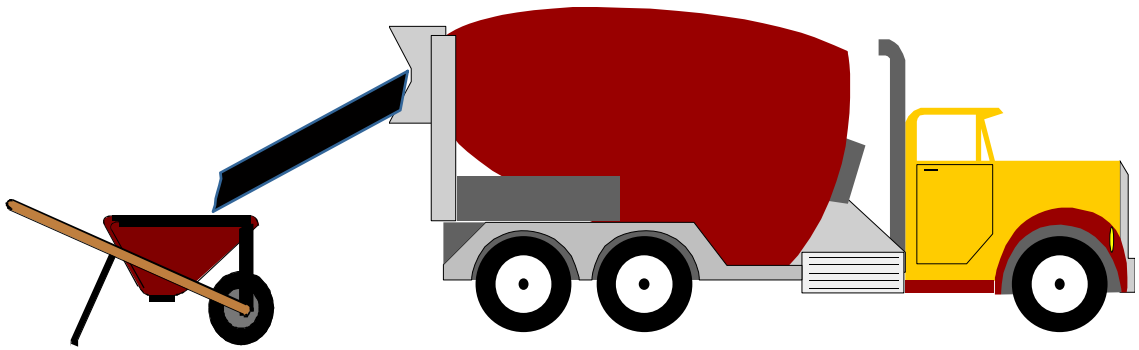
Quality Concrete

Fundamentals of Concrete

- Desired Properties of Concrete
  - Fresh (Contractor)
  - Hardened (Engineer)
  - Aesthetics (Architect/Owner)



ESSENTIALS of Quality Concrete

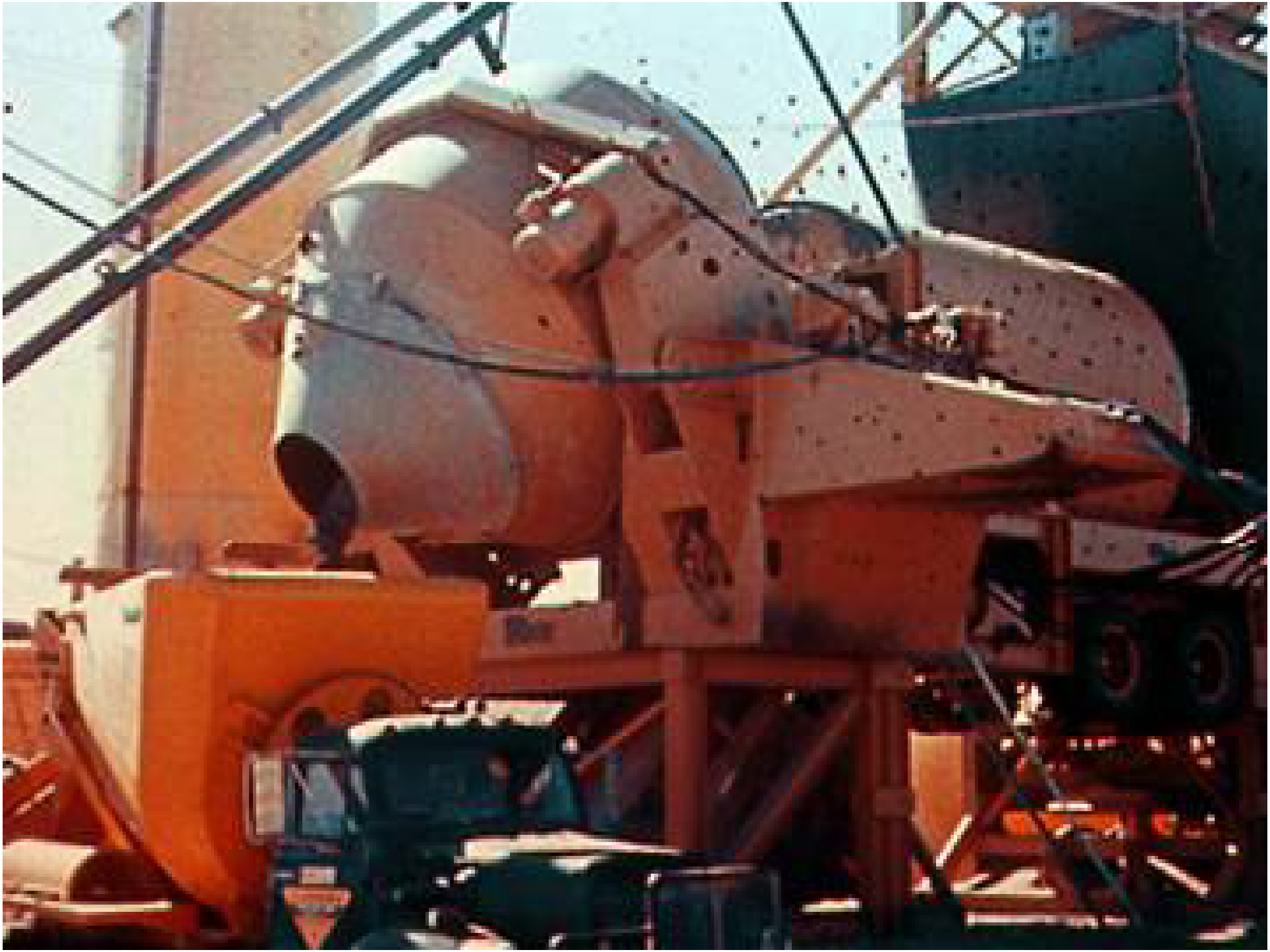
- 1. Suitable Materials
- 2. Proper Proportioning, Mixing, and Transporting
- 3. Proper Placing, Consolidation
- 4. Proper Finishing & Jointing
- 5. Proper Curing

Fresh Concrete

- Consistency
- Workability
- Uniformity
- Bleeding
- Setting & Hardening

Consistency

- Variability of Concrete Mix from Batch to Batch (Truck to Truck)
- Not a Measure of Workability!



