

Course: Concrete Technology

Lecture 15: Special concretes

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Session Objectives

- Understand the properties, behavior, and applications of specialized concrete types.
- Evaluate the influence of materials and environmental conditions on performance.
- Recognize essential quality control measures for durable concrete construction.



Content

- Lightweight Concrete
- High-Strength Concrete
- Self-Compacting Concrete
- Pervious Concrete
- Shotcrete
- Hot Weather Concrete
- Cold Weather Concrete



Lightweight Concrete

Definition and Classification


- Structural lightweight concrete combines reduced density with adequate load-carrying strength capacity.
- Equilibrium density typically ranges between 1,440 and 1,850 kilograms per cubic meter.
- Three categories include structural, moderate-strength, and insulating lightweight concrete types.
- Classification depends on density, strength, aggregate type, and intended function.



Source: Leca UK. (n.d.)


Constituent Materials

LIGHTWEIGHT CONCRETE: CONSTITUENT MATERIALS



1. Cementitious Materials

Ordinary Portland cement remains the primary binder. Supplementary cementitious materials such as fly ash, slag cement, silica fume, and natural pozzolans may also be incorporated to improve workability, durability, and long-term strength development.




Manufactured Lightweight Aggregates

Expanded shale Expanded clay Expanded slate Sintered fly ash

2. Lightweight Aggregates


The most distinctive component of lightweight concrete is the aggregate. Lightweight aggregates may be naturally occurring or manufactured.



Natural Lightweight Aggregates


Pumice Scoria Volcanic cinders

These aggregates contain numerous internal pores that reduce density while contributing to thermal insulation.



3. Water

Water quality requirements are generally similar to those for conventional concrete. However, because lightweight aggregates often exhibit high absorption capacities, careful moisture control becomes essential.



4. Chemical Admixtures

Water-reducing admixtures, superplasticizers, air-entraining agents, retarders, and accelerators are commonly used to improve concrete performance and compensate for some of the challenges associated with lightweight aggregate absorption.

Main Characteristics of Lightweight Concrete

MAIN CHARACTERISTICS OF LIGHTWEIGHT CONCRETE



1. Reduced Density

Densities may be reduced by 20 to 40% compared with conventional concrete. Lower dead load allows smaller structural members and foundations, resulting in significant material savings.



2. High Strength-to-Weight Ratio

Structural lightweight concretes commonly achieve compressive strengths between 20 and 55 MPa. This is valuable in high-rise buildings and bridge construction.



3. Improved Thermal Insulation

Porous structure reduces thermal conductivity, providing better insulation than conventional concrete and improving energy efficiency.



4. Enhanced Fire Resistance

Internal pore structure reduces thermal conductivity and improves resistance to explosive spalling during fire exposure. Often achieves longer fire-resistance ratings than normal-weight concrete.



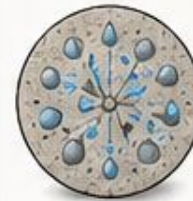
5. Reduced Modulus of Elasticity

Modulus of elasticity is typically lower than normal-weight concrete due to the more deformable lightweight aggregate. This affects structural deflections and must be considered in design.



6. Shrinkage and Creep Characteristics

Creep and drying shrinkage values differ from conventional concrete. Shrinkage may be higher, and creep behavior can vary. Proper curing and proportioning help control these effects.



7. Internal Curing Benefits

Lightweight aggregates store water in their pores and gradually release it during hydration, promoting continued cement hydration and reducing self-desiccation and cracking risk.

Fresh Concrete Properties

- Workability depends strongly on aggregate characteristics, conditioning, and admixture usage.
- Lightweight concrete generally exhibits good resistance to segregation during placement.
- Proper aggregate pre-wetting improves pumpability and maintains mixture consistency effectively.
- Finishing procedures resemble conventional concrete but require careful surface handling.

Hardened Concrete Properties

- Structural lightweight concrete commonly achieves compressive strengths between twenty and fifty-five.
- Tensile and flexural strengths remain adequate for many structural applications.
- Properly designed mixtures provide excellent durability under aggressive exposure conditions.
- Air entrainment improves freeze-thaw resistance and supports long-term performance reliability.

Main Applications

- High-rise buildings benefit from reduced structural loads and smaller foundations.
- Lightweight bridge decks reduce demands on girders, piers, and foundations.
- Precast elements facilitate transportation, handling, and installation during construction projects.
- Rehabilitation projects minimize added dead loads while maintaining structural capacity.



Source: Leca UK. (n.d.)

Quality Control Measures

- Aggregate moisture control significantly influences workability, strength, density, and pumpability.
- Sampling, slump testing, and temperature monitoring ensure production consistency requirements.
- Unit weight and density verification confirm compliance with design assumptions.
- Strength testing, curing control, and aggregate inspection ensure concrete quality.



