- **ROYAL CIVIL SERVICE COMMISSION**
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2011
EXAMINATION CATEGORY : TECHNICAL

PAPER III: SUBJECT SPECIALIZATION PAPER for CIVIL ENGINEERING

Date : 30th **October 2011**
Total Marks : **100**
Examination Time : **2.5 Hours**
Reading Time : **15 Minutes**

INSTRUCITONS

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 HB 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.

5. This Question booklet consists of 10 pages. 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.

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

7. **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.

SECTION A

Part I – Multiple Choice Questions (30 marks)

1. For durability in moderate exposure condition, a minimum cement content of 290kg/m3 would require maximum water cement ratio of :
   a) 0.45
   b) **0.55**
   c) 0.60
   d) 0.65

2. It is more often preferable that a beam section be designed as :
   a) reinforced concrete section
   b) balanced section
   c) **underreinforced section**
   d) overreinforced section

3. A doubly reinforced beam section becomes necessary under which following states:
   a) when depth is restricted
   b) when bending moment at a section can change in sign
   c) to improve the ductility of beam
   d) **all of the above**

4. The principal tensile strength of concrete would be approximately ……..percent of its   compressive strength:
   a) 5%
   b) **10%**
   c) 15%
   d) 25%

5. If cracking is permitted for concrete in tension, the value of Poisson's ratio of concrete will be:
   a) **0**
   b) 0.5
   c) 1
   d) 2

6. Moment Redistribution procedure allows a designer to alter moments at particular sections to achieve the benefits of:
   a) a more balanced moment distribution
   b) a reduction in the range of the moment envelop
   c) a reduction in the reinforcement requirements
   d) **all of the above**

7   Preliminary estimate for a project is prepared :
    a) for the feasibility studies
    b) for getting the technical sanctions
    c) for getting the administrative sanctions
    d) for preparing detailed estimates

8   A construction schedule indicates:
    a) the rate of progress of each operation
    b) the actual progress of works
    c) the expenditure of materials
    d) both rate of progress and actual progress

9   The management technique that is more suitable for application in the construction project would be:
    a) Gantt Chart
    b) PERT
    c) CPM
    d) all of the above

10. What type of Contract systems are followed in Bhutan especially in the construction industry:
    a) Lum sum contrat
    b) Item Rate contract
    c) Labour contract
    d) All of the above

11. In a FILLET weld a general rule is adopted which is :
    a) **the leg should be equal to thickness of metal**
    b) the leg should be less than the thickness of metal
    c) the leg should be half the thickness of metal
    d) half the leg should be equal to the thickness of metal

12. The ratio of lateral strain to linear strain is known as:
    a) **modulus of elasticity**
    b) modulus of rigidity
    c) Poisson's ratio
    d) elastic limit

13. The moment of inertia of semi circle about its XX axis is given by:
    a) $0.22 \, r^3$
    b) $0.11r^4$
    c) $0.14 \, r^4$
    d) $0.2 \, r^4$

14. Which of the following forms the basis of rigid bodies and strength of materials :
    a) centriod
    b)   centre of gravity
    c)   moment of inertia
    d)   any of the above

15. In a cantilever of length L carrying a load whose intensity varies uniformly from zero at the free end to w per unit run at the fixed end, the maximum bending moment (BM) is:
    a) $wl^2/6$
    b) $wl^2/8$
    c) $wl^2/4$
    d) $wl^2/12$

16. Columns which have length less than 8 times their diameter or slenderness ratio less than 32 are called:
    a) long columns
    b) short columns
    c) slender columns
    b) intermediate columns

17. A perfect truss frame should satisfy which of the following equations:
    a) $m = 2J - 3$
    b) $m = 2J - 4$
    c) $m = 3J - 2$
    d) $m = 3J - 3$

18. What is the most important design parameter used in designing a continuous flow rectangular sedimentation tank for removal of discrete particles?
    a) Length of the tank
    b) Surface overflow rate
    c) Depth of the tank
    d) Temperature of the water to be treated

19. Which one of the following parameters is not included in the routine characterization of, solid waste for its physical composition?
    a) Moisture content
    b) Density
    c) Particle size analysis
    d) Energy value

20. Consider the following treatment process units in a water treatment plant:
    1) Coagulation
    2) Disinfection
    3) Sedimentation
    4) Filtration
    Which is the correct sequence of the process units in the water treatment plant?
    a) 2-4-3-1
    b) 1-4-3-2
    c) 2-3-4-1
    d) 1-3-4-2

21. Choose the statically indeterminate beams from the followings:

a) Fixed beams
b) Continuous beams
c) Both above
d) None of the above

22. What are the air pollutants responsible for acid rain within and downwind areas of major industrial emissions?
   a) Hydrogen sulfide and oxides of nitrogen
   b) Sulfur dioxide and oxides of nitrogen
   c) Carbon dioxide and hydrogen sulfide
   d) methane and hydrogen sulfide

23. Which one of the following conditions is valid in case of unconfined compression test in comparison to triaxial test?
   a) Minor principal stress = 0
   b) Minor principal stress = 0.5 × major principal stress
   c) Minor principal stress = major principal stress
   d) Major principal stress = 3 × minor principal stress