Factors Impacting Consistency

- w/cm
- Wash Water
- Aggregate Moisture
- Temperature
- Haul Time
- Mixing Time
- Admixture Dosage

Workability

- Ease of Placing, Consolidating, and Finishing Freshly Mixed Concrete.
- Degree of Resistance to Segregation
- Control of Slump Loss

Factors Impacting Workability

- w/cm
- Cement Fineness
- Use of SCM's,
- Admixtures
- Aggregates
  - Shape & Gradation
- Admixture Compatibility
  - Slump Loss
- Method of Placement

Uniformity

- Provide a Homogeneous Mixture
- Lack of Segregation
- Proper Consolidation

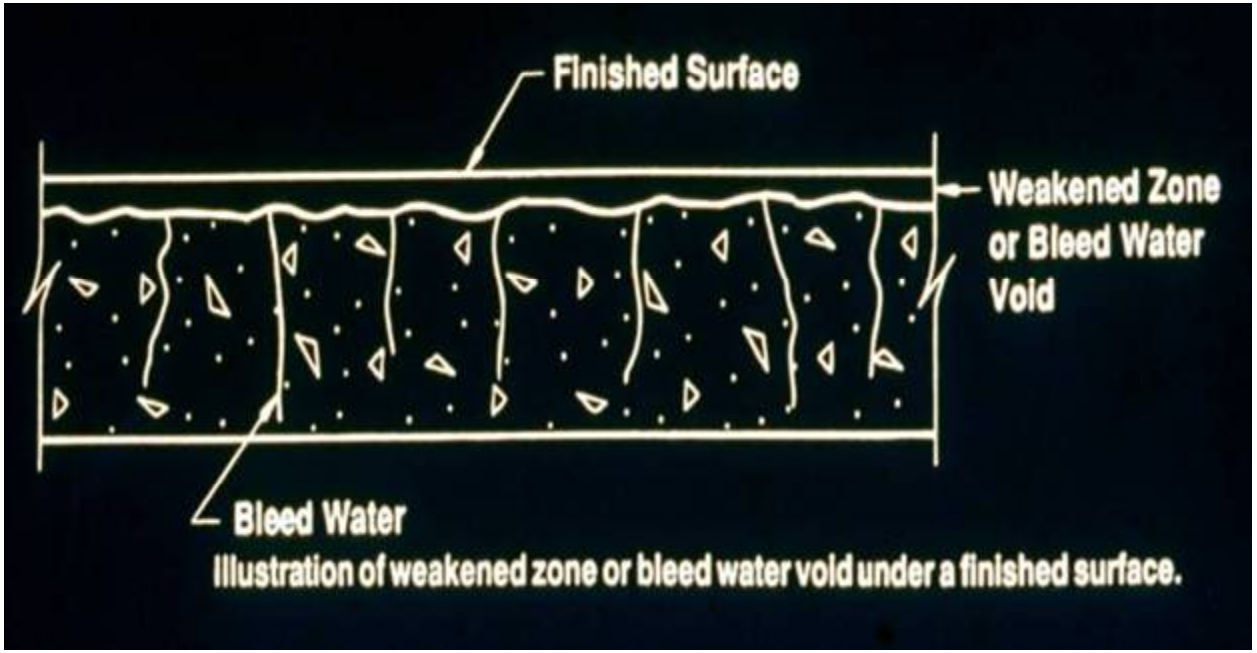
Improper consolidation

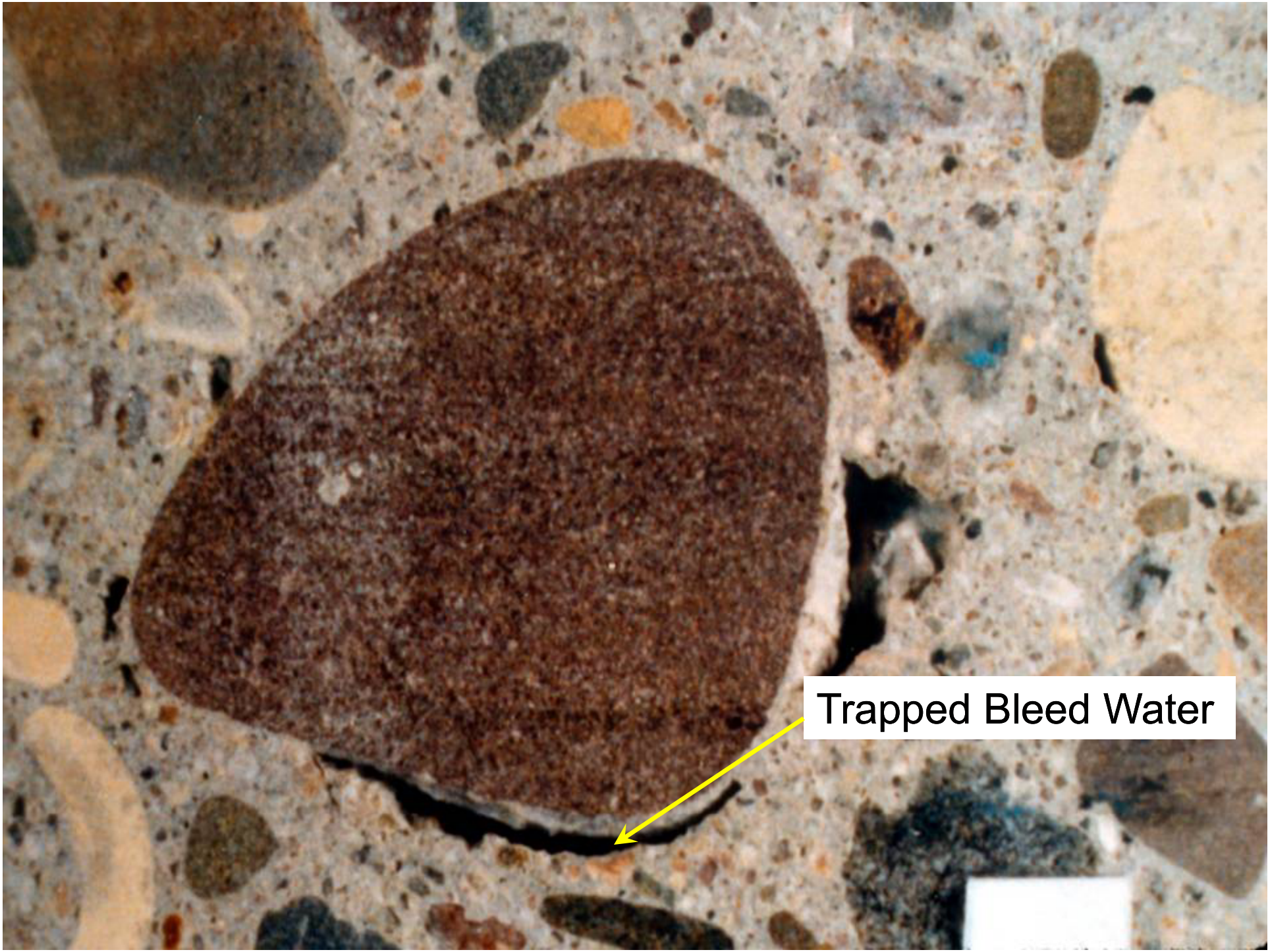
Factors Impacting Uniformity

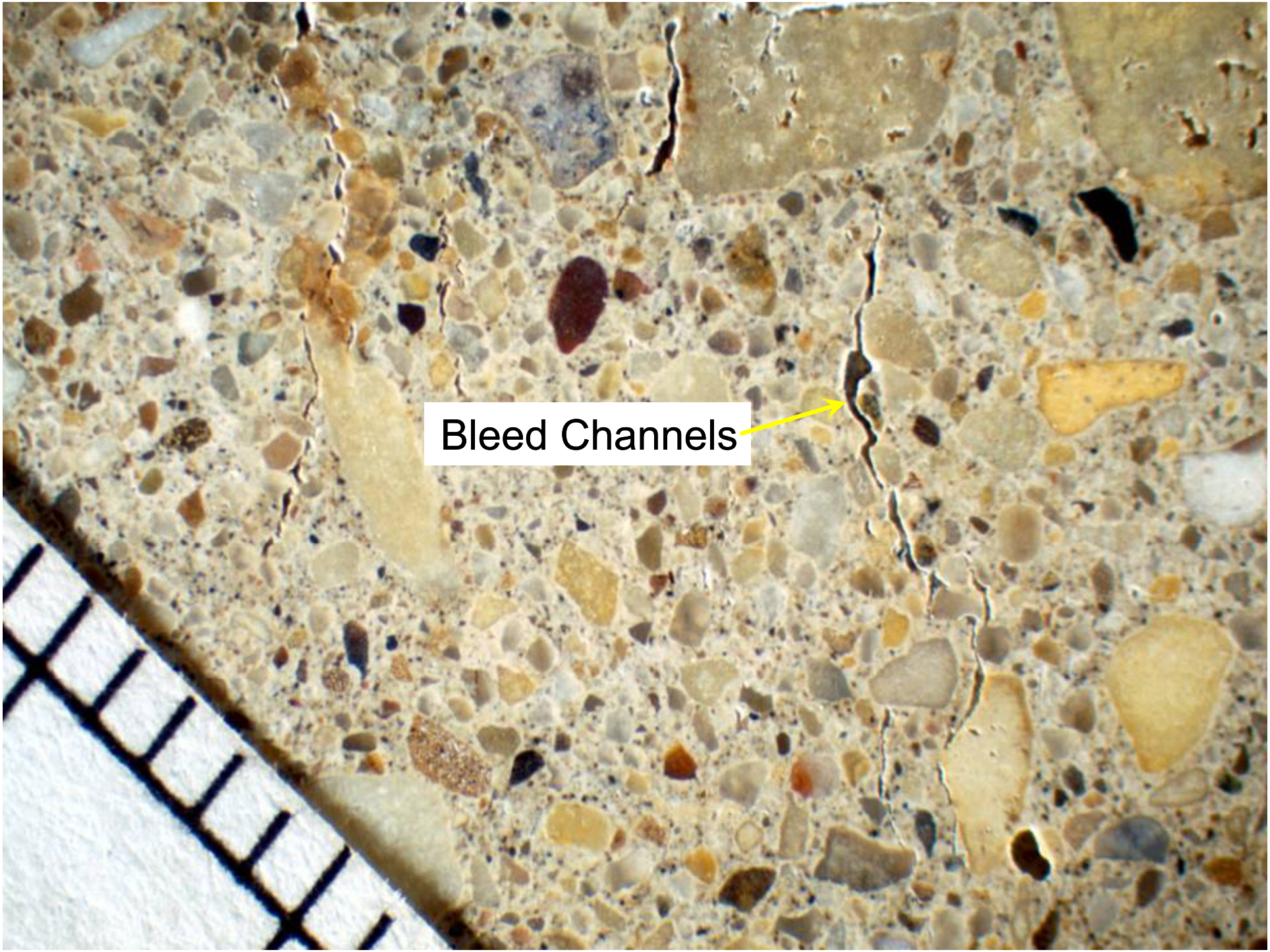
- w/cm
- Aggregates
  - Gradation
- Mixing
  - Speed,Time
- Constructibility
- Method of Placement
- Consolidation

