# Question Paper 2013

## Civil Engineering

### *(Paper II)*

### (Civil and Structural)

**1.** (*a*) Write a short note on Night Irrigation. (15)

(*b*) Give a brief account of the drawbacks in Kennedy's theory. (15)

(*c*) For a Highway project, a straight tunnel is to be run between two points P and Q whose co-ordinates are given below:

| | Co-ordinates | |
|---|---|---|
| **Point** | **N** | **E** |
| P | 0 | 0 |
| Q | 4020 | 800 |
| R | 2110 | 1900 |

It is desired to sink a shaft at S, the mid-point of PQ. S is to be fixed from R, the third known point. Calculate

(*i*) The co-ordinates of S

(*ii*) The length of RS

(*iii*) The bearing of RS (15)

(*d*) Find out the time required for 50% consolidation in a soil having thickness of 800 cm and pervious strata at top and bottom. What will be the value of coefficient of consolidation if coefficient of permeability = 0.0000001 cm/sec? (15)

Void ratio = 1.8, $m_v = 0.0003$ cm²/gm

Time factor ($T_v$) = 0.3

$\gamma_w = 1$ gm/cc

**2.** (*a*) Calculate the ultimate bearing capacity per unit area of:

(*i*) A strip footing 1 m wide

(*ii*) A square footing 3m × 3 m

(*iii*) A circular footing of diameter 3 m

Given:

Unit weight of the soil 1.8 t/m³, cohesion = 2t/m² and φ = 20 degree. $N_c = 17.5$, $N_q = 7.5$ and $N_r = 5$.(15)

(*b*) Calculate the discharge through a pipe of dia. 200 mm when the difference of pressure head between two ends of a pipe 500 m apart is 4 m of water. Take the value of f = 0.009 in the formula

$$h_f = \frac{4 \cdot f.L \cdot V^2}{d \cdot 2g} \quad (15)$$

(*c*) Compare and contrast Flexible and Rigid pavements. (15)

(*d*) Discuss the impact of Urbanisation and Industrialisation in water resource (in terms of both quantity and quality). (15)

**3.** (*a*) The annual sinking fund of a machine costing ₹ 50,000 is ₹ 150 and its salvage value is estimated to be ₹ 5,000. Assuming interest rate as 4%, determine the life of the machine. (20)

(*b*) Describe the factors affecting the rate analysis. (10)

(*c*) Write a short note on the classification of bricks. (15)

(*d*) Discuss the constituent parts of paint and their functions. (15)

**4.** (*a*) List the physical tests that are generally used on cement. Describe any three of them. (15)

(*b*) Discuss the relation between water-cement ratio and strength. (15)

(*c*) Design a cantilever beam which projects beyond the fixed end by 3m. The superimposed load on it is 10 kN/m. Use M 20 grade ($\sigma_{cbc}$ = 7 N/mm²) of concrete and Fe 415 steel ($\sigma_{st}$ = 230 N/mm²). Assume moderate exposure conditions. (30)

**5.** A simply supported 18 m effective span RCC rectangular beam of 500 mm × 1500 mm (overall depth) section is reinforced throughout with 21 nos. 25 mm diameter bars in three layers of 7 bars each at clear cover of 37.5 mm on tensile face. The reinforcement on the compression face is 4 – 25 mm + 1 – 20 mm diameter bars in one layer at an effective cover of 50 mm. The clear cover between the different layers on tension face is 25 mm. M 25 grade concrete and Fe 415 grade steel bars are used in the beam throughout. The beam is laterally restrained throughout the span.

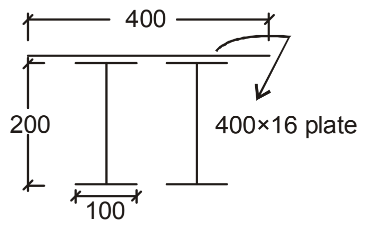
(*a*) What shall be the superimposed uniformaly distributed load *w*, that the beam can carry at working conditions? (15)

(*b*) Design the shear reinforcement at support if design shear strength of concrete $\tau_c$ is given as follows for different values of $p = 100\,A_s/bd$. (15)

| p | 1.25 | 1.5 | 1.75 |
|---|---|---|---|
| $\tau_c$ (MPa) | 0.70 | 0.74 | 0.78 |

(*c*) Calculate the moment of resistance of the compound steel section shown in the figure. The compound section consists of two steel sections ISMB 200 @ 25.4 kg/m ($I_{XX} = 2235.4\ cm^4$, $A_{XX} = 32.33\ cm^2$) with a single cover plate, 40 cm wide and 16 mm thick connected to the top flange.

