Time: 3 Hours **Total Marks: 80**

N.B: (1) Question No. 1 is compulsory.
(2) Attempt any three questions out of remaining five questions.
(3) Assume suitable data wherever required and state it clearly.
(4) Illustrate your answers with neat component sketches wherever required.
(5) IS 1343:1980, IS 3370 and relevant codes require for design are permitted.

1. Design a post tensioned pre-stressed concrete slab bridge deck for a national highway crossing to suit the following data: **32**

Clear span = 10 m
Live load = IRC class AA traced vehicle
width of bearing = 400 mm
Clear width of roadway = 7.5m
footpath 1m on either side
kerbs = 500 mm wide
thickness of wearing coat = 80mm
type of structure = class 1 type

Materials M40 grade concrete and 6 mm diameter high tensile wires with an ultimate tensile strength of 1200 N/mm^2 housed in cables with 12 wires and anchored by freyssinet anchorages of 150 mm diameter. For supplementary reinforcement, adopt Fe 415 grade HYSD bars. Compressive stress at transfer, fci =35 N/mm^2, loss ratio =0.8. The permissible compressive stresses in concrete at transfer and working loads are f_{ct} = 15 N/mm^2, f_{cw} = 12 N/mm2, $f_{tt} = f_{tw} = 0$

OR

Design a post tensioned roof girder as a class I structure using following data
Effective span = 45 m
Live load = 9 kN/m
Dead load (excluding self-weight) = 2 kN/m
Load Factors (For dead load = 1.4, for live load 1.6) Cube strength of concrete, fcu = 50 N/mm^2
Cube strength at transfer fci = 35 N/mm^2
Tensile strength of concrete ft = 1.7 N/mm^2
Modulus of elasticity of concrete Es = 34 kN/mm^2, Loss ratio = 0.85
8 mm diameter high tensile wires having a characteristic tensile strength fpu = 1200 N/mm^2 are available for use.
The modulus of elasticity of high tensile wires is 200 kN/mm^2.

2. **a)** What is concordant cable profile? Explain its advantages **4**

b) A reinforced concrete dome of 30 m base diameter and a rise of 3. 5 m is to be designed for a pre-stressed concrete cylindrical tank. The shell dome to be provided with a pre-stressed concrete ring beam. **12**
Design the dome and thering beam for a superimposed load of 1.5 kN/m^2. The 5 mm diameter high tensile wires initially stressed to 1000 N/mm^2 are available for pre-stressing the ring beam. The loss ratio is 0.80 and permissible compressive stress in concrete at transfer is 14 N/mm^2. Assume radius of the shell dome = 32 m, thickness of shell = 75 mm, semi central angle $\alpha = 28° 4'$.

3. **a)** A prestressed beam with rectangular cross section with a width of 150 mm and depth of 300 mm is continuous over two spans AB = BC = 10m. The cable with zero eccentricity at the ends and an eccentricity of 50mm towards the top fibers of the beam over the central support, carries an effective force of 550kN. **12**

(i) Calculate the secondary moments developed at B.

(ii) If the beam supports the concentrated load of 25 kN each at mid points of the span, evaluate the resultant stresses at the central support section B.

Also locate the position of pressure line at the section.

b) Explain stages of prestressing **4**

4. **a)** Write a short note on design of prestressed concrete liquid storage tank. **6**

b) A composite beam of rectangular section is made up of a pre-tensioned inverted T-beam having a slab thickness and width of 150 and 1050mm respectively The rib size is 150 mm by 800 mm The cast in situ has thickness and width of 1000mm with the modulus of elasticity of 30 kN/mm^2 If the differential shrinkage is 100×10^{-6} units, estimate the shrinkage stresses developed in the precast and cast in situ units. **10**

5. **a)** Explain the concept of load balancing. **4**

b) Design a non-cylinder prestressed concrete pipe of 500 mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2, using a 2.5 mm high tensile wire stressed 1000 N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service loads are 14 and 0.7 N/mm^2. The loss ratio is 0.8. Calculate also the test pressure required to produce a tensile stress of 0.7 N/mm^2 in concrete when applied immediately after tensioning and also the winding stress in steel if ES = 35 kN/mm^2 **12**

6. **a)** Explain methods of prestressing of shell structure **4**

b) Design a post-tensioned pre-stressed concrete two-way slab, 6m × 9 m with discontinuous edges, to support an imposed load of 3 kN/m^2. Cables of four wires of 5 mm diameter carrying an effective force of 130 kN are available for use. Design the spacing of cables in the two directions and check for the safety of the slab against collapse and excessive deflection at service loads. Assume (B. M coefficients for short span = 0.089, = 0.056 for long span), *fck* = 40 N/mm^2, *fp* = 1500 N/mm^2 and *Ec* = 38 kN/mm^2 **12**

