Course: Concrete Technology

Lecture 13: Testing of hardened concrete

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Session Objectives

- Understand ASTM-based concrete quality control procedures.
- Evaluate concrete using destructive and nondestructive tests.
- Interpret results affecting performance, durability, and reliability.

Content

- Quality Control of Fresh Concrete
- Quality Control of Hardened Concrete

Fresh and Hardened Concrete Relationship

- Fresh properties influence hardened concrete performance.
- Concrete exhibits complex, non-linear material behavior.
- Workability affects strength, durability, and deformability.
- Testing evaluates quality throughout concrete development.

Quality Control of Fresh Concrete

Standards for fresh concrete tests

Source: Open AI (2026)

Concrete Sampling: Purpose and Equipment

- Obtain representative fresh concrete sample.
- Required for quality control testing.
- Uses shovel, scoop, and wheelbarrow.
- PPE ensures safe field operations.

Source: ASTM International

Sampling Procedure Requirements

- Moisten equipment without leaving free water.
- Sample from middle third of discharge.
- Collect sufficient concrete volume.
- Remix sample before testing procedures.

Source: Open AI (2026)

Sampling Time and Volume Requirements

- Collect at least two sample portions.
- Begin testing within five minutes.
- Minimum sample volume: one cubic foot.
- Complete tests within fifteen minutes.

Source: ASTM International

Slump Test Equipment

- Evaluates fresh concrete workability.
- Uses Abrams cone and base plate.
- Consolidation performed with tamping rod.
- PPE required during testing.

Source: ASTM International

Slump Test Procedure

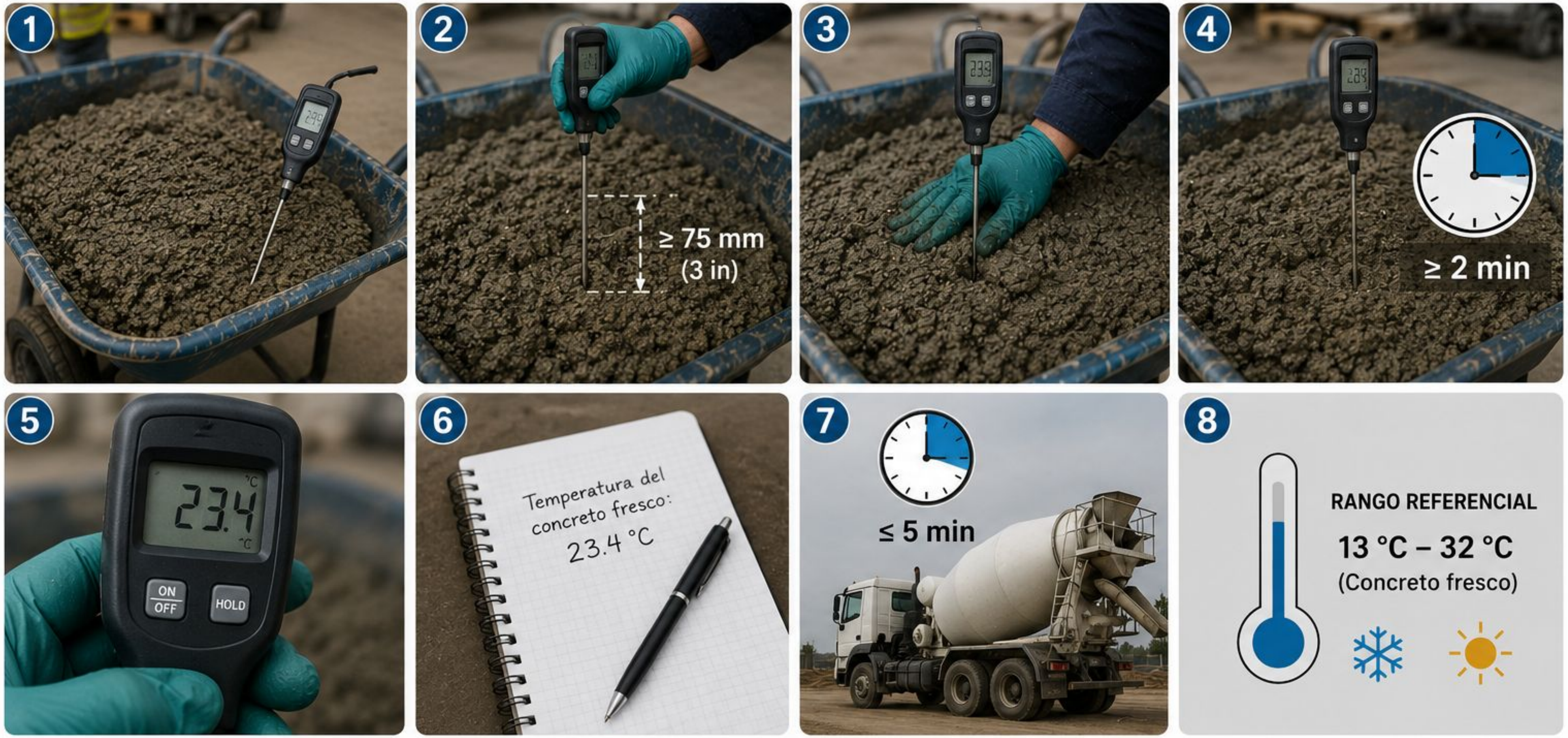
Source: ASTM International

Fresh Concrete Temperature Test

- Temperature affects concrete performance.
- Influences setting and strength development.
- Conducted according to ASTM C1064.
- Uses thermometer and concrete sample.