Bleeding

- Settlement of Solid Particles and Migration of Water to Surface of Concrete
- Timing with Finishing Operations




Trapped Bleed Water


Bleed Channels

Factors Impacting Bleeding

Rate and Capacity

- w/cm
- Cement Fineness
- Aggregate
  - Gradation
- Use of SCM's
- Admixtures
- Temp., RH, Wind

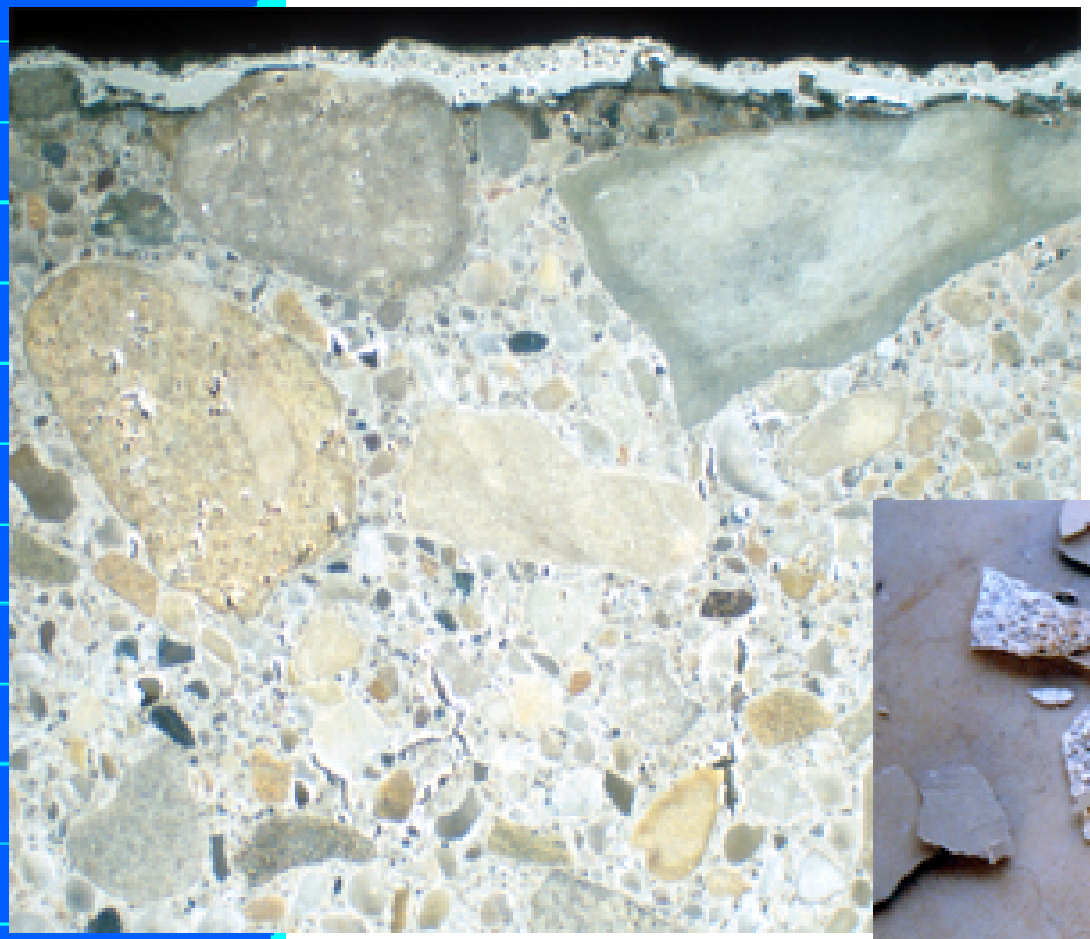
Setting and Hardening

- Setting- Loss of Plasticity of Paste and Conversion to Solid Material
- Hardening- Development of Hardness and Strength Following Set
- Impacts

  Construction

  Schedule

Sealing The Surface



- Improper Tooling
- Traps Bleed Water and Air Beneath Layer of Mortar

Factors Impacting Setting & Hardening

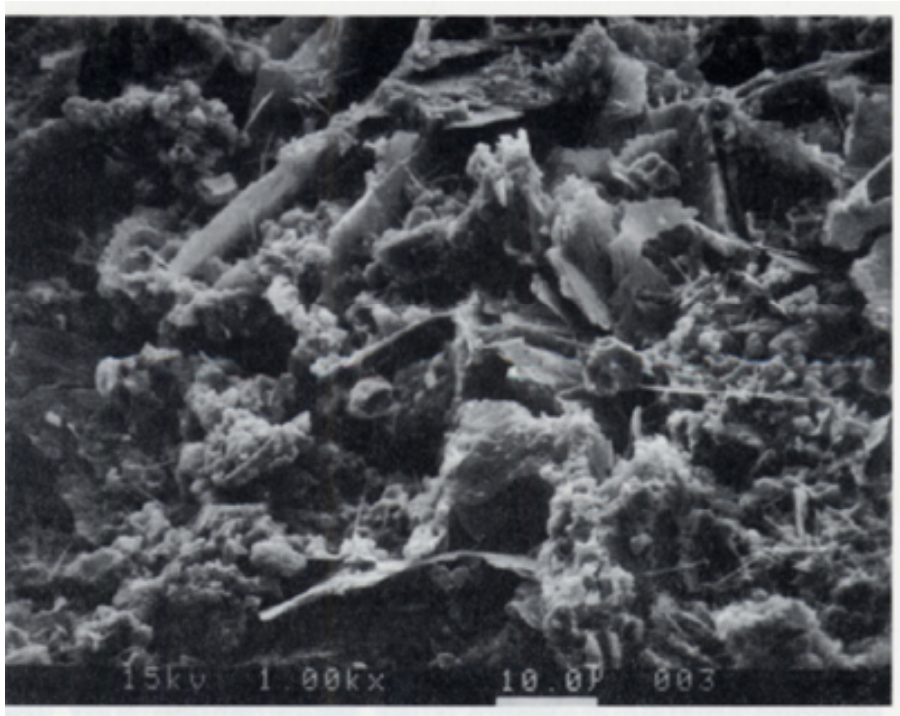
- w/cm
- Use of SCM's, Admixtures
- Temperature
- Rate & Heat of Hydration
- Cement
  - Gypsum (CaSO4)
    - Content & Form