Time: 3 Hours **Total Marks: 80**

N.B.
1. **Question No. 1 is Compulsory.**
2. **Solve any three questions from remaining questions.**
3. **Assume suitable data wherever required and state them clearly.**
4. **Use of relevant IS codes is permitted**

Q. 1 Attempt any **FOUR** of the following

a) Explain Airy's theory for design of silos **5**

b) Explain the difference between the bunkers and silos in the systematic manner w.r.t. various points. **5**

c) What is yield line list the characteristics features of yields lines. **5**

d) Derive the expression for design tensile force typical corbel. **5**

e) Write design steps for deep beam **5**

Q.2 Design a silo for storing wheat with dimension, height 16m, diameter 5m. The conical dome has Central opening 50cm. Use Airy's Theory. Use M20 concrete and Fe415 steel. For Wheat take density = 7850 N/m^3; μ =0.466 μ' =0.444. Draw neat sketch Showing reinforcement details. **20**

Q.3 a) Derive the expression relating yield line moment and ultimate load intensity Wu for Simply supported equilateral triangular slab (isotopically reinforced). **12**

b) Explain the Direct Design method for flat slab. **8**

Q.4 Design a strip footing for row of 4 column of size 350mm square. Center to center distance between the adjacent columns is 5.5m. The two exterior columns carry a load of 1800 kN each and two interior columns carry a load of 2200 kN each. Assume SBC of soil as 280 kN/m^2. Use M20/Fe415. **20**

Q.5 Design an intermediate portal frame for a hall of 10 m × 60 m is to be covered with R.C.C. slab supported on a rectangular portal frames at 5 m c/c. The clear height of the hall is 4.0 m from the floor level. The plinth height is 0.50 m and the firm soil is available at 1.7 m below the ground level. The structure is single storeyed. **20**
Use Limit State Method. Draw neat sketches showing details of reinforcement in portal frame. The live load may be assumed to be 4.5 kN/m^2 and the floor finishes, 2 kN/m^2. Use concrete of M-25 grade and TOR steel.

Q.6 Design either square or circular bunker and draw the neat sketch showing details of the reinforcement for the bunker to store 350 kN of wheat using the following data: **20**
Unit weight of wheat: 7850 /m^3;
Angle of repose: 30°
The stored wheat is to be surcharged at its angle of repose.
Use M-20 concrete and HYSD steel of grade Fe 415.
Design either square or circular bunker. Draw the neat sketch showing details of the reinforcement.

Duration: 3hrs **[Max Marks: 80]**

Instructions:

(1) Question No.1 is **Compulsory**.
(2) Attempt any **three** questions out of the remaining five.
(3) Each **full** question carries **20** marks.
(4) Assume suitable data, if required and state it clearly.

Q.1 Briefly explain the following: **(any FOUR)**

a Compatibility conditions 05M
b Octahedral stresses 05M
c Energy methods for the solution of buckling problems 05M
d Biharmonic equation in Cartesian coordinates 05M
e Torsional buckling 05M

Q.2 a The state of plane stress at a point is given by: 12M
$\sigma_x = 35$Mpa. $\sigma_y = 50$MPa and $\tau_{xy} = -35$MPa.
Determine the principal stresses, the maximum shearing stress and the octahedral shearing stress.

b The displacement components of a body are 08M
$u_x = 2x+y$; $u_y = z$; $u_z = z-y$
determine strain in the direction of $1/\sqrt{3}$, $1/\sqrt{3}$, $1/\sqrt{3}$

Q.3 a Derive the equation of deflection of a cantilever beam having length L carrying a concentrated load P at the free end. 12M

b The components of the strain tensor at a point in a body are given by $\varepsilon_x = 0.001$, $\varepsilon_y = 0.003$, $\varepsilon_z = \gamma_{xy} = 0$, $\gamma_{yz} = 0.001$, $\gamma_{xz} = -0.004$. If the modulus of elasticity $E = 2 \times 10^5$ N/mm^2 and the Poisson's ratio is 0.28, determine the components of the stress tensor. Also determine Lame's constant. 08M

Q.4 a Derive Euler's expression for buckling load of a column with both ends hinged. 12M
b Derive the equation for torsion of rectangular bars of thin cross section. 08M

Q.5 a A prismatic column of length L and flexural rigidity EI carries an axial compressive force P and a central lateral load W. Derive the expression for the midspan deflection and maximum bending moment. One end of the beam column is hinged and the other end is supported on rollers. 15M

b State Bettis's Reciprocal theorem. What are its applications? 05M

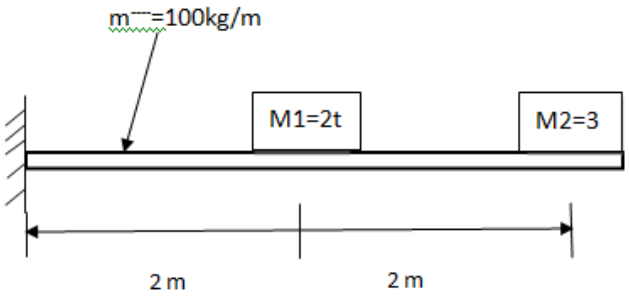
Q.6 Write short notes on:

a Plane stress and plane strain problems 05M
b Prandtl's membrane analogy 05M
c Lateral buckling of beams 05M
d Hydrostatic and deviator stress tensors 05M

