

Barry

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
2023 ACADEMIC YEAR MID-YEAR FINAL EXAMINATIONS

JUNE 2023

AEN 4131 FARM STRUCTURES

TIME: THREE (3) HOURS

INSTRUCTIONS:

1. ANSWER FIVE QUESTIONS (TWO (2) FROM SECTION A AND THREE (3) FROM SECTION B).
2. SECTIONS A AND B SHOULD BE ANSWERED IN SEPARATE BOOKLETS

INFORMATION

1. THIS EXAMINATION PAPER CONTAINS SEVEN (7) QUESTIONS.
 2. ALL QUESTIONS CARRY 20 MARKS.
 3. THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS
-

SECTION A

QUESTION 1

- (a) Soil has many advantages as a building material. However, its main weakness as a building material lies in its low resistance to water. Stabilizers are used to overcome this weakness. Give **three (3)** in which stabilisers help to increase the soil's resistance to the destructive effects of water and other weather elements. (6)
- (b) Explain why clay and sand are considered as soil stabilisers. (2)
- (c) Wattle and daub is one of the construction techniques that use earth as a building material.
- (i) Mention **three (3)** factors that generally make the wattle and daub structures have a short life span. (6)
 - (ii) Give any **three (3)** ways in which the durability of the wattle and daub structures can be increased. (6)

QUESTION 2

- (a) Concrete is a very common building material. Apart from temperature, placement and quality of materials and curing aspects, mention **two (2)** major factors that affect the strength of concrete (4)
- (b) You are tasked to supervise the construction of a concrete slab for a storage shed. You are required to ensure that the correct amounts of materials are bought, and the right amount of water is added during concrete mixing. You are provided with the following information:

- Nominal mix: 1:3:5 (cement: sand: stones)
- Number of 50 kg bags of cement required: 60
- Volume of one 50 kg bag of cement: 37 litres
- Moisture content in sand = 4%
- Moisture content in the stones = 1%
- Bulk density of the completely dry sand: 1400kg/m^3
- Bulk density of the completely dry stones: 1600kg/m^3
- Density of water = 1000 kg/m^3
- A 50 kg bag of cement costs K145.00
- A tone of sand costs K50.00
- A tone of stones costs K60.00
- A 200L drum of water costs K10

Leaving your final answers to 1 decimal place, calculate:

- The number of tonnes of sand to be bought. (4)
- The number of tonnes of stones to be bought. (4)
- The volume of water in litres to be added if the strength of the cured concrete is to be about 10 N/mm^2 (read from Figure 3.2). (4)
- The total cost of constructing the slab if the labour cost is 20% of the total cost of cement and aggregates. (4)

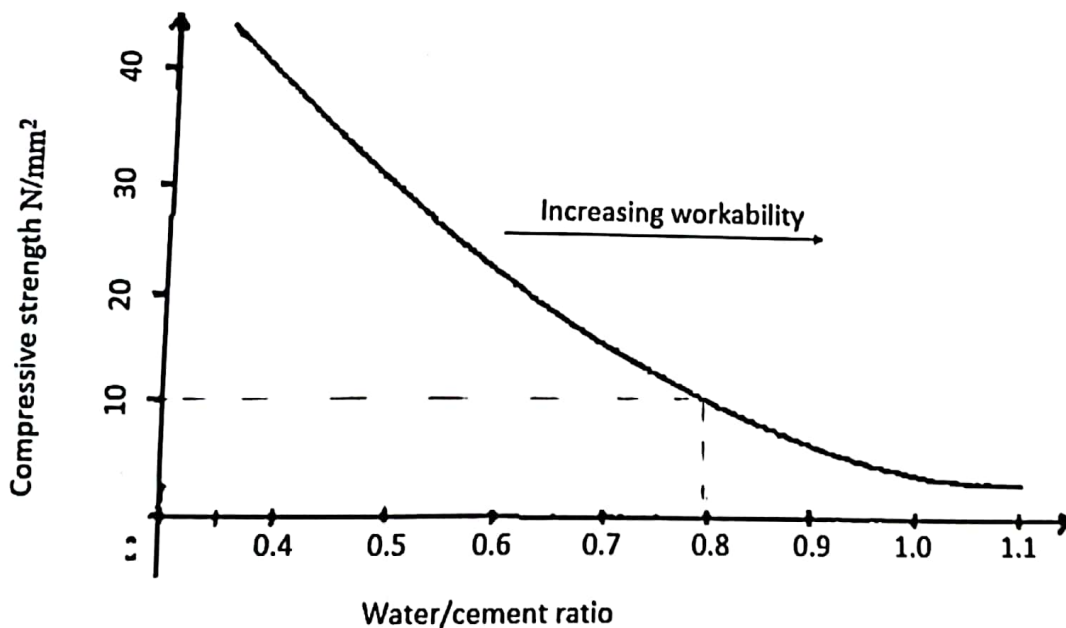


Figure 3-2: Relationship of water/cement ratio with concrete workability and strength

QUESTION 3

- In the beam design process, a sign convention enables consistency in the design results and their interpretation. If the familiar sign convention is that the loading in Figure 3-3A (a) is positive, do the following: (4)
 - Sketch Figure 3-3A (b) and draw arrows on both cut sections to show the direction of the positive internal shear force (V)

- (ii) Sketch Figure 3-3A (c) and draw arrows on both cut sections to show the direction of the positive internal bending moment (M)

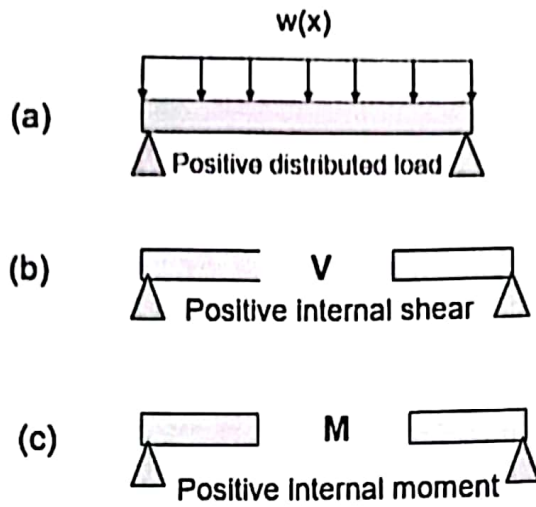


Figure 3-3A: Beam design sign convention

- (b) A simply supported beam is loaded with a uniformly distributed load as shown in Figure 3.3B. For the beam, you are requested to: (16)
- Determine the reaction forces at the supports A and C.
 - Draw the shear force and bending moment diagrams.