Source: ASTM International

Fresh Concrete Temperature Measurement



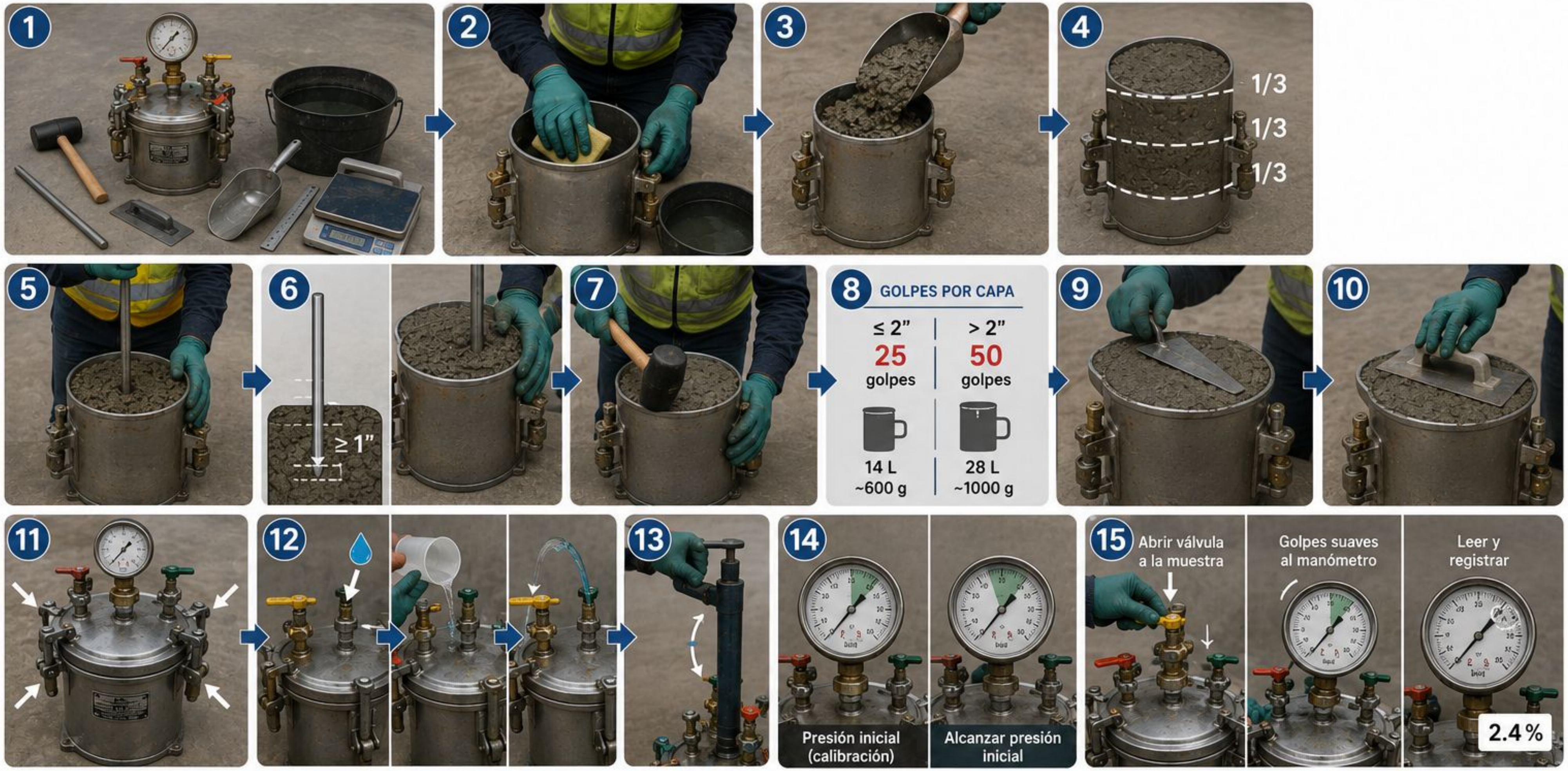
Source: ASTM International

Air Content Test Equipment

- Measures entrained and entrapped air content.
- Conducted according to ASTM C231 requirements.
- Uses Washington air meter and accessories.
- PPE required during testing procedures.

