

**DESIGN OF TALL STRUCTURES
(CIV3242)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 4 (four) from Group B to E, taking one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) The main purpose of providing bracing in a structure is to:
 - (a) Reduce dead load
 - (b) Resist lateral loads
 - (c) Increase floor area
 - (d) Improve aesthetics
- (ii) The lateral displacement between two successive floors is called:
 - (a) Deflection
 - (b) Drift
 - (c) Rotation
 - (d) Settlement
- (iii) Dynamic sensitivity due to wind load effects acts on:
 - (a) Low-rise buildings
 - (b) Flexible structures
 - (c) Tall structures, chimneys, towers
 - (d) Retaining walls
- (iv) In structural dynamics, an SDOF system means:
 - (a) Single direction of force
 - (b) Single degree of freedom
 - (c) Single displacement only
 - (d) Single structural member
- (v) The base shear in earthquake analysis represents:
 - (a) Maximum bending moment at roof
 - (b) Total horizontal seismic force at base
 - (c) Vertical load at foundation
 - (d) Wind pressure on building
- (vi) The response spectrum method is mainly used for:
 - (a) Static analysis
 - (b) Dynamic analysis
 - (c) Foundation design
 - (d) Soil testing
- (vii) The response reduction factor (R) represents
 - (a) Reduction due to soil
 - (b) Reduction due to ductility and energy dissipation
 - (c) Reduction due to height
 - (d) Reduction due to wind

- (viii) Which analysis method uses actual earthquake ground motion records?
 (a) Equivalent static method (b) Response spectrum method
 (c) Time history method (d) Moment distribution method
- (ix) Strain energy in a structural member is:
 (a) The energy required to break the material
 (b) The energy stored in the material due to deformation under load
 (c) The energy dissipated as heat during deformation
 (d) The energy used to overcome internal friction in the material
- (x) Shear wall is a structural element used to resist
 (a) Vertical loads only (b) Vertical loads and moments
 (c) Lateral or horizontal forces primarily (d) Moments only

Fill in the blanks with the correct word

- (xi) In tall buildings, the structural design is mainly governed by _____ loads rather than gravity loads.
- (xii) A structural system whose motion can be described by a single independent displacement is called a _____ system.
- (xiii) In the seismic design formula $V_b = A_h \times W$, the term W represents the _____ of the building.
- (xiv) Flat slabs are analysed using _____ method and _____ method.
- (xv) The vertical reinforcement ratio in shear walls should not be less than _____.

Group - B

2. (a) Explain the design process of a tall building. [[CIV3242.1](Understand/LOCQ)]
 (b) Discuss the importance of strength, stability, and stiffness in tall building design. [[CIV3242.1](Understand/LOCQ)]
6 + 6 = 12
3. (a) Explain infilled frame structures with advantages and disadvantages. [[CIV3242.2](Apply/IOCQ)]
 (b) Explain flat plate and flat slab structures. [[CIV3242.2](Apply/IOCQ)]
6 + 6 = 12

Group - C

4. (a) Explain the nature of wind and its design implications. [[CIV3242.3](Remember/LOCQ)] [[CIV3242.6](Apply/IOCQ)]
 (b) List down and explain different design considerations for wind loading. [[CIV3242.3](Remember/LOCQ)] [[CIV3242.6](Apply/IOCQ)]
6 + 6 = 12
5. A reinforced concrete chimney of height = 80m and diameter = 3.0m is located in Terrain category 2. The structure is located in Wind zone V ($V_b = 50$ m/s). Calculate the design wind pressure at top using Gust factor method. Consider the following:

- Terrain, height and structure size factor (k_2) and Importance factor (k_4) as per Table 2 IS 875.
- Topography factor (k_3) = 1.0
- Force Coefficient = 1.3
- The natural frequency of chimney = 0.6 Hz
- Peak factor (g_v) = 3.0 (for category 1 and 2), 4.0 (for category 3 and 4).
- $L_h = 85(h/10)^{0.25}$
- Structural damping ratio = 0.05
- Size reduction factor (S) = 0.15
- Reduced frequency ratio = 1.0
- For Terrain category 2, $z_0 = 0.0$

Refer the following tables from I.S 875:Part (III) guidelines (attached herewith) for other parameters

Table 1 Risk Coefficients for Different Classes of Structures in Different Wind Speed Zones
(Clause 6.3.1)

Sl No.	Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed m/s					
			33	39	44	47	50	55
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	All general buildings and structures	50	1.0	1.0	1.0	1.0	1.0	1.0
ii)	Temporary sheds, structures such as those used during construction operations (for example, formwork and false work), structures during construction stages and boundary walls	5	0.82	0.76	0.73	0.71	0.70	0.67
iii)	Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0.94	0.92	0.91	0.90	0.90	0.89
iv)	Important buildings and structures such as hospitals communication buildings/towers, power plant structures	100	1.05	1.06	1.07	1.07	1.08	1.08

Table 2 Factors to Obtain Design Wind Speed Variation with Height in Different Terrains
(Clause 6.3.2.2)

Sl No.	Height z m	Terrain and Height Multiplier (k_2)			
		Terrain Category 1	Terrain Category 2	Terrain Category 3	Terrain Category 4
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	1.05	1.00	0.91	0.80
ii)	15	1.09	1.05	0.97	0.80
iii)	20	1.12	1.07	1.01	0.80
iv)	30	1.15	1.12	1.06	0.97
v)	50	1.20	1.17	1.12	1.10
vi)	100	1.26	1.24	1.20	1.20
vii)	150	1.30	1.28	1.24	1.24
viii)	200	1.32	1.30	1.27	1.27
ix)	250	1.34	1.32	1.29	1.28
x)	300	1.35	1.34	1.31	1.30
xi)	350	1.35	1.35	1.32	1.31
xii)	400	1.35	1.35	1.34	1.32
xiii)	450	1.35	1.35	1.35	1.33
xiv)	500	1.35	1.35	1.35	1.34

	k_4
Structures of post-cyclone importance for emergency services (such as cyclone shelters, hospitals, schools, communication towers, etc)	1.30
Industrial structures	1.15
All other structures	1.00

[[CIV3242.3](Analyse/HOCQ)] [[CIV3242.6](Apply/IOCQ)]

Group - D

6. (a) Discuss the advantages and limitations of Equivalent Static Method.
[[CIV3242.4](Understand/LOCQ)] [[CIV3242.6](Apply/IOCQ)]
(b) Explain the Response Spectrum Method of seismic analysis.
[[CIV3242.4](Understand/LOCQ)] [[CIV3242.6](Apply/IOCQ)]
6 + 6 = 12
7. Calculate the design base shear for a 10-story residential building located in seismic zone III with a total seismic weight of 4000 kN, natural period of 0.5 seconds, and soil type II. Use the equivalent static method as per IS 1893-2016.
[[CIV3242.4](Understand/LOCQ)] [[CIV3242.6](Apply/IOCQ)]
12

Group - E

8. Design an internal panel of a flat slab for a Live Load of 4000 N/m². The slab is provided with a floor finish of 1000 N/m². The panels are 6m X 6m. (Use M25 grade concrete and Fe 500 steel). Also provide the reinforcement detailing.
[[CIV3242.5](Analyse/HOCQ)] [[CIV3242.6](Apply/IOCQ)]
9. Vividly explain the following:
(i) Advantages of shear wall
(ii) Various types of shear wall (along with neat sketches).
[[CIV3242.3](Analyse/HOCQ)]
(3 + 9) = 12
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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	31.25	43.75	25