Paper III: Subject Specialization (Civil Engineering)

Date: 20th December 2008   Maximum Time-150 min.
Roll No.: _____   Maximum Marks – 100

READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. Under the provision of Civil Service Common Examination for Technical Graduates Procedures, candidates shall write his/her **Roll No. only** on the Answer Book in the **space provided** only.

2. Use either **Blue or Black ink** only for written part and **Pencils** only for sketches.

3. No other particulars, which would indicate the identity of a candidate, shall be written on this. Any candidates found guilty of writing his particulars and making any identification marks on and/or in this book **shall be disqualified from the consideration for future employment**.

4. This book is the property of RCSC and shall not be taken away from the examination hall. This book consists of **12 pages** and no page shall be removed or torn.

5. Candidates will not be allowed to carry any papers inside the Examination Hall except **Admit Card and Non-programmable Calculators.**

6. Candidates will be required to produce the Admit Card while entering the Examination Hall and as and when demanded by the concerned authorities.

7. **Do not** write anything during the first 15 minutes. This time is provided to read the Instructions carefully and verify the book.

8. This paper has two sections, namely **Section A** and **Section B**, each carrying 50 marks. **Section A** consists of 35 questions and you have **to answer all the questions**. **Section B** consists of two questions and you have **to answer only one question**.

9. All answers for **Both Section A** and **Section B** should be written on the **Answer Sheets provided**. For multiple choice questions, first write the question number and then the answer number in the answer sheet provided. No marks will be awarded for incorrect answer, no answer or more than one answer.

10. Once the examination begins, you will not be allowed to ask questions or borrow calculators/drawing instruments or leave the examination hall.

11. Any candidate who completes the examination before stipulated time will be required to close the book and sit quietly, till you are allowed to leave the hall.

Answer all the questions: Questions 1 to 30 carry **ONE mark** each and questions 31 to 35 carry **FOUR marks** each.

1. **The Bending Moment diagram of a certain portion of a beam is parabolic. For that section the Shear Force would be:**
    a) Zero
    b) Linearly varying
    c) Constant
    d) None of the above

2. **In a multi-storied building with overhead water tank distribution system, the water pressure at the top floors can be increased by:**
    a) Using a bigger diameter distribution pipe
    b) Using a smaller diameter distribution pipe
    c) Combination of bigger and smaller diameter pipes
   d) Increasing the length of distribution pipe

3. **Strength in concrete increases with:**
    a) Increase in water cement ratio
    b) Decrease in water cement ratio
    c) Decrease in size of aggregate
    d) Decrease in curing time

4. **The purpose of lateral ties in short RC column is to:**
    a) Increase load carrying capacity of the column
    b) Avoid buckling of longitudinal bars
    c) Facilitate construction
    d) Facilitate compaction of concrete

5. **A Reinforced Concrete slab of 3m X 7m X 150mm thick is subjected to normal loading conditions on the top. The main reinforcement bars for the slab shall be placed:**
    a) At the bottom of the slab parallel to the longer span
    b) At the bottom of the slab parallel to the shorter span
    c) At the bottom of the slab parallel to both the sides
    d) At the top of the slab parallel to the shorter span

6. **When cement content in cement mortar is reduced, the**
    a) Slump increases
    b) Consistency decreases
    c) Compressive strength decreases
    d) None of the above

7. **The maximum compressive stress in concrete for design purposes is based on partial safety factor of :**
    a) 0.87
    b) 1.15
    c) 1.50
    d) 1.85

8. **The following data were obtained from the shear test result of a soil. From the graph, the value of "cohesion C" from Mohr – Coulomb's formula is:**