Source: ASTM International

Air Content Test Preparation



Source: ASTM International

Unit Weight Test Equipment

Source: ASTM International

Specimen Molding and Curing

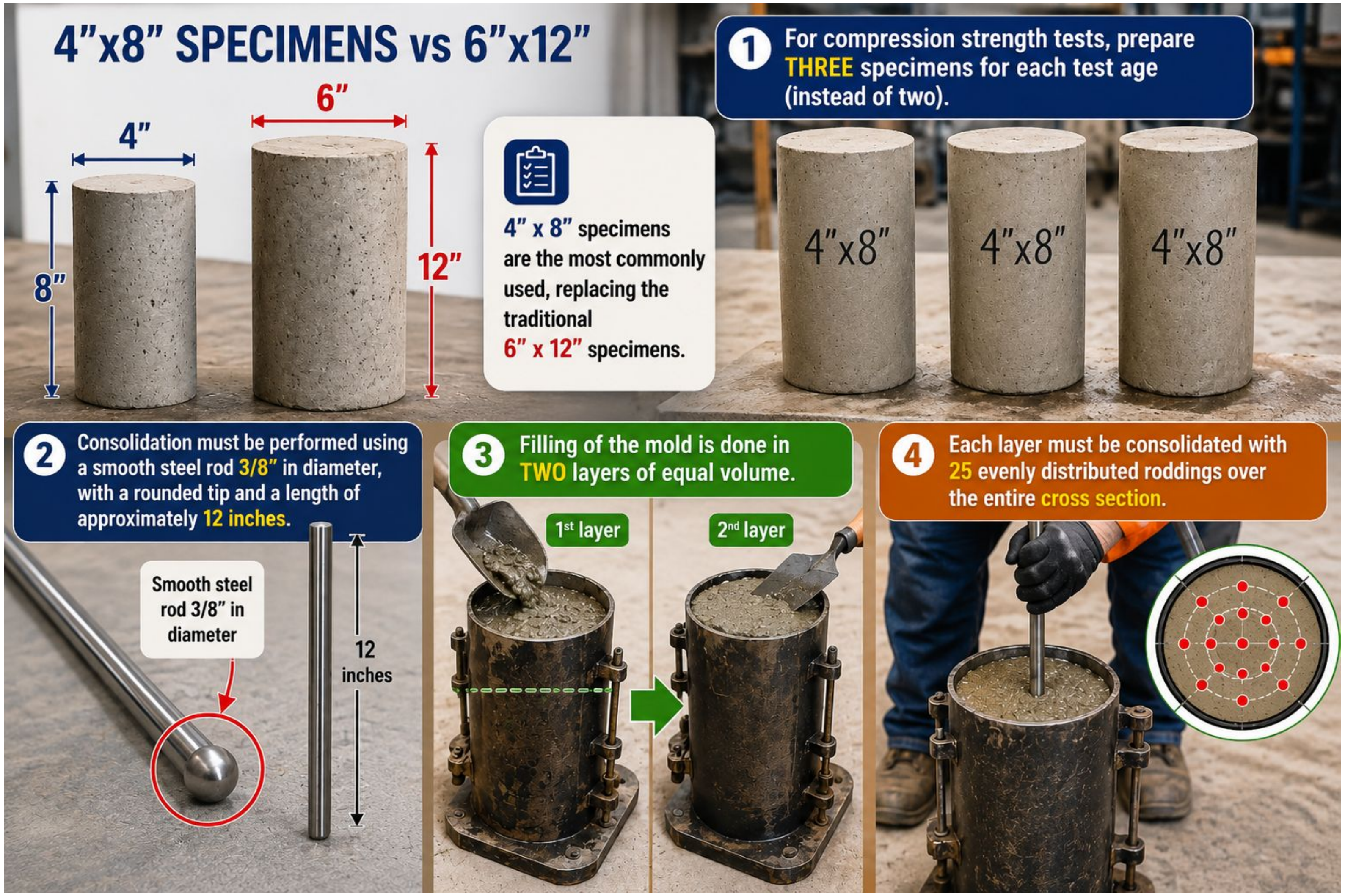
- Prepare specimens for hardened concrete testing.
- Conducted according to ASTM C192.
- Uses cylindrical or prism molds.
- Apply release agent before casting.

Source: ASTM International

Finishing and Initial Storage

Source: ASTM International

Requirements for 4×8-Inch Cylinders



Source: ASTM International

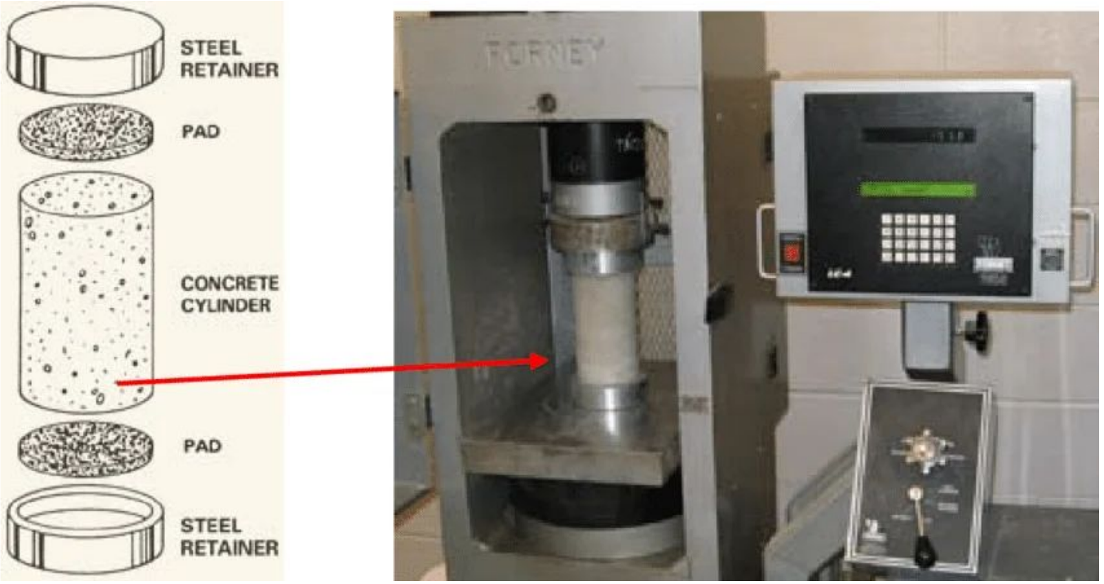
Quality Control of Hardened Concrete

Standards for hardened concrete tests

Source: Open AI (2026)

Compressive Strength Test Equipment

- Compressive strength evaluates concrete load-carrying capacity.
- Hydraulic press applies controlled axial compression.
- Calipers measure specimen dimensions for calculations.
- Neoprene pads improve load distribution uniformity.



