Subject Name: Design of Reinforced Concrete Structures

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Year and Sem, Department:III / I

Unit-I: (Title)

INTRODUCTION TO BASIC CONCEPTS of RC. Design – Limit State method

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)
1.What is Limit State?
• "A limit state is a state of impending failure, beyond which a structure ceases to perform its intended function satisfactorily, in terms of either safety or serviceability"

2. **Safety: implies that the likelihood of (partial or total) collapse of structure is acceptably low not only under (normal loads) service loads but also under overloads.**

3.Serviceability: satisfactory performance of structure under service loads without discomfort to user due to excessive deflections, cracking, vibration etc.

4.Ultimate Limit State
• This requires that the structure must be able to withstand, with an adequate factor of safety against collapse, the loads for which it is designed.

• Limit state of Collapse: flexure, shear, compression, torsion, bearing, etc.

• Possibility of buckling or overturning must also be taken into account, as must the possibility of accidental damage as caused, for example, by an internal explosion.

5. Deflection: appearance or efficiency of any part of the structure must not be adversely affected by deflections.

6. Cracking: local damage due to cracking and spalling must not affect the appearance, efficiency or durability of structure.

7. Durability: this must be considered in terms of the proposed life of the structure and its conditions of exposure.Serviceability Limit States

8. Excessive vibration: which may cause discomfort or alarm as well as damage.

9.**Fatigue: must be considered if cyclic loading is likely.**
10.Fire resistance: this must be considered in terms of resistance to collapse, flame penetration and heat transfer.

11. Special circumstances: any special requirements of the structure which are not covered by any of the more common limit states, such as earthquake resistance, must be taken into account.

12.What is partial safety factor?

• In Limit State Design, the load actually used for each limit state is called the "Design Load" for that limit state

• "Design Load" is the product of the characteristic load and the relevant partial safety factor for loads

• Design load = γf x (characteristic load)Why do we use partial safety factors?

• Partial safety factor is intended to cover those variations

13.Partial Factors of Safety

• Other possible variations such as constructional tolerances are allowed for by partial factors of safety applied to the strength of materials and to loadings.

14. Design load = characteristic load x partial factor of safety (γf)

15. What is Design Strength?

In design calculations "Design Strength" for a given material and limit state is obtained by dividing the characteristic strength by the partial safety factor for strength, appropriate to that material and that limit state.

16. When assessing the strength of a structure or structural member for the limit state of collapse, the partial safety factor should be taken as 1.5 for concrete and 1.15 for steel

Short Questions

UNIT – I
CONCEPT OF RC DESIGN – BEAMS

1. Explain the difference between WSM and LSM methods of design
2. Define Modular ratio?
3. Why doubly reinforced beams are preferred?
4. What are the main factor(s) affecting the stress-strain relationship?
5. What are the main objectives of structural design?
6. What are the Limiting strength of concrete and steel in R.C. Beam?
7. Why code restricts the values of areas of steels in Compression and Tension?
8. Distinguish between structural design and structural analysis.
9. What is the effective flange width of Tee beam?
10. What are the advantages and disadvantages of providing large clear cover to reinforcement in flexural members?

LONG Questions

UNIT – I
CONCEPT OF RC DESIGN – BEAMS

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1. a) Explain the assumptions made in the Limit state of Flexure.
b)What is the difference between deterministic design and probabilistic design?

2. a) With the help of neat sketch derive the stress block parameters for limit state of flexure. What are the main objectives of structural design?
b)Discuss the merits and demerits of the traditional methods of design (working stress method, ultimate load method).

3. a) Show that deflection control in normal flexural members can be achieved by limiting span/effective depth ratios.
b)What is a 'theoretical bar cut-off point'? Why does the Code disallow curtailment of flexural tension reinforcement at this point?

4 a) Under what circumstances are doubly reinforced beams resorted to?
b)A designer provides areas of tension and compression reinforcement (in a doubly reinforced beam) that result in percentage pt and pc in excess of the values obtained from design tables (corresponding to a given Mu/bd2). Is it guaranteed that the design will meet all the Coderequirements?

5. a) Explain the dependence of span/effective depth ratios (for deflectioncontrol, as per Code) on the percentage tension and compression reinforcement, as well as the grade of tension steel.
b)What is meant by limit state? Discuss the different 'limit states' to be considered in reinforced concrete design

6 a) A singly reinforced beam of 250mm X 450 mm effective depth is reinforced with 4 no 20mm dia bars in tension. Determine the moment of resistance of the section and also the maximum moment of resistance of the section using working stress method of design. Mention whether the section is under reinforced or over reinforced. Use M20 and Fe415.
b) A reinforced concrete beam of rectangular section has the cross- sectional dimensions
shown in Fig. Assuming M 20 grade concrete and Fe 415 grade steel, compute (i) the cracking moment and (ii) the stresses due to an applied moment of 50 kNm.

7. a) Consider the same beam section of problem 2. Assuming M 20 grade concrete and Fe 415 grade steel, determine the allowable bendingmoment, and the stresses in concrete and steel corresponding to this moment.
b) Explain the stress – strain curves adopted by IS 456 in flexural compression.

8.a) Explain characteristic strength of materials and characteristic loads.
b) A rectangular reinforced concrete beam, located inside a building in a coastal town, is simply supported on two masonry walls 230 mm thick and 6m apart (centre-to-centre). The beam has to carry, in addition to its own weight, a distributed live load of 10 kN/m and a dead load of 5 kN/m. Design the beam section for maximum moment at mid-span. Assume Fe 415 steel.

