

Troubleshooting Fresh Concrete Problems



Freshly-Mixed Concrete Problems

- Construction errors
- Design errors
- Slump loss
- Workability
- Cement-admixture compatibility
- Setting
- Mix temperature
- Air content control



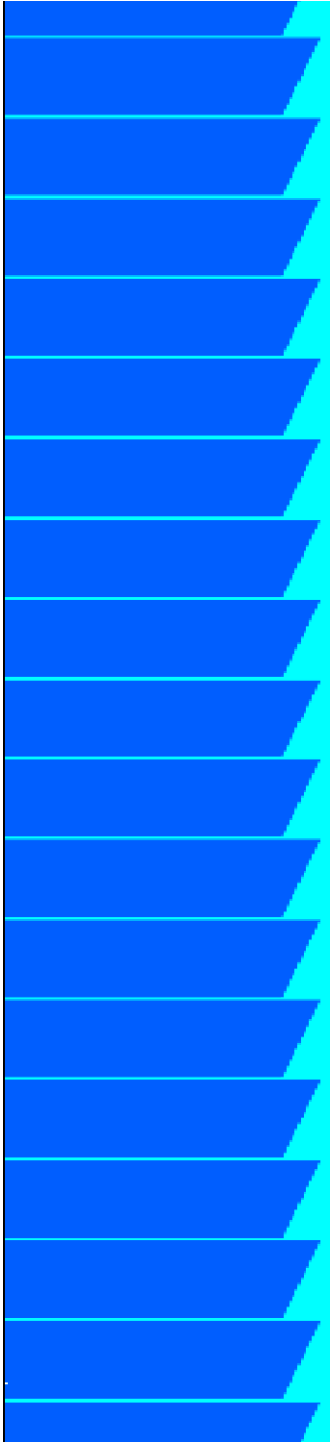
Construction Errors

- H₂O Concrete
- Improper Alignment of Forms
- Consolidation
- Location of Steel
 - ◆ Not Secured
- Movement of Formwork
 - ◆ While concrete is setting, can induce cracking or separations
 - ◆ Water enters Concrete – F-T
- Settling of Concrete
- Sub grade settlement



Design Errors

- Inadequate Structural Design
 - ◆ Spalling – high compressive or high torsion or shear stresses
 - ◆ Cracking – tensile
 - ◆ Poor Design Details
 - ✧ Localized stress concentrations
 - ✧ Water Ponding
 - ✧ Abrupt changes in section
 - ✧ Insufficient steel or reentrant corners or openings
 - ✧ Inadequate provisions for deflection
 - ✧ Incompatibility of materials
 - Mod. E, thermal
 - ✧ Poorly Designed Expansion joints
 - ✧ Neglecting Creep



SLUMP



Slump Loss





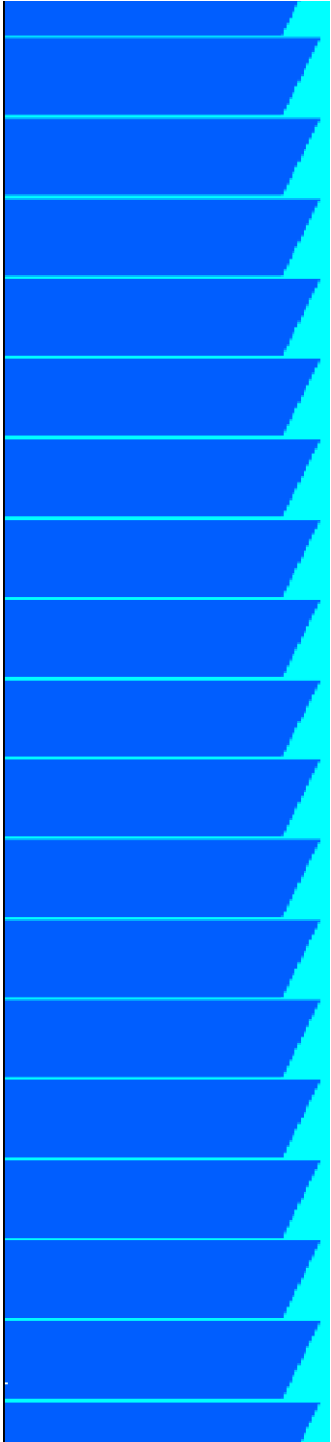


Workability

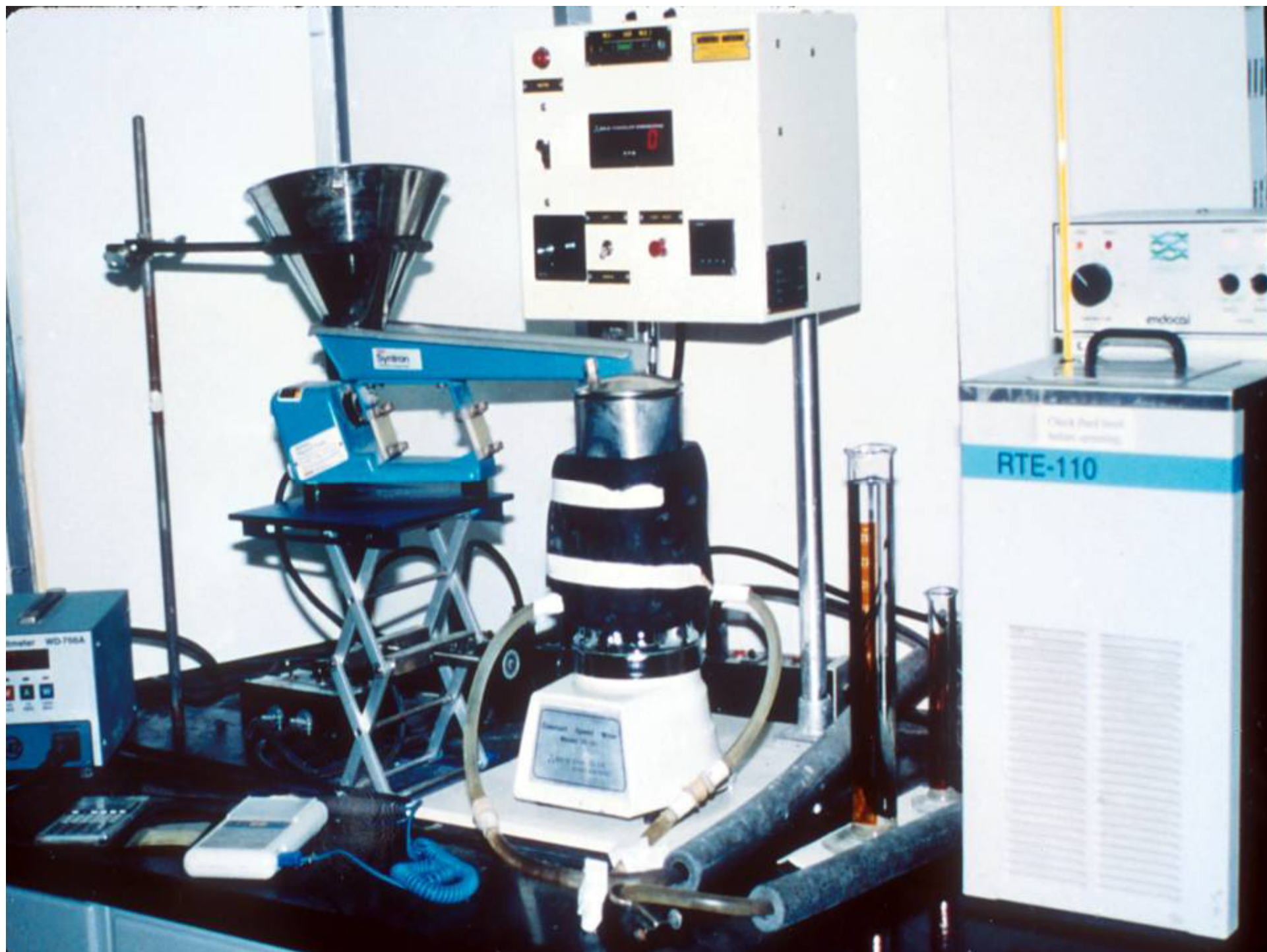
- Slump Loss
 - ◆ Cement False Set
 - ◆ Cement-admixture Incompatibility
 - ◆ Sequence of Admixture Addition
- Pumping
 - ◆ Cement Content
 - ◆ Fly Ash
 - ◆ Aggregate Content/ Gradation



Cement - Admixture Compatibility



Mini – Slump Cone Test









Proposed Version of Mini-Slump Cone Test

- Cement: 500g
- W/C: 0.50
- Mixing water temperature: 22 ± 1 C
- Mixing Schedule: 0.5 min. mix – 2 min. rest – 1.5 min. mix
- Mixing rpm: 13,000
- Testing Schedule:
 - ◆ 2,5; Remix – 15, 30, 45 min.
- Remixing: 2 min. prior to test 1,200 rpm for 1 min.

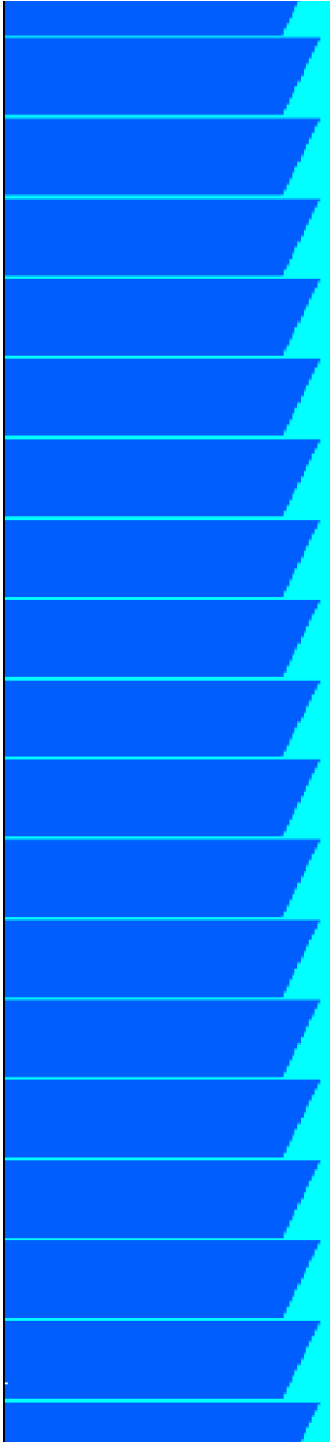
Mini – Slump Cone Test

Admix- tures		W/C	Pat Area, in.				
			Minutes				
I.D.	oz.		2	5	15	30	45
None	0	0.42	5.0	9.7	7.7	6.7	5.8
None	0	0.45	5.8	15.9	13.4	11.8	9.3
W.R.A.	3	0.42	7.4	10.0	7.3	6.2	4.8
W.R.A.	5	0.42	8.0	7.3	4.0	3.3	2.9
W.R.A.	7	0.42	7.6	6.8	3.7	2.9	2.6
W.R.A.	9	0.42	8.9	8.5	3.5	2.9	2.3
W.R.A.		Contained sugar and TEA					



TEA

- Accelerates C_3A
- Retards C_3S



Setting Time



Spot Setting

- Coke or Coffee
- Cigars
- Reshipped Concrete
- Admixture Overdose
- Wrong Concrete
- Shipped From Two Plants



If the Concrete Isn't Set

- Eventually it Will
- Don't Overwork Slabs
- Prevent Moisture Evaporation
- Prevent Freezing



