2013-2014
B.TECH (III YEAR) EXAMINATION
(CIVIL ENGINEERING)
DESIGN OF CONCRETE STRUCTURE-I
(CE-311)

Maximum Marks: 60

Duration: Three Hours

Answer all questions
Assume data suitably if not given
Notations have their usual meaning. Use of IS: 456-2000 is permissible

1. Design a rectangular beam for an effective span of 4.5m which is subjected to a dead load of 15kN/m and a live load of 12 kN/m. Use M20 and Fe500 concrete and steel grade respectively. Provide nominal clear cover to meet the requirement of fire resistance rating of 2hrs and durability requirements for severe exposure. Assume the width of beam as 300mm. Show the reinforcement details with neat sketches. List the relevant clauses of the IS 456-2000 while solving the design problem.

2(a) Prove the following expression

\[ L_d = \frac{0.87\sigma_y\phi}{4\tau_{bd}} \]

Where, \( L_d \) = development length; \( \sigma_y \) = stress in steel; \( \phi \) = diameter of bar and \( \tau_{bd} \) = bond stress

04

2(b) A simply supported beam with an effective depth of 450mm and 300mm width is reinforced with 3#16mm diameter HYSD bars going into the support. If the design shear force at the centre of the support is 150 kN, determine the anchorage length. The width of the support is 300mm. Use M20 concrete mix and Fe 415 grade of steel.

08

OR

2(a) Sketch the critical section for shear and describe the shear failure mechanism.

04

2(b) Design the shear reinforcement at 1m distance from support in a tapered cantilever beam of constant width 250mm. The effective span of the beam is contd...
3.5m and the tension reinforcement consists of 4#20mm diameter bars. The overall depth at fixed end and free end is 450mm and 250mm respectively. The shear force and bending moment is 120 kN and 170 kNm respectively at working loads. Use M20 concrete mix and Fe 415 steel grade.

3(a) Describe the salient features of $P_u - M_u$ interaction curve for axially loaded column.

3(b) Design a RC column ~ 300mm wide and 450mm deep to resist an ultimate load of 1300kN and an ultimate bending moment of 60kNm about major axis bisecting the depth of the column. The unsupported length is 4m and is effectively held in position at both ends and restrained against rotation at one end. Use M20 concrete mix, Fe415 steel grade and the effective cover is 60mm.

4. Design a class room slab of a multi panel floor system with all four edges continuous and centre to centre spans of 3.75m×3.75m. Assume a floor finish of 1 kN/m². Assume concrete grade as M20 and steel grade as Fe 415. Show a neat sketch of reinforcement details in the middle and edge strip.

OR

4' Design an interior panel of a flat slab. The slab is supported on columns spaced at 4.25×4.25m in either direction. The size of the column is 500mm×500mm. Assume a live load of 2kN/m² and a floor finish of 1kN/m². Height of the column is 5m. Assume concrete grade as M25 and steel grade as Fe 415. Show a neat sketch of reinforcement details in the middle and column strips.

5. A square column 300mm×300mm in cross section carries a working load of 600kN. If the safe bearing capacity of soil is 100kN/m², Calculate
   - Footing size
   - Thickness of the footing and the area of reinforcement for concrete grade M20 and steel grade of Fe415

The column is reinforced with 8# 20mm bars of grade Fe415. Show a neat sketch of reinforcement detail.
1(a) What assumptions are made in idealization of a structure? Give advantages and disadvantages of indeterminate structures.

1(b) Find the fixed end moments and draw the bending moment diagram for the beam shown in Fig.1. The support \( B \) is sinking by 1cm. Use Mohr's theorem. Take \( E = 200 \text{ GPa} \) and \( I = 8000 \text{ cm}^4 \).

OR

1'(a) Determine the degree of kinematic indeterminacy for the structure shown in Fig.2. Also draw the deflected shape.
1'(b) A continuous beam ABCDE is loaded as shown in Fig.3. The Support B sinks by 2cm whereas support C rises by 1cm. Draw shear force bending moment diagrams for the beam. Use three moment equations method (Castigliano's theorem). Take $E=210 \text{GPa}$ and $I=10,000 \text{cm}^4$.