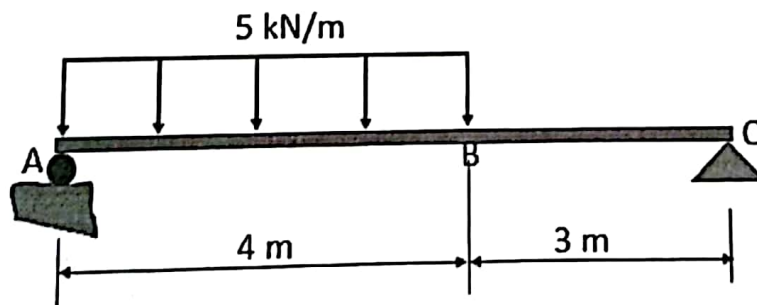


Figure 3-3B: Uniformly distributed load on a simply supported beam

SECTION B

QUESTION 4

- (a) List any **three (3)** functions of each of the following building elements: (12)
- (i) Floor
 - (ii) Foundation
 - (iii) Walls
 - (iv) Roof
- (b) Briefly describe using a sketch, the process of laying roofing sheets. (8)

QUESTION 5

- (a) A brooder houses 10,000 day-old chicks. The sensible heat production at ambient temperature is approximately 1.6 W/chick, and the moisture production is 3.5 g/hour per chick. The building has an average AU value of 712.3 W/K. The outside temperature is 5°C at a relative humidity of 70%, while the desired internal conditions must be maintained at 31°C and a relative humidity of 70%. There are 20 light bulbs of 100 W capacity in the building that are always on for lighting. The latent heat of water vaporisation is 2454 kJ/kg, while the specific heat capacity of air is 1.005 kJ/kg°C. The density of air can be evaluated using the outside conditions. The recommended minimum ventilation rate for day-old chicks is 0.16 m³/hr/chick.

Calculate the required supplemental heating in the brooder house.

Note: Include heat loss due to moisture evaporation in the brooding house. Use the psychrometric chart for 1500 m above sea level. (12)

- (b) In an evaporative cooling installation, outside air at 30°C dry bulb temperature and 15 g/kg absolute humidity is passed through wet pads until the inside air becomes saturated.
- (i) What is the amount of heat converted from sensible heat to latent heat in this process if the latent heat of water vaporisation is 2454 kJ/kg? (2)
 - (ii) What is the dry bulb temperature in the room? (2)
 - (iii) To improve the conditions further, the air is reheated to 25°C using a filament heater, how much heat energy is supplied? (4)

QUESTION 6

A farmer intends to invest in a pig production unit with 80 sows and will practice an eight (8) week weaning period. Each pen should be occupied at all times except for a period of one week for cleaning and sanitation. The farmer will also practice single-stage finishing of pigs from 12 weeks to 27 weeks of age. The following periods must also be considered:

- i. An average weaning to conception period of 20 days;
- ii. A gestation period of 114 days;
- iii. A period of rearing of weaners of 28 days;
- iv. Sows are brought to farrowing pens one week before farrowing; and
- v. An extra period of 21 days for the last pig to reach marketable weight.

Assuming that eight (8) pigs per litter survive to 12 weeks, **determine:**

- (a) Number of farrowings per year; (3)
- (b) Number of farrowing pens; (5)
- (c) Number of servicing/gestation pens with 5 pigs in one pen; (6)
- (d) Number of growing/finishing pens assuming each litter occupies one pen. (6)

QUESTION 7

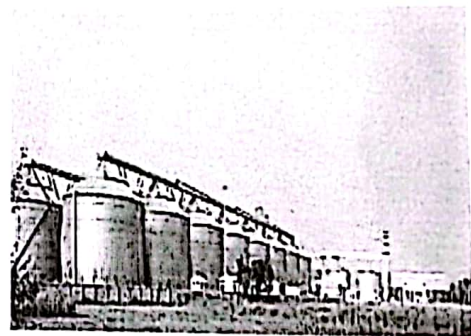
- (a) Briefly discuss the role of storage in the economy. (5)
- (b) What factors should be considered when locating a warehouse for grain storage purposes? (6)
- (c) The two (2) alternative large-scale grain storage technologies used in Zambia are given in Table 7-1. Typical infrastructure designs are shown in Figures 7-1(a) and (b). Most large-scale grain stores in Zambia have been designed for bag storage, but a few bulk storage structures exist, especially in cities and among grain milling companies. Make a comparison of the two (2) alternative systems. (9)

Table 7-1: Large-scale grain storage technologies

Bag system	Warehouses; Permanent platforms covered by tarpaulins
Bulk system	Concrete silos; Steel silos



(a) Bag storage in a warehouse



(b) Bulk storage in steel silos

Figure 7-1: Types of large-scale grain storage infrastructure

*****END OF EXAMINATION*****

LIST OF EQUATIONS

$$Q = EAV \quad Q = VA \quad V = \varphi [(2gh (T_i - T_o/T_i))]^{1/2}$$

$$q_s + q_e + q_{sup} \pm q_l - q_B = q_{vi} - q_{vo} \quad q_v = q_s + q_{sup} - q_w - q_b \quad q_v = q_s - q_b$$

$$q_l = MNh_{fg} \quad mC_p\Delta T = q_s - \sum AU\Delta T \quad MN + mW_o = mW_i$$

