Concrete Technology (DI04006011)

Civil Engineering Department

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Lecture 1.1: History of cement invention.

Civil Engineering Department

Lecture Agenda

- 1. History of cement invention.
- 2. Summary and Q&A

1.1 History of cement invention.

- Joseph Aspdin, an English bricklayer, patented Portland cement in 1824.
- It was named 'Portland' due to its resemblance to Portland stone quarried in Dorset.
- Early Roman concrete used pozzolanic ash mixed with lime to form a durable binder.
- Isaac Johnson further improved the process in 1845 by firing chalk and clay at much higher temperatures.
- The rotary kiln revolution in the 1890s allowed for continuous mass production of cement.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.2: Overview of Cement Manufacturing.

Civil Engineering Department

Lecture Agenda

- 1. Overview of Cement Manufacturing.
- 2. Summary and Q&A

1.2 Overview of Cement Manufacturing.

1. Raw Materials: Calcareous & Argillaceous

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2. Mixing & Grinding (Dry/Wet Process)

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3. Clinkering in Rotary Kiln (1400-1500°C)

↓

4. Grinding Clinker + 2-3% Gypsum

↓

5. Final Product: Portland Cement

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.3: Bogue's compounds and its functions

Civil Engineering Department

Lecture Agenda

- 1. Bogue's compounds and its functions
- 2. Summary and Q&A

1.3 Bogue's compounds and its functions

Compound	Function	Percentage
Tricalcium Silicate (C3S)	Early strength & initial set	30-50%
Dicalcium Silicate (C2S)	Ultimate/later strength	20-45%
Tricalcium Aluminate (C3A)	Rapid hydration, high heat	8-12%
Tetracalcium Aluminoferrite (C4AF)	Flux, reduces temp, low strength	6-10%

Key Note

The relative proportion of these four compounds dictates the cement type.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.4: Physical and Chemical properties of cement.

Civil Engineering Department

Lecture Agenda

- 1. Physical and Chemical properties of cement.
- 2. Testing of cement as per BIS.
- 3. Summary and Q&A

1.4 Physical and Chemical properties of ceme...

- Physical properties: Fineness, setting time, soundness, compressive strength, and specific gravity.
- Chemical properties: Ratio of percentage of alumina to iron oxide, lime saturation factor.
- Loss on ignition: Should not exceed 5% by mass.
- Insoluble residue: Should not exceed 2% by mass.
- High fineness increases the rate of hydration and early strength development.

1.5 Testing of cement as per BIS.

Fineness (Sieve)

Consistency (Vicat)

Setting Time

Soundness

Compressive Strength

- **Initial Setting Time:** Min 30 mins
- **Final Setting Time:** Max 600 mins

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.5: Various Grades and types of cements for different site conditions and its pro...

Civil Engineering Department

Lecture Agenda

- 1. Various Grades and types of cements for different site conditions and its properties.
- 2. Summary and Q&A

Definition

Cement is classified by its 28-day compressive strength (e.g., Grade 53 = 53 MPa).

- Ordinary Portland Cement (OPC): Grades 33, 43, and 53, used in general construction.
- Rapid Hardening Cement (RHC): Used for early formwork removal and cold weather concreting.
- Sulphate Resisting Cement: Used in marine conditions and soils with high sulphate content.
- Portland Slag Cement (PSC) & Portland Pozzolana Cement (PPC): Eco-friendly, low heat, high durability.
- Low Heat Cement: Used in mass concreting (dams) to prevent thermal cracking.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.6: Role of Aggregate, types of aggregate and it's source, Classification of aggr...

Civil Engineering Department

Lecture Agenda

- 1. Role of Aggregate, types of aggregate and it's source, Classification of aggregate, Soundness of aggregate, Alkali Aggregate Reaction, Grading of aggregate.
- 2. Summary and Q&A

1.7 Role of Aggregate, types of aggregate an...

- Aggregates form 70-80% of concrete volume, providing dimensional stability and wear resistance.
- Source: Natural (river sand, crushed rock) or Artificial (slag, recycled aggregate).
- Classification: Fine aggregates (passing 4.75mm IS sieve) and Coarse aggregates (retained on 4.75mm).
- Soundness: Resistance to volume changes due to physical environmental effects like freezing/thawing.
- Alkali-Aggregate Reaction: Chemical reaction between active silica in aggregate and alkalis in cement, causing expansion.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 1.7: Testing of aggregate as per BIS.