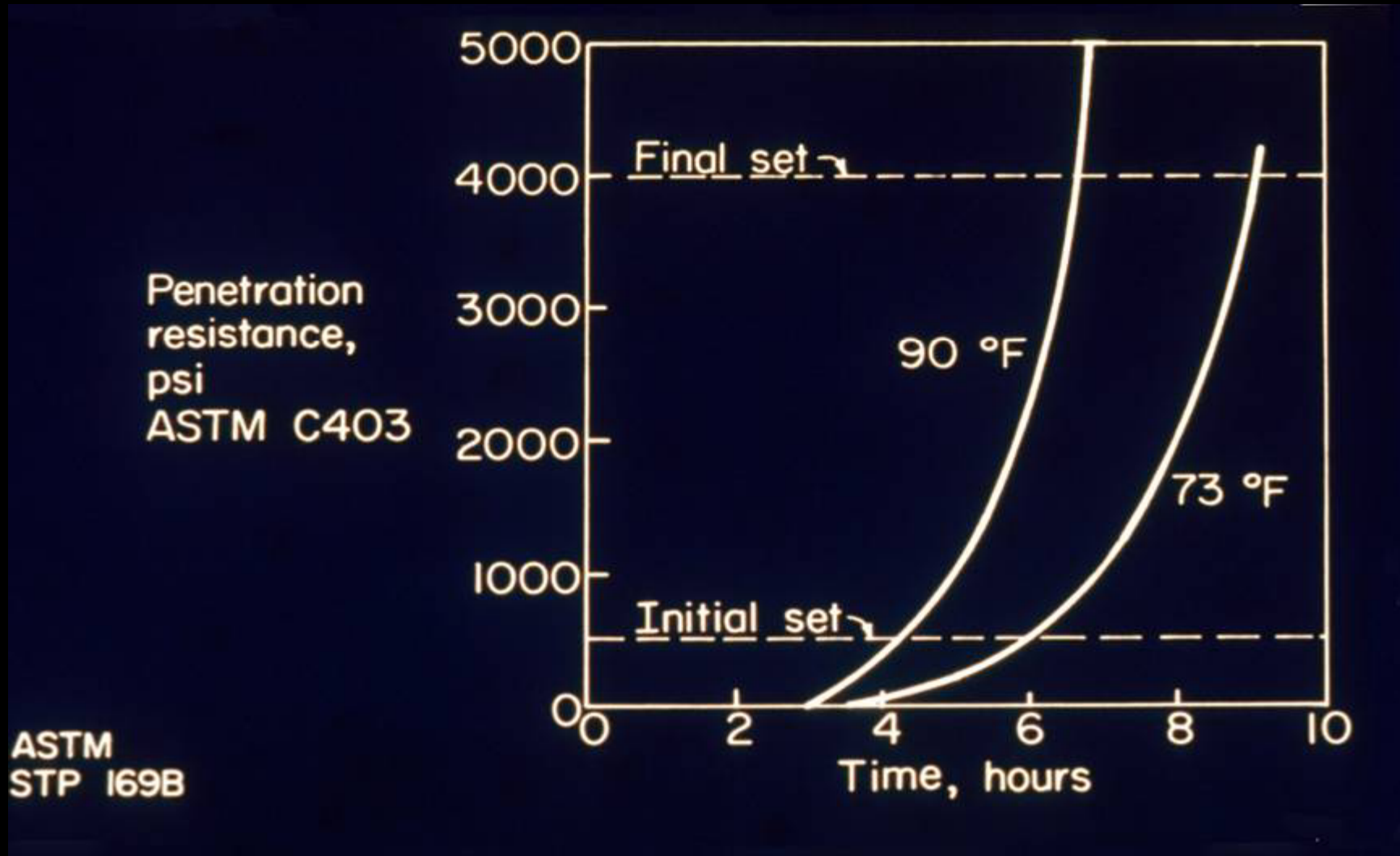


Setting Time

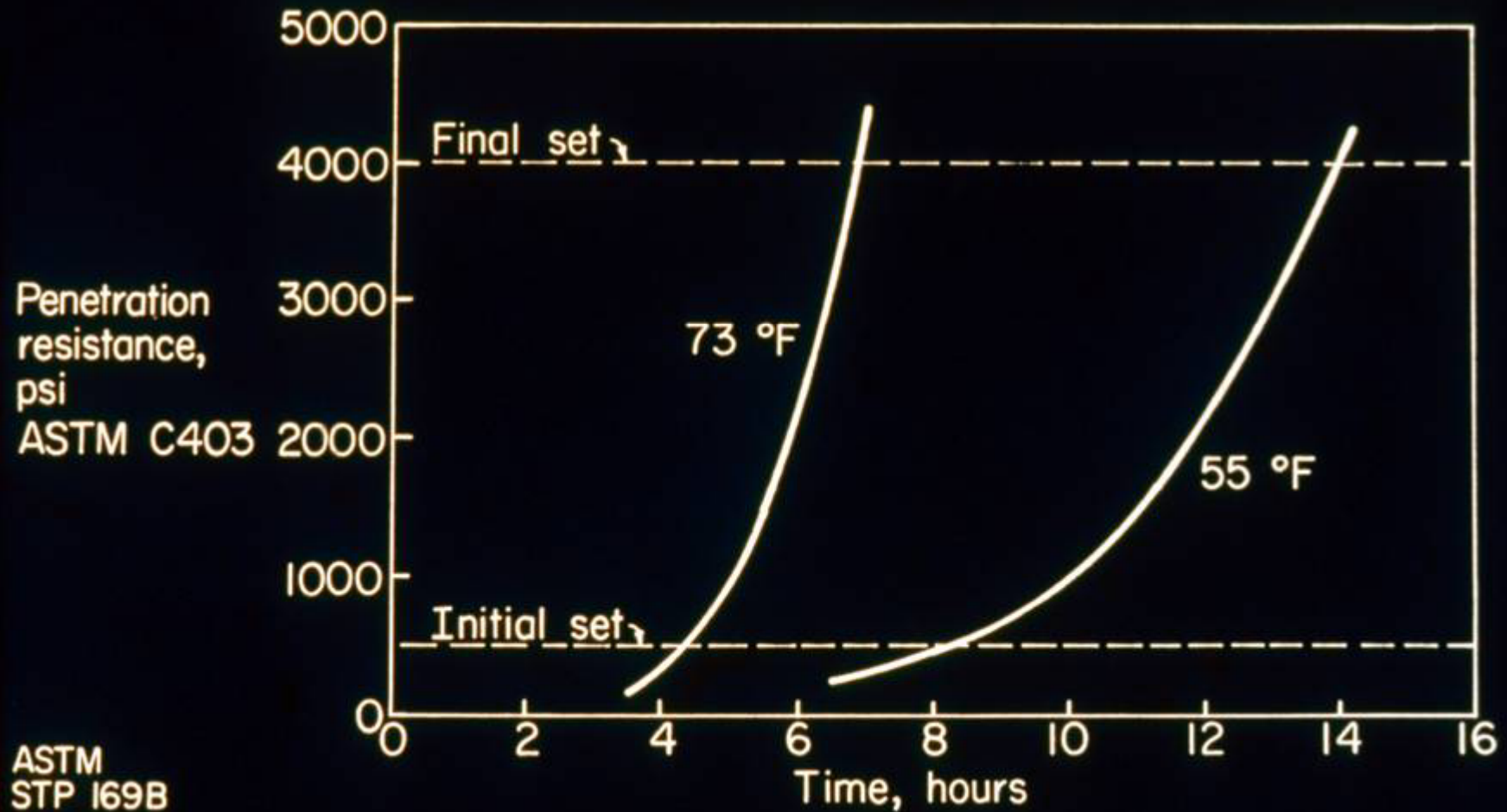
- Pozzolans
- Temperature
- Contamination
 - ◆ Sugar
 - ◆ Water