Direct Shear Test

$$y = 0.39x + 0.26$$

(Shear Stress kg/cm² vs Normal Stress kg/cm²)
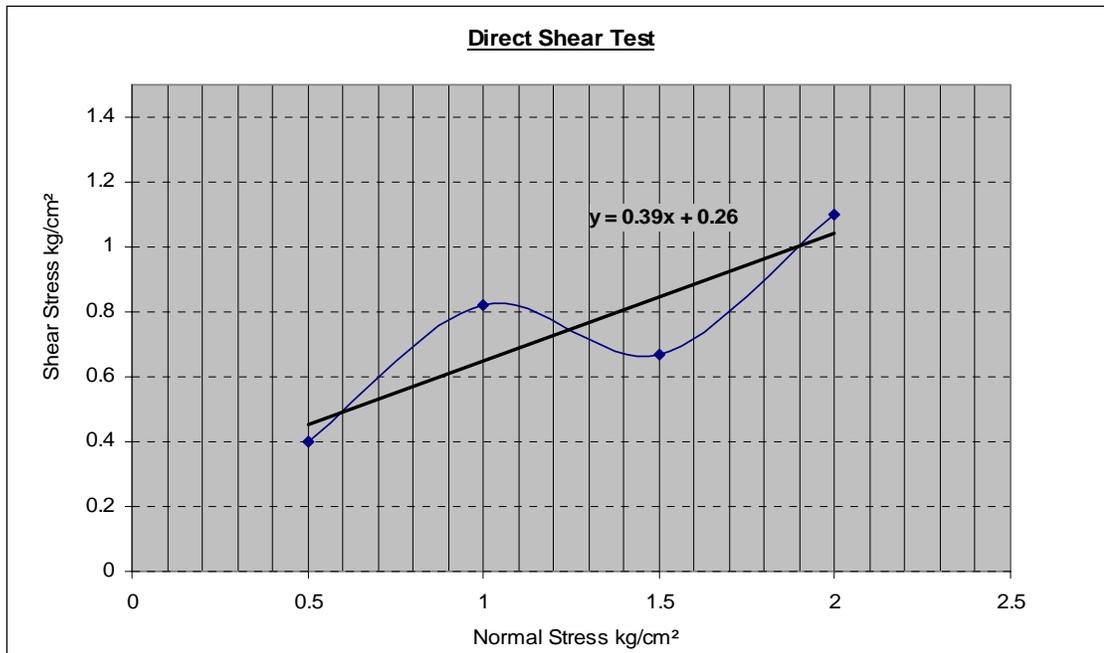
    a) 0.39
    b) 0.26
    c) 0.39 + 0.26
    d) 0.39 - 0.26

9. **A reinforced concrete column is designed with 16 nos. of 20 Ø bars. If it is desired to replace these bars by 25Ø bars, then the nearest number of 25Ø bar is:**

    a) 10
    b) 12
    c) 14
    d) 16

10. **The maximum value of the bending moment diagram of a beam with span "l" with uniformly distributed load of "q kN/m" is $\frac{ql^2}{8}$ at the mid span. The corresponding value of the shear force at the mid span will be:**

    a) Minimum
    b) Maximum
    c) Zero
    d) Constant

11. **The gas coming out from a sludge digestion tank is:**

    a) Methane only
    b) Carbon dioxide
    c) 70% methane and 30% carbon dioxide
    d) 30% methane and 70% carbon dioxide

12. **Given $\sum M_{col} = 1.3 \sum M_{beams}$, the equation represents:**

    a) Strong column weak beam concept
    b) Strong beam weak column concept
    c) Moment magnification factor for beams
   d) None of the above
   Where M is the derived moment

13. **In a stone masonry wall, the main function of a *through* stone is:**

    a) To stitch the inner and the outer wall of a masonry structure
    b) To maintain the corner edges straight and vertical
    c) To give strength to the masonry wall
    d) To provide holes for inserting the scaffoldings

14. **The traditional Bhutanese architecture mandates the use of cornices such as *Bho* and *Phana* at different floor level thus making the structure to project outward at every floor level. From dynamic point of view the structure is:**

    a) Stable
    b) Not stable
    c) Stable with small projections
    d) Stable with large projections

