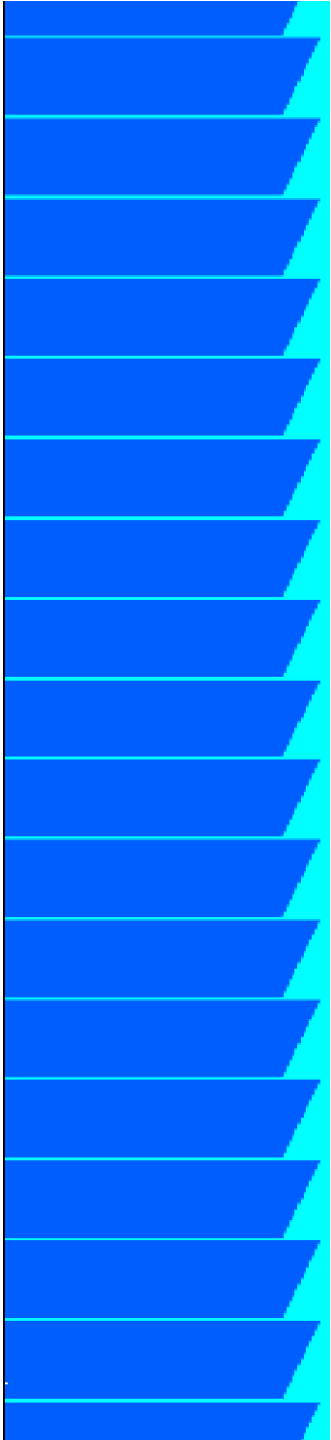


# Troubleshooting Hardened Concrete Problems





- When troubleshooting concrete problems it is important to relate the symptom to causes of distress and deterioration.



# Identify Concrete Surface Defects

ACI 201.1 R

- Dusting
- Blisters
- Delaminations
- Cracking
- Popouts
- Mortar Flaking & Scaling
- Spalling
- Bugholes
- Cold Joint
- Discoloration
- Efflorescence
- Honeycombing (Internal?)



# References

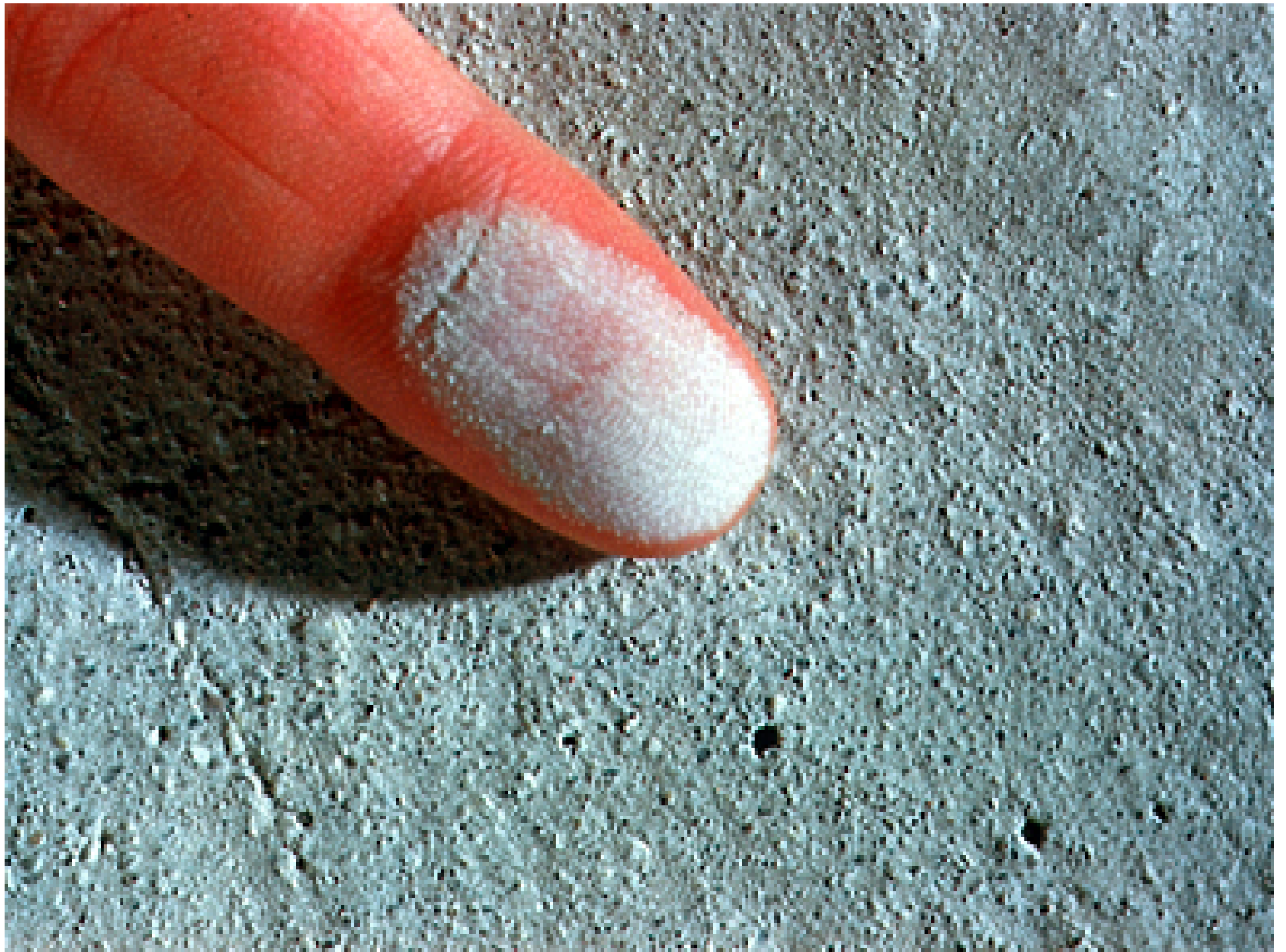
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- ACI 201- Condition Survey
- PCA- IS177- Concrete Surface Defects
- Corps of Engineers- Evaluation and Repair Guide



