

Course: Concrete Technology

Lecture 6: Fresh Concrete Properties

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Session Objectives

- Understand key fresh concrete properties
- Recognize role in material behavior
- Identify tests, procedures, equipment
- Emphasize need for property control

Content

- General overview
- Key fresh properties and control
- Evaluation methods and testing
- Setting process and early performance



General Overview

Concrete States and Performance

- Fresh, setting, hardened states
- Properties define performance
- Strength most used but not sufficient
- Design includes durability and stability



Source: Basic Engineering. (n.d.)

Fresh Concrete Requirements

- Proper formwork filling capability
- Flow around reinforcement
- Homogeneous mass formation
- Enables on-site quality decisions



Source: Basic Engineering. (n.d.)



Key fresh properties and control

Quality Criteria of Fresh Concrete

- Adequate formwork filling ability
- Proper reinforcement encapsulation
- Ensures bond and structural performance
- Homogeneity and density required



Source: [Engineering Encyclopedia \(a.d.\)](#)

Factors Influencing Fresh Properties

- Material quality not sufficient alone
- Workmanship affects performance
- Construction process is critical
- Environmental conditions impact behavior



Source: GFP Mobile Mix Supply. (n.d.)

Main Fresh Concrete Properties

- Workability and consistency
- Segregation and bleeding control
- Unit weight and air content
- Water content influence



Source: Basic Engineering. (n.d.)

Workability: Definition and Scope

- Effort to achieve compaction
- Overcomes internal and external friction
- Ensures placement without segregation
- Depends on element and method



Source: Brown, R. (2023)

Components of Workability

- Compactability reduces voids
- Cohesion prevents segregation
- Plasticity enables deformation
- Consistency governs flowability



Source: Energy EcocreteFiber. (n.d.)

Factors Affecting Workability

- Water, air, aggregates, paste ratio
- Climate impacts fresh behavior
- Each factor modifies performance
- Interaction effects are critical



Source: AKCP. (2021)

Effect of Water Content

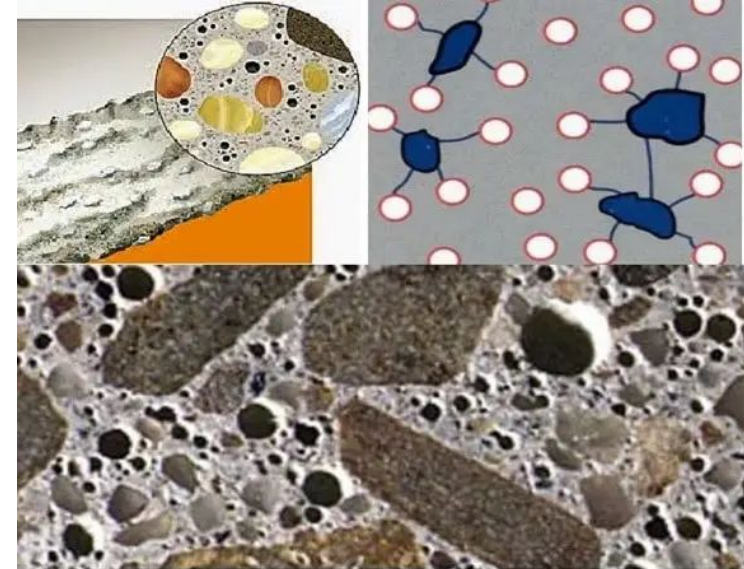
- ~15% volume; only part hydrates
- Remaining water governs flowability
- More water increases lubrication
- Excess reduces strength and durability



Source: Civil Engineering Forum. (n.d.)

Influence of Air Content

- Entrapped vs entrained air types
- Entrained air improves mobility
- Reduces required water content
- Enhances workability and cohesion



Source: Hamakareem, M. I. (n.d.)

Aggregate Properties and Workability

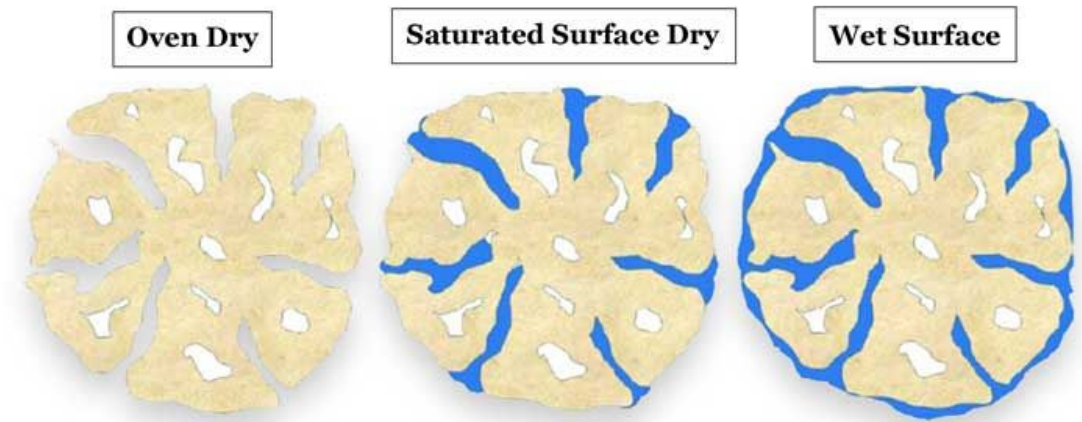
- Size, shape, texture are key
- Gradation affects packing and voids
- Angular particles hinder flow
- Larger size lowers water demand



Source: Concrete Network. (n.d.)