Civil Engineering Department

Lecture Agenda

- 1. Testing of aggregate as per BIS.
- 2. Quality of water, impurities in mixing water and permissible limits as per BIS.
- 3. Summary and Q&A

1.8 Testing of aggregate as per BIS.

- Sieve Analysis: Conducted to determine the particle size distribution (grading) and fineness modulus.
- Specific Gravity & Water Absorption: Measured using pycnometer or wire basket method.
- Aggregate Impact Value (AIV): Measures toughness or resistance to sudden impact.
- Aggregate Crushing Value (ACV): Measures resistance to gradual compressive loads.
- Los Angeles Abrasion Test: Determines the wear/abrasion resistance of coarse aggregates.

1.9 Quality of water, impurities in mixing w...

- Water acts as a reactant in hydration and a lubricant for workability.
- General rule: Water fit for drinking is generally fit for making concrete.
- pH of mixing water should not be less than 6.0.
- Permissible limits (IS 456): Organic (200 mg/l), Inorganic (3000 mg/l), Sulphates (400 mg/l).
- Chlorides: Max 2000 mg/l for plain concrete, 500 mg/l for reinforced concrete.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.8: Concrete chain - Various stages of making fresh concrete at site

Civil Engineering Department

Lecture Agenda

- 1. Concrete chain - Various stages of making fresh concrete at site
- 2. Summary and Q&A

- Batching: Accurately measuring materials (cement, aggregates, water, admixtures).
- Mixing: Thoroughly blending the batched materials to achieve a uniform, homogeneous mass.
- Transportation: Moving the fresh concrete from the mixer to the final placement location.
- Placing & Compaction: Depositing concrete into forms and removing entrapped air.
- Finishing & Curing: Leveling the surface and maintaining moisture for hydration.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.9: workability, factors affecting workability, Effect of water cement ratio, adj...

Civil Engineering Department

Lecture Agenda

- 1. workability, factors affecting workability, Effect of water cement ratio, adjustments of materials to avoid segregation and bleeding , methods of Measurement of workability as per BIS - slump test, compaction factor test, flow table test, vee bee test .
- 2. Summary and Q&A

2.2 workability, factors affecting workabili...

- Workability: The ease with which concrete can be mixed, transported, placed, and compacted.
- Factors affecting: Water content, mix proportions, aggregate size/shape/texture, use of admixtures.
- Segregation: Separation of coarse aggregate from the mortar. Bleeding: Water rising to the surface.
- Slump Test: Most common field test; measures the subsidence of a concrete cone.
- Compaction Factor & Vee-Bee Test: Used in labs for low workability or stiff concrete mixes.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.10: Methods of Batching, mixing of materials for making fresh concrete - hand mix...

Civil Engineering Department

Lecture Agenda

- 1. Methods of Batching, mixing of materials for making fresh concrete - hand mixing and machine mixing, mixing time.
- 2. Summary and Q&A

2.3 Methods of Batching, mixing of materials...

- Volume Batching: Less accurate, prone to bulking of sand errors. Weight Batching: Highly recommended, accurate.
- Hand Mixing: Used for small jobs; requires 10% extra cement to compensate for poor mixing.
- Machine Mixing: Uses pan or drum mixers; produces uniform concrete efficiently.
- Mixing Time: Typically 1.5 to 2.5 minutes; over-mixing can cause aggregate breakdown or loss of workability.
- Sequence of charging: Coarse aggregate, fine aggregate, cement, and then water.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.11: Methods of Transportation of fresh concrete - conventional and through pumps ...