9. a) Design beams for a class room of 6x12 m in size. The thickness of the slab above the beams is 120 mm. The centre to centre distance of the beams is 3 m. Use M20 grade concrete. Draw neatly the structuraldetails to a suitable scale.

b) A singly reinforced concrete beam is 300x450 mm deep to the centre of tension reinforcement which consists of 4 bars of 16mm diameter. If the safe stresses on concrete and steel are 7 N / mm2 and 230 N / mm2 respectively, find the moment of resistance of the section. Take M = 13.33.

10. a) A Rectangular RC beam is of 230mm × 550mm, overall size, with an effective covers of 50mm on both the tension and compression sides. It is reinforced with 4 bars of 16mm diameter bars on compression side. Calculate the steel on the tension side and Ultimate moment of resistance of section. Use M25 concrete and Fe 500 steel.

b) Design an L beam for an office floor given the following data: Clear span: 6m
Thickness of flange = 150mm Service load:
4kN/m2 Spacing of beam : 3m
fck = 25N/mm2, fy = 415N/mm2
L beams are monolithic with columns. Width of column = 300mm.
Sketch the reinforcement details.

Multiple Choice Questions **/ Choose the Best: (Minimum 10 to 15 with Answers)**

1. Limit State Method is based on _____________ (C)
a) calculations on service load conditions alone
b) calculations on ultimate load conditions alone
c) calculations at working loads and ultimate loads
d) calculations on earthquake loads

2. What is limit state? (A)
a) Acceptable limits for safety and serviceability requirements before failure occurs
b) Acceptable limits for safety and serviceability requirements after failure occurs
c) Acceptable limits for safety after failure occurs
d) Acceptable limits for serviceability after failure occurs

3. Which of the following format is used in limit state method? (B)
a) Single safety factor
b) Multiple safety factor
c) Load factor
d) Wind factor

4. Which of the following factors is included in the limit state of strength?(B)
a) Fire
b) Failure by excessive deformation
c) Corrosion
d) Repairable damage or crack due to fatigue

5. Which of the following factors is included in the limit state of serviceability?(D)
a) Brittle facture
b) Fracture due to fatigue

c) Failure by excessive deformation
d) Deformation and deflection adversely affecting appearance or effective use of structur

6. What is permanent action according to classification of actions by IS code?(A)
a) due to self weight
b) due to construction and service stage loads
c) due to accidents
d) due to earthquake loads

7. What is variable action according to classification of actions by IS code?(C)
a) due to self weight
b) due to accidents
c) due to construction and service stage loads
d) due to earthquake loads

8. Which of the following relation is correct? (D)
a) Design Load = Characteristic Load
b) Design Load = Characteristic Load + Partial factor of safety
c) Design Load = Characteristic Load / Partial factor of safety
d) Design Load = Characteristic Load x Partial factor of safety

9. Which of the following relation is correct? (C)
a) Design Strength = Ultimate strength + Partial factor of safety
b) Design Strength = Ultimate strength – Partial factor of safety
c) Design Strength = Ultimate strength /Partial factor of safety
d) Design Strength = Ultimate strength x Partial factor of safety

10. Which of the following criteria is to be satisfied in selection of member in limit state method? (B)
a) Factored Load > Factored Strength
b) Factored Load ≤ Factored Strength
c) Factored Load ≥ Factored Strength
d) Sometimes Factored Load < Factored Strength (or) Factored Load > Factored Strength

Unit-II: (Title)

SHEAR, TORSION AND BOND

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

1. Flexural cracks: form at the bottom near mid span and propagate upwards.

2. Web shear cracks: form near neutral axis close to support and propagate inclined to the beam axis.

3.Flexure shear cracks: These cracks form at bottom due to flexure and propagate due to both flexure and shear.• Formation of cracks for a beam with large span-to-depth ratio and uniformly distributed loading
a)Initiation of flexural cracks
b) Growth of flexural cracks and formation of flexure shear and web shear cracks.c) Cracks before failure
• Magnitude and relative value of each component change with increasing load.Modes of Failure
• For beams with low span-to-depth ratio or inadequate shear reinforcement, the failure may be due to shear.

4.Failure due to shear is sudden as compared to failure due to flexure.

• Five modes of failure due to shear are identified.
1. Diagonal tension failure
2. Shear compression failure
3. Shear tension failure
4. Web crushing failure
5. Arch rib failure
• Mode of failure depends on span-to-depth ratio, loading, cross section of beam, amount and anchorage of reinforcement.5-Aug-16 43**Diagonal tension failure: inclined crack propagates rapidly due to inadequate shear reinforcement.**

6. Shear compression failure: crushing of concrete near the compression flange above the tip of the inclined crack. diagonal cracks propagate horizontally along the bars.

7.Web crushing failure: concrete in the web crushes due to inadequate web thickness.

8.Arch rib failure
• Design for shear is to avoid shear failure; beam should fail in flexure at its ultimate flexuralstrength.

