(3 Hours)   (Total Marks: 80)

N. B.: 1. **Question number 1** is **compulsory**; attempt **any three** out of remaining five questions.
      2. Assume suitable **data** if **required** and mention it clearly.
      3. **Answer and design** must be in accordance to **IRC and bridge rules**.
      4. **Support answers** and **solutions** with suitable **sketches**.

1.   Attempt any four
   (a) What are different components of lattice girder? also explain how load get transferred from [05]
       train to the lattice truss girder, support your answer with sketch.
   (b) What is difference between a fixed and an expansion type bearing? Explain functioning of one [05]
       bearing of each type with neat sketches.
   (c) What is a well foundation? What are various shapes of well foundations? Also sketch [05]
       components of well foundation
   (d) What are various methods of launching of girders? Explain any one in detail. [05]
   (e) What do you mean by "Economic Span Length" of bridge? Develop equation for the same. [05]
       What are its limitations?

2. (a) What is the provision to account dynamic effect of imposed load for roadway bridges? How [05]
       different factors influence on it? Calculate impact factor for the following cases.
       i. A PSC deck slab bridge of span 14m is to be designed to carry IRC Class-A vehicle.
       ii. A PSC longitudinal girder for a bridge of span 30m is to be designed to carry IRC Class-
       70R tracked vehicle.
   (b) Locate position of IRC Class A train of vehicles along and across a PSC girder bridge of span [15]
       25m to produce maximum Bending Moment in a critical girder. Carriage width is 7.5m.
       Longitudinal girders are provided at 2.5m c/c and cross girders are provided at 5m c/c.

3.   A road bridge on a national highway has effective span 12 m, depth of deck is 500 mm and [20]
     thickness of wearing coat is 90 mm. It is subjected to LLBM 182 kN-m due to IRC vehicular
     loads and DLBM 200 kN-m. Considering loss ratio 0.85 and f_p = 1700 MPa, f_i = 1250 MPa,
     f_{ck} = 60 MPa, f_{ci} = 50 MPa and this is class 1 type structure. Determine suitable arrangement
     of Freyssinet cables containing 12 wires of 7mm diameter, suggest spacing and locate cables
     in safe zone with proper profile. Stresses must be within permissible limits in the extreme fibers
     of the slab. Check the section for under and over reinforced for Severe conditions. **Check
     against shear and design of end blocks are not expected.**

4. (a) Design Section **A** and Section **C** of following **Balanced Cantilever Bridge.** [10]
   IRC Class AA tracked vehicle is carried out over a bridge length of 77m.
       Road width between kerbs are 7.5m and foot path on either side is 1.2m.
       Spacing between T-beam is 1.8m and width of girder is 450mm.
       Thickness of deck slab and wearing coat are 200mm and 90mm respectively.
       Materials; M25 grade concrete and Fe-415 grade HYSD bars are used.
       Design of Deck slab is not expected.

A |— 20 M —| B | 5 M | C ↑ | G — 27 M — | D ↑ | 5 M | E |— 20 M —| F
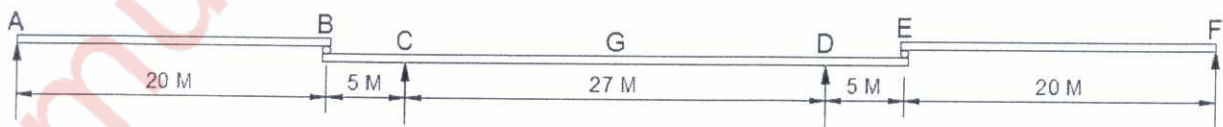
Arrangement of span in Balanced Cantilever Bridge

   (b) Define: Bridge, culvert, foot bridge, High level bridge, submersible bridge, deck bridge, [04]
       through bridge, semi through bridge.
   (c) What is permissible limit for tilt or shift of a well foundation? Enlist different method to rectify [06]
       tilt, explain any one.

