PCA

Concrete Technology and Codes

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

- H_2O 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

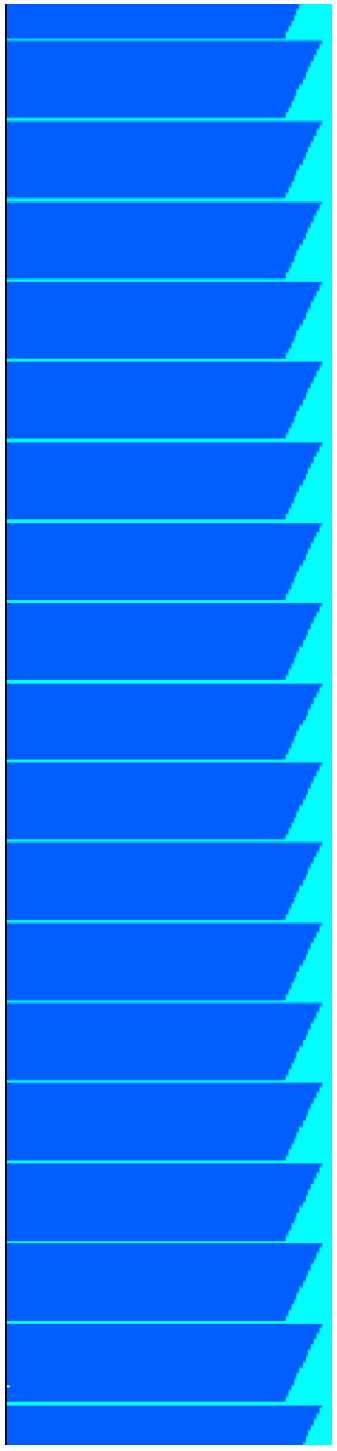
- Inadequate Structural Design
  - Spalling – high compressive or high torsion or shear stresses
  - Cracking – tensile
  - Poor Design Details
    - Localized stress concentrations
    - Water Ponding
    - Abrupt changes in section
    - Insufficient steel or reentrant corners or openings
    - Inadequate 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


RTE-110

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.

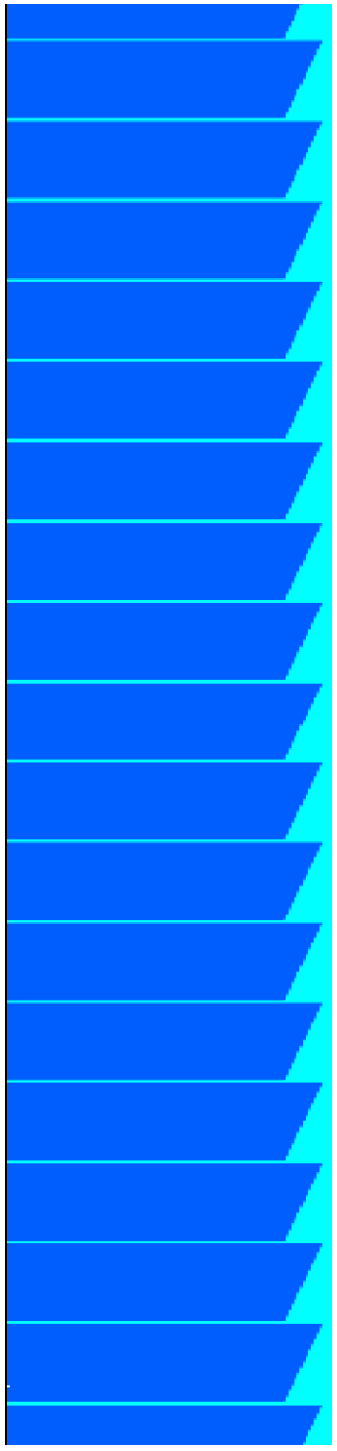
Mini – Slump Cone Test

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

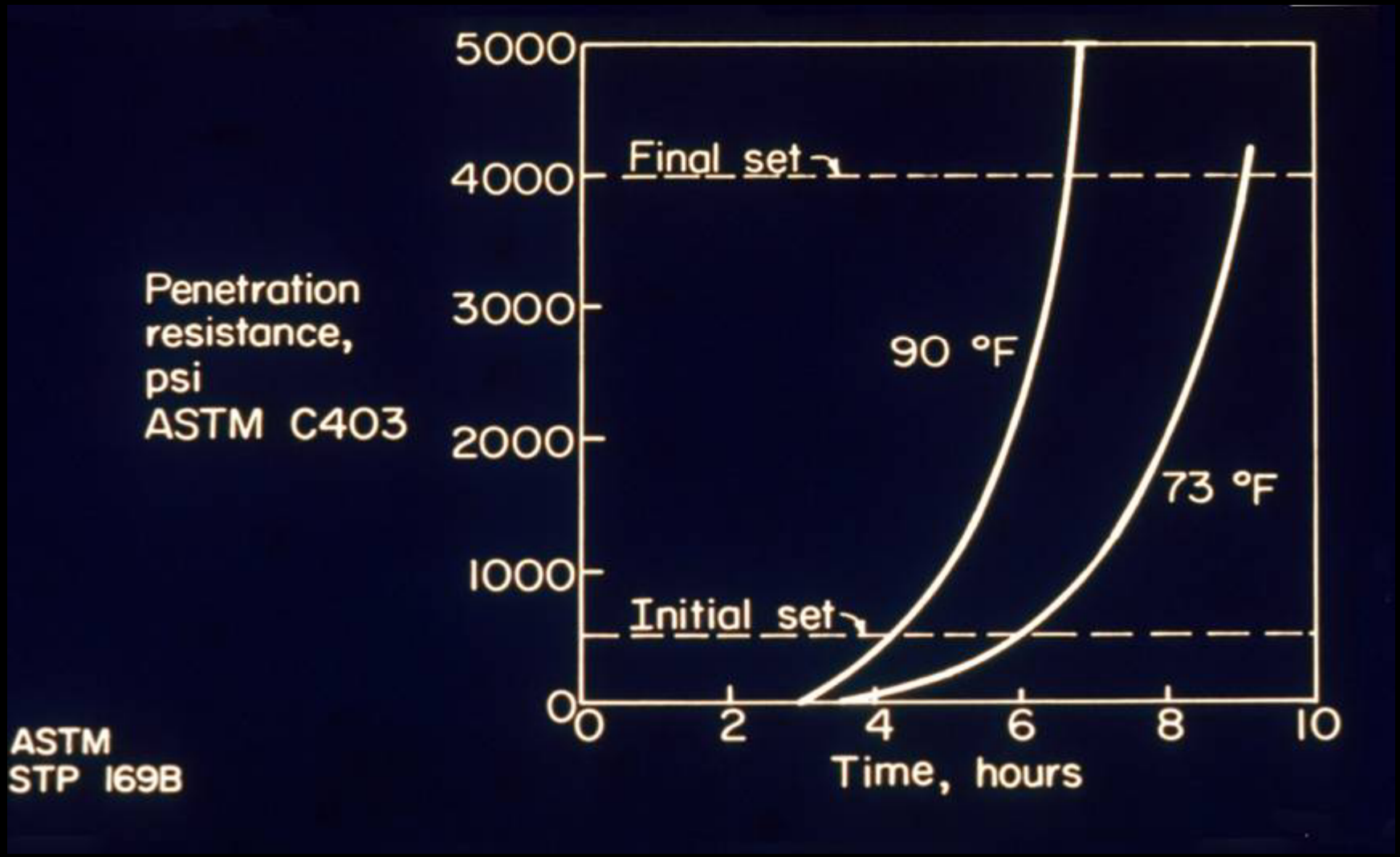
- Eventually it Will
- Don't Overwork Slabs
- Prevent Moisture Evaporation
- Prevent Freezing

Setting Time

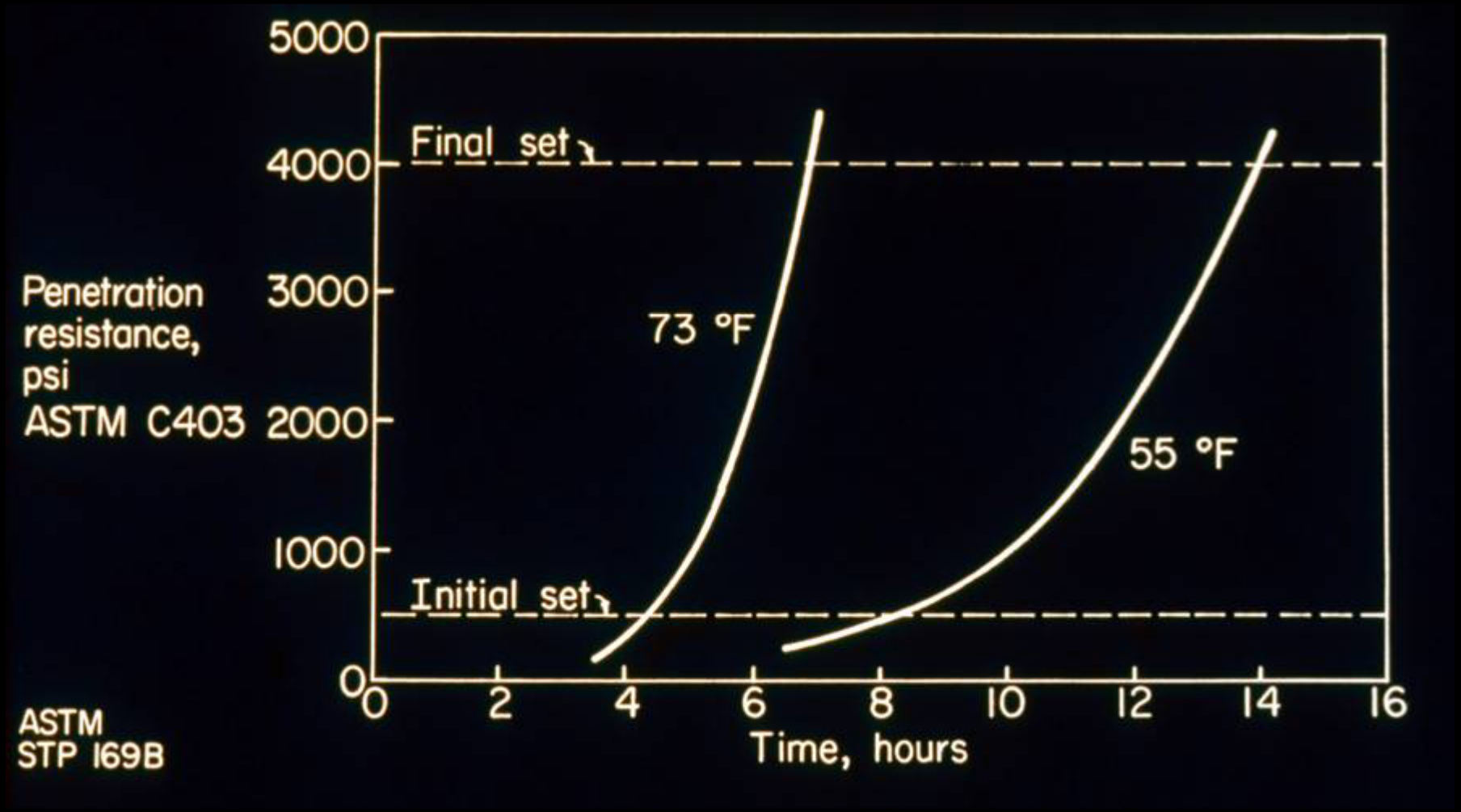
- Pozzolans
- Temperature
- Contamination
  - Sugar
  - Water

