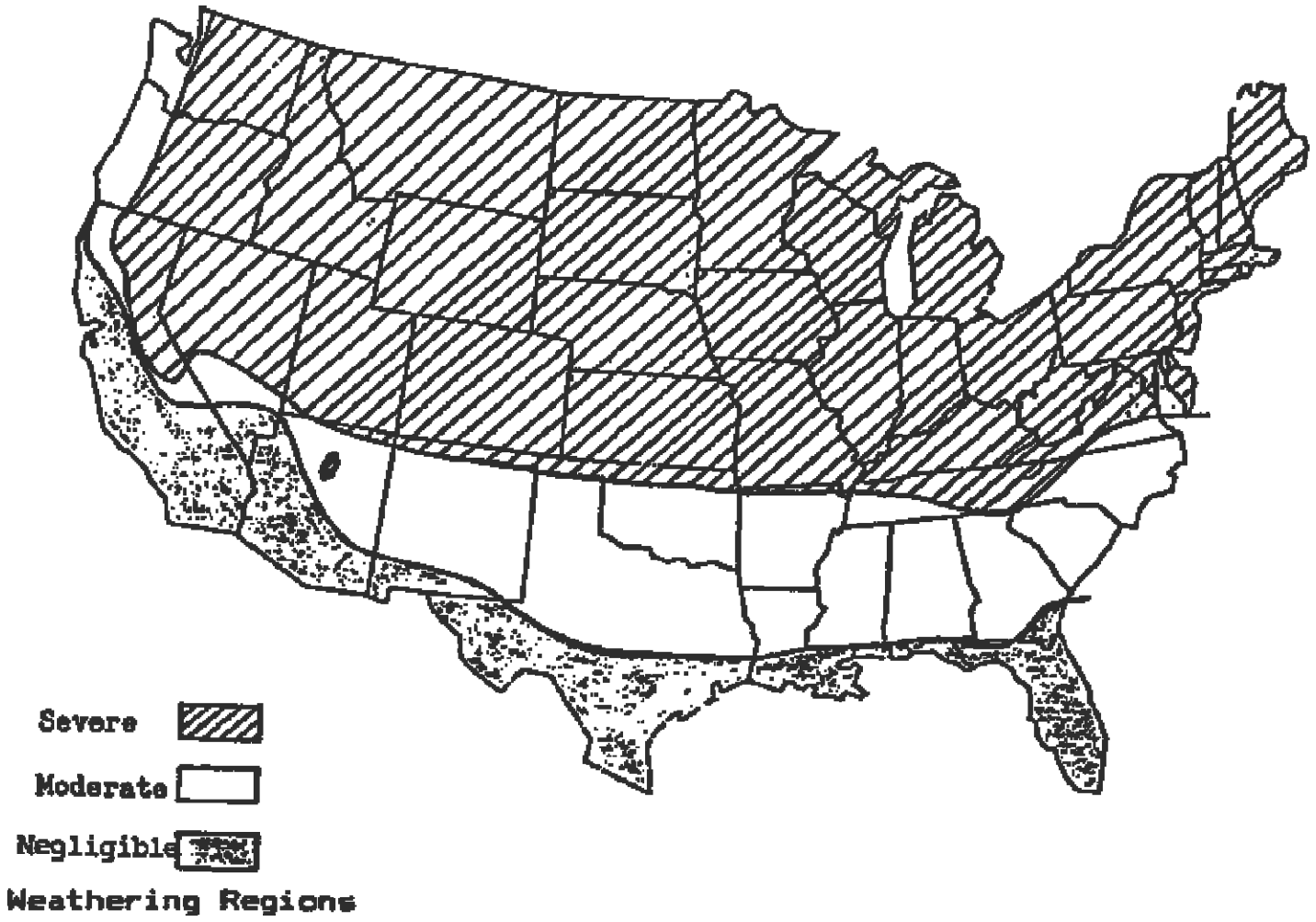
PCA

Concrete Technology and Codes

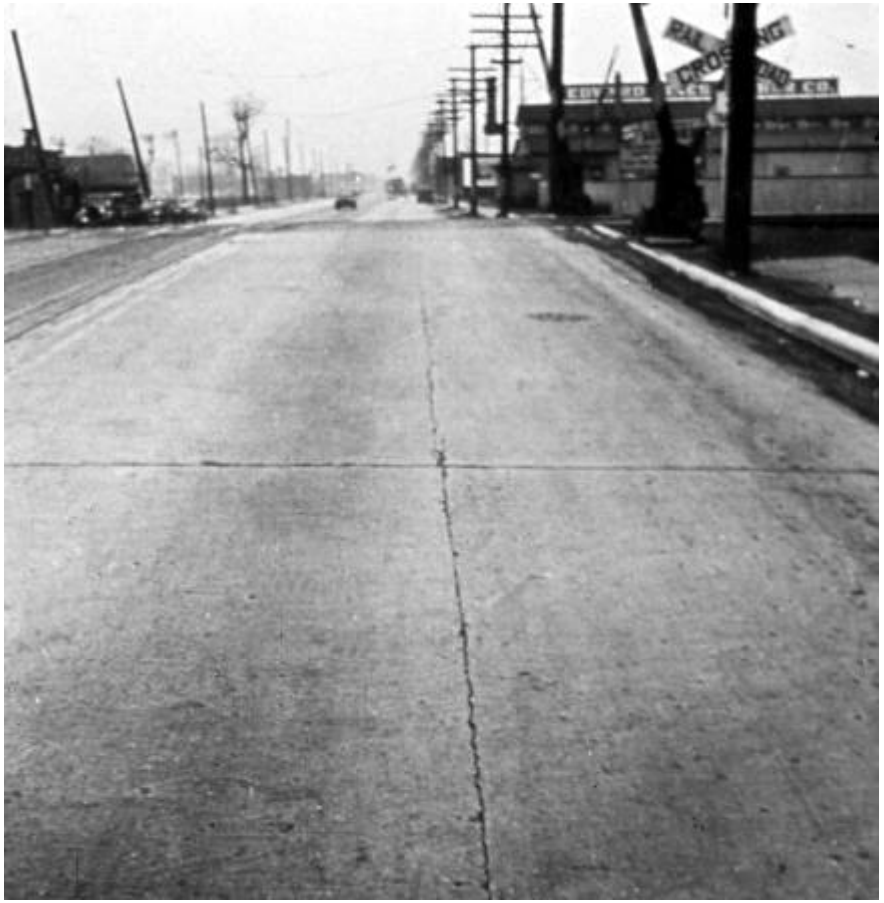
Freeze / Thaw