24. A rectangular beam of length L supported at its two ends carries a central concentrated load W at its centre. The maximum deflection occurs
   a) at the ends
   b) at 1/3 from both ends
   c) at the mid span
   d) at 1/4 from both ends

25. The typical flexible pavement failures are
   a) alligator and longitudinal cracking
   b) consolidation of pavement layers
   c) formation of waves and corrugations
   d) all of the above

26. The compressive strength of 100 mm cube as compared to 150 mm cube is always
   a) less
   b) more
   c) equal
   d) may be any of the above

27. For the design of retaining walls the minimum factor of safety against over-turning is taken as

a) 1.5

b) 2.0

c) 2.5

d) 3.0

28. When the fluid properties do not change with time, it is a _____ flow

a) steady

b) uniform

c) unsteady

d) non-uniform

29. A centrifugal pump converts _____ energy into hydraulic energy

a) electrical

b) mechanical

c) kinetic

d) pressure

30. Generally for RCC works the concrete used is of the grade

a) M10

b) M20

c) M25

d) M30

Part II – Short Answer Questions (5 marks each)

Q1. In the design of a simply supported skew bridge, which direction of reinforcement should be provided?

Q2. For designing concrete structures, normally maximum aggregate sizes are adopted with ranges from 10mm to 20mm. Does an increase of maximum aggregate size benefit the structures?

Q3. Are there any differences in the methods of compaction between clayey soil material and sandy material?

Q4. What is the difference between working stress approach and limit state approach?

SECTION B (Answer only **one** question- 50 marks)

Question 1:

Part A): A 5 storey shopping complex project is under construction in Thimphu and the Contractor is all set to carry out the third floor slab casting. The Engineer does his final checks including the on site slump test of the concrete mix. The slump test passed and the Engineer orders the Contractor to go ahead with the slab casting. Also, the Engineer decides to send some cube samples for compression test to a recognized laboratory. After 7 days, the compression test results arrive and it has failed.

Q 1) What is the basic difference between Slump test and Compression test and what are they used for? Why cannot a compression test be done at site before any concreting works? (4 marks)

Q2) If you are the Engineer in the above case, what would you have done if the Slump test failed in the first place. (4 marks)

Q3) Since the compression test failed and the concrete slab already cast, technically what do you suggest. (6 marks)

Q4) Propose your own quality assurance plan to be implemented so that such complications can be avoided in project executions. (6 marks)

Q5) Construct a network diagram for the above Project comprising the following activities, A,B,C,D,E,F and G having the following relationships. Number the events and also indicate the activity duration in your network. Identify the critical path and name the critical activities. (10 marks)

- A is the initial activity of the Project (A precedes activities B,C and D)
- B precedes E
- C precedes F
- D precedes G
- E precedes F
- F precedes G
- G is the terminal activity of the project.

Duration of the activities in days are:
- A=3
- B=6
- C=16
- D=10
- E=8
- F=5
- G=3

Part B): In the above shopping complex project, a floor has to carry a load of 12kN per square meter. The floor is supported on rectangular joists each 300mm x 100mm and 5m long.

Q1) Calculate the maximum bending moment to which each joist is subjected.
(8 marks)

Q2) Calculate the distance apart (centre to centre) at which joists should be placed so that the maximum stress in the joists should not exceed $8x10^6 \text{ N/m}^2$. (8 marks)

Q3) Which reinforcement type, Fe 415 or Fe500 would you prefer to use in the design for the above mentioned shopping complex? Give at least four reasons for your choice.
(4 marks)

Question 2:

Part A:

The Royal Government of Bhutan proposes to construct a road link between Shingkhar (Bumthang) and Gorgan (Lhuntse). The bypass is expected to save travel time, distance and reduce various risks associated by avoiding Thrumshing La Pass. Assuming you have been assigned the job of route survey,

Q1) Explain the various stages of route survey that you would undertake. Please explain each stage?   (15 marks)

Q2) What are the controlling factors determining the selection of the road alignment?
(10 marks)

Part B:

Q1) The Department of Roads proposes to widen a stretch of existing single lane road of length 40 km between Sarpang and Gelephu to double lane at a total cost of Nu. 6.5 lakhs per km and the rate of interest is 10% per year. The annual cost of maintenance of the existing single lane is 7000 per km and that of improved double lane is estimated 9000 per km. The average vehicle operation cost on the existing road is Nu 1.3 per vehicle-Km and that of the improved road is estimated to be Nu 1.15 per vehicle-Km.

If the present traffic is 2000 vehicles per day and at the end of 15 years design period the traffic is estimated to be doubled, determine whether the investment on improvement of the road is economically viable through a cost-benefit analysis during the 15 year period.

(12 marks)

Consider the followings:

$Cr = P \times CRF$

Where
Cr = Present annual cost of improvement
P = Total cost of improvement
CRF = Capital Recovery Factor = 0.13147

Q2) For mechanized construction of the above work, what plants and equipment do you feel are necessary?   (3 marks)

Q3) Elaborate construction steps involved in executing the above work?

(10 marks)