FORMS

Effect of Hot Weather on Rate of Hardening



Effect of Cold Weather on Rate of Hardening



Setting Time

- Cement
  - Type
    - Fineness
    - Chemistry

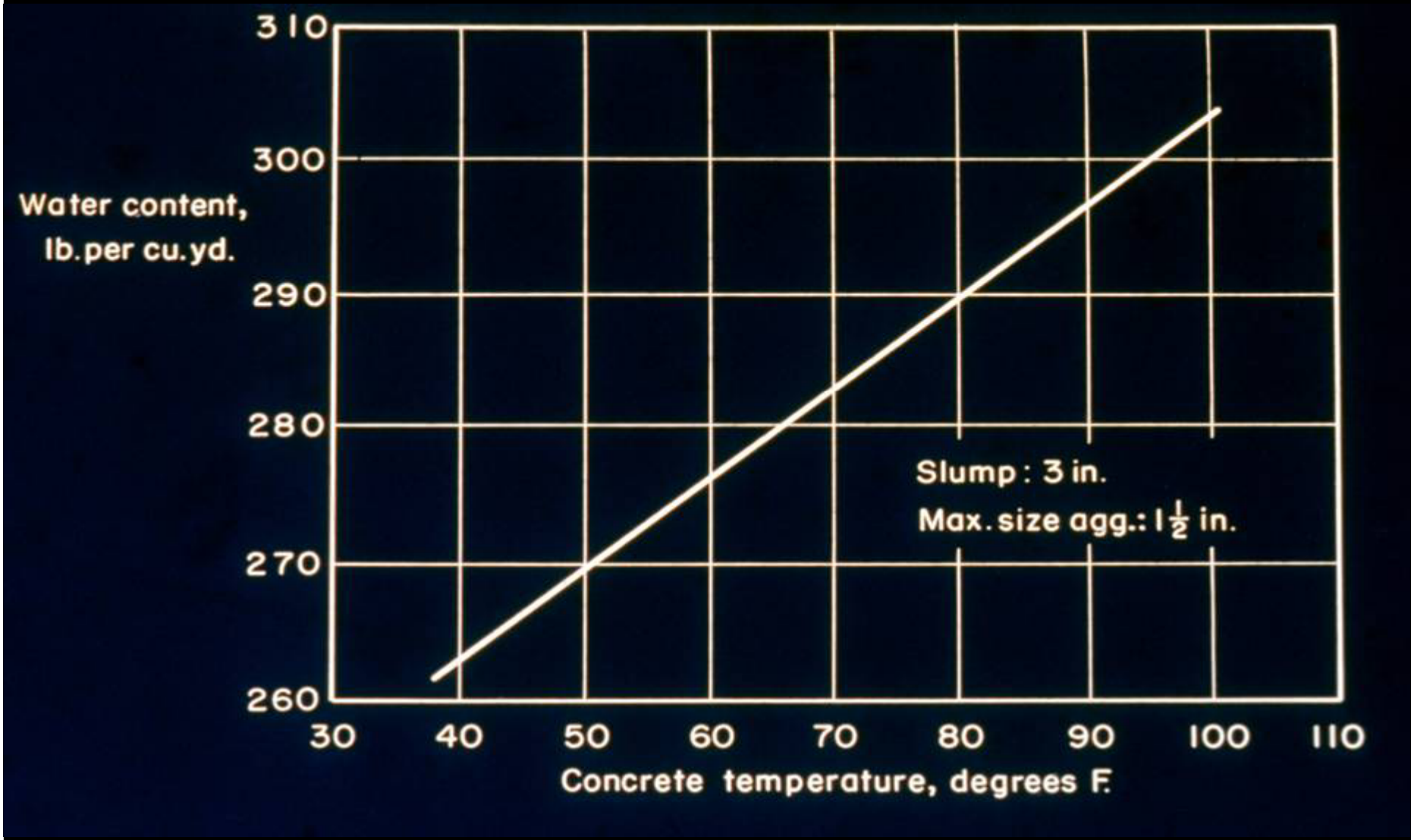
Setting Time

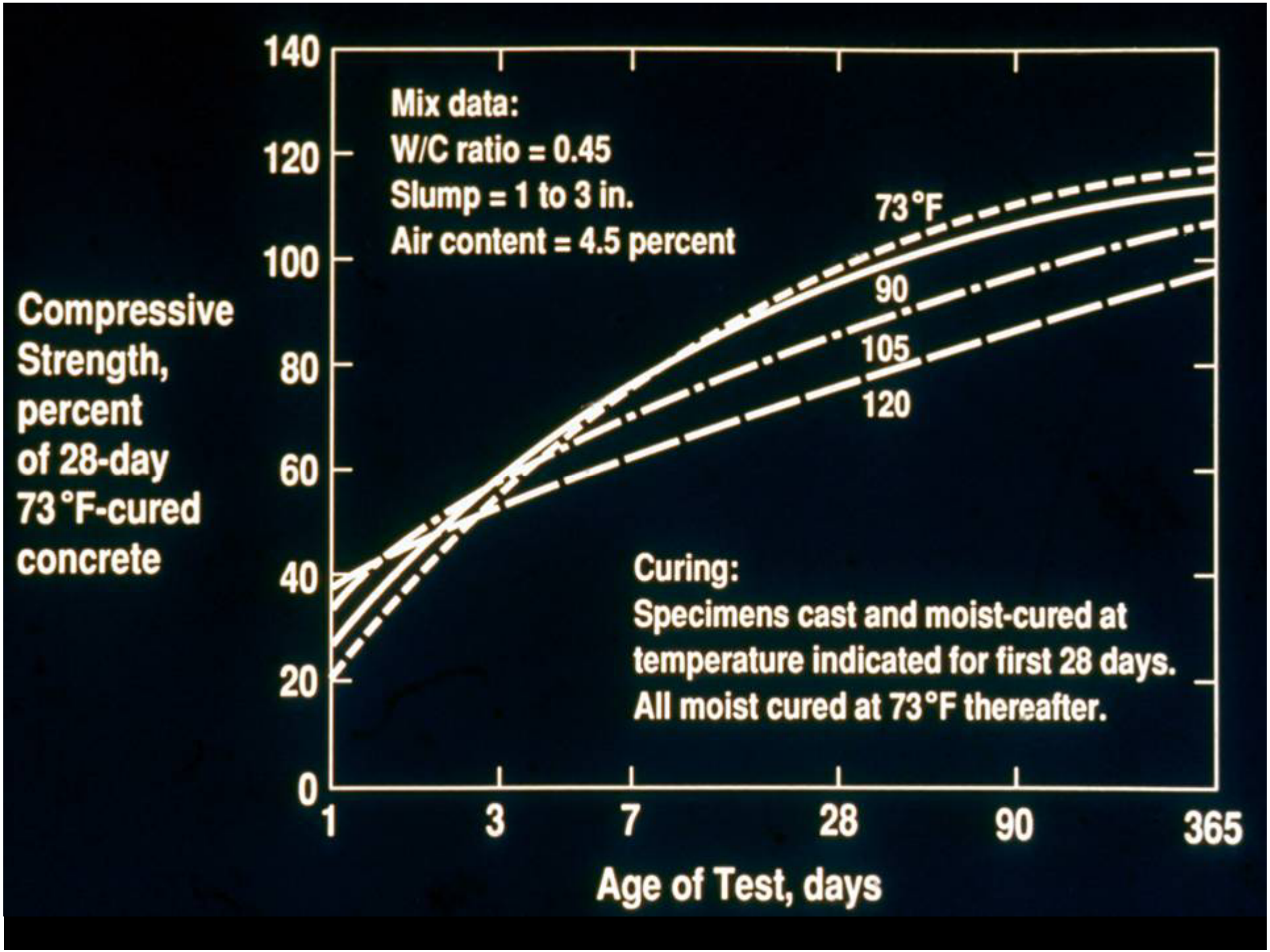
- Admixtures
  - Type
  - Dosage

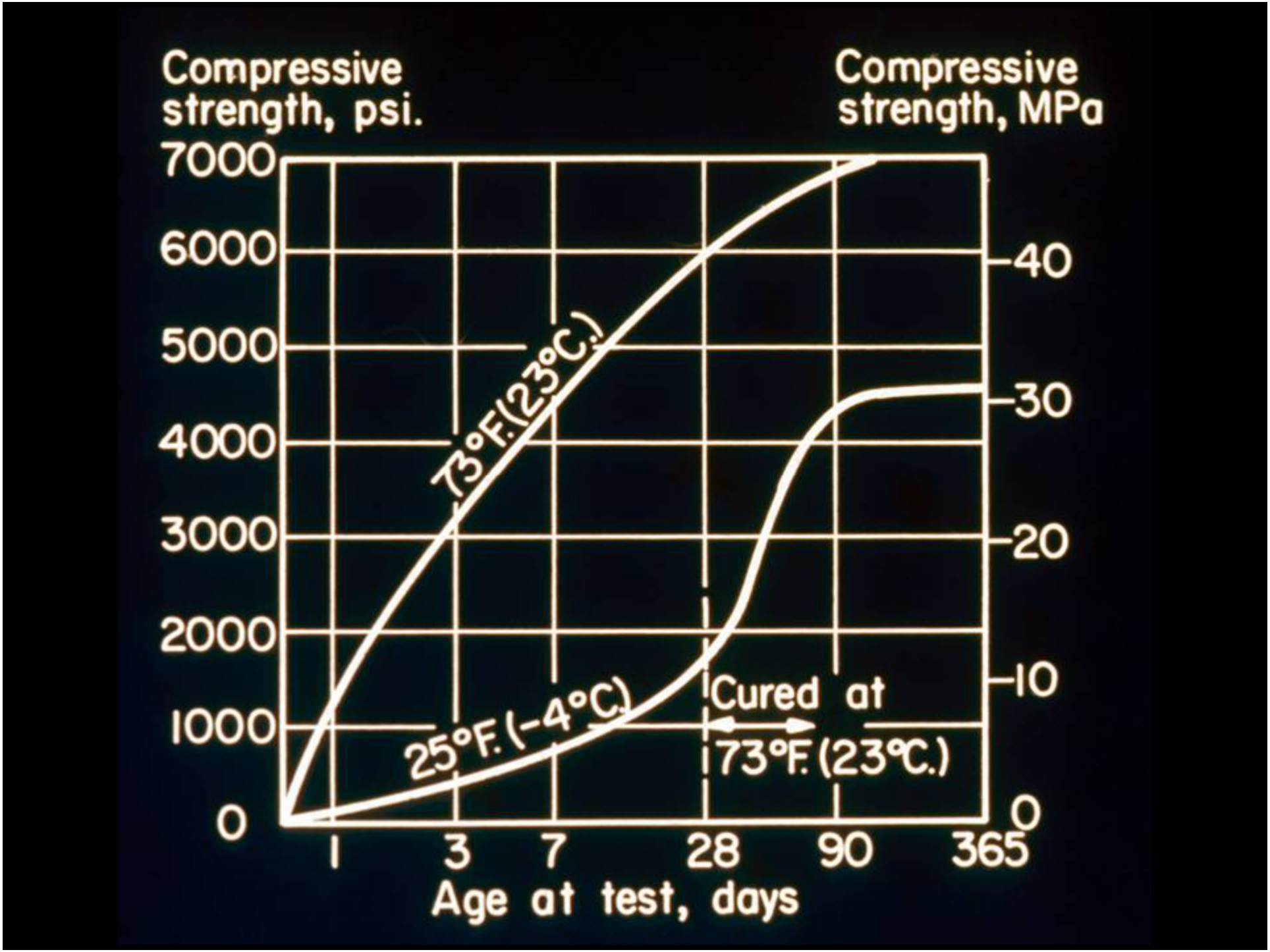
Mix Temperature

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

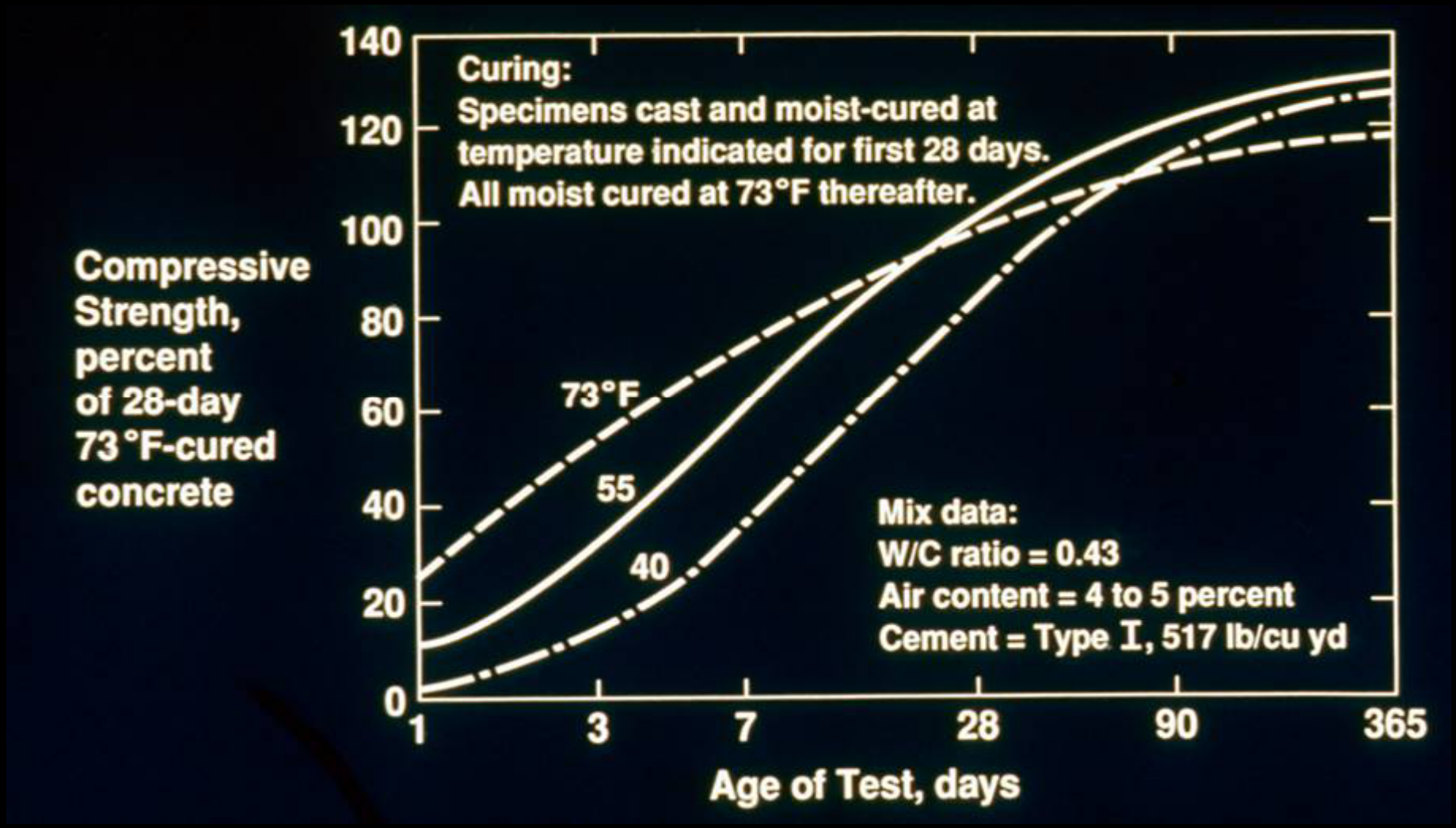
Temperature Vs. Water Requirements




Mix data:
W/C ratio = 0.45
Slump = 1 to 3 in.
Air content = 4.5 percent
73 °F
90
105
120
Curing:
Specimens cast and moist-cured at temperature indicated for first 28 days.
All moist cured at 73 °F thereafter.
Compressive Strength, percent of 28-day 73 °F-cured concrete
140
120
100
80
60
40
20
0
1
3
7
28
90
365
Age of Test, days