Civil Engineering Department

Lecture Agenda

- 1. Methods of Transportation of fresh concrete - conventional and through pumps and pipeline.
- 2. Summary and Q&A

2.4 Methods of Transportation of fresh concr...

- Conventional methods: Wheelbarrows, buckets, dumpers, and transit mixers.
- Chutes: Used for gravity transport; slope should be steep enough to prevent segregation.
- Pumps and Pipelines: Highly efficient for high-rise buildings and large volume placements.
- Pumped concrete requires a cohesive mix with adequate fines and workability (slump 75-100mm).
- Precautions: Prevent segregation, avoid delays, and protect from extreme weather during transport.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.12: Placing of concrete - formwork stripping time, under water concreting

Civil Engineering Department

Lecture Agenda

- 1. Placing of concrete - formwork stripping time, under water concreting
- 2. Summary and Q&A

2.5 Placing of concrete - formwork stripping...

- Forms must be rigid, clean, and oiled before placing concrete.
- Concrete should be placed in uniform layers (150-300mm) and as close to its final position as possible.
- Free fall of concrete should not exceed 1.5 meters to prevent segregation.
- Formwork stripping time: 16-24 hours for vertical surfaces (columns/walls), longer for slabs/beams.
- Underwater concreting: Uses Tremie pipe or skip to prevent washing away of cement.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.13: Compaction, importance of compaction, methods - hand compaction, machine comp...

Civil Engineering Department

Lecture Agenda

- 1. Compaction, importance of compaction, methods - hand compaction, machine compaction - various vibrators and other equipments, time of vibration, vibrating techniques and precautions.
- 2. Summary and Q&A

- Compaction expels entrapped air; 5% air voids can reduce strength by up to 30%.
- Hand compaction: Rodding, tamping, or ramming used for high slump mixes.
- Internal Vibrators (Needle): Immersed directly into concrete; highly effective.
- Form Vibrators (External): Attached to formwork; used for thin walls or heavily reinforced sections.
- Precautions: Do not over-vibrate (causes segregation); withdraw the needle slowly.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.14: Methods of finishing of fresh concrete, Laitance & its removal.

Civil Engineering Department

Lecture Agenda

- 1. Methods of finishing of fresh concrete, Laitance & its removal.
- 2. Summary and Q&A

- Screeding: Striking off excess concrete to bring the surface to the proper grade.
- Floating: Removing irregularities and compacting the surface using wooden or metal floats.
- Troweling: Final step to produce a smooth, hard, dense surface (done after surface moisture evaporates).
- Laitance: A weak layer of cement and fine dust that forms on the surface due to bleeding.
- Removal of laitance: Essential for good bond in subsequent lifts; removed by brushing or water jet.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 2.15: Curing, importance of curing, period of curing accelerated curing, Convention...

Civil Engineering Department

Lecture Agenda

- 1. Curing, importance of curing, period of curing accelerated curing, Conventional methods of curing - water curing methods, Special methods of curing- steam, membrane, Infrared, Electrical.
- 2. Summary and Q&A

2.8 Curing, importance of curing, period of ...

- Curing: Maintaining favorable moisture and temperature conditions for ongoing hydration.
- Importance: Ensures proper strength development, durability, and reduces shrinkage cracks.
- Water curing: Ponding, spraying/fogging, or covering with wet burlap/gunny bags.
- Membrane curing: Applying chemical compounds to form a moisture-retaining film.
- Accelerated curing: Steam curing or electrical curing used in precast industry to gain early strength.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.16: Hardened Concrete and its Properties: Compressive Strength, Tensile Strength,...

Civil Engineering Department

Lecture Agenda

- 1. Hardened Concrete and its Properties: Compressive Strength, Tensile Strength, Bond Strength, Flexural Strength, Durability and impermeability.
- 2. Summary and Q&A

- Compressive Strength: The most critical property; heavily relies on w/c ratio and compaction.
- Tensile & Flexural Strength: Concrete is weak in tension (approx 10% of compressive strength).
- Bond Strength: Resistance to sliding between reinforcing steel and surrounding concrete.
- Impermeability: Resistance to the flow of fluids; crucial for protecting reinforcement from corrosion.
- Durability: Ability to withstand weathering action, chemical attack, and abrasion.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.17: Hardened Concrete and its Properties: Compressive Strength, Tensile Strength,...

Civil Engineering Department

Lecture Agenda

- 1. Hardened Concrete and its Properties: Compressive Strength, Tensile Strength, Bond Strength, Flexural Strength, Durability and impermeability.
- 2. Summary and Q&A

3.1 Hardened Concrete and its Properties: Co...

- Compressive Strength: The most critical property; heavily relies on w/c ratio and compaction.
- Tensile & Flexural Strength: Concrete is weak in tension (approx 10% of compressive strength).
- Bond Strength: Resistance to sliding between reinforcing steel and surrounding concrete.
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Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.18: Factors affecting Compressive Strength.

