**ROYAL CIVIL SERVICE COMMISSION**

**BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2014**

**EXAMINATION CATEGORY: TECHNICAL**

**PAPER III: SUBJECT SPECIALIZATION PAPER for CIVIL ENGINEERING**

**Date : 12th October 2014**

**Total Marks : 100**

**Examination Time : 150 minutes (2.5 hours)**

**Reading Time : 15 minutes (prior to examination time)**

**READ THE FOLLOWING INSTRUCTIONS CAREFULLY:**

1. Write your Roll Number clearly on the Answer Booklet in the space provided.
2. The first 15 minutes is being provided to check the number of pages, printing errors, clarify doubts and to read the instructions. You are NOT PERMITTED to write during this time.
3. Use either Blue or Black ink pen or ball point pen for the written part and Pencils for the sketches and drawings.
4. All answers should be written on the Answer Booklet provided. Candidates are not allowed to write anything on the question paper or any other materials.
5. It is divided into two sections – namely SECTION A and SECTION B.
6. SECTION A consists of two parts: Part I and Part II.

Part I consists of 30 Multiple-Choice Questions carrying one (1) mark each and is compulsory. The answer of your choice should be clearly written in whole along with the question and option number on your answer booklet. Eg. 31 (c).

Part II consists of four (4) short answer questions of five (5) marks each and all questions are compulsory

1. SECTION B consists of two Case Studies. Choose only **ONE** case study and answer the questions under your choice. Each case study carries fifty (50) marks in total.

* The paper has 15 printed pages in all, including this Instruction Page.

**SECTION A**

**PART –I : Multiple Choice Questions**

**Choose the correct answer and write down the letter of the correct answer chosen in the Answer Sheet against the question number. E.g. 71 (c ). Each question carries ONE mark.**

1. **Poisson’s Ratio, Bulk Modulus and Young’s Modulus and are connected by the relation:**
2. **E = K/3 (1+ 2/m)**
3. **E= 3K (1 – 2/m)**
4. **E = 2K ( 1 + 1/m)**
5. **K = E/3 (1 – 2/m)**
6. **The maximum shear stress from a Mohr’s circle is given by:**
7. **the radius of the circle**
8. **the diameter of the circle**
9. **the distance of the farthest point on the Mohr’s circle from origin**
10. **the distance of center from the origin**
11. Any change in moisture content of a soil changes
    1. strength of the soil
    2. value of angle of shearing resistance
    3. amount of compaction required
    4. all the above
12. Two soil samples A and B are tested in the Laboratory for the consistency limits. The results are as follows:

|  |  |  |
| --- | --- | --- |
|  | **Sample A** | **Sample B** |
| Liquid limit | 40% | 60% |
| Plastic limit | 20% | 25% |

From the results above, which soil sample is more plastic?

* 1. sample A
  2. sample B
  3. none
  4. both

1. Which network given below has error looping?



1. network (a)
2. network (b)
3. network (c)
4. network (d)
5. For low head and high discharge, the suitable turbine is
   1. Kaplan
   2. Francis
   3. Pelton
   4. Propeller
6. Moment of Inertia of a rectangular section (having width = b and Depth = d) about x – axis is given by :
   1. Ix = (b3d) / 12
   2. Ix = (b2d2) / 6
   3. Ix = (bd) / 6
   4. Ix = (bd3) / 12
7. For a viscous flow through circular pipes, certain curves are shown in figure given below. Curve Y in the figure below is for:



* 1. pressure distribution
  2. velocity distribution
  3. shear stress distribution
  4. none of the above

1. If A is the area of flow, P is the wetted perimeter and T is the top width of flow, the hydraulic radius is defined as:
   1. A/P
   2. A/T
   3. P/A
   4. T/A
2. Number of reaction components possible at a hinge on rollers support is:
   1. 0
   2. 1
   3. 2
   4. 3
3. The slope of curve of Shear Force diagram at any section will be equal to
   1. the bending moment at the section
   2. the area of the loading diagram from end to that section
   3. the slope of loading at that section
   4. the ordinate of loading diagram at that section
4. To avoid any possibility of tension occurring in masonry structures, the resultant of various forces at any level must pass through
   1. the center of the section
   2. a corner of the section
   3. middle third of the width or the depth of the section
   4. totally outside of the section