Aggregate Absorption and Fines

- Porous aggregates increase water demand
- Alters water–cement ratio
- Fines improve cohesion but raise demand
- Organic matter reduces durability

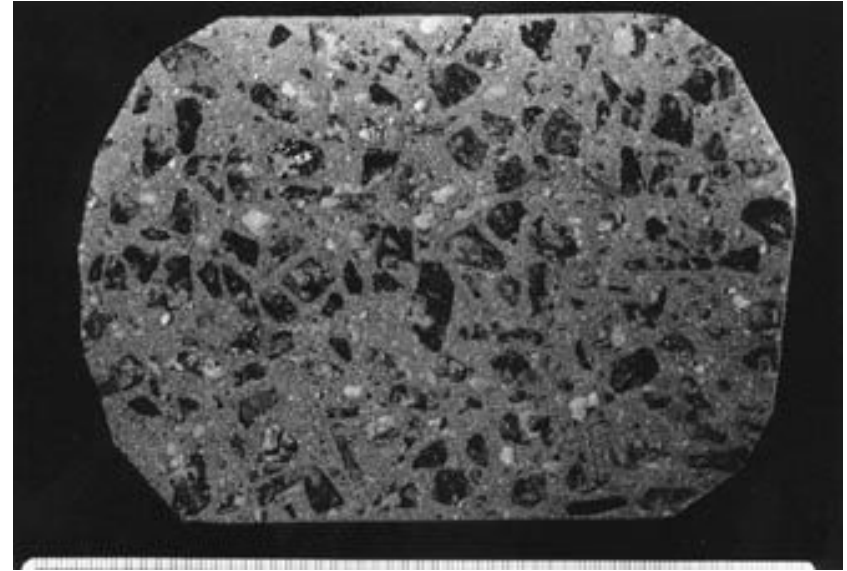


Illustrations of Oven Dry (OD) and Saturated Surface Dry (SSD) particles

Source: Gilson Company, Inc. (2024)

Paste-to-Aggregate Ratio

- Paste acts as lubricant
- Higher paste improves workability
- Increases cohesion and compaction ease
- Excess may cause segregation



Source: Federal Highway Administration. (n.d.)

Climatic Effects on Workability

- Wind and heat increase evaporation
- Temperature alters setting behavior
- Humidity affects moisture loss
- Requires preventive control measures



Source: AIMIX Group. (n.d.)

Time and Temperature Effects

- Workability decreases over time
- Early hydration reduces free water
- Aggregate moisture influences loss
- Concrete temperature is critical



Source: Ojeda, D. (2025)

Workability Loss Over Time

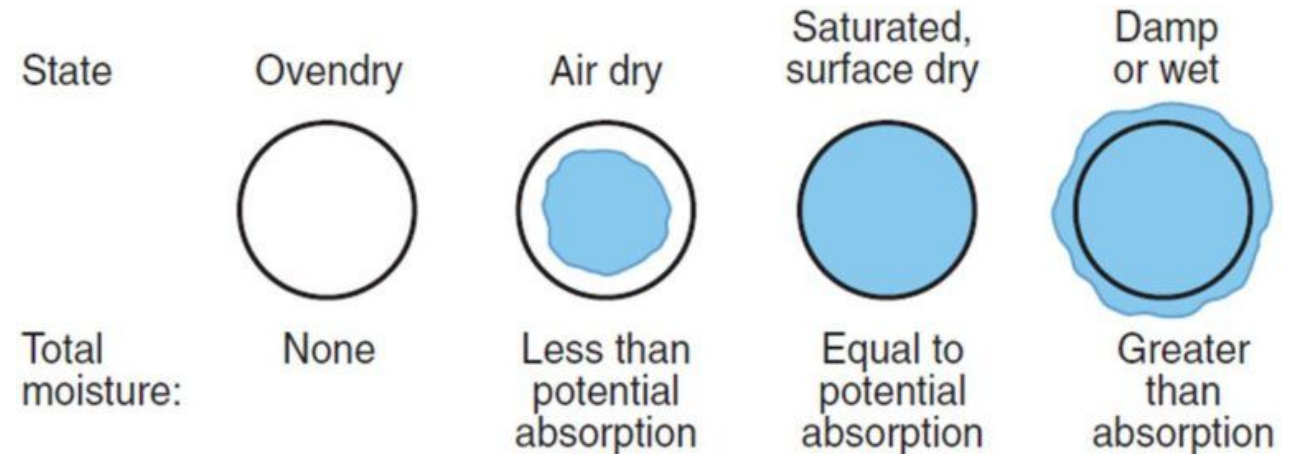
- Slump decreases after mixing
- Heat and wind accelerate loss
- Admixtures may modify behavior
- Timing is key in placement



Source: Ojeda, D. (2025)

Aggregate Moisture Condition

- Natural states vary widely
- SSD is design reference condition
- Controls effective water content
- Ensures consistent workability



Source: CivilWeb Spreadsheets. (n.d.)