$$m(h_i - h_{tp}) = q_l \quad q_v = mC_p\Delta T \quad q_B = \sum AU\Delta T$$

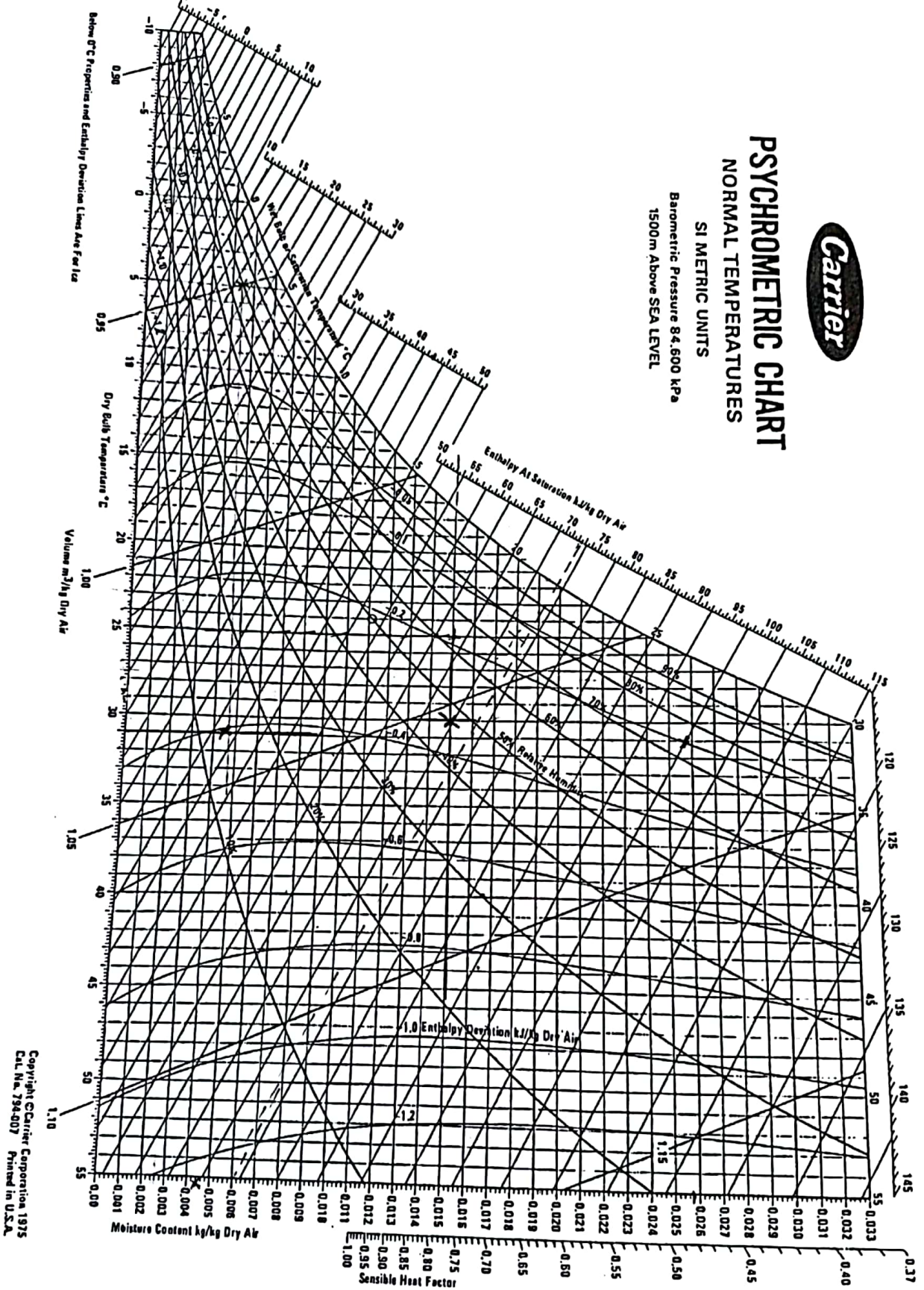


PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 84,600 kPa
1500m Above SEA LEVEL



Copyright © Carrier Corporation 1975
Cat. No. 794-007 Printed in U.S.A.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF AGRICULTURAL ENGINEERING

FIRST HALF OF ACADEMIC YEAR TEST

YEAR: 2023

AEN 4131: FARM STRUCTURES

TIME ALLOWED: TWO HOURS

INSTRUCTIONS:

- i. THERE ARE FOUR QUESTIONS IN THE PAPER, ATTEMPT ALL QUESTIONS
 - ii. ALL QUESTIONS CARRY EQUAL MARKS
-

QUESTION 1

- (a) Building materials can be classified either as natural or as manmade. Name TWO natural building materials and TWO manmade building materials. [8 Marks]
- (c) Timber has natural defects and those due to poor handling and seasoning. List any TWO natural defects and any TWO defects due to poor handling and seasoning of timber [8 Marks]
- (d) Earth as building material has many advantages that encourage and facilitate self-help and community participation in house building, but it also has disadvantages.
- i) List any TWO advantages of soil as a building material [4 Marks]
 - ii) List any TWO disadvantages of soil as a building material [5 Marks]

QUESTION 2

- (a) Concrete is a very common building material. Mention TWO major factors that affect the strength of concrete [5 Marks]
- (b) You are tasked to supervise the construction of a concrete slab for a storage shed. You are required to ensure that the correct amounts of materials are bought and the right amount of water is added during concrete mixing. You are provided with the following information:
- Nominal mix: 1:3:5 (cement: sand: stones)
 - Number of 50 kg bags of cement added: 50
 - Volume of one 50 kg bag of cement: 37 litres
 - Bulk density of the completely dry sand: 1400kg/m^3
 - Bulk density of the completely dry stones: 1600kg/m^3
 - Density of water = 1000 kg/m^3

Leaving your answers to 1 decimal place, calculate:

- i) The number of tonnes of sand to be bought. [5 Marks]
- ii) The number of tonnes of stones to be bought. [5 Marks]
- iii) The volume of water in litres to be added if the strength of the cured concrete, read from Fig. Q2, is to be about 10 N/mm^2 . [10 Marks]

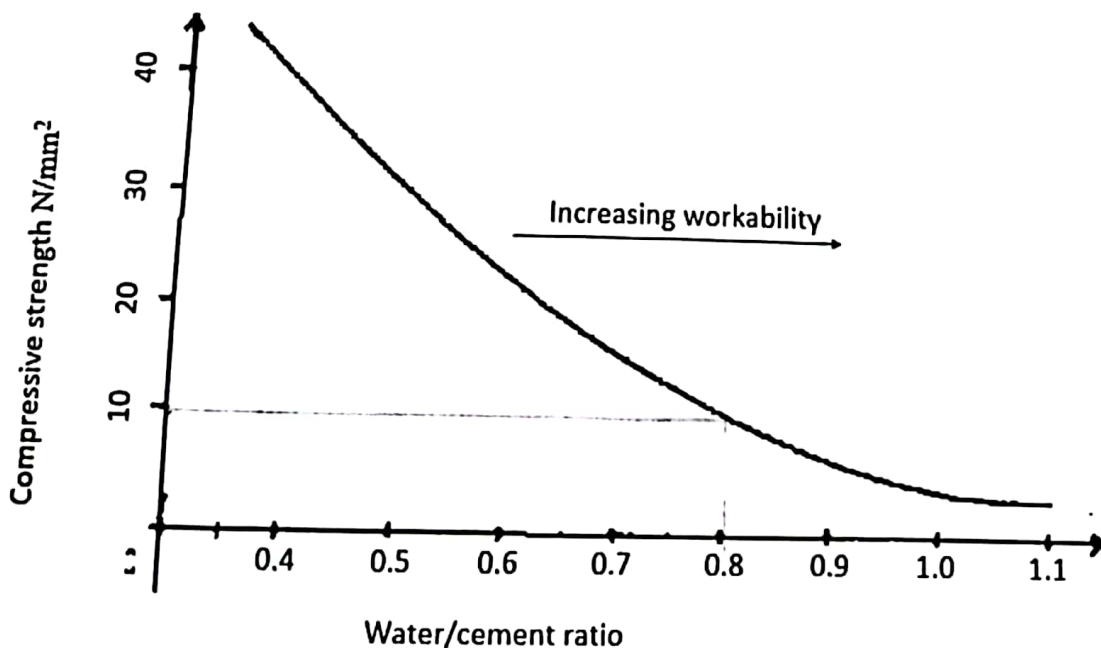


Fig. Q2

QUESTION 3

- (a) There are two broad categories of loads that are considered when designing agricultural buildings. Name the TWO categories of loads and for each category, give TWO examples of loads. [6 Marks]
- (b) Consider a suspended floor where loads due to maize bags are supported by a set of equally spaced beams Fig. Q3. The first half of the floor has some bags removed such that the distributed surface load is 10 kN/m^2 while the other half has more bags such that the distributed surface load is 25 kN/m^2 . Determine:
- The total load in (kN) supported by beam B. [9 Marks]
 - The uniform distributed line loads $Q1$ and $Q2$ supported by the 2 m and 3 m parts of beam B. [5 Marks]
 - The reactions $R1$ and $R2$ at the ends of beam B. [5 Marks]

