National Institute of Technology, Hamirpur (HP)

Civil Engineering Department

Name of the Examination: END Semester, DEC-2023

Branch: Civil Engineering | **Semester**: VII
Course Name: Bridge Engineering | **Course Code**: CE-451
Duration: 3 Hours | **Marks:** 50

Note: Answer the questions as mentioned for each section (Assume any suitable data whenever required). Necessary IS codes (IS-456, IRC-6, IRC-21, IRC-83, IRC-112 etc.) are allowed during the examination. Draw neat sketches whenever required.

Section – A (Answer any One question)

1. (a) Mention the various advantages of reinforced concrete box culverts in comparison with other types of cross-drainage works adopted in highway structures. (2)

   (b) Design a reinforced concrete box culvert having a clear vent way of 3 m by 3 m. The superimposed dead load on the culvert is 12.8 kN/m^2. The live load is estimated as 50 kN/m^2. Density of soil at site is 18 kN/m^3. Angle of repose = 30°. Adopt M-25 grade concrete and Fe-550 HYSD bars. Sketch the details of reinforcements in the box culvert. The design should conform to the specifications of IRC: 112-2011. (6)

2. Design a RCC slab culvert for a National Highway crossing to suit the following data:

   Carriage way - Two lane (7.5 m wide);
   Clear span = 6 m;
   Width of bearing = 400 mm;
   Foot paths - 1 m on ether side
   Wearing coat = 80 mm
   Loading: IRC Class AA tracked vehicle

   Design the reinforced concrete slab deck and sketch the details of reinforcements in the longitudinal and cross-section of the slab. The design should conform to the specifications of IRC: 6-2016 and IRC: 112-2020. Use materials such as M-25 Grade Concrete and Fe-415 Grade HYSD bars. (8)

Section – B (Answer All the questions)

3. Describe Courbon's method of analysis in the case of a T-beam and slab bridge with the assumption made in the analysis. (5)

4. Design an R.C.C. Tee beam girder bridge to suit the following data using M-25 Grade concrete and Fe-415 HYSD reinforcements. The preliminary dimensions may be assumed (based on experience) as shown in Fig. 1.

   Clear width of carriageway = 7.5m;
   Span (Centre to Centre of bearings) = 16m;
   Kerbs on either side = 600 by 300 mm;
   Live load: IRC Class AA tracked vehicle;
   Thickness of the wearing coat = 80 mm;

   Using Courbon's method, compute the design moments and shear forces and design the deck slab, main girders and cross girders conforming to the specifications of IRC: 6-2014 and IRC: 112-2011. Sketch the details of reinforcements in deck slab, main and cross girders. (20)

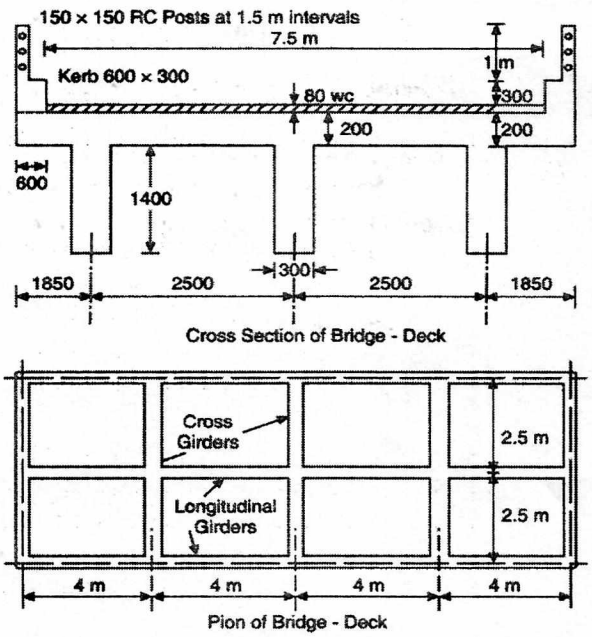

Fig.1 T-Beam and Slab Bridge Deck.

Dr Amrit Kumar Ray 29/11/2023 (10)

Section – C (Answer any One question)

5. Design an elastomeric pad bearing to support a Tee beam girder of a bridge using the following data:

Maximum dead load reaction per bearing = 300 kN
Maximum live load reaction per bearing = 700 kN
Longitudinal force due to friction per bearing = 45 kN
Effective span of the girder = 16 m
Estimated rotation at bearing of the girder due to dead and live loads = 0.002 radians
Concrete for Tee beam and bed block = M-20 Grade
Total estimated shear strain due to creep, shrinkage and temperature = 6×10^{-4}. (8)

6. (a) Briefly explain the different types of pile foundations adopted for bridges. Briefly explain the various structural components of a typical well foundation, specifying the function of each of these components. (3)

(b) Design a well foundation for the pier of a major highway bridge to suit t following data: (5)

The internal diameter of well = 2.5 m
Type of soil strata: Clayey (K=0.033)
Depth of well = 25 m below bed level
Materials: M-20 Grade Concrete and Fe-415 Grade HYSD bars

Design the well and verify the stresses in the steining. Sketch the details of reinforcements in the well.

Section – D (Answer All the questions)

7. Write short notes on (Any Two): (4)

a) Basis For Selection of Bearings
b) Elastomeric POT Bearings
c) Forces on Bearings
d) Stability of Abutment

8. Verify the adequacy of the dimensions for the pier shown in Fig.2. The following details are available: (5)

Top width of the pier: 1.6 m
Height of the pier up to springing level: 10 m
c/c of bearings on either side: 1.00 m
Side batter: 1 in 12
High flood level: 1 m below the bearing level
Span of the bridge: 16 m
Loading on span: IRC Class AA
Road: Two-lane Road with 1 m wide footpath on either side.

Superstructure: Consists of three longitudinal girders of 1.4 m depth with a deck slab of 200 mm depth. Rib width of girders = 300 mm, Material of the pier: Concrete M15.

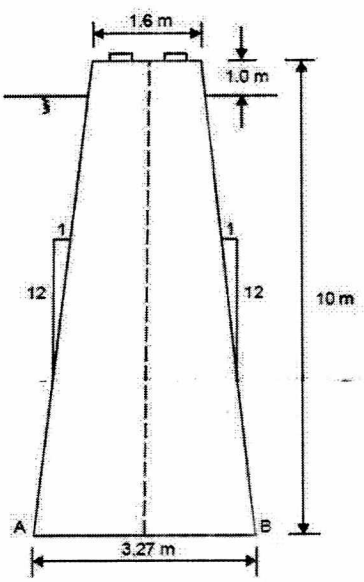

Fig. 2 Section of the pier

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