What is Reinforced Concrete Design?

Worksheet

Reinforced concrete design determines the concrete dimensions and steel reinforcement needed so a member safely resists its design loads, typically expressed through the nominal moment capacity Mn = Asfy(d a/2).

$$M = \frac{1}{2} f_c b d^2$$

Questions

1. What material carries the tensile forces in a reinforced concrete beam?

A) Concrete
B) Steel reinforcement
C) Formwork
D) Aggregate

2. In Mn = Asfy(d a/2), what does 'a' represent?

A) Total beam depth
B) Steel area
C) Depth of the equivalent compression stress block
D) Span length

3. What happens if a beam has too little steel reinforcement?

A) It becomes over-reinforced
B) It fails suddenly and brittlely without warning
C) It gets stronger
D) Nothing changes

4. Why is concrete cover important?

A) It increases weight only
B) It protects steel from corrosion and fire
C) It has no structural purpose
D) It reduces strength

5. A beam has As = 1200 mm, fy = 420 MPa, d = 500 mm, and a = 35 mm. Find its nominal moment capacity.

6. Find the stress block depth a for As = 900 mm, fy = 420 MPa, f'c = 25 MPa, b = 300 mm.

7. A slab strip needs Mn 60 kNm with fy = 420 MPa, d = 180 mm, a = 20 mm. Find the required As.

8. Define: What does 'reinforced' concrete mean?

9. Define: Why combine concrete and steel?

10. Define: What is the effective depth d?

Answer Key

1. B) Steel reinforcement - Concrete resists compression; steel rebar resists tension.

2. C) Depth of the equivalent compression stress block - 'a' is the depth of the rectangular stress block in the compression zone.

3. B) It fails suddenly and brittlely without warning - Under-reinforced sections should yield steel first for ductile failure; too little steel risks sudden brittle failure at first cracking.

4. B) It protects steel from corrosion and fire - Cover shields reinforcement from moisture, chlorides, and heat, preventing corrosion and maintaining fire resistance.

5. Mn = Asfy(d a/2) Mn = 1200 420 (500 17.5) Mn = 1200 420 482.5 = 243,180,000 Nmm 243.2 kNm

6. a = Asfy / (0.85f'cb) a = (900 420) / (0.85 25 300) a = 378,000 / 6,375 59.3 mm

7. Mn = Asfy(d a/2) As = Mn / (fy(d a/2)) As = 60,000,000 / (420 (180 10)) As = 60,000,000 / 71,400 840 mm

8. Concrete embedded with steel bars (rebar) that carry the tensile forces concrete alone cannot resist.

9. Concrete is strong in compression but weak in tension; steel is strong in tension - together they resist bending efficiently.

10. The distance from the extreme compression fiber to the centroid of the tension steel.