GATE-1999

CIVIL ENGINEERING

Duration : Three hours | **Maximum marks : 150**

SECTION A. (75 Marks)

1. This question consists of 35 (Thirty five) multiple choice type sub-questions, each carrying one mark. The answer to the multiple choice questions MUST be written only in the boxes corresponding to the question by writing A, B, C, or D in the answer book. $(35 \times 1 = 35)$

1.1. Limit of the function $\lim_{n \to \infty} \frac{n}{\sqrt{n^2 + n}}$ is

(a) $\frac{1}{2}$ (b) 0
(c) ∞ (d) 1

1.2. The function $f(x) = e^x$ is
(a) Even
(b) Odd
(c) Neither even nor odd
(d) None of the above

1.3. If A is any $n \times n$ matrix and k is a scalar, $|kA| = \alpha |A|$, where α is
(a) kn (b) n^k
(c) k^n (d) k/n

1.4. The infinite series $\sum_{n=1}^{\infty} \frac{(n!)^2}{(2n)!}$
(a) Converges (b) Diverges
(c) Is unstable (d) Oscillates

1.5. Number of inflection points for the curve $y = x + 2x^4$ is
(a) 3 (b) 1
(c) n (d) $(n + 1)^2$

1.6. Number of terms in the expansion of general determinant of order n is
(a) n^2 (b) n !
(c) n (d) $(n + 1)^2$

1.7. Two perpendicular axes x and y of a section are called principal axes when
(a) Moments of inertia about the axes are equal $(I_x = I_y)$
(b) Product moment of inertia (I_{xy}) is zero
(c) Product moments of inertia $(I_x \times I_y)$ is zero
(d) Moment of inertia about one of the axes is greater than the other

1.8. In section, shear centre is a point through which, if the resultant load passes, the section will not be subjected to any
(a) Bending (b) Tension
(c) Compression (d) Torsion

1.9. For a fixed beam with span L, having plastic moment capacity of M_p, the ultimate central concentrated load will be
(a) $\frac{4M_p}{L}$ (b) $\frac{M_p}{8L}$
(c) $\frac{6M_p}{L}$ (d) $\frac{8M_p}{L}$

1.10. In reinforced concrete, pedestal is defined as compression member, whose effective length does not exceed its dimension by
(a) 12 times (b) 3 times
(c) 16 times (d) 8 times

1.11. The minimum area of tension reinforcement in a beam shall be greater than
(a) $\frac{0.85\ bd}{f_y}$ (b) $\frac{0.87\ f_y}{bd}$
(c) 0.04 bd (d) $\frac{0.4\ bd}{y}$

1.12. The characteristic strength of concrete is defined as that compressive strength below which not more than
(a) 10% of results fall (b) 5% of results fall
(c) 2% of results fall (d) None of these

1.13. Maximum strain at the level of compression steel for a rectangular section having effective cover to compression steel as d′ and neutral axis depth from compression face x_u is
(a) $0.0035\left(1 - \frac{d'}{x_u}\right)$ (b) $0.002\left(1 - \frac{d'}{x_u}\right)$
(c) $0.0035\left(1 - \frac{x_u}{d'}\right)$ (d) $0.002\left(1 - \frac{x_u}{d'}\right)$

1.14. A steel beam supporting loads from the floor slab as well as from wall is termed as

(a) Stringer beam (b) Lintel beam

(c) Spandrel beam (d) Header beam

1.15. The problem of lateral buckling can arise only in those steel beams which have

(a) moment of inertial about the bending axis larger than the other

(b) moment of inertial about the bending axis smaller than the other

(c) fully supported compression flange

(d) none of these

1.16. The values of liquid limit and plasticity index for soils having common geological origin in a restricted locality usually define