15. **A plot of land is in the shape of a trapezium whose dimensions are given in the figure below. Hence the perimeter of the field is:**
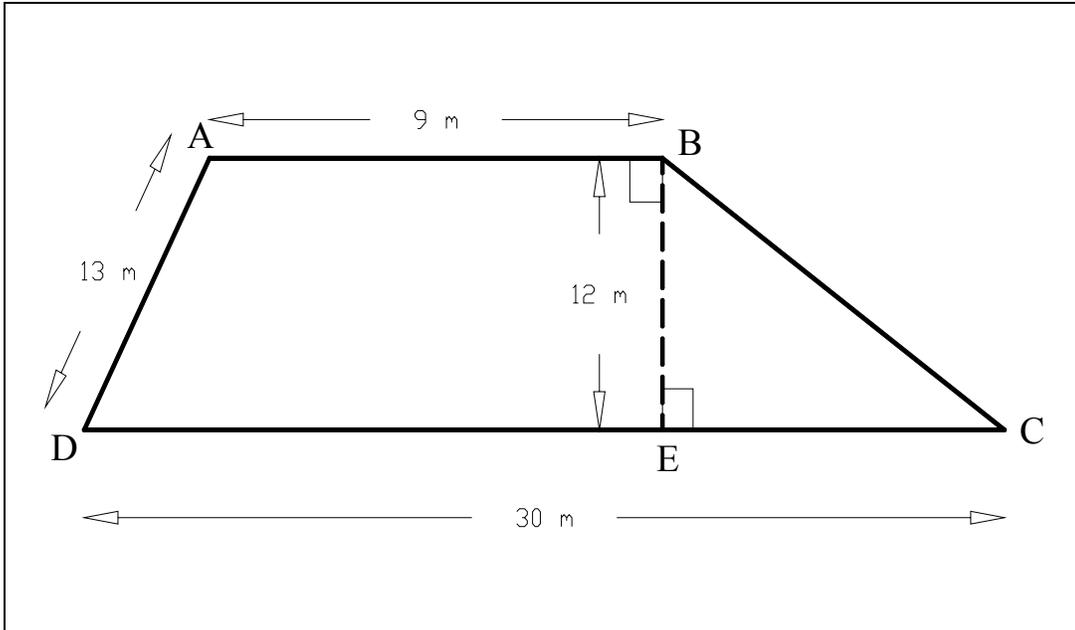
a) 50 m
b) 64 m
c) 72 m
d) 84 m

16. **The maximum area of tension reinforcement in a beam shall not exceed:**

a) $\dfrac{0.85bd}{f_y}$

b) $\dfrac{0.87bd}{bd}$

c) $\dfrac{0.4bd}{y}$

d) 0.04bD

17. **Width of carriageway for a single lane is recommended to be**

a) 7.5 m
b) 7.0 m
c) 3.75 m
d) 5.5 m

18. **Super elevation on highway pavement is provided to take care of**

    a) Centrifugal Force
    b) Drainage
    c) Sight Distance
    d) Off-Tracking

19. **Which common construction material has an average density close to the value of 2400 kg/m^3 :**

    a) Concrete
    b) Stone
    c) Steel
    d) Brick

20. **Which of the following best describes the principal reasons for seasoning timber?**

    a) Seasoned timber is immune to termite attacks
    b) Seasoned timber is much easier to cut and handle
    c) Seasoned timber has much better appearance
    d) Seasoned timber is more stable with dimensional changes

21. **What is the chemical formula for limestone?**

    a) $NaCl$, sodium chloride
    b) $CaSO_4$, calcium sulphate
    c) $CaCO_3$, calcium carbonate
    d) SiO_2, silica dioxide

22. **Most properly, ground water is defined as:**

    a) water only in the saturated zone
    b) all subsurface water
    c) water only in the vadose zone
    d) all water near the surface of the earth

23. **Most of the water in the hydrosphere is in:**

    a) rivers and lakes
    b) the oceans
    c) the atmosphere
    d) aquifers

24. **A weir should be used to measure water in which of the following locations?**

    a) Above ground storage tanks
    b) Household service lines
    c) Open channels
    d) Water mains

25. **Total Dynamic head is best described as the**

   a) Total velocity of water in a main at full pumping pressure
   b) Total energy that a pump must develop for pumping to take place
   c) Total pressure in feet of head, measured at the pump discharge during periods of rest in the system
   d) Pumping end of any device used to force water into a pressure system

26. **A line on a topographic map connecting points of equal elevation is known as:**

   a) Meridian line
   b) Stadia line
   c) Contour line
   d) Isogonic line

27. **The type of rock formed from magma or lava is:**

   a) Igneous
   b) Sedimentary
   c) Metamorphic
   d) Crystals

28. **The capillary fringe above the water table is potentially highest in:**

   a) Sandy soil
   b) Clayey soil
   c) Gravelly soil
   d) Loamy soil

29. **What causes water to move through pores in soil and rocks**

   a) Temperature
   b) Viscosity
   c) Barometric pressure
   d) Gravity

30. **The partial factor of safety for limit state of collapse for DL+LL+WL is:**