1. For ordinary domestic sewage BOD reaction is expected to get completed in about (20°C) :
   1. 10 days
   2. 15 days
   3. 20 days
   4. 30 days
2. Seven day compressive strength of a good Portland cement, as obtained from the compressive test on cement-sand mortar cubes, should not be less than:
   1. 200 kg/cm2
   2. 175 kg/cm2
   3. 150 kg/cm2
   4. 125 kg/cm2
3. A pile commonly used to reduce seepage and control the uplift pressure under hydraulic structures is know as:
   1. friction pile
   2. compaction pile
   3. bearing pile
   4. sheet pile
4. If the contour lines are straight, parallel and equally spaced, they represent:
5. a uniform Slope
6. a plane surface
7. a gradual slopes
8. a rough, rugged terrain
9. Which of the following represents the smallest scale:
10. 1 cm : 10 mm
11. 1 cm : 10 cm
12. 1 cm : 10 m
13. 1 cm : 10 km
14. Some of the general causes of pavement failures is due to:
15. Defects in the quality of materials used
16. Settlement of foundation of embankment of the fill material itself
17. Inadequate surface or subsurface drainage in the locality resulting in the stagnation of water in the sub-grade or in any of the pavement layers
18. All of the above
19. Admixture in the concrete can be added to concrete, just before or during the mixing:
20. to accelerate the initial setting time while pumping concrete over long distance.
21. to increase the resistance to freezing and thawing
22. to decrease heat evolution
23. to increase rate of bleeding and segregation
24. (i) & (ii)
25. (ii) &(iii)
26. (iii) & (iv)
27. (i), (iii) & (iv)
28. Which of the following statement is TRUE?
29. The maximum area of tension reinforcement in RC components is limited to certain percentages of the gross cross-sectional area to avoid difficulty in placing and compacting concrete properly in the form work.
30. A sudden failure would occur with less alarming deflection when beam is designed as a balanced reinforced beam.
31. Steel is strong in compression and concrete is strong in tension.
32. Creep and shrinkage are time dependant deformations, generally compressive in nature.
33. i), ii) & iii)
34. ii) & (iii)
35. iii) & iv)
36. i), ii) & iv)
37. It is assumed that a diagonal crack develops at 45° for the full depth of the beam, and the spacing of shear stirrups is , then number of stirrups crossing a crack is equal to:
    1. 2
    2. All of the above

Where is the effective cover of the beam.

1. The minimum grade of concrete for all the reinforced concrete works should be:
2. M 10
3. M 15
4. M 20
5. M 25
6. The Rankine formula used to obtain the depth of foundation, h is:



11. Which ONE of the following is NOT TRUE for ductility detailing of a reinforced concrete structure:
12. at least two bars should be provided continuously both at top and bottom of a RC beam.
13. not more than 50% of the reinforcement should be spliced at one section for RC beam and column.
14. when column terminates at the footing, a minimum confining length of 300 mm must be provided into the footing.
15. in beam-column connections, the reinforcement from the beam should not be anchored in the joint.
16. In a water supply scheme, the structural components are constructed in the following order:
17. Source, Intake, Treatment Plant, Service Reservoir and Distribution System.
18. Source, Treatment Plant, Intake, Service Reservoir and Distribution System.
19. Source, Service Reservoir, Treatment Plant, Intake and Distribution System.
20. Intake, Source, Service Reservoir, Treatment Plant and Distribution System.
21. What does term night soil indicates?
22. untreated sewage.
23. sewage which is undergoing the treatment process.
24. human and animal excreta.
25. sewage or waste water obtained from manufacturing plants of the industries.
26. Raising of outer edge of pavement with respect to the inner edge throughout the length of the horizontal curve to counteract the effect of centrifugal force and to reduce the tendency of the vehicle to overturn or skid is known as:
27. Cant
28. Banking
29. Superelevation
30. All of the above
31. The amount of inclination, with respect to a horizontal plane, measured in a vertical plane lying at right angles to the strike of the bedding is defined as:
32. dip of bed
33. fault line
34. strike of bed
35. folds
36. The unit weight of water is:
37. 0.1 g/cc
38. 1 g/cc
39. 10 g/cc
40. 100 g/cc
41. One kg- force is equal to:
42. 9.81 kN
43. 0.981 kN
44. 0.0981 kN
45. 0.00981 kN

**PART –II: Short Answer Questions (20 marks)**

**Answer all the questions. Marks are given against each question in the brackets.**

1. Answer the following two questions **( 2 x 2.5 = 5 marks)**
   1. Is the Bridge shown below statistically determinate?



* 1. For the beam structure shown below, draw the influence line for reaction at support B. The length of the beam is 10m.



1. Answer the following two questions
   1. Explain briefly what is shrinkage limit (SL)? **(1.5 marks)**

* 1. A 12-hour storm rainfall with following depths in cm occurred over a basin 2.0, 2.5, 7.6, 3.8, 10.6, 5.0, 7.0, 10.0, 6.4, 3.8, 1.4, and 1.4 The surface run-off resulting from the above storm is equivalent to 25.5 cm depth over the basin. Determine the average infiltration index for the basin.