(a) a zone above A - line

(b) a staright line parallel to A - line

(c) a straight line perpendicular to A - line

(d) points may be anywhere in the plasticity chart

1.17. The toughness index of clayey soils is given by

(a) Plasticity index/Flow index

(b) Liquid limit/Plastic limit

(c) Liquidity index/Plastic limit

(d) Plastic limit/Liquidity index

1.18. Principle involved in the relationship between submerged unit weight and saturated weight of a soil is based on

(a) Equilibrium of floating bodies

(b) Archimedes' principle

(c) Stokes' law

(d) Darcy's law

1.19. For an anisotropic soil, permeabilities in x and y directions are k_x and k_y respectively in a two dimensional flow. The effective permeability k_{eff} for the soil is given by

(a) $k_x + k_y$ (b) $\frac{k_x}{k_y}$

(c) $(k_x^2 + k_y^2)^{½}$ (d) $(k_x k_y)^{½}$

1.20. Cohesion in soil

(a) decreases active pressure and increases passive resistance

(b) decreases both active pressure and passive resistance

(c) increases the active pressure and decreases the passive resistance

(d) increases both active pressure and passive resistance

1.21. Consolidation in soils

(a) is a function fo the effective stress

(b) does not depend on the present stress

(c) is a function of the pore water pressure

(d) is a function of the total stress

1.22. The sequent depth ratio of a hydraulic jump in a rectangular horizontal channel is 10.30. The Froude Number at the beginning of the jump is

(a) 5.64 (b) 7.63

(c) 8.05 (d) 13.61

1.23. In an iceberg, 15% of the volume projects above the sea surface. If the specific weight of sea water is 10.5 kN/m³, the specific weight of iceberg in kN/m³ is

(a) 12.52 (b) 9.81

(c) 8.93 (d) 7.83

1.24. The ordinate of the Instantaneous Unit Hydrograph (IUH) of a catchment at any time t, is

(a) the slope of the 1-hour unit hydrograph at that time

(b) the slope of the direct runoff unit hydrograph at that time

(c) difference in the slope of the S - curve and 1 - hour unit hydrograph

(d) the slope of the S - curve with effective rainfall intensity of 1cm/hr

1.25. An isochrone is a line on the basin map

(a) joining raingauge stations having equal rainfall duration

(b) joining points having equal rainfall depth in a given time interval

(c) joining points having equal time of travel of surface runoff to the catchment outlet

(d) joining ponts which are at equal distance from the catchment outlet.

1.26. In a steady radial flow into an intake, the velocity is found to vary as $(1/r^2)$, where r is the radial distance. The acceleration of the flow is proportional to

(a) $\frac{1}{r^5}$ (b) $\frac{1}{r^3}$

(c) $\frac{1}{r^4}$ (d) $\frac{1}{r}$

1.27. A soil formation through which only seepage is possible, being partly permeable and capable of giving insignificant yield, is classified as

(a) Aquifer (b) Aquitard

(c) Aquifuge (d) Aquiclude

1.28. Temporary hardness in water is caused by the presence of

(a) Bicarbonates of Ca and Mg

(b) Sulphates of Ca and Mg

(c) Chlorides of Ca and Mg

(d) Nitrates of Ca and Mg

1.29. Blue baby disease (methaemoglobinemia) in children is caused by the presence of excess

(a) Chlorides (b) Nitrates

(c) Fluoride (d) Lead

1.30. Standard 5-day BOD of a waster water sample is nearly x% of the ultimate BOD, where x is

(a) 48 (b) 58

(c) 68 (d) 78

1.31. The minimum dissolved oxygen content (ppm) in a river necessary for the survival of aquatic life is

(a) 0 (b) 2

(c) 4 (d) 8

1.32. Chlorine is sometimes used in sewage treatment

(a) to avoid flocculation

(b) to increase biological activity of bacteria

(c) to avoid bulking of activated sludge

(d) to help in grease separation

1.33. The total length (in km) of the existing National Highways in India is in the range of

(a) 15,000 to 25,000 (b) 25,000 to 35,000

(c) 35,000 to 45,000 (d) 45,000 to 55,000

1.34. The relationship between the length (l) and radius (r) of an ideal transition curve is given by

(a) $l \propto r$ (b) $l \propto r^2$

(c) $l \propto \frac{1}{r}$ (d) $l \propto \frac{1}{r^2}$

1.35. Rapid curing cutback bitumen is produced by blending bitumen with

(a) Kerosene

(b) Benzene

(c) Diesel

(d) Petrol

2. This question consists of 20 (Twenty) multiple choice type sub-questions, each carrying TWO marks. The answers to the multiple choice questions MUST be written only in the boxes corresponding to the question number writing A, B, C or D in the answer book.