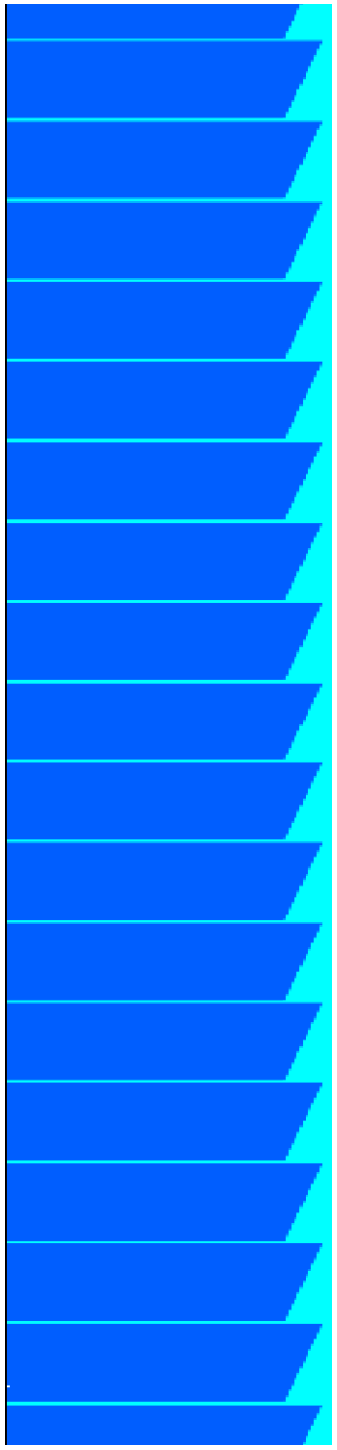

Compressive strength, psi.
Compressive strength, MPa
7000
6000
5000
4000
3000
2000
1000
0
40
30
20
10
0
73°F.(23°C.)
25°F.(-4°C.)
Cured at
73°F.(23°C.)
1
3
7
28
90
365
Age at test, days

Low Temperature Effects



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

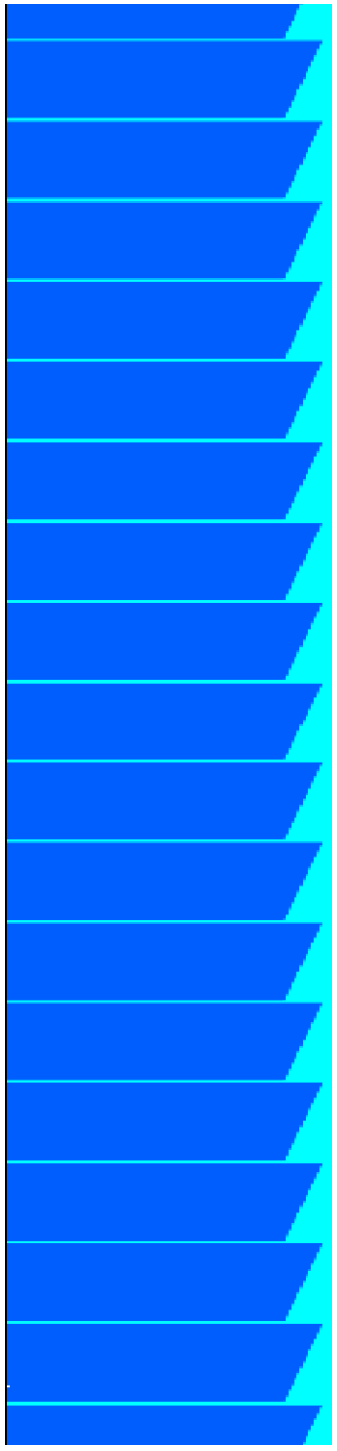
- Float as soon as concrete has been struck off
  - Only one or two passes
- DO NOT SEAL THE SURFACE
  - Do not tip bull floats
- Floating must end before visible bleed water rises to surface
- Wait for concrete to stop bleeding

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



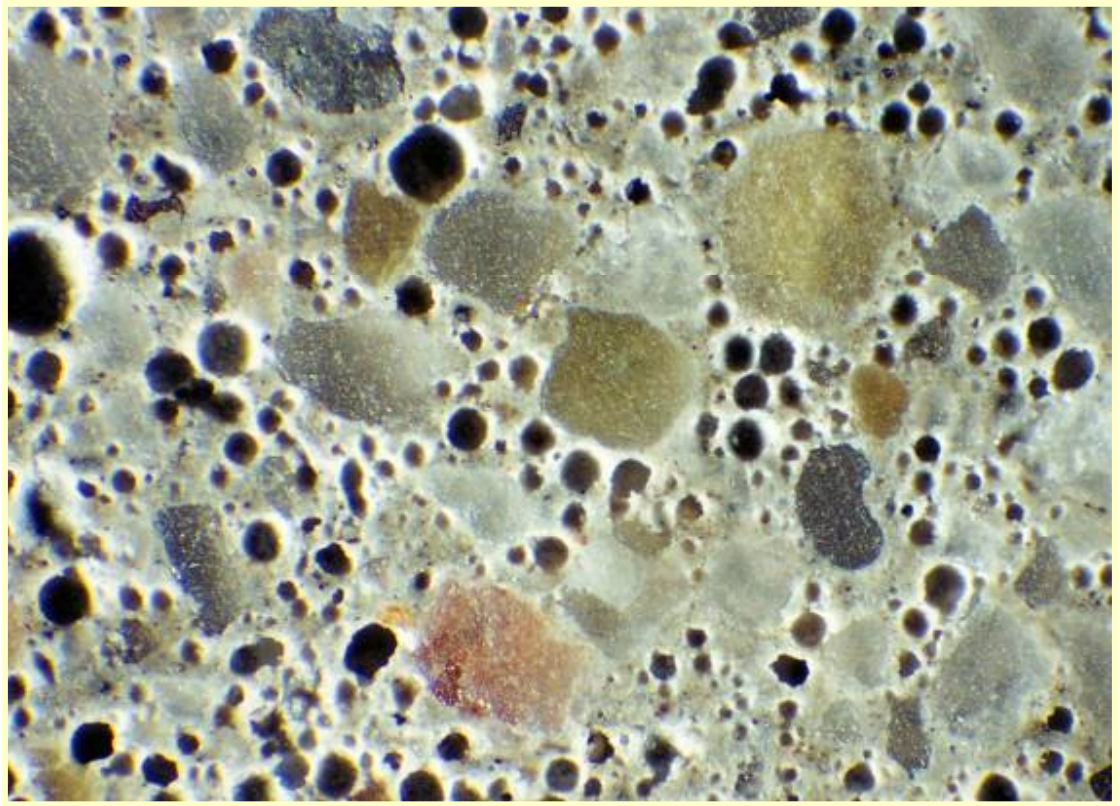
Control of Air Content in Concrete

Total Target Air Contents for Concrete

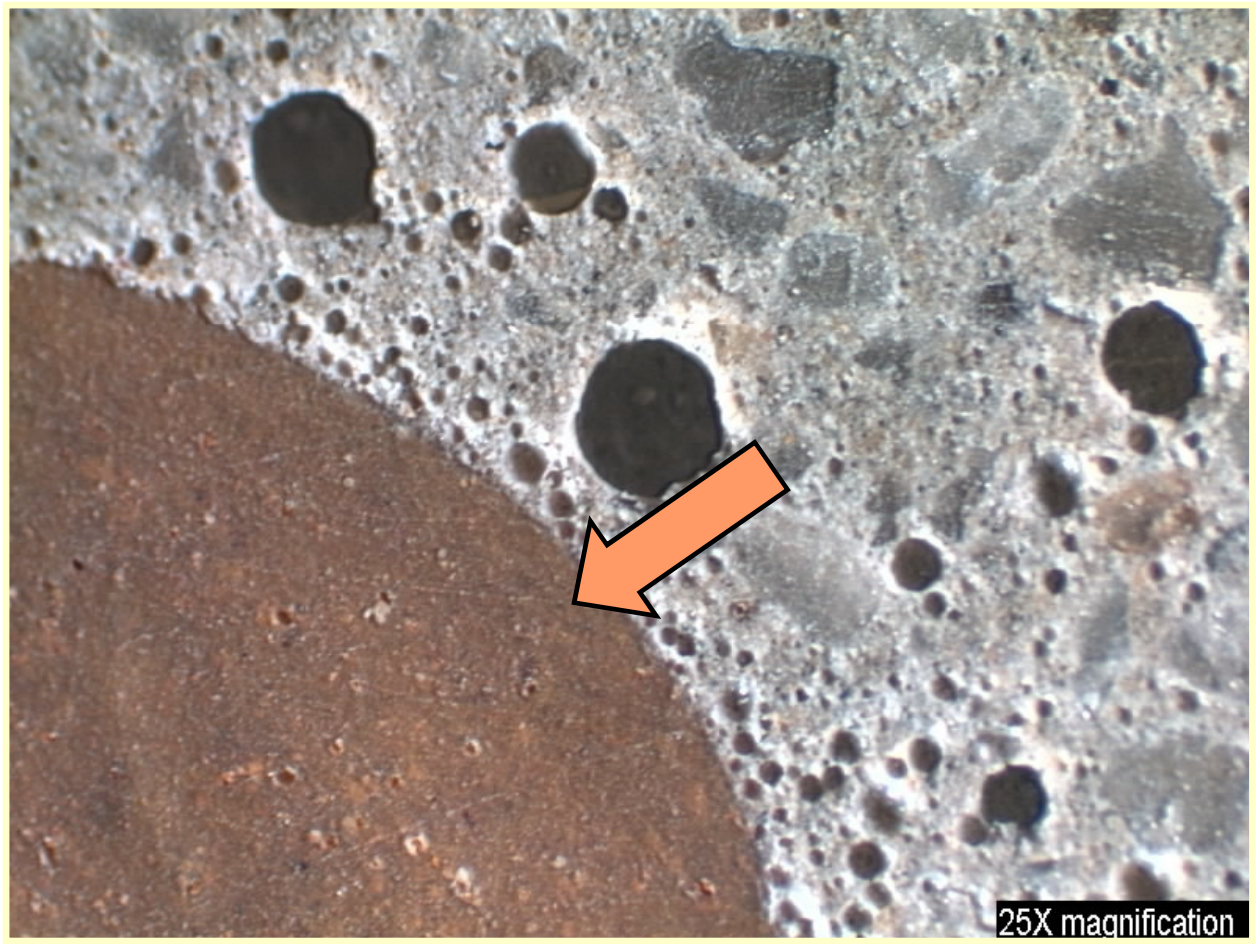
Nominal max. Aggregate Size,in.	Severe Exposure	Moderate Exposure	Mild Exposure
3/8	7-1/2	6	4-1/2
½	7	5-1/2	4
¾	6	5	3-1/2
1	6	4-1/2	3
1-1/2	5-1/2	4-1/2	2-1/2

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

High Air Content

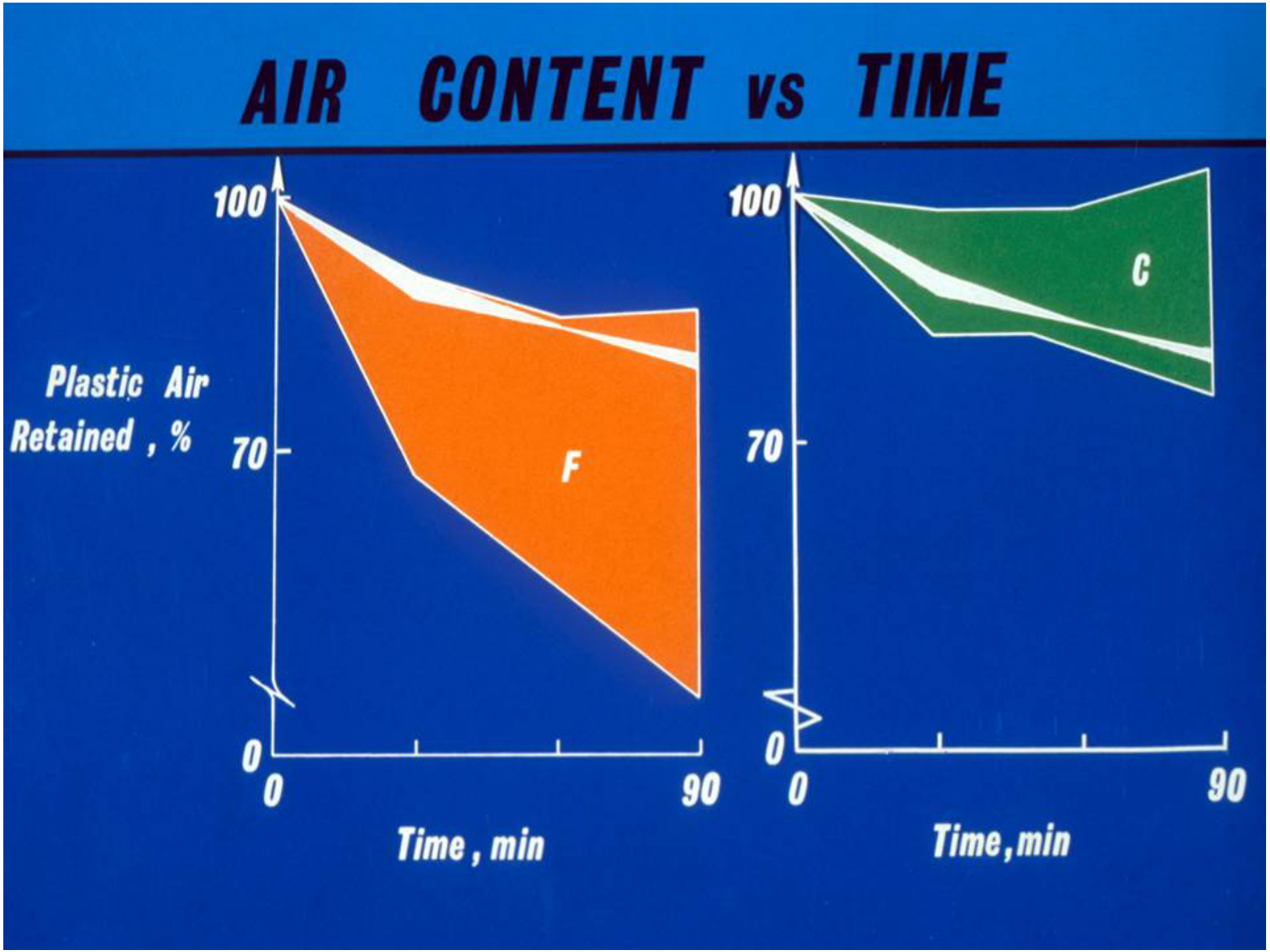


Air-Void Clusters at Interface



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
Plastic Air Retained , %
100
70
0
0
90
Time , min
F
100
70
0
0
90
Time , min
C