Evaluation methods and testing

Workability Testing Overview

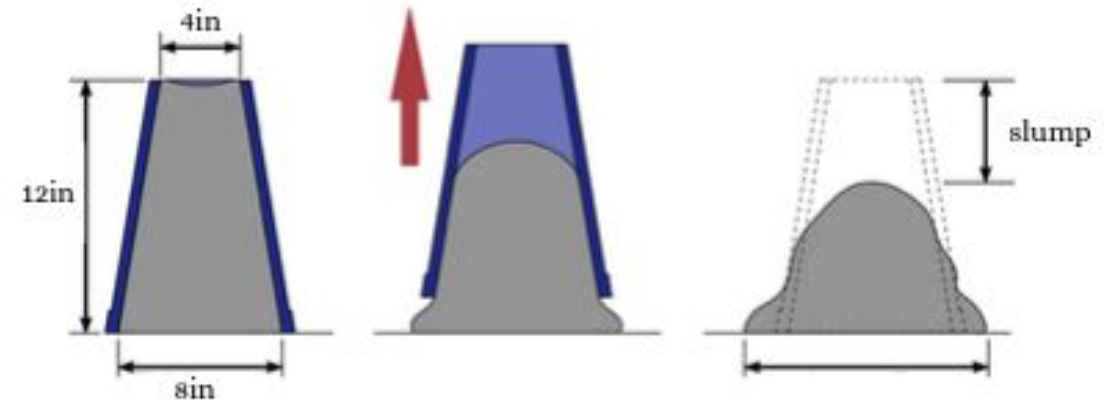
- No direct tests for cohesion/adhesion
- Visual assessment often required
- Tests evaluate related properties
- Essential for quality control



Source: Gilson Company, Inc. (n.d.)

Slump Test Fundamentals

- Measures consistency and flowability
- Indicates plastic state behavior
- Not a direct workability measure
- Widely used practical index



Source: Gilson Company, Inc. (n.d.)

Slump Test Procedure

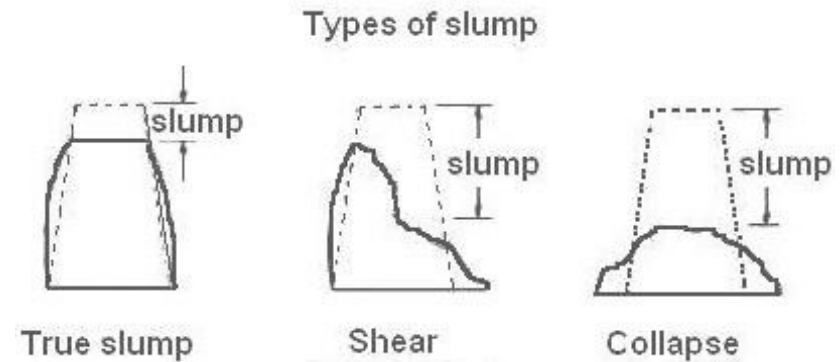
- Uses Abrams cone (ASTM C143)
- Filled in three compacted layers
- 25 rod strokes per layer
- Slump = height difference



Source: Gilson Company, Inc. (n.d.)

Slump Test Applications and Limits

- Simple, fast, low-cost method
- Limited for very dry/fiber mixes
- Irregular slump indicates issues
- Detects variability in materials



Typical profiles for completed slump test samples. Source: Gilson Company, Inc. (n.d.)

Consistency Classification by Slump

Concrete Slump Range		
Slump, in (mm)	Degree of Workability	Application
0–1 (0–25)	Very low	Very dry mixes in slip forms or paving machines with high-powered vibration
1–2 (25–50)	Low	Low-workability mixes used for foundations with light reinforcement; Pavements consolidated by hand-operated vibration
2–4 (50–100)	Medium	Medium workability mixes for manually consolidated flat slabs. Normal reinforced concrete manually placed; heavily reinforced sections with mechanical vibration.
4–7 (100–175)	High	High workability concrete for sections with congested reinforcement; May not respond well to vibration.

Source: Gilson Company, Inc. (n.d.)