![Diagram of continuous beam](image)

2 Analyse the continuous beam as shown in Fig.4 and draw BMD. The support B sinks by 20mm. Take $E=200 \text{ GPa}$ and $I=10^8 \text{mm}^4$. Use slope deflection or moment distribution method.

![Diagram of continuous beam](image)

3 Determine $\Sigma \delta V$ for the truss as shown in Fig.5 Joint D is point of reference. Take $E=200 \text{ GPa}$; $A_c=24,000 \text{mm}^2$ and $A_t=12,000 \text{mm}^2$.

![Diagram of truss](image)

**OR**

3' Determine the force in the redundant member for the frame as shown in Fig.6. Take $E=200 \text{ GPa}$; $A_c=6,000 \text{mm}^2$ and $A_t=3000 \text{mm}^2$.  

*Contd... 3*
4. The parabolic arches shown in Fig. 7 pinned to one another and to a column BD at B, are hinged to abutments at A and C. The arches has variable moment of inertia $I = I_0 \sec \theta$. If the column restraint is 450 kN/cm for side sway due to the horizontal thrust at B. Find the horizontal thrust in each arch and draw the BMD. Neglect any vertical yield of the column at B. $I_c = 40,000 \text{cm}^4$; $E = 200 \text{GPa}$. Also find Normal and Tangential force at 10m from abutment A.

5(a) Show that the length of the cable supported at same level with uniformly distributed load on span is $L + \frac{8d^2}{3L}$.
5(b) An un-stiffened suspension cable carries a uniformly distributed load of 8kN/m over a span of 30m as shown in Fig.8. The suspension cable is supported on frictionless rollers fixed at to the piers. The cable is inclined at 30° to the horizontal. One pier is 5m below the other and the maximum dip at the lowest point is 3m below the lower pier. Calculate (a) maximum and minimum tension in the cable and (b) the horizontal and vertical force at each pier.

OR

5'(a) Show for the cable supported at different levels with udl on span, the horizontal tension is \[ \frac{wl^2}{2(\sqrt{d_1} + \sqrt{d_2})^2} \]

5'(b) The cable of a suspension bridge has a span of 100m and a central dip of 10m. Each cable is stiffened by a girder hinged at the ends and at the middle. A dead load of 20kN/m acts on the whole girder and a live load of 30kN/m of length 20m moves over the girder. Determine the maximum tension in the cable when the live load is situated on the left hand half of the stiffening girder such that the right hand end of the live load is just over the central hinge. Also draw the shear force and bending moment diagram for the girder.
Maximum Marks: 60

(i) Attempt All questions. All questions carry equal marks
(ii) Assume suitable data if required
(iii) All symbols have their usual meanings.

Q. No.

1(a) Why dimensional analysis and model testing are essential prior to construction of hydraulic structures? Taking suitable variables develop model scale for discharge on spillway based on Froude Model law.

1(b) What is difference between Moody’s diagram and Stanton diagram? If the velocities in 60 cm pipe carrying oil are 4.5 m/s and 4.2 m/s on the centre line and at a radial distance of 10 cm from the axis, calculate the discharge in the pipe.

OR

1'(a) Oil is pumped through a 7.5 cm diameter and 1 km long pipe at uniform rate. The dynamic viscosity of the oil is 0.1 N.s/m². A power input of 5.4 kW with an overall efficiency of 60% at the pump noted. Determine the quantity of the oil pumped per minute. Relative density of the oil is 0.90.

Q1'(b) The discharge Q through a sluice gate depends upon the gate opening height d, head of water H, gravity g, density ρ and dynamic viscosity μ of water. Using Buckingham’s Pi – Theorem method, obtain an expression for discharge Q in terms of all independent variables.