FLY ASH

Freshly-Mixed Concrete Problems

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

BLEEDING AND FINISHING RELATED PROBLEMS

Bleeding

- Subsidence
- Capacity vs. rate

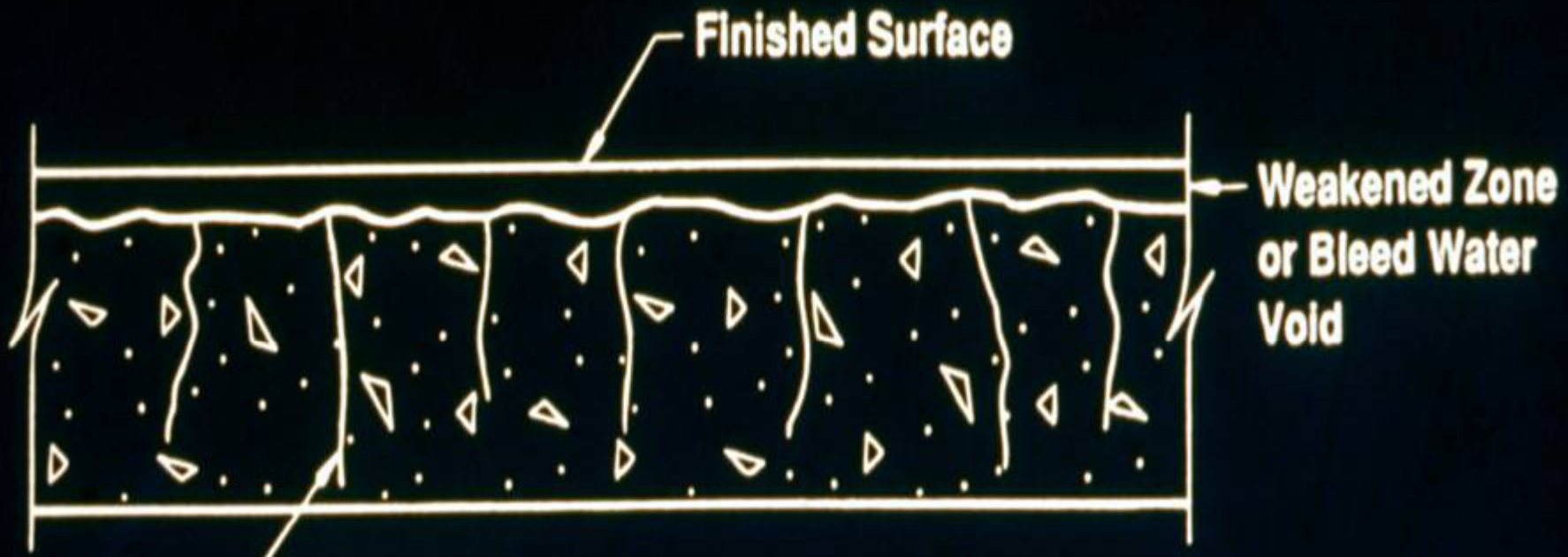
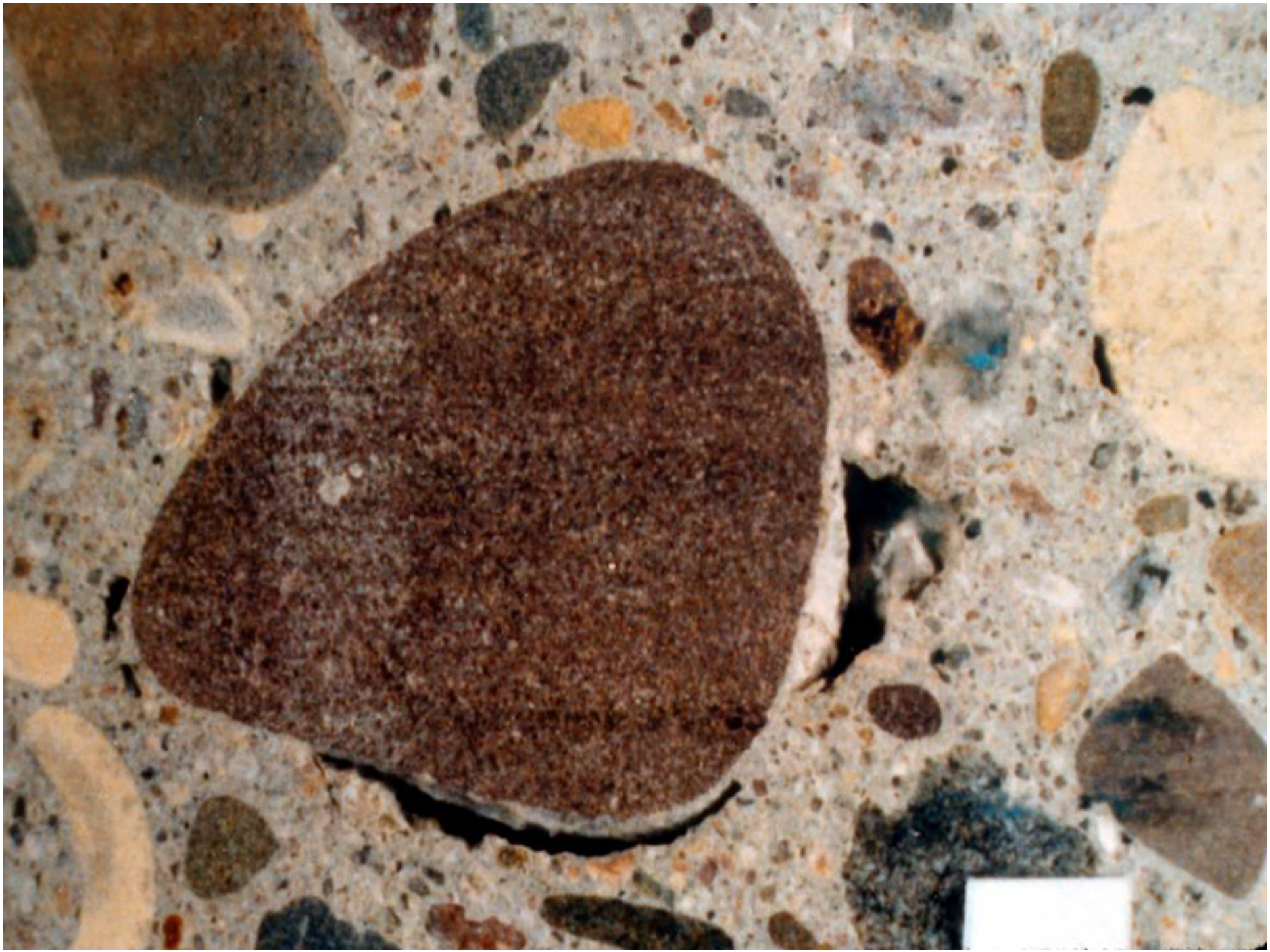
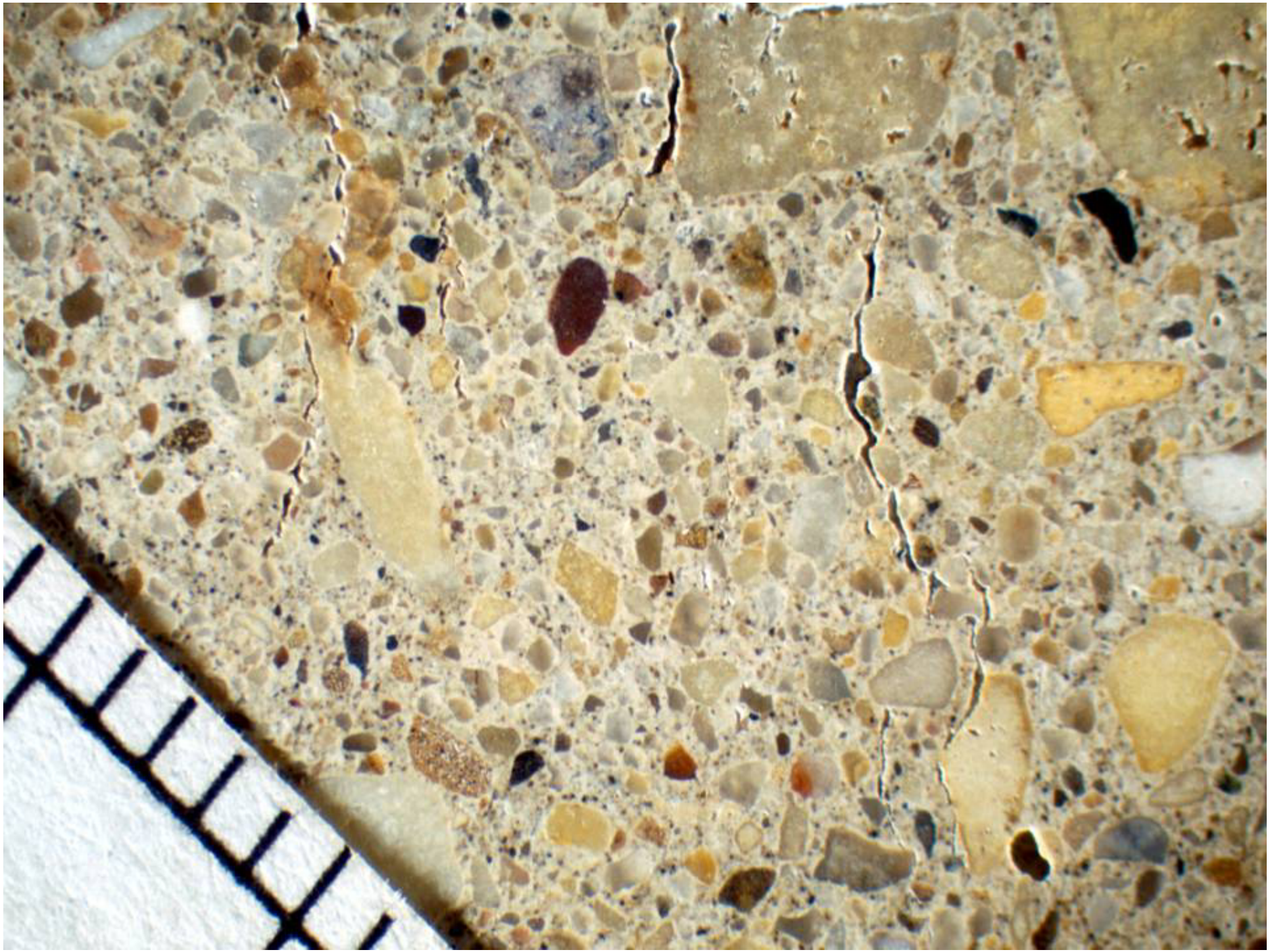
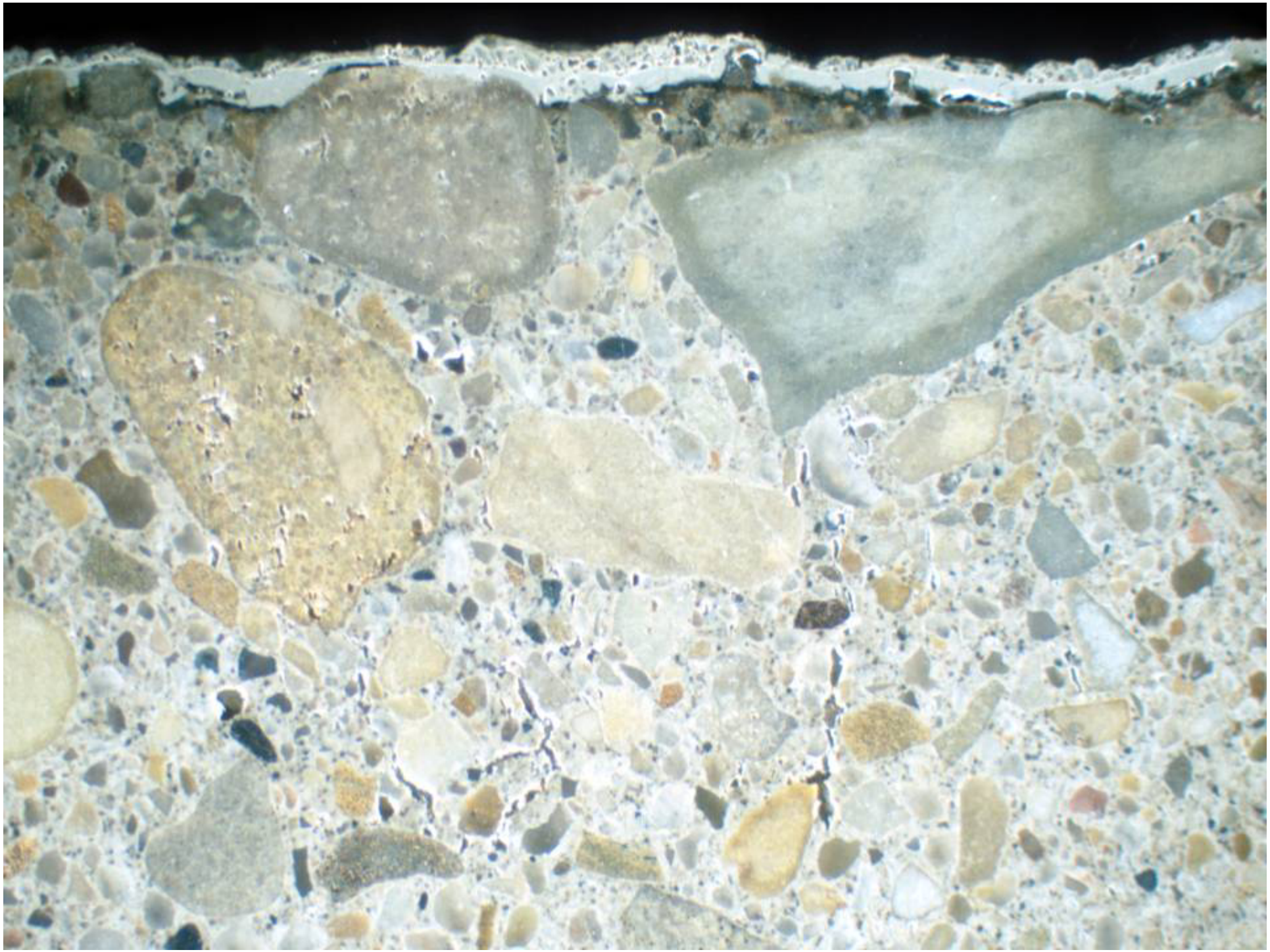


Illustration of weakened zone or bleed water void under a finished surface.