# Surface Defects- Dusting

- Development of a fine, powdery material at the surface of hardened concrete.







Use Ventilated Heaters





# Surface Defects- Blistering

- The irregular raising of a thin layer at the surface of placed mortar or concrete during or soon after completion of the finishing operation.

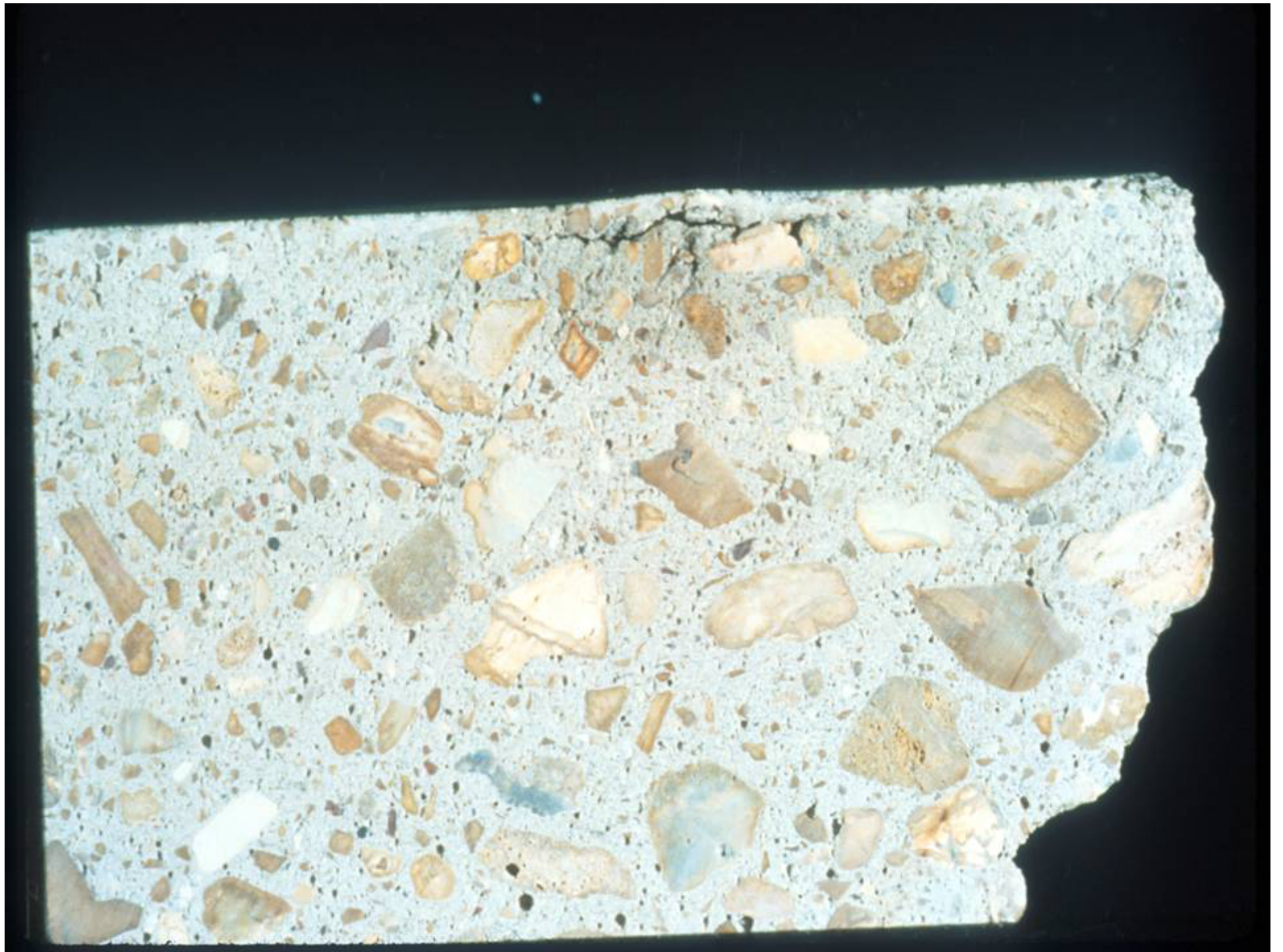




# Blisters

Causes:

- Too many fines
- Too much or too little vibration
- Early finishing





# Blisters

## Prevention:

- Avoid high slumps and excess fines
- Use appropriate cement content
- Warm subgrade in cold weather
- Do not place slab directly on vapor retarder



# Blisters

Prevention:

- Do not overwork the concrete
- Do not seal (finish) the surface too soon
- Use proper finishing techniques and timing
- Reduce evaporation
- Avoid air contents of more than 3% for interior slabs