Q2.(a) Differentiate between:
   (i) Energy thickness and momentum thickness
   (ii) Hydrodynamic smooth and rough boundaries
   (iii) Form drag and skin drag

Q2(b) A 20 Km/h wind blows over a 6 m flat plate. If the density and kinematic viscosity of air are 1.2 Kg/m³ and 1.5 x 10⁻⁵ m²/s respectively, calculate the force per metre width of the plate. Also estimate the thickness of the boundary layer at the trailing edge.
Q2(b) What is Strouhal number? A high tension cable 5 cm in diameter is strung out between two towers. At a wind velocity of 80 Km/h, calculate the
(i) Drag per unit length of the cable,
(ii) Frequency of the vortex shedding,

Use following data:
\[ \rho_a = 1.2 \text{ Kg/m}^3 \quad \text{and} \quad \frac{1}{\nu} = 15 \times 10^{-6} \text{ m}^2/\text{s}, \]  \[ C_D \text{ of a cylinder are as follows:} \]
For \(10^4 < Re \leq 5 \times 10^5\), \(C_D = 1.2\), and For \(Re > 5 \times 10^5\), \(C_D = 0.35\)

Q3(a) Write the expressions for equivalent pipe when five pipe lines with diameters \(d_1, d_2, d_3, d_4, \) and \(d_5\) with lengths \(l_1, l_2, l_3, l_4, \) and \(l_5\) are connected in series and also in parallel. The friction factors for all pipes may be taken as \(f\).

Q3(b) Estimate the discharge in each pipe in following pipe network system using Hardy-Cross method.

Q4(a) How turbines are classified based on head and discharge?

A reaction turbine works at 450 rpm under a head of 115 m. The diameter of the inlet is 1.2 m and the flow area is 0.4 m\(^2\). At the inlet the absolute and relative velocities make angles of 20° and 60° respectively with the tangential velocity. Determine (i) The power developed and (ii) hydraulic efficiency. Assume the velocity of whirl at the outlet to the zero.

Q4(b) Two homologous pumps A and B are to run at the same sped of 600 rpm. Pump A has an impeller of 50 cm diameter and discharges 0.4 m\(^3\)/s of water under a net head of 50 m. Determine the size of B and its net head if is to discharge 0.30 m\(^3\)/s.

OR

Q4(b) Draw the neat sketch of a centrifugal pump assembly and explain the function of each.

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**Fig. 1** Pipe Network
2013-14
B.TECH. WINTER (VI SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
TRANSPORTATION ENGINEERING
(CE-317)

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q. No.  Question                                             M.M.
1(a)  Discuss steps for practical design of super elevation. Also mention the minimum and maximum values of super elevation. [06]
1(b)  Give the sketches of various types of summit and valley curves of vertical alignment for a National Highway. Design a summit curve of National Highway for a stopping sight distance and over taking sight distance of 200m and 500m respectively. The junction point has a rising gradient of 1 in 50 and falling gradient of 1 in 30. [05]
2(a)  Discuss in detail about Highway Research Board classification system to classify subgrade soil. [06]
2(b)  A plate bearing test was conducted on a soaked subgrade during monsoon season using a plate of diameter 45 cm. The load values corresponding to the mean settlement are given below. Determine the modulus of subgrade reaction and ultimate bearing capacity of soil. [06]

<table>
<thead>
<tr>
<th>Mean Settlement (mm)</th>
<th>0.0</th>
<th>0.24</th>
<th>0.52</th>
<th>0.76</th>
<th>1.05</th>
<th>1.30</th>
<th>1.55</th>
<th>1.78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load (kg)</td>
<td>0.0</td>
<td>500</td>
<td>950</td>
<td>1200</td>
<td>1380</td>
<td>1500</td>
<td>1600</td>
<td>1650</td>
</tr>
</tbody>
</table>

OR

2'(a)  What are the various tests for judging the suitability of road stones? Discuss any four of them in detail. [06]
2'(b)  Differentiate between: (i) Bitumen and Tar (ii) Cutback and Emulsion [06]
3  Discuss the steps for the design of flexible pavement as per IRC: 37-2001 recommendations. Also mention all the critical combination of stresses (wheel load and temperature) considered in the design of rigid pavement. [12]
4(a)  Explain any three of the following:
(i) Airport capacity (ii) Cross wind component (iii) Turning zone (iv) Basic Runway Length (v) Approach surface [06]
4(b)  What do you understand by wind rose diagram? The following is the average wind data for 10 years. An airport is to be designed for a single runway. Draw Wind Rose.
diagram and determine the best orientation of runway and value of calm period in percent.