9. **Behavior of RC members under Shear (including combined loads with other loads) is very complex**
1. Non-homogeneity of materials
2. Presence of Cracks and Reinforcement
3. Nonlinearity in Material Response ,

10**• Ultimate Strength: “load corresponding to the total and**

complete failure due to shear and diagonal tension"

11• **Diagonal Cracking Strength: "load corresponding to formation of first fully developed inclined crack"**

12.Design of Shear Reinforcement
I. When the shear stress is greater than shear strength given in Table 19 (IS 456), shear reinforcement shall be provided in any of the following forms
a. Verticalstirrups
b. Bent-up bars along with stirrups and
c. Inclined stirrups

13.Characteristic Strength
• "Characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall".

14.Characteristic Load = Mean Load ± 1.64 (standard deviation).

15.Working Stress Design
• The sections of the members of the designed assuming straight line structure are stress-strain relationships ensuring that at service loads the stresses in the steel

and concrete do not exceed the allowable working stresses

Short Questions

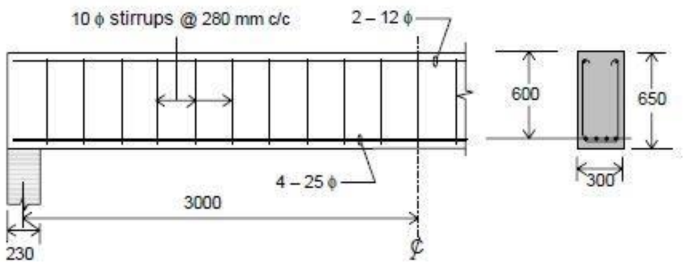
UNIT- II
SHEAR, TORSION AND BOND

1. For design of continuous beam what is the span to depth ratio adopted?
2. What is the expression for spacing of vertical stirrups in R.C. beams for shear?
3. What are the limits for spacing of shear reinforcement?
4. Explain, with examples, the difference between equilibrium torsion and compatibility torsion.
5. What is the purpose of splicing of reinforcement? What are the different ways by which this can be achieved?
6. Define 'development length'. What is its significance?
7. Explain the loading conditions for checking Serviceability.
8. Under what situations do the following modes of cracking occur in reinforced concrete beams:
(a) flexural cracks, (b) diagonal tensioncracks, (c) flexural-shear cracks and (d) splitting cracks?
9. List out the factors influencing the short term deflection, long term deflection of RC beams
10. What are the various remedial measures for control of cracking ?

LONG Questions

UNIT – II
SHEAR, TORSION AND BOND

1.A simply supported beam of 6 m span (c/c), (shown in Fig.), is to carry a uniform dead load of 20 kN/m (including beam weight) and a uniform live load of 30 kNm. The width of the supporting wall is 230 mm. Assume M 25 concrete and Fe 415 steel.



(a) Determine the adequacy of the 10 mmφ U-stirrups as shear reinforcement.
(b) If the shear reinforcement is to be provided in the form of 10φ stirrups inclined at 60o to the beam axis, determine the required spacing.
(c) If two of the tension reinforcement bars are terminated at 300 mm from the centre of the support, check the adequacy of shear strength atthe bar cut-off point.

2. A plain concrete beam (M 20 grade concrete) has a rectangular section, 300 mm wide and 500 mm deep (overall). Estimate the 'cracking torque'. Also determine the limiting torque beyond which torsional reinforcement is required (as per the Code), assuming τ_c=0.3 MPa.

3. Design the torsional reinforcement in a rectangular beam section, 350 mm wide and 750 mm deep, subjected to an ultimate twisting moment of 140 kNm, combined with an ultimate (hogging) bending moment of 200 kNm and an ultimate shear force of 110kN. AssumeM 25 concrete, Fe 415 steel and mild exposure conditions

4. A simple supported beam is 6m on span and carries a load of 50 KN/m.6 Numbers of 20mm bars are provided at the centre of the span and 4 numbers of these bars are continued up to the supports. Check the development length if M20grade concrete and Fe 415 steel are provided.

5. Design a T – beam for the following data. Span = 9 m , Ends are simply supported.
Spacing of the beams = 3 m
Super imposed load = 4 kN / m2 Floor finish = 0.75 k/m2
Thickness of the slab = 125 mm
Weight of the wall on the beam = 15 kN / m
Width of the web = 230 mm
Total depth = 680 mm Use M 25 grade concrete and Fe 500 grade steel. Design the beam for shear reinforcement also.Check the design for all necessary conditions. Draw to a suitable scale:

a) The longitudinal section showing the reinforcement details
b) The cross section of the beam at salient points, showing the reinforcement details.

6. A rectangular beam 230mm wide is subjected to the following at a section

1. Sagging bending moment of 25kNm.
2. Shear force of 20kN.
3. Torsional moment of 30kNm.

Use M25 and Fe-415 steel. Design a suitable section and find the reinforcement required in the section.

7. A rectangular simply supported beam of span 5m is 300mm x 500mm in cross section. It carries a live load of 10kN/m and a dead load of 5kN/m. (including self weight). It is reinforced with 4 bars of 25mm diameter on the tension side at an effective cover of 50mm. Calculate
the short term deflection at mid span. Use M25 concrete and Fe-415 steel.

8.A rectangular beam of span 7 m (centre-to-centre of supports), resting on 300 mm wide simple supports, is to carry a uniformly distributed dead load (excluding self-weight) of 15 kN/m and a live load of 20 kN/m. Using Fe 415 steel, design the beam section at mid-span, based on first principles. Check the adequacy of the section for strength,
using design aids. Also perform a check for deflection control. Assume that the beam is subjected to moderate exposure conditions

9. A beam of 450mm width is having 6 Nos of 25mm bars of fe 415
grade. The total depth of the beam is 950mm. Obtain the arrangement of steel to confirm to the crack control as per IS456.