Weathering Regions



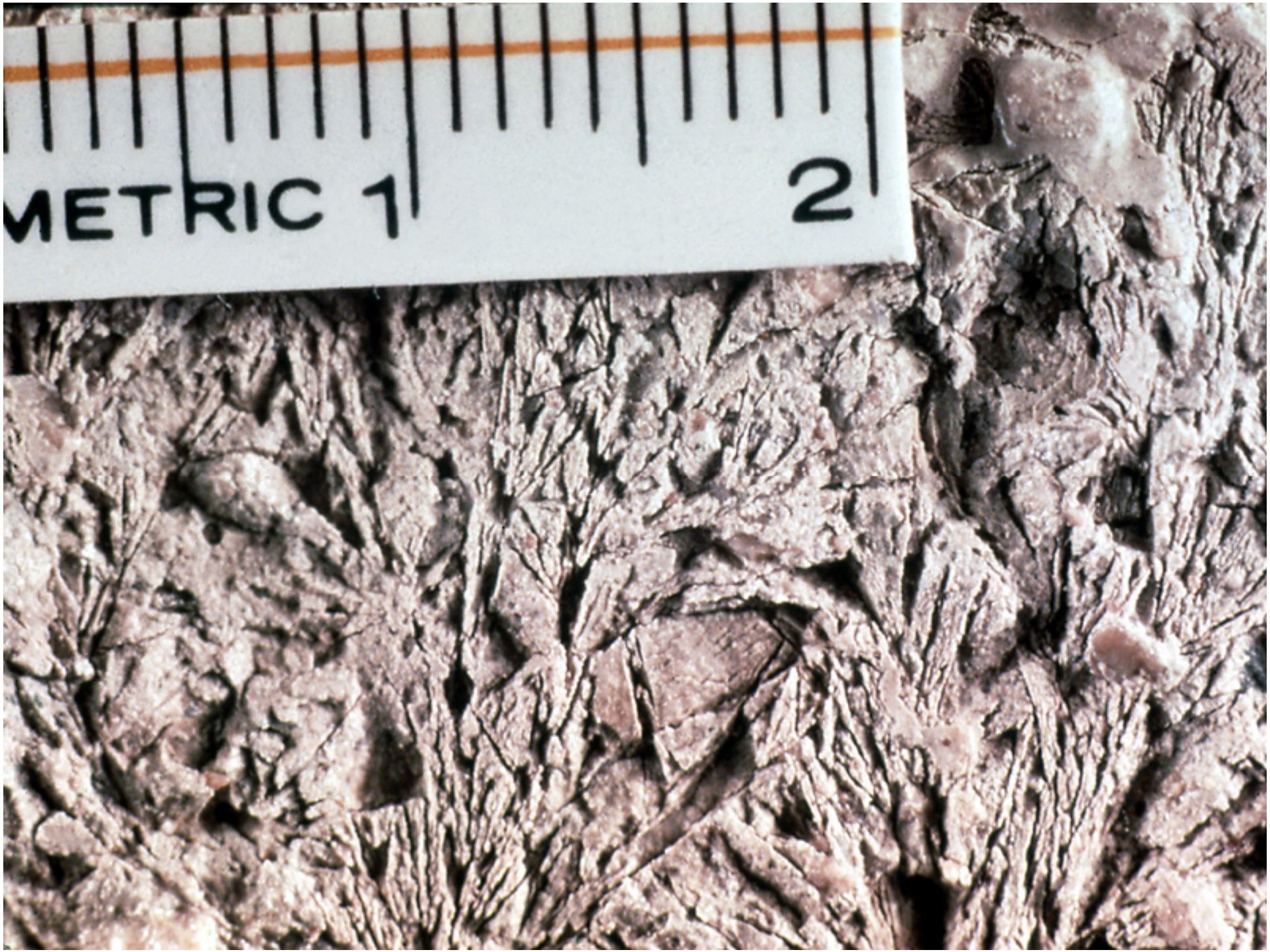
North Lanes Constructed With Non Air-Entrained Portland Cement