Source: Open AI (2026)



High-Strength Concrete

Definition and Classification


- High-strength concrete achieves significantly greater strengths than conventional structural concrete.
- Strength classifications range from moderate high-strength to ultra-high-strength concrete categories.
- Moderate high-strength concrete commonly reaches strengths between fifty-five and seventy.
- Classification depends primarily on compressive strength and intended structural applications.



Source: ResearchGate. (2021)


Constituent Materials

HIGH-STRENGTH CONCRETE: CONSTITUENT MATERIALS




1. Cement

Portland cement is the primary binder. High-strength mixtures use cements with consistent quality. Cement content is generally higher, but excessive cement may increase shrinkage and thermal cracking risks.



2. Supplementary Cementitious Materials

- **Silica Fume:** Extremely fine particles fill voids and contribute to secondary hydration, densifying the microstructure.
- **Fly Ash:** Improves workability, reduces heat generation, and contributes to long-term strength.
- **Ground Granulated Blast Furnace Slag:** Enhances durability and increases later-age strength.




3. Aggregates

Aggregate quality is critical. Desirable properties:


- High strength
- Low porosity
- Good durability
- Appropriate gradation
- Strong bond with cement paste

At high strengths, aggregate strength may become the controlling factor.



4. Water

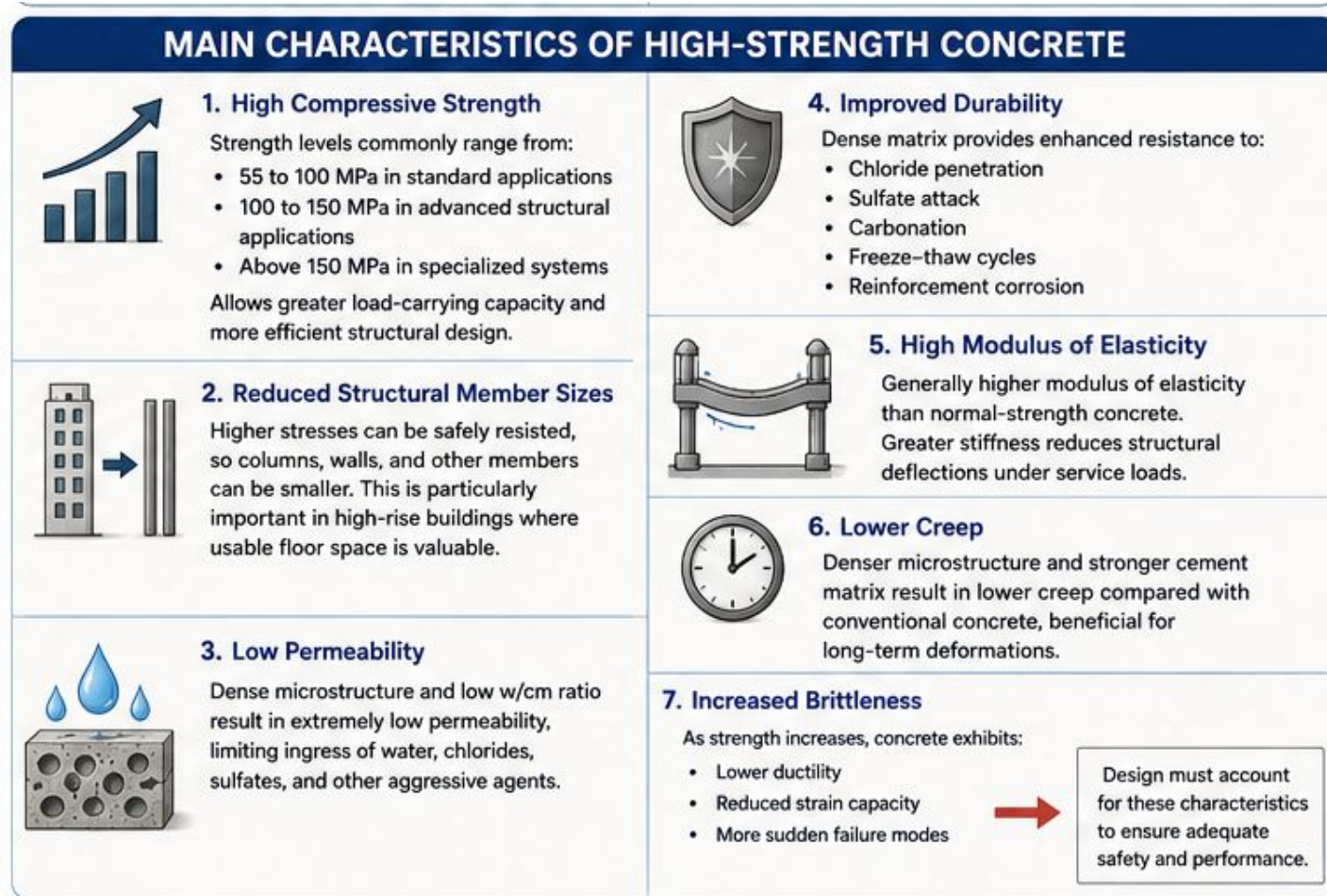
Water quality is similar to conventional concrete. High-strength concrete uses very low water-cementitious material ratios.