Compression test configuration (concrete cylinder).
Source: ASTM International

Compressive Strength Test Procedure

Source: ASTM International

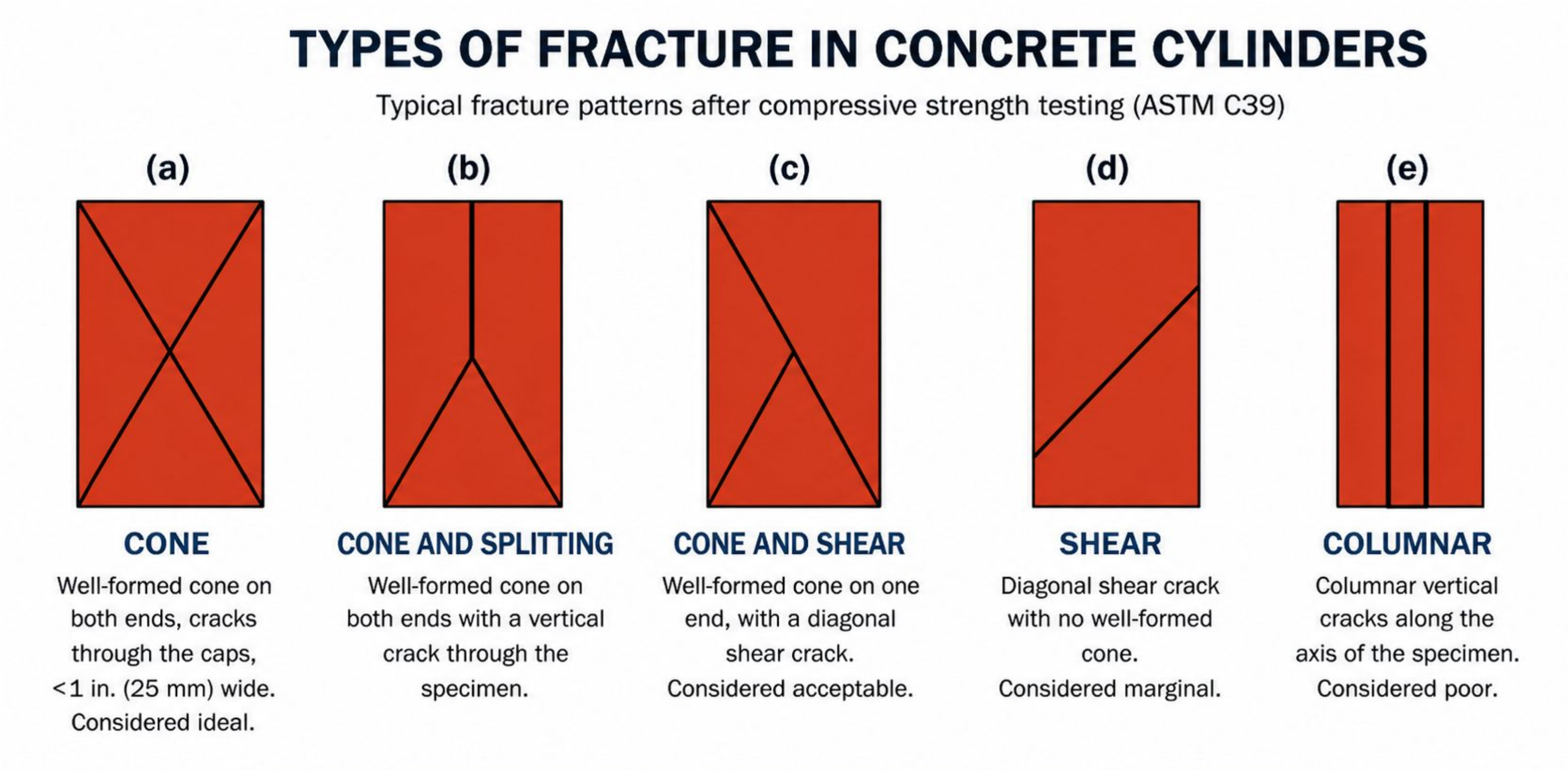
Testing Age Tolerances

- Concrete strength changes continuously with age.
- Testing ages require specific permissible tolerances.
- Record molding and testing times accurately.
- Proper timing ensures reliable result interpretation.

AGE OF TEST	PERMISSIBLE TOLERANCE
1 day	± 0.5 hr
3 days	± 2 hr
7 days	± 6 hr
28 days	± 20 hr
90 days	± 2 days

Source: Author's own ellaboration

Failure Types in Compression Testing



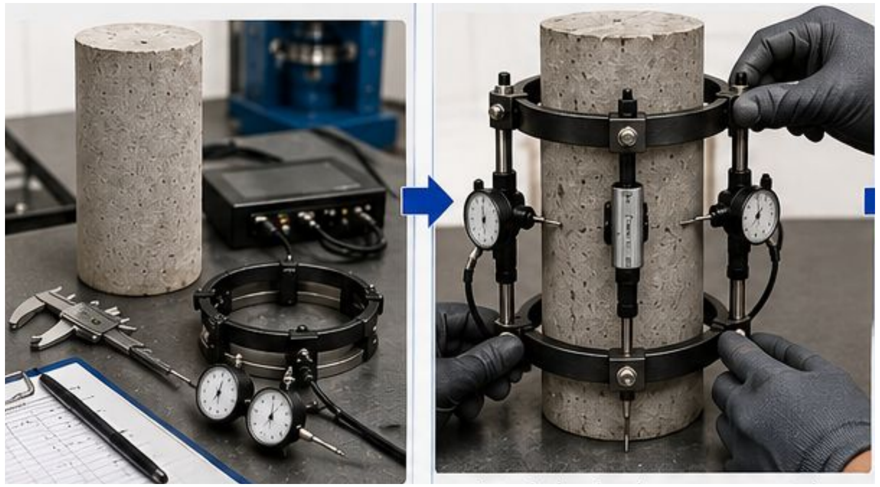
Source: Pasquel. (1998)

Variables Affecting Strength Results

- Curing conditions strongly influence strength development, variability, and long-term concrete performance.
- Improper sampling, consolidation, transportation, or moisture control increases result variability significantly.
- Loading rate, specimen alignment, and equipment calibration directly affect measured strengths.
- Standardized procedures minimize variability and ensure reliable, representative compression test results.