Bad Surface Scaling After 2 Years

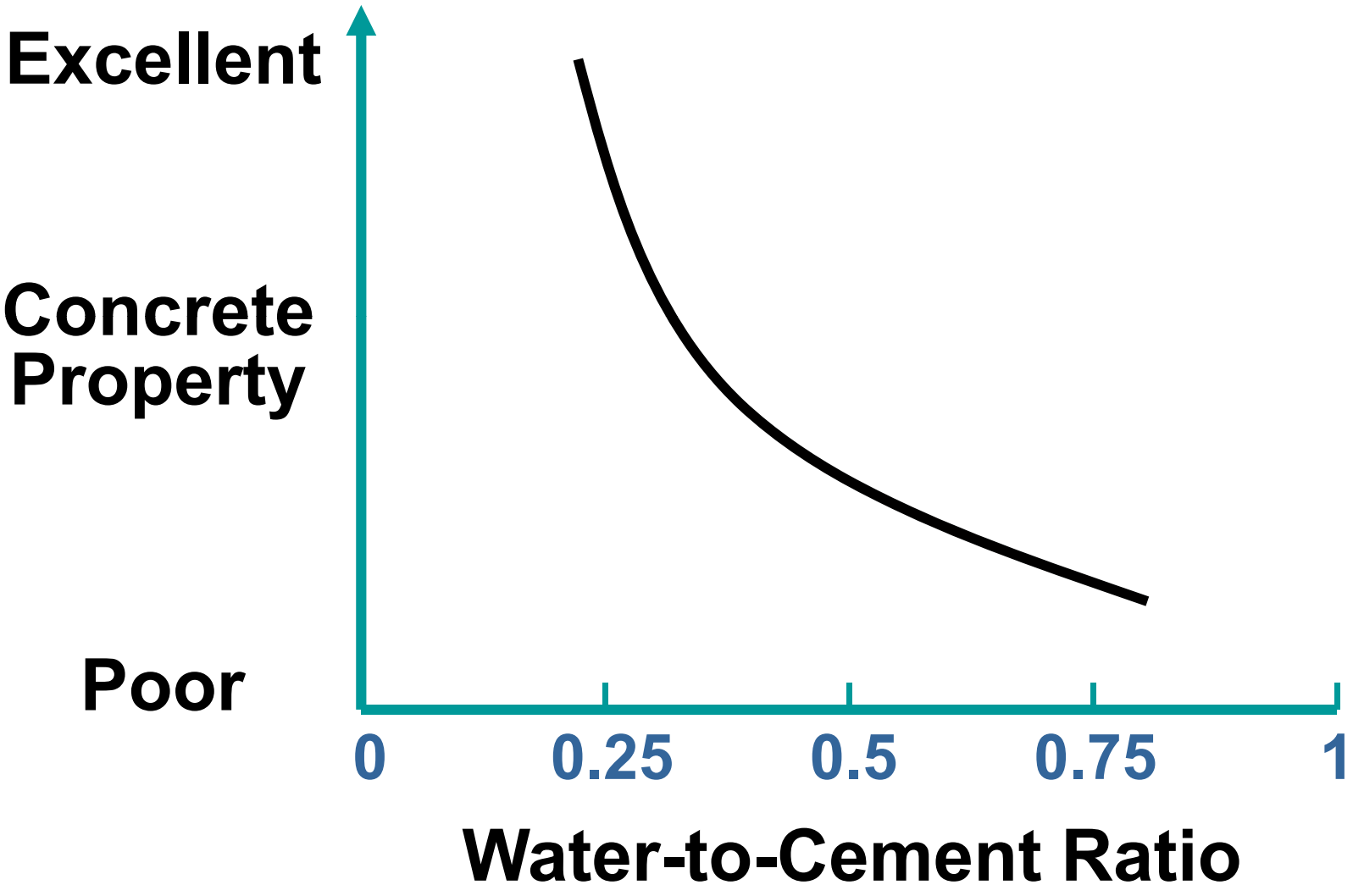


South Lanes Constructed With Air-Entrained Portland Cement

No Scaling After 7 Years


METRIC 1
2

Effect of W/C Ratio on Concrete Properties



.25 .30 .35 .40 .45 .50 .55 .60 .65 .70

Water Cement Ratio -

By weight Lb. Water / Lb. Portland Cement

Characteristics of an adequate air void system

- Spacing factor less than 0.008 in
- Specific surface ~600 in^2/ in^3 or more