5. Chemical Admixtures

- **High-Range Water Reducers:** Superplasticizers are essential for adequate workability at low w/cm ratios.
- **Retarders:** Control setting time, especially in large placements or warm weather.
- **Air-Entraining Agents:** Used when freeze-thaw exposure is anticipated.

Main Characteristics of High-Strength Concrete



Fresh Concrete Properties

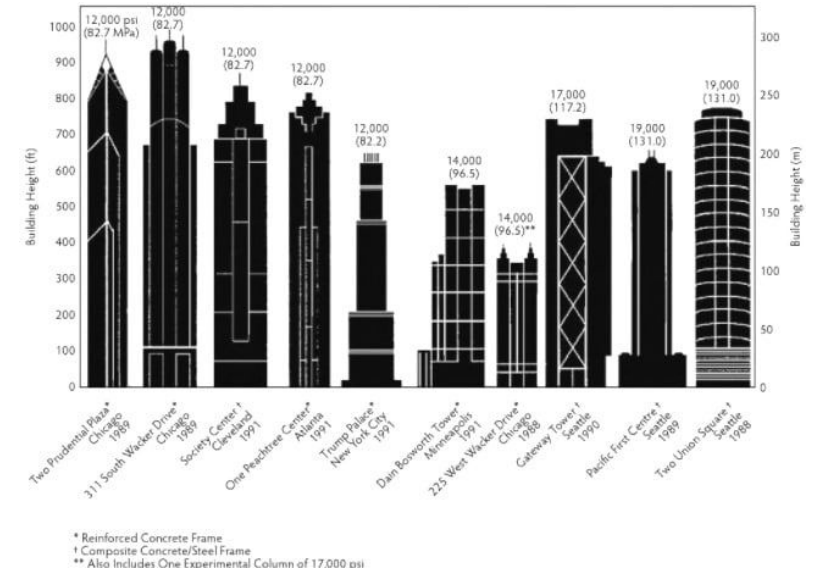
- Low water-cementitious ratios are essential for achieving high compressive strengths.
- Superplasticizers provide excellent workability while maintaining low water contents effectively.
- Silica fume increases cohesiveness and reduces segregation during concrete placement.
- Higher cement contents may generate excessive hydration heat requiring thermal control.

Hardened Concrete Properties

- Strength development often continues beyond twenty-eight days with supplementary materials.
- Tensile strength increases but reinforcement remains necessary for structural applications.
- Excellent abrasion resistance benefits industrial floors, pavements, and hydraulic structures.
- Low permeability improves corrosion resistance and protects reinforcing steel effectively.

Main Applications

- High-rise buildings utilize smaller columns for improved structural efficiency benefits.
- Prestressed concrete members accommodate larger prestressing forces and heavier loads.
- Long-span bridges benefit from reduced member sizes and improved durability.
- Offshore and industrial structures require exceptional strength and durability performance.



Source: QGreen Tech. (n.d.)

Quality Control Measures

- Material qualification verifies consistency, compatibility, and performance before production.
- Water-cementitious ratio control critically influences strength, durability, and concrete quality.
- Fresh concrete testing monitors slump, temperature, air content, and consistency.
- Comprehensive documentation verifies compliance, quality control, and specification requirements.



Source: Open AI (2026)



Self-Compacting Concrete (SCC)

Definition and Classification

- Self-compacting concrete flows without vibration while maintaining stability and uniformity.
- Filling ability ensures complete formwork filling under concrete self-weight alone.
- Passing ability allows movement through congested reinforcement without blockage occurring.
- Segregation resistance maintains uniform aggregate distribution during placement and hardening.







Source: American Concrete Institute. (2015)

Constituent Materials



Source: Author's own elaboration

Main Characteristics of Self-Compacting Concrete

MAIN CHARACTERISTICS OF SCC	
	Exceptional Flowability The defining characteristic of SCC is its ability to flow under its own weight without vibration. The concrete spreads easily throughout the formwork while maintaining homogeneity and aggregate distribution.
	Self-Consolidation Unlike conventional concrete, SCC eliminates the need for internal or external vibration. This characteristic reduces labor requirements and minimizes construction errors associated with inadequate consolidation.
	Excellent Passing Ability Properly designed SCC can flow through densely reinforced sections without blockage. This capability is particularly valuable in: <ul style="list-style-type: none">• Bridge piers• Shear walls• Deep beams• Precast components
	Superior Surface Finish Because SCC completely fills formwork and eliminates vibration defects, finished surfaces often exhibit: <ul style="list-style-type: none">• Reduced bug holes• Improved uniformity• Better architectural appearance
	Reduced Noise Levels Eliminating mechanical vibration significantly reduces construction noise. This advantage is especially beneficial in urban environments, hospitals, schools, and occupied buildings.
	Improved Durability The superior consolidation achieved by SCC minimizes internal voids and honeycombing, resulting in enhanced durability.
	High Stability Well-designed SCC maintains aggregate suspension during transportation, placement, and hardening, preventing segregation and bleeding.