   a) 1.5
   b) 0.9
   c) 1.2
   d) 1.0

   Where DL = Dead Load
         LL = Live Load
         WL = Wind Load

31. For the loading condition given below, select the correct BM diagram assuming EI as constant *(4 marks)*
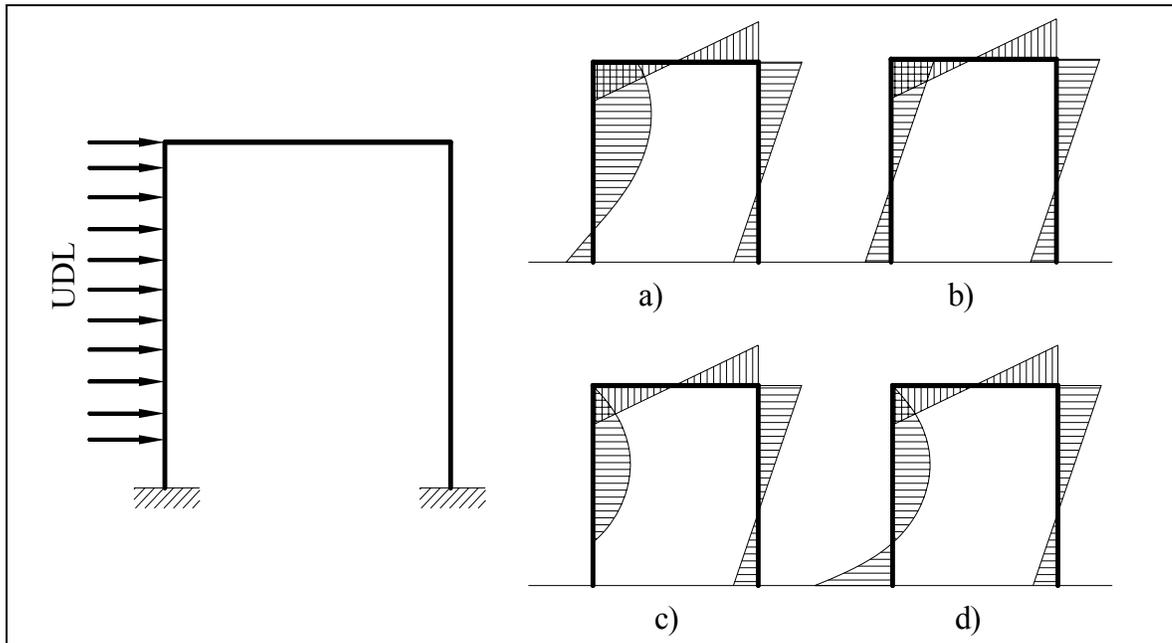
32. A rectangular beam 300x450mm has the following details:

    a) Characteristic strength of concrete σ_{ck} = 20 N/mm^2
    b) Characteristic strength of steel σ_y = 415 N/mm^2
    c) Depth of neutral axis from extreme compression fiber χ = 73 mm
    d) Area of steel in tension **A_t** in mm^2
    e) Lever arm between compression (C) and Tension force (T) **Z** = 258 mm
    f) Width of the beam = **b** in mm
    g) Moment of Resistance **Mu**
    h) Compressive Force **C** = 0.36*σ_{ck}*b* χ
    i) Tensile Force **T** = 0.87* σ_y*A_t

