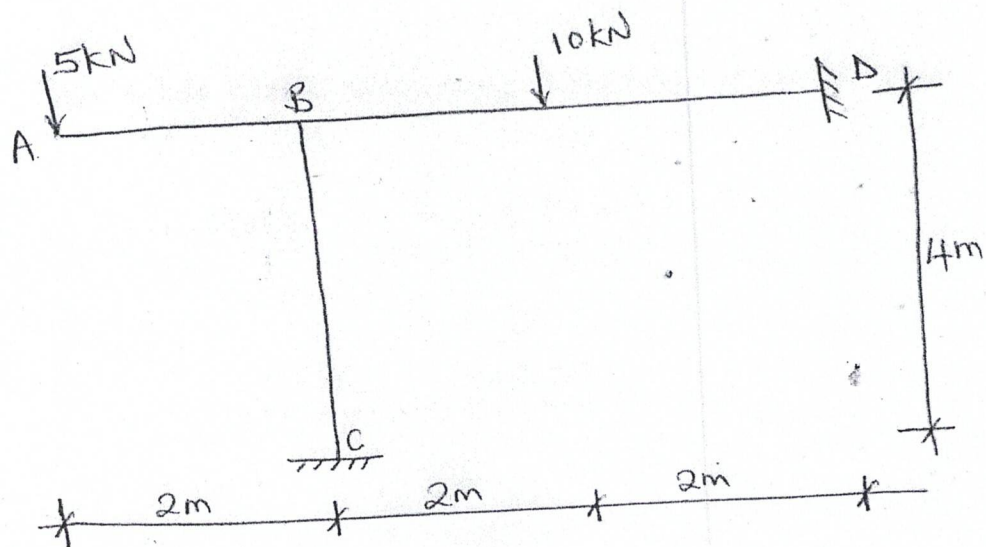


Fig Q5

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