Hardened Concrete Properties

- Hydration
- Drying Rate
- Strength
- Durability
- Permeability & Watertightnes
- Abrasion Resistance
- Volume Stability & Crack Control

Hydration

- Chemical Reaction between Cement and Water to Form New Compounds.
- Provides Setting, Hardening, and Strength Properties of Concrete



Hydration

Cement Hydrates in Layers…

Methods of Curing

SUPPLY <u>ADDITIONAL WATER</u>

- Ponding
- Soaker hose
- Wet sand
- Wet burlap
- Immersion (precast)
- Steam curing

Methods of Curing

SEAL IN MIX WATER

- Curing compound
- Waterproof paper
- Polyethylene sheets


4 2
-D U M P

Controlling Temperature

ACI 305- Hot Weather Concreting

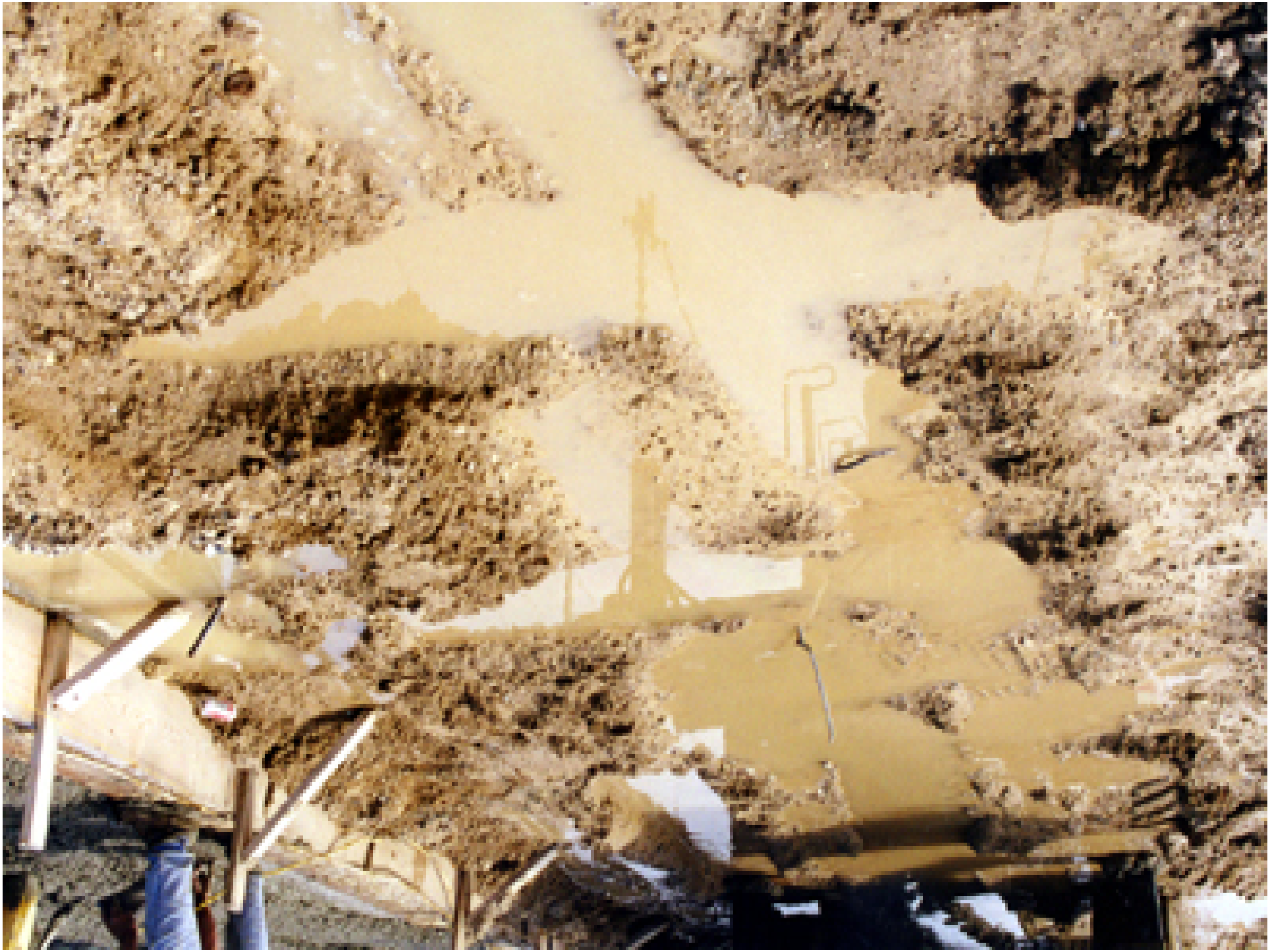
ACI 306- Cold Weather Concreting

Factors Impacting Hydration

- Amount of Water- RH>80%
- Clinker Composition
- Cement Fineness
- Admixtures
  - Retarders
  - Accelerators
- Curing Temperature
- Curing Duration
- Space