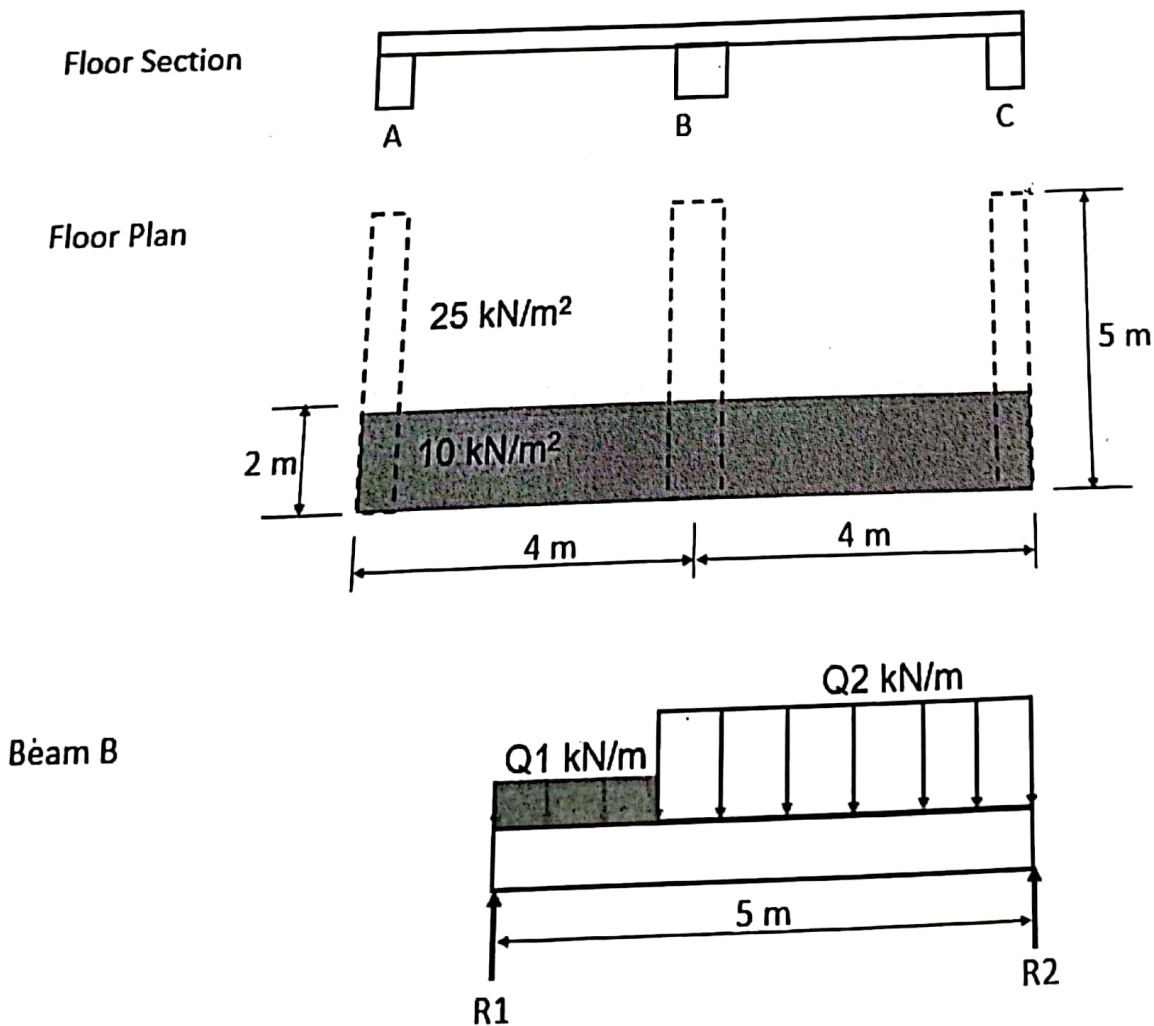


Fig. Q3

QUESTION 4

The bars in the truss, (Fig. Q4), have each the same cross-sectional area. If the maximum average normal tensile and compressive stress is not to exceed 140 MPa, determine the minimum cross-sectional area of the bars that will safely support the loading shown. The cross-sectional area should be provided in mm^2 .

[25 Marks]