10. A doubly reinforced beam of rectangular section 300mm wide x500mm overall depth is reinforced with 4 bars of 20 mm diameter on the tension face and 2 bars of 16 mm diameter on the compression face. Assume moderate exposure condition. The beam spans over 9 m. Check the deflection control if Fe 415 steel is used. Use M25 concrete.

Multiple Choice Questions **/ Choose the Best: (Minimum 10 to 15 with Answers)**

1. Which type of cables are advantages in reducing the effective shear?(b)
a) Straight
b) Curved
c) Trapezoidal
d) Longitudinal

2. The various codes recommend empirical relations to estimate:(a)
a) Ultimate shear resistance
b) Ultimate torsional resistance
c) Ultimate bending resistance
d) Ultimate load

3. Which type of shear reinforcement should be provided for members with thin webs?(c)
a) Maximum shear reinforcement
b) Minimum shear reinforcement
c) Nominal shear reinforcement
d) Tensile reinforcement

4. The pre and post tensioned members with bonded tendons bond stress between:(a)
a) Steel and concrete
b) Steel and water

c) Steel and aggregates
d) Steel and plastic

5. In case of pre tensioned member, the computations of transmission length is influenced by: (a)
a) Bond
b) Flexure
c) Torsion
d) Tension

6. When prestress is transferred to concrete by means of external anchorages which pressure is developed: (a)
a) Bearing
b) Twisting
c) Torsion
d) Bent

7. The bearing pressure on the concrete is given as:(b)
a) 0.4fci
b) 0.8fci
c) 0.12fci
d) 0.2fci

8. The effective punching area Apun is generally the contact area of:(b)
a) Tendon device
b) Anchorage device
c) Stress device
d) Strain device

9. The end block of a beam has a rectangular section 100mm wide by 200mm deep, the force of cable is 200kn. Find the actual bearing pressure?(c)
a) 30n/mm2
b) 40n/mm2
c) 20n/mm2
d) 10n/mm2

10. The end block of a prestressed concrete beam has a rectangular section; a cable carrying a force of 200kn is to be anchored against the end block at the centre if the cube strength of concrete at transfer is 30n/mm2. Design the maximum permissible bearing pressure?(Abr = 10000mm2) (d)
a) 24n/mm2
b) 48n/mm2
c) 54n/mm2
d) 12n/mm22

Unit-III: (Title)

DESIGN OF SLABS

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

1.Effective Flange Width
Portions near the webs are more highly stressed than areas away from the web

2.Effective width (beff)
beff is width that is stressed uniformly to give the same compression force actually developed in compression

3.**One-way slabs:**
When the ratio of the longer to the shorter side (*L/ S*) of the slab is at least equal to 2.0, it is called one-way slab. Under the action of loads, it is deflected in the short direction only, in a cylindrical form.

4.*Shrinkage Reinforcement Ratio*

According to ACI Code 7.12.2.1 and for steels yielding at
where, b = width of strip, and h = slab thickness. y the gross concrete area, or f = 4200kg / c,mth2 e shrinkage reinforcement is taken not less than 0.0018 of As shrinkage = 0.0018b h

5.*Minimum Reinforcement Ratio*

According to ACI Code 10.5.4, the minimum flexural reinforcement is not to be less than the shrinkage reinforcement, or Asmin = 0.0018b h

6.Spacing Of Flexural Reinforcement Bars

Flexural reinforcement is to be spaced not farther than three times the slab thickness, nor farther apart than 45 cm, center-to-center.

7.Spacing Of Shrinkage Reinforcement Bars

Shrinkage reinforcement is to be spaced not farther than five times the slab thickness, nor farther apart than 45 cm, center-tocenter.

8.**Design of Two-way Slabs**
• Restrained two way slab is divided into middle strip and edge strips. Middle strip is forming three-fourth of slab width in width directions.

9. Long span moment coefficient"αy" is a constant for given end conditions of slab, irrespective of the span ratios.

10. Short span coefficient varies sharply with variation of the ratio of spans

11.Design of Two-way Slabs
• Slab thickness should be calculated based on the greater value of the negative B.M on the short span.
Mu = Kfckbd2

Short Questions

UNIT – III
DESIGN OF SLABS

1. Reinforced concrete slabs are generally singly reinforced. Why not doubly reinforced?
2. Explain clearly the difference between one way and two way slabs.
3. Explain the need for corner reinforcement in two way rectangular slabs whose corners are prevented from lifting up.
4. The main Reinforcement of a R.C. slab consists of 10mm bars at spacing of 10cm. if it is desired to replace 10mm bars by 12mm bars, then what is the spacing of 12mm bars?
5. What is the minimum Flexural Reinforcement in Slabs in either direction?
6. In case of slab, how the area of steel is expressed in terms of centre-to-centre spacing of bars?
7. What are the limits of percentage of steel in slabs?
8. Differentiate one-way and two-way slabs?
9. What is the maximum size of coarse aggregate in slab?
10. Torsional reinforcement is required in which type of slabs and why?