FORMS

Effect of Hot Weather on Rate of Hardening



Effect of Cold Weather on Rate of Hardening





Setting Time

- Cement
 - ◆ Type
 - Fineness
 - Chemistry



Setting Time

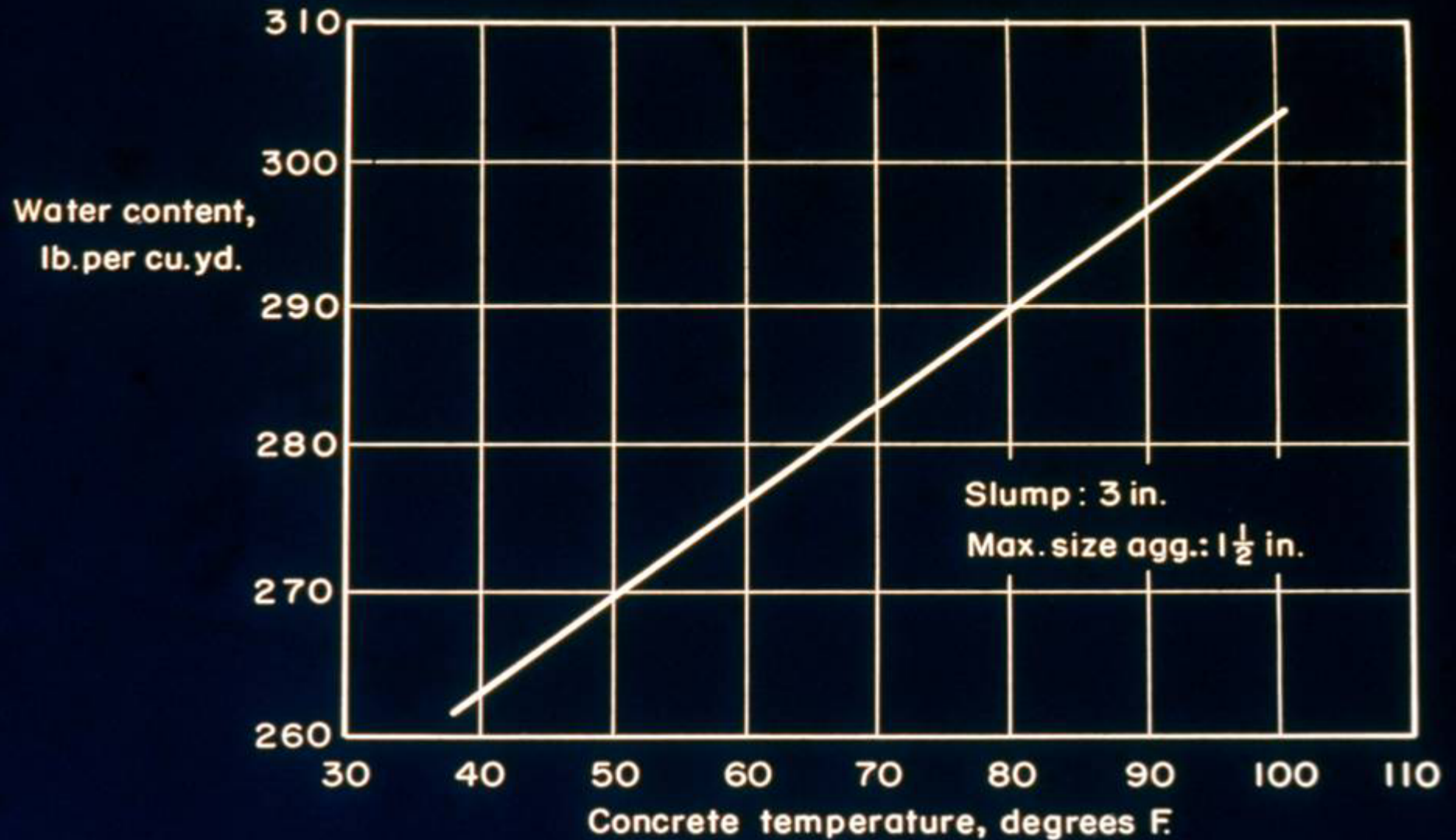
- Admixtures
 - ◆ Type
 - ◆ Dosage



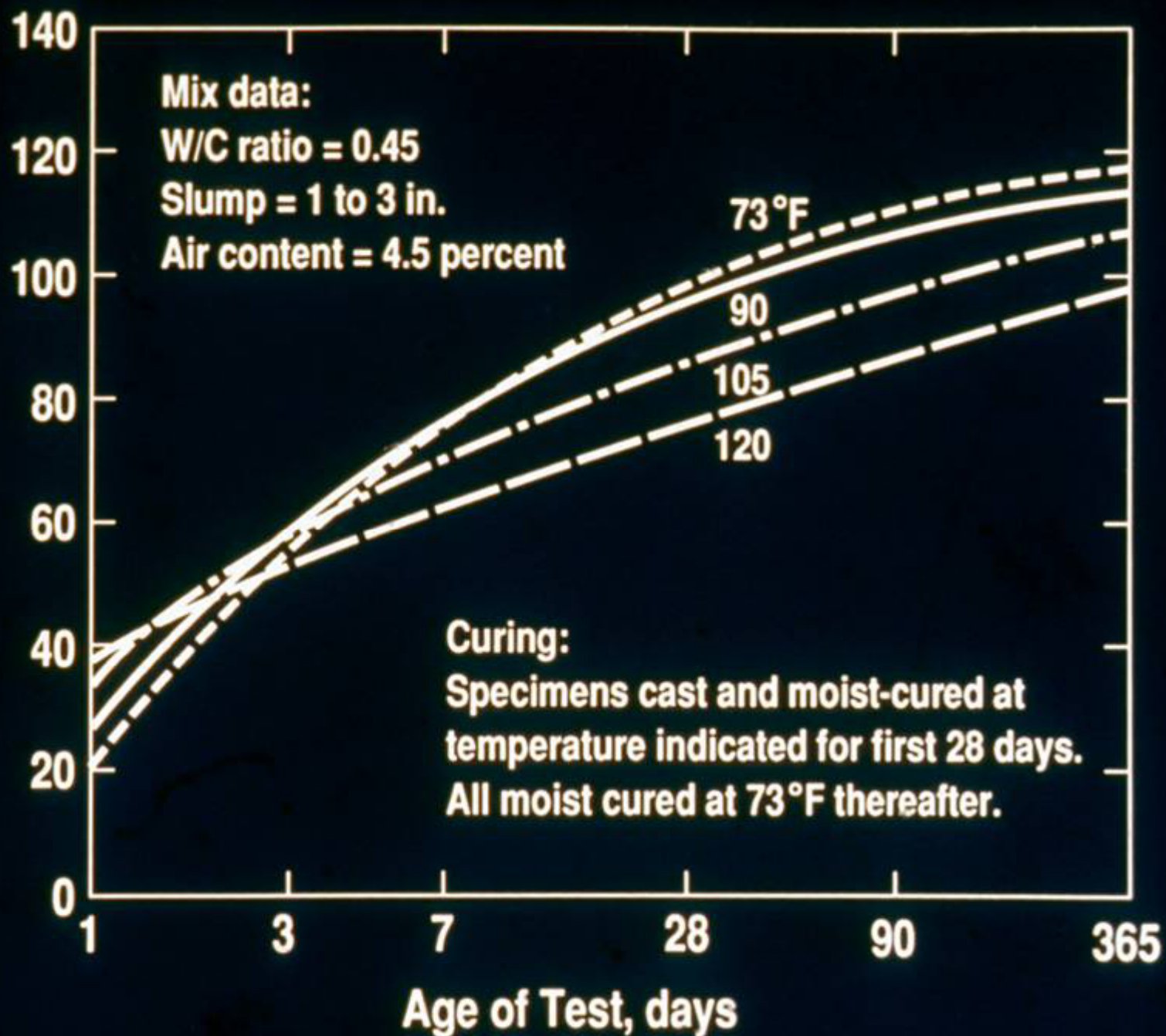
Mix Temperature

- Slump
- Slump Loss
- Water
 - ◆ Retempering
- W/C
- Finishing

Temperature Vs. Water Requirements

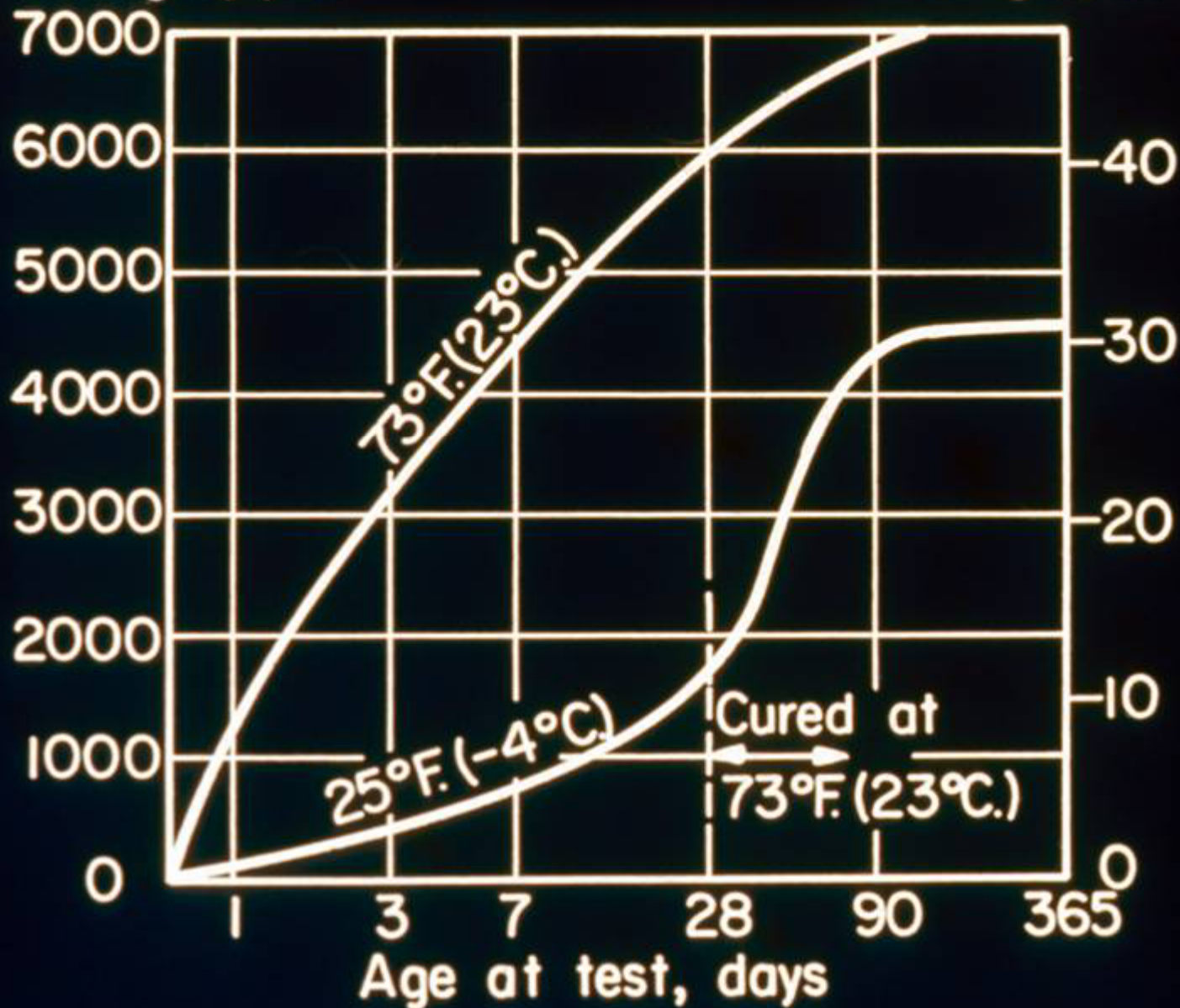


**Compressive
Strength,
percent
of 28-day
73°F-cured
concrete**



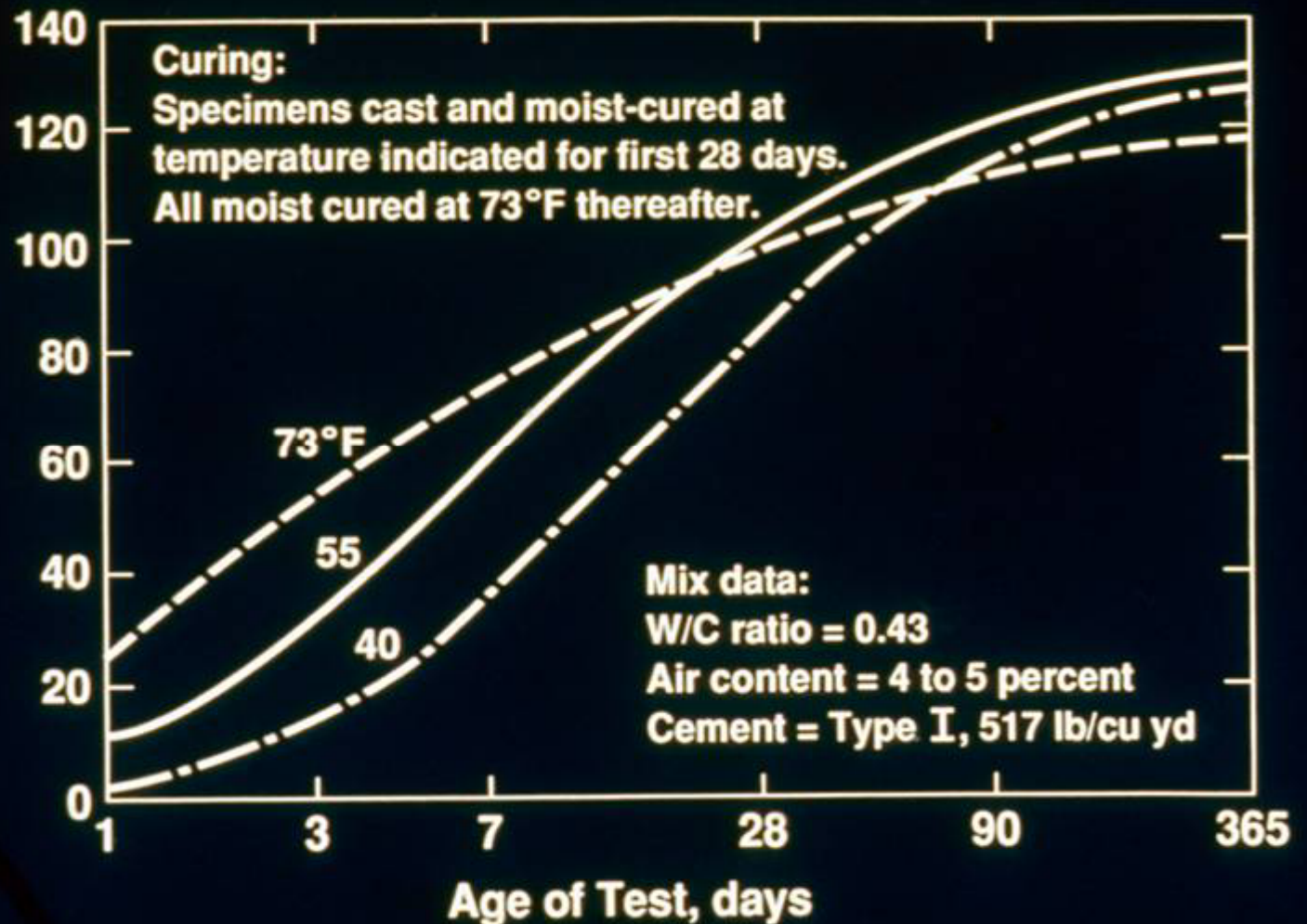
Compressive
strength, psi.

Compressive
strength, MPa



Low Temperature Effects

Compressive
Strength,
percent
of 28-day
73°F-cured
concrete





Mix Temperature (Continued)

- Baptizing
- Air Content
- Strength Development
- Long-term Strength







Baptizing

- Higher W/C
- Reduces Air Content
- Promotes Scaling



Delaminations of Troweled Surface

- More like to form if:
 - ◆ Underlying concrete sets slowly – Cool subgrade
 - ◆ Retardation
 - ✧ Retarders
 - ✧ Fly Ash
 - ◆ High A/E
 - ◆ Premature finishing
 - ◆ Bleeding or air rising
 - ◆ Jitterbug
 - ◆ Dry shake in A/E
 - ◆ Sticky concrete
 - ◆ Thicker slabs
 - ◆ Placed in vapor barrier



Finishing

- Float as soon as concrete has been struck off
 - ◆ Only one or two passes
- **DO NOT SEAL THE SURFACE**
 - ◆ Do not tip bull floats
- Floating must end before visible bleed water rises to surface
- Wait for concrete to stop bleeding



Finishing (continued)

- Finishing During Bleeding
 - ◆ Scaling
 - ◆ Dusting
 - ◆ Blisters
 - ◆ Crazing
- Troweling
 - ◆ Not for outside work
 - ◆ Will be slippery when wet
 - ◆ Trowel burns
 - ◆ Tilting – chatter
- **NO SPRINKLING OR CEMENT ON SURFACE**
- Cure ASAP and water sheen has disappeared



Did You Seal the Surface?

- A Simple test
 - ◆ Leave a small test area without finishing (no bull floating)
 - ◆ Compare to bull floated area
 - ◆ If bleed water appears on the test area (unfinished area), but not on the bull floated area, then bull floating has sealed surface





Control of Air Content in Concrete

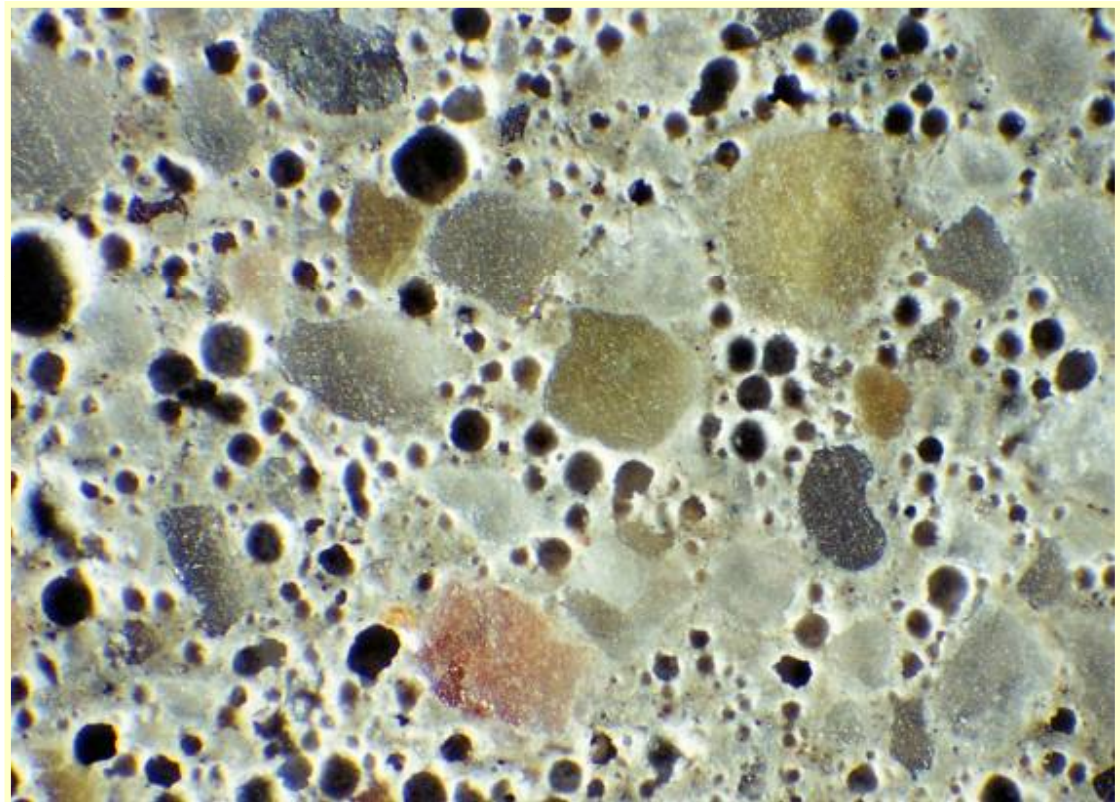


Total Target Air Contents for Concrete

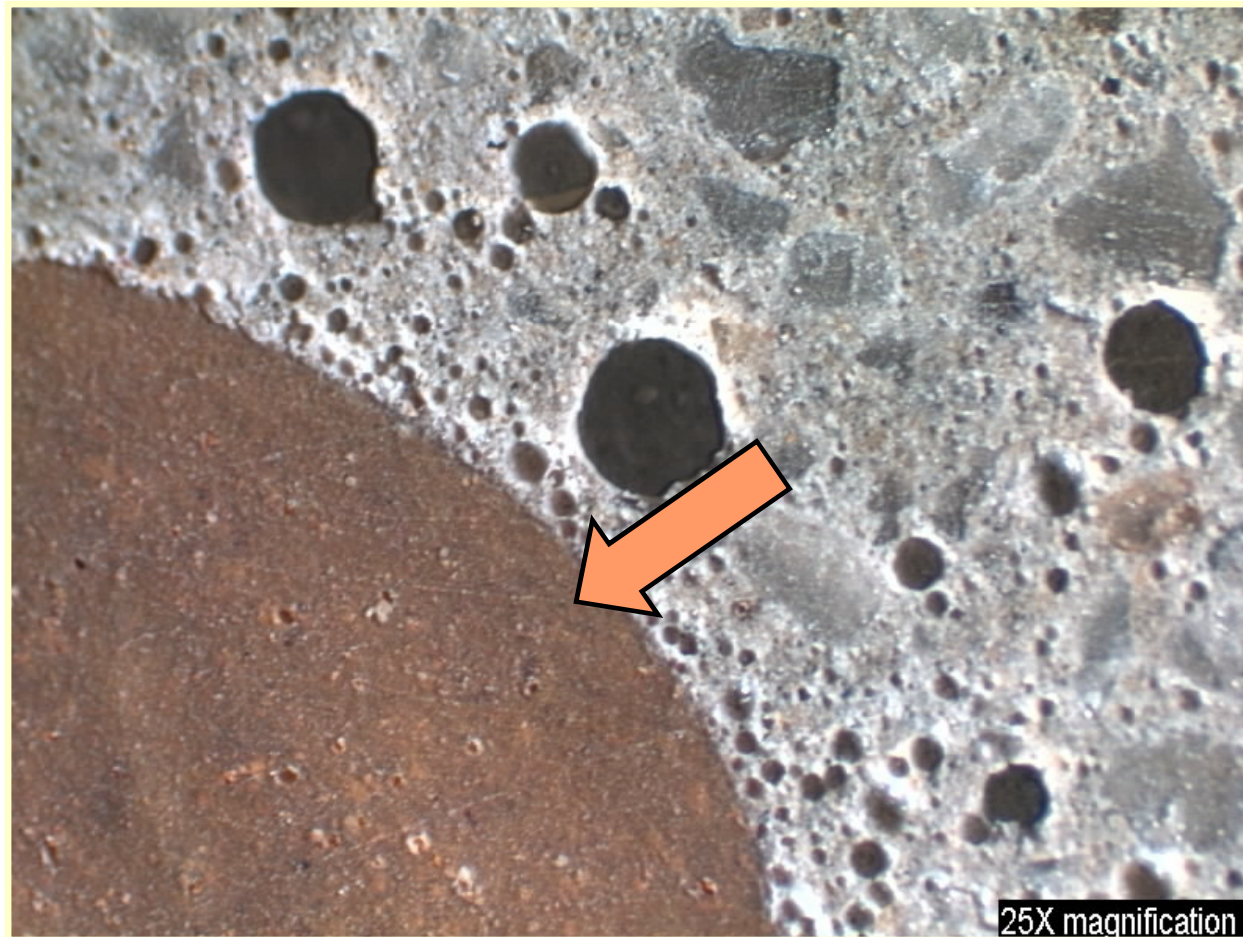
Nominal max. Aggregate Size,in.	Severe Exposure	Moderate Exposure	Mild Exposure
3/8	7-1/2	6	4-1/2
1/2	7	5-1/2	4
3/4	6	5	3-1/2
1	6	4-1/2	3
1-1/2	5-1/2	4-1/2	2-1/2