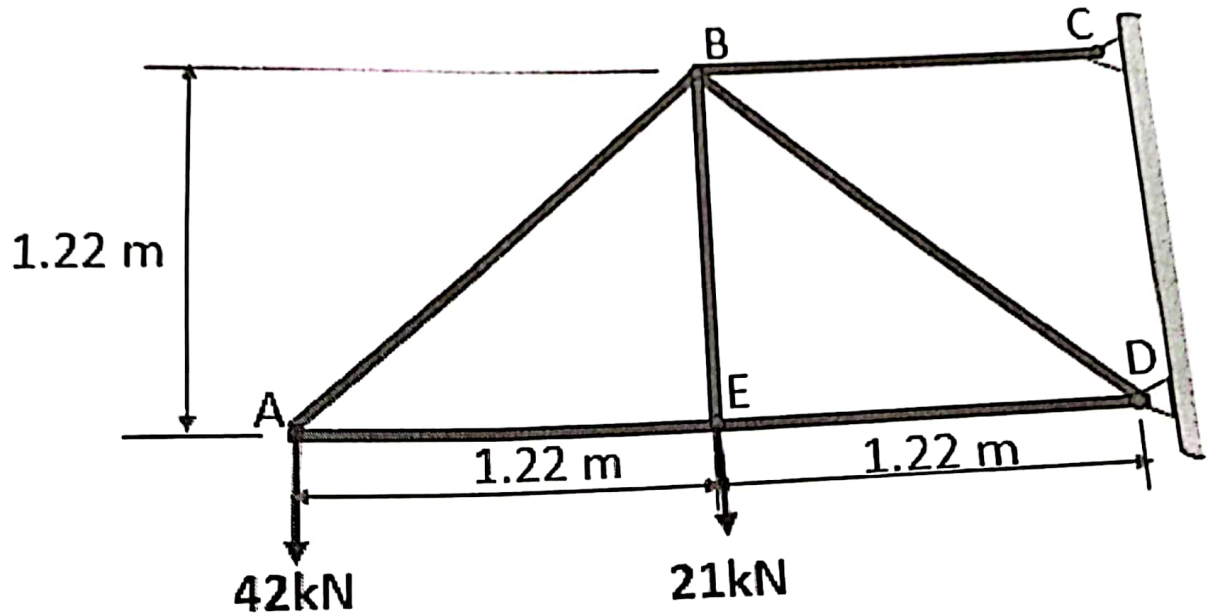


Fig. Q4

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF AGRICULTURAL ENGINEERING

2021/2022 MID ACADEMIC YEAR TEST

AEN 4131: FARM STRUCTURES

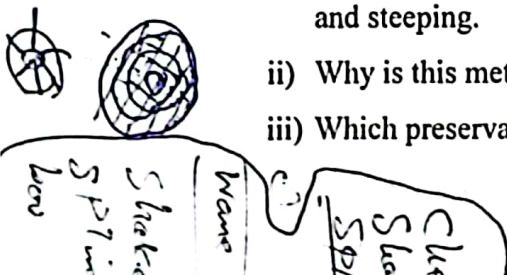
TIME ALLOWED: TWO HOURS

INSTRUCTIONS:

- i. THERE ARE FOUR QUESTIONS IN THE PAPER, ATTEMPT ALL QUESTIONS
 - ii. ALL QUESTIONS CARRY EQUAL MARKS
-

QUESTION 1

- (a) Building materials can be classified either as natural or as manmade. Name TWO natural building materials and TWO manmade building materials. [6 Marks]
- (b) Mention FOUR factors that make wood or timber one of the common building materials both in rural and urban areas [8 Marks]
- (c) The strength, stiffness and dimensional stability of timber are related to its moisture content. Seasoned timber has higher qualities in these aspects than green timber. Mention any TWO timber seasoning methods and for each method, give ONE advantage and disadvantage of using it. [6Marks]
- (d) Timber for permanent structures should be treated with preservatives. One method of applying preservatives is superficial preservation.
 - i) Why is this method not as effective as the other pressure impregnation and steeping. [2 Marks]
 - ii) Why is this method not suitable for clear liquid preservatives? [2 Marks]
 - iii) Which preservative is commonly used with this method? [1 Mark]



QUESTION 2

- (a) Soil is one of the oldest building materials. List any FOUR qualities of soil that encourage and facilitate self-help and community participation in house building in rural areas [8 Marks]
- (b) As a building material, soil has THREE major weaknesses. Mention these weaknesses and explain how soil stabilization can be used to overcome them [12 Marks]
- (c) When poorly constructed, the wattle and daub structure has a short life span. List any TWO activities that should be done during construction to increase the life span of the structure [5 Marks]

QUESTION 3

- (a) Other than the rate of curing, the effect of temperature, quality of aggregates and placement methods, mention TWO aspects that greatly affect the strength of concrete. [2 Marks]
- (b) A farmer wants to construct a concrete slab for a circular silo. The total volume of the concrete for the slab is determined to be 18.00 m^3 . You are told that the nominal mix used for such slabs is 1:2:3. Given the following:
- Aggregate used is completely dry
 - Bulk density of sand and stones is 1400 kg/m^3 and 1600 kg/m^3 respectively.
 - The volume of the concrete slab is two-thirds ($\frac{2}{3}$) of the sum of volumes of the individual materials and the concrete use efficiency is 94%, waste 6%

Leaving your answers to 1 decimal place, calculate:

- i) The maximum size of the coarse aggregate (stones) in mm. [2 Mark]
- ii) The number of 50 kg bags of cement that are required given cement in a 50 kg bag has a volume of 37 litres. [7 marks]
- iii) The number of tones of sand that would be bought. [7 Marks]
- iv) The number of tones of stones that would be bought. [7 Marks]

QUESTION 4

- (a) There are two broad categories of loads that are considered when designing agricultural buildings. Name the TWO categories of loads and for each category, give TWO examples of loads. [6 Marks]
- (b) Besides being stationary, give additional TWO conditions that should be fulfilled for a structure to be in static equilibrium. [4 Marks]
- (b) A suspended floor is to be built. The floor is to be supported by 4 equally spaced beams as shown in Fig.Q4. If the uniformly distributed surface load imposed by the floor on the beams is to be 100 kN/m^2 . Determine:
- The equivalent concentrated load to be supported by beam B or C. [5 Marks]
 - The equivalent concentrated load to be supported by beam A or D. [5 Marks]
 - The uniformly distributed line load to be imposed on beam A. [5 Marks]