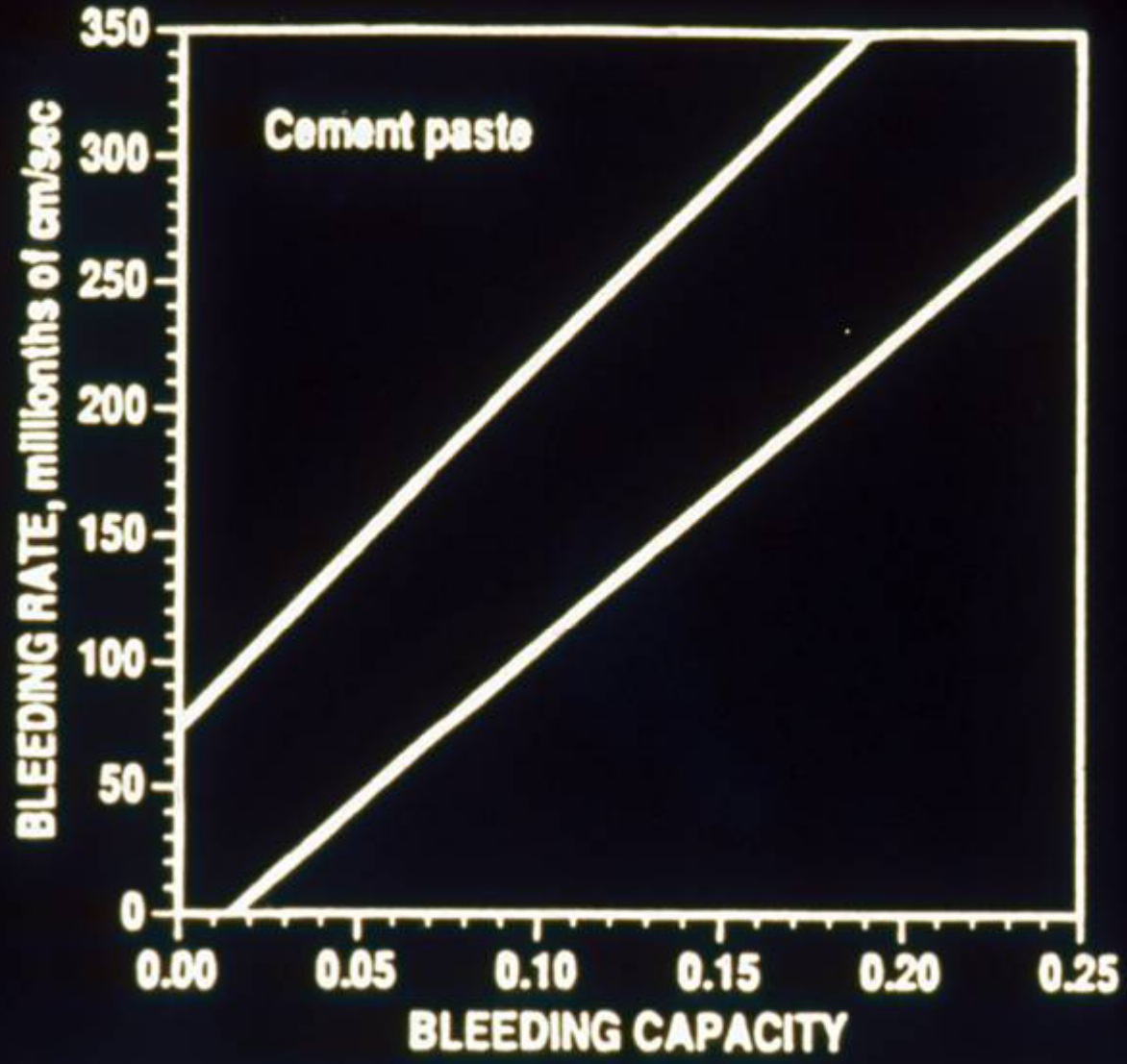
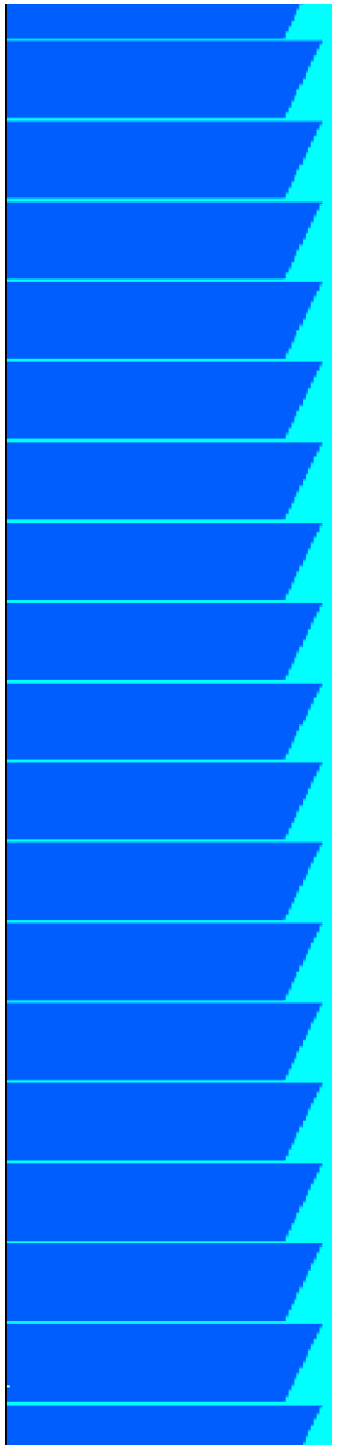


FIG. 9—Relationship between bleeding rate and bleeding capacity for cement paste using a variety of cements. Approximately 100 data points were used to develop the range [4].



Bleeding

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

Bleeding (continued)

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

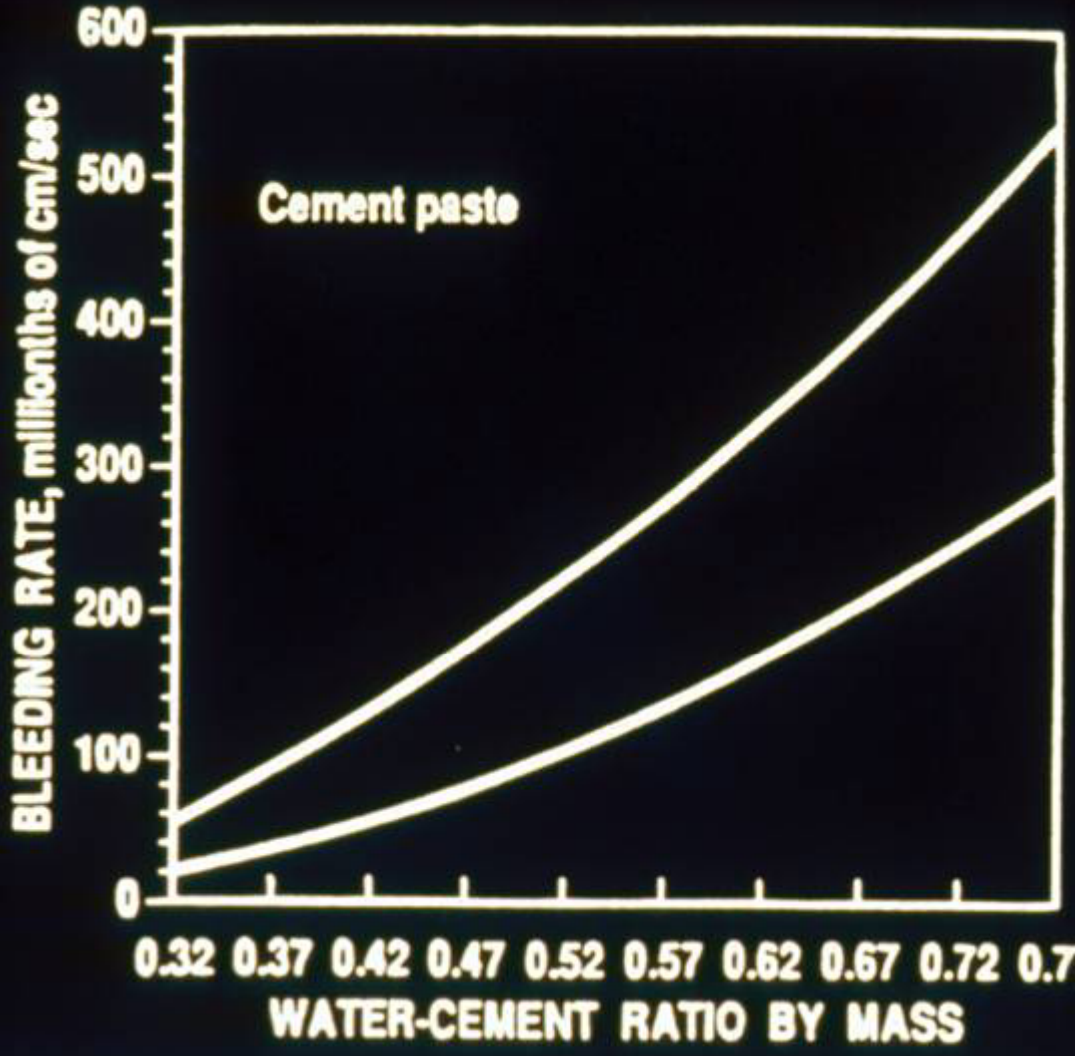


FIG. 6—Range in relationship between bleeding rate and water-cement ratio of pastes made with normal portland cement and water. The range is attributed to different cements having different chemical composition and fineness [*4*].

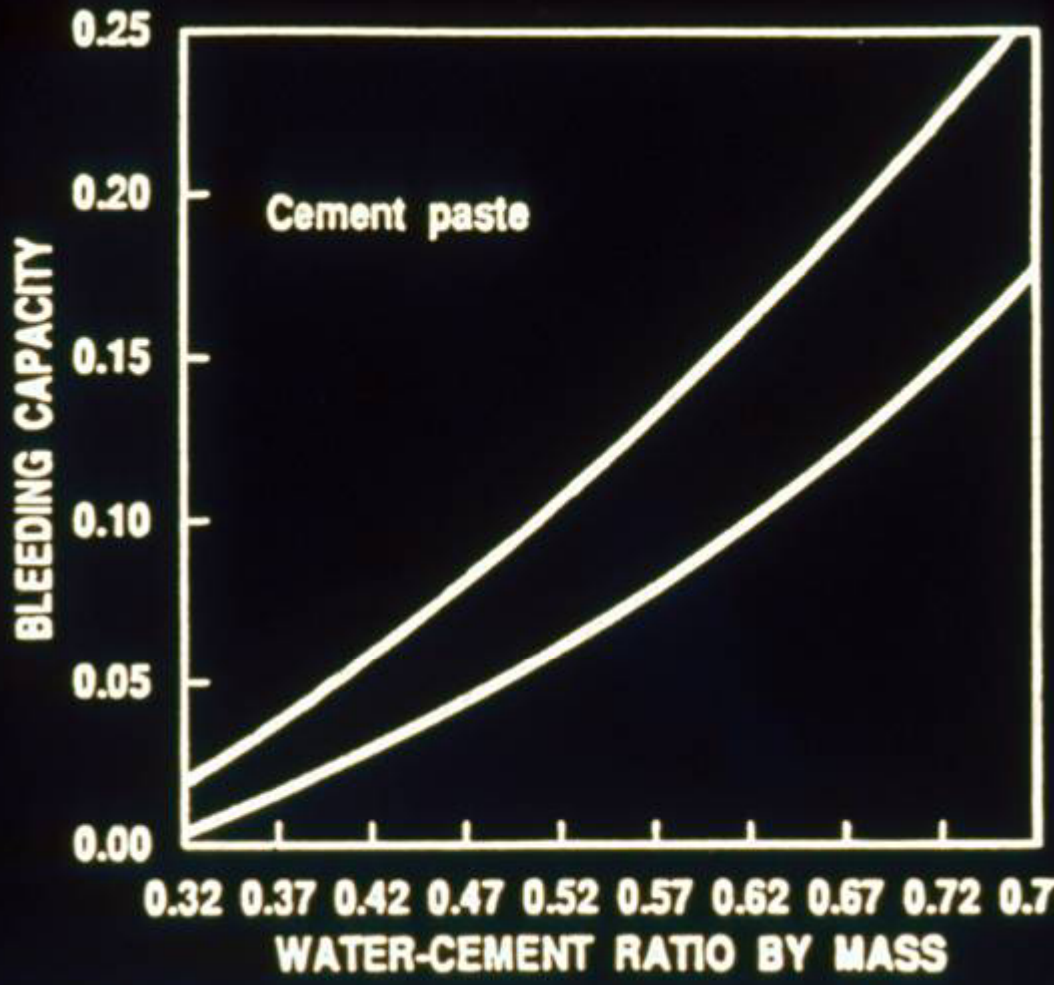


FIG. 7—Range in relationship between bleeding capacity (total settlement per unit of original paste height) and water-cement ratio of pastes made with normal portland cement and water. The range is attributed to different cements having different chemical composition and fineness [*4*].