- Voids per linear inch - 1-1/2 to 2 times the percentage of air.

Air Content for Durability

- Approximately 9% of air in the mortar fraction of the concrete should provide the recommended air content for durability, regardless of changes in cement, maximum aggregate size, consistency or type of aggregate

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

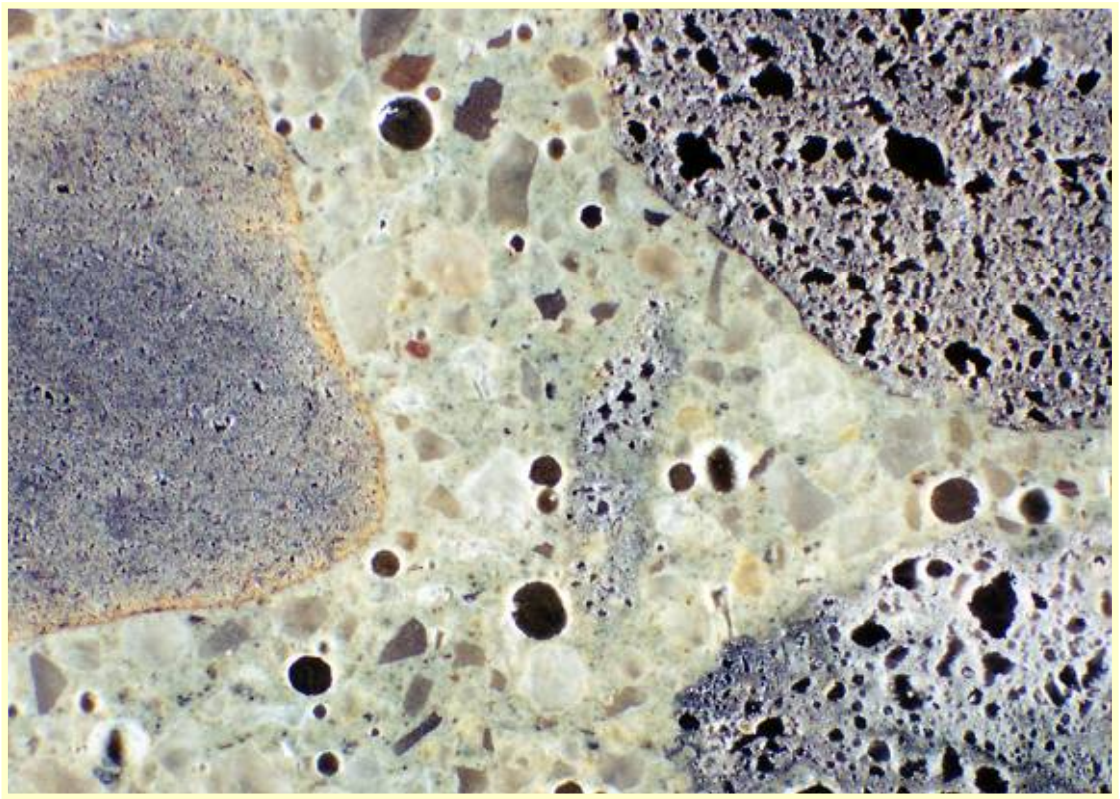
Project specifications usually allow within -1 to 2% of target value