Project specifications usually allow within -1 to 2% of target value

High Air Content



Air-Void Clusters at Interface

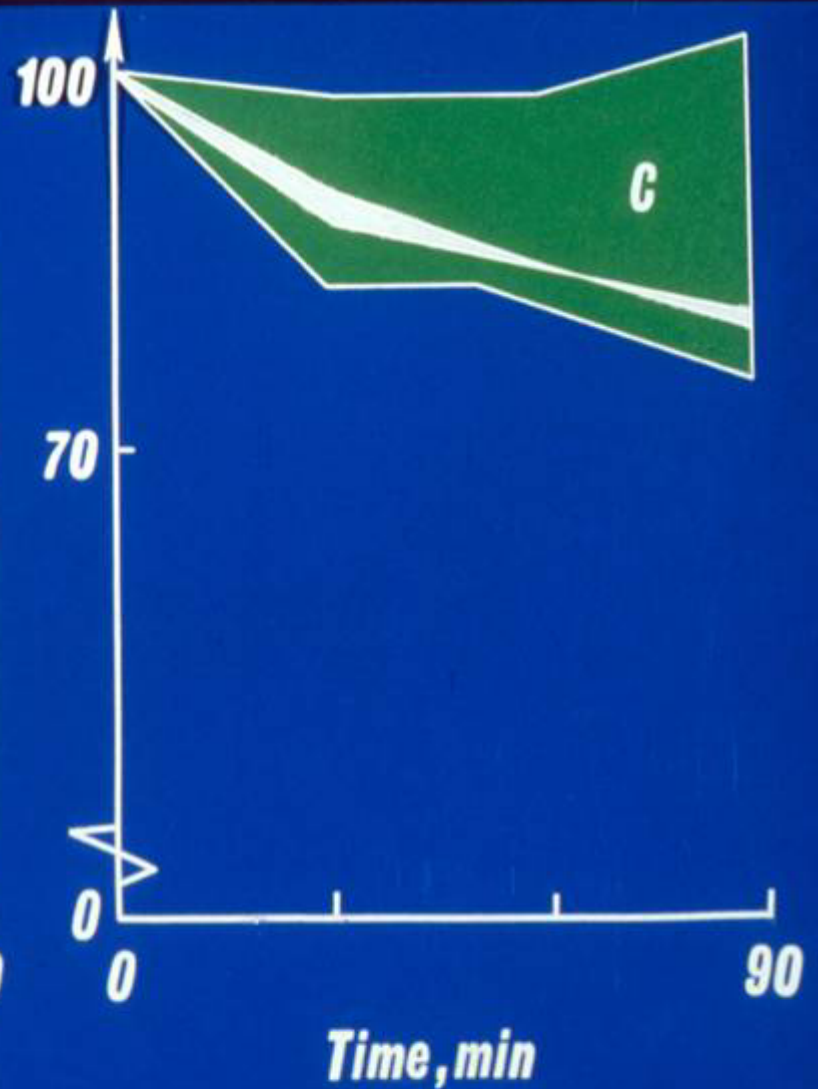
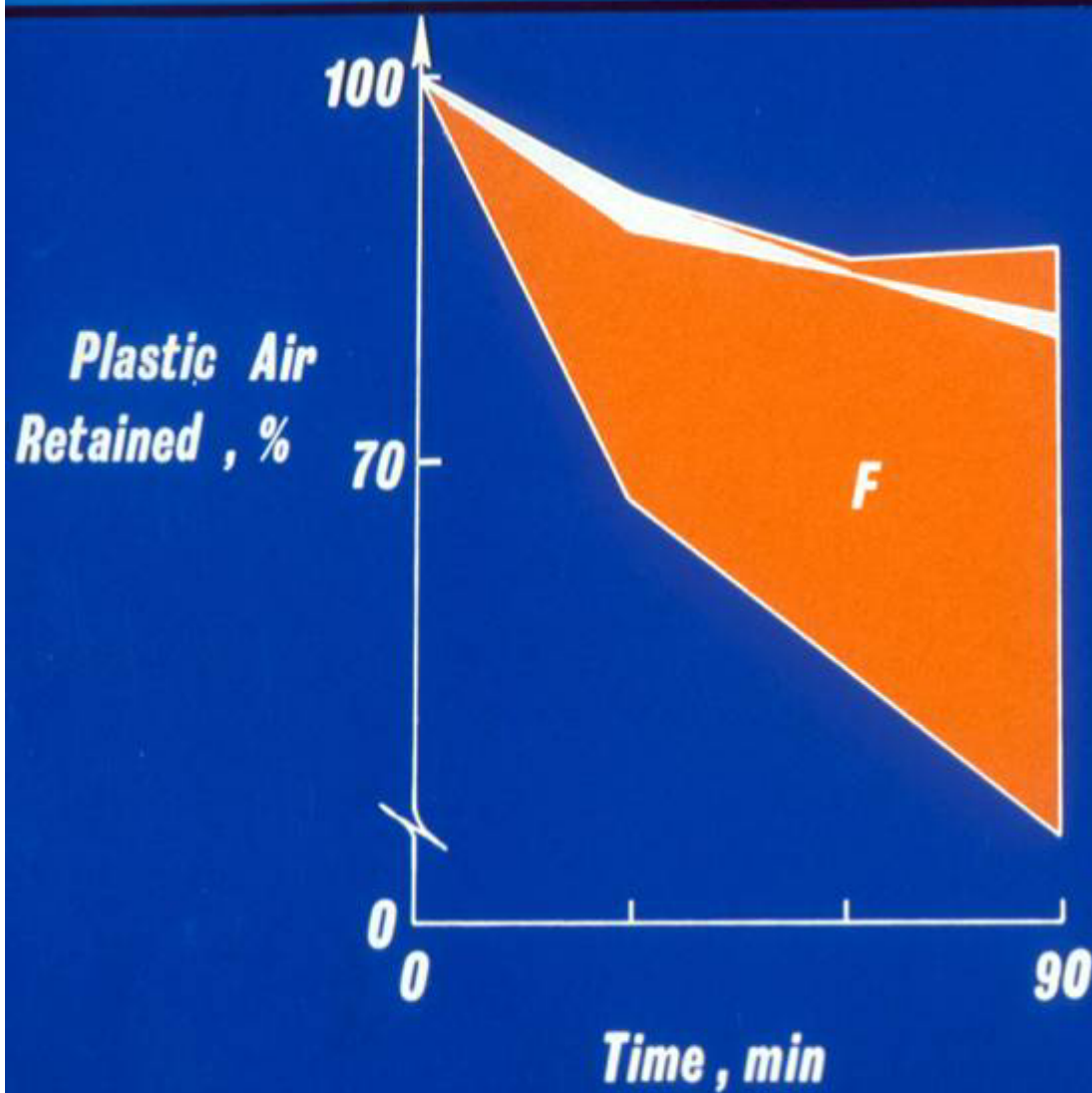




Air Content

- AEA
- Verify by L-T
- Changes in Materials
- Sequence of AEA Additions
- PCA Manual on Control of Air Content