Remolding (Vebe) Test

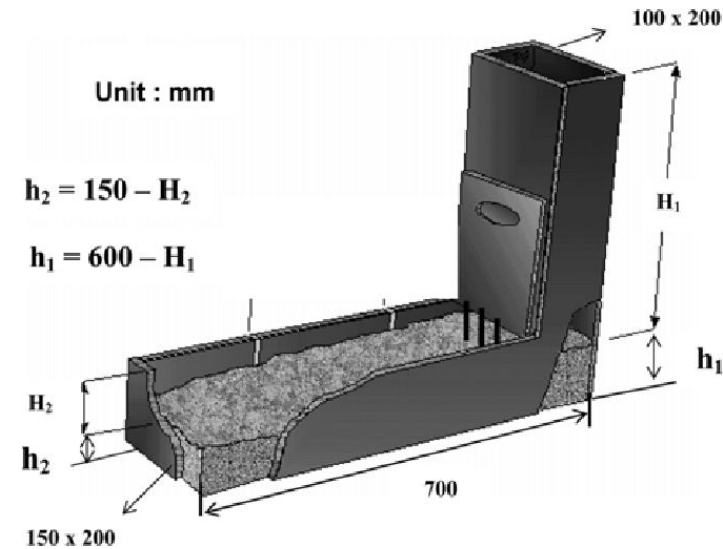
- Measures remolding effort
- Uses vibration and piston
- Time/energy as parameter
- Suitable for lab evaluation



Source: CivilWeb Spreadsheets. (n.d.)

Flowability Test (L-Box)

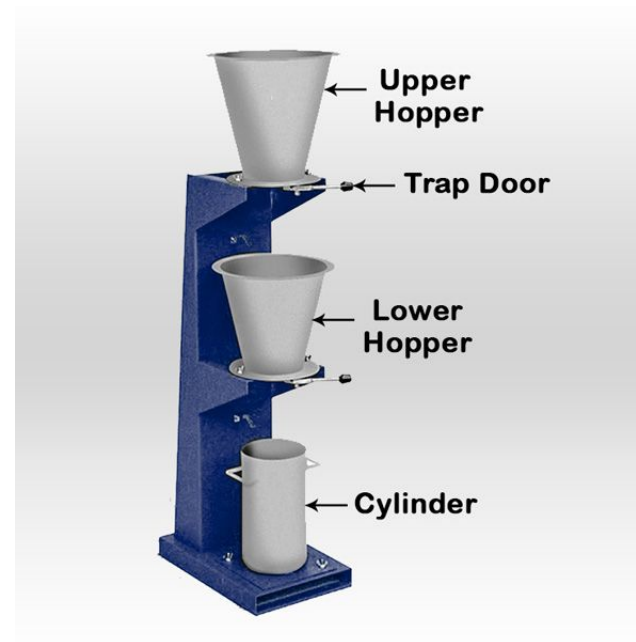
- Evaluates flow with obstacles
- Measures height difference
- Assesses passing ability
- Ensures no segregation



Source: Sonebi, M. (2007)

Compaction Factor Test

- Based on density ratio
- Measures compaction ease
- Uses hopper and cylinder
- Ideal for low-flow mixes



Source: Gharpedia. (n.d.)

Limits of Workability Tests

- Do not capture all parameters
- Require visual inspection
- Assess finishability separately
- Introduce concept of pumpability



Source: Luton Group. (n.d.)

Segregation in Concrete

- Separation of coarse particles
- Causes non-uniform distribution
- Reduces strength and durability
- Must be prevented for quality



Source: Suryakanta. (2014)

Causes of Segregation

- Density differences cause separation
- Shape and size affect packing
- Poor gradation increases voids
- Improper handling intensifies segregation



Source: Pro Crew Software. (2020)

Segregation Control Measures (ACI 304)

- Proper mix proportioning required
- Avoid excessive drop heights
- Minimize transport time/distance
- Control vibration and placement



Source: Quality Engineers Guide. (n.d.)

Control of Bleeding (Exudation)

- Use finer or well-graded sand
- Increase cement or add pozzolans
- Use finer cement and admixtures
- Improve cohesion and reduce water rise



Source: Anand, P. (2016)

Unit Weight of Fresh Concrete

- Depends on aggregates and air
- Influenced by density and porosity
- Affected by moisture condition
- Key for yield verification



Source: Certified Material Testing Products. (2024)

Unit Weight Test (ASTM C138)

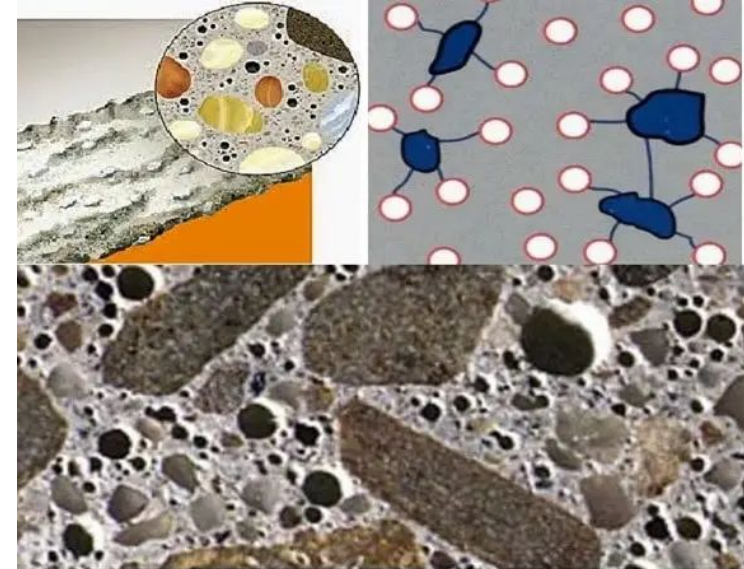
- Mass over known volume
- Three layers, compacted
- Net mass excludes container
- Used to calculate yield