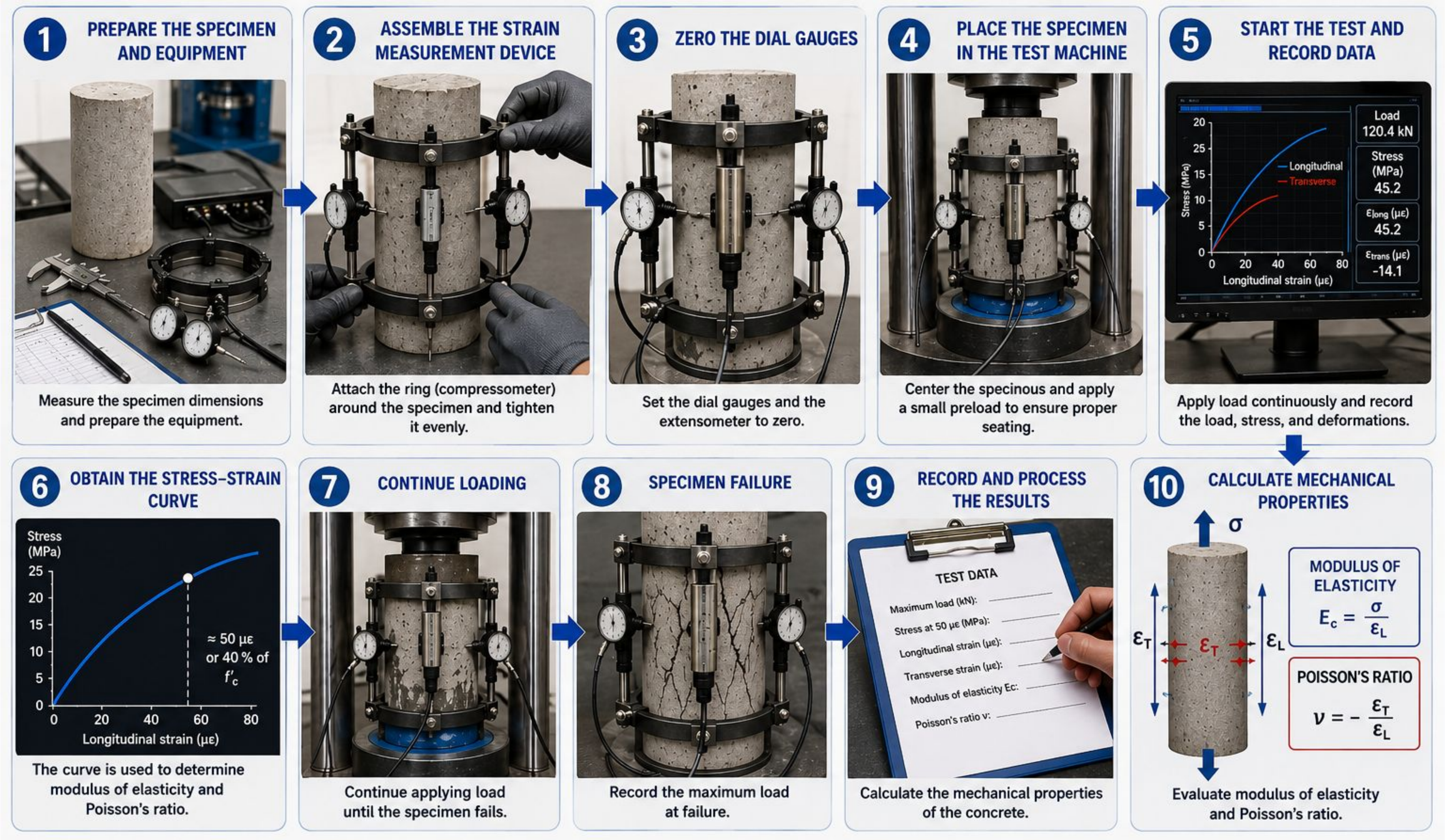
Modulus of Elasticity and Poisson's Ratio Equipment

- Conducted according to ASTM C469 requirements.
- Uses cylinders similar to compression testing specimens.
- Compressometer measures longitudinal and transverse deformations simultaneously.
- Data acquisition system records loads and strains.