(20 × 2 = 40)

2.1. If c is a constant, solution of the equation $\frac{dy}{dx} = 1 + y^2$ is

(a) $y = \sin(x + c)$ (b) $y = \cos(x + c)$

(c) $y = \tan(x + c)$ (d) $y = e^x + c$

2.2. The equation $\begin{vmatrix} 2 & 1 & 1 \\ 1 & 1 & -1 \\ y & x^2 & x \end{vmatrix} = 0$, represents a parabola passing through the points

(a) (0, 1), (0, 2), (0, –1) (b) (0, 0), (–1, 1), (1, 2)

(c) (1, 1), (0, 0), (2, 2) (d) (1, 2), (2, 1), (0, 0)

2.3. The Laplace transform of the function

$$f(t) = k, \; 0 < t < c$$
$$= 0, \; c < t < \infty, \text{ is}$$

(a) $\left(\frac{k}{s}\right) e^{-sc}$ (b) $\left(\frac{k}{s}\right) e^{sc}$

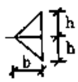
(c) $k\,e^{-sc}$ (d) $\left(\frac{k}{s}\right)(1 - e^{-sc})$

2.4. Value of the function $\lim_{x \to a} (x - a)^{(x-a)}$ is

(a) 1 (b) 0

(c) ∞ (d) a

2.5. The shape factor of the section shown in the figure 1 is



(a) 1.5

(b) 1.12

(c) 2

(d) 1.7

2.6. The slope of the elastic curve at the free end of a cantilever beam of span L, and with flexural rigidity EI, subjected to uniformly distributed load of intensity w is

(a) $\frac{wL^3}{6EI}$ (b) $\frac{wL^3}{3EI}$

(c) $\frac{wL^4}{8EI}$ (d) $\frac{wL^3}{2EI}$

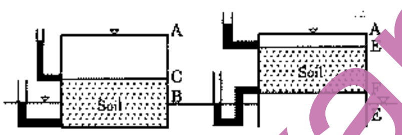
2.7. If an element of a stressed body is in a state of pure shear with a magnitude of 80N/mm², the magnitude of maximum principal stress at that location is

(a) 80 N/mm²
(b) 113.14 N/mm²
(c) 120 N/mm²
(d) 56.57 N/mm²

2.8. Two steel plates each of width 150 mm and thickness 10 mm are connected with three 20 mm diameter rivets placed in a zig - zag pattern. The pitch of the rivets is 75 mm and gauge is 60 mm. If the allowable tensile stress is 150 MPs, the maximum tensile force that the joint can withstand is

(a) 195.66 kN
(b) 195.00 kN
(c) 192.75 kN
(d) 225.00 kN

2.9. The two tubes shown in Fig.2 may be considered to be permeameters. Dimensions of the smaple in Fig. (i) and (ii) are alike, and the elevations of head water and tail water are the same for both the figures. A, B, ... etc. indicate points and AB, AE, ...etc. indicated heads. Head loss through these samples are



(a) (i) BD, (ii) FB
(b) (i) AC, (ii) AE
(c) (i) AD, (ii) AF
(d) (i) AB, (ii) AB

2.10. A river 5 m deep consists of a sand bed with saturatd unit weight of 20 kN/m³. v_w = 9.81 kN/m³. The effective vertical stress at 5m from the top of sand bed is

(a) 41 kN/m²
(b) 51 kN/m²
(c) 55 kN/m²
(d) 53 kN/m²

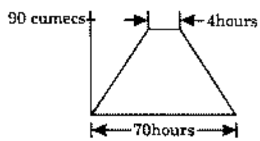
2.11. A soil sample in its natural state has mass of 2.290 kg and a volume of 1.15 × 10⁻³ m³. After being oven dried, the mass of the sample is 2.035 kg. G_s for soil is 2.68. The void ratio of the natural soil is

