SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY
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CE6505 DESIGN OF REINFORCED CONCRETE ELEMENTS

UNIT – III

LIMIT STATE DESIGN FOR BOND, ANCHORAGE SHEAR & TORSION

QUESTIONS & ANSWERS

PART – A

1. What are the types of shear failure in reinforced concrete beams?

1. Shear – tension (or) Diagonal tension
2. Flexure – shear
3. Shear compression
4. Shear – bond

2. How do you prevent minimum shear reinforcements?

- Brittle shear failure cracks which can occur without shear reinforcements
- Sudden failure due to bursting of concrete of concrete cover and bond to the tension reinforcements
- The shear reinforcements help to hold the main reinforcement while concreting forming an effective cage
- Formation of cracks due to the thermal and shrinkage stresses are minimized.
- Shear reinforcement act as effective ties for the compression steel and make them effective.

3. How do you develop bond mechanisms between concrete?

- Chemical adhesion is the grip developed due to the gum like property of the gum like property of the hydration products of cement in concrete.
- Frictional resistance developed due to the relative movements between concrete and steel bars depending upon the surface characteristics on f the bars and the grip developed due to shrinkage of concrete.

- Shearing resistance or dilatancy due to mechanical interlock developed as a consequence of surface protrusion as ribs in deformed bars.

4. Define bond stress.

The tangential or shear stress developed along the contact surface of the reinforcing bar and the surrounding concrete if generally termed as bond stress and is expressed in terms of the tangential force per unit nominal surface of the reinforcing bar.

5. List out the various types of reinforcement.

1. Lapping of bars
2. Stirrups at splice locations
3. Staggered splicing
4. Mechanical connections
5. Butt welding of bars
6. Lap welding of bars.

6.Write the formula for developing length.

Development length $Ld = \varphi\sigma s/4\tau bd$

Where Ld Development length

Φ is the diameter of the bar

σs is the stress in the bar

τbd is the design bond stress

7. What are the criteria recommended by IS 456-2000 for anchorage value of bend?

(a) The radius of the bend be not less than twice the diameter of the round bar

(b) The length of the straight part of the bar beyond the end of the curve be at least four times the diameter of the round bar.

(c) Whatever be the angle through which the bar is bend, the assumed anchorage value should not taken as more than equivalent to a length of bar equal to sixteen times the diameter of the round bar.

8. What is the necessity of bending reinforcement?

Bars are bent under different circumstances

- They may be bent to form hooks so as to develop proper anchorage
- Bars have to be bent so as to form loops as in the case of stirrups as shear reinforcement
- Bars may be also be bent to resist diagonal tension. They may also bend up to form necessary reinforcement for hogging bending moments.

9. What are the points to be considered in anchoring shear reinforcement?

(a) Inclined bars: The development length shall be as for bars in tension. This length shall be measured as under.

(i) In tension zone, from the end of the sloping or inclined portion of the bar

(ii) In compression zone, from the mid depth of the beam.

(b) Stirrups: For stirrups and ties, the complete development lengths and anchorage shall be deemed to have provided when the bar is bent through and angle of at least 90^o

10. What are the criteria recommended by IS 450-2000 for cover to reinforcement?

1.At each end of a reinforcing bar – not less not 25mm nor less than twice the diameter of such bar.

2. For longitudinal reinforcement in a column- not less than 40mm nor less the diameter of such bar

3.For longitudinal reinforcement in a beams- not less than 25mm nor less the diameter of such bar

4. For tensile, compressive, shear and other reinforcement in a slab and other reinforcement in a slab- not less than 15mm nor less the diameter of reinforcement

11. Give the property of good a bond between concrete reinforcement.

1. Sufficient cover for reinforcement
2. Richness of concrete
3. using twisted bars, welding the stirrup bars with the main bars
4. Roughness of steel

12. What is meant by end anchorage?

Mild steel bars embedded in concrete are sometimes hooked so as to have proper anchorage with concrete. If bars are provided with hooks, the necessary grip or bond length can be reduced. The anchorage value of the hook alone is considered as 16d where d is the diameter of the bar

13. Write short note on splices in tensile reinforcement.

Splices at point of maximum tensile stress shall be avoided wherever possible, splices where used shall be welded, lapped or otherwise fully developed. In any case the splice shall transfer the entire computed stress from bar to bar.

Lapped splices in tension shall not be used for bars of sizes larger than 36mm diameter and such splices shall preferably be welded.

14. Define shear strength.

The resistance to sliding offered by the material of beam is called shear strength.

15. What are the important factors affecting the shear resistance of a Reinforced concrete member without shear reinforcement?

