BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
CIVIL ENGINEERING DEPARTMENT
FIRST-SEMESTER 2023-2024
CE G616: BRIDGE ENGINEERING
COMPREHENSIVE EXAMINATION (OPEN BOOK)

DURATION: 3 Hrs. **MAX. MARKS: 100**

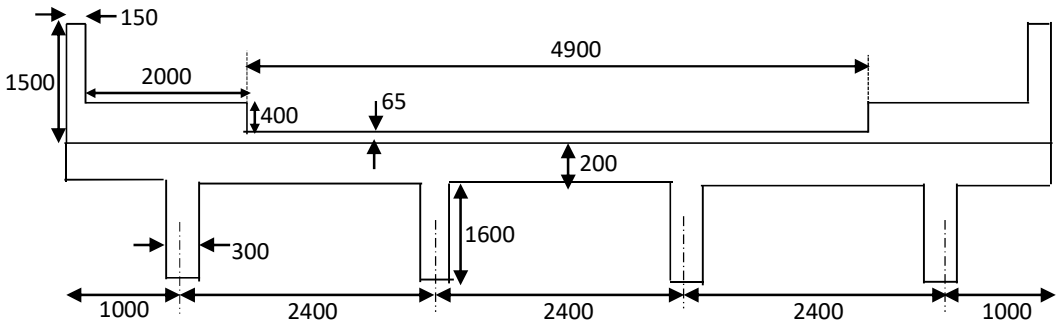
Q1. In a T-beam bridge of overall width 9.2 m and span 19.2 m, the 300 mm wide longitudinal girders are provided at 2.4 m c/c spacing as shown in figure. The 250 mm wide web transverse girders having overall depth 75% of longitudinal girders are provided at 3.84 m c/c.

a) determine the moment in the exterior longitudinal girder due to Dead loads,

b) Assuming the wheel/distributed loads as concentrated load acting at their centroid and making the use of Courbon's method, determine the maximum moment in the exterior girder due to Live loads as specified by IRC 6.

c) Maximum moments in the transverse girder due to (i) dead loads, and (ii) live load

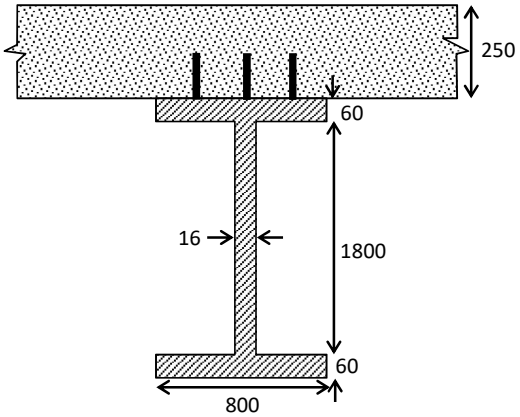
[30]



Q2. In an 18 m span and 9 m wide T-beam bridge, there are three longitudinal girders and <u>NO</u> transverse girders are provided in the bridge. The thickness of concrete slab and wearing coat is 220 mm and 65 mm, respectively. The web width and web depth of longitudinal girders is 200 mm and 1500 mm (excluding slab) and they are provided at 3.0 m c/c. Assuming there are no kerbs/footpaths, calculate the flexural and torsional parameters for this bridge.

[10]

Q3. In a composite bridge of span 16 m, the concrete slab of thickness 250 mm is provided over the steel I-girders located at 2.5 m center to center spacing. The slab is connected by three stud type shear connectors in a row and the spacing of rows is 200 c/c. The diameter and height of stud shear connectors is 20 mm and 100 mm respectively. The grade of concrete is M30 and yield strength of shear connectors is 385 MPa. For the full shear connection, determine, (i) position of neutral axis, (ii) Maximum horizontal shear capacity of composite section, and (iii) ultimate moment of resistance of the composite section. The material parameters are $\alpha_{cc} = 0.67, \gamma_c = 1.5, \gamma_m = 1.10, \eta = 1.0, and\ \lambda = 1.0$.



[25]

Q4. A multi-span bridge having each span 20 m and there are three girders which are provided at 3.0 m c/c. The bridge is supported on rectangular section piers having width (measured along the bridge longitudinal axis) at top and bottom as 2.5 m and 4.0 m, respectively. The length of pier (measured perpendicular to bridge longitudinal axis) at top and bottom is 8.0 m and 10.0 m, respectively. The RL of pier top and bottom is 500.0 m and 510.0 m respectively, and RL for HFL and LWL is 509.0 and 502.0 m respectively. The dead load and live load transferred to pier from each span are 1800 kN and 720 kN respectively. The eccentricity of superstructure reaction (along longitudinal axis of bridge) is 0.6 m. The projected depth of superstructure may be taken at 2.0 m. The wind pressure acting on superstructure as well as on the pier is estimated as 2.5 kN/m^2. Draw the stress variation under the pier at (i) HFL, and (ii) LWL

a) along the longitudinal direction of bridge,

b) along the direction transverse to bridge longitudinal axis. The load distribution factors among the longitudinal girders may be taken 0.75, 0.15, and 0.10.

[20]

Q5. An elastomeric pad bearing is to be designed under one of the four longitudinal girders in a 20 m span simply supported T-beam bridge. The self-weight of the bridge deck is determined as 120 kN per meter span (inclusive of deck slab and wearing coat, longitudinal and transverse girders). For a girder, the live load reaction (at bearing) and the maximum moment (at mid-span) is found 240 kN and 720 kNm, respectively. In addition to vertical reactions, the bearing is also subjected to a longitudinal force of 20 kN (due to braking effect) and a longitudinal movement (translation) due to shrinkage and creep is 4 mm and the same due to temperature effect is 2 mm. Based on vertical reactions on bearing, identify the suitable size indexes of elastomeric pad. As a trial, if a designer randomly selects size *index no. 3* elastomeric pad bearing with *three layers* of elastomers. Check its adequacy for supporting the girder under consideration. Take grade of concrete as M30 and *EI* of a girder is 2.3×10^{16} mm^2.

[15]