1
2
3
4
5
6
7
8
9
10

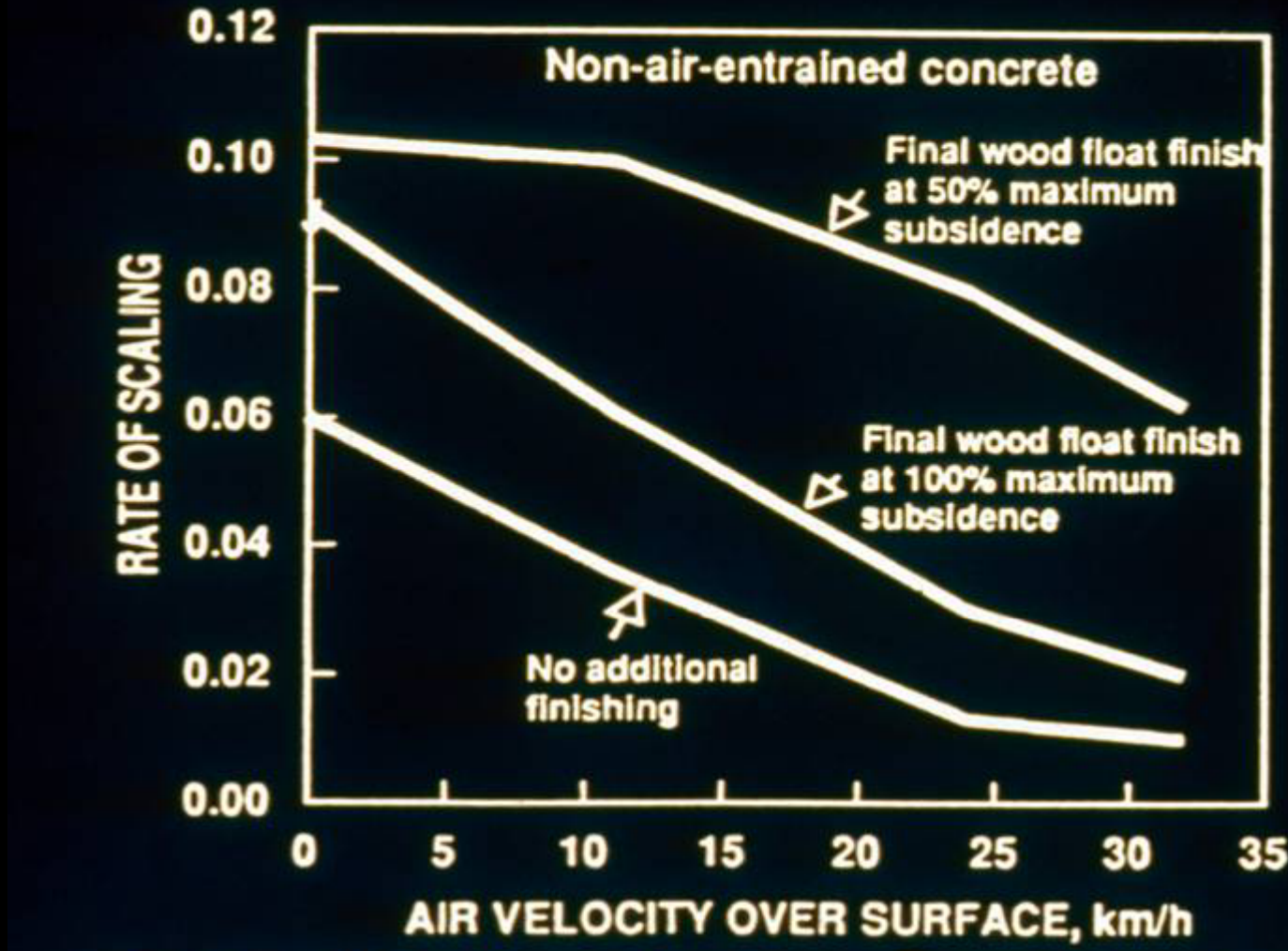


FIG. 18—Effect of time of final finish on scale resistance of concrete after 100 cycles of test. Higher scaling values indicate more scaling. All samples received a wood float strikeoff. Concrete with a final wood finish at 50% subsidence scaled much more than concrete finished after bleeding stopped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

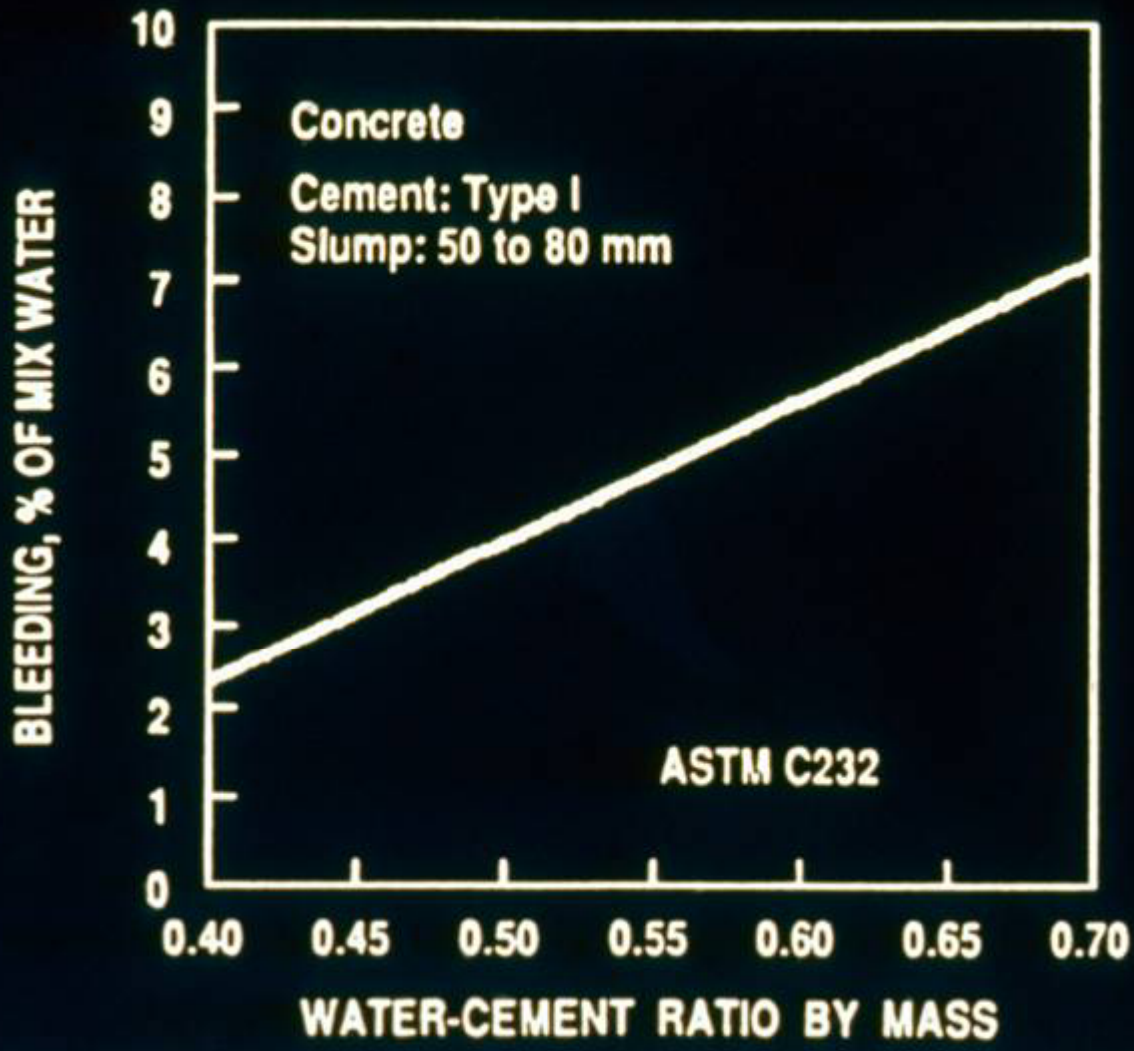


FIG. 25—Relationship between water-cement ratio and bleeding of concrete. Bleeding is expressed as a percent of mix water [*15*].

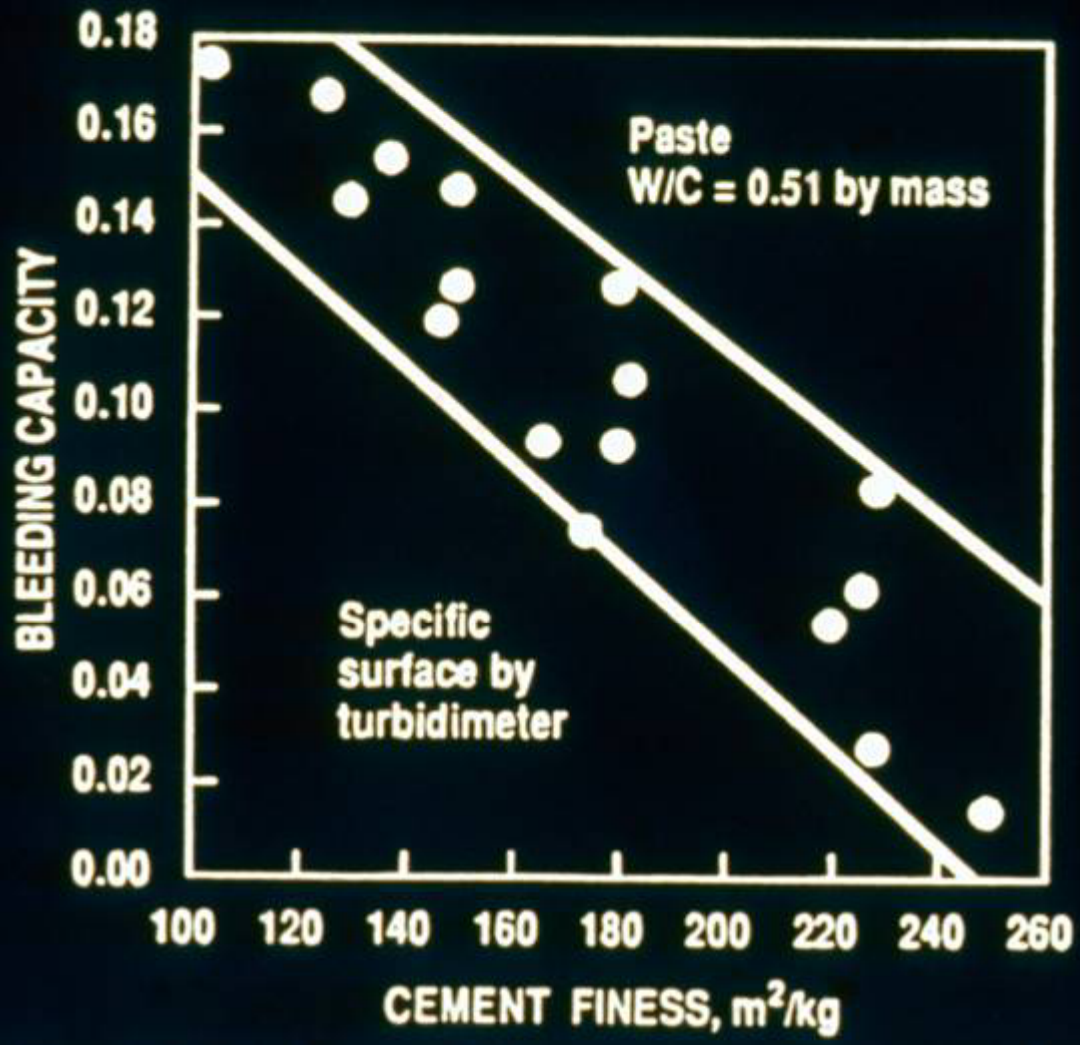


FIG. 26—Effect of cement fineness by Wagner turbidimeter on bleeding capacity of paste. Note that Wagner values are a little more than half of Blaine values [4].