(a) 0.40
(b) 0.45
(c) 0.55
(d) 0.53

2.12. Triaxial compression test of three soil specimens exhibited the patterns of failure as shown in the figure. Failure modes of the samples respectively are

(a) (i) brittle, (ii) semi-plastic, (iii) plastic
(b) (i) semi-plastic, (ii) brittle, (iii) plastic
(c) (i) plastic, (ii) brittle, (iii) semi-plastic
(d) (i) brittle, (ii) plastic, (iii) semi-plastic

2.13. A direct runoff hydrograph due to an isolated storm with an effective rainfall of 2 cm was trapezoidal in shape as shown in the figure. The hydrograph corresponds to a catchment area (in sq. km.) of



(a) 790.2
(b) 599.4
(c) 689.5
(d) 435.3

2.14. The number of revolutions of a current meter in 50 seconds were found to be 12 and 30 corresponding to the velocities of 0.25 and 0.46 m/s respectively. What velocity (in m/s) would be indicated by 50 revolutions of that current meter in one minute?

(a) 0.42
(b) 0.50
(c) 0.60
(d) 0.73

2.15. In a river, discharge is 173 mp³/s; water surface slope is 1 in 6000; and stage at the gauge station is 10.0 m. If during a flood, the stage at the gauge station is same and the water surfae slope is 1 in 2000, the flood discharge in m³/s, is approximately

(a) 371
(b) 100
(c) 519
(d) 300

2.16. A hydraulic turbine has a discharge of 5 m³/s, when opertating under a head of 20 m with a speed of 500 rpm. If it is to operate under a head of 15 m, for the same discharge, the rotational speed in rpm will approximately be

(a) 433
(b) 403
(c) 627
(d) 388

2.17. Two samples of water A and B have pH values of 4.4 and 6.4 respectively. How many times more acidic sample A is than sample B?

(*a*) 0

(*b*) 15

(*c*) 100

(*d*) 200

2.18. In a BOD test, 5 ml of waste is added to 295 ml of aerated pure water. Initial dissolved oxygen (D.O.) content of the diluted sample is 7.8 mg/l. After 5 days of incubation at 20°C, the D.O. content of the sample is reduced to 4.4 mg/l. The BOD of the waste water is

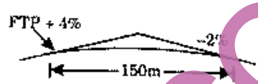
(*a*) 196 mg/l

(*b*) 200 mg/l

(*c*) 204 mg/l

(*d*) 208 mg/l

2.19. A parabolic curve is used to connect a 4% upgrade with 2% downgrade as shown in the figure. The highest point on the summit is at a distance of (measured horizontally from the first tangent point-FTP)



(*a*) 50 m

(*b*) 60 m

(*c*) 75 m

(*d*) 100 m

2.20. A two lane single carriage-way is to be designed for a design life period of 15 years. Total two-way traffic intensity in the year of completion of construction is expected to be 2000 commercial vehicles per day. Vehicle damage factor = 3.0, Lane distribution factor = 0.75. Assuming an annual rate of traffic growth as 7.5%, the design traffic expressed as cumulative number of standard axles, is

(*a*) 42.9×16^6

(*b*) 22.6×16^6

(*c*) 10.1×16^6

(*d*) 5.3×16^6

SECTION B. (75 Marks)

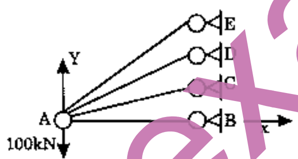
This section cosists of TWENTY questions of FIVE marks each. ANY FIFTEEN out of them have to be answered. Answers to each question must be started on a fresh page. If more number of questions are attempted, score off the answer not to be evalutated, else only the first fifteen unscored answers will be considered strictly. (15 × 5 = 75)

3. Show that the matrix [A] is orthogonal and determine its eigen values.

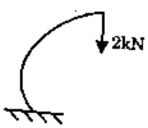
$$[A] = \begin{bmatrix} \frac{2}{3} & \frac{1}{3} & \frac{2}{3} \\ -\frac{2}{3} & \frac{2}{3} & \frac{1}{3} \\ \frac{1}{3} & \frac{2}{3} & -\frac{2}{3} \end{bmatrix}$$