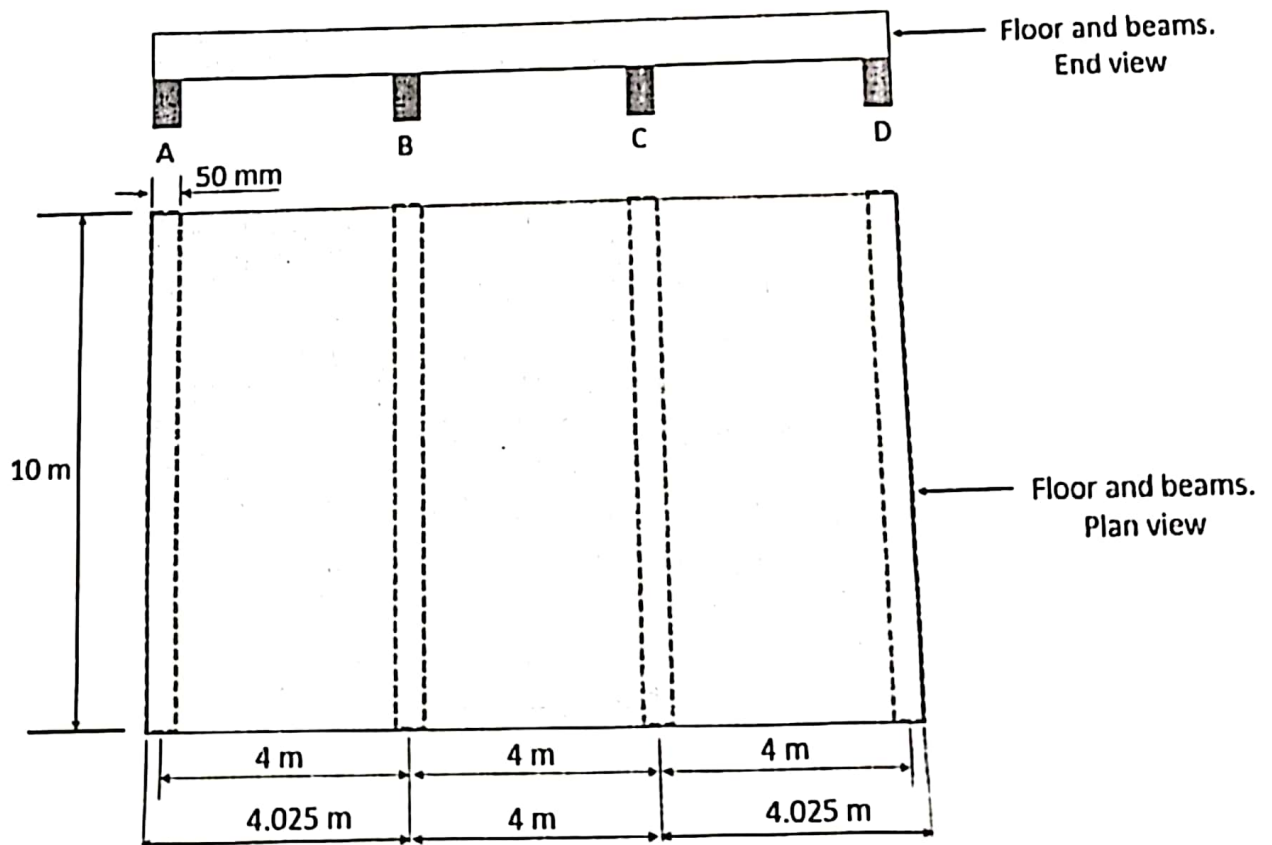


Fig. Q4

fore

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
2022 ACADEMIC YEAR MID-YEAR FINAL EXAMINATIONS

JUNE 2022

AEN 4131 FARM STRUCTURES

TIME: THREE (3) HOURS

INSTRUCTIONS:

1. ANSWER FIVE QUESTIONS (THREE (3) FROM SECTION A AND TWO(2) FROM SECTION B).
2. SECTION A AND B SHOULD BE ANSWERED IN SEPARATE BOOKLETS

INFORMATION

1. THIS EXAMINATION PAPER CONTAINS SEVEN (7) QUESTIONS.
 2. ALL QUESTIONS CARRY 20 MARKS.
 3. THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS
-

SECTION A

QUESTION 1

- (i) List any FOUR factors that are considered when building a farmhouse. [4 Marks]
- (ii) Timber is a common building material used in rural and urban areas. Give FOUR factors that make timber a common building material. [4 Marks]
- (iii) Defects in timber may make it unsuitable for its intended purposes. Name TWO examples of timber defects under each of the following categories:
 - (a) Natural defects [2 Marks]
 - (b) Defects due to poor conversion [2 Marks]
 - (c) Defects due to the poor seasoning of sawn timber [2 Marks]
- (iv) There are three major methods of seasoning timber. Name any TWO timber seasoning methods. For each method, give ONE advantage and ONE disadvantage. [6 Marks]

QUESTION 2

- (i) With the aid of sketches define the following:
 - (a) Cantilever beam [2 Marks]
 - (b) Continuous beam [2 Marks]
- (ii) The 6 m long beam shown in Fig. Q2. has a pin support at A and a smooth (roller) support at B.



- (a) Determine the reaction forces at the supports A and B. [4 Marks]
- (b) Showing your calculations, draw the shear force diagram (SFD) and bending moment diagram (BMD) for the beam. [10 Marks]
- (c) Give the value of the maximum shear force and state its location. [1 Marks]
- (d) Give the value of the maximum bending moment and state its location. [1 Marks]

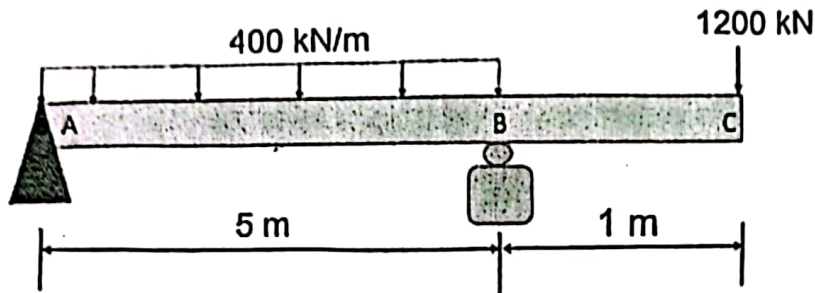


Fig. Q2.

QUESTION 3

- (i) Methods for concrete compaction are associated with its workability.
- (a) Name one major factor that affects the workability of concrete. [2 Marks]
- (b) Name the simple test used to estimate the workability of concrete. [2 Marks]
- (ii) Provided is information about the concrete mix for the work you are supervising as an agricultural building specialist:
- Nominal mix: 1:3:5 (cement : sand : stone)
 - Number of 50 kg bags of cement added: 20
 - Volume of water added: 620 litres
 - Moisture content of sand: 4%
 - Moisture content of stones: 1.5%
 - Bulk density of the sand: 1400 kg/m^3
 - Bulk density of the stones: 1600 kg/m^3
 - Density of water: 1000 kg/m^3

Leaving your answers to 1 decimal place, calculate:

- (a) The weight of the aggregates. [4 Marks]
- (b) The total weight of water in the mix. [4 Marks]
- (c) The water cement ratio [4 Marks]
- (d) The estimated compressive strength of the concrete using Fig. Q3. [4 Marks]

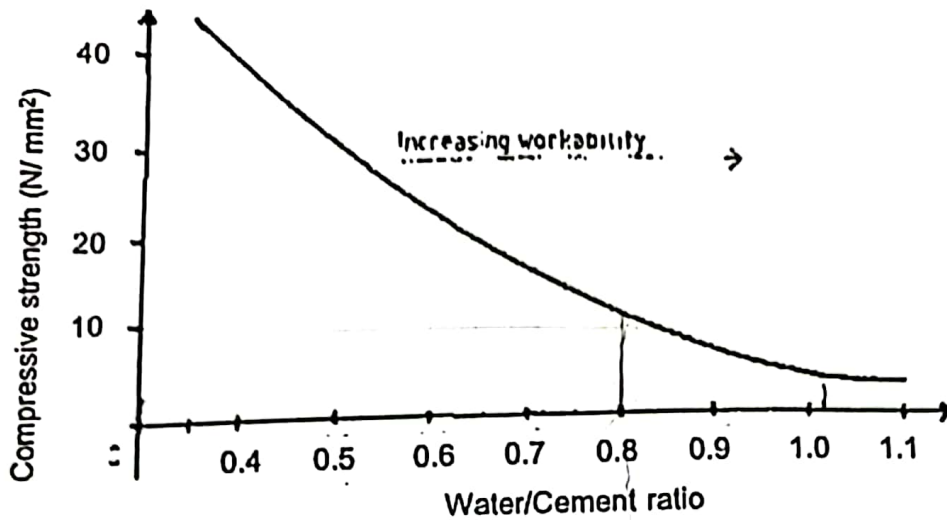


Fig. Q3.