**(3.5 marks)**

1. Answer the following two questions
   1. Write any two causes of pot holes in a flexible pavement? **(2 marks)**
   2. Write down the construction procedures for repairs of pot holes? **(3 marks)**
2. Figure below shows the foundation layout of a building. The dimension of the column is 400 mm x 400 mm and thickness of the footing pad is 500 mm.
3. Estimate the total quantity of earthwork to be excavated to lay the foundation?

**(2.5 marks)**

1. Also find the total quantity of earthwork required to be filled back after foundation is laid?  **(2.5 marks)**

*Note: The dimensions indicated in the figure are in metres and the figure is not to scale.*



**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.**

**Question 1.**

Suppose you are working as a civil engineer for a consulting firm. You have been assigned to design a cantilever retaining wall (T type) to retain earth for a height of 4m. The backfill is horizontal. The density of soil is 18kN/m3. Safe bearing capacity of soil is 200 kN/m2. Take the co-efficient of friction between concrete and soil as 0.6. The angle of repose is 30 degrees.

[Use M20 concrete and Fe415 steel]

[Provide Toe Projection of 0.75mm]

[Provide 450mm thickness for stem at the base and 200mm at the top]

**Follow the steps given below to solve this question**

1. Find the Depth of Foundation (Df) and total Height (H) of the Retaining Wall **{5 marks}**

1. Find thickness of base slab [ hint: (1/10 to 1/14 ) \*H ] **{2.5 marks}**
2. Find width of base slab (hint: 0.5 H to 0.6 H ) **{2.5 marks}**

1. Design Stem **{13 marks}**
2. Design Heel  **{10 marks}**
3. Design Toe **{7 marks}**
4. Sketch ( Cross Section of wall, longitudinal section of wall for about 2m,

Sectional plan of base slab) **{7 marks}**

1. What is retaining wall? List and briefly explain the two most commonly used retaining wall?

**{3 marks}**

**Question 2**

**Question 2 has two sub-questions 2.1 and 2.2. [Question 2.1 carries 20 marks and 2.2 carries 30 marks]**

* 1. National highways are the primary roads that connect most of the Dzongkhags in Bhutan. However, during monsoon the highways are often blocked due to landslides causing traffic disruption. In this case, you are an engineer working for the Road sector. As such, you have been assigned the task to conduct technical assessment of the above road block site and recommend remedial measures/ techniques to minimise future landslides from happening at the same location. Therefore, in your 'Site Assessment Report' you may like to furnish the following information:
     1. When does the movement of soil occur? **{2 marks}**
     2. What are the likely causes of landslides? *(Give your answer in bullet points)* **{4 marks}**
     3. What are the techniques that you would recommend to prevent and correct landslides? *(Give your answer in bullet points)***{4 marks}**
     4. What does EIA stands for? **{2 marks}**
     5. Briefly explain in your own words the term EIA? **{3 marks}**
     6. Mention some of the objectives for conducting EIA? **{5 marks}**

2.2 Design a doubly reinforced rectangular beam for an effective span of 5 m. The superimposed load is 30 kN/m and size of the beam is limited to 300 mm x 500 mm overall. Use M 20 mix and Fe 500 grade steel. {**30 marks}**

Given:

1. Effective cover = 0.1D
2. factor of safety = 1.5
3. Unit weight of RCC = 25 kN/m3

(**Hint:** Calculate the steel requirements both in tension and compression. Also carry check on the max. Steel in tension)

The following tables and information may be useful for the design.

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 1 Limiting moment of resistance values, N mm** | | | |
| Grade of concrete | Grade of Steel | | |
| Fe 250 steel | Fe 415 steel | Fe 500 steel |
| General | 0.148 σck bd2 | 0.138 σck bd2 | 0.133 σck bd2 |
| M20 | 2.96 bd2 | 2.76 bd2 | 2.66 bd2 |
| M25 | 3.70 bd2 | 3.45 bd2 | 3.33 bd2 |
| M30 | 4.44 bd2 | 4.14 bd2 | 3.99 bd2 |

|  |  |
| --- | --- |
| **Table 2 Maximum depth of neutral axis** | |
| σy N/mm2 | xm |
| 250 | 0.53 d |
| 415 | 0.48 d |
| 500 | 0.46 d |

0.87 σy At = σsc Asc

M - Mlim = (σsc Asc - σcc Asc) (d - d')

0.87 σy At = 0.36 σck b xm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 3 Stress σsc, N/mm2 in compression reinforcement** | | | | |
| Grade of steel σy N/mm2 | d'/d | | | |
|  | 0.05 | 0.1 | 0.15 | 0.2 |
| 250 | 217 | 217 | 217 | 217 |
| 415 | 355 | 353 | 342 | 329 |
| 500 | 424 | 412 | 395 | 370 |