<table>
<thead>
<tr>
<th>Wind Direction</th>
<th>Percent Time with Wind Velocity (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(6.4 - 25)</td>
</tr>
<tr>
<td>N</td>
<td>0.30</td>
</tr>
<tr>
<td>NNE</td>
<td>6.10</td>
</tr>
<tr>
<td>NE</td>
<td>7.00</td>
</tr>
<tr>
<td>ENE</td>
<td>3.20</td>
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<tr>
<td>E</td>
<td>0.70</td>
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<tr>
<td>ESE</td>
<td>1.90</td>
</tr>
<tr>
<td>SE</td>
<td>4.60</td>
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<td>SSW</td>
<td>6.00</td>
</tr>
<tr>
<td>SW</td>
<td>4.20</td>
</tr>
<tr>
<td>WSW</td>
<td>6.60</td>
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<tr>
<td>W</td>
<td>2.60</td>
</tr>
<tr>
<td>WNW</td>
<td>2.50</td>
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<tr>
<td>NW</td>
<td>1.50</td>
</tr>
<tr>
<td>NNW</td>
<td>1.50</td>
</tr>
</tbody>
</table>

5(a) What is creep of rails? Discuss the wave action theory of creep and explain various preventive and remedial measures that can be taken.

5(b) What are the different types of station yards? With the aid of neat sketches, explain the functioning and types of a marshalling yard.

5(c) Define sleeper density of railway track and draw neat sketch of left hand turn out by showing various components of it.

OR

5'(a) Define wear of rails and classify it. Discuss and suggest suitable measures to reduce the wear of rails.

5'(b) Define gauge of a railway track, enumerate different gauges used in India and discuss their suitability at different locations. Why uniformity of gauges is necessary in any country?

5'(c) What do you understand by tractive effort and hauling capacity of Locomotive? Determine the mean tractive effort developed by an engine and check whether the working of engine is satisfactory or unsatisfactory from the following data:

(i) Wheel load = 2.0 tones (ii) Difference in steam pressure = 3.1 kg/cm²
(iii) Dia. of piston = 27 cm (iv) Length of stroke = 50 cm (v) Dia. of wheel = 1.6 m
Q.No. | Question                                                                                                                                                                                                 | M.M.
---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---
1.  | Determine the design loads on the purlins of an industrial building near Aligarh, given the following data:  
    Basic wind velocity at Aligarh: 47 m/s  
    Class of building: General with life of 50 years  
    Terrain: Category 2  
    Maximum dimension: 35 m  
    Width of building: 12 m  
    Height at eave level: 9 m  
    Topography: less than 3°  
    Permeability: Low  
    Span of truss: 12 m  
    Pitch: 1/5  
    Sheeting: A.C. Sheets  
    Spacing of purlins: 1.35 m  
    Spacing of trusses: 5 m | [15]
2.  | A bracket plate bolted to a vertical column is loaded as shown in Figure 1. If M20 bolts of grade 4.6 are used at a pitch of 50mm and a gauge 100mm,  
    Determine the maximum value of the factored load P which can be carried safely. The grade of steel is E250. | [15]
2. (a) Find the collapse load factor for the continuous beam shown below. The beam section is uniform throughout.

2 (b) Calculate the value of shape factor for a rectangular section.

3. Design a built up column comprising of two rolled steel I sections to resist a factored axial compressive load of 4000 kN. Length of column is 5 m and is restrained in translation and rotation at base but not in translation at top. Use Fe410 grade steel. Also design single lacing system.

3’ A battened column consists of 2 ISLC 300 placed toe to toe. Length of the column is 4 m with both ends hinged. Use Fe410 grade steel. Determine
   i. Size of the batten plate and
   ii. Check for force and stresses in batten plate

4. Design a 27 m welded plate girder using 410 grade steel. The plate girder is carrying a UDL of 20 kN/m excluding its self weight and two concentrated loads of 450 kN at 6 m from either end of the span. The girder is laterally supported throughout. Design the cross section for an un-stiffened web. Check for the shear and moment capacity of the section.
Q.No. | Question | M.M.
---|---|---
1(a) | Differentiate between various orders of triangulation. Write down the specifications of each order. | [04]
1(b) | What is meant by reduction to centre? On occupying a ground station A of a Triangulation survey, it was evident that some elevation of the theodolite would be necessary, in order to sight the signals at adjacent stations, P on the left and Q on the right. It was found however, that these stations could be seen from a ground station B, South West of A, so that AB approximately bisected the angle PBQ. Whereupon, B was adopted as a false station and the distance AB was carefully measured, being 2.835m, while the angles PBA and ABQ were observed to be 28° 16' 35" and 31° 22' 20" respectively. The side PQ was computed to be 994.87m in the adjacent triangle, and when A was under observation, the interior angles at P and Q were found to have mean value of 62° 34' 15" and 57° 39' 20" respectively. Determine accurately the magnitude of the angle PAQ. | [08]

