

ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2015
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for *Civil Engineering*

Date	: 11 October 2015
Total Marks	: 100
Examination Time	: 150 minutes (2.5 hours)
Reading Time	: 15 Minutes (prior to examination time)

GENERAL INSTRUCTIONS:

1. Write your Roll Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is being provided to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A and SECTION B:
 - **SECTION A** has two parts: Part I - 30 Multiple-Choice Questions
Part II - 4 Short Answer Questions
All questions under SECTION A are COMPULSORY.
 - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions under your choice.
4. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating any or correct Section, Part and Question Number will NOT be evaluated and no marks would be awarded.
5. Begin each Section and Part in a fresh page of the Answer Booklet.
6. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
7. Use of any other paper including paper for rough work is not permitted.
8. You are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.
9. This paper has **14** printed pages in all, including this instruction page.

GOOD LUCK!

SECTION A

PART I - Multiple Choice Questions (30 Marks)

Choose the correct answer and write down the letter of the correct answer chosen in the Answer Booklet against the question number. E.g. 31 (c). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. The atmospheric pressure head in terms of water column is:
 - a. 33.80 ft
 - b. 9.81 ft
 - c. 11.81 ft
 - d. 22.80 ft

2. The discharge through a rectangular notch is given by:
 - a. $Q = 8/15 C_d \times L \times H^{5/2}$
 - b. $Q = 8/15 C_d \times L \times H^{3/2}$
 - c. $Q = 2/3 C_d \times L \times H^{5/2}$
 - d. $Q = 2/3 C_d \times L \times H^{3/2}$

3. A tie is a member which
 - a. does not suffer any stress irrespective of loading conditions
 - b. is primarily subject to axial tension
 - c. connects to joints
 - d. suffers two equal and opposite forces at the two ends

4. If the strains in the principal directions are ϵ_x , ϵ_y and ϵ_z , the volumetric strain will be:
 - a. $1/3 (\epsilon_x + \epsilon_y + \epsilon_z)$
 - b. $3 (\epsilon_x + \epsilon_y + \epsilon_z)$
 - c. $(\epsilon_x + \epsilon_y + \epsilon_z)^3$
 - d. $(\epsilon_x + \epsilon_y + \epsilon_z)$

5. A cantilever is subjected to a concentrated load W at the mid-point of the span. The slope at the free end will be
 - a. $WL^2 / 8EI$
 - b. $WL^2 / 6EI$
 - c. $WL^2 / 3EI$
 - d. WL^2 / EI

6. A simply support beam is subjected to pure moment. This will be resisted through
- a moment reaction at hinged end
 - a moment reaction at the mid span
 - a couple formed by reactions from the two supports
 - a moment reaction at hinge on rollers end
7. The difference between B.M values at any two sections will be equal to:
- the area of S.F diagram between those two sections
 - the difference in slope of S.F diagram at the same sections
 - the area of loading diagram between the two sections
 - the moment of area of loading diagram between the two sections taken about mid-point between the two sections
8. The Euler Crippling load for a column with one end fixed and other hinged is
- $\pi^2 EI / l^2$
 - $\pi^2 EI / 4 l^2$
 - $4\pi^2 EI / l^2$
 - $2\pi^2 EI / l^2$
9. The effective length of a column with one fixed end and other free is
- $L/2$
 - $2L$
 - L
 - $L\sqrt{2}$
10. The water absorption of a good brick after 25 h immersion should be less than
- 25%
 - 20%
 - 15%
 - 10%
11. If P_n is the normal stress at the toe, and θ is the angle made by the downstream face with the vertical. The maximum principal stress at the toe of the gravity dam for no tail water condition is given by:
- $P_n \tan^2 \theta$
 - $P_n \sec^2 \theta$
 - $P_n \cot^2 \theta$
 - $P_n \operatorname{cosec}^2 \theta$