4. Find the maximum and minimum values of the function $f(x) = \sin x + \cos 2x$ over the range $0 < x < 2\pi$.

5. Figure below shows the members of a truss structure, subjected to a vertical load of 100 kN as shown. Calculate the displacements of node A using Matrix Method. The corss sectional area of each member is $0.001\ m^2$ and modulus of elasticity of the material (E) is $2.0 \times 10^8\ kN/m^2$. Lenghts AB = 3.0 m, AC = 3.464 m; AD = 4.243 m; AE = 6.0 m. Angles BAC = 30°; BAD = 45°; BAE = 60°.



6. Figure below shows a cantilever member bent in the form of a quadrant of a circle with a radius of 1.0 m up to the centre of the cross section. The member is subjected a load of 2 kN as shown. The member is having circular cross section with a diameter of 50 mm. Modulus of elasticity(E) of the material is 2.0×10^5 MPa. Calculate the horizontal displacement of the tip.



7. Two wheels, placed at a distance of 2.5 m apart, with a load of 200 kN on each of them are moving on a simply supported girder (I-section) of span 6.0m. The top and bottom flanges of the I - section are of 200 × 20 mm and the size of web plate is 800 × 6 mm. If the allowable and average shear stresses are 110 MPa, 165 MPa and 100 MPa respectively, check the adequacy of the section against bending and shear stresses (self-weight of the girder, may be neglected.)

8. The width and depth of a reinforced concrete beam is 250 mm and 400 mm respectively. The beam is provided with 4 Number of 20 mm tor bars in the tension zone. The beam is subjected to a shear force of 150 kN (Factored). Check the requirement of shear reinforcement and provide if required. Grade of concrete is M 20 and that of steel is Fe 415. The shear strength of concrete for different percentages of tensile steel are as below.

[$V_{us} = 0.87\ f_y A_{sv}\ d/S_v$ and $(A_{sv}/S_v) \geq 0.4b/f_y$ with the terms having usual meaning]

% of Steel	Shear strength of concrete (τ_c) in N/mm^2k
1.0	0.62
1.25	0.67
1.50	0.72

9. A beam with a rectangular cross section of size 250 mm wide and 350 mm deep is prestressed by a force of 400 kN using 8 number 7 mm ϕ steel cables located at an eccentricity of 75 mm. Determine the loss of prestress due to creep of concrete. Grade of concrete is M40; Coefficient of creep is 2; Stress at transfer is 80%, Modulus of elasticity of steel (E_s) is 2.0×10^5 MPa.

10. A layer of saturated clay 5 m thick is overlain by sand 4.0 m deep. The water table is 3 m below the top surface. The saturated unit weights of clay and sand are 18 kNm^3 and 20 kN/m^3 respectively. Above the water table, the unit weight of sand is 17 kN/m^3 Calculate the effective pressures on a horizontal plane at a depth of 9 m below the ground surface. What will be the increase in the effective pressure at 9 m if the soil gets saturated by capillary, up to height of 1 m above the water table? $\gamma_w = 9.81\ kN/m^3$.

11. (a) A building is constructed on the ground surface beneath which, there is a 2 m thick saturated clay layer sandwiched between two highly previous layers. The building starts settling with time. If the average coefficient of consolidation of clay is 2.5×10^{-4} cm²/s, in how many days will the building reach half of its final settlement ? $T_{50} = 0.197$.

(b) A 1.25 m layer of soil (n = 0.35, G = 2.65) is subjected to an upward seepage head of 1.85 m. What depth of coarse sand would be required above the existing soil to provide a factor of safety of 2 against piping ? Assume that coarse sand has the same porosity and specific gravity as the soil, and that there is negligible head loss is sand, $\gamma_w = 9.81$ kN/m³.