Drying Rate

- Rate at Which Concrete Dries Out.
- Concrete Does Not Harden or Cure by Drying Out.
- Hydration Will Cease Once Loss of Moisture Drops Below 80% RH



Factors Impacting Drying Rate

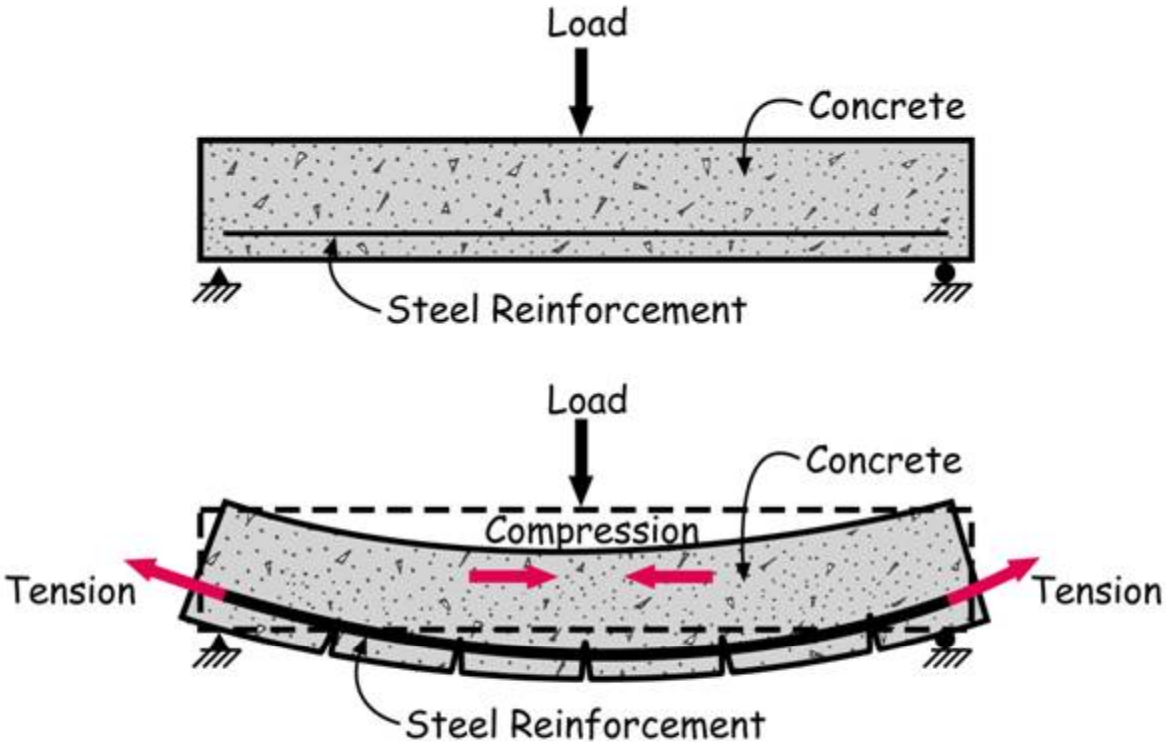
- w/cm
- Materials
  - Density of Concrete
- Size of Element
- Drying Conditions
  - Temperature
  - External Moisture
- Vapor Retarders
- Curing
  - Method & Duration