Assume bending stress = 150 MPa. (15)




Dimensions in mm

(*d*) A mild steel T section has the following cross-sectional dimensions:

Total depth = 200 mm

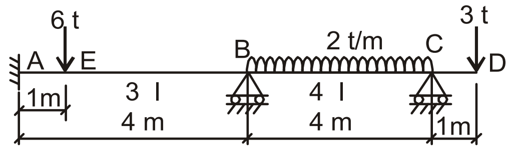
Width of flange = 120 mm

Thickness of flange = 20 mm

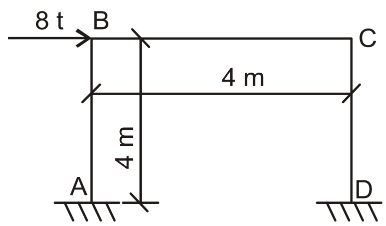
Thickness of web = 20 mm

If the yield stress, $\sigma_y$ = 250 MPa, determine the plastic moment capacity of the section. Also calculate the shape factor for the section. (15)

**6.** (*a*) Analyze the beam shown in figure and determine the end moments. Plot the B.M.D. on the tension side. (30)




(*b*) Analyze the portal frame shown in the figure. Also sketch the deflected shape of the frame. The end A is fixed and the end D is hinged. Also, the value of EI is constant throughout. (30)




**Essential Tables of IS : 456 : 2000 Code of Practice**

26.2.1.1 Design bond stress in limit state method for plain bars in tension shall be as below:

| Grade of concrete | M 20 | M 25 | M 30 | M 35 | M 40 and above |
|---|---|---|---|---|---|
| Design bond tress, $\tau_{db}$, N/mm$^2$ | 1.2 | 1.4 | 1.5 | 1.7 | 1.9 |

**Table 16 : Nominal Cover to Meet Durability Requirements (Clasue 26.4.2)**

| Exposure | Nominal Concrete Cover in mm Not Less Than |
|---|---|
| Mild | 20 |
| Moderate | 30 |
| Severe | 45 |
| Very severe | 50 |
| Extreme | 75 |

***Notes :***

1. For main reinforcement up to 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by ${}^{+10}_{0}$ mm.
3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is M 35 and above.

**Table 19 : Design Shear Strength of Concrete, $\tau_c$, N/mm²**

(Clauses 40.2.1, 40.2.2, 40.3, 40.4, 40.5.3, 41.3.2, 41.3.3 and 41.4.3)

| $100\frac{A_s}{bd}$ | Concrete Grade | | | | | |
|---|---|---|---|---|---|---|
| | M 15 | M 20 | M 25 | M 30 | M 35 | M 40 and above |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| ≤ 0.15 | 0.28 | 0.28 | 0.29 | 0.29 | 0.29 | 0.30 |
| 0.25 | 0.35 | 0.36 | 0.36 | 0.37 | 0.37 | 0.38 |
| 0.50 | 0.46 | 0.48 | 0.49 | 0.50 | 0.50 | 0.51 |
| 0.75 | 0.54 | 0.56 | 0.57 | 0.59 | 0.59 | 0.60 |
| 1.00 | 0.60 | 0.62 | 0.64 | 0.66 | 0.67 | 0.68 |
| 1.25 | 0.64 | 0.67 | 0.70 | 0.71 | 0.75 | 0.76 |
| 1.50 | 0.68 | 0.72 | 0.74 | 0.76 | 0.78 | 0.79 |
| 1.75 | 0.71 | 0.75 | 0.78 | 0.80 | 0.82 | 0.84 |
| 2.00 | 0.71 | 0.79 | 0.82 | 0.84 | 0.86 | 0.88 |
| 2.25 | 0.71 | 0.811 | 0.85 | 0.88 | 0.90 | 0.92 |
| 2.50 | 0.71 | 0.82 | 0.88 | 0.91 | 0.93 | 0.95 |
| 2.75 | 0.71 | 0.82 | 0.90 | 0.94 | 0.96 | 0.98 |
| 3.00 and above | 0.71 | 0.82 | 0.92 | 0.96 | 0.99 | 1.01 |