Source: Certified Material Testing Products. (2024)

Air Content in Concrete

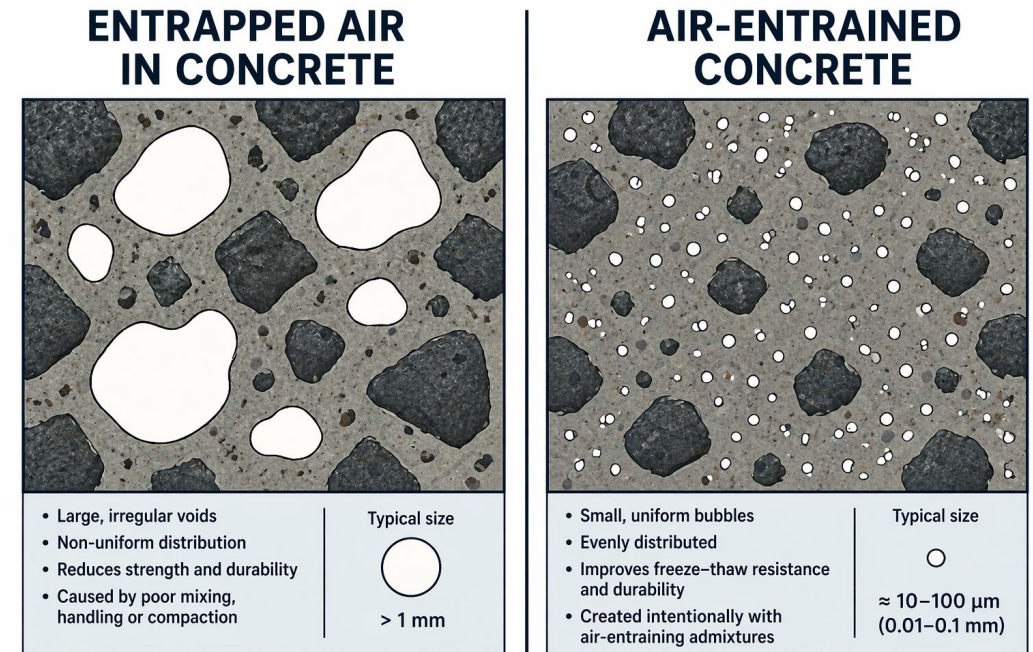
- Entrapped or entrained air present
- Typical range: 1%–6%
- Influenced by fines and organics
- Affects workability and quality



Source: Hamakareem, M. I. (n.d.)

Entrapped vs Entrained Air

- Entrapped air forms large voids
- Reduces strength and finish
- Entrained air improves durability
- Uniform bubbles enhance performance



Source: Belkowitz, J. (2026)

Air Content Test (ASTM C231)

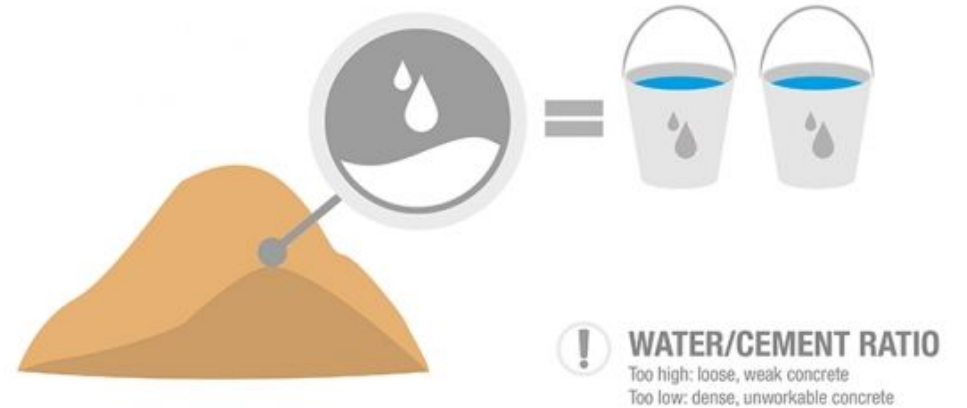
- Based on pressure principle
- Uses sealed air meter
- Measures total air directly
- Ensures quality and durability



Source: The Constructor. (n.d.)