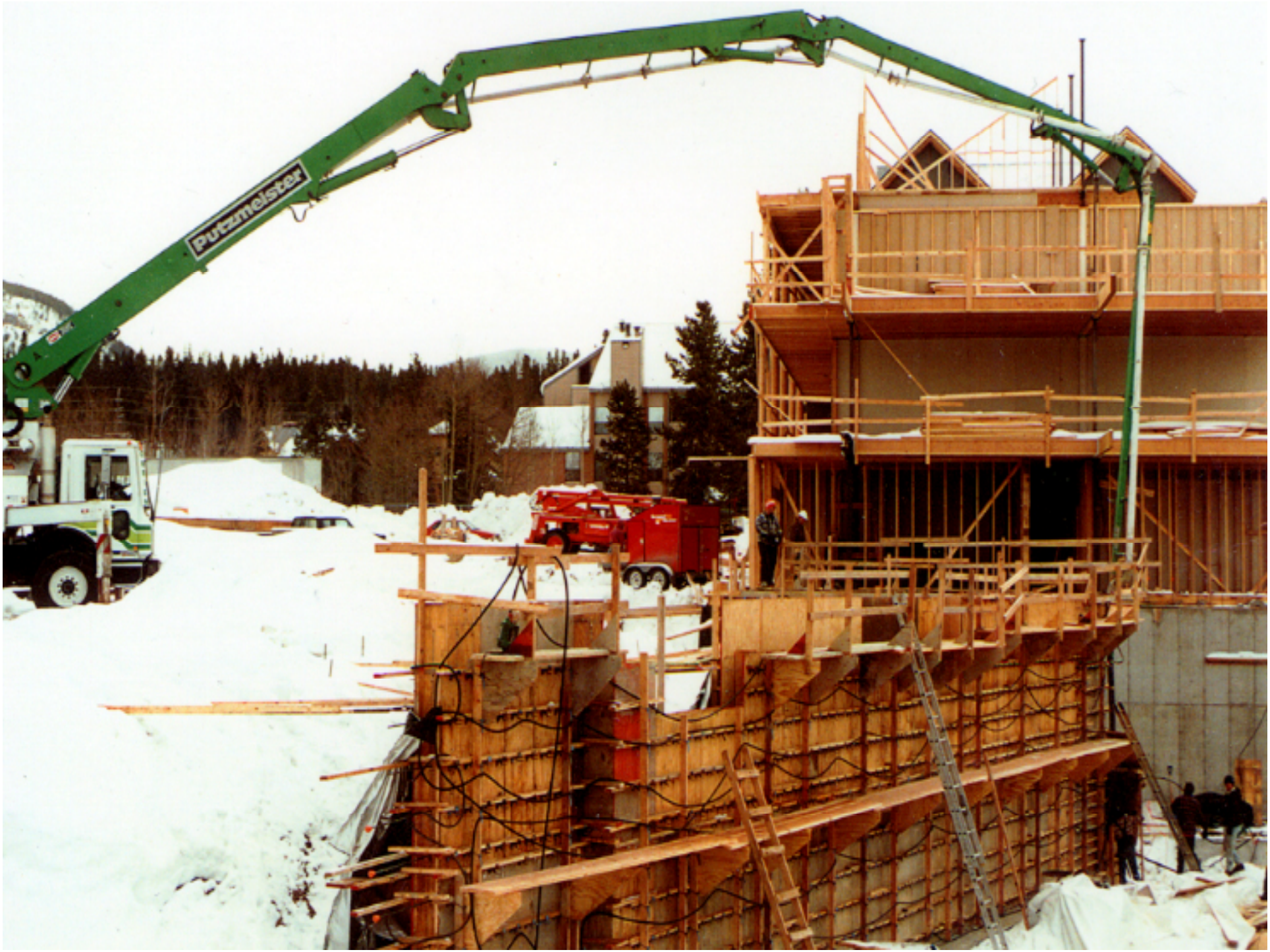
Strength

- Compressive Strength- Measured Resistance of Concrete to Axial Loading.

Strength

- Concrete is strong in compression, but weak in tension.




Putzmeister

Factors Impacting Strength

- w/cm
- Age
- Air Content
- Aggregate Bond
- Handling
- Curing Temperature
- Testing Errors

Durability

Factors Impacting Durability

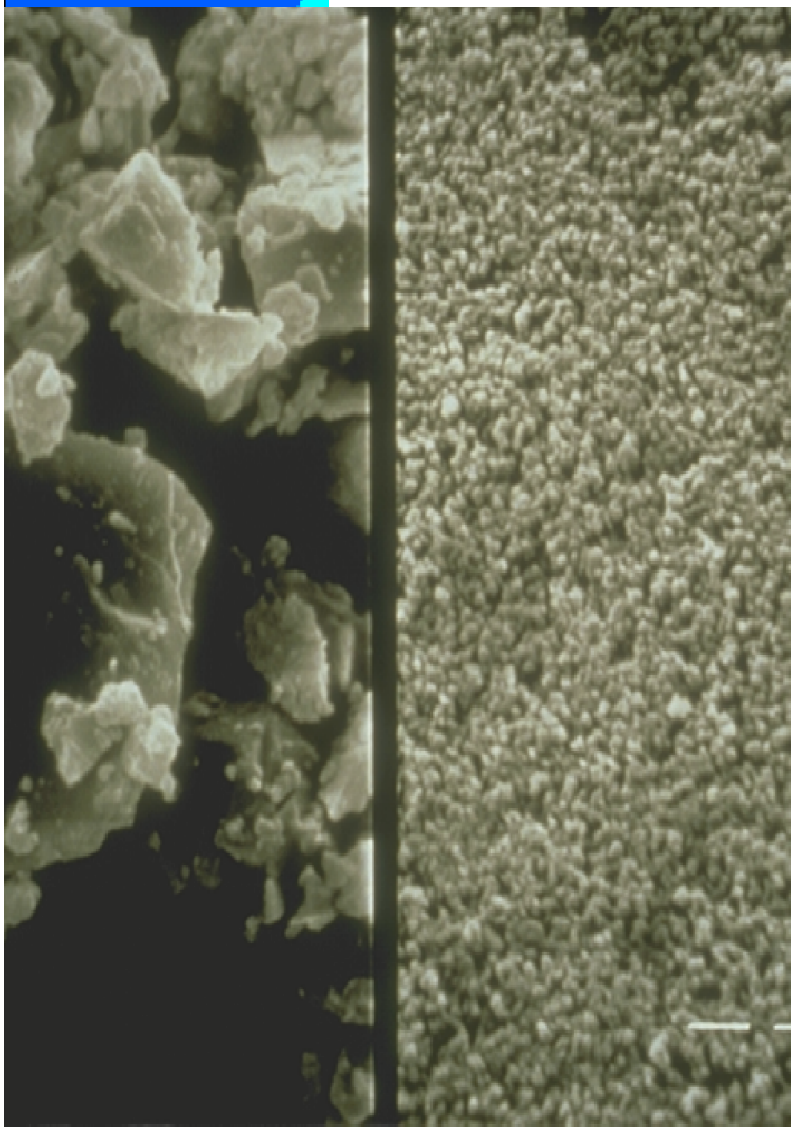
- Reactive Aggregate
  - ASR
  - ACR
- HIDE
- Carbonation
- Corrosion
- Chemical Attack
  - Sulfate Attack
- Seawater Exposure

Permeability & Watertightness

- Permeability-
  Amount of Moisture Migration Through Concrete.
- Watertightness-
  Ability of Concrete to Resist Moisture Penetration by Water or Other Substances (Liquid, Gas, or Ions).