AIR CONTENT vs TIME



FLY ASH





Freshly-Mixed Concrete Problems

- Bleeding
- Erratic batching
- Stickiness
- Harshness
- Segregation
- Yield



BLEEDING AND FINISHING RELATED PROBLEMS



Bleeding

- Subsidence
- Capacity vs. rate

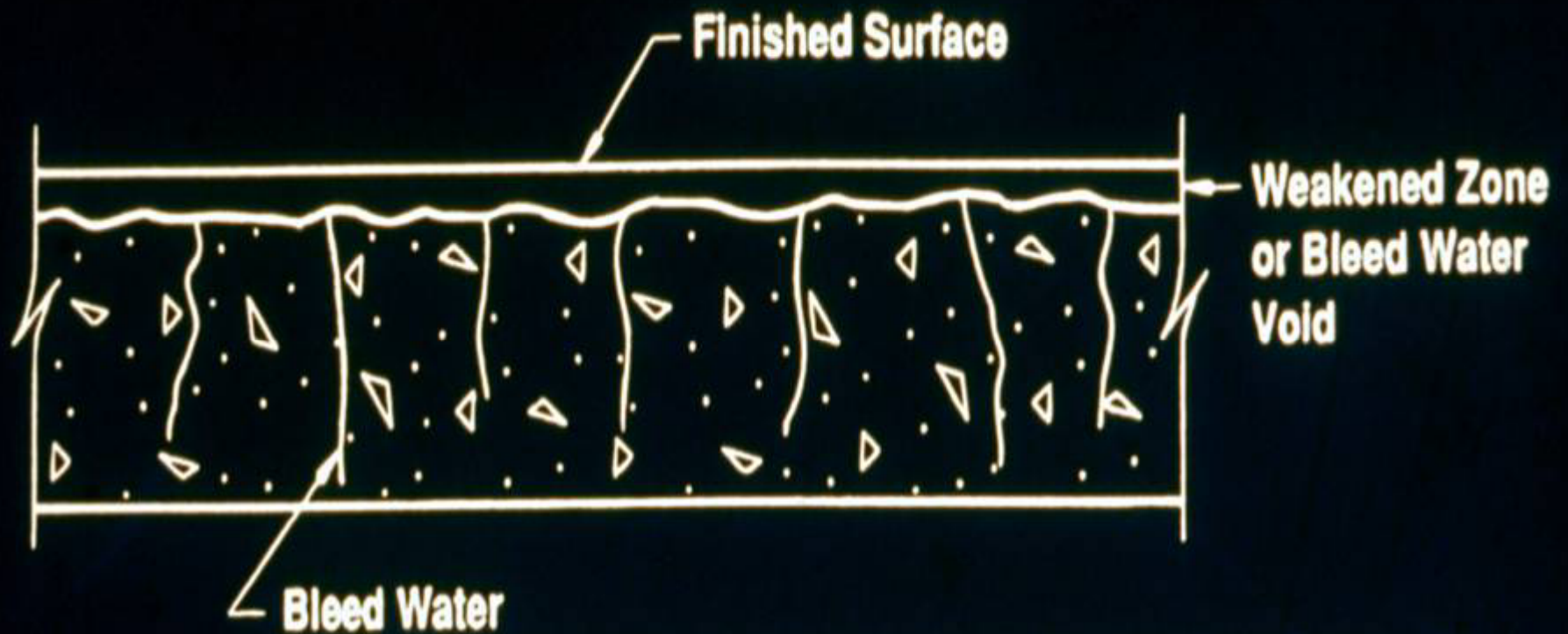
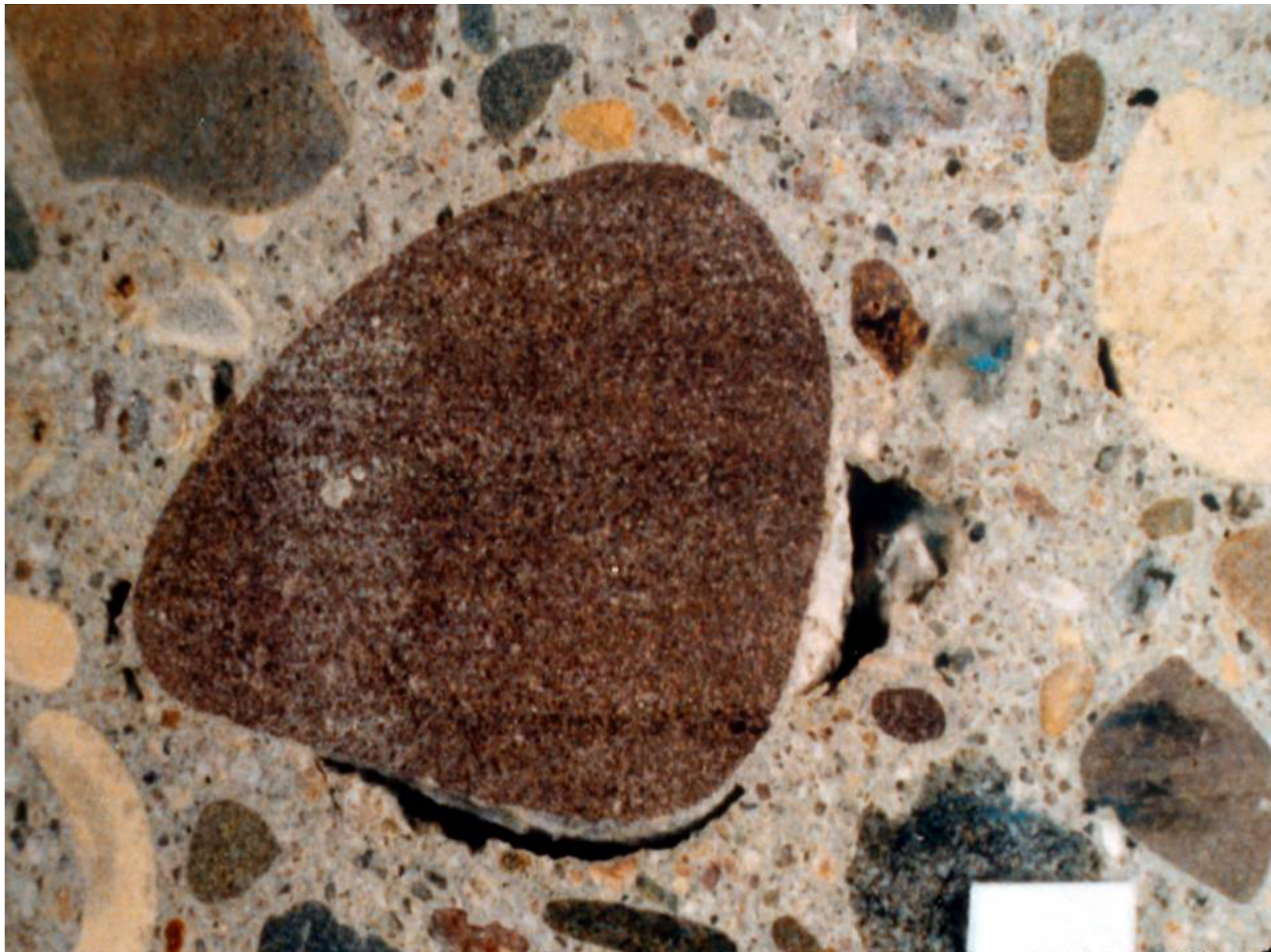
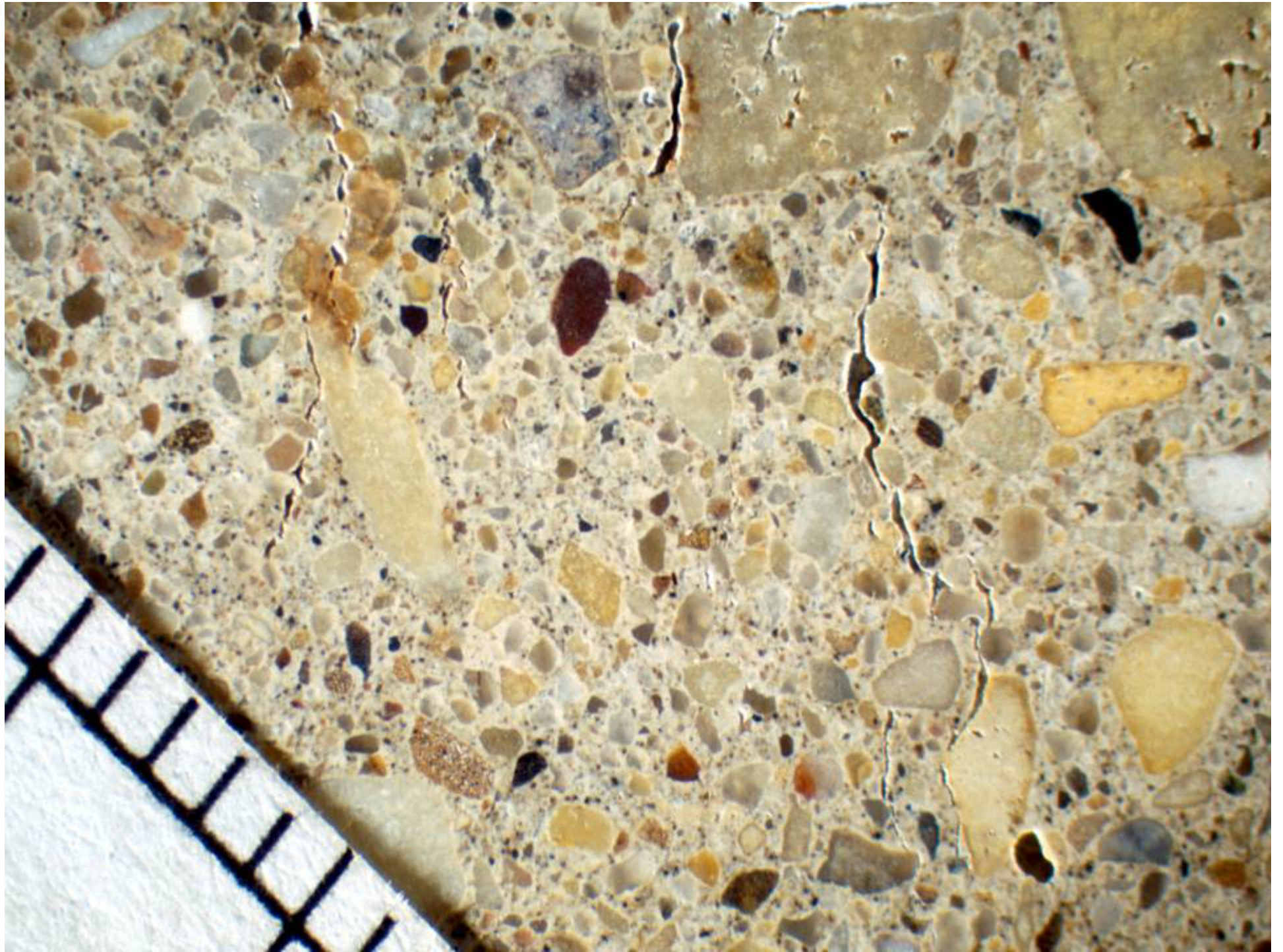
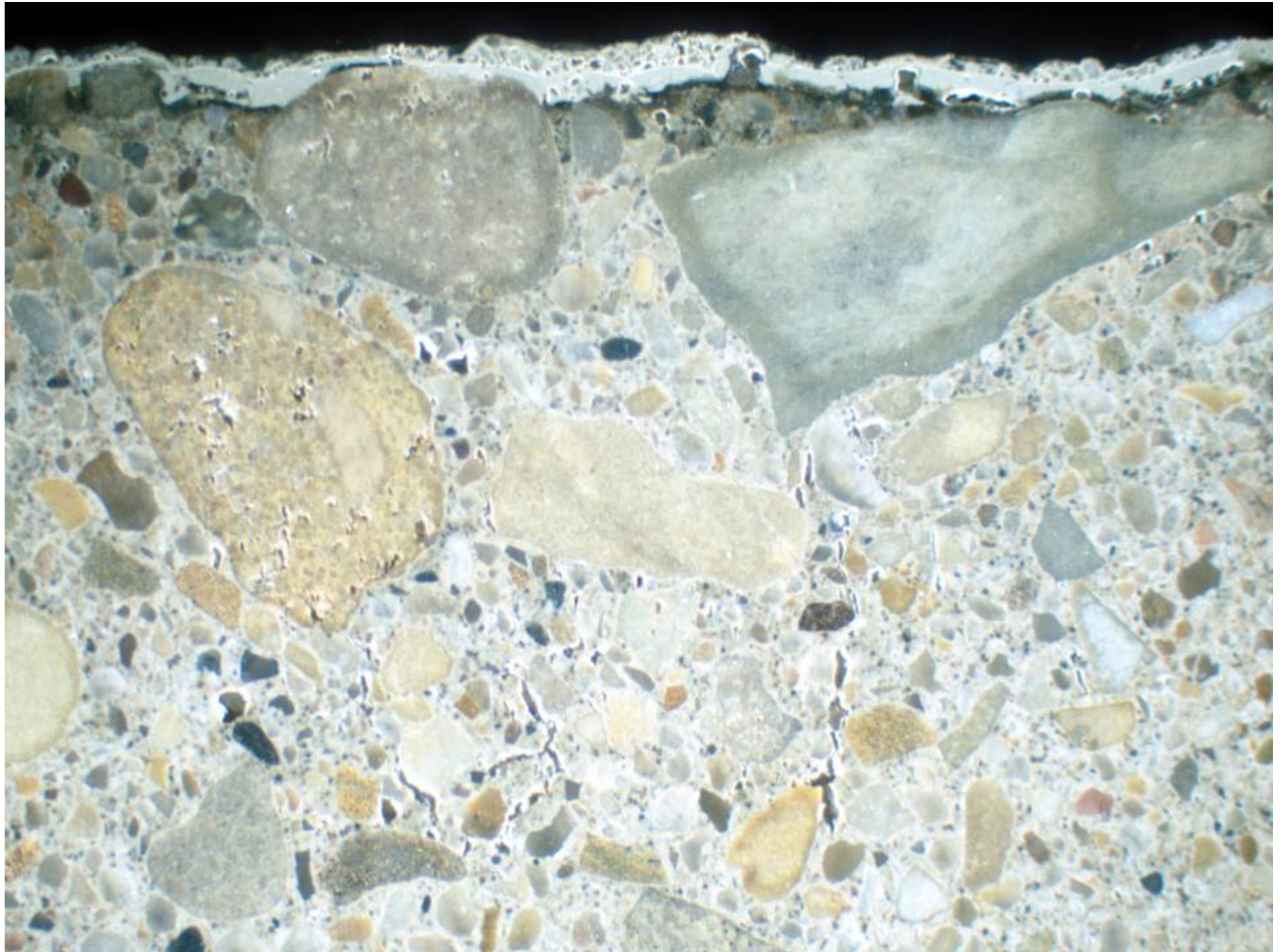


Illustration of weakened zone or bleed water void under a finished surface.









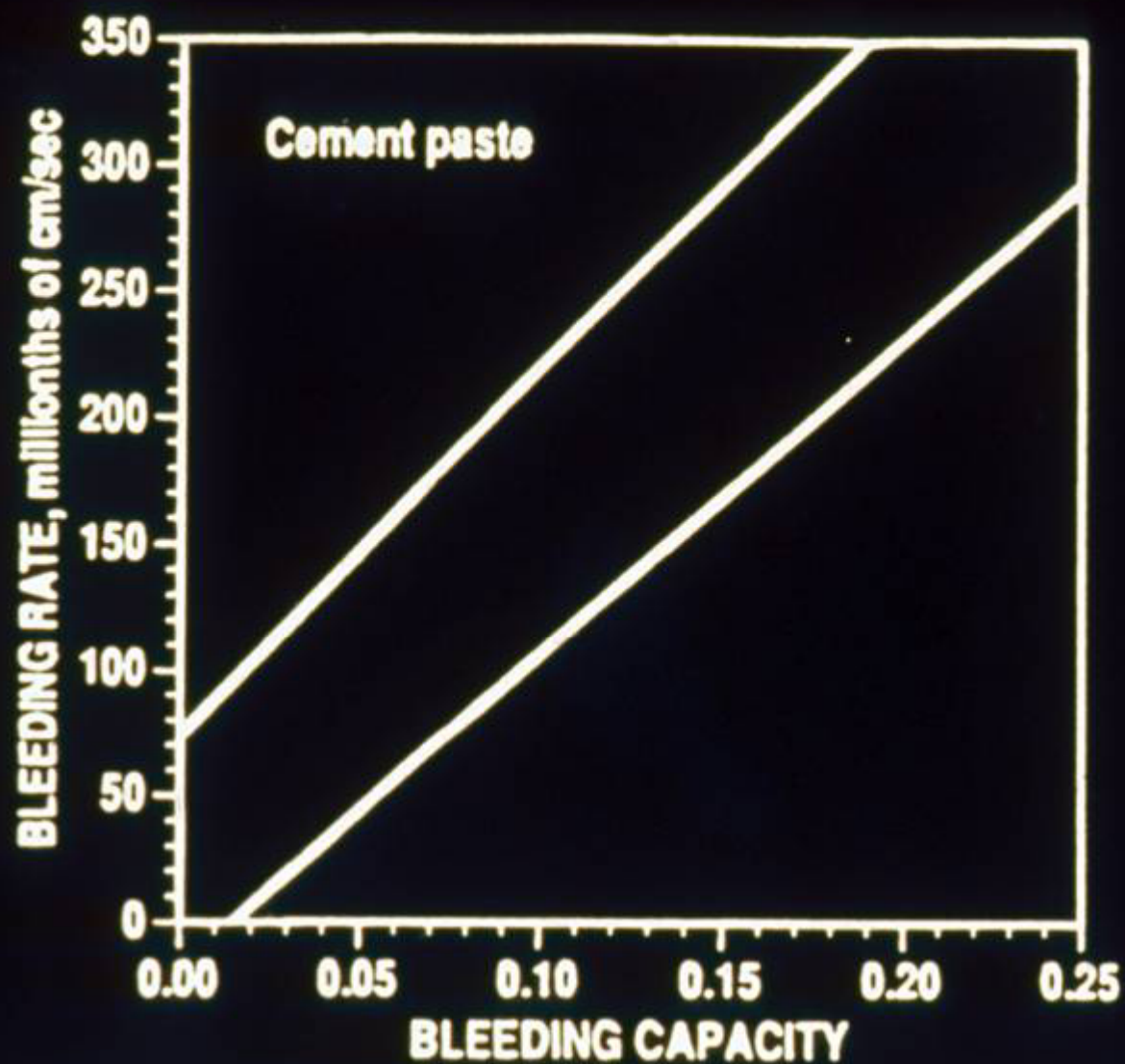


FIG. 9—Relationship between bleeding rate and bleeding capacity for cement paste using a variety of cements. Approximately 100 data points were used to develop the range [4].