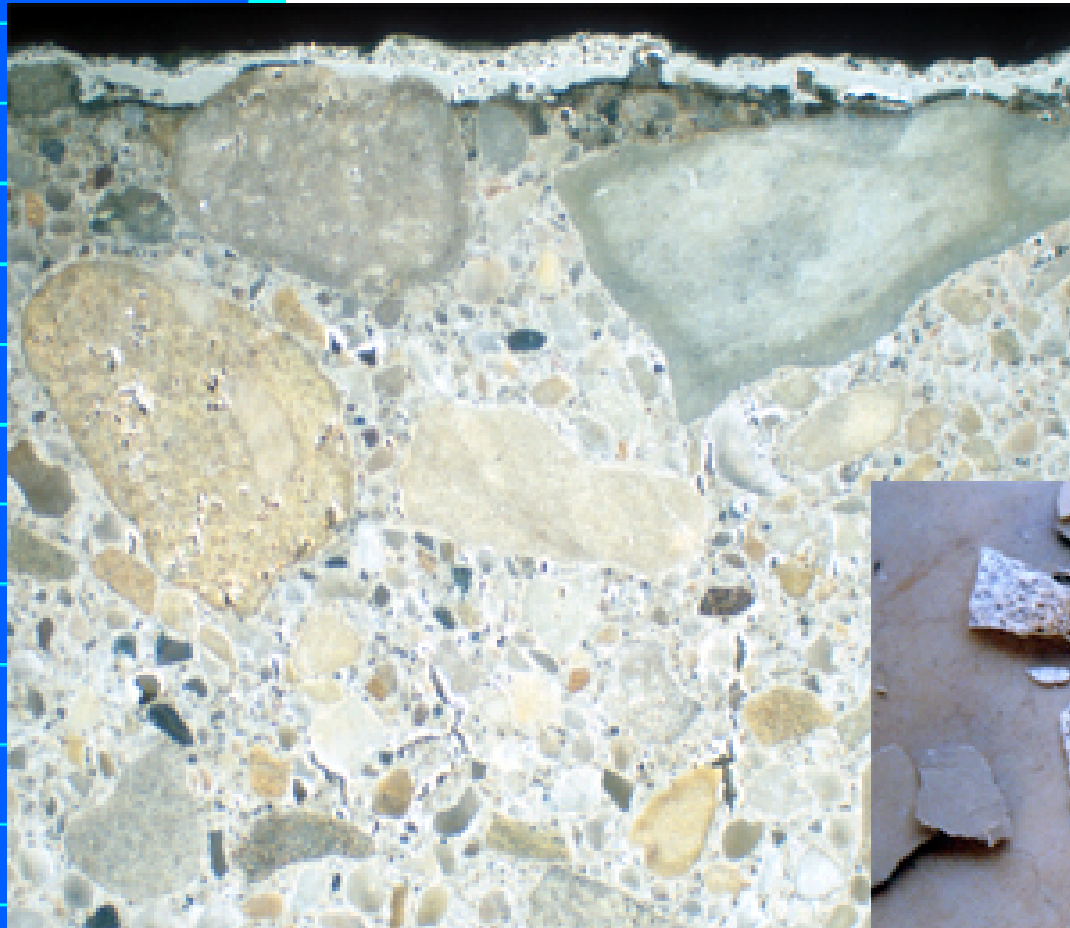
# Surface Defects- Delamination

- A separation along a plane parallel to a surface. In the case of a concrete slab, a horizontal splitting, cracking, or separation of a slab in a plane roughly parallel to, and generally near, the upper surface.





# Sealing The Surface



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









# Surface Defects- Crazing

- Fine, random cracks or fissures in the surface of plaster, cement paste, mortar, or concrete.