12. For no tension to develop in the gravity dam, the eccentricity of the resultant force should be:
- $< b/12$
 - $< b/9$
 - $< b/6$
 - $< b/4$
 - $< b/3$
13. The most economical central angle of an arch dam is
- 33°
 - 95°
 - 175°
 - 133°
14. In case of permeable foundations the d/s pile is provided
- to modify the uplift pressure on the floor
 - to prevent undermining
 - to increase the vertical creep
 - to reduce the uplift pressure on the floor
15. Dry stone pitching on a sloping face of an earth dam or river embankment is known as
- lining
 - cushion
 - skin reinforcement
 - revetment
16. The enlarged body of water above the intake of a hydroelectric plant is called
- Forebay
 - Reservoir
 - Pond
 - Boom
17. The ratio of inertial forces to gravity force is called
- Gravity number
 - Weber number
 - Reynold number
 - Froude number

18. BOD represents
- pollutional strength of waste
 - pollutional strength of an organic fraction of wastes
 - pollutional strength of an inorganic fraction of wastes
 - pollutional strength of bio-degradable organic wastes
19. Velocity of flow in sewer should be between
- 30m/s – 60m/s
 - 10m/s – 20m/s
 - 5m/s – 10m/s
 - 0.6m/s – 3 m/s
20. The basic relationship between water content w , *bulk density* γ , and dry density γ_d is given by:
- $\gamma_d = \gamma / (1 - w)$
 - $\gamma_d = \gamma / (1 + w)$
 - $\gamma_d = (\gamma + w) / \gamma$
 - $\gamma_d = (\gamma - w) / \gamma$
21. At liquid limit a soil has
- high shear strength
 - zero shear strength
 - negligible or very low shear strength
 - nothing to do with the shear strength
22. In Terzaghi's theory of one-dimensional consolidation
- hydrodynamic lag alone is considered and plastic lag is ignored
 - plastic lag alone is considered and hydrodynamic lag is ignored
 - both hydrodynamic and plastic lag are considered
 - both hydrodynamic and plastic lag are ignored
23. Select the correct statement
- when footing is flexible, contact pressure distribution is uniform
 - when footing is rigid, the settlement of the footing uniform
 - contact pressure distribution will be different for clays and sands
 - All the above

24. The angle made by failure envelope with horizontal in the Mohr's circle is
- angle of wall friction
 - angle of internal friction
 - surcharge angle
 - cohesion angle
25. the minimum radius for intersection curve when speed is 35km/h is
- 15m
 - 25m
 - 35m
 - 50m
26. In low heat cement, the proportion of the following compound is kept at low value
- tri-calcium silicate
 - tri-calcium aluminate
 - both (a) and (b)
 - none of the above
27. The approximate allowable stress in axial compression in reinforced concrete is
- $0.25f_{ck}$
 - $0.44f_{ck}$
 - $0.33f_{ck}$
 - $0.30f_{ck}$
28. The net effect due to prestressing in a prestressed concrete beam is usually
- compression
 - tension
 - bending and tension
 - bending and compression
29. The number of rivets required in a joint is equal to
- load / tearing strength of plate
 - load / bearing strength of a rivet
 - load / rivet value
 - load / shear strength of a rivet

30. The following readings correspond to the check at the end of a page of level field book but they are not given in order. They represent a continuously rising ground

100.000, 6.000, 0.000, 106.000, 13.000, 7.000

Therefore, in the above $\sum BS =$

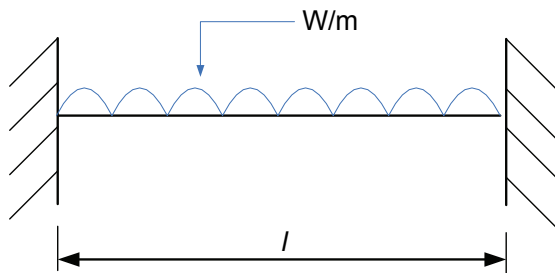
- a. 0.000
- b. 6.000
- c. 7.000
- d. 13.000

PART II – Short Answer Type Questions (20 Marks)

Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

1. For udl of W/m acting on the beam shown below

- a. Draw Shear Force Diagram (2.5 Marks)
- b. Draw Bending Moment Diagram (2.5 Marks)



2. The cross section of a singly reinforced concrete beam is 300 mm wide and 400mm deep to the center of the reinforcement which consists of four bars of 16mm diameter. If the stresses

in concrete and steel are not to exceed 7 N/mm^2 and 140 N/mm^2 respectively, determine the moment of resistance of the section.

