NARSIMHA REDDY ENGINEERING COLLEGE
UGC AUTONOMOUS ACCREDITED BY NBA & NAAC WITH A-GRADE

25CE301 BUILDING MATERIALS AND CONCRETE TECHNOLOGY

UNIT-V

MIX DESIGN AND SPECIAL CONCRETES – DETAILED NOTES
1. MIX DESIGN OF CONCRETE

Definition

Concrete mix design is the process of selecting suitable ingredients of concrete and determining their relative proportions to produce concrete with required strength, durability, and workability at minimum cost.

Objectives of Mix Design

1. Achieve required strength
2. Obtain desired workability
3. Ensure durability
4. Economical concrete production
5. Minimize segregation and bleeding

TYPES OF CONCRETE MIX
1. Nominal Mix

Definition

Concrete mix in which proportions are fixed by standard ratios.

Examples

- 1:2:4
- 1:1.5:3

Advantages

- Simple
- No laboratory testing required

Disadvantages

- Less accurate
- May not provide optimum strength

2. Design Mix

Definition

Concrete mix in which proportions are determined scientifically based on material properties and strength requirements.

Advantages

- Economical
- Better quality control
- Desired strength achieved

Disadvantages

- Requires laboratory testing

Difference Between Nominal Mix and Design Mix

Nominal Mix	Design Mix
Fixed proportions	Scientifically designed
Less accurate	More accurate
Used for small works	Used for major works
Lower quality control	Better quality control

FACTORS INFLUENCING MIX DESIGN

Factor	Influence
Water-cement ratio	Controls strength
Workability	Affects placing and compaction
Aggregate size	Affects water demand
Aggregate shape	Influences workability
Cement type	Affects strength and durability
Exposure conditions	Determines durability requirements
Degree of compaction	Influences strength

INDIAN STANDARD METHOD OF MIX DESIGN

(IS 10262:2019)

The Indian Standard method is used to determine proportions of concrete ingredients scientifically.

Steps in IS Method of Mix Design

Step 1: Design Stipulations

- Grade designation
- Type of cement
- Maximum aggregate size
- Workability requirement
- Exposure condition

Step 2: Target Mean Strength

Formula

fck′=fck+1.65sf'_{ck}=f_{ck}+1.65sfck′=fck+1.65s

Where:

- fck′f'_{ck}fck′ = Target mean strength
- fckf_{ck}fck = Characteristic compressive strength
- sss = Standard deviation

Importance of Target Strength

Concrete strength varies due to material and construction variations. Therefore target strength is taken higher than characteristic strength.

Step 3: Selection of Water-Cement Ratio

Definition

Water-Cement Ratio=Weight of WaterWeight of CementWater\text{-}Cement\ Ratio = \frac{Weight\ of\ Water}{Weight\ of\ Cement}Water-Cement Ratio=Weight of CementWeight of Water

Importance

- Controls strength
- Controls durability
- Controls permeability

Abram's Law

Statement

Strength of concrete is inversely proportional to water-cement ratio.

Strength∝1Water-Cement RatioStrength \propto \frac{1}{Water\text{-}Cement\ Ratio}Strength∝Water-Cement Ratio1

Step 4: Selection of Water Content

Water content depends on:

- Aggregate size
- Workability requirement
- Shape of aggregate

Step 5: Calculation of Cement Content

Formula

Cement Content=Water ContentWater-Cement RatioCement\ Content = \frac{Water\ Content}{Water\text{-}Cement\ Ratio}Cement Content=Water-Cement RatioWater Content

Step 6: Estimation of Aggregate Proportions

- Fine aggregate percentage
- Coarse aggregate percentage

Step 7: Trial Mixes

Trial mixes are prepared and tested to achieve required properties.

WORKABILITY OF CONCRETE

Definition

Ease with which concrete can be mixed, transported, placed, and compacted.

Factors Affecting Workability

1. Water content
2. Aggregate shape
3. Aggregate grading
4. Cement content
5. Admixtures

AIR CONTENT IN CONCRETE

Definition

Percentage of air voids present in concrete.