Swan

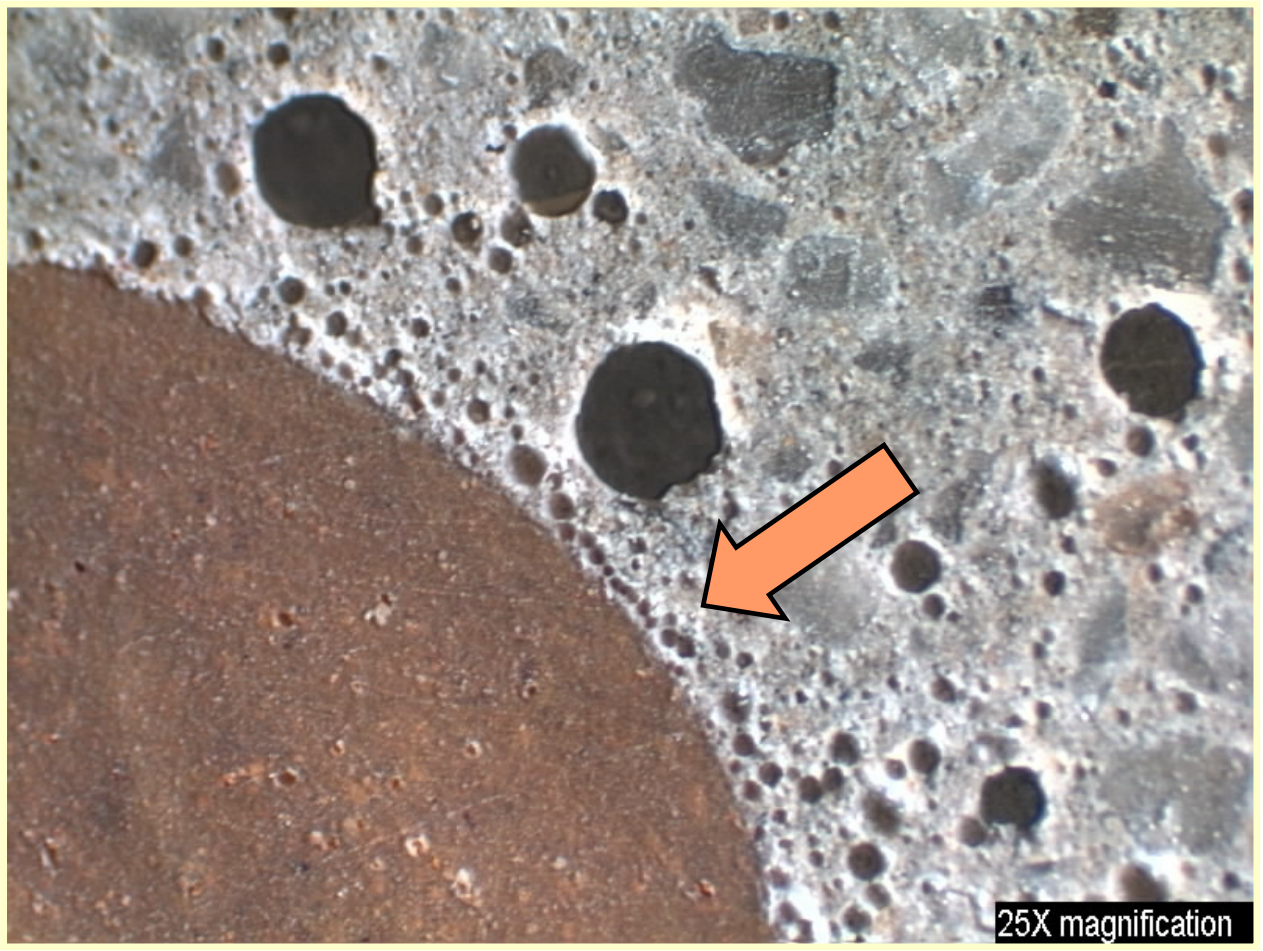
Air-Void System Analysis

- **Measure air content**
- **Determine parameters of air-void system**
- **Evaluate durability**
- **Predict future performance**