QUESTION 4

- (a) Other than dust, odours, and disease agents, list FOUR factors that affect the quality of the environment in the agricultural building. [4 Marks]
- (b) One mechanism of controlling the environment in agricultural buildings is through ventilation. Give any THREE ways by which ventilation helps to improve the environment in these buildings. [4 Marks]
- (c) Most air enters a farrowing house at 10°C and 60% relative humidity. The fresh air replaces fouled air removed from the house using an exhaust fan. Suppose the exhaust air is leaving the house at a rate of 2 m³/s, the temperature of 25°C and relative humidity of 70%. Assuming the only source of heat were the sows and piglets, the sources of moisture were sows, piglets, feed, pig dung, and water from the drinking points. Using the Psychrometric chart provided (Fig Q4):
- How much sensible heat from the sows and piglets was added to the air per hour? [4 Marks]
 - How much latent heat was added to the air per hour? [4 Marks]
 - How much moisture was added to the air per hour? [4 Marks]

SECTION B

QUESTION 5

A farmer intends to invest in a pig production unit with 100 sows and will practice an eight (8) week weaning period. Each pen should always be occupied except for one week for cleaning and sanitation. The farmer will also practice single-stage finishing of pigs from 12 weeks to 27 weeks. The following periods must also be considered:

Average weaning to conception period of 20 days;

A gestation period of 114 days;

A period of rearing of weaners of 28 days;

Sows are brought to farrowing pens one week before farrowing; and

An extra period of 21 days for the last pig to reach marketable weight.

If ten (10) piglets survive per litter, *determine*:

(a) the number of farrowing's per year.

[4 Marks]

(b) the number of farrowing pens.

[5 Marks]

(c) the number of servicing/gestation pens.

[5 Marks]

(d) the number of growing/finishing pens assuming each litter occupies one pen.

[6 Marks]

QUESTION 6

a) Write short notes on the following factors affecting the design of a Rural Settlement

(i) Cultural practices

[2 Marks]

(ii) Climate

[2 Marks]

(iii) Economic activities

[2 Marks]

(iv) Local materials and labour

[2 Marks]

(v) Legislation

[2 Marks]

b) Zone planning is a valuable tool when planning a new farmstead. Using the sketch shown in Figure 6:

(i) Identify the various zones numbered I to IV

[2 Marks]

(ii) Describe the facilities that may be found in each of the areas numbered 1 to 5.

[8 Marks]

x 15

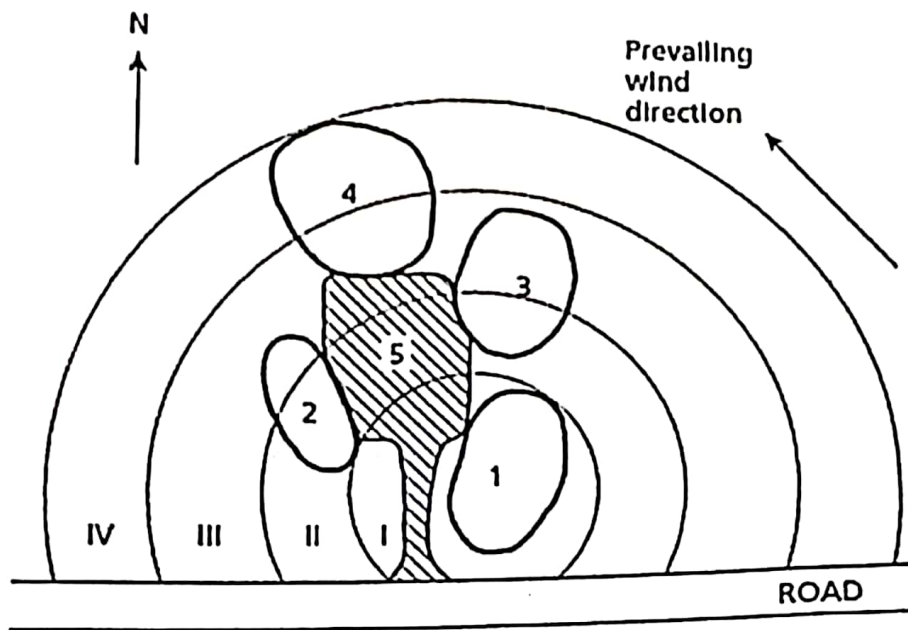


Figure 6. Zone planning for a Farmstead

QUESTION 7

- (a) Briefly discuss the following types of Rural Settlements:
- (i) Clustered Rural Settlements. [5 Marks]
 - (ii) Dispersed Rural Settlements. [5 Marks]
- (b) Outline any five (5) factors to consider when undertaking site selection for various buildings on a Farmstead. [10 Marks]

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL SCIENCE

NAME : BUSIKU SIMUYWENZE

COMP #. : 2018 1558 65

COURSE CODE: AEN 4131

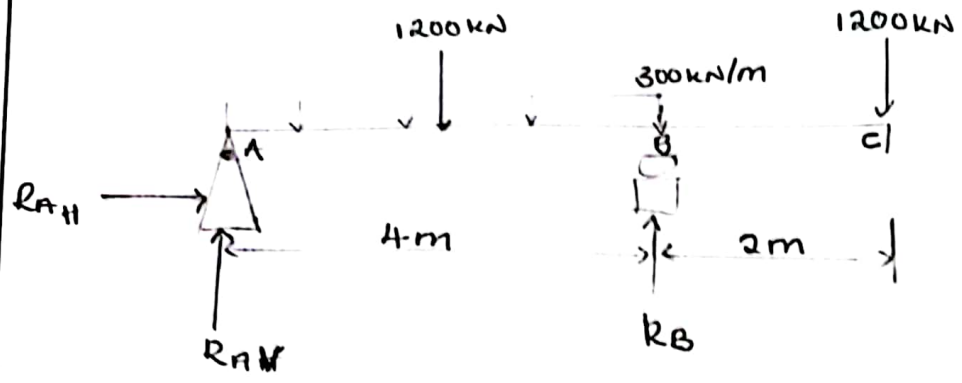
TASK : ASSIGNMENT 3

LECTURER: DR. K. SIMOKONDA

DUE DATE: 30.05.2022

100%

(i)