Source: Author's own elaboration

Fresh Concrete Properties

- Filling ability measures capacity to completely fill formwork under gravity.
- Passing ability evaluates flow through reinforcement without blockage or segregation.
- Segregation resistance maintains mixture uniformity and prevents aggregate settlement problems.
- Proper viscosity balances flowability, stability, and resistance to bleeding effects.

Hardened Concrete Properties

- SCC achieves compressive strengths comparable to many conventional structural concretes.
- Tensile strength and elasticity generally match conventional concrete performance levels.
- Improved consolidation reduces voids, permeability, and potential durability problems.
- Shrinkage and creep characteristics remain similar to conventional concrete mixtures.

Main Applications

- Heavily reinforced structures benefit from improved placement and complete consolidation.
- Precast manufacturing uses SCC for productivity, quality, and dimensional accuracy.
- High-rise buildings utilize SCC within congested columns, walls, and cores.
- Bridges, tunnels, and repairs benefit from SCC's exceptional flowability characteristics.



Source: American Concrete Institute. (2015)

Quality Control Measures

- Material qualification verifies aggregate grading, fillers, admixtures, and cement consistency.
- Moisture control prevents variations affecting flowability, stability, and SCC performance.
- Slump flow, J-Ring, and L-Box tests assess fresh properties.
- Continuous monitoring ensures uniform strength development, stability, and workability.



Source: Open AI (2026)



Pervious Concrete

Definition and Classification






- Pervious concrete contains interconnected voids allowing water infiltration through pavement.
- High void contents typically range between fifteen and thirty percent.
- Structural pervious concrete provides drainage capability and moderate load-bearing capacity.
- Classifications depend on intended drainage, structural, or architectural performance requirements.



Source: Bay Area Pervious Concrete. (2015)

Constituent Materials

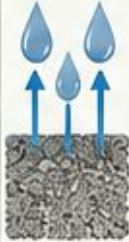








PERVIOUS CONCRETE

CONSTITUTIOUS MATERIALS	COARSE AGGREGATES	FINE AGGREGATES	WATER	CHEMICAL ADMIXTURES
<p>Ordinary Portland cement serves as the primary binding material. Supplementary cementitious materials may also be incorporated, including:</p> <ul style="list-style-type: none">• Fly ash• Slag cement• Silica fume• Natural pozzolans <p>These materials can improve workability, durability, and long-term strength development.</p>	<p>Coarse aggregates are the primary structural component of pervious concrete.</p> <p>Common sizes: 9.5 mm to 19 mm</p>  <p>Uniformly graded aggregates are typically preferred because they promote the formation of interconnected voids.</p> <p>Aggregate characteristics significantly influence:</p> <ul style="list-style-type: none">• Permeability• Strength• Void content• Durability	<p>Unlike conventional concrete, pervious concrete contains little or no fine aggregate.</p> <p>The absence of sand creates the interconnected pore structure that allows water infiltration.</p> <p>In some cases, small amounts of fine aggregate may be included to improve strength while maintaining permeability.</p> 	 <p>Water content must be carefully controlled. Because pervious concrete mixtures contain relatively low paste volumes, small variations in water content can significantly affect workability and performance.</p> 	<p>Various admixtures may be used, including:</p> <ul style="list-style-type: none">• Water reducers• Retarders• Hydration stabilizers• Air-entraining agents <p>These admixtures help improve workability and placement characteristics.</p> 

Source: Author's own elaboration

Main Characteristics of Pervious Concrete

MAIN CHARACTERISTICS OF PERVIOUS CONCRETE

 <p>High Permeability The most important characteristic of pervious concrete is its ability to allow water to pass through the pavement structure. Typical infiltration rates range from 80 to more than 700 liters per minute per square meter depending on mixture design and installation quality. This permeability greatly reduces surface runoff during rainfall events.</p>		 <p>High Void Content Pervious concrete typically contains 15% to 30% interconnected voids. The void structure allows water to infiltrate while also influencing strength and durability characteristics.</p>
 <p>Reduced Unit Weight Because of its significant void content, pervious concrete generally exhibits lower density than conventional concrete. Typical densities range from 1,600 to 2,000 kg/m³ depending on aggregate characteristics and void content.</p>		 <p>Environmental Benefits Pervious concrete contributes to sustainable development by:</p> <ul style="list-style-type: none">• Reducing stormwater runoff• Promoting groundwater recharge• Improving water quality• Reducing flooding• Supporting sustainable drainage systems
 <p>Noise Reduction The porous surface can absorb sound and reduce tire-pavement noise compared to conventional pavements.</p>	 <p>Thermal Benefits Pervious pavements may contribute to lower surface temperatures and reduced urban heat island effects due to increased air circulation and moisture movement.</p>	 <p>Moderate Structural Capacity Although not intended for heavy-duty highway applications, properly designed pervious concrete can provide sufficient strength for:</p> <ul style="list-style-type: none">• Parking lots• Residential streets• Sidewalks• Low-volume pavements