Civil Engineering Department

Lecture Agenda

- 1. Factors affecting Compressive Strength.
- 2. Summary and Q&A

3.2 Factors affecting Compressive Strength.

- Water-Cement Ratio (Abram's Law): Strength is inversely proportional to the w/c ratio.
- Degree of Compaction: Voids dramatically reduce the load-carrying capacity.
- Age of Concrete: Strength increases rapidly initially, then slows down, continuing over time.
- Curing Temperature: Higher initial temperatures accelerate early strength but may reduce long-term strength.
- Aggregate Characteristics: Texture and maximum size affect the transition zone and bond strength.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.19: IS Test Procedure to find Compressive & Tensile Strength of Concrete, Accepta...

Civil Engineering Department

Lecture Agenda

- 1. IS Test Procedure to find Compressive & Tensile Strength of Concrete, Acceptance Criteria, and Mean Strength & Standard Deviation.
- 2. Summary and Q&A

3.3 IS Test Procedure to find Compressive & ...

- Cubes (150mm) are cast, compacted, and cured for 28 days for compressive strength testing.
- Tested in a Compression Testing Machine (CTM) at a loading rate of 14 N/mm2/minute.
- Acceptance Criteria (IS 456): The average of three specimens determines the strength; variation must be within limits.
- Split Tensile Test: A cylinder is laid horizontally and loaded compressively to failure.
- Mean Strength = Characteristic Strength + (1.65 x Standard Deviation).

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.20: Creep and Shrinkage of Concrete & its effect, factors affecting Creep and shr...

Civil Engineering Department

Lecture Agenda

- 1. Creep and Shrinkage of Concrete & its effect, factors affecting Creep and shrinkage.
- 2. Summary and Q&A

3.4 Creep and Shrinkage of Concrete & its ef...

- Creep: Time-dependent permanent deformation of concrete under sustained load.
- Factors affecting Creep: Magnitude of load, age at loading, moisture content, w/c ratio.
- Shrinkage: Reduction in volume of concrete mainly due to loss of moisture.
- Types of Shrinkage: Plastic shrinkage (before setting) and Drying shrinkage (hardened state).
- Effects: Leads to cracking, increased deflection, and loss of prestress in prestressed concrete.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.21: Durability of Concrete & factors affecting it.

Civil Engineering Department

Lecture Agenda

- 1. Durability of Concrete & factors affecting it.
- 2. Summary and Q&A

3.5 Durability of Concrete & factors affecti...

- Durability is the ability to resist weathering, chemical attack, and abrasion.
- Permeability: The primary factor; dense, impermeable concrete is generally durable.
- Sulphate Attack: Sulphates react with C3A, causing expansion and disruption; mitigate using Sulphate Resisting Cement.
- Carbonation: CO_2 penetrates concrete, reduces pH, and destroys the passivating layer around steel.
- Freezing and Thawing: Water in pores freezes and expands, causing spalling; mitigate using air-entraining agents.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.22: Importance of NDT.

Civil Engineering Department

Lecture Agenda

- 1. Importance of NDT.
- 2. Summary and Q&A

3.6 Importance of NDT.

- Non-Destructive Testing (NDT) assesses concrete properties without causing structural damage.
- Importance: Useful for existing structures, evaluating post-fire or post-earthquake damage.
- Quality Assurance: Used to verify uniformity and locate internal voids or honeycombing.
- No single NDT method provides a direct measure of strength; they provide empirical correlations.
- Often combined with partially destructive tests (like core extraction) for reliable strength assessment.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 3.23: Methods of NDT for Concrete-Rebound Hammer Test, Ultrasonic Pulse Velocity T...

Civil Engineering Department

Lecture Agenda

- 1. Methods of NDT for Concrete- Rebound Hammer Test, Ultrasonic Pulse Velocity Test.
- 2. Summary and Q&A

- Rebound Hammer Test (Schmidt Hammer): Evaluates surface hardness of concrete.
- Rebound number correlates empirically with compressive strength; affected by surface smoothness and moisture.
- Ultrasonic Pulse Velocity (UPV) Test: Measures the velocity of an ultrasonic pulse passing through concrete.
- Higher UPV indicates dense, good-quality concrete; lower velocity indicates voids, cracks, or deterioration.
- UPV can determine dynamic modulus of elasticity and estimate the depth of cracks.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.24: Nominal Mix and Design Mix.