Water Content in Concrete

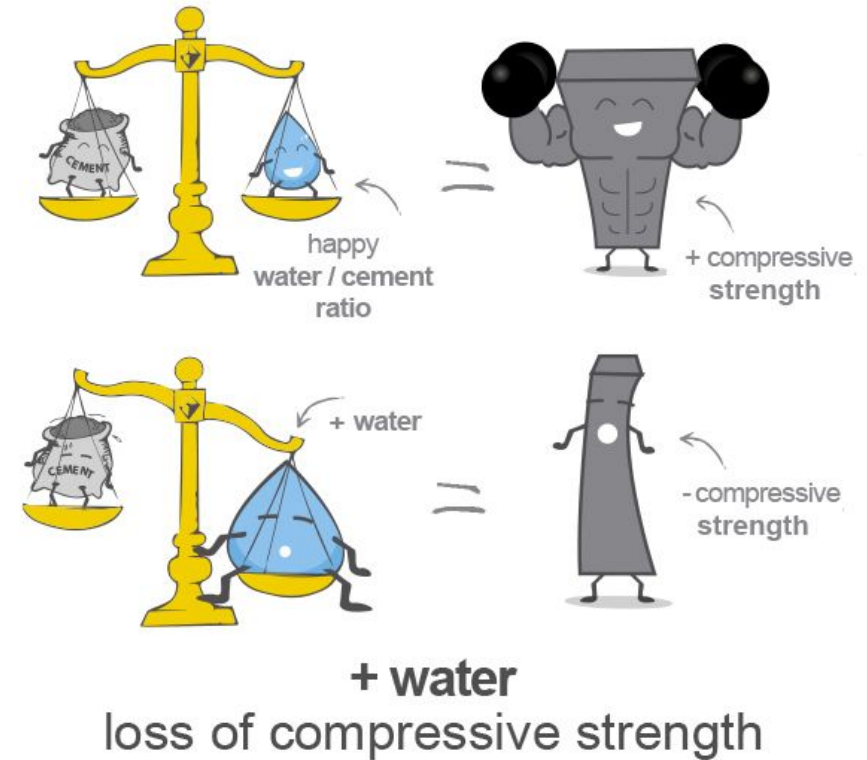
- Key factor for performance
- Affects workability and strength
- Must match design values
- Requires strict control



Source: Fiori Group. (n.d.)

Water Reduction Test

- Compares reference vs admixture mixes
- Evaluates water-reducing capacity
- Same workability as benchmark
- Optimizes mix design and performance



Source: Best Support Underground. (n.d.)



Setting process and early performance

Concrete Setting Process

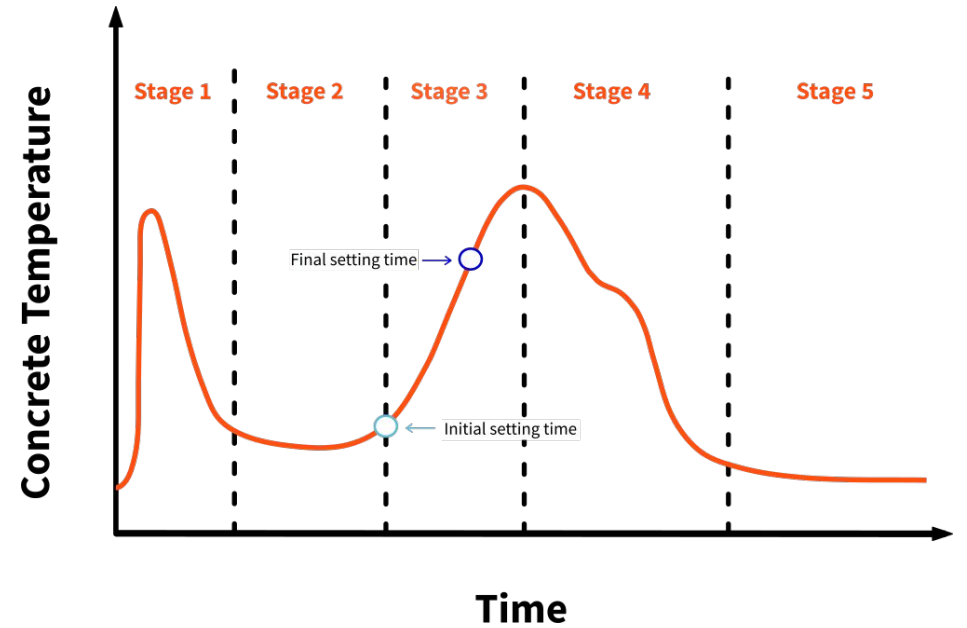
- Transition: plastic to rigid state
- Deformation capacity decreases
- Key changes in properties
- Includes setting and shrinkage



Source: All Mix Concrete. (n.d.)