Fresh Concrete Properties

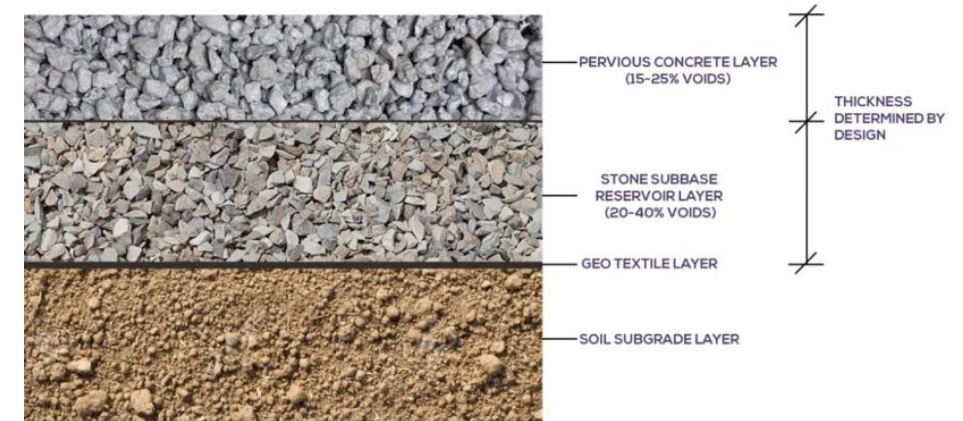
- Fresh pervious concrete appears stiff due to low paste volumes.
- Adequate cohesion maintains aggregate bonding while preserving interconnected void structures.
- Small water variations significantly affect permeability, strength, and workability performance.
- Prompt placement and curing are essential for achieving desired properties.

Hardened Concrete Properties

- Compressive strengths are lower than conventional concrete due to voids.
- Permeability remains the defining property governing hydraulic performance effectiveness overall.
- Freeze-thaw durability depends on proper drainage and system design considerations.
- Properly maintained pervious concrete can provide decades of reliable service.

Main Applications

- Parking lots utilize pervious concrete to reduce stormwater runoff effectively.
- Sidewalks, walkways, and plazas benefit from improved drainage performance.
- Residential streets and parks support sustainable water infiltration practices.
- Green infrastructure systems use pervious concrete for groundwater recharge purposes.



Typical section of a Pervious Concrete Pavement.
Source: Sonebi, M., Bassuoni, M. T., & Yahia, A. (2016)

Quality Control Measures

- Aggregate gradation control ensures consistent void structure and permeability performance.
- Moisture monitoring prevents variations affecting strength, workability, and infiltration capacity.
- Density and void content testing verify compliance with design requirements.
- Proper curing and maintenance preserve long-term drainage and durability performance.



Source: Open AI (2026)

A vertical strip of weathered, greyish-brown wooden planks runs along the left edge of the page. The planks are stacked vertically, showing signs of age and wear, with some small holes and dark spots. The rest of the page is a plain, light beige background.

Shotcrete


Definition and Classification

- Shotcrete is pneumatically projected concrete or mortar applied at high velocity.
- Dry-mix shotcrete adds water at nozzle, enabling flexible placement operations.
- Wet-mix shotcrete provides consistency, reduced dust, and higher productivity.
- Fiber-reinforced and structural shotcrete improve toughness and load resistance.



Source: Instituto del Cemento y del Hormigón de Chile. (n.d.)

Constituent Materials




1. Cementitious Materials


Ordinary Portland cement serves as the primary binder in most shotcrete mixtures. Supplementary cementitious materials may be incorporated to improve performance.

Common materials include:

- Fly ash
- Silica fume
- Slag cement
- Natural pozzolans



Silica fume is particularly beneficial because it improves cohesion, adhesion, durability, and rebound reduction.




2. Aggregates


Aggregates used in shotcrete must satisfy strict grading requirements.

Desired aggregate characteristics include:

- Proper gradation
- Cleanliness
- Durable mineralogy
- Suitable particle shape




Maximum aggregate sizes are generally smaller than those used in conventional concrete to facilitate pumping and projection.






3. Water


Water quality requirements are similar to those for conventional concrete. In dry-mix shotcrete, nozzle water control is particularly important because it directly influences strength, rebound, and durability.



4. Chemical Admixtures

Numerous admixtures are commonly used.

<h4>Accelerators</h4> <p>Accelerating admixtures are frequently used in tunneling and mining applications where rapid strength development is required.</p>	<h4>Water Reducers</h4> <p>Water-reducing admixtures improve workability and pumping characteristics.</p> 	<h4>Superplasticizers</h4> <p>High-range water reducers facilitate low water-cementitious material ratios while maintaining pumpability.</p> 	<h4>Air-Entraining Agents</h4> <p>Air entrainment may be required in environments subjected to freeze-thaw exposure.</p> 
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5. Fibers

Fiber reinforcement has become increasingly common in modern shotcrete.