12. (a) Compute the intensity of passive earth pressure at a depth of 8 m in a cohesionless sand with an angle of internal friction of 30° when water rises to the ground level. Saturated unit weight of sand is 21 kN/m³; $\gamma_w = 9.81$ kN/m³.

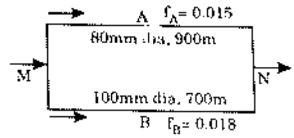
(b) A vertical excavation was made in a clay deposit having unit weight of 22 kN/m³. it caved in after the digging reached 4 m depth. Assuming $\phi = 0$, calculate the magnitude of cohesion.

13. A footing 2.25 m square is located at a depth of 1.5m in a sand of unit weight 18 kN/m³. The shear strength parameters are $c' = 0$ and $\phi' = 36°$. Calculate the safe load carried by the footing against complete shear failure. Factor of safety against shear failure is 3. Use Terzaghi's analysis.

$$N_c = 65.4,\ N_q = 49.4,\ N_\gamma = 54.0.$$

14. A vertical water jet is issuing upwards from a nozzle with a velocity of 10 m/s. The nozzle exit diameter is 60 mm. A flat horizontal plate with a total of 250 N is supported by the impact of the jet. Determine the equilibrium height of the plate above the nozzle exit. Neglect all losses and take unit weight of water as 1000 kg/m³.

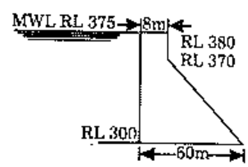
15. Two pipes A and B are connected in parallel between two points M and N as shown in the figure 8. Pipe A is of 80 mm diameter, 900 m long and its friction factor is 0.015. Pipe B is of 100 mm diameter, 700 m long and its friction is 0.018. A total discharge of 0.030 m³/s is entering the parallel pipes throught the division at M. Calculate the discharge in the two pipes A and B.



16. The inflow hydrograph for a river reach is given below. Route this flood to a downstream point of the river using Muskingham method of flood routing. Assume that the initial flood discharge at the downstream point is equal to 100 m³/s. For the river reach, Muskingham coefficient (K) = 18 hours and weighing factor (x) = 0.3. Use a routing period of 12 hours.

Time (hours)	0	12	24	36	48
Inflow (m³/s)	100	750	780	470	270

17. Fig. 9 shows the section (non - overflow portion) of a straight gravity dam built with concrete. Considering water pressure and uplift pressure, and neglecting the other external forces acting on the dam, check whether the resultant passes through the middle third of the base for the reservoir full condition. In the figure, RL stands for Reduced Level in metres and MWL stands for Maximum Water Level. (Unit weight of water is 1000 kg/m³ and that of concrete is 2400 kg/m³)



18. A rectangular sedimentation tank is designed for a surface overflow rate (surface loading) of 12,000 litre/hour/m². What percentage of the suspended particles of diameter (a) 0.003 mm and (b) 12 mm will be removed in the tank. Appropriate expressions for settling velocity (V_s, mm/s) may be selected from the formulate given below.

Kinematic viscosity (nu) of water = 0.897 mm²/s.

Specific gravity of particles = 2.65.

Stroke's : $V_s = \dfrac{g}{18}\dfrac{d^2}{v}(s-1)$

Hazen's: $V_s = \left[\dfrac{4}{3}\dfrac{gd}{C_p}(s-1)\right]^{0.5}$ $C_D = \dfrac{24}{Re} + \dfrac{3}{\sqrt{Re}} + 034$

where Re is the Reynolds number.

Newton's : $V_s = [3.33\ gd\ (s-1)]^{0.5}$

19. Design a septic tank for a colony of 200 people. The colony is supplied water at a rate of 135 litres/person/day. Assume a detention period of 24 hours and 75% of the water becomes waste water. The tank is cleaned once in a year. The rate of deposition of sludge is 40 litres/person/years. Depth of tank is to be kept as 2.0 m. Provide a free board of 0.3 m. Length to breath ratio may be kept as 3 : 1.

20. The driver of a car, applied brakes and barely avoided hitting an obstacle on the road. The vehicle left skid marks of tyres on the road for a length of 25 m. There was a speed limit restriction of 55 kmph for that road. Was the driver of the car violating the limit if he was travelling on

(*a*) level road

(*b*) a 4% downgrade.