(5 Marks)

3. Rainfall of a magnitude 3.8cm and 2.8 cm occurring on two consecutive 4-h duration on catchment area of 27km^2 produced the following of the flow at the outlet of the catchment. Estimate the rainfall excess and ϕ index

(5 Marks)

Time of start of rainfall (h)	Observed flow (m^3/s)
-6	6
0	5
6	13
12	26
18	21
24	16
30	12
36	9
42	7
48	5
54	5
60	4.5
66	4.5

4. Answer the following

a. What does the term consistency mean in soil mechanics?

(1 mark)

b. Please describe Atterberg Limits and illustrate different states of soil with a diagram?
(3 marks)

c. What is shrinkage limit? **(1 mark)**

SECTION B: Case Study

Choose either Question 1 or Question 2 (not both) from this section. Each Question carries 50 marks and specific marks to each sub-question is given in the brackets.

Case 1

You are recruited as an Engineer for a construction firm. As a new engineer in the firm, you are asked to look after a small building construction project. During your engagement as a site engineer of that construction project, the situation demands you to answer the following questions.

- a. What is shallow foundation? **(1 mark)**

- b. What are (i) combined footing (ii) Continuous footing (iii) Strap footing **(3.5 marks)**

- c. Let the load on the column be 1000kN, including the weight of the column itself. The weight of the footing may be approximated as 10% of the load on the column. Say the safe bearing capacity of the soil is 150 kN/m². With the given information, find the size of the square footing. **(3.5 marks)**

- d. The depth of the footing is determined based on what two considerations? **(2 Marks)**

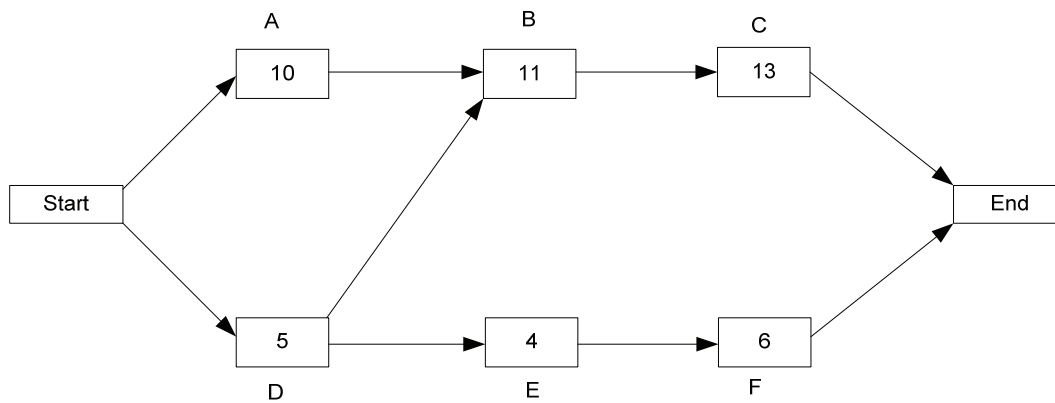
- e. It was found that your sand stock has been exposed to humid atmosphere, briefly describe how can you calculate the percentage of bulking at the site? Why you need to know the percentage of bulking? **(4 marks)**

- f. If the in-situ slump test fails, as a site engineer, what would you do? Please answer this question considering the workability, strength, durability and also standard contractual clauses of the construction projects.

(4 marks)

- g. You are given the CPM diagram shown below by your Project Manager. Please find out the earliest start date and the earliest possible finish date for the activity B.

(5 marks)