Civil Engineering Department

Lecture Agenda

- 1. Nominal Mix and Design Mix.
- 2. Summary and Q&A

4.1 Nominal Mix and Design Mix.

- Nominal Mix: Fixed volumetric proportions (e.g., 1:2:4 for M15, 1:1.5:3 for M20).
- Usage: Limited to low-grade concrete (up to M20) and small-scale, non-critical construction.
- Limitations of Nominal Mix: Does not account for aggregate variations or specific strength requirements.
- Design Mix: Proportions determined experimentally in a lab to achieve specified strength and workability.
- Advantages of Design Mix: Economical, accounts for local material properties, ensures guaranteed strength.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.25: Nominal Mix and Design Mix.

Civil Engineering Department

Lecture Agenda

- 1. Nominal Mix and Design Mix.
- 2. Summary and Q&A

4.1 Nominal Mix and Design Mix.

- Nominal Mix: Fixed volumetric proportions (e.g., 1:2:4 for M15, 1:1.5:3 for M20).
- Usage: Limited to low-grade concrete (up to M20) and small-scale, non-critical construction.
- Limitations of Nominal Mix: Does not account for aggregate variations or specific strength requirements.
- Design Mix: Proportions determined experimentally in a lab to achieve specified strength and workability.
- Advantages of Design Mix: Economical, accounts for local material properties, ensures guaranteed strength.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.26: Concrete Mix Design and its importance.

Civil Engineering Department

Lecture Agenda

- 1. Concrete Mix Design and its importance.
- 2. Summary and Q&A

4.2 Concrete Mix Design and its importance.

- Concrete Mix Design is the process of selecting suitable ingredients and determining their relative quantities.
- Objective 1: Achieve the specified characteristic compressive strength at a given age (usually 28 days).
- Objective 2: Attain required workability for easy placement and compaction.
- Objective 3: Ensure maximum durability in the given environmental exposure conditions.
- Objective 4: Produce concrete as economically as possible by optimizing cement content.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.27: Concrete Mix Design and its importance.

Civil Engineering Department

Lecture Agenda

- 1. Concrete Mix Design and its importance.
- 2. Summary and Q&A

4.2 Concrete Mix Design and its importance.

- Concrete Mix Design is the process of selecting suitable ingredients and determining their relative quantities.
- Objective 1: Achieve the specified characteristic compressive strength at a given age (usually 28 days).
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- Objective 3: Ensure maximum durability in the given environmental exposure conditions.
- Objective 4: Produce concrete as economically as possible by optimizing cement content.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.28: Different methods of Mix Design and its suitability.

Civil Engineering Department

Lecture Agenda

- 1. Different methods of Mix Design and its suitability.
- 2. Summary and Q&A

4.3 Different methods of Mix Design and its ...

- IS Method (IS 10262): The standard Indian method, based on empirical relationships and local materials.
- ACI Method (American Concrete Institute): Based on the absolute volume method and dry-rodded aggregate weight.
- DOE Method (British Method): Focuses on the relationship between compressive strength and free water-cement ratio.
- Suitability: The IS method is mandatory for structural concrete projects in India.
- Mix design must be verified by casting trial batches and adjusting for yield and workability.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.29: Concrete Mix Design as per IS 10262.

Civil Engineering Department

Lecture Agenda

- 1. Concrete Mix Design as per IS 10262.
- 2. Summary and Q&A

4.4 Concrete Mix Design as per IS 10262.

- Step 1: Determine target mean strength (fck' = fck + 1.65*s).
- Step 2: Select water-cement ratio based on target strength and durability requirements (IS 456).
- Step 3: Estimate water content based on aggregate size and required slump.
- Step 4: Calculate cement content (Water content / w/c ratio) and check against minimum requirements.
- Step 5: Estimate proportion of coarse and fine aggregate volumes, then calculate absolute weights.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.30: Concrete Mix Design as per IS 10262.