Importance of Setting Time

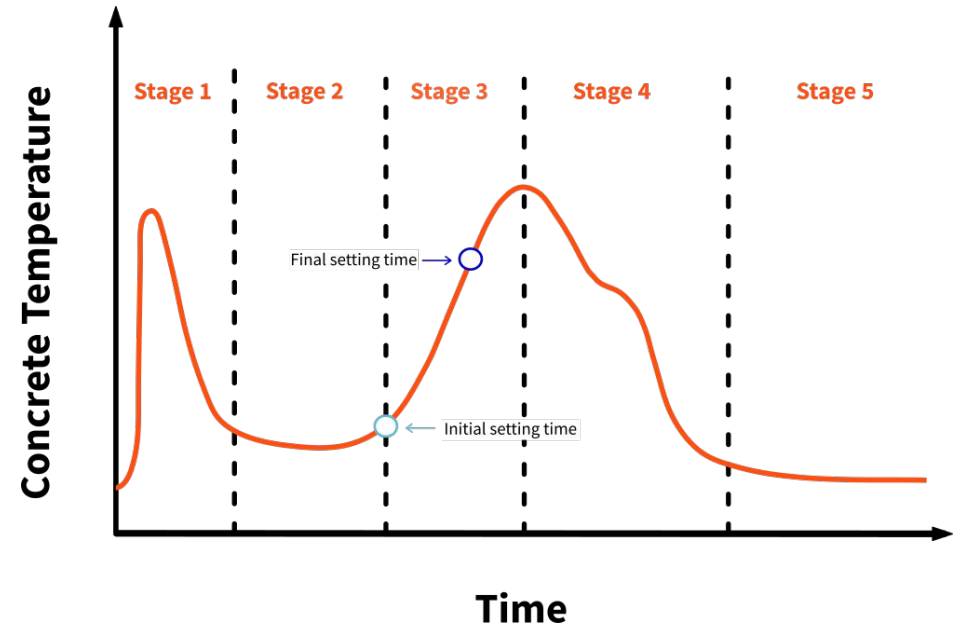
- Controls construction operations
- Balances transport and placement
- Must fit project conditions
- Key for scheduling and quality



Source: Maturix. (2021)

Types of Setting Behavior

- Slow, normal, rapid setting
- Retarders delay hardening
- Accelerators speed up process
- Selected by project needs



Source: Maturix. (2021)

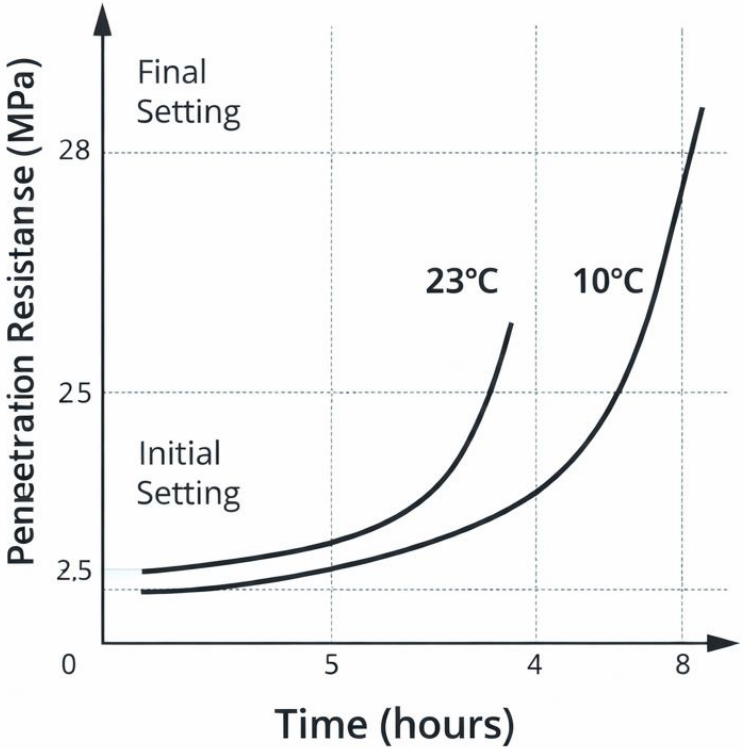
Setting Time Test (ASTM C403)

- Based on penetration resistance
- Uses sieved mortar sample
- Measures force vs time
- Defines setting curve

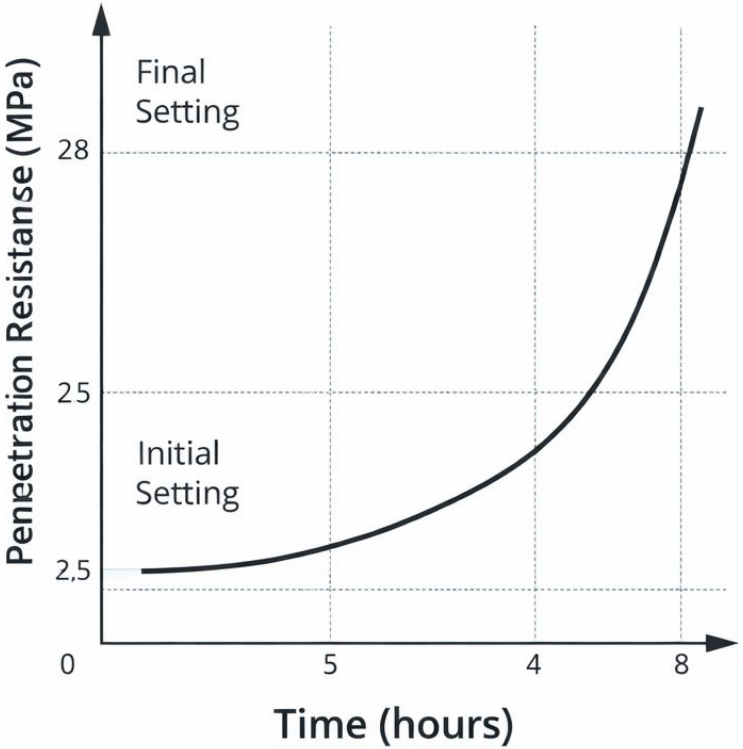


Source: Gilson Company, Inc. (n.d.)