# Crazing

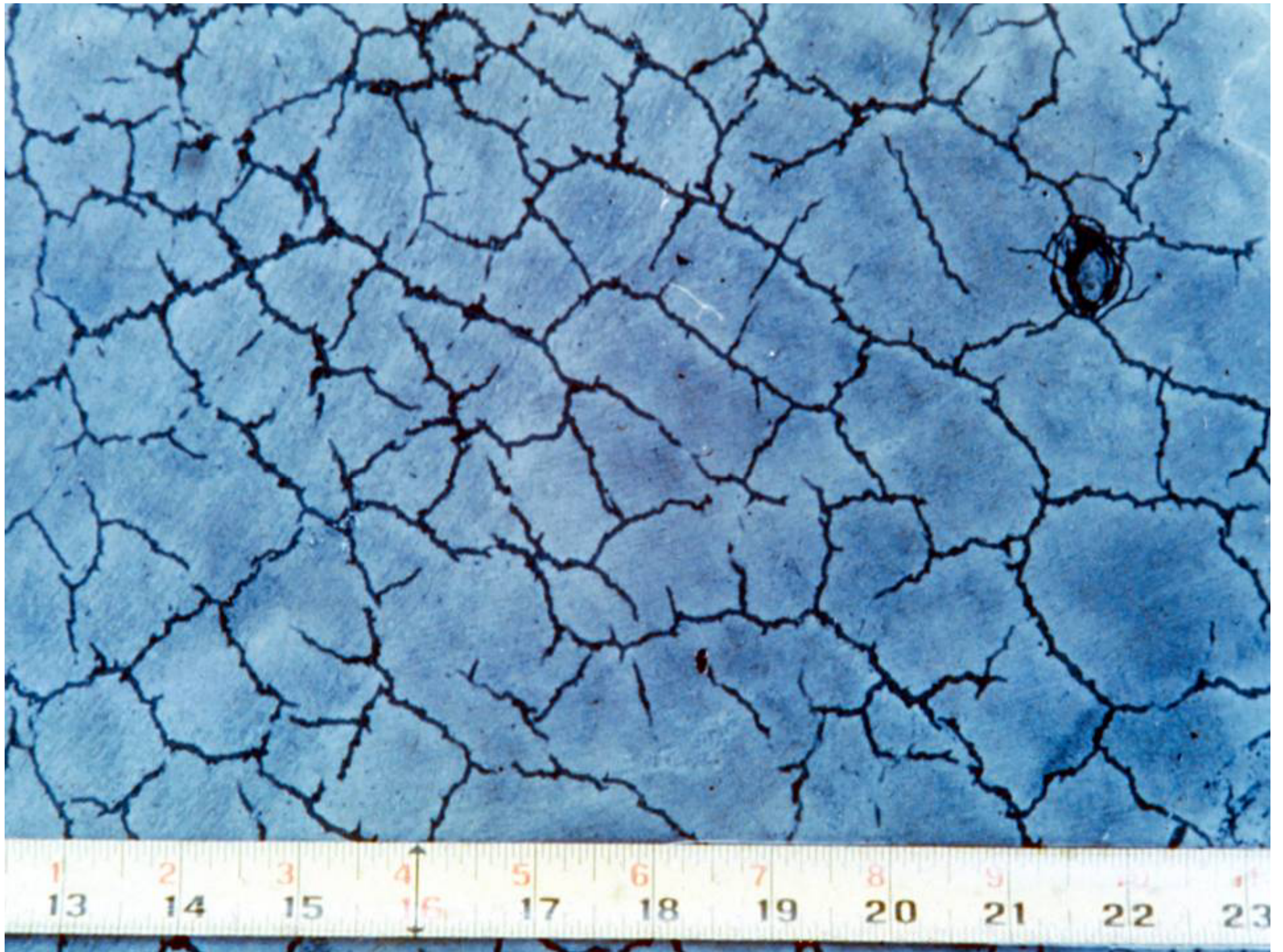
Causes:

- Rapid surface drying after setting
- Applying dry cement to surface during finishing











# Surface Defects- Popouts

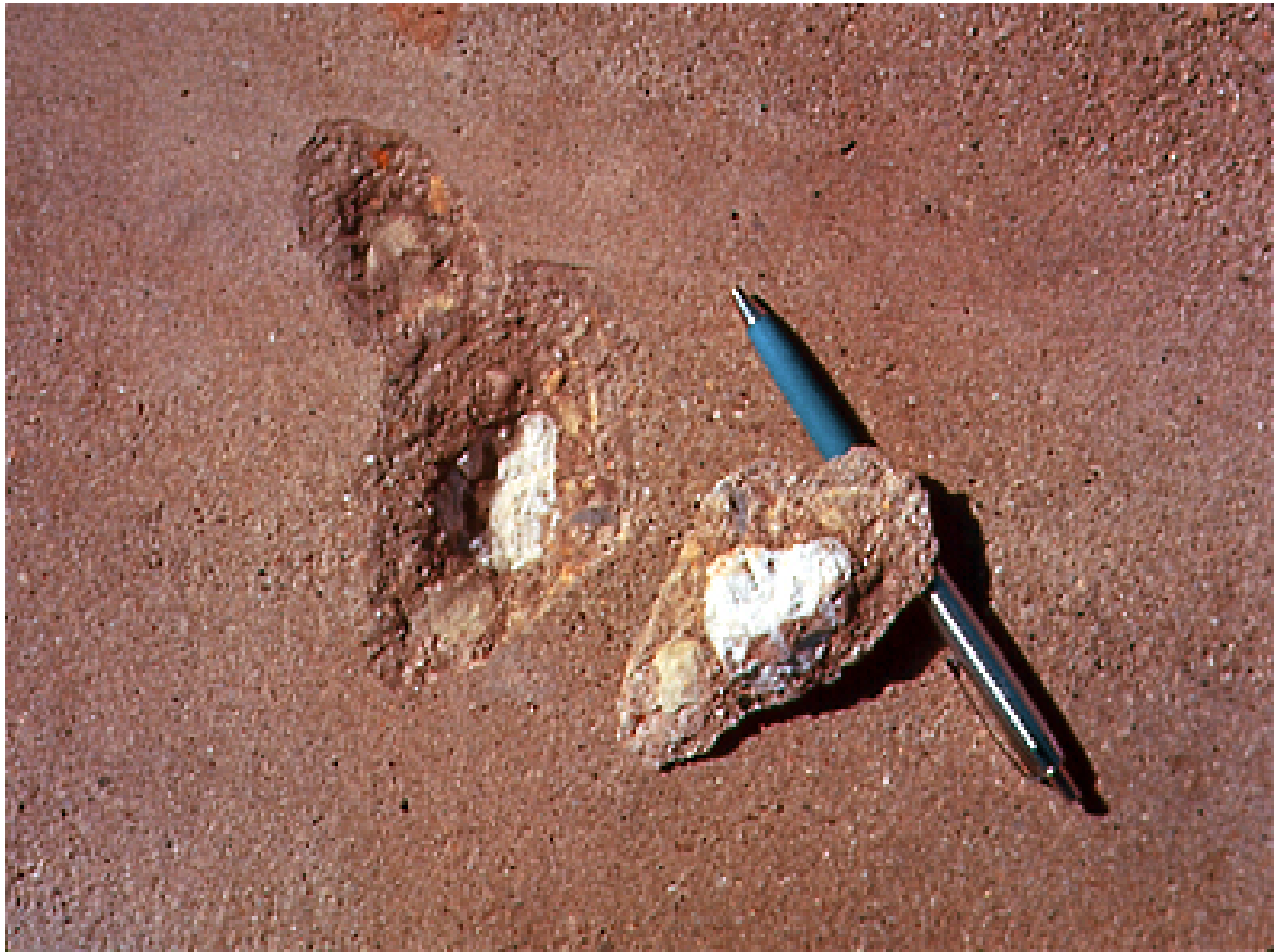
- Conical fragment that breaks from the concrete surface. A fractured aggregate particle is often at the bottom of the hole.