Common fiber types include:









- Steel fibers
- Synthetic fibers
- Polypropylene fibers



Fibers enhance toughness and crack resistance while reducing the need for conventional reinforcement in certain applications.

Main Characteristics of Shotcrete

	<p>1. Pneumatic Placement</p> <p>The defining characteristic of shotcrete is its application through pneumatic projection.</p> <p>The high velocity of impact produces effective consolidation without the need for vibration.</p>	
	<p>2. Excellent Bond Strength</p> <p>Shotcrete develops exceptional bond strength with properly prepared substrates.</p> <p>This characteristic makes it particularly suitable for repair and rehabilitation projects.</p>	
	<p>3. Reduced Formwork Requirements</p> <p>Because shotcrete adheres to vertical and overhead surfaces, extensive formwork is often unnecessary.</p> <p>This advantage can significantly reduce construction costs and accelerate project schedules.</p>	

	<p>4. High Density and Consolidation</p> <p>Properly applied shotcrete exhibits excellent consolidation and low permeability.</p> <p>The impact force generated during placement contributes to the development of a dense microstructure.</p>	
	<p>5. Versatility</p> <p>Shotcrete can be applied to:</p> <ul style="list-style-type: none">• Vertical surfaces• Overhead surfaces• Curved geometries• Irregular rock formations• Complex structural configurations	
	<p>6. Rapid Construction</p> <p>The placement process is often faster than conventional concrete construction, particularly in projects involving difficult access or irregular surfaces.</p>	
	<p>7. Fiber Reinforcement Compatibility</p> <p>Shotcrete is highly compatible with fiber reinforcement systems, allowing improved toughness and crack control.</p>	

Fresh Shotcrete Properties

- Adequate pumpability ensures continuous material delivery through hoses efficiently.
- Proper cohesion minimizes segregation and promotes uniform shotcrete placement.
- Rebound characteristics influence material waste, quality, and construction efficiency.
- Build-up capacity allows thick applications without sagging or sloughing.

Hardened Shotcrete Properties

- Compressive strengths comparable to conventional structural concrete are achievable.
- Strong bond develops with concrete, rock, masonry, and steel.
- Fiber reinforcement improves toughness, energy absorption, and crack resistance.
- Proper design and curing ensure durability under aggressive exposures.

Main Applications

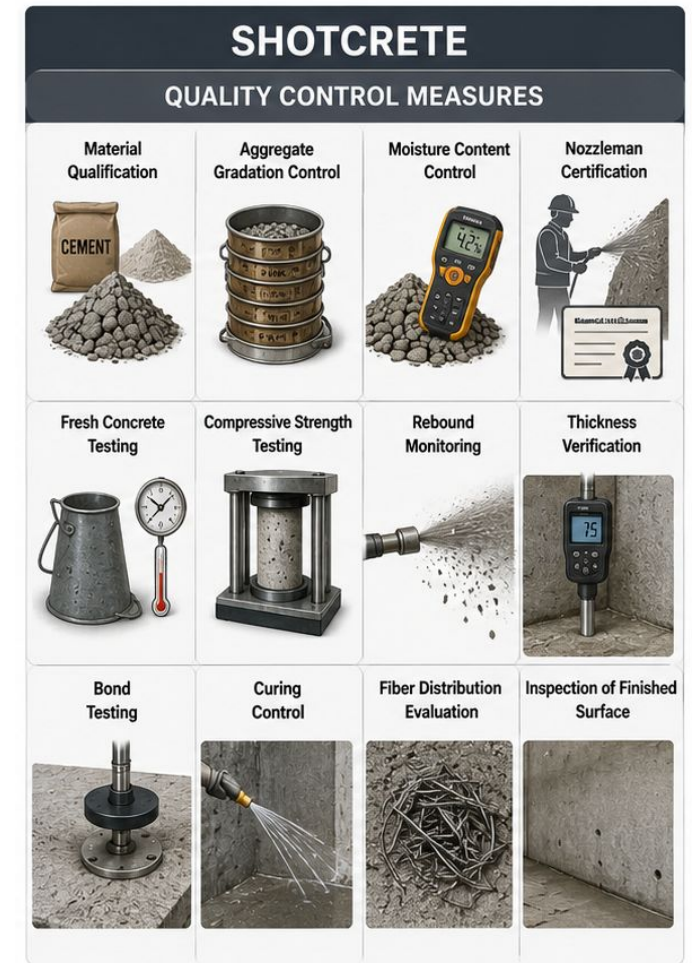
- Tunnels and mines use shotcrete for support and stabilization.
- Slope stabilization benefits from shotcrete's adaptability to irregular surfaces.
- Repairs of bridges, dams, and structures commonly utilize shotcrete.
- Water-retaining and underground structures frequently rely on shotcrete systems.



Source: Instituto del Cemento y del Hormigón de Chile. (n.d.)