Initial and Final Setting



28 Mpa = 285 kg/cm² = 4061 psi
3.5 Mpa = 35.7 kg/cm² = 508 psi

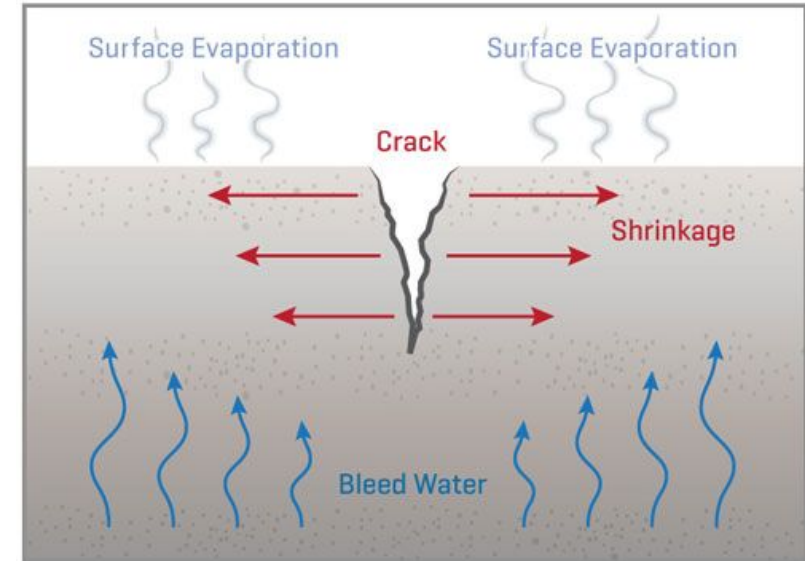


28 Mpa = 285 kg/cm² = 4061 psi
3.5 Mpa = 35.7 kg/cm² = 508 psi

Source: Gomezjurado, J., Osorio, J., & Niño, J. (2014)

Plastic Shrinkage Phenomenon

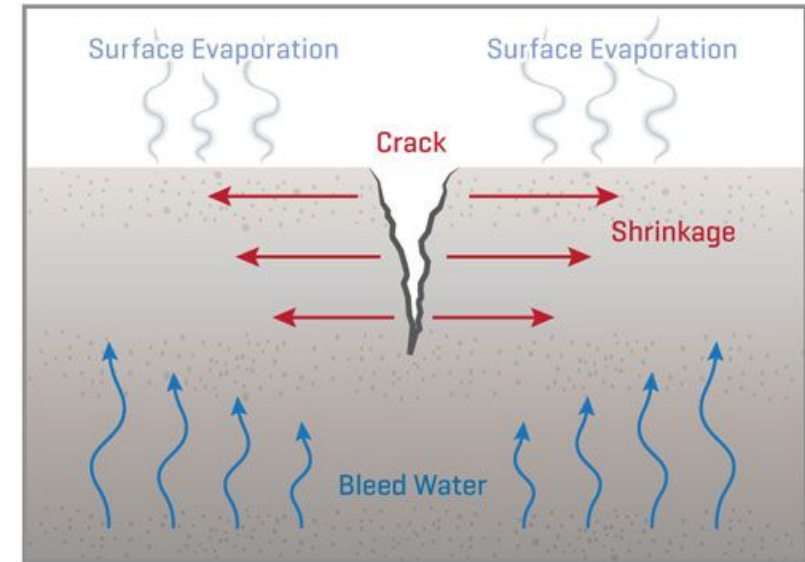
- Volume reduction during setting
- Causes surface cracking
- Linked to hydration and evaporation
- Common in slabs and hot climates



Source: Gilson Company, Inc. (2024)

Control of Plastic Shrinkage

- Occurs in fresh state
- Evaporation > bleeding causes stress
- Requires proper curing
- Major source of early cracking



Source: Gilson Company, Inc. (2024)

Conclusions

- ❑ Fresh-state behavior directly governs performance and durability in the hardened state
- ❑ Workability controls placement, compaction, finishing, and prevents defects like segregation
- ❑ Water content is the most critical parameter affecting workability, strength, and durability
- ❑ Materials, aggregate properties, workmanship, processes, and environment jointly influence behavior
- ❑ Standard tests provide indicators but require field inspection and engineering judgment
- ❑ Integrated control of materials and construction processes ensures uniformity and long-term performance

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