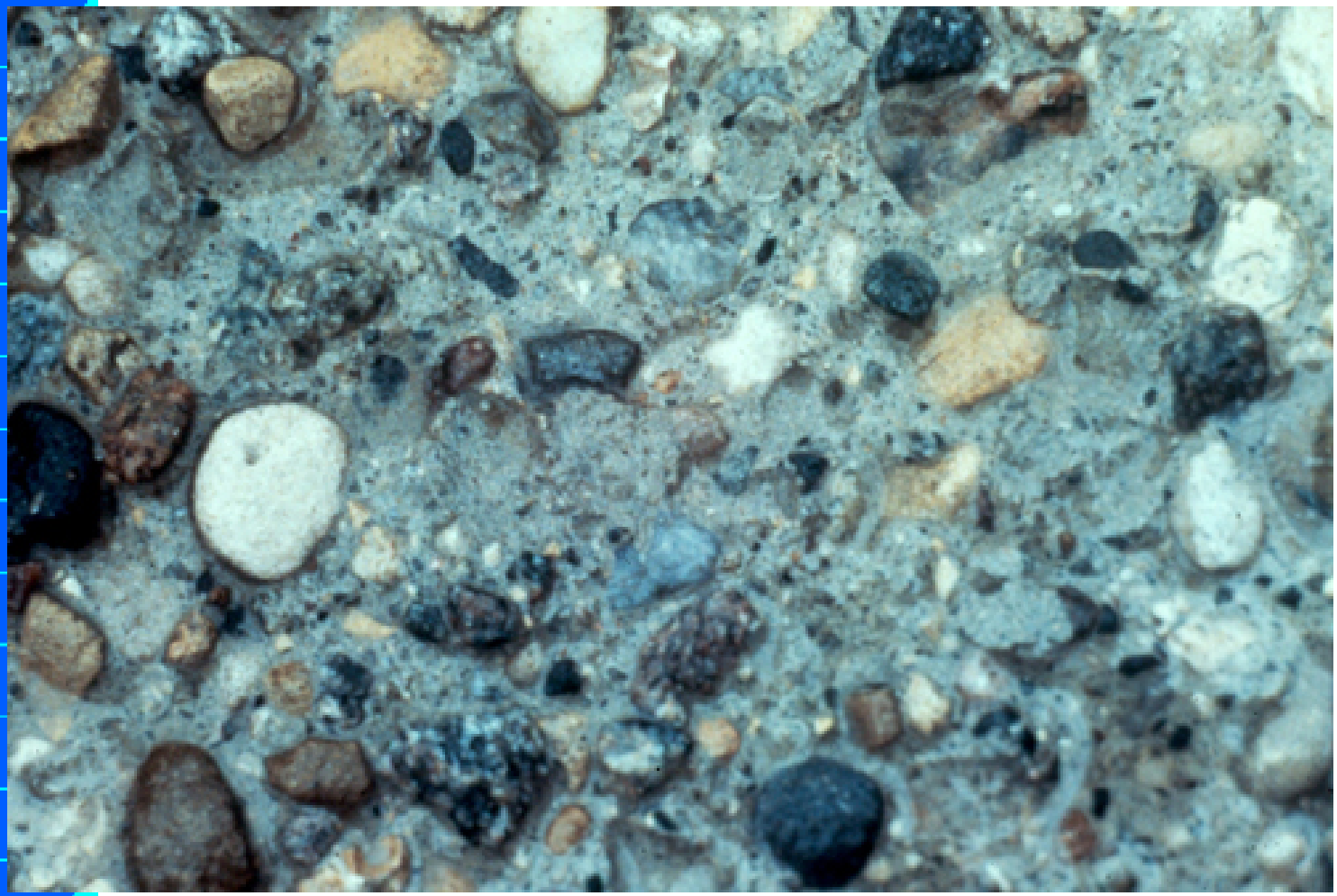

GGBF slag
grade 120
Portland Cement
Type I
Si Silica Fume
(microsilica)
Fly Ash
class C

Factors Impacting Permeability & Watertightness



- Material Fineness
  - Cement
  - Use of SCM's
  - Aggregate Gradation
- Paste/Aggregate Ratio
- Aggregate Paste Bond
- Curing
- Sealers
- Vapor Retarders

Abrasion Resistance



Factors Impacting Abrasion Resistance

- w/cm
- Curing
- Type of Aggregate
- Surface Finish
- Surface Treatment
- Exposure

Volume Stability & Crack Control

- Concrete Changes Volume due to Changes in Temperature, Moisture, and Stress.
  - Creep
  - Shrinkage
- Control Volume Changes With Jointing.
  - Contraction
  - Isolation
  - Construction

Jointing-Crack Control

*Table 6-1. Maximum Spacing of Contraction Joints in Meters (Feet)**

Slab thickness mm (in.)	Maximum-size aggregate less than 19 mm (¾ in.)	Maximum-size aggregate 19 mm (¾ in.) and larger
125 (5)	3.0 (10)	3.75 (13)
150 (6)	3.75 (12)	4.5 (15)
175 (7)	4.25 (14)	5.25 (18)**
200 (8)	5.0 (16)**	6.0 (20)**
225 (9)	5.5 (18)**	6.75 (23)**
250 (10)	6.0 (20)**	7.5 (25)**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Factors Impacting Volume Stability

- Restraint, Jointing
- w/cm
- Amount of Aggregate
- Properties of Aggregate
- Size & Shape of Member
- RH and Temp
- Method of Curing & Drying
- Degree of Hydration
- Time

Summary

Desired Properties of Concrete:

- Consistency
- Workability
- Uniformity
- Bleeding
- Setting & Hardening
- Hydration
- Drying Rate
- Strength
- Durability
- Permeability & Watertightness
- Volume Stability & Crack Control

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