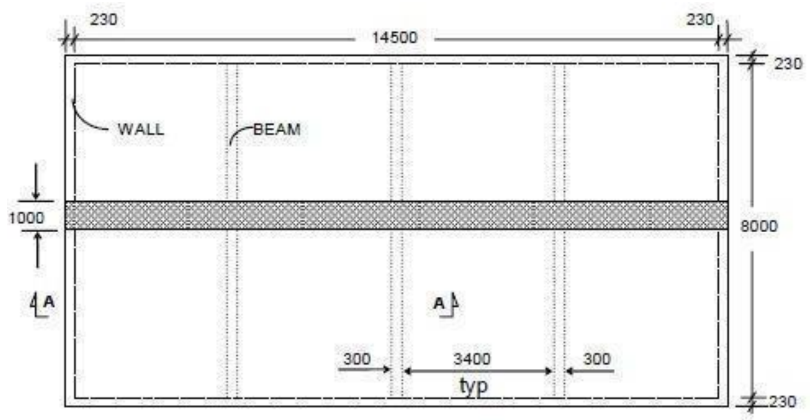
LONG Questions

UNIT-III
DESIGN OF SLABS

1. Determine the ultimate moment of resistance of a 150 mm thick slab, reinforced with 10 mm φ bars at 200 mm spacing located at an effective depth of 125 mm. Assume M 20 concrete and Fe 415 steel.

2. Design a one–way slab, with a clear span of 4.0 m, simply supported on 230 mm thick masonry walls, and subjected to a live load of 4 kN/m2 and a surface finish of 1 kN/m2. Assume Fe 415 steel.
Assume the beam is subjected to moderate exposure conditions

3. The plan of a floor slab system, covering an area 8.0 m × 14.5 m (clear spans) is shown in Fig. The slab rests on a 230 mm thick masonry wall all around. For economy, the span of the slab is reduced by providing three (equally spaced) intermediate beams along the 8.0 m direction, as shown. The specified floor loading consists of a live load of 4 kN/m2, and a dead load (due to floor finish, partitions etc.) of 1.5 kN/m2 in addition to the self–weight. Assuming Fe 415 steel, design and detail the floor slab. Assume the beam is subjected to moderate exposure conditions.



PLAN

4. Design a simply supported slab to cover a hall with internal dimensions 4.0 m× 6.0 m. The slab is supported on masonry walls 230 mm thick. Assume a live load of 3 kN/m2 and a finish load of 1 kN/m2. Use M 20 concrete and Fe 415 steel. Assume that the slab corners are free to lift up.

5. Design a slab over 5m x 7m room supported on masonry walls all around with adequate restraint with corners held down. The live load on slab is 2.5 KN /m2. The slab has a bearing of 150 mm on the walls. Use M2o grade concrete. Draw the structural detailing neatly to a suitable scale.

6. Design a slab over a residential room of 4m x 6m size. Two short edges of the slab are discontinuous. Use M2o grade concrete and fe 415 grade steel.

7. Design a rectangular slab for a class room of size 4.8 x 6.2m supported on its all four edges. Two adjacent edges of the slab are discontinuous and the remaining two edges are continuous. A finishing of 20mm brick concrete surface shall be provided on the slab. Design the slab using M2o grade concrete and fe 415 gradesteel. Draw the structural details neatly to a suitable scale.

8. Distinguish between One-way and Two-way slabs with sketches.
9. Design a reinforced concrete slab of size 5m x 4m. All the four edges are discontinuous and corners are held down. The slab has to carry a live load of 3kN/m2.And floor finish 1kN/m2.Use M20 concrete and Fe 500 steel.
10. A reinforced concrete canopy slab, designed as a cantilever, is under construction. Prior to the removal of the formwork, doubts are expressed about the safety of the structure. It is proposed to prop up the free edge of the cantilever with a beam supported on pillars.Comment on this proposal.

Multiple Choice Questions **/ Choose the Best: (Minimum 10 to 15 with Answers)**

1. Which type of cables are advantages in reducing the effective shear?(b)
a) Straight
b) Curved
c) Trapezoidal
d) Longitudinal

2. The various codes recommend empirical relations to estimate:(a)
a) Ultimate shear resistance
b) Ultimate torsional resistance
c) Ultimate bending resistance
d) Ultimate load

3. Which type of shear reinforcement should be provided for members with thin webs?(c)
a) Maximum shear reinforcement
b) Minimum shear reinforcement
c) Nominal shear reinforcement
d) Tensile reinforcement

4. The pre and post tensioned members with bonded tendons bond stress between:(a)
a) Steel and concrete
b) Steel and water
c) Steel and aggregates
d) Steel and plastic

5. In case of pre tensioned member, the computations of transmission length is influenced by: (a)
a) Bond
b) Flexure
c) Torsion
d) Tension

6. When prestress is transferred to concrete by means of external anchorages which pressure is developed: (a)
a) Bearing
b) Twisting
c) Torsion
d) Bent

7. The bearing pressure on the concrete is given as:(b)
a) 0.4fci
b) 0.8fci
c) 0.12fci
d) 0.2fci

8. The effective punching area Apun is generally the contact area of:(b)
a) Tendon device
b) Anchorage device
c) Stress device
d) Strain device

9. The end block of a beam has a rectangular section 100mm wide by 200mm deep, the force of cable is 200kn. Find the actual bearing pressure?(c)
a) 30n/mm2
b) 40n/mm2
c) 20n/mm2
d) 10n/mm2

10. The end block of a prestressed concrete beam has a rectangular section; a cable carrying a force of 200kn is to be anchored against the end block at the centre if the cube strength of concrete at transfer is 30n/mm2. Design the maximum permissible bearing pressure?(Abr = 10000mm2) (d)
a) 24n/mm2
b) 48n/mm2

c) 54n/mm2
d) 12n/mm22

Unit-IV: (Title)

COLOUMNS

Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

1.**Compression Members**
The failure of members in compression are due either to the load exceeding the ultimate strength in compression (crushing) or due to buckling under the load, because the applied load is larger than the critical buckling load.