Also compute the average decleration rate developed (in the process of braking) on the level road. Assume the longitudinal coefficient of friction between the tyres and the road surface as 0.5.

21. On a two-lane two-way highway, a car A was following a truck B and both were travelling at a speed of 40 kmph. While looking for an opprotunity to overtake the truck, the driver of the car A saw another car C coming from the opposite direction. At that moment, the distance between A and C was 450 m. After an initial hesitation period of two seconds, the driver of car A started the overtaking operation. The distance between A and B at that instance was 30 m. A overtook B by accelerating at an uniform rate of 1.20 m/sec². When the overtaking operation was completed, there was a distance of 25 m between B and A. Determine the distance between the two cars (A and C) at the instance of completion of the overtaking action. The distance between different vehicles given are as measured from the front the bumper of one vehicle to the front bumper of another vehicle. Design speed of the highway is 80 kmph.

22. A ortion of a highway is to be constructed with 25 cm thick plain cement concrete slab. The design traffic intensity is estimated to be 3000 commercial vehicles per day. Using the data given below, check the adequacy of the slab thickness as per IRC : 58 – 1988 procedure.

Dimensions of slab = 4.5 m × 3.5 m

Design wheel load, P = 5100kg

Design tyre pressure, p = 7.2 kg/cm²

Foundation strength, k = 6 kg/cm³

Flexural strength of concrete = 40 kg/cm²

Elastic modulus value of concrete,

$E = 3.0 \times 10^5$ kg/cm³

Poisson's ratio of concrete, $\mu = 0.15$

Coefficient of thermal expansion of concrete,

$\alpha = 10 \times 10^{-6}/°C$

Maximum value of temperature differential in the slab, $\Delta t = 15°C$

Radius of relative stiffness, l = 90.3 cm

Radius of tyre contact area, a = 15 cm

Radius of equivalent distribution of pressure,

b = 14.5 cm

Use the following expressions wherever necessary:

Edge stress (due to load) in kg/cm²

$$= 0.526 \frac{P}{h^2} (0.54\,\mu) \left(4 \log_{10} \frac{l}{b} + \log_{10} b - 0.4048\right)$$

Corner stress (due to load) in kg/cm²

$$= \frac{3P}{h^2}\left[1 - \left(\frac{a\sqrt{2}}{l}\right)^{1.2}\right]$$

Edge stress (due to temperature differential) in kg/cm² $= Ea \frac{\Delta t}{2} C$

Bradbury coefficients (C) may be taken as 0.72 and 0.43.

ANSWERS

1.1. (*d*)	1.2. (*b*)	1.3. (*a*)	1.4. (*a*)	1.5. (*a*)	1.6. (*c*)	1.7. (*c*)	1.8. (*d*)	1.9. (*d*)	1.10. (*b*)
1.11. (*a*)	1.12. (*b*)	1.13. (*a*)	1.14. (*a*)	1.15. (*b*)	1.16. (*b*)	1.17. (*a*)	1.18. (*b*)	1.19. (*d*)	1.20. (*d*)
1.21. (*c*)	1.22. (*b*)	1.23. (*c*)	1.24. (*d*)	1.25. (*c*)	1.26. (*a*)	1.27. (*b*)	1.28. (*a*)	1.29. (*b*)	1.30. (*c*)
1.31. (*c*)	1.32. (*c*)	1.33. (*b*)	1.34. (*c*)	1.35. (*d*)					
2.1. (*c*)	2.2. (*b*)	2.3. (*d*)	2.4. (*b*)	2.5. (*c*)	2.6. (*a*)	2.7. (*a*)	2.8. (*c*)	2.9. (*d*)	2.10. (*b*)
2.11. (*d*)	2.12. (*c*)	2.13. (*b*)	2.14. (*c*)	2.15. (*d*)	2.16. (*a*)	2.17. (*c*)	2.18. (*b*)	2.19. (*d*)	2.20. (*a*)