Quality Control Measures

- Material qualification verifies cement, aggregates, fibers, and admixture quality.
- Aggregate moisture and grading control ensure consistent shotcrete performance.
- Nozzleman certification improves application quality and construction reliability significantly.
- Strength, thickness, bond, curing, and surface inspections ensure compliance.



Source: Open AI (2026)



Hot Weather Concrete











Definition of Hot Weather Concreting

- Hot weather includes conditions accelerating hydration and moisture evaporation rates.
- High temperatures, wind, humidity, and sunlight affect concrete performance.
- Problems commonly increase when concrete temperatures exceed thirty degrees.
- Environmental factors collectively determine severity more than temperature alone.



Source: Sika Limited. (n.d.)

Environmental Factors Affecting Concrete

	<p>1. High Air Temperature</p> <p>Elevated air temperatures increase the rate of cement hydration and accelerate moisture loss from the concrete surface.</p>	<p>Consequences include:</p> <ul style="list-style-type: none">• Faster setting• Increased water demand• Reduced workability retention	
	<p>2. High Concrete Temperature</p> <p>The temperature of fresh concrete directly influences hydration kinetics.</p> <p>Higher concrete temperatures lead to:</p> <ul style="list-style-type: none">• Rapid strength gain at early ages• Increased heat generation• Greater shrinkage• Reduced long-term strength		
	<p>3. Low Relative Humidity</p> <p>Dry air increases evaporation rates from exposed concrete surfaces.</p> <p>Excessive evaporation may cause:</p> <ul style="list-style-type: none">• Plastic shrinkage cracking• Surface crusting• Finishing difficulties		
	<p>4. High Wind Speed</p> <p>Wind removes moisture from the concrete surface and increases evaporation rates. Even moderate wind speeds can significantly increase drying under hot conditions.</p>		
	<p>5. Solar Radiation</p> <p>Direct sunlight increases both surface temperature and evaporation rate. Dark formwork and reinforcement exposed to sunlight may become significantly hotter than ambient air.</p>		

Effects on Fresh Concrete

- Higher temperatures increase water demand and reduce workability retention.
- Rapid slump loss complicates transportation, placement, consolidation, and finishing.
- Accelerated setting shortens finishing time and increases cold-joint risks.
- Plastic shrinkage cracking develops under evaporation exceeding bleeding rates.

Effects on Hardened Concrete

- Elevated temperatures reduce long-term strength despite rapid early gains.
- Increased drying shrinkage contributes to cracking and serviceability concerns.
- Thermal gradients may generate stresses causing thermal cracking damage.
- Durability decreases due to permeability, cracking, and aggressive exposure.

Curing Requirements

- Curing prevents rapid moisture loss and preserves concrete performance.
- Moist curing methods include spraying, ponding, and wet burlap.
- Curing compounds reduce evaporation when wet curing is impractical.
- Extended curing periods may be necessary under severe conditions.

CURING REQUIREMENTS

Importance of Curing	Moist Curing	Curing Compounds	Protective Coverings	Extended Curing
<p>Curing is particularly critical in hot weather because moisture loss occurs rapidly.</p> <p>Insufficient curing may result in:</p> <ul style="list-style-type: none">• Reduced strength• Increased permeability• Surface cracking• Reduced durability	<p>Continuous moist curing is among the most effective curing methods.</p> <p>Common techniques include:</p> <ul style="list-style-type: none">• Water spraying• Wet burlap• Ponding	<p>Membrane-forming curing compounds help reduce moisture loss when continuous wet curing is impractical.</p>	<p>Plastic sheets and other coverings can reduce evaporation and maintain moisture availability.</p>	<p>Longer curing periods may be necessary under severe environmental conditions.</p>
				