Civil Engineering Department

Lecture Agenda

- 1. Concrete Mix Design as per IS 10262.
- 2. Summary and Q&A

4.4 Concrete Mix Design as per IS 10262.

- Step 1: Determine target mean strength (fck' = fck + 1.65*s).
- Step 2: Select water-cement ratio based on target strength and durability requirements (IS 456).
- Step 3: Estimate water content based on aggregate size and required slump.
- Step 4: Calculate cement content (Water content / w/c ratio) and check against minimum requirements.
- Step 5: Estimate proportion of coarse and fine aggregate volumes, then calculate absolute weights.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 4.31: Example of Mix design as per IS method for ordinary and standard grade of con...

Civil Engineering Department

Lecture Agenda

- 1. Example of Mix design as per IS method for ordinary and standard grade of concrete without and with admixtures.
- 2. Summary and Q&A

- Example without admixture: Given M25, slump 75mm, max aggregate 20mm. Calculate water 191 L, cement 382 kg/m3.
- Example with admixture (Superplasticizer): Reduces water requirement by 20%.
- Revised water content: 153 L. Revised cement content (for same w/c): 306 kg/m3 (Economical!).
- Check max cement limit (450 kg/m3) and min cement for exposure condition.
- Final mix proportions expressed as a weight ratio (e.g., Cement : Sand : Aggregate = 1 : 1.6 : 2.8).

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.32: Admixtures in concrete: Purpose, properties and application for different typ...

Civil Engineering Department

Lecture Agenda

- 1. Admixtures in concrete: Purpose, properties and application for different types of admixture such as accelerators, retarders, water reducing admixtures, air entraining agents and super plasticizers.
- 2. Summary and Q&A

5.1 Admixtures in concrete: Purpose, propert...

- Admixtures: Chemicals added before or during mixing to modify concrete properties.
- Accelerators (e.g., Calcium Chloride): Speed up setting time and early strength; used in cold weather.
- Retarders (e.g., Sugar, Gypsum): Delay setting time; used in hot weather or long hauls.
- Water Reducing Admixtures (Plasticizers): Increase workability without adding water.
- Air Entraining Agents: Introduce microscopic air bubbles to resist freezing and thawing cycles.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.33: Admixtures in concrete: Purpose, properties and application for different typ...

Civil Engineering Department

Lecture Agenda

- 1. Admixtures in concrete: Purpose, properties and application for different types of admixture such as accelerators, retarders, water reducing admixtures, air entraining agents and super plasticizers.
- 2. Summary and Q&A

5.1 Admixtures in concrete: Purpose, propert...

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- Air Entraining Agents: Introduce microscopic air bubbles to resist freezing and thawing cycles.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.34: Admixtures in concrete: Purpose, properties and application for different typ...

Civil Engineering Department

Lecture Agenda

- 1. Admixtures in concrete: Purpose, properties and application for different types of admixture such as accelerators, retarders, water reducing admixtures, air entraining agents and super plasticizers.
- 2. Summary and Q&A

- Admixtures: Chemicals added before or during mixing to modify concrete properties.
- Accelerators (e.g., Calcium Chloride): Speed up setting time and early strength; used in cold weather.
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- Water Reducing Admixtures (Plasticizers): Increase workability without adding water.
- Air Entraining Agents: Introduce microscopic air bubbles to resist freezing and thawing cycles.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.35: Special Concrete: Properties, Advantages and limitations of the following typ...

Civil Engineering Department

Lecture Agenda

- 1. Special Concrete: Properties, Advantages and limitations of the following types of Special Concretes Self-Compacting Concrete (SCC), Pervious Concrete, Fiber reinforced concrete, Ready mix concrete, Fly ash concrete, Recycled Aggregate Concrete, High performance Concrete, 3D printed Concrete
- 2. Summary and Q&A

5.2 Special Concrete: Properties, Advantages...

- Self-Compacting Concrete (SCC): Flows under its own weight, no vibration needed; uses superplasticizers and VMA.
- Pervious Concrete: High porosity, allows water to pass through; used in eco-friendly parking lots for groundwater recharge.
- Fiber Reinforced Concrete: Contains steel, glass, or synthetic fibers; vastly improves tensile strength and impact resistance.
- Ready Mix Concrete (RMC): Manufactured in a batching plant and delivered in transit mixers; ensures high quality control.
- Fly Ash / Recycled Aggregate Concrete: Sustainable options that reduce carbon footprint and landfill waste.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.36: Special Concrete: Properties, Advantages and limitations of the following typ...