(3 Hours) **Total Marks : 80**

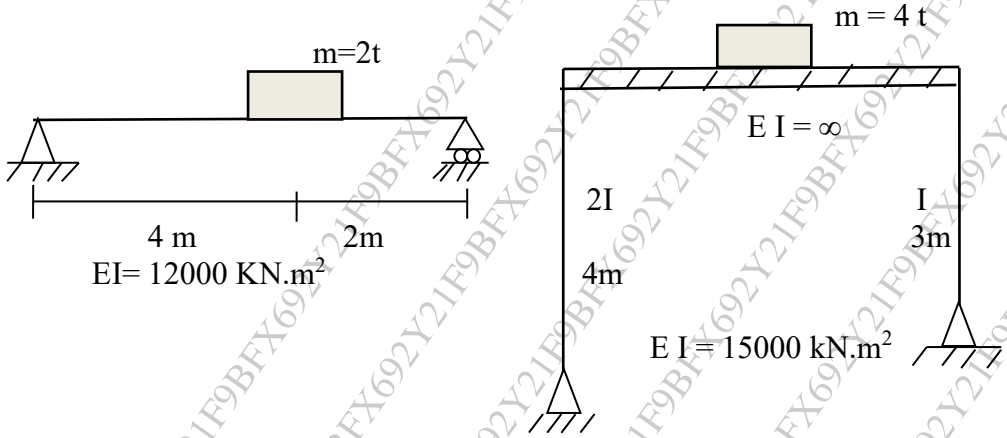
N.B:
1. **Attempt any FOUR questions.**
2. **Assume suitable data wherever necessary.**
3. **Figures to the right indicate full marks.**

1(a)	Explain the terms, magnitude and intensity of earthquake. How it is measured?	5
(b)	What is damping? Explain the various the various types of damping. What are the effects of damping on the structure?	5
(c)	State the different methods of seismic analysis as per IS 1893-2002.Also state under what conditions these methods are used.	5
(d)	What is transmissibility of a system? Briefly explain how vibration isolation can be achieved.	5
2 (a)	Derive the expression for steady state response of damped SDOF system subjected to harmonic force defined by $P_{(t)}= P_0 \cos \omega t$.	10
(b)	For the beam shown in figure, calculate the fundamental frequency using Rayleigh's method. $E=2x10^5 Mpa$, $I = 9x10^7 mm^4$	10



3(a)	A three storey single bay frame has same storey height. The storey stiffness are $K_1= K_2= K_3= K$, and the lumped mass on each storey is $m_1=2m$,$m_2=1.5m$ and $m_3=m/2$. Calculate natural frequencies and mode shapes. Also find the normal modes and verify the orthogonality principle.	15
(b)	What are the ductility provisions in the RCC buildings as per IS 13920.	5

4(a) For the structural systems shown in the figure, compute the natural frequency of vibration. 6



(b) A machine of 1000 kg mass supported on springs of total stiffness 1000 kN/m and has an unbalanced rotating element which results in a disturbing force of 500 N at a speed of 1000 rpm. Assuming 5% and10% damping, calculate 10

i. Its amplitude of motion.
ii. Transmissibility and
iii. Force transmitted to foundation.

(c) What is an earthquake? Explain how the earthquakes are classified based on their causes. 4

5(a) Starting from first principle ,derive the expression for frequency of vibration of a simply supported beam of span L, flexural rigidity EI and uniform mass 'm' kg/m. 10

(b) Explain the concept involved in carrying out modal analysis of structure subjected to dynamic loads in MDOF system. 10

6 (a) A three storey frame with the free vibration characteristics are given below is subjected to a suddenly applied constant load of 30 KN at 2nd floor level & 20KN at 3rd floor level, determine maximum displacement of each storey. 15

Storey Level	Storey Height (m)	Mass No.	Mass (t)	Mode shapes		
				T= 0.29 sec	T= 0.12 sec	T= 0.10 sec
				Mode 1 (Φ1)	Mode 2 (Φ2)	Mode 3 (Φ3)
First	3	1	25	0.404	-0.676	2.959
Second	3	2	25	0.716	-0.526	-2.578
Roof	3	3	22	1.0	1.0	1.0

(b) State and prove orthogonality principle. 5

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