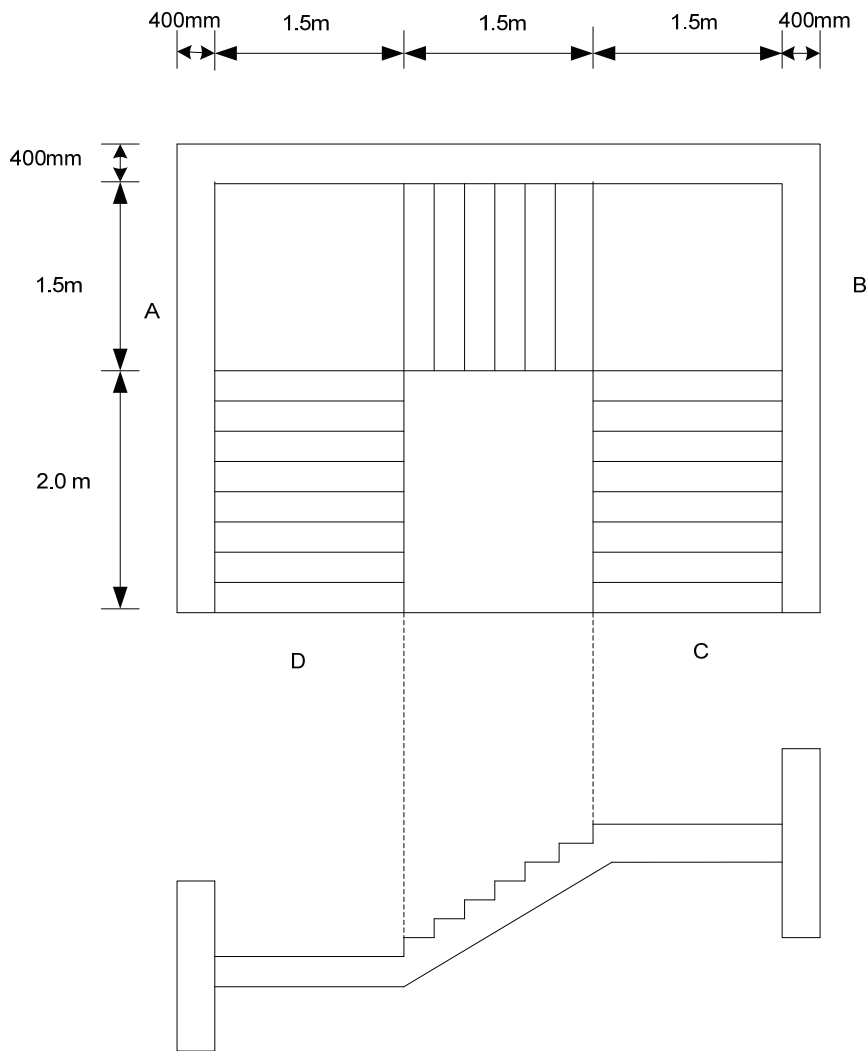


- h. A column 300mm x 300mm x 6 m long has to support a load of 640kN. Design the column with M 20 concrete & Fe 415 steel.

(10 Marks)

- i. In your construction project, the structural designer has forgotten to design the staircase while the architect has given the drawings of the staircase as indicated in the figure below. Hence, design the staircase. The risers are 150mm and the tread are 250mm. The walls are 400mm thick and stair slab has full bearing on the masonry walls. The supporting beam is 400mm wide. Use M20 concrete and TOR steel reinforcement (Fe 415)

(17 Marks)



Case 2

Say you are working for a Government Department. And you are required to multi-task from design works to site supervision works. As a part of your work, answer the following questions

- a. If you are visiting a construction site, what volume of container would you recommend for measuring coarse and fine aggregate while preparing a concrete mix? And if you want to increase the strength of the concrete for a given proportion of ingredients (e.g 1:1.5:3), what would you recommend?

(3 Marks)

- b. Due to low bearing capacity and considering the scouring depth, if the foundation of a bridge needs to be taken to more than 5 m depth, open excavation is not recommended, why? And what kind of foundation would you recommend?

(4 Marks)