Low Air Content

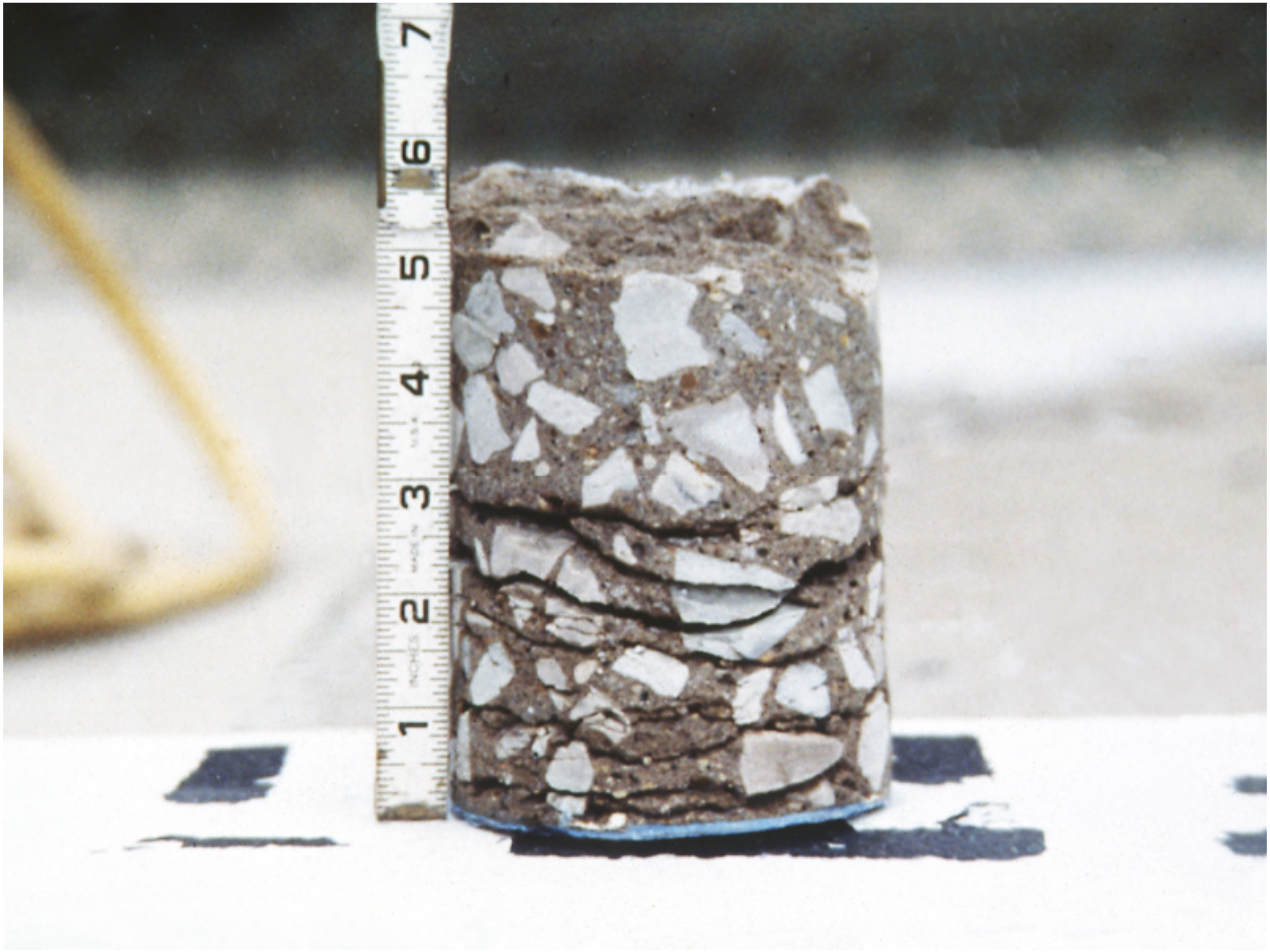


Air-Void Clusters at Interface



Freeze-Thaw Resistance