2.Design a column to carry a central load of 3600 lb. The column has to be 15" long. Due to space limitation the largest dimension cannot exceed 1.0 inch. The column will be welded at both ends.

Short Questions

UNIT-IV

1. What are the design strengths of steel in tension or bending compression and axial compression?
2. What are the limits of percentage of the longitudinal reinforcement in a column?
3. What is the purpose of lateral ties in a RC column?

A column of size 450 mm × 600 mm, subject to an axial load of 2000 kN under service dead and live loads. The column has an unsupported length of 3.0m and is braced against sideway in both directions. Use

4. M 20 concrete and Fe 415 steel. What are the minimum eccentricities ex and ey?
5. Using the Limit State design, what is the value of longitudinal reinforcement for the above column in question
6. What is the difference between load carrying capacity of a helically reinforced column and that of a tied column?
7. What is the role of transverse steel ties in reinforced concrete columns?
8. What is slenderness ratio? Explain.
9. Differentiate between short and long column.
10. Define equivalent length of a column. Define crushing and buckling

LONG Questions

UNIT-IV
SHORT AND LONG COLUMNS

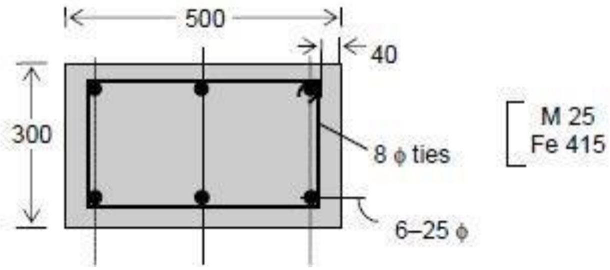
1.Design the reinforcement in a column of size 450 mm × 600 mm, subject to an axial load of 2000 kN under service dead and live loads. The column has an unsupported length of 3.0m and is braced against sideway in both directions. Use M 20 concrete and Fe 415 steel
2.A short column, 600 mm × 600 mm in section, is subject to a factored axial load of 1500 kN. Determine the minimum area of longitudinal steel to be provided, assuming M 20 concrete and Fe 415

steel.

3.Design the reinforcement in a spiral column of 400 mm diameter subjected to a factored load of 1500 kN. The column has an unsupported length of 3.4 m and is braced against sideway. Use M 25 concrete and Fe 415 steel.

4.For the column section shown in above figure (problem4) determine the design strength components and corresponding eccentricity of loading with respect to the minor axis alone, for the limiting condition of 'no tension' in the section.

5. For the column section shown in Fig, determine the design strength components corresponding to the condition of 'balanced failure'. Assume M 25 concrete and Fe 415 steel. Consider loading eccentricity with respect to the major axis alone. Assume 8 φ ties and 40 mm clear cover.



6. For a column section shown above figure (problem4), construct the design interaction curve for axial compression combined with uniaxial bending about the major axis. Hence, investigate the safetyof the column section under the following factored load effects:

(i) Pu = 2275 kN, Mux = 46.4 kNm (maximum axial compression);

ii) Pu = 1105 kN, Mux = 125 kNm (maximum eccentricity).

7. Using the design aids given in SP : 16, design the longitudinal reinforcement in a rectangular reinforced concrete column of size 300 mm × 600 mm subjected to a factored load of 1400 kN and a factored moment of 280 kNm with respect to the major axis. Assume M 20 concrete and Fe 415 steel.

8. Design a short square column, with effective length 3.0m, capable of safely resisting the following factored load effects (under uniaxial eccentricity):

(i) Pu = 1625 kN, Mu = 75 kNm

Pu =365 kN, Mu = 198 kNm. Assume M 25 concrete and Fe 415 steel

10. Design a symmetrically reinforced short column 450 x 450mm under bi axial bending with a load of 1000 KN and Mx = 75 KN-m and My=60 KN-m use M20 grade concrete and fe 415 grade steel

11. Design a column of unsupported length 3m to carry an axial load of 2000 kN and a BM of 150kNm at service conditions. Design the column as a short column. The column is subjected to severe exposure condition and grade of steel is Fe500. Provide equal reinforcement on all the faces. Use M30 concrete. Sketch reinforcement details.