Importance

- Improves workability
- Improves frost resistance
- Reduces segregation

MIX DESIGN EXAMPLE USING IS METHOD

Example Data

- Grade: M25
- Maximum aggregate size: 20 mm

- Exposure: Moderate
- Slump: 75 mm

Procedure

1. Determine target strength
2. Select water-cement ratio
3. Estimate water content
4. Calculate cement content
5. Determine aggregate proportions
6. Prepare trial mix

ACCEPTANCE CRITERIA FOR CONCRETE

(As per IS 456:2000)

Concrete is accepted if:

1. Average strength of group of specimens ≥ characteristic strength
2. Individual test results are within permissible limits

QUALITY CONTROL IN CONCRETE

Definition

Techniques and procedures used to ensure required quality in concrete production.

Objectives

- Uniform quality
- Required strength
- Durability
- Economy

Quality Control Measures

1. Proper material selection
2. Accurate batching
3. Proper mixing
4. Adequate curing
5. Testing of concrete

QUALITY ASSURANCE

Definition

Planned systematic activities to ensure quality requirements are fulfilled.

Difference Between Quality Control and Quality Assurance

Quality Control	Quality Assurance
Detects defects	Prevents defects
Product oriented	Process oriented
Inspection based	System based

SPECIAL CONCRETES
1. SELF-COMPACTING CONCRETE (SCC)

Definition

Concrete that flows and compacts under its own weight without vibration.

Ingredients

- Cement
- Fine aggregates
- Coarse aggregates
- Superplasticizers
- Mineral admixtures

Properties

- High flowability
- No segregation
- Excellent surface finish
- High durability

Advantages

- Reduces labor
- Faster construction
- Better compaction

Applications

- Congested reinforcement areas
- Complex formworks

2. LIGHTWEIGHT CONCRETE

Definition

Concrete having lower density than normal concrete.

Ingredients

- Lightweight aggregates

- Cement
- Water
- Admixtures

Properties

- Low density
- Good thermal insulation
- Reduced dead load

Applications High-rise buildings

- Partition walls
- Roof insulation

3. HIGH PERFORMANCE CONCRETE (HPC)

Definition

Concrete with superior strength and durability compared to normal concrete.

Ingredients

- Low water-cement ratio
- Superplasticizers
- Silica fume
- High-quality aggregates

Properties

- High strength
- High durability
- Low permeability

Applications

- Bridges
- Tall buildings
- Marine structures

4. FIBER-REINFORCED CONCRETE (FRC)

Definition

Concrete containing fibers to improve tensile strength and crack resistance.

Types of Fibers

- Steel fibers
- Glass fibers
- Synthetic fibers
- Carbon fibers

Properties

- Improved toughness
- Reduced cracking
- Better impact resistance

Applications

- Pavements
- Industrial floors
- Airport runways

5. ROLLER COMPACTED CONCRETE (RCC)

Definition

Dry concrete compacted using rollers.

Ingredients

- Cement
- Aggregates
- Water
- Fly ash

Properties

- Low water content
- High density
- Economical

Applications

- Dams
- Pavements
- Heavy-duty roads

IMPORTANT DIFFERENCES
Nominal Mix vs Design Mix

Nominal Mix	Design Mix
Fixed ratios	Scientifically proportioned
Less accurate	Accurate

Nominal Mix	Design Mix
Small works	Major works

SCC vs Normal Concrete

SCC	Normal Concrete
No vibration needed	Vibration required
High flowability	Moderate flowability
Better finish	Normal finish

Lightweight Concrete vs Normal Concrete

Lightweight Concrete	Normal Concrete
Low density	High density
Reduced dead load	Higher dead load

IMPORTANT UNIVERSITY QUESTIONS

1. Define concrete mix design and explain its objectives.
2. Differentiate nominal mix and design mix.
3. Explain factors influencing mix design.
4. Explain IS 10262:2019 method of mix design.
5. Explain target mean strength and water-cement ratio.
6. Discuss acceptance criteria for concrete as per IS 456:2000.
7. Explain quality control and quality assurance in concrete.
8. Write notes on self-compacting concrete.
9. Explain properties of high-performance concrete.
10. Discuss lightweight concrete, fiber-reinforced concrete, and roller compacted