Bleeding

- W/C
- Scaling
- Air velocity over surface
- Cement fineness
- Cement content
- Fly Ash



Bleeding (continued)

- Air content
- Admixtures
 - ◆ WRA
 - ◆ Plasticizers
 - ◆ Chlorides
- Aggregates

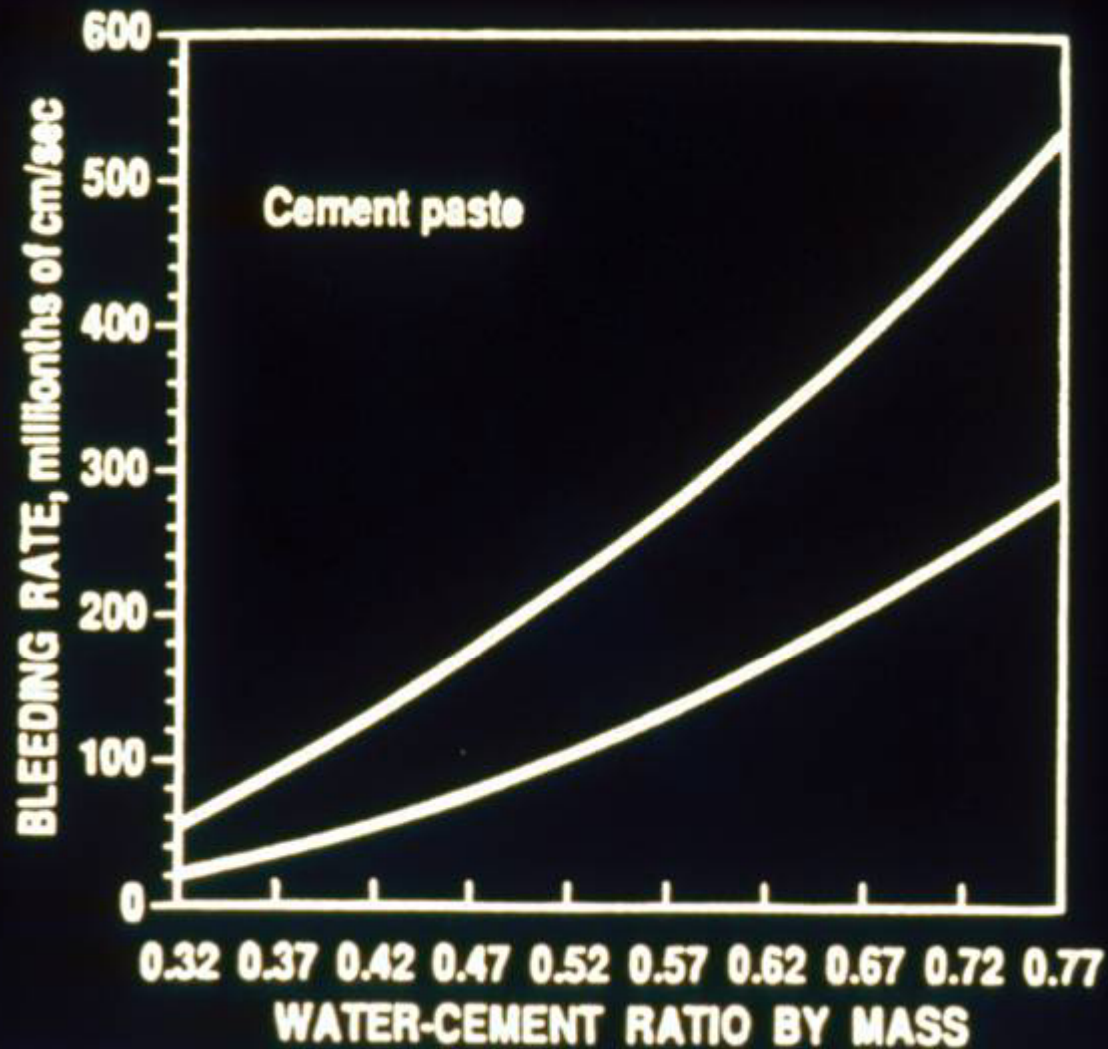


FIG. 6—Range in relationship between bleeding rate and water-cement ratio of pastes made with normal portland cement and water. The range is attributed to different cements having different chemical composition and fineness [4].

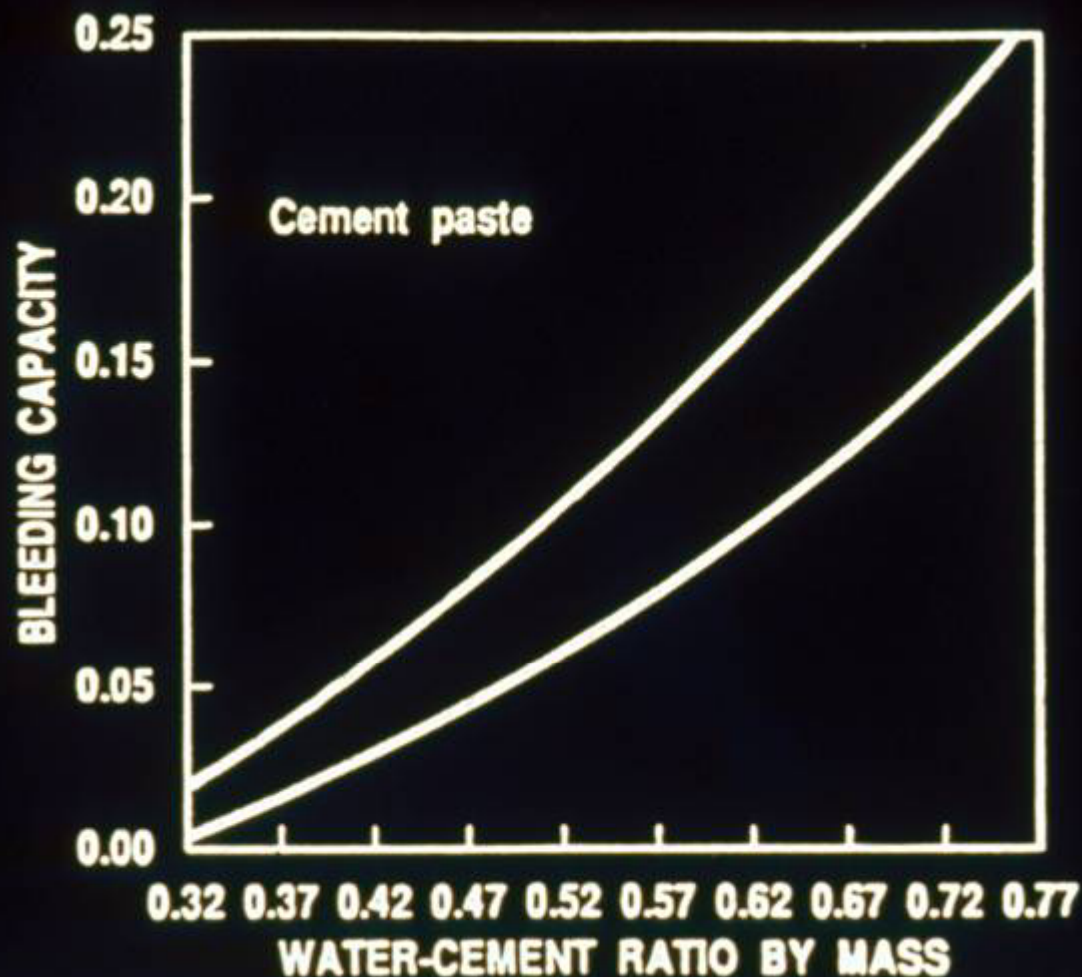


FIG. 7—Range in relationship between bleeding capacity (total settlement per unit of original paste height) and water-cement ratio of pastes made with normal portland cement and water. The range is attributed to different cements having different chemical composition and fineness [4].



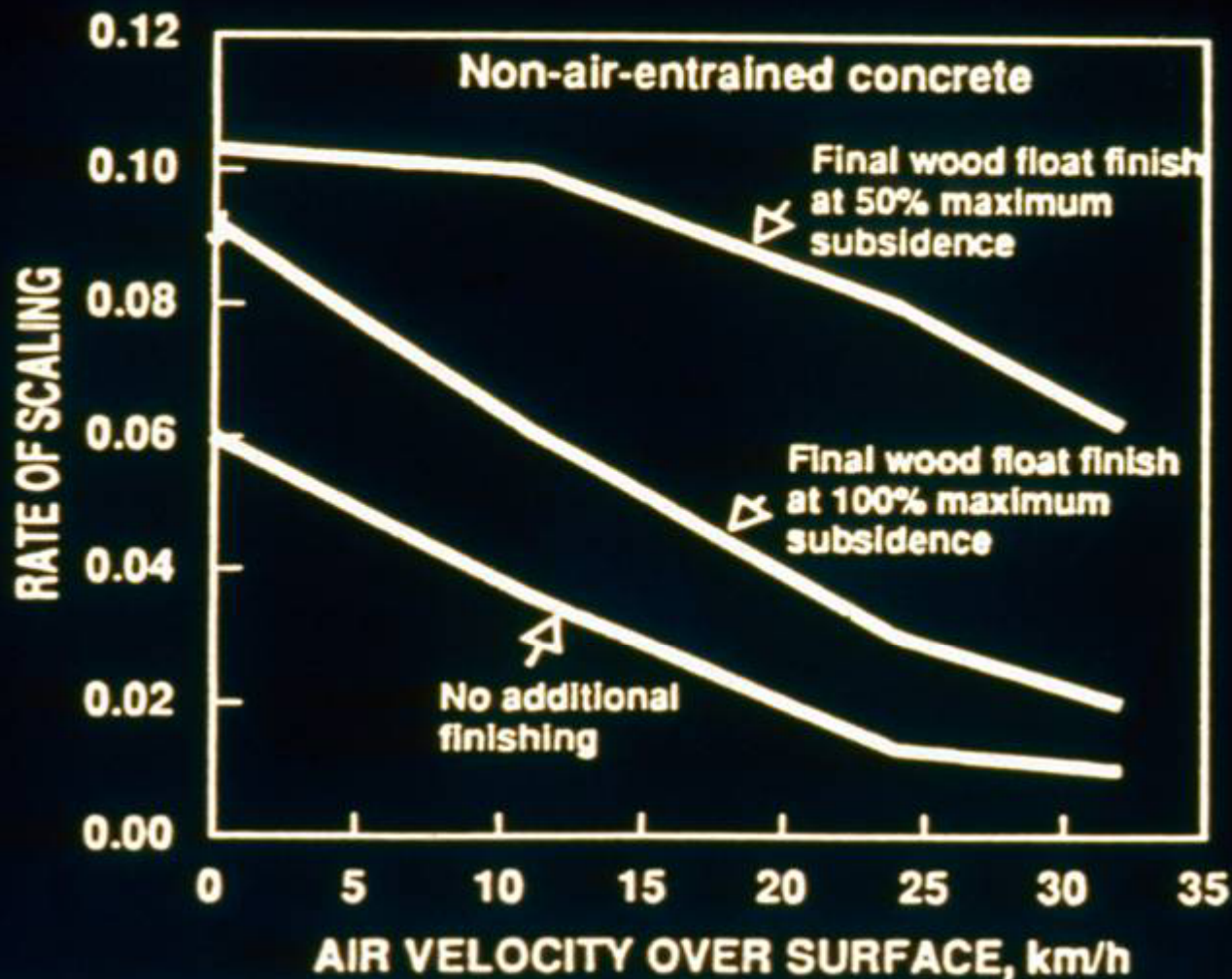


FIG. 18—Effect of time of final finish on scale resistance of concrete after 100 cycles of test. Higher scaling values indicate more scaling. All samples received a wood float strikeoff. Concrete with a final wood finish at 50% subsidence scaled much more than concrete finished after bleeding stopped or concrete not receiving a final finish [14].

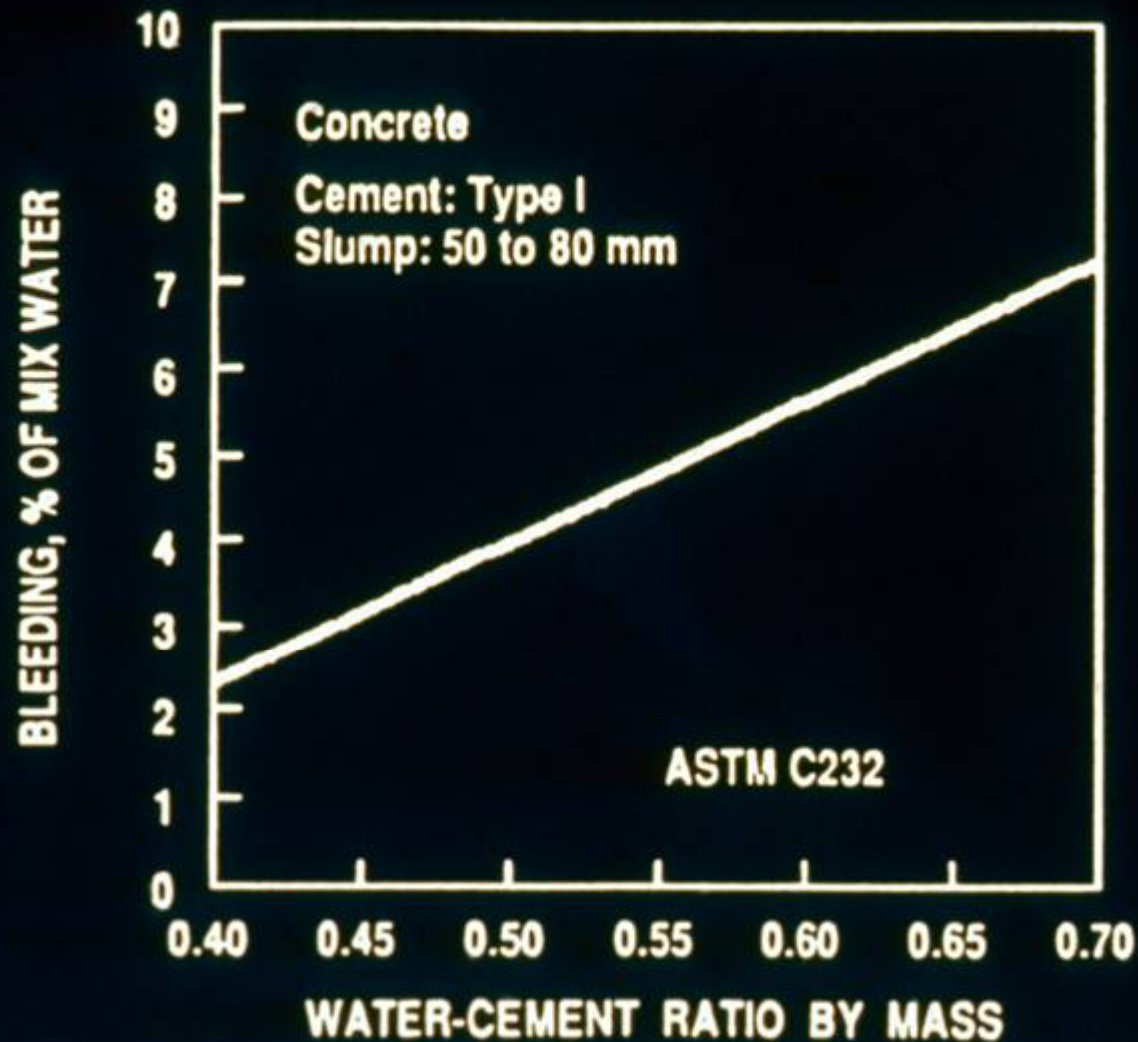


FIG. 25—Relationship between water-cement ratio and bleeding of concrete. Bleeding is expressed as a percent of mix water [15].