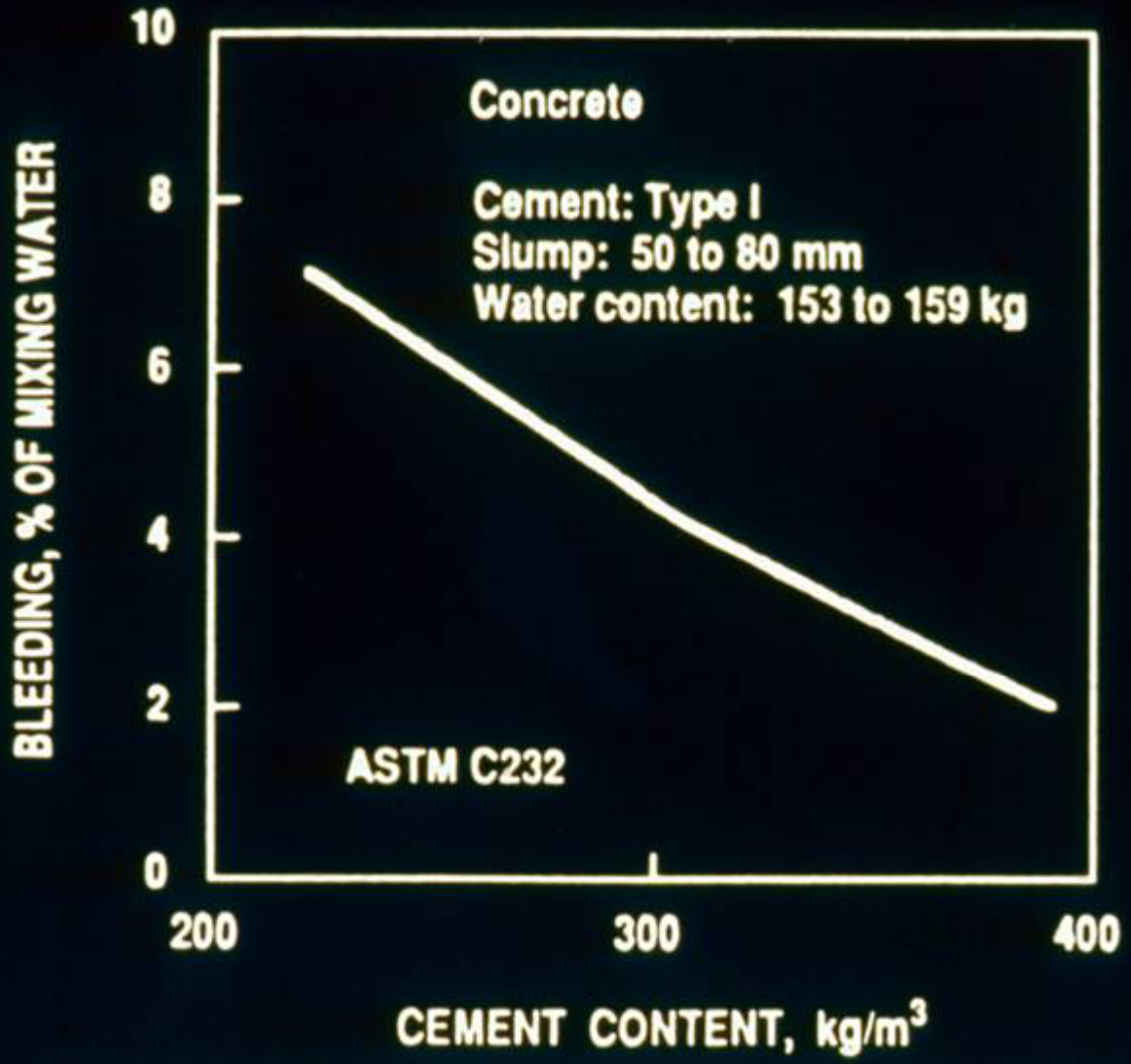


FIG. 27—Relationship between cement content and bleeding of concrete. The increased cement content reflects a decreased water-cement ratio. Bleeding is expressed here as a percent of mix water [*15*].

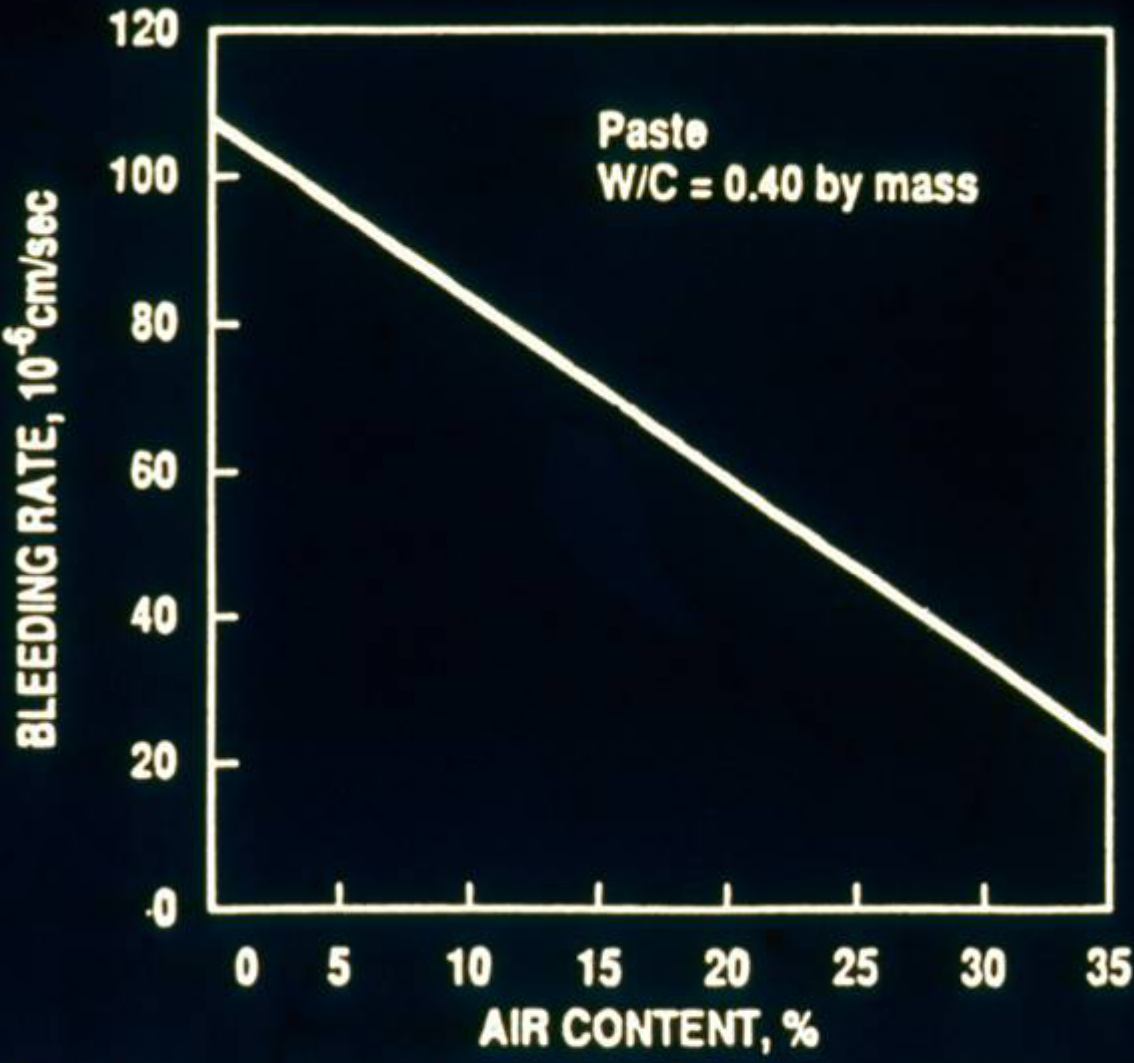


FIG. 29—The effect of entrained air on bleeding rate of paste [3].

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/m³	Slump, mm	Bleeding, % by mass of mix water	Bleeding, mL/cm² 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

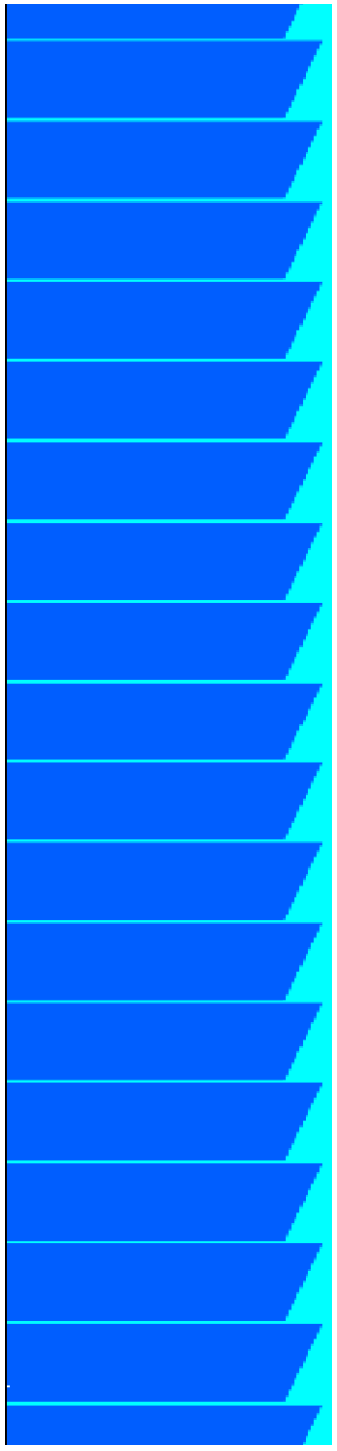
TABLE 6—Effect of Calcium Chloride on Bleeding Rate and Bleeding Capacity [*4*].[a]

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

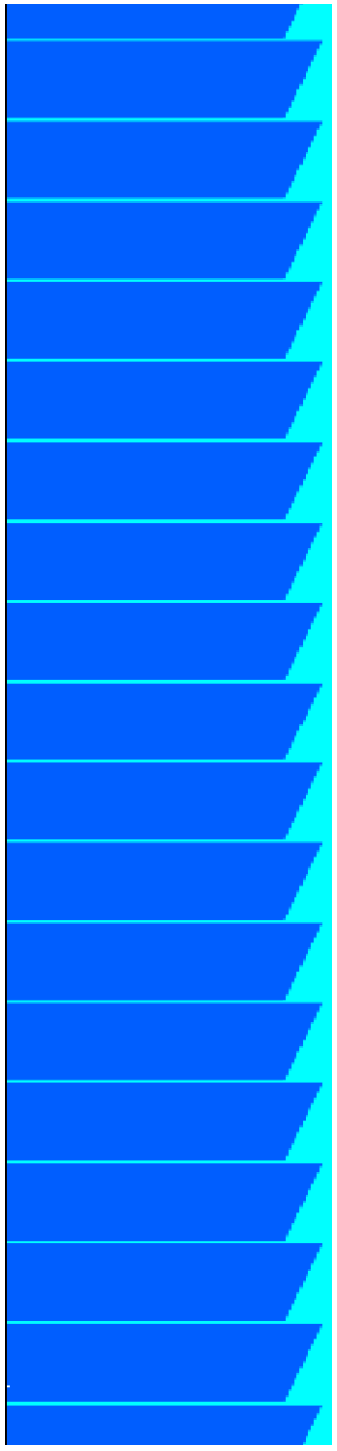
[a] Amount of $CaCl_2$ was 1% of the cement mass and about 2.1% of water. The water-cement ratio was 0.466 by mass.

Bleeding - Durability

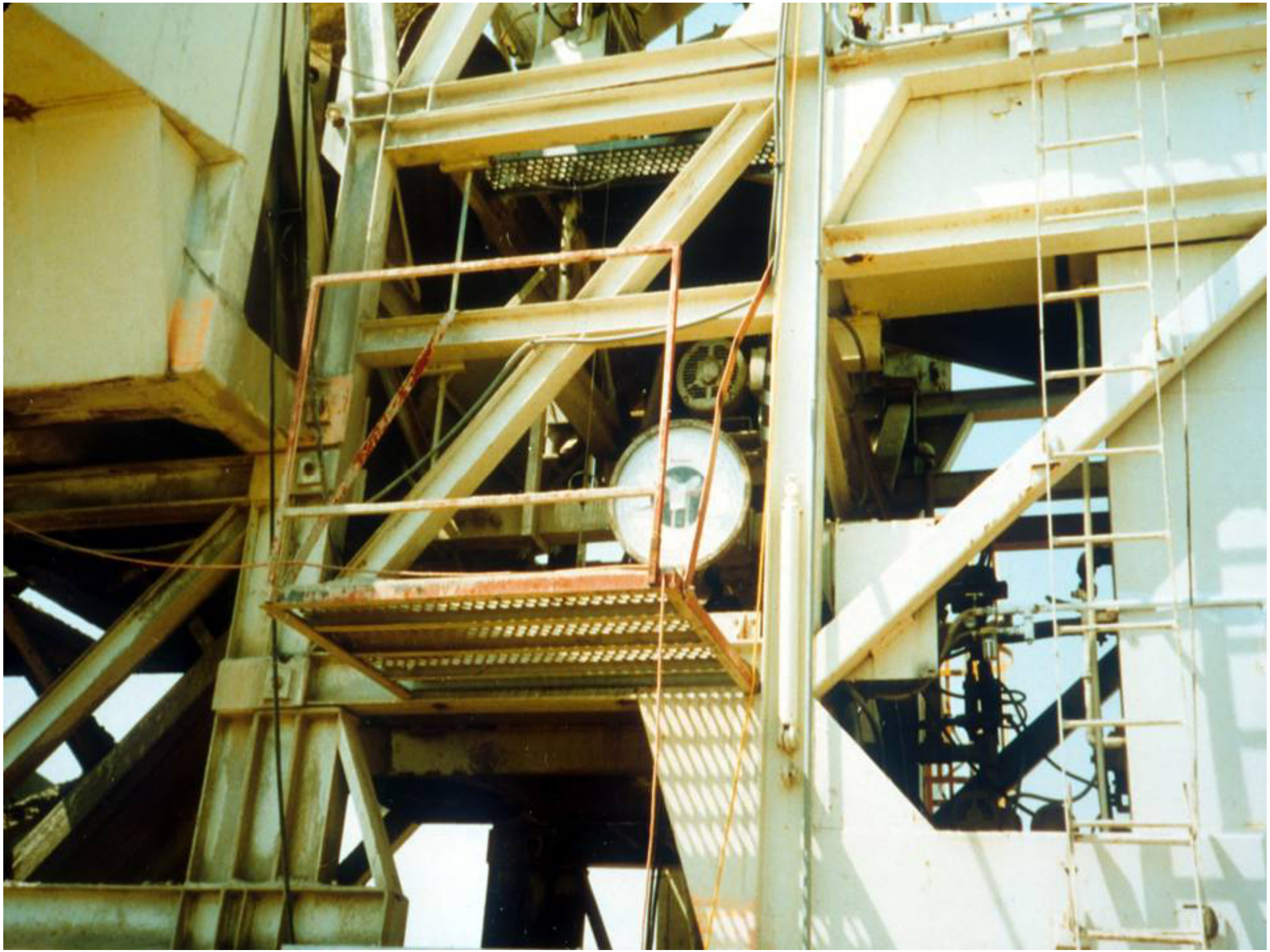
- Scaling
- Mortar flaking
- Surface delaminations
- Blisters
- Sand streaking