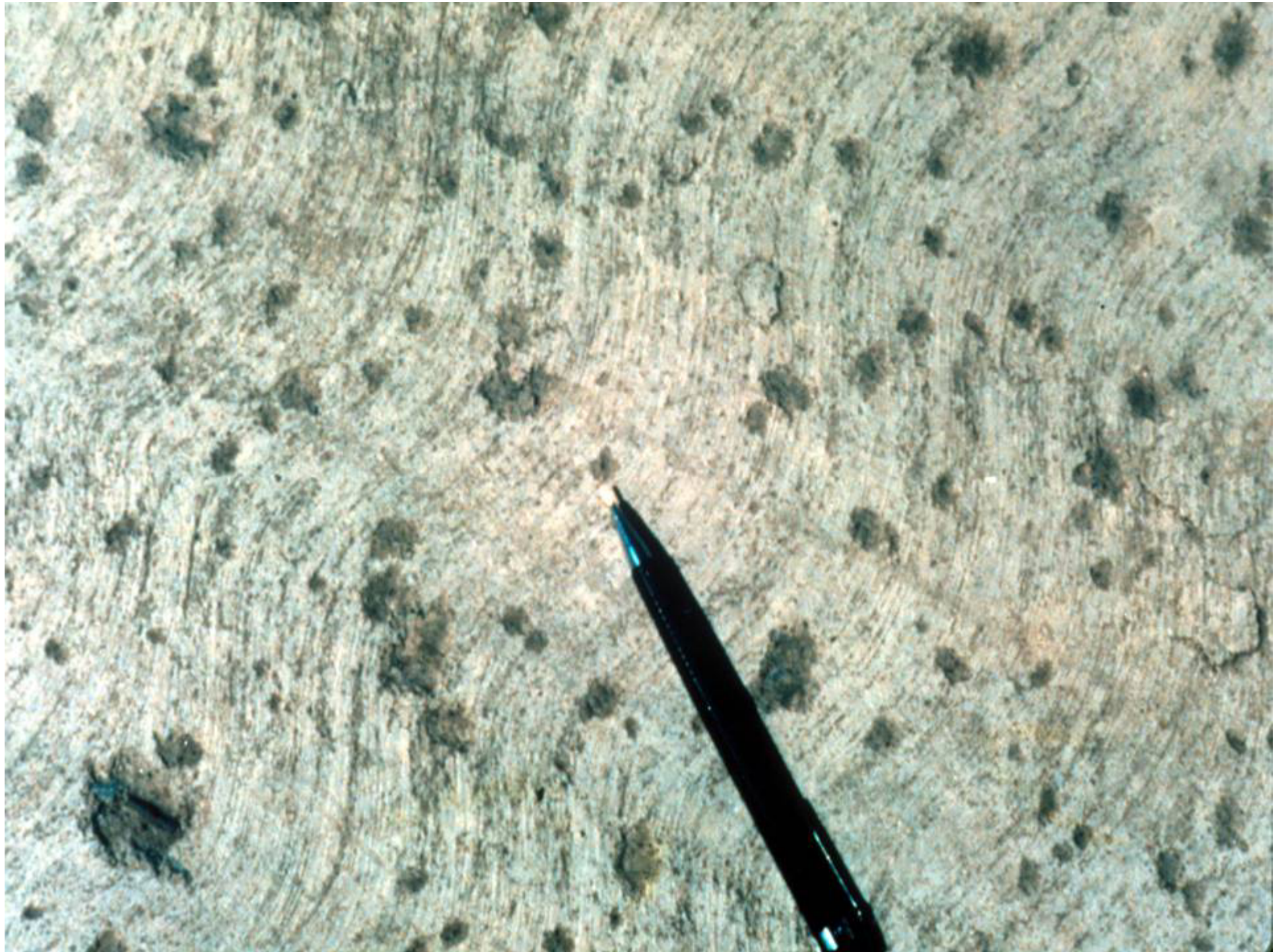


# Popouts

## Causes:

- Porous rock with high absorption, low specific gravity:
  - ◆ Pyrite
  - ◆ Hard-burned dolomite
  - ◆ Coal
  - ◆ Shale
  - ◆ Soft, fine-grained limestone
  - ◆ Chert
- Alkali-aggregate reactivity