Source: ASTM International

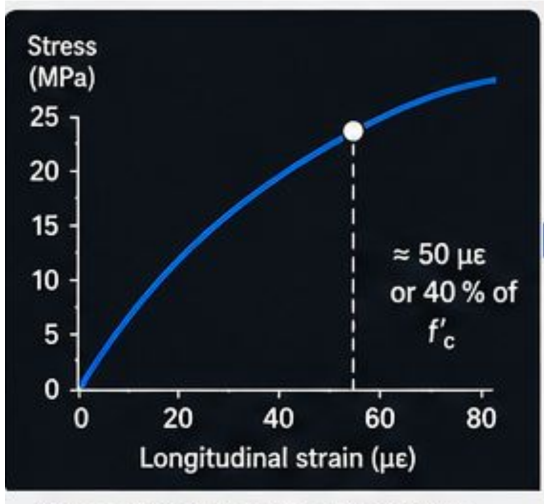
Modulus of Elasticity Test Procedure



Source: ASTM International

Interpretation of Elastic Properties

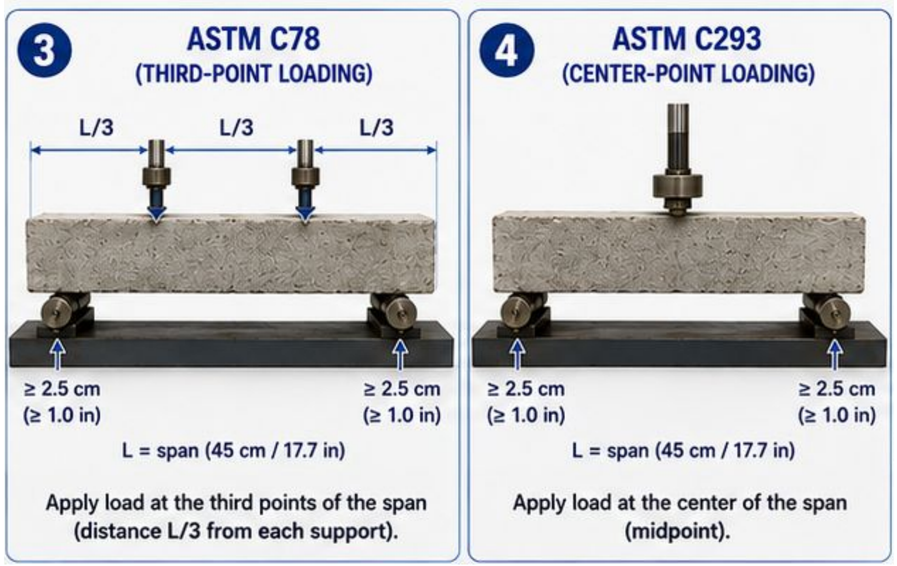
- Modulus represents concrete stiffness under applied loading.
- ASTM uses secant modulus for nonlinear behavior.
- Poisson’s ratio relates lateral and longitudinal strains.
- Stress-strain curve reveals deformation characteristics clearly.



Source: Open AI (2026)

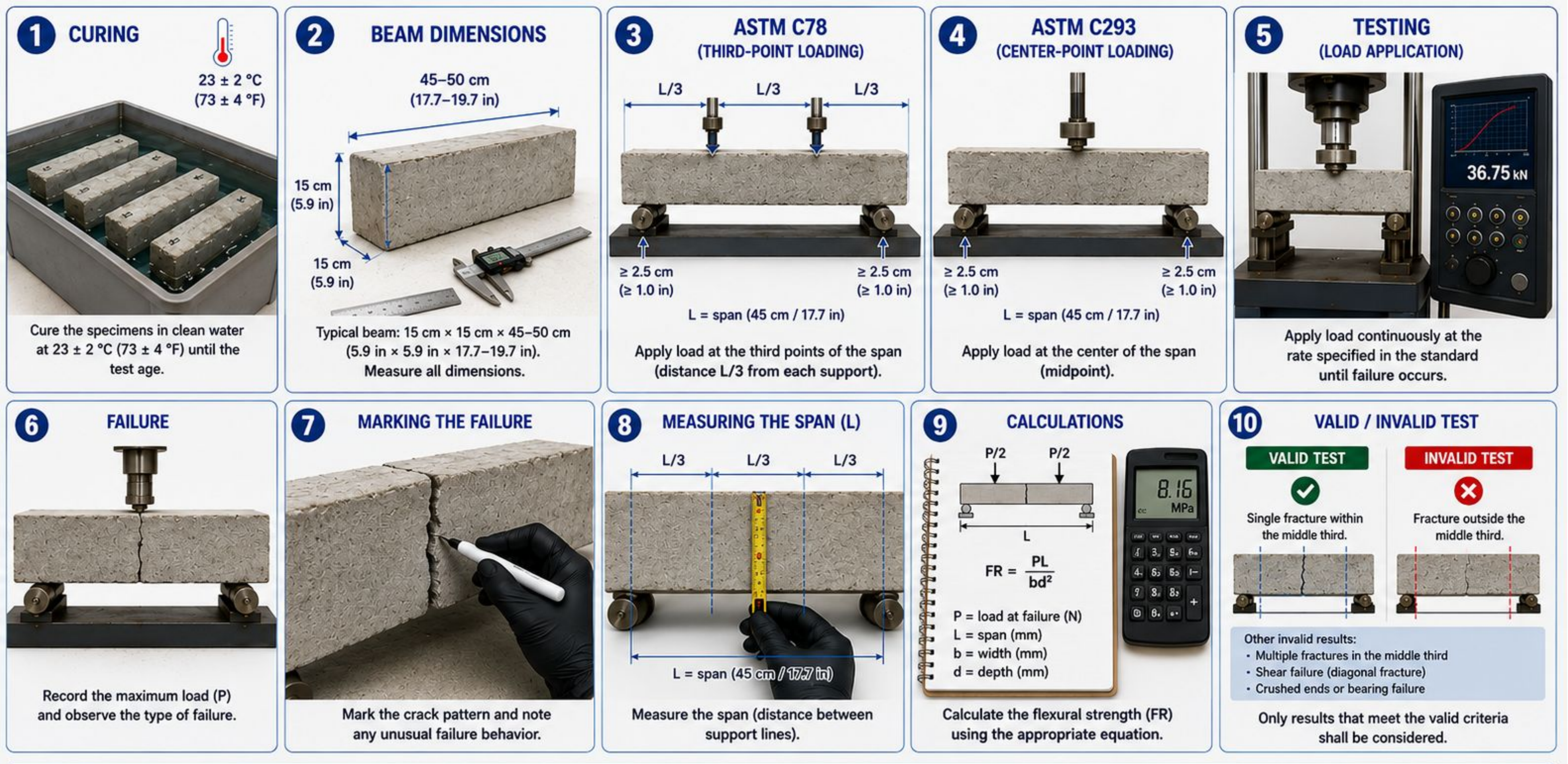
Flexural Strength Test Equipment

- Evaluates tensile resistance induced by bending stresses.
- ASTM C293 uses single-point loading configuration.
- ASTM C78 uses third-point loading configuration.
- Prism beams tested using flexural loading apparatus.