OR

1' (a) | What is meant by axis signal correction? Derive the formula used for the same. | [04]
1' (b) | Two proposed triangulation stations A and D are 120 km apart and their respective elevations above mean sea level are 282 m and 1105 m. The altitude of two peaks B and C on the profile between them are respectively 378m and 646 m and the distances AB and AC are 47km and 83km respectively. Find whether the station A and D are intervisible. If, not, compute the height of the scaffold at D in order that... | [08]
the line of sight may clear the obstacle by 3m taking A as a ground station.

2 (a) Enumerate various linear methods of layout of simple circular curve. Derive the equations required for setting out the curve by offsets from long chord.

2 (b) Two straights $T_1V$ and $V T_2$, having bearings of $45^\circ$ and $110^\circ$ respectively are to be connected by $4^\circ$ curve (based on chord of 30m), due to inaccessible intersection point, the following traverse is run from a point $P$ on the rear tangent to the point $S$ on the forward tangent:

<table>
<thead>
<tr>
<th>Line</th>
<th>Length (m)</th>
<th>Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>PQ</td>
<td>110.20</td>
<td>60$^\circ$ 30'</td>
</tr>
<tr>
<td>QR</td>
<td>90.50</td>
<td>130$^\circ$ 20'</td>
</tr>
<tr>
<td>RS</td>
<td>180.70</td>
<td>30$^\circ$ 40'</td>
</tr>
</tbody>
</table>

compute the chainage of Point of curve, Point of Intersection and Point of Tangency.

OR

2'(a) A parabolic vertical curve is to be set out connecting two uniform grades $\pm 2\%$ and $-1.5\%$. The chainage and reduced level of point of intersection are 850.0m and 70.50m respectively. The rate of change of grade is $0.05\%$ per chain of 20m. Calculate the reduced levels of the highest point, point of beginning and point of end of the curve.

2'(b) Describe the procedure adopted for the calculation of length of transition curves.

2'(c) Differentiate between compound curve and reverse curve.

3 (a) The observations closing the horizon at a station are

$A = 24^\circ 22' 18.2''$  weight = 1
$B = 30^\circ 12' 24.4''$  weight = 2
$A + B = 54^\circ 34' 48.6''$  weight = 3
$C = 305^\circ 25' 13.9''$  weight = 2
$B + C = 335^\circ 37' 38.0''$  weight = 3

Find the most probable values of the angles $A$, $B$ and $C$. 

Contd... 3
3(b) The following are the observed values of an angle:
   \(30^\circ 20' 30''\) \(w=2\); \(30^\circ 20' 32''\) \(w=3\); \(30^\circ 20' 35''\) \(w=4\)

Find (i) probable error of single observation of unit weight
(ii) probable error of weighted arithmetic mean
(iii) probable error of observation of weight 3.

4(a) Define the following terms:
Vertical, Declination, Celestial Horizon, Zenith Distance and Azimuth of the heavenly body. Illustrate your answer with sketches.

4(b) Find the LMT of observation at a place from the following data:
LAT of observation = \(16^\text{h} 20^\text{m} 40^\text{s}\)
ET at GMN = \(5^\text{m} 10.75^\text{s}\) additive to apparent time and increasing \(0.32^\text{s}/\text{hr.}\) longitude of the place = \(25^\circ 30'\) W

5(a) A vertical photograph of a flat area having an average elevation of 300m above mean sea level was taken with a camera having a focal length of 20cm. A section line AB, 250m long in the area, measures 8.50cm on the photograph. A tower TB in the area also appears on the photograph. The distance between the images of top and bottom of the tower measures 0.46cm on the photograph. The distance of image of top of the tower is 6.46cm determine the height of the tower.

5(b) Briefly describe the applications of hydrographic survey.

5(c) Briefly describe the various equipments used for taking soundings.