# Popouts

## Prevention:

- Use low slump, low water content mix
- Use durable crushed stone or beneficiated aggregate
- Slope the slab surface to drain water properly
- Use supplementary cementing materials to control ASR-induced popouts

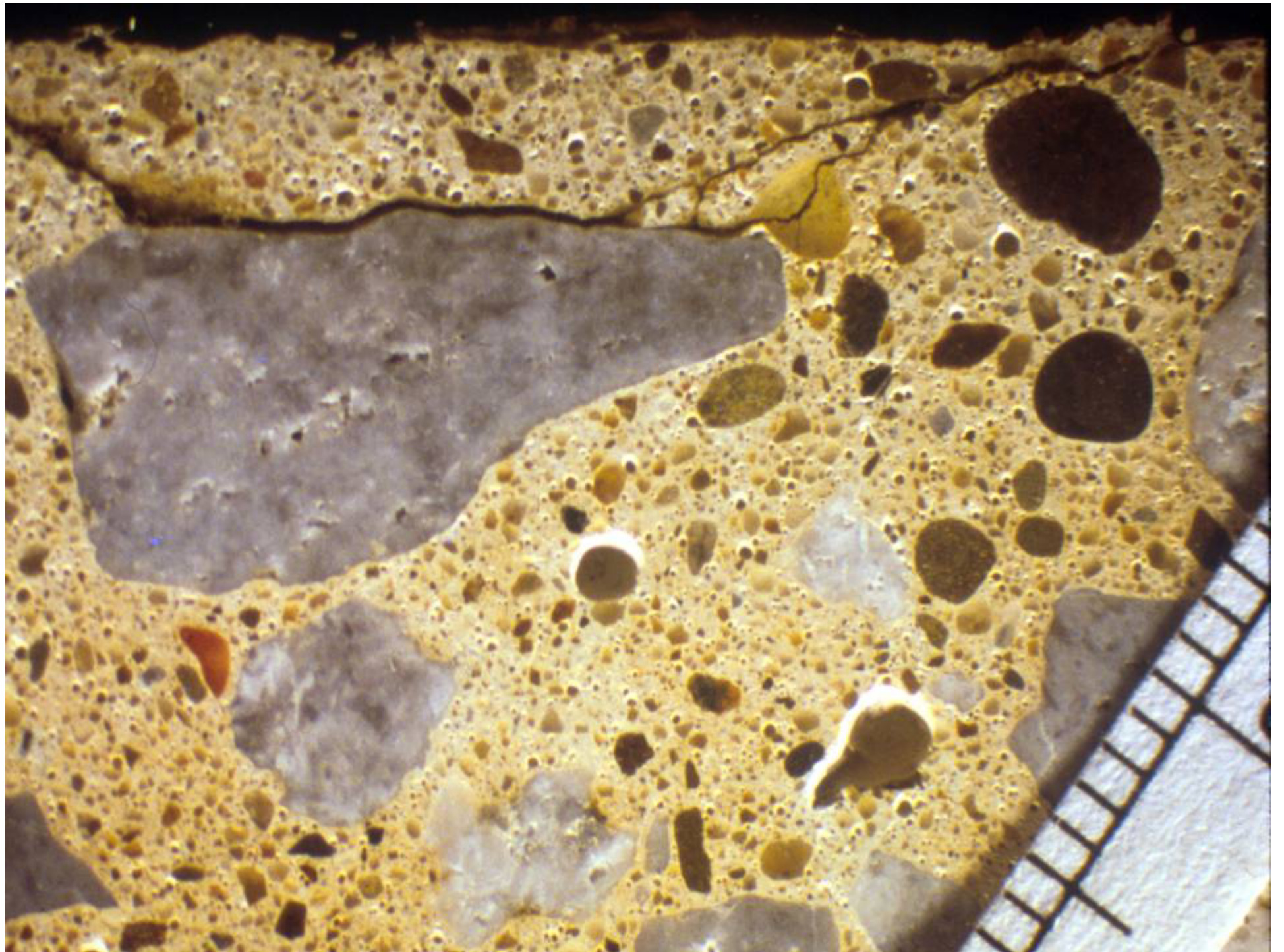


# Surface Defects- Mortar Flaking

- A form of scaling over coarse aggregate (“popoffs”)









# Surface Defects- Scaling

- Local flaking or peeling away of the near-surface portion of concrete or mortar.







# Surface Defects- Spalling

- A fragment, usually in the shape of a flake, detached from a larger mass by a blow, by the action of weather, by pressure, or by expansion within the larger mass.











# Surface Defects- Bugholes

- Small regular or irregular cavities, usually not exceeding 15 mm in diameter, resulting from entrapment of air bubbles in the surface of formed concrete during placement and compaction.