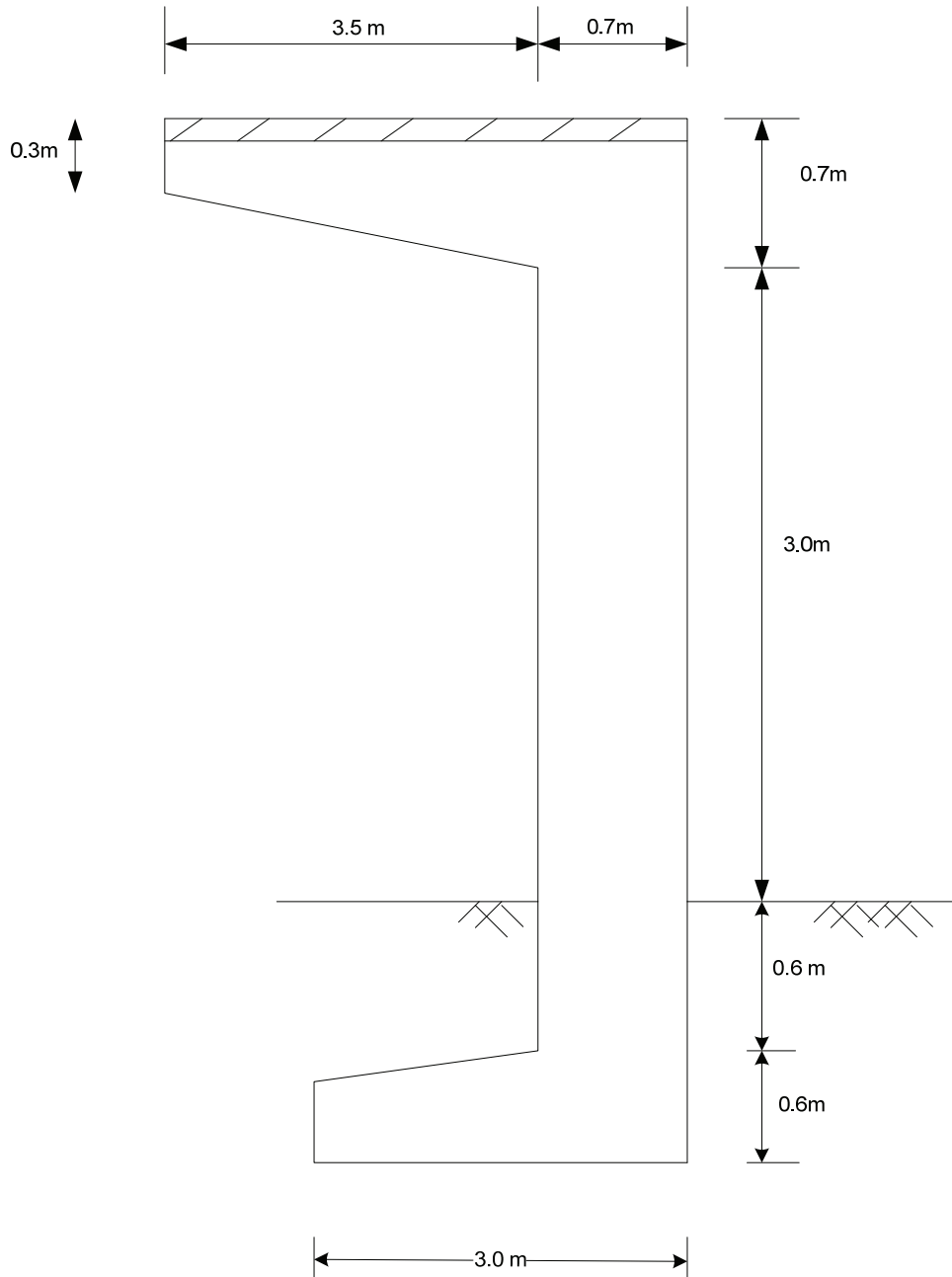
- c. It is important that the structures constructed to retain any kind of liquid should be impervious. What are the most important conditions for reinforced concrete structure to be impervious?

(3 marks)

- d. Design a cantilever shed for a bus stop at Luntenzampa area. The shed is 3 m high above the ground. It is 3.50 m wide and shall consist of a 120 mm thick slab supported on frames 3 m centers. Refer the figure below for carrying out the design works.

[Use M 15 concrete and Fe 415 Steel bars]

[Assume, LL = 150 kg/m² or 1500N/mm²]



Follow the steps given below to solve sub-question d

- i. Design the top slab
[use: $c = 50 \text{ kg/cm}^2$, $t = 1400 \text{ kg/cm}^2$ and $a = 0.87s d$, $Q = 8.7$] (9 Marks)
- ii. Design the beam supporting the slab [note: it is a tapering beam] (9 Marks)

- iii. Design the column [assume column section of 300mm x 700mm] **(9 Marks)**

- iv. Design the foundation [assume base width 3m ; depth of foundation of 600mm max and 300 mm min] **(9 Marks)**

- v. Sketch a figure showing reinforcement details. **(4 Marks)**