***Note:*** The term $A_s$ is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

**Table 20 : Maximum Shear Stress, $\tau_{cmax}$, N/mm²**

(Clauses 40.2.3, 40.2.3.1, 40.5.1 and 41.3.1)

| Concrete Grade | M 20 | M 25 | M 30 | M 35 | M 40 and above |
|---|---|---|---|---|---|
| $\tau_{c\,max}$, N/mm² | 2.8 | 3.1 | 3.5 | 3.7 | 4.0 |

**Table 21 : Permissible Stresses in Concrete**

(*Clauses B-1.3, B-2.1, B-2.1.2, B-2.3 and B-4.2*) All values in N/mm²

| Grade of Concrete | Permissible Stress in Compression | | Permissible Stress in Bond (Average) for plain Bars in Tension |
|---|---|---|---|
| | Bending | Direct | |
| (1) | (2) | (3) | (4) |
| | $\sigma_{abc}$ | $\sigma_{cc}$ | $\tau_{bd}$ |
| M 10 | 3.0 | 2.5 | – |
| M 15 | 5.0 | 4.0 | 0.6 |
| M 20 | 7.0 | 5.0 | 0.8 |
| M 25 | 8.5 | 6.0 | 0.9 |
| M 30 | 10.0 | 8.0 | 1.0 |
| M 30 | 11.5 | 9.0 | 1.1 |
| M 35 | 13.5 | 10.0 | 1.2 |
| M 45 | 14.5 | 11.0 | 1.3 |
| M 50 | 16.0 | 12.0 | 1.4 |

***Notes:***

1. The values of permissible shear stress in concrete are given in Table 23.
2. The bond stress given in col. 4 shall be increased by 25 percent for bars in compression.

**Table 23 : Permissible Shear Stress in Concrete**

(Clauses B-2.1, B-2.3, B-4.2, B-5.2.1, B-5.2.2, B-5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B-6.4.3 and Table 21)

| $100\frac{A_s}{bd}$ | Permissible Shear Stress in Concrete, $\tau_c$, N/mm² Grade of concrete | | | | | |
|---|---|---|---|---|---|---|
| | M 15 | M 20 | M 25 | M 30 | M 35 | M 40 and above |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| ≤ 0.15 | 0.18 | 0.18 | 0.19 | 0.20 | 0.20 | 0.20 |
| 0.25 | 0.22 | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 |
| 0.50 | 0.29 | 0.30 | 0.31 | 0.31 | 0.31 | 0.32 |
| 0.75 | 0.34 | 0.35 | 0.36 | 0.37 | 0.37 | 0.38 |
| 1.00 | 0.37 | 0.39 | 0.40 | 0.41 | 0.42 | 0.42 |
| 1.25 | 0.40 | 0.42 | 0.44 | 0.45 | 0.45 | 0.46 |
| 1.50 | 0.42 | 0.45 | 0.46 | 0.48 | 0.49 | 0.49 |
| 1.75 | 0.44 | 0.47 | 0.49 | 0.50 | 0.52 | 0.55 |
| 2.00 | 0.44 | 0.49 | 0.51 | 0.53 | 0.54 | 0.55 |
| 2.25 | 0.44 | 0.51 | 0.53 | 0.55 | 0.56 | 0.57 |
| 2.50 | 0.44 | 0.51 | 0.55 | 0.57 | 0.58 | 0.60 |
| 2.75 | 0.44 | 0.51 | 0.56 | 0.58 | 0.60 | 0.62 |
| 3.00 and above | 0.44 | 0.51 | 0.57 | 0.60 | 0.62 | 0.63 |

***Note:*** $A_s$ is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

**Table 24 : Maximum Shear Stress, $\tau_{cmax}$, N/mm²**

(Clauses B-5.2.3, B-5.2.3.1, B-5.5.1 and B-6.3.1)

| Concrete Grade | M 15 | M 20 | M 25 | M 30 | M 35 | M 40 and above |
|---|---|---|---|---|---|---|
| $\tau_{c\,max}$, N/mm² | 1.6 | 1.8 | 1.9 | 2.2 | 2.3 | 2.5 |