5. Determine **design bending moment and shear force** on longitudinal girder of a 28m span [20] bridge, due to IRC Class AA tracked vehicle and self-weight of bridge superstructure. Clear carriage width is 7.8m, footpath on either side is 1.5m and cross girders are provided at 4m c/c. Thickness of deck stab is 300mm thickness of wearing coat is 100mm. Area of cross girder is 70% of area of longitudinal girder.
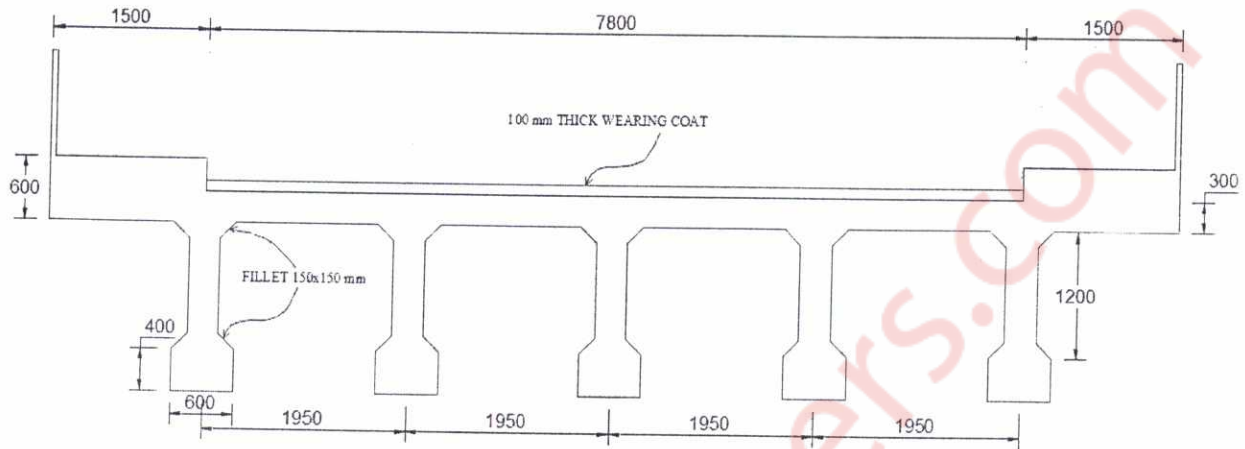
6. (a) What are different types of foundations used in bridges? How different factors influence type [05] of foundation?

(b) Determine **Design forces** due to **dead** and **live load** in diagonal member L_3U_4 of a lattice girder [15] bridge of **40m** span as shown below.

Consider self-weight of different elements per meter span per track as under:

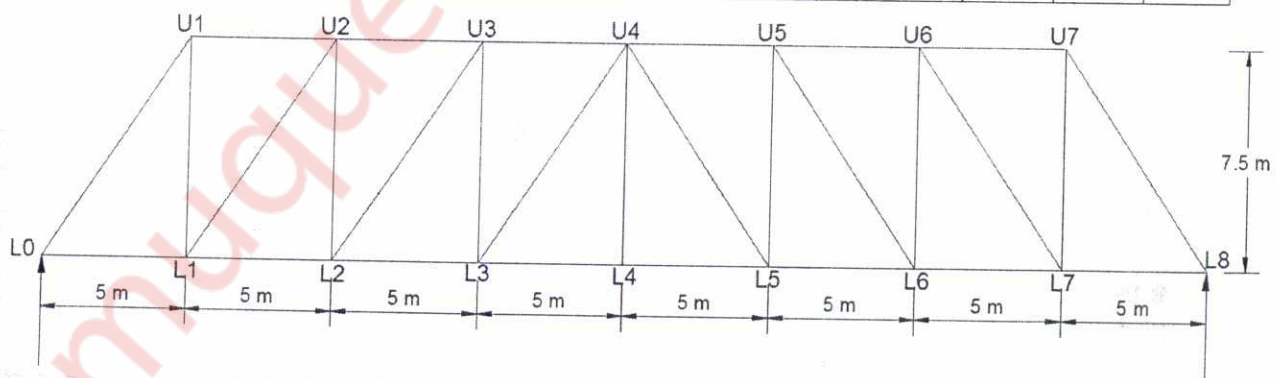Stringers: 3000N/m, Stock rail: 500N/m, Guard rails: 400N/m,

cross beams and bracings: 3000N/m, fasteners: 3000N/m,

PSC sleepers are spaced 400mm c/c and are of size 2.8m x 250mm x 250mm

Take self-weight of each girder (top chord, bottom chord, diagonals and vertical members): 12000N/m.

Bridge is to be designed to carry a single track Broad gauge loading-1987 as under

Span (m)	15	16	17	18	19	20	21	22	23	24	25
Loading*	1631	1695	1751	1820	1886	1964	2039	2123	2203	2280	2356

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