Multiple Choice Questions / **Choose the Best: (Minimum 10 to 15 with Answers)**

1. Which type of cables are advantages in reducing the effective shear?(b)

a) Straight

b) Curved

c) Trapezoidal

d) Longitudinal

2. The various codes recommend empirical relations to estimate:(a)
a) Ultimate shear resistance
b) Ultimate torsional resistance
c) Ultimate bending resistance
d) Ultimate load

3. Which type of shear reinforcement should be provided for members with thin webs?(c)
a) Maximum shear reinforcement
b) Minimum shear reinforcement
c) Nominal shear reinforcement
d) Tensile reinforcement

4. The pre and post tensioned members with bonded tendons bond stress between:(a)
a) Steel and concrete
b) Steel and water
c) Steel and aggregates
d) Steel and plastic

5. In case of pre tensioned member, the computations of transmission length is influenced by: (a)
a) Bond
b) Flexure
c) Torsion
d) Tension

6. When prestress is transferred to concrete by means of external anchorages which pressure is developed: (a)
a) Bearing
b) Twisting
c) Torsion
d) Bent

7. The bearing pressure on the concrete is given as:(b)
a) 0.4fci
b) 0.8fci
c) 0.12fci
d) 0.2fci

8. The effective punching area Apun is generally the contact area of:(b)
a) Tendon device
b) Anchorage device
c) Stress device
d) Strain device

9. The end block of a beam has a rectangular section 100mm wide by 200mm deep, the force of cable is 200kn. Find the actual bearing pressure?(c)
a) 30n/mm2

b) 40n/mm2
c) 20n/mm2
d) 10n/mm2

10. The end block of a prestressed concrete beam has a rectangular section; a cable carrying a force of 200kn is to be anchored against the end block at the centre if the cube strength of concrete at transfer is 30n/mm2. Design the maximum permissible bearing pressure?(Abr = 10000mm2) (d)

a) 24n/mm2
b) 48n/mm2
c) 54n/mm2
d) 12n/mm22

Unit-V: (Title)
DESIGN OF FOOTINGS
Important points / Definitions: (Minimum 15 to 20 points covering complete topics in that unit)

1.Footings are structural members used to support columns and walls and to transmit and distribute their loads to the soil in such a way that the load bearing capacity of the soil is not exceeded, excessive settlement, differential settlement,or rotation are prevented and adequate safety against overturning or sliding is maintained.

2.***Wall footings*** are used to support structural walls that carry loads for other floors or to support nonstructural walls.

3.***Isolated or single footings*** are used to support single columns. This is one of the most economical types of footings and is used when columns are spaced at relatively long distances.

4.***Combined footings*** usually support two columns, or three columns not in a row. Combined footings are used when two columns are so close that single footings cannot be used or when one column is located at or near a property line.

5.***Cantilever or strap footings*** consist of two single footings connected with a beam or a strap and support two single columns. This type replaces a combined footing and is more economical.

6.***Continuous footings*** support a row of three or more columns. They have limited width and continue under all columns.

7.***Rafted or mat foundation*** consists of one footing usually placed under the entire building area. They are used, when soil bearing capacity is low, column loads are heavy single footings cannot be used, piles are not used and differential settlement must be reduced.

8.***Pile caps*** are thick slabs used to tie a group of piles together to support and transmit column loads to the piles.

Short Questions

UNIT – V
DESIGN OF FOOTINGS

1. What are the conditions should be satisfied during the design of a combined footing?
2. Explain about one-way and two-way shear in footings?
3. What are the situations in which combined footings are preferred to isolated footings?
4. Under what circumstances is a trapezoidal shape preferred to a rectangular shape for a two-column combined footing?
5. Explain about the Minimum cover required in a footing?
6. Describe briefly the load transfer mechanism in a two-column combined footing.
7. Explain the method of determining the effective spans of stairs.
8. Draw schematic diagrams of different types of staircases based on different structural systems. Mention four general considerations for the design of a staircase
9. Explain about the following stair cases

(C) A stair case B) dog legged stair C) An open stair D) A geometrical stair

10. Name five types of staircases based on geometrical configurations.Draw a typical flight and show:
(a) trade, (b) nosing, (c) riser, (d) waist and (e) going.

LONG Questions

UNIT –V
DESIGN OF FOOTINGS

1. Design a square footing for a rectangular column 300 mm × 500 mm, reinforced with 6–25 φ bars, and carrying a service load of 1250 kN. Assume soil with an allowable pressure of 200 kN/m2 at a depth of 1.25 m below ground. Assume Fe 415 grade steel for both column and footing, and M 20 grade concrete for the footing and M 25 grade concrete for the column.

2. Design a rectangular footing for a circular column, 500 mm in diameter, reinforced with 8–25 φ bars, and carrying an axial load of 2500 kN. Assume soil with a safe bearing capacity of 300 kN/m2 at a depth of 1.5 m below ground. Assume Fe 415 grade steel for both column and footing, and M 20 grade concrete for the footing and M 30 grade concrete for the column.

3. Design an isolated footing for a column, 300 mm × 500 mm, reinforced with 6–25 φ bars with Fe 415 steel and M 25 concrete [refer Fig. 13.14(a), Example 13.5], subject to a factored axial load Pu = 1000 kN and a factored uniaxial moment Mux = 120 kNm (with respect to the major axis) at the column base. Assume that the moment is reversible. The safe soil bearing capacity may be taken as 200 kN/m2 at a depth of 1.25 m. Assume M 20 concrete and Fe 415 steel for the footing.

4. Design a combined footing for two columns C1 (400 mm × 400 mm with 4–25 φ bars) and C2 (500 mm × 500 mm with 4–28 φ bars) supporting axial loads P1 = 900 kN and P2 = 1600 kN respectively
(under service dead and live loads). The column C1 is an exterior column whose exterior face is flush with the property line. The centre-to-centre distance between C1 and C2 is 4.5 m. The allowable soil pressure at the base of the footing, 1.5 m below ground level, is 240 kN/m2. Assume steel of grade Fe 415 in columns as well as footing, and concrete of M 30 grade in columns and M 20 grade in footing.