    1. Calculate the area of reinforcement bars A_t - *(2 marks)*

    2. Calculate the Moment of Resistance M_u with respect to Concrete. - *(2 marks)*

33. Estimate the quantity of following materials in m^3 required to produce 10m^3 of PCC in 1:2:4. *(Hint consider the dry volume of PCC as 52% greater than the wet volume)*
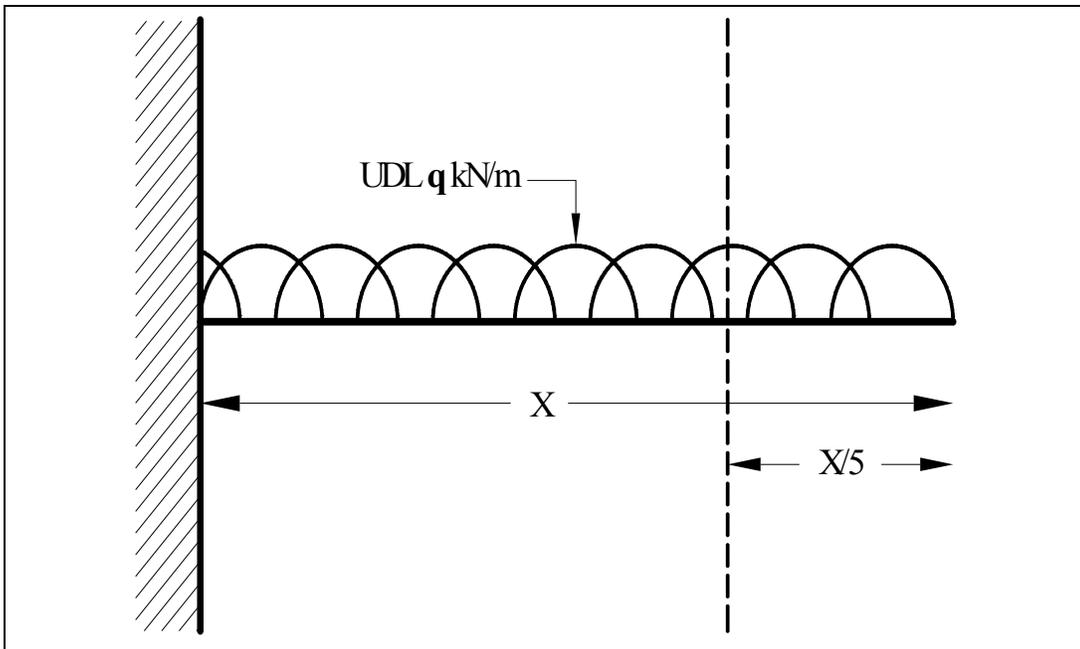
    1. Sand   - *(2 marks)*

    2. Aggregate - *(2 marks)*

34. **1. Explain the term workability.** *(2 mark)*

   2. What are the factors affecting workability? *(2 marks)*

35. In the figure given below, the maximum bending moment at a fixed end of the cantilever caused by UDL is M.

   1. Calculate the BM at a section X/5 from the free end   - *(2 marks)*
   2. Draw the bending moment and shear force diagram   - *(2 marks)*

Question 1

Part A): An assessment of a 30 year old building has been done to find out its strength. The building represents a Bhutanese architectural masterpiece and it is a RC frame structure three storey high. The important findings of the assessment are:

a) The building is able to withstand gravity load only and not the lateral forces.

b) The quality of concrete in beams, columns and foundations are poor and their strength is below the acceptable limit.

c) The size of beams, columns and foundation do not satisfy the minimum required criteria.

d) Hairpin cracks have been observed in some of the beams and columns. Significant cracks were also observed in the walls and plasters.

e) Seepage from the surrounding area has caused the bearing capacity of the underground soil to reduce.

f) Horizontal and vertical irregularities with large offsets and projections were noted.

g) Important structural deficiencies like absence of a diaphragm or a roof slab has been identified and the building has been classified as very weak structure which poses high risk to the occupants.

Based on the report, the assessment team recommended the demolition of the building in order to protect the loss of human lives. The owner however, is reluctant and wants to save his building at any cost.

1. Write down various structural strengthening measures that you would adopt in order to make the building strong. - *(10 marks)*

2. What would you do to improve the condition of soil at the foundation level? – *(5 marks)*

3. An important structural element i.e roof slab has been not been constructed. Write the implication it would have on the overall performance of the building from dynamic point of view? – *(10 marks)*

Part B):   A RC retaining wall 50m long with 8m high has been constructed. The structure is composed of two elements, rectangular columns 750mmx450mm and a shear wall 250mm thick 8m high is structurally interconnected as shown below.