$$R_{AH} = 0$$

$$+\uparrow \sum F_y = 0$$

$$R_{AV} + R_B - (1200 \times 2) = 0$$

$$R_{AV} + R_B = 2400 \quad \text{①}$$

$$+\curvearrowleft \sum M_A = 0$$

$$1200 \times 2 + 1200 \times 6 - 4R_B = 0$$

$$4R_B = 2400 + 7200$$

$$R_B = \frac{9600}{4}$$

$$R_B = 2400 \text{ kN} \quad \checkmark \quad 10$$

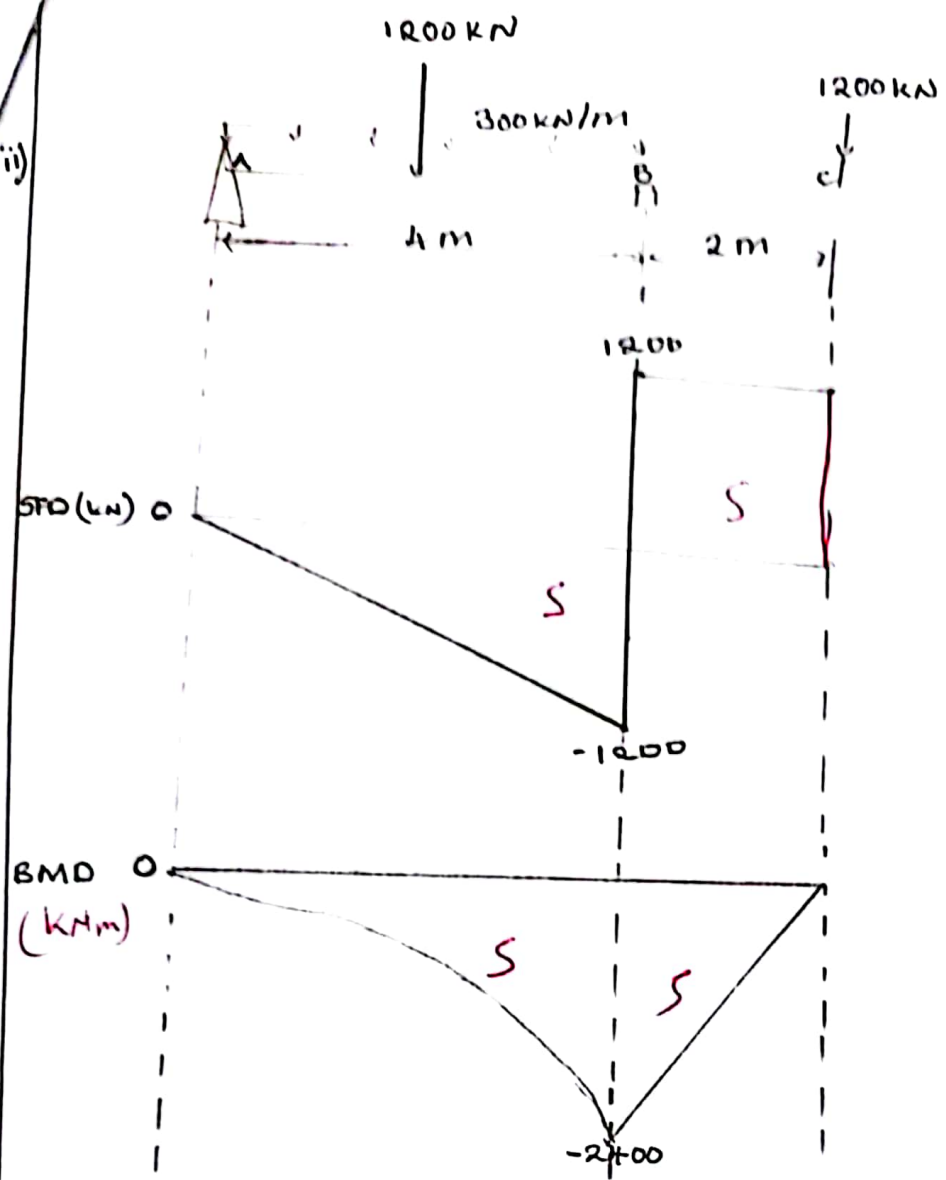
From ①

$$R_{AV} + R_B = 2400$$

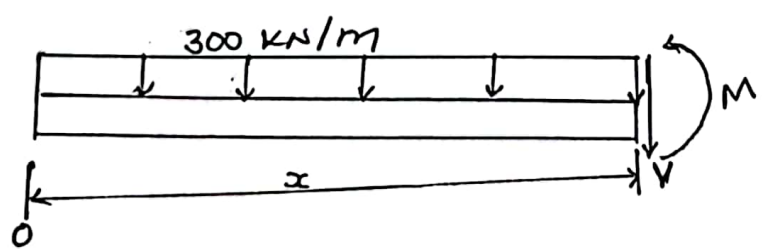
$$R_{AV} + 2400 = 2400 \quad \checkmark$$

$$\underline{\underline{R_{AV} = 0}} \quad 10$$

ii)



SECTION AB



$$+\uparrow \sum F_y = 0$$

$$0 - 300x - V = 0$$

$$V = -300x$$

For $x = 0$ ✓
 $V = 0$ ✓

For $x = 4$ ✓
 $V = -1200 \text{ kN}$ ✓

$$\sum M_0 = 0$$

$$0x - 300x \times \frac{x}{2} - M = 0$$

$$M = -150x^2$$

For $x = 0$

$$M = 0 \quad \checkmark$$

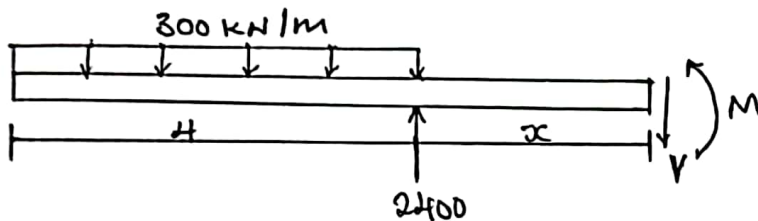
For $x = 4$

$$M = -150 \times 4^2$$

$$M = -150 \times 16$$

$$M = \underline{\underline{-2400 \text{ kNm}}} \quad \checkmark$$

SECTION BC



$$\sum F_y = 0$$

$$0 - 300 \times 4 + 2400 - V = 0$$

$$0 - 1200 + 2400 - V = 0$$

$$V = 2400 - 1200$$

$$V = 1200 \text{ kN}$$

For $x = 0$

$$V = 1200 \text{ kN} \quad \checkmark$$

$$\sum M_x = 0$$

$$0(4+x) - 1200(2+x) + 2400x - M = 0$$

$$-2400 - 1200x + 2400x - M = 0$$

$$M = -2400 + 1200x$$

For $x = 0$

$$M = -2400 \text{ kNm} \quad \checkmark_{10}$$

For $x = 2$

$$M = -2400 + 1200(2)$$

$$M = -2400 + 2400$$

$$M = \underline{0} \quad \checkmark_{10}$$

- iii. Maximum shear force = \checkmark_{5} 1200 kN at B
Between B and C
- iv. Maximum bending moment = \checkmark_{5} $+2400 \text{ kNm}$ at B