Source: ASTM International

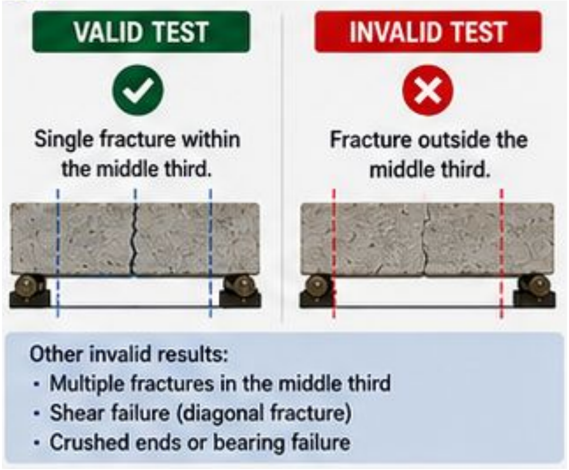
Flexural Strength Test Procedure



Source: ASTM International

Interpretation of Flexural Strength Results

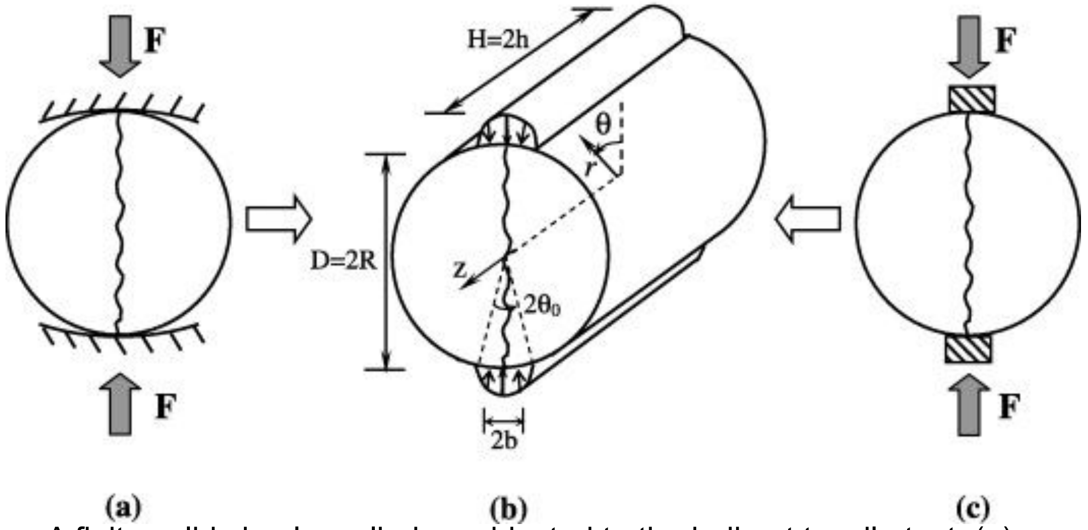
- Modulus rupture indicates bending tensile resistance.
- Strength depends on materials and curing conditions.
- Aggregate characteristics significantly influence flexural performance.
- Fracture pattern helps validate testing results.



Source: Open AI (2026)

Indirect Tensile Strength Test Equipment

- ASTM C496 uses Brazilian splitting test method.
- Cylindrical specimens similar compression test specimens.
- Bearing strips distribute load uniformly across cylinder.
- Hydraulic press applies controlled compressive loading.



A finite solid circular cylinder subjected to the indirect tensile test: (a) ISRM Brazilian test; (b) Mathematical model; and (c) ASTM test..
Source: Mindess, Sidney, Young, J. Francis, & Darwin, David. (2013)

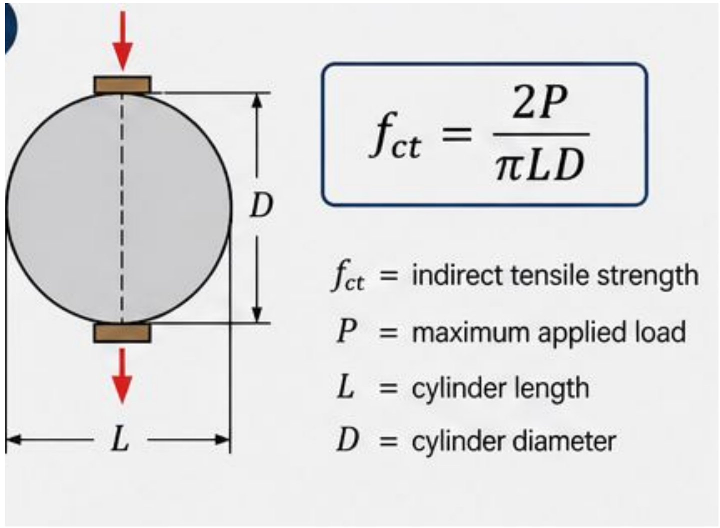
Indirect Tensile Strength Procedure

- Position cylinder horizontally between loading platens.
- Place bearing strips along opposite diametrical lines.
- Increase load continuously until specimen failure.
- Calculate tensile strength using standard equation.

Source: Author's own ellaboration

Interpretation of Tensile Strength Results

- Vertical crack indicates typical splitting test failure.
- Tensile strength exceeds direct tensile test values.
- Property depends on mixture and curing quality.
- Concrete requires reinforcement under significant tensile stresses.