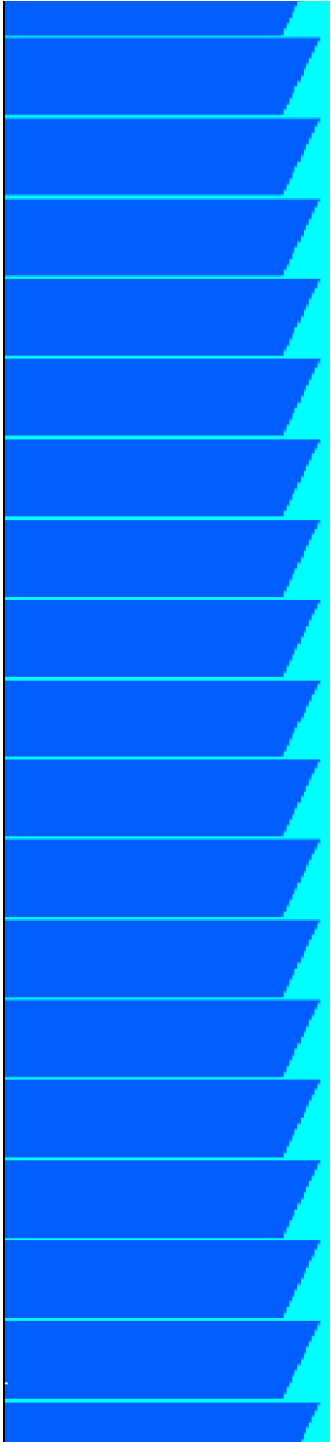




# Surface Defects- Cold Joint

- Visible lines on the surfaces of formed concrete indicating the presence of joints where one layer of concrete had hardened before subsequent concrete was placed.











# Surface Defects- Discoloration

- A departure of color from that which is normal or desired.





# Surface Defects- Staining

- Spotted or mottled light or dark blotches.







# Surface Defects- Efflorescence

- Deposit, usually white, formed on a surface, the substance having emerged in solution from within concrete or masonry and subsequently having been precipitated by evaporation.







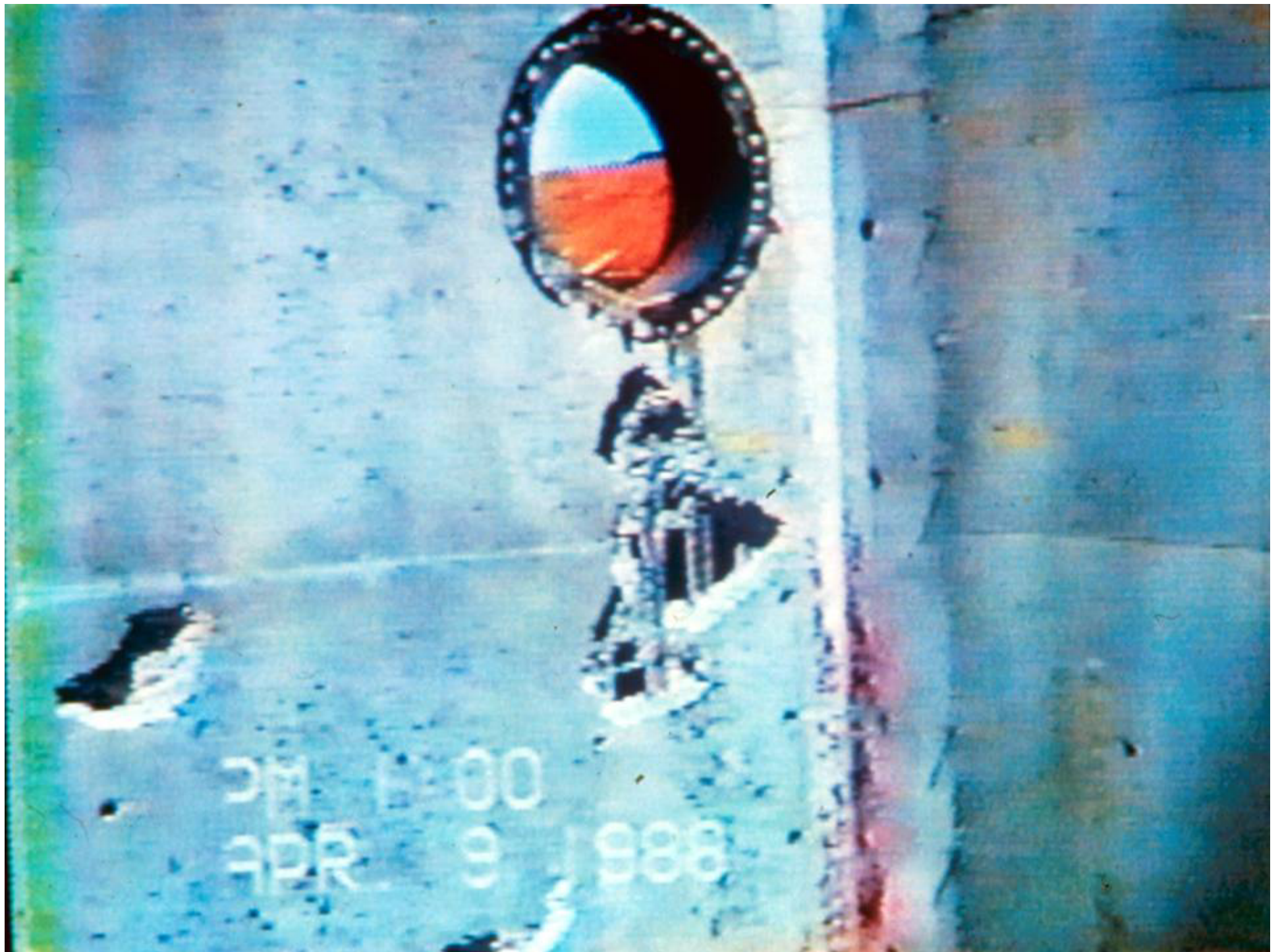


# Surface (Internal?) Defects- Honeycombing

- Voids left in concrete due to failure of the mortar to effectively fill the spaces among coarse aggregate particles.