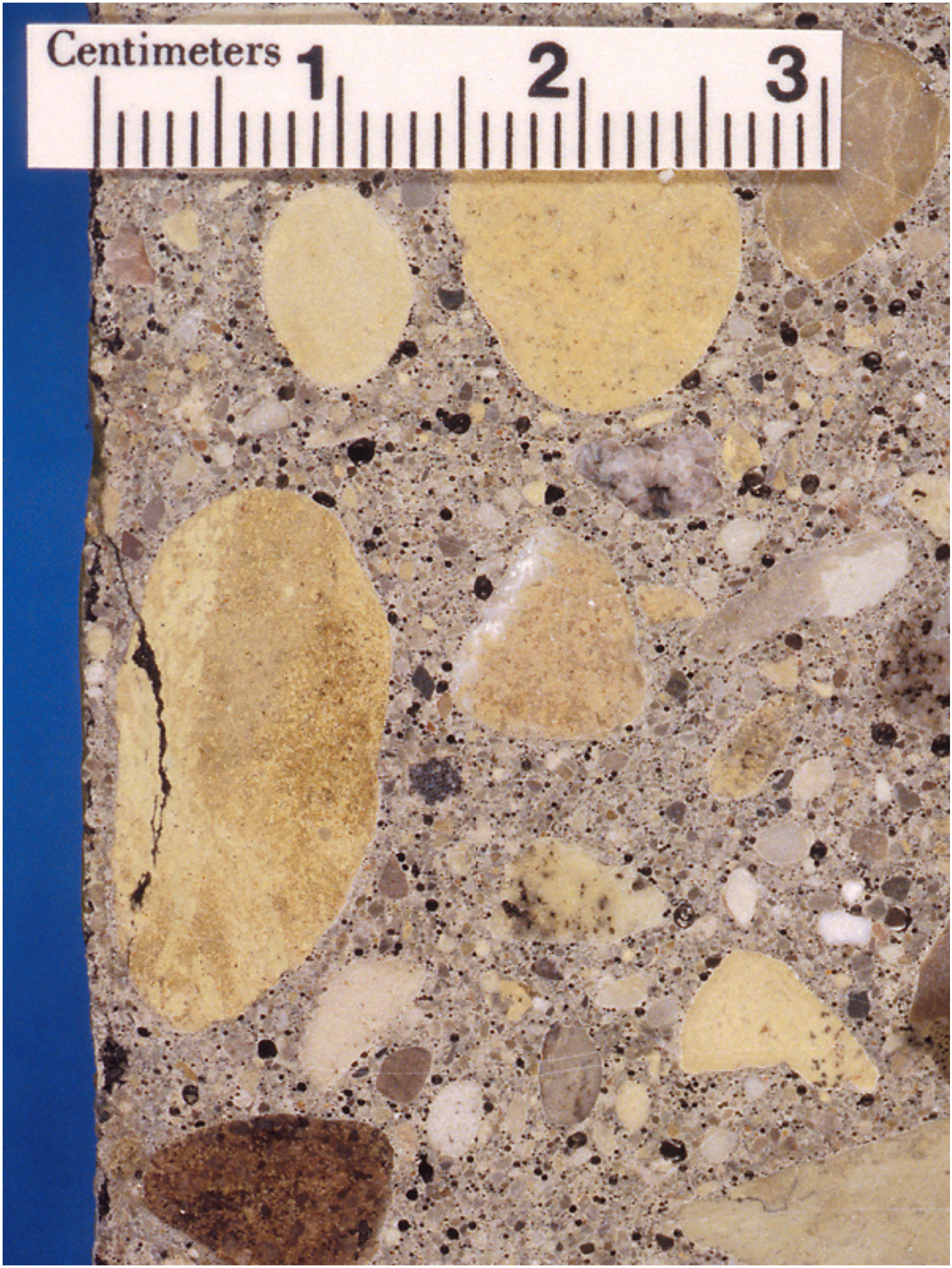
- Air-Void System (ASTM C 457)
- ASTM C 666
- ASTM C 672