Civil Engineering Department

Lecture Agenda

- 1. Special Concrete: Properties, Advantages and limitations of the following types of Special Concretes Self-Compacting Concrete (SCC), Pervious Concrete, Fiber reinforced concrete, Ready mix concrete, Fly ash concrete, Recycled Aggregate Concrete, High performance Concrete, 3D printed Concrete
- 2. Summary and Q&A

5.2 Special Concrete: Properties, Advantages...

- Self-Compacting Concrete (SCC): Flows under its own weight, no vibration needed; uses superplasticizers and VMA.
- Pervious Concrete: High porosity, allows water to pass through; used in eco-friendly parking lots for groundwater recharge.
- Fiber Reinforced Concrete: Contains steel, glass, or synthetic fibers; vastly improves tensile strength and impact resistance.
- Ready Mix Concrete (RMC): Manufactured in a batching plant and delivered in transit mixers; ensures high quality control.
- Fly Ash / Recycled Aggregate Concrete: Sustainable options that reduce carbon footprint and landfill waste.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.37: Modern trends and research in concrete technology, relevant journals and inst...

Civil Engineering Department

Lecture Agenda

- 1. Modern trends and research in concrete technology, relevant journals and institutes.
- 2. Summary and Q&A

- Modern trends heavily focus on sustainability: Green concrete, geopolymer concrete (zero cement).
- Nano-technology in concrete: Using nano-silica to achieve ultra-high performance and densification.
- 3D Printed Concrete: Automated extrusion for rapid, formwork-free construction of complex geometries.
- Smart Concrete: Embedded sensors or conductive fibers for structural health monitoring.
- Prominent research institutes: ACI, RILEM, CSIR-CBRI, and Indian Concrete Institute (ICI).

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 5.38: Modern trends and research in concrete technology, relevant journals and inst...

Civil Engineering Department

Lecture Agenda

- 1. Modern trends and research in concrete technology, relevant journals and institutes.
- 2. Summary and Q&A

- Modern trends heavily focus on sustainability: Green concrete, geopolymer concrete (zero cement).
- Nano-technology in concrete: Using nano-silica to achieve ultra-high performance and densification.
- 3D Printed Concrete: Automated extrusion for rapid, formwork-free construction of complex geometries.
- Smart Concrete: Embedded sensors or conductive fibers for structural health monitoring.
- Prominent research institutes: ACI, RILEM, CSIR-CBRI, and Indian Concrete Institute (ICI).

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.39: Definition of repair, rehabilitation and retrofitting

Civil Engineering Department

Lecture Agenda

- 1. Definition of repair, rehabilitation and retrofitting
- 2. Summary and Q&A

6.1 Definition of repair, rehabilitation and...

- Repair: Restoring a damaged or degraded structure to an acceptable functional condition.
- Rehabilitation: Upgrading a structure to meet the original service level or current safety standards.
- Retrofitting: Strengthening an existing structure to enhance its performance beyond its original design.
- Seismic Retrofitting: Specifically upgrading structures to withstand earthquake forces.
- The goal is to extend the service life and ensure structural integrity safely.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.40: Deterioration of concrete, types, causes and prevention.

Civil Engineering Department

Lecture Agenda

- 1. Deterioration of concrete, types, causes and prevention.
- 2. Summary and Q&A

6.2 Deterioration of concrete, types, causes...

- Types of deterioration: Cracking, spalling, delamination, scaling, and honeycomb.
- Causes: Overloading, foundation settlement, fire damage, chemical attack, weathering.
- Physical causes: Freeze-thaw cycles, thermal expansion/contraction, abrasion.
- Prevention: Use of low w/c ratio, adequate cover thickness, proper compaction, and curing.
- Applying protective coatings or sealers can significantly delay surface deterioration.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.41: Corrosion of reinforcement, causes and prevention.