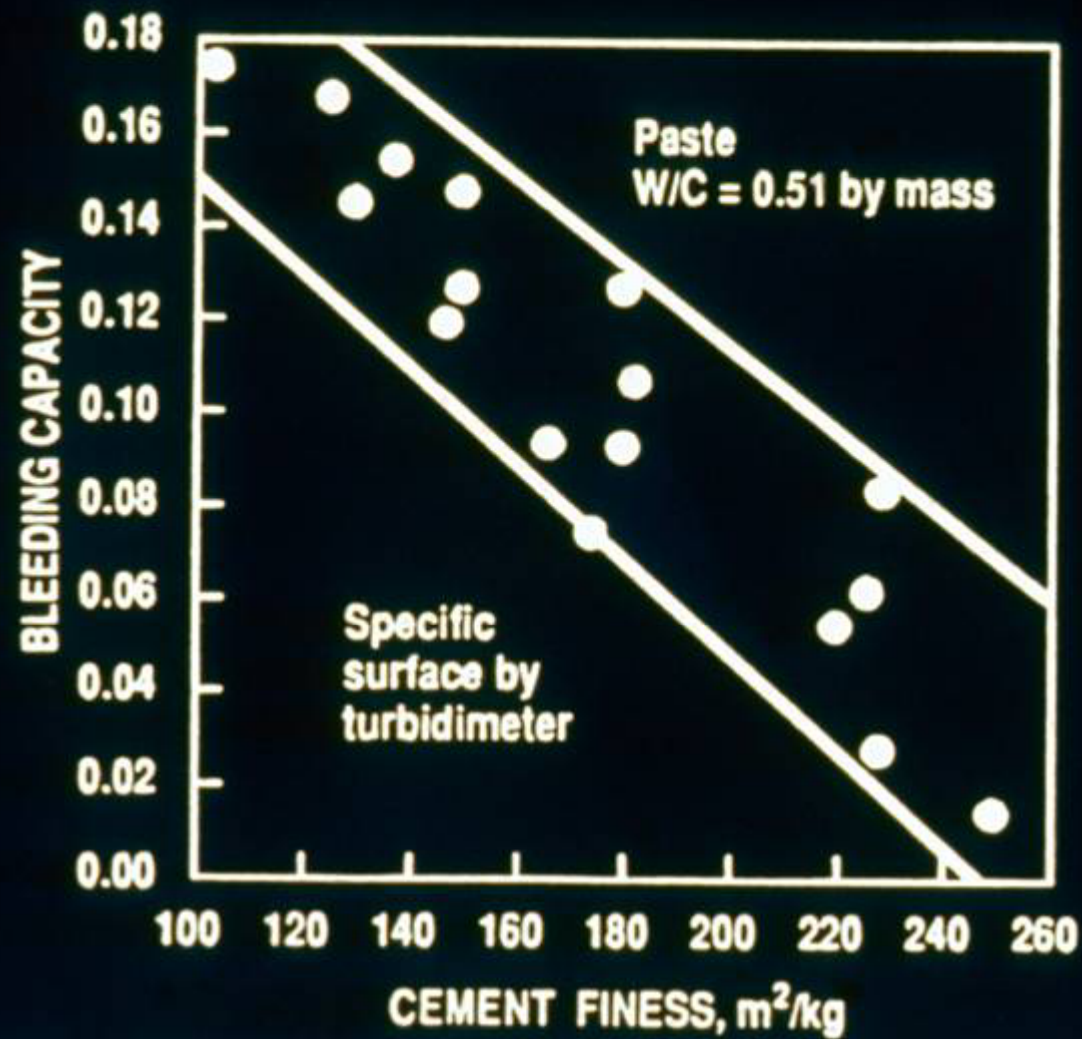


FIG. 26—Effect of cement fineness by Wagner turbidimeter on bleeding capacity of paste. Note that Wagner values are a little more than half of Blaine values [4].

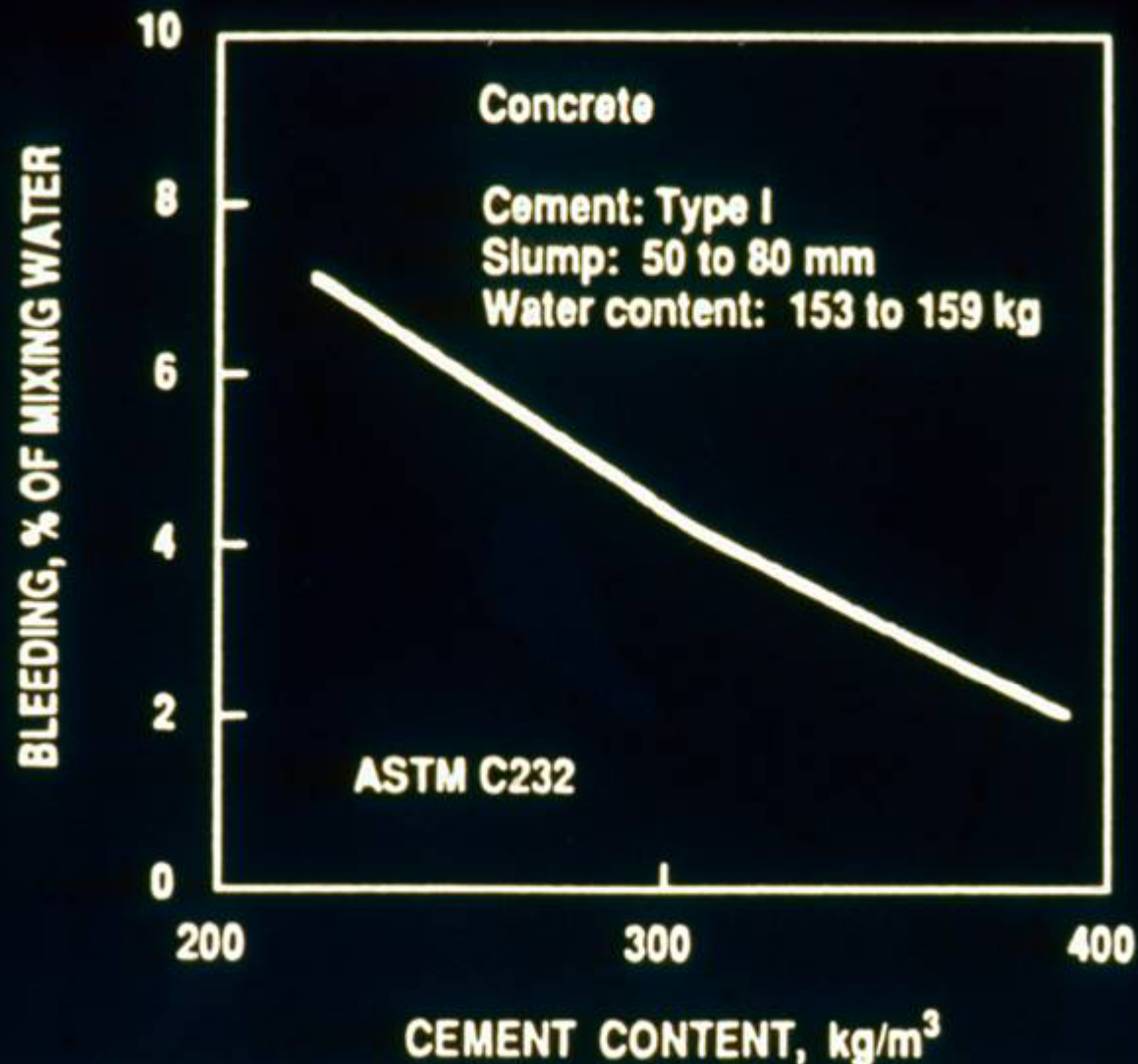


FIG. 27—Relationship between cement content and bleeding of concrete. The increased cement content reflects a decreased water-cement ratio. Bleeding is expressed here as a percent of mix water [15].

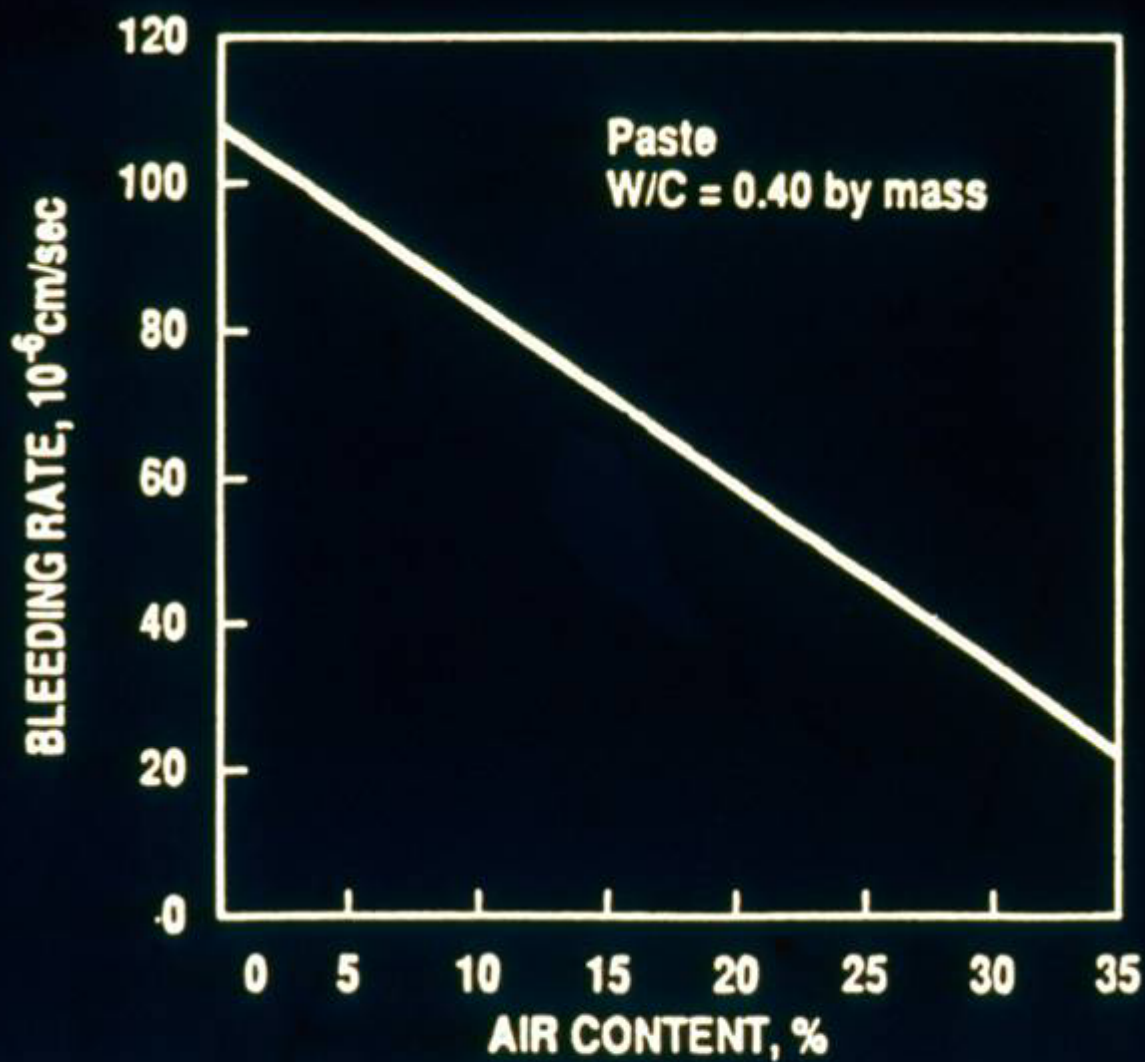


FIG. 29—The effect of entrained air on bleeding rate of paste [3].

TABLE 5—Bleeding of Concretes With and Without Plasticizers (ASTM C 232 Bleeding Test) [22].

Mix Identification	Water-Cement Ratio by Mass	Water Content, kg/m ³	Slump, mm	Bleeding, % by mass of mix water	Bleeding, mL/cm ² of surface
Control 1	0.47	143	75	1.09	0.031
Control 2	0.58	171	215	3.27	0.143
Melamine sulfonate	0.47	143	215	1.59	0.060
Naphthalene sulfonate	0.47	144	225	1.50	0.059

TABLE 6—Effect of Calcium Chloride on Bleeding Rate and Bleeding Capacity [4].^a

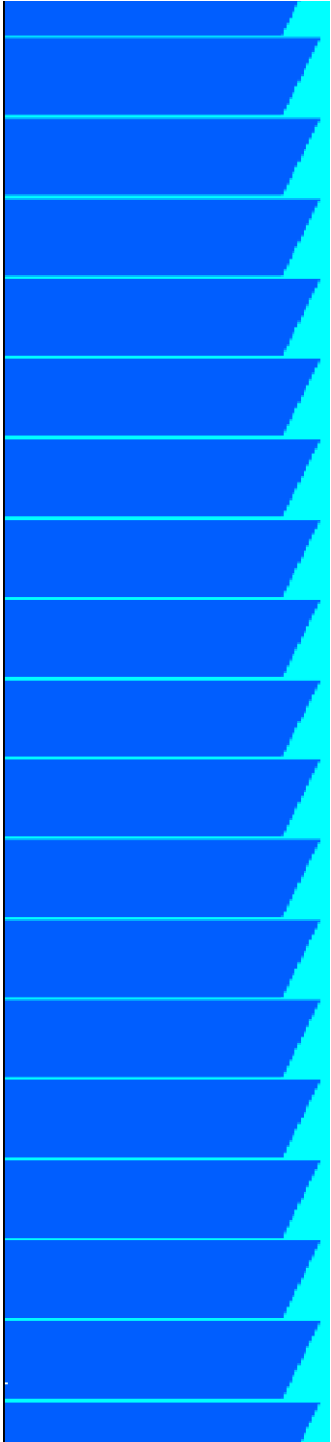
ASTM C 150 Cement Type	Admixture Addition	Bleeding Time, min	Bleeding Rate, 10 ⁻⁶ cm/s	Bleeding Capacity, ΔH
I	none	71	163	0.085
	CaCl ₂	38	146	0.040
II	none	71	139	0.072
	CaCl ₂	46	103	0.039
III	none	46	129	0.049
	CaCl ₂	26	89	0.020

^a Amount of CaCl₂ was 1% of the cement mass and about 2.1% of water. The water-cement ratio was 0.466 by mass.