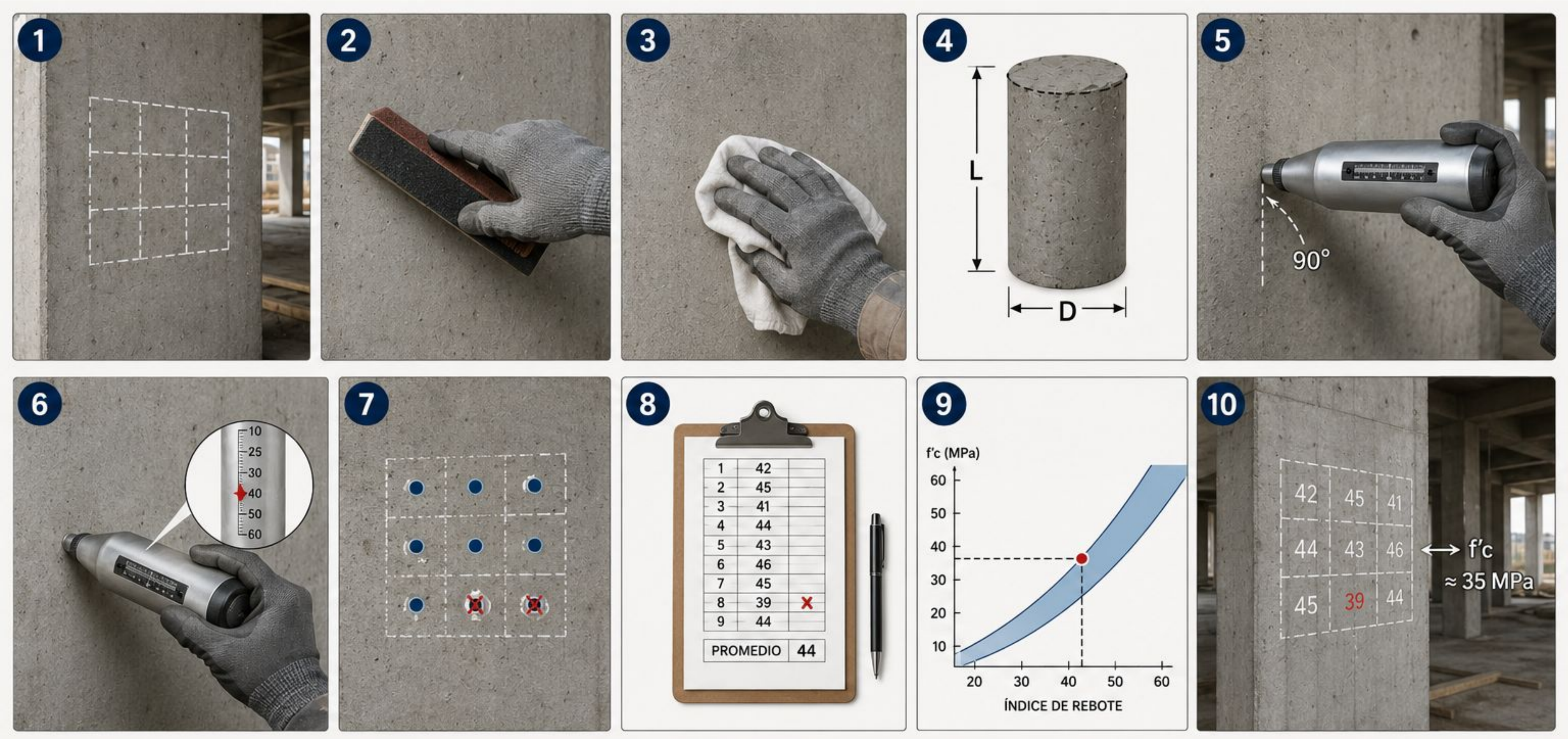
Source: ASTM International

Rebound Hammer Test Equipment

- ASTM C805 provides nondestructive evaluation procedure.
- Schmidt hammer estimates strength from surface hardness.
- Abrasive stone prepares testing surface adequately.
- Correlation curves estimate compressive strength values.

Source: ASTM International

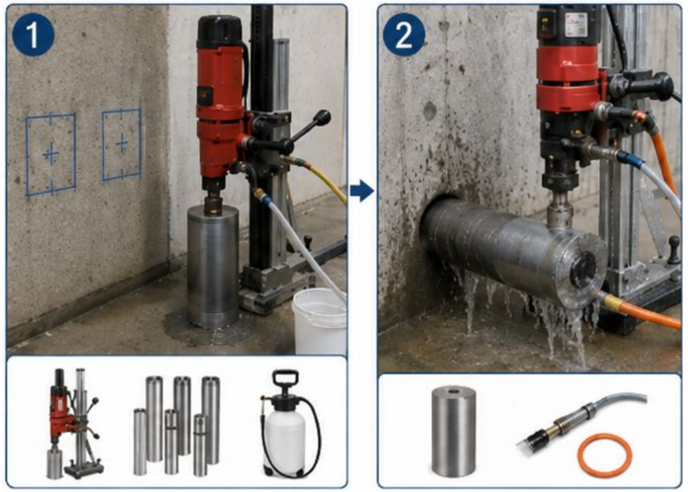
Rebound Hammer Test Procedure



Source: ASTM International

Core Extraction and Testing Equipment

- ASTM C42 evaluates in-place concrete strength directly.
- Core drilling machine extracts structural concrete specimens.
- Diamond bits and water cooling prevent damage.
- Compression testing determines strength of extracted cores.



Source: ASTM International

Core Testing Procedure

Source: ASTM International

Interpretation of Core Test Results

- Core testing directly evaluates in-place concrete strength, providing reliable information for structural condition assessments.
- Results are influenced by age, geometry, moisture, drilling damage, reinforcement, and extraction orientation.
- Core strengths are typically lower than laboratory-cured cylinders, reflecting actual field performance conditions.
- Core extraction also assesses uniformity, defects, cracking, consolidation quality, and material durability characteristics.

Conclusions

- Quality control begins with fresh concrete evaluation and continues through hardened concrete performance and compliance verification.
- Fresh concrete tests assess workability, consistency, uniformity, and suitability before placement and consolidation operations commence.
- Proper sampling, curing, temperature control, and testing procedures ensure reliable, representative, and accurate results.
- ASTM procedures and laboratory and field testing support durable, safe, and high-performance concrete structures.

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