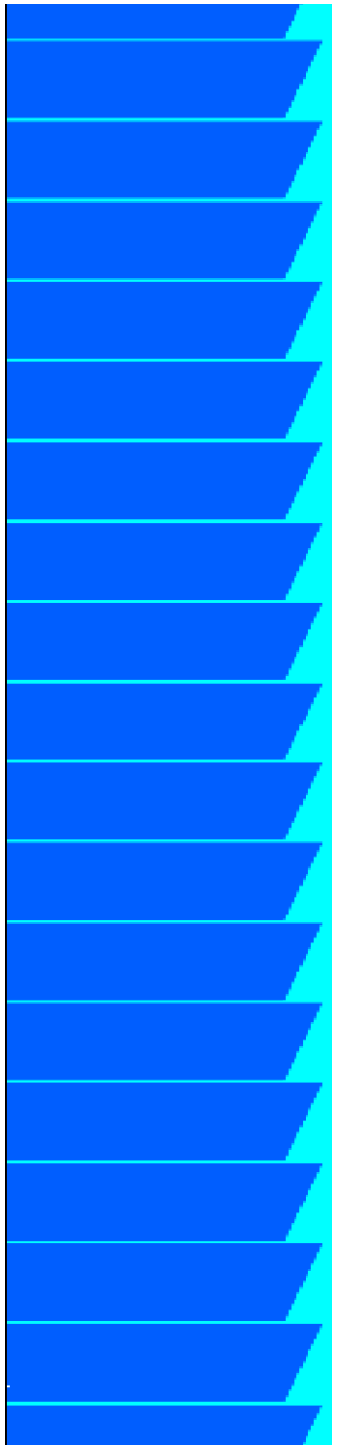


Erratic Batching

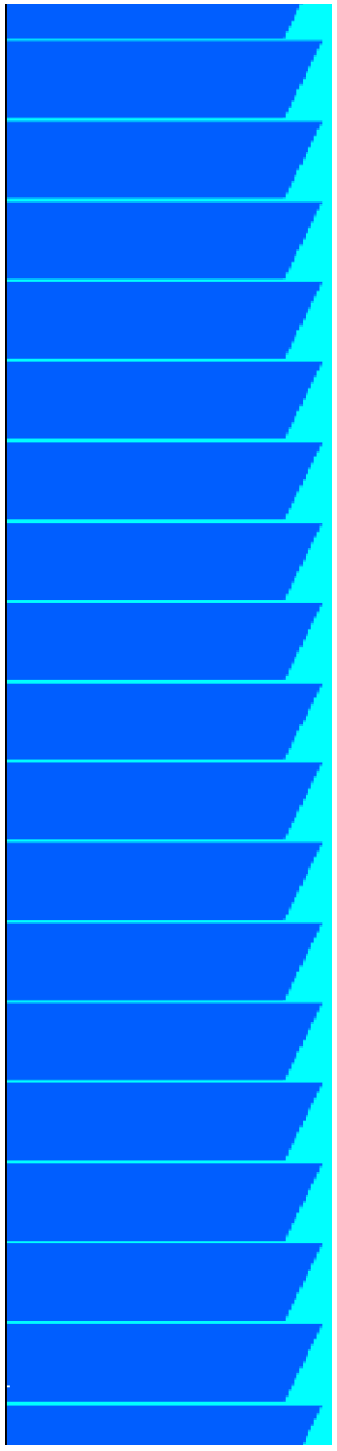


Weighing





Moisture Compensation



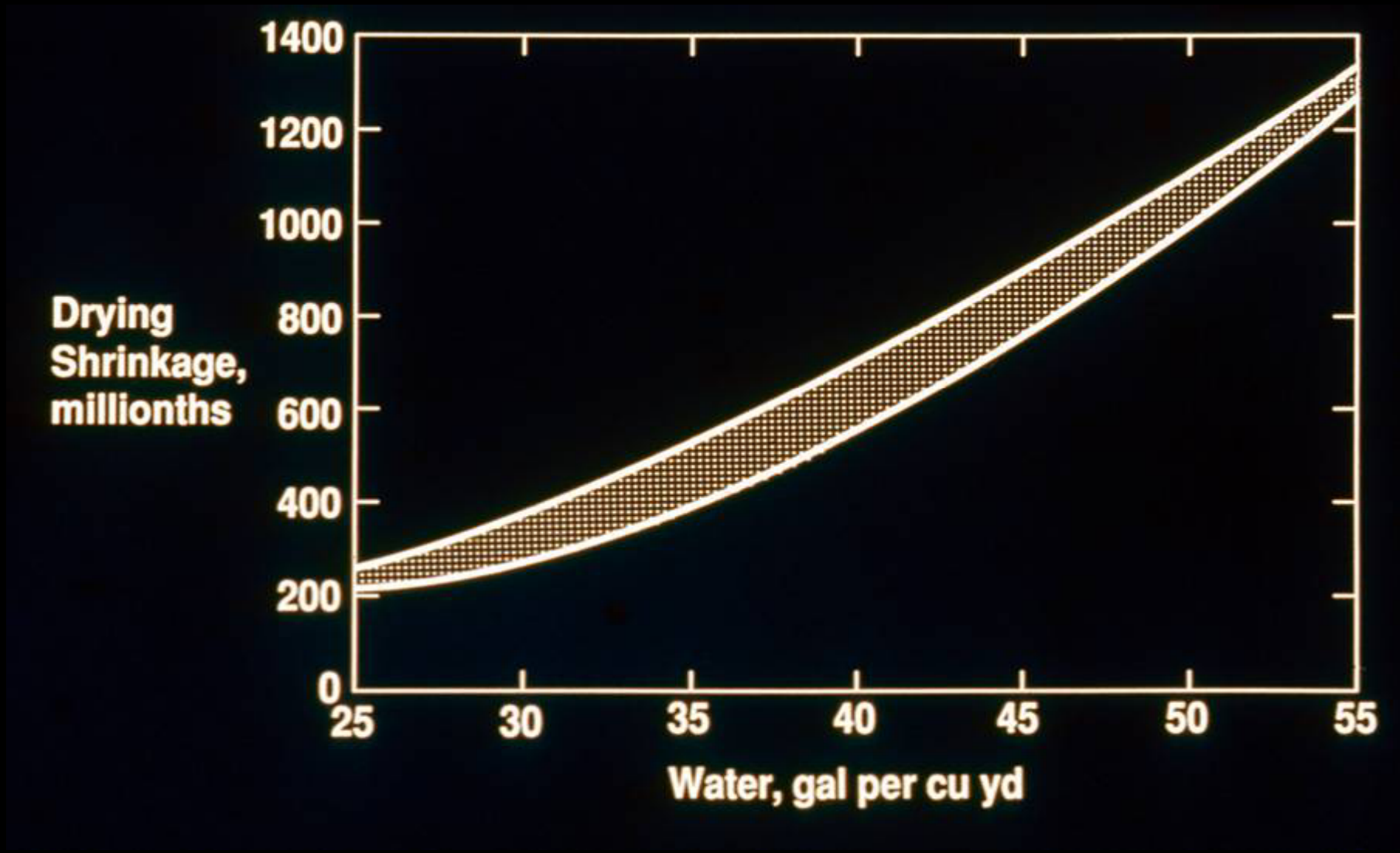
Slump

- Wet
- Dry

Slump - Wet

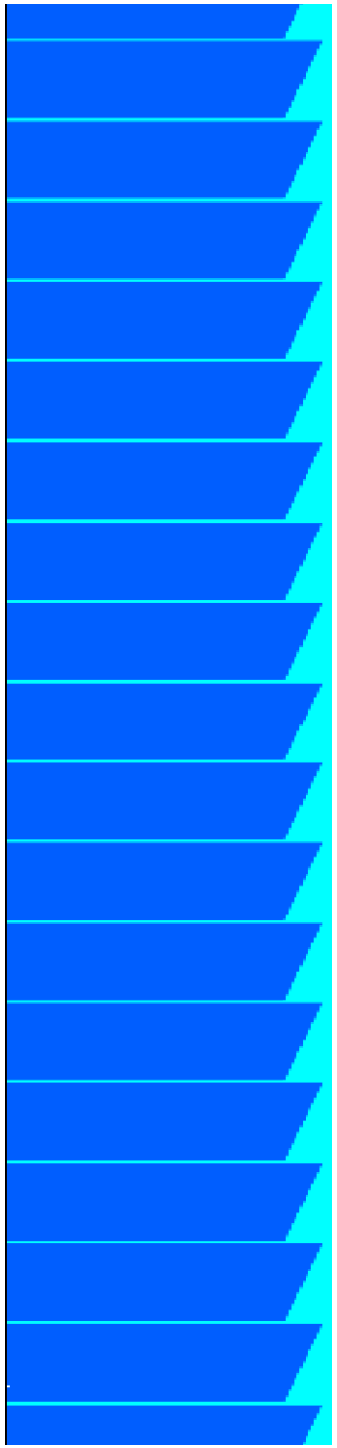
- W/C
- Strength
- Air content
  - Air-void system
- Durability

Shrinkage and Water Content



Slump – Wet (continued)

- Shrinkage
- Cracks
- Permeability
- Pumping

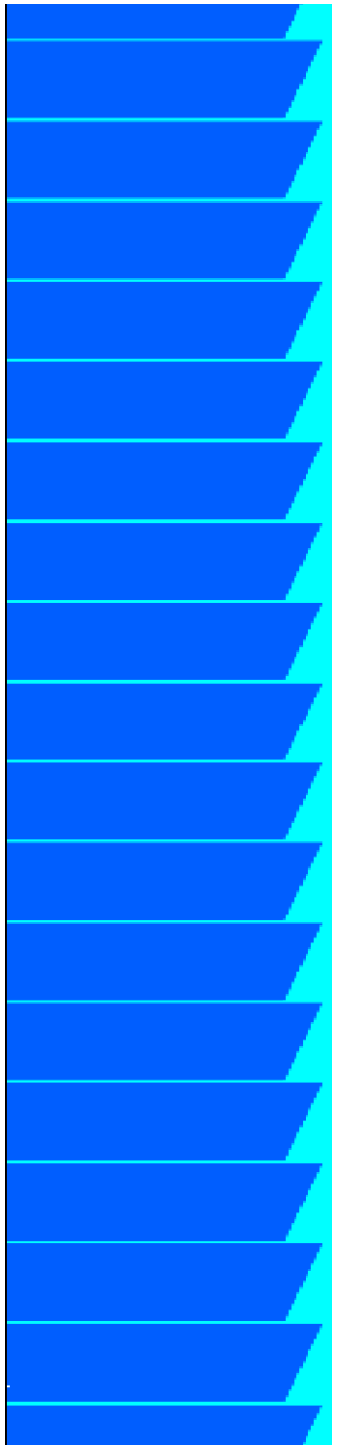


Slump - Dry

- 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

- 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)

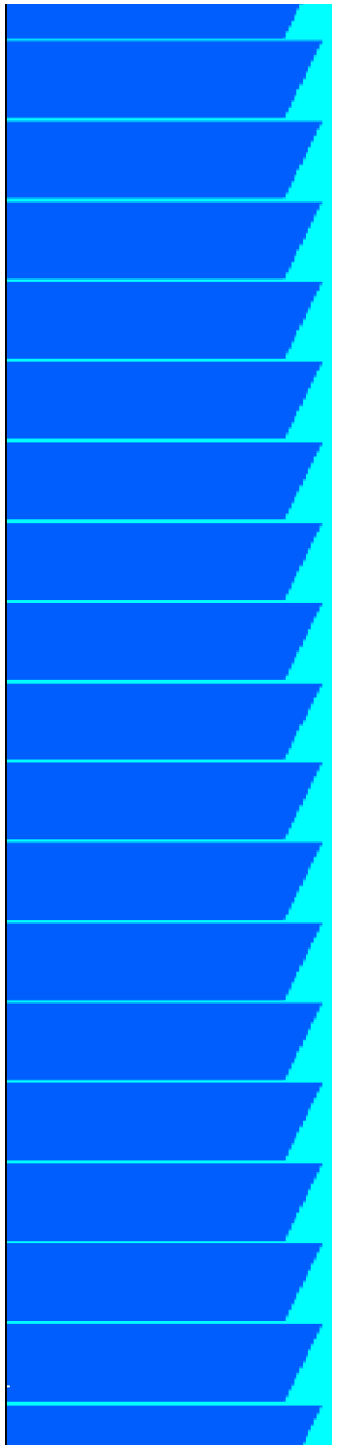
- Remedies
  - Add ~ 2%
  - Stiffer forms
  - Check proper elevation of slabs

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?