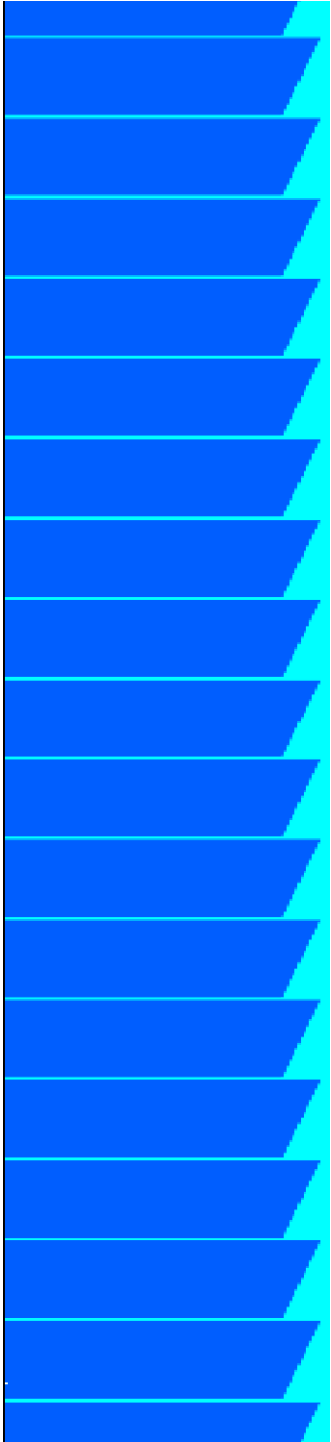


Bleeding - Durability

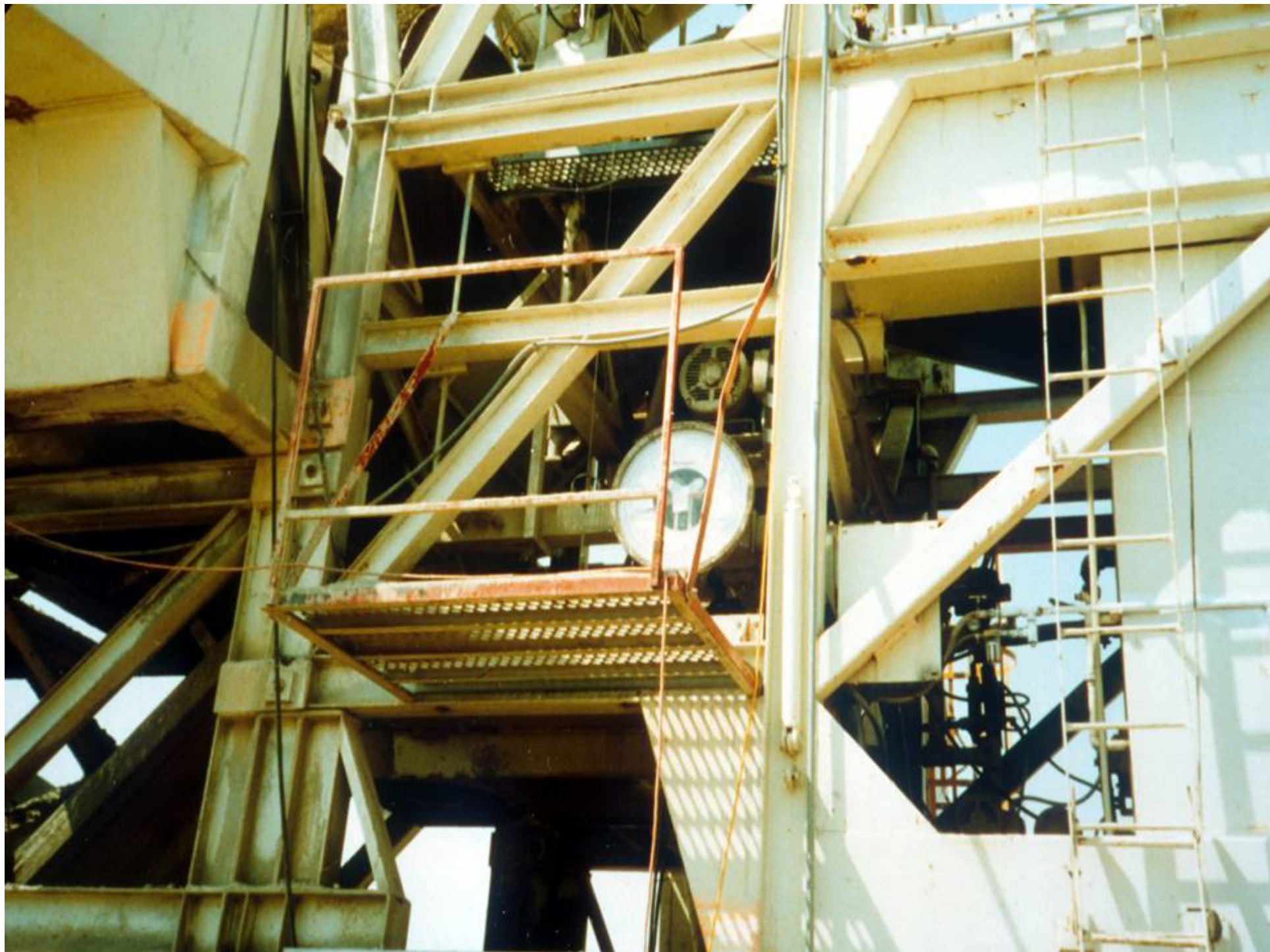
- Scaling
- Mortar flaking
- Surface delaminations
- Blisters
- Sand streaking



Erratic Batching



Weighing









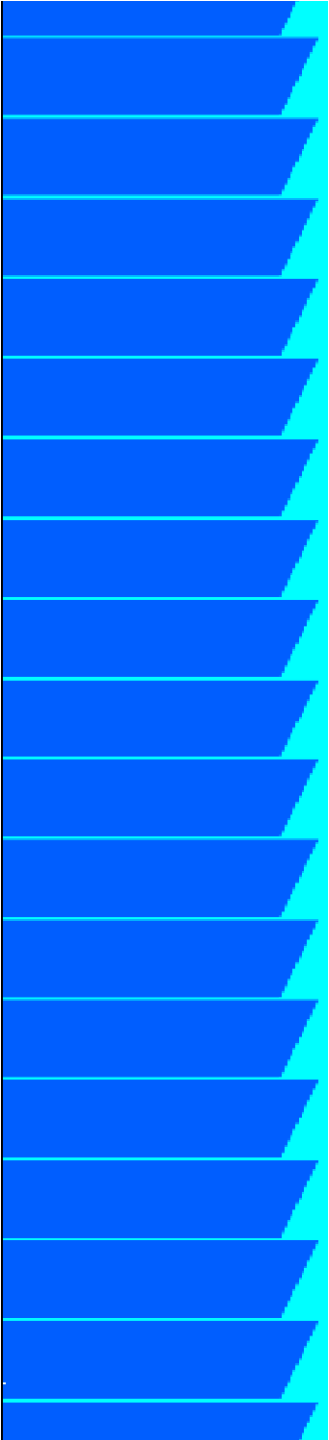
Moisture Compensation





Slump

- Wet
- Dry

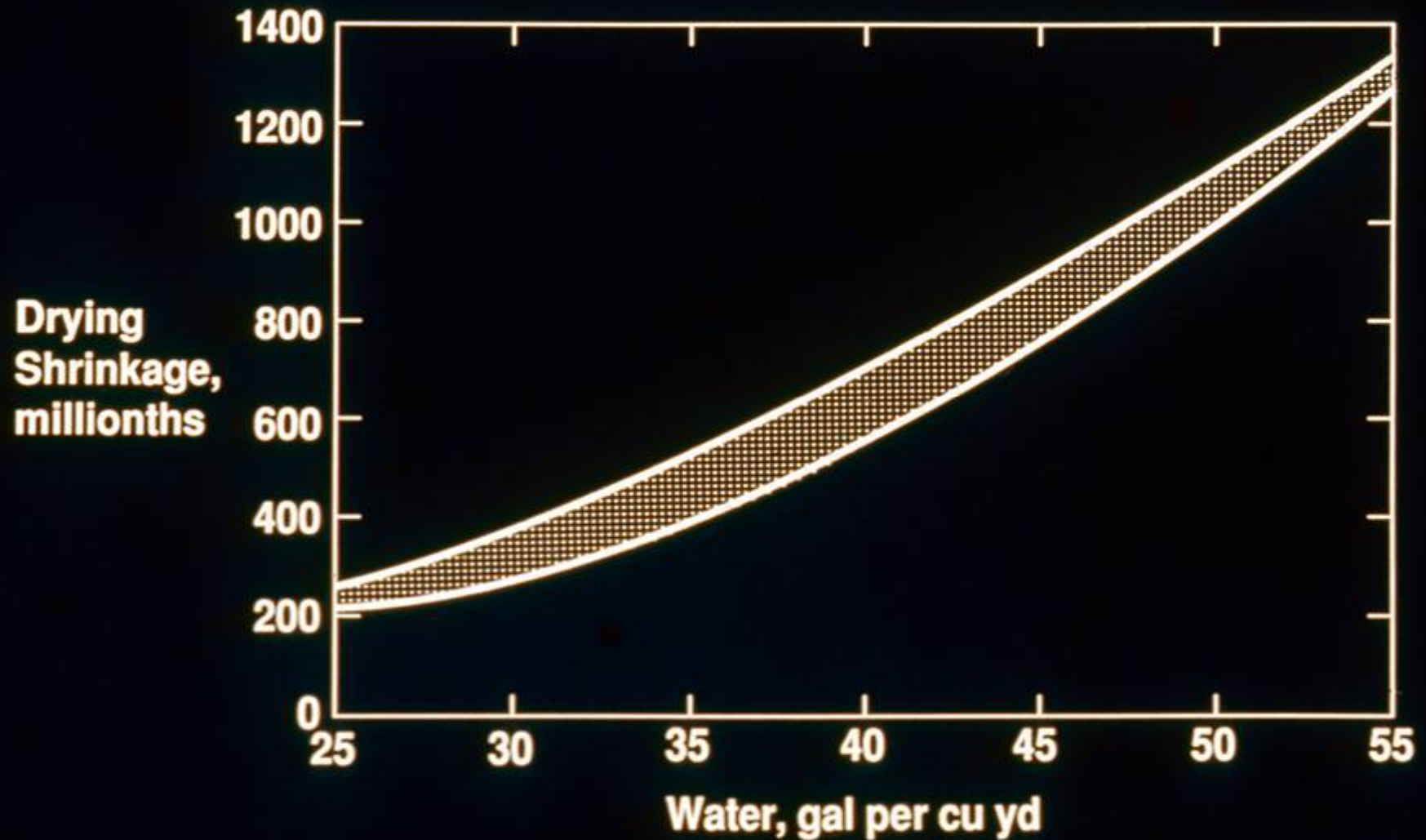




Slump - Wet

- W/C
- Strength
- Air content
 - ◆ Air-void system
- Durability

Shrinkage and Water Content





Slump – Wet (continued)

- Shrinkage
- Cracks
- Permeability
- Pumping



Slump - Dry

- Finishing
- Pumping
- Consolidation
- Erratic strengths
- Air content



Sticky Mixes

- Worst condition combination of
 - ◆ Wet
 - ◆ Over sanded mixes
 - ◆ A/E
 - ◆ On hot, dry day
- Use less sand (150 – 200 lbs) with A/E



Stickiness

- Fines
- Aggregate cleanliness and gradation
- Cement
- Air-entrainment
- Pumping



Stickiness (continued)

- Bleeding
- Finishing
- Overworking surface (loss of air)
- Mineral admixture
 - ◆ Fly ash
 - ◆ Silica fume



Harsh Mixes

- Lack paste –low cementitious content
- Use air (3-4%)
- Use some more
 - ◆ Fine sand
or
 - ◆ Fly ash
or
 - ◆ Cement
- **AGAIN-DO NOT BAPTIZE CONCRETE**
to aid finishing use fog spray w/o excess
water being worked into slab is safer



Segregation

- Cause
 - ◆ Excessive slump
 - ◆ Over vibration
- Use
 - ◆ A/E
 - ◆ S.P.
 - ◆ Drop chutes (3-4 ft)



Yield

- Causes
 - ◆ Miscalculation of form volume
 - ◆ Deflection – distortion of forms
 - ◆ Irregular subgrade
 - ✧ Placement over poorly prepared granular fill
 - ✧ Settlement of subgrade



Yield - Miscalculation

- $\frac{1}{8}$ in. in 4 in. slab = 3% shortage or 1 yd in 32 yd



Yield - Subgrade

- Irregular subgrade
- Placement over granular fill
- Settlement
- To determine in-place thickness
 - ◆ Radar
 - ◆ Cores



Yield (continued)

- Remedies
 - ◆ Run ASTM C138
 - ◆ Measure formwork accurately
 - ✎ Near end of large pours
accurately measure remaining
volume to adjust remaining
trucks



Yield (continued)

- Remedies
 - ◆ Add ~ 2%
 - ◆ Stiffer forms
 - ◆ Check proper elevation of slabs



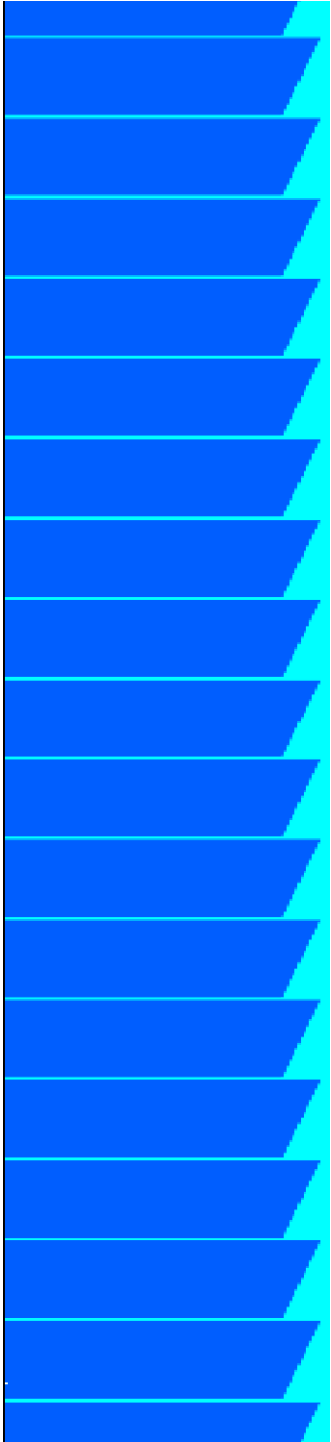
Mixing Water

- Delivery tickets
 - ◆ Provide allowable H_2O
 - ◆ DO **NOT** exceed W/CM



Summary

- Many sources of fresh concrete problems
- Construction errors
- Design errors
- Material issues
- Do not exceed w/cm!



Questions?