The important factors affecting the shear resistance of a reinforced concrete member without shear reinforcement are

- Characteristic strength of concrete
- Percentage of longitudinal steel
- Shear span to depth ratio
- Axial compressive / Tensile force
- Effect of cross section
- Effect of two way action

16. What are the types of reinforcement used to resist shear?

The types of reinforcement used to resist shear are

a. Vertical Stirrups

b. Inclined Stirrups

c. Bent up bars along with stirrups

17. Define Torsion.

Equal and opposite moments applied at both ends of structural element (Member) or its part about its longitudinal axis is called Torsion. Also termed as torsional moment or twist or torque.

18.What is compatibility torsion? Give an example

Compatibility torsion is the torsion induced in the member due to compatibility of rotations at the joint of interconnected members.

Examples:

Spandrel beam rigidly connected to cross beam, inter connected bridge girder and grids in horizontal plane.

19.Explain Equilibrium Torsion.

Torsional moment developed in one or more elements of a structure to maintainequilibrium is called as equilibrium torsion. It is also known as determinate torsion or Primary Torsion.

20. Define bond. (Or) What is bond?

Bond is defined as grip between concrete and steel.

(Or)

The force that prevents the relative movement between concrete and steel is known as bond.

(Or)

Bond in reinforced concrete beams is the adhesive force developed between concrete and steel bars embedded in concrete, which resists any force that tends to push or pull the bars.

21. List out the different types of bond.

The different types of bond are

Flexure bond

Anchorage bond

22. Define flexure bond

In flexure member on account of shear of a variation in bending moment, which inturn causes a variation in axial tension along the length of bar.

23. What is meant by Anchorage bond?

Over the length of anchorage provided for a bar or near the end (or cutoff point) of a reinforcing bar.

24.Reinforced concrete slabs are generally safe and do not require shear reinforcement. Why?

The thickness of slab (controlled by limiting deflection criteria) is usually adequate in terms of shear capacity.

(Or)

Normally the thickness of slab is so chosen that the shear can be resisted by concrete itself and the slab does not need extra shear reinforcements

PART - B

1. A rectangular beam width b=350mm and d=550mm has a factored shear of 400KN at the critical section near the support. The steel at the tension side of the section consists of four 32mm bars which are continued to support. Assuming fck=25 andfy=415(N/mm2) design vertical stirrups for the section.

2. A reinforced concrete rectangular beam has a breadth of 350mm and effective depth of 800mm. It has a factored shear of 105kN at section XX. Assuming that fck=25, fy=415(N/mm2) and percentage of tensile steel at that section is 0.5percent, determine the torsional moment the section can resist if no additional reinforcement for torsion isprovided. Workout the problem according to IS456 principles of design for torsion.A simply supported beam is 5m in span and carries a characteristic load at 75kN/m. If6Nos. of 20mm bras are

continued into the supports. Check the development length atthe supports assuming grade M20 concrete and Fe415steel.

3. A rectangular RCC beam is 400x900mm in size. Assuming the use of grade M25 concrete and Fe415 steel, determine the maximum ultimate torsional moment at thesection can take it.No torsion reinforcement is provided andMaximum torsion reinforcement is provided.

4. A rectangular beam width b = 250mm and effective depth 500mm reinforced with 4 bars of 20mm diameter. Determine the shear reinforcement required to resist a shearforce of 150kN. Use concrete M20 and steel Fe415.

5. Design a rectangular beam section of width 250mm and effective depth 500mm,subjected to an ultimate moment of 160kNm, ultimate shear force of 30kN and ultimatetorsional moment of 10kNm. Use concrete M20 and steel 415.

6. A RC beam 300x450mm in cross section in reinforced with 3 Nos. 20mm diameter ofgrade Fe250, with an effective cover of 50mm. The ultimate shear at the section of 138kN.Design the shear reinforcement (i)Using only vertical strips without bending anybar for resisting. (ii) Bending 1 bar dia 20mm at 45 degree to resist shear at the section.Assume concrete of grade M20.

7. A reinforced concrete beam 500mm deep and 230mm wide is reinforced with8Nos.20mm diameter bars at mid span to carry a UDL of 22.5kN/m (inclusive of its ownweight) over simple span of 8m. Assuming concrete grade M20, steel grade Fe415, loadfactor 1.5 and width of support 230mm (i) determine the minimum development lengthrequired for 20mm diameter bar to develop full strength (ii) apply check for flexuraldevelopment length at support assuming all bar to continue at support (iii) determine theminimum number of bars required at support for development length of flexure.