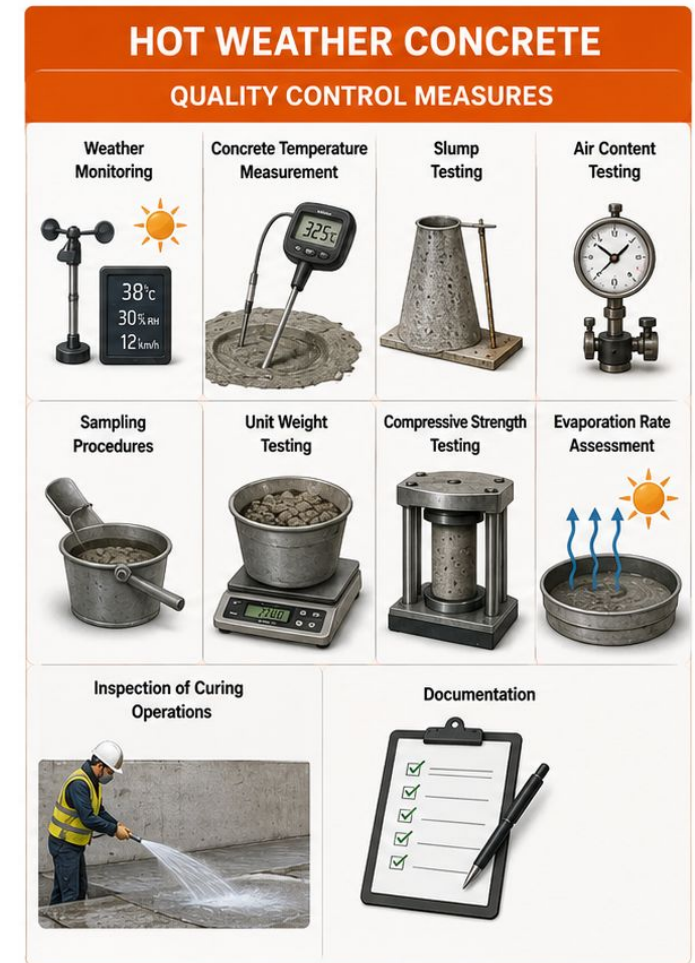
Source: Author's own elaboration

Main Applications

- Building projects frequently require hot weather concreting during summers.
- Highways and pavements experience intense heat and solar exposure.
- Bridges and mass concrete structures require temperature control measures.
- Industrial and marine projects often face challenging hot environments.

Quality Control Measures

- Monitor temperature, humidity, wind speed, and solar radiation continuously.
- Measure concrete temperature and workability using standard ASTM procedures.
- Evaluate strength, air content, unit weight, and sampling quality.
- Inspect curing effectiveness and document environmental and testing data.



Source: Open AI (2026)



Cold Weather Concrete

Definition of Cold Weather Concreting

- Cold weather concreting requires protection against freezing and strength loss.
- Conditions include low temperatures, snow, ice, and frozen ground.
- Temperature fluctuations during curing can adversely affect concrete performance.
- Main objective is maintaining temperatures above freezing during hydration.



Source: AKCP. (2021)


Effects on Fresh and Hardened Concrete

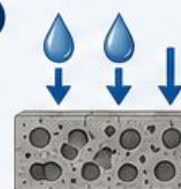
EFFECTS OF COLD WEATHER ON FRESH CONCRETE

1  **Reduced Workability**
 Fresh concrete generally becomes less workable as temperatures decrease.


The reduction in workability may affect:

- Placement
- Consolidation
- Finishing



2  **Slower Bleeding**
 Low temperatures reduce bleeding rates because hydration proceeds more slowly.

While reduced bleeding can be beneficial in some situations, it may complicate finishing operations.



3  **Extended Finishing Window**
 Delayed setting increases the time available for finishing but may also prolong construction operations and expose concrete to adverse weather conditions.





4  **Increased Risk of Surface Damage**
 If finishing is performed improperly or protection measures are inadequate, surface defects may develop.

Examples include:

- Scaling
- Dusting
- Delamination



EFFECTS OF COLD WEATHER ON HARDENED CONCRETE

<p>1  Reduced Early-Age Strength</p> <p>The most noticeable effect of cold weather is slower strength development.</p> <p>Although ultimate strength may eventually equal or exceed that obtained under normal conditions, the rate of development is significantly reduced.</p>	<p>2  Potential Long-Term Benefits</p> <p>When freezing is prevented, slower hydration can sometimes produce a denser microstructure and slightly improved long-term strength.</p>	<p>3  Freeze-Thaw Damage</p> <p>Concrete exposed to repeated freeze-thaw cycles while saturated may experience deterioration if adequate air entrainment is not provided.</p>	<p>4  Increased Permeability from Early Freezing</p> <p>Concrete that freezes before sufficient hydration has occurred often exhibits:</p> <ul style="list-style-type: none"> • Increased permeability • Reduced durability • Lower strength 	<p>5  Surface Scaling</p> <p>Scaling may occur when freezing and thawing cycles affect inadequately protected concrete surfaces.</p> <p>The presence of deicing salts can accelerate this deterioration mechanism.</p>
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Main Applications

- Buildings often require winter concreting to maintain project schedules.
- Highways and bridges frequently need cold weather placement procedures.
- Industrial facilities in cold regions rely on specialized practices.
- Infrastructure and precast projects require year-round temperature control.

Quality Control Measures

- Monitor weather conditions, temperatures, wind speeds, and forecasts continuously.
- Measure concrete temperature, slump, air content, and unit weight.
- Strength testing and maturity monitoring verify adequate strength development.
- Inspect protection systems and maintain comprehensive project documentation.



Source: Open AI (2026)

Conclusions

- ❑ Specialized concretes such as lightweight, high-strength, self-compacting, pervious concrete, and shotcrete have expanded the capabilities of modern construction by addressing specific structural, construction, and environmental requirements.
- ❑ Each type provides unique benefits, including reduced weight, increased strength, improved constructability, enhanced sustainability, or greater adaptability to complex applications.
- ❑ Environmental conditions, particularly hot and cold weather, significantly affect concrete performance and require appropriate construction and curing practices.
- ❑ The successful use of any concrete technology depends on proper mixture design, quality materials, effective curing, and rigorous quality control to ensure long-term strength, durability, and performance.

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Course: Concrete Technology

Lecture 15: Special concretes

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