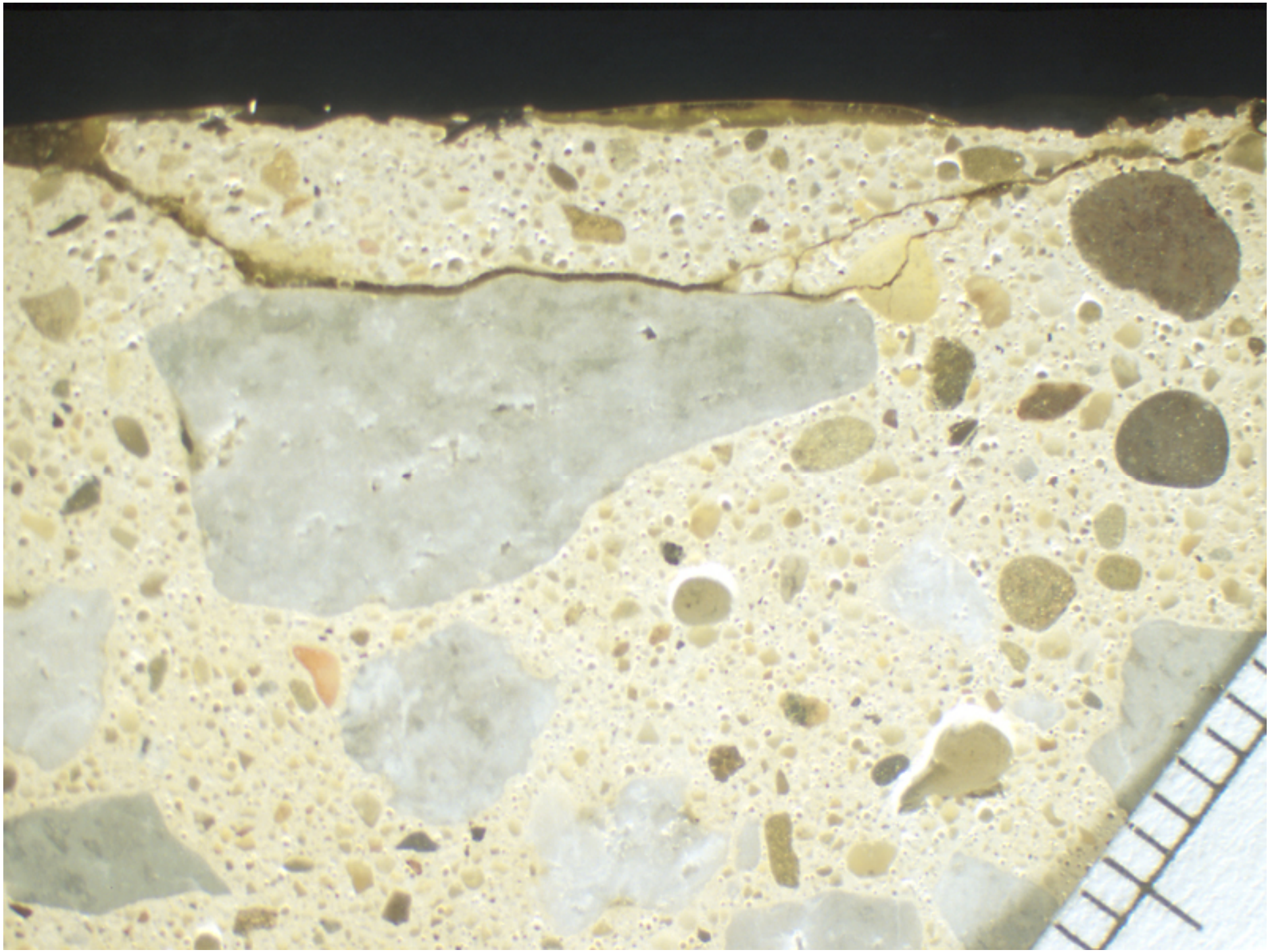

1
2
3
4
5
6
7


METRIC 1
2

Factors Affecting F/T of Aggregates (D-Cracking)

- Saturated conditions
- Coarse aggregate
  - Pore structures
  - Composition
  - Particle size
- Pavement Design
  - Sub-surface drainage


Centimeters
1
2
3



Avoidance of F/T Damage

- Use properly air-entrained concrete
- Strength of the concrete
- W/CM ratio
- Curing-followed by drying period
- Minimum exposure to moisture
  - Well draining sub base
  - Sloped for proper drainage
  - Sealer

Exterior Concrete Mix

- w/c= 0.45
- Cement Content 564 lb./cu. yd.
- Air entrainment ~ 6%
- Good drainage
- Proper finishing and low slump mix
- Curing followed by drying
- Avoid salt use for the first year

F/T Scaling

- Air void system
- W/C
- Aggregates
  - Cherts (popouts)
- Bleeding
  - Premature finishing
  - Weakened alyer
  - Overworked slabs
  - Baptizing
- Drainage
- Curing
- Late fall construction

Questions