Civil Engineering Department

Lecture Agenda

- 1. Corrosion of reinforcement, causes and prevention.
- 2. Summary and Q&A

6.3 Corrosion of reinforcement, causes and p...

- Corrosion of reinforcement is the most common cause of concrete deterioration globally.
- Mechanism: Depassivation of steel due to carbonation or chloride ingress, leading to rust formation.
- Rust has 3-6 times the volume of steel, creating massive internal tensile stress that spalls concrete.
- Prevention: Adequate concrete cover depth, dense/impermeable concrete, fusion-bonded epoxy coated rebars.
- Cathodic protection and corrosion inhibiting admixtures are advanced preventive measures.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.42: Repair and Rehabilitation stages- Removal of damaged concrete, Pretreatment o...

Civil Engineering Department

Lecture Agenda

- 1. Repair and Rehabilitation stages- Removal of damaged concrete, Pretreatment of surfaces and reinforcement, Application of repair materials, Repair Procedure.
- 2. Summary and Q&A

6.4 Repair and Rehabilitation stages- Remova...

- Stage 1: Condition assessment and identifying the root cause of the damage.
- Stage 2: Removal of defective/spalled concrete beyond the corroded rebar to expose sound concrete.
- Stage 3: Pretreatment of surfaces; cleaning rust from rebars (sandblasting) and applying anti-corrosive coating.
- Stage 4: Application of bonding agent to ensure monolithic behavior between old and new material.
- Stage 5: Placing the repair material, proper compaction, and curing according to specifications.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.43: Repair and Rehabilitation material - Cement, Steel and special material like,...

Civil Engineering Department

Lecture Agenda

- 1. Repair and Rehabilitation material - Cement, Steel and special material like, Shotcrete, Epoxy resins, Epoxy mortar, Gypsum cement mortar, Quick setting cement mortar etc.
- 2. Summary and Q&A

- Cement Mortar: Standard economical repair material for minor surface defects.
- Polymer Modified Mortar (PMM): Addition of polymers improves bond strength, flexibility, and impermeability.
- Epoxy Resins: Extremely high bond strength and chemical resistance; used for crack injection.
- Shotcrete / Gunite: Pneumatically applied high-velocity mortar; excellent for vertical/overhead repairs.
- Quick Setting Cement: Used for emergency repairs, plugging active water leaks, or underwater patching.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.44: Repair and Rehabilitation techniques - Grouting, Guniting, Routing and sealin...

Civil Engineering Department

Lecture Agenda

- 1. Repair and Rehabilitation techniques - Grouting, Guniting, Routing and sealing, Stitching, Drilling and Plugging etc.
- 2. Summary and Q&A

- Grouting: Injecting fluid cementitious or chemical mixtures into voids or cracks under pressure.
- Guniting: Dry-mix shotcrete applied at high velocity to rebuild spalled surfaces.
- Routing and Sealing: Enlarging surface cracks into a V-shape and filling with flexible elastomeric sealants.
- Stitching: Drilling holes across a crack and inserting U-shaped steel staples anchored with epoxy.
- Drilling and Plugging: Used to stop active water leaks in retaining walls or basements.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.

Lecture 6.45: Retrofitting Methods - Adding Steel Bracing, Jacketing Method, External Plate...

Civil Engineering Department

Lecture Agenda

- 1. Retrofitting Methods - Adding Steel Bracing, Jacketing Method, External Plate Bonding, Base Isolation Technique, Mass Reduction Technique, Wall Thickening Technique, Fiber Reinforced Polymer (FRP), Adding Shear Wall, Epoxy Injection Method, Section Enlarging Reinforcing Method etc.
- 2. Summary and Q&A

- Jacketing Method: Encasing existing columns/beams in a new layer of reinforced concrete or steel plates.
- Fiber Reinforced Polymer (FRP): Wrapping structural members with carbon/glass fiber sheets for immense tensile strength.
- Adding Shear Walls or Steel Bracings: Vastly increases the lateral load capacity (seismic retrofit) of the building.
- Base Isolation Technique: Inserting flexible bearings at the foundation to decouple the building from ground motion.
- Mass Reduction Technique: Removing heavy architectural elements to reduce seismic inertial forces.

Summary

- Recap of the specific material properties and methods discussed.
- Always refer back to the standard IS codes for parameter limits.