5. Design a rectangular isolated sloped footing for a column of size 250 mm x 750 mm carrying an axial load of 2600 kN. The S.B.C. of the soil is 300 kN / m2. Use M 25 grade concrete and Fe 415 grade steel Draw to a suitable scale,
a) Plan of the footing
b) Sectional elevation of the footing showing the reinforcement details.

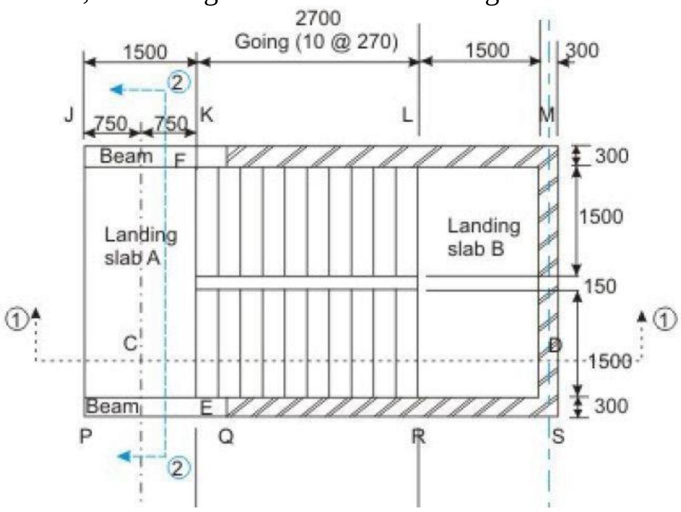
6. Design an isolated footing for a square column, 450 mm × 450 mm, reinforced with 8–25 φ bars, and carrying a service load of 2300 kN. Assume soil with a safe bearing capacity of 300 kN/m2 at a depth of 1.5 m below ground. Assume M 20 grade concrete and Fe 415 grade steel for the footing, and M 25 concrete and Fe 415 steel for the column.

7. A straight staircase is made of structurally independent tread slabs, cantilevered from a reinforced concrete wall. Given that the riser is 150 mm, tread is 300 mm, and width of flight is 1.5 m, design a typical tread slab. Apply the live loads specified in the IS Loading Code for stairs liable to be overcrowded. Use M 20 concrete and Fe 250 steel. Assume mild exposure conditions.

8. A straight staircase is made of structurally independent tread slabs, cantilevered from a reinforced concrete wall. Given that the riser is 150 mm, tread is 300 mm, and width of flight is 1.5

m, design a typical tread slab. Apply the live loads specified in the IS Loading Code for stairs liable to be overcrowded. Use M 20 concrete and Fe 250 steel. Assume mild exposure conditions.

9. Design the waist-slab type of the staircase of Fig. Landing slab A is supported on beams along JK and PQ, while the waist-slab and landing slab B are spanning longitudinally as shown in Fig.. The finish loads and live loads are 1 kN/m2 and 5 kN/m2, respectively. Use riser R = 160 mm, trade T = 270 mm, concrete grade = M 20 and steel grade = Fe 415.



10.A dog legged stair case is to be detailed with the following particulars:Clear dimension of stair case room=4.48 m x 2.1 m The floor to floor height is 3.2 m
Width of each tread =250 mm Width of each rise = 160 mm
Thickness of waist slab = 150 mm Width of flight =1m
All round wall = 230 mm
Both flights are supported at the ends of landing on 230 mm wall.
(Landing and flight spans in the same direction) The first flight starts from the plinth level
Main steel for each flight = #12@120 Distribution steel for each flight = #8@ 200
Use M20 concrete and Fe 415 steel.Draw to a suitable scale The plan of stair caseSectional elevation of the Ground flightSectional elevation of the First flight

Multiple Choice Questions / **Choose the Best: (Minimum 10 to 15 with Answers)**

1. The creep strains are caused due to [ ]
   A) Dead load only B) Live load only C) Both D) None
2. Deflection can be controlled by using appropriate [ ]
   A) Aspect ratio B) Modular ratio C) water/cementratio D) None
3. The maximum deflection for a beam at service condition is [ ]
   A) Span/250 B) Span/350 C) 20mm D) both b & c
4. For a 75mm thick RCC slab, the maximum size of reinforcement bar is [ ]
   A) 12mm dia B) 10mm dia C) 8mm dia D) 6mm dia
5. The minimum thickness of a flat slab required according to IS: 456-2000 is [ ]
   A) 125mm B) 150mm C) 100mm D) 200mm
6. The thickness of slab depends on _______________ [ ]
   A) l/d ratio B) dia of bar C) spacing of reinforcement D) none
7. Drops are provided in flat slabs to resist [ ]
   A) Bending movement B) Shear C) Thrust D) Torsion

08. The maximum cement content for durability as per IS 456-2000 is _______________

09. The ratio of 7 days and 28 days cube strength is ____________________

10. The maximum distance between expansion joints in concrete structures as per IS: 456-2000 is _______

11. The partial safety factor for steel in limit state for serviceability is ___________

12. A beam reinforced on tension side in the direction of bending is called ___________

13. The maximum tension reinforcement in a singly reinforced beam is________% of gross area.

14. The shape of idealized stress strain curve for concrete is prescribed by IS 456 is _______________

15. The factor of safety for reinforcing steel in working stress method is ________________

16. Modular ratio of M20 concrete is ___________

17. The torsional effect is significant in case of______________beam