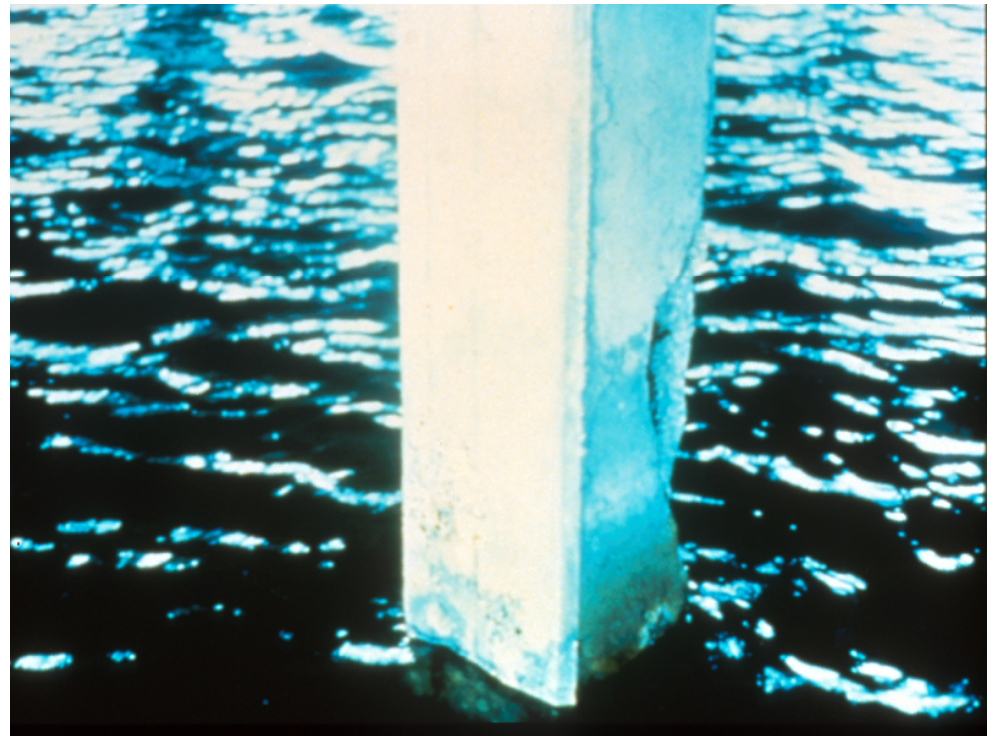






# Durability

## Chemical Attack



# Durability

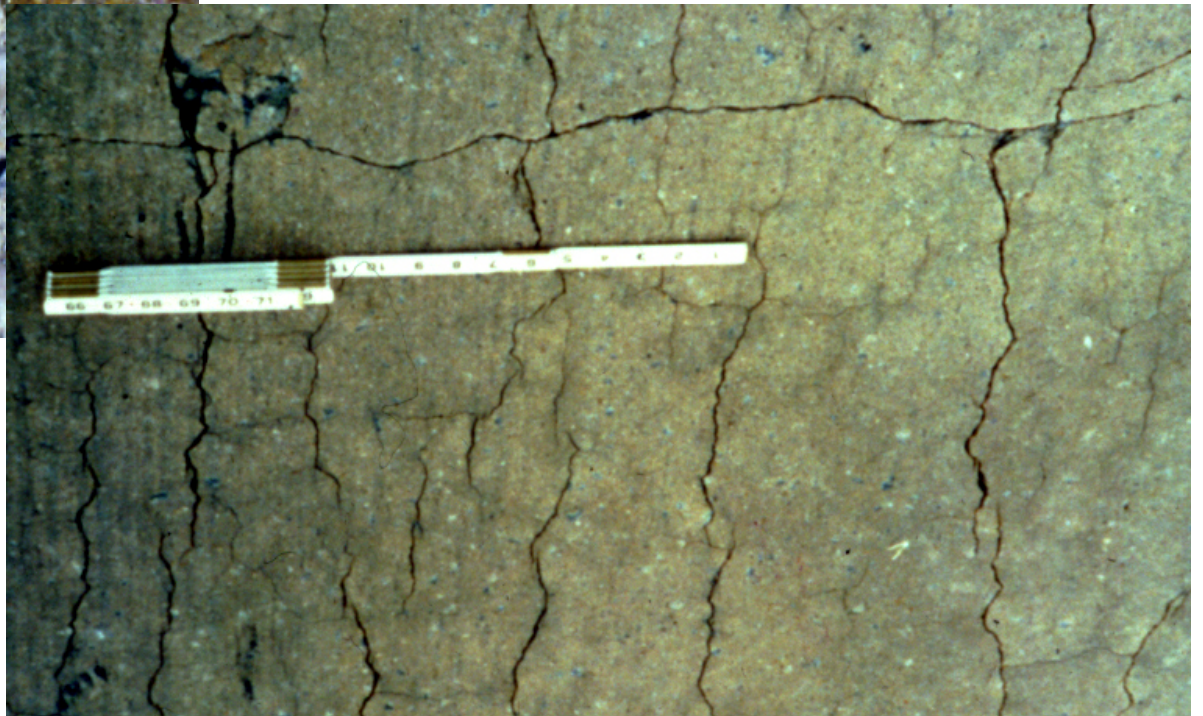