Note: all dimensions in mm

Section Y-Y
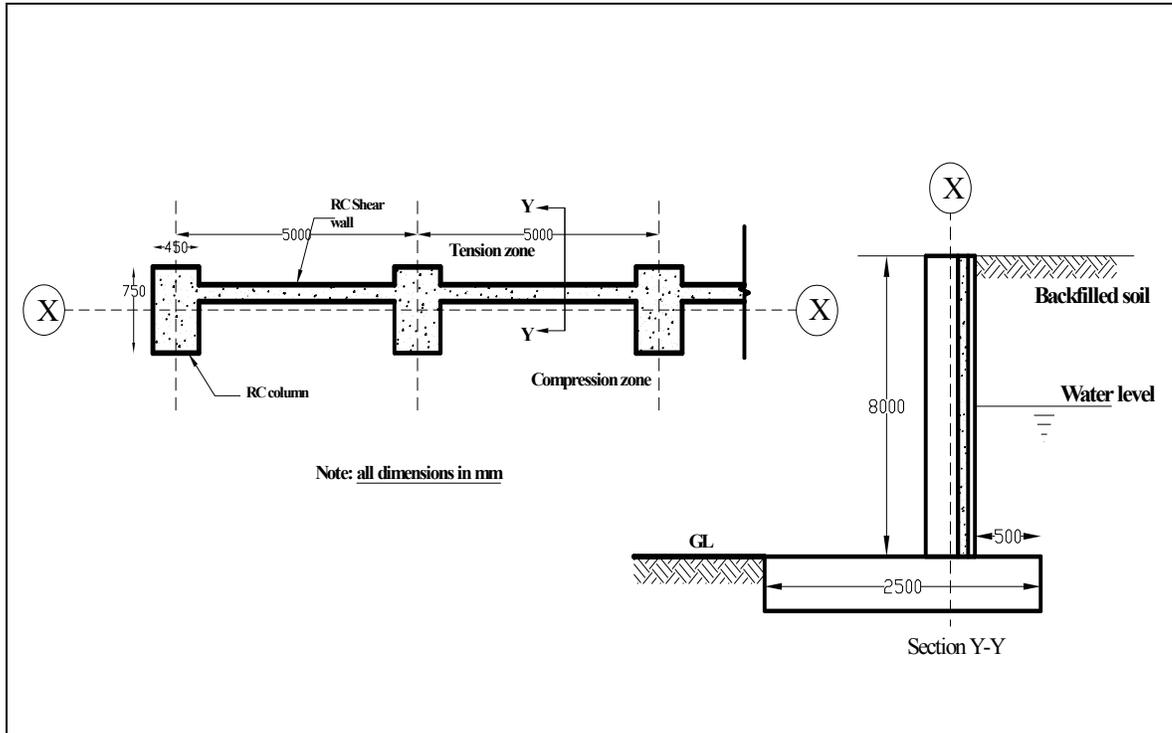
The structure was backfilled with soil up to the height of 8m and with water up to the height of 4m.

1. Find the overturning moment of the structure with respect to the given ground level (GL). – *(10 marks)*

2. Owing to a huge overturning moment, the base of the columns on the compression side gets heavily crushed due to the excessive compressive force applied to it. However, the tension side of the column was found intact and no tension cracks have been developed. Further, the shear wall did not suffer any damage either on the compression side or on the tension side. State with technical reasons why this phenomenon has occurred? – *(15 marks)*

Assume density of soil as 1800 kg/m³ and water as 1000 kg/m³

Question 2:

Part A): A bridge construction site has adopted a mix design formula of 1: 1.3: 2.7 for the main RCC works with water-cement ratio of 0.5. The sand for the mix was stored without proper storage facility and due to heavy downpour, the sand has bulked. The percentage of water absorbed was 10% and a mass concreting work is programmed for next few hours.

1. You as the engineer in charge of the project and assuming that the normal sand is beyond reach due to time constraint, explain various corrective actions you would adopt while using the bulked sand in RC works in order to achieve the same designed strength of concrete. – *(15 marks)*

2. Explain the advantages and disadvantages of using the bulked sand. – *(10 marks)*

Part B): The construction industry in the country has been blamed for poor quality of construction thereby reducing the effective lifespan of the infrastructure. Frequent repair and maintenance are inevitable adding extra cost to the project. The technical capacity of most of our contractors to execute the work independently is almost non-existent and the site engineer has to be present almost 24 hours a day. The capacity of site engineer is stretched to its limit because of numerous sites required to look after. Under this scenario:

1. Develop a quality control measures or quality assurance plans to be implemented for: - *(15 marks)*

    i. Sand
    ii. Aggregate
    iii. Concrete

2. Resurfacing of roads in high altitude presents considerable challenges especially during winter months. Describe the type of road materials, construction techniques and type of road pavement that you would use stating various advantages associated with them. – *(5 marks)*

3. Similarly highlight the problems related to concreting during: - *(5 marks)*

    i. Winter in high altitude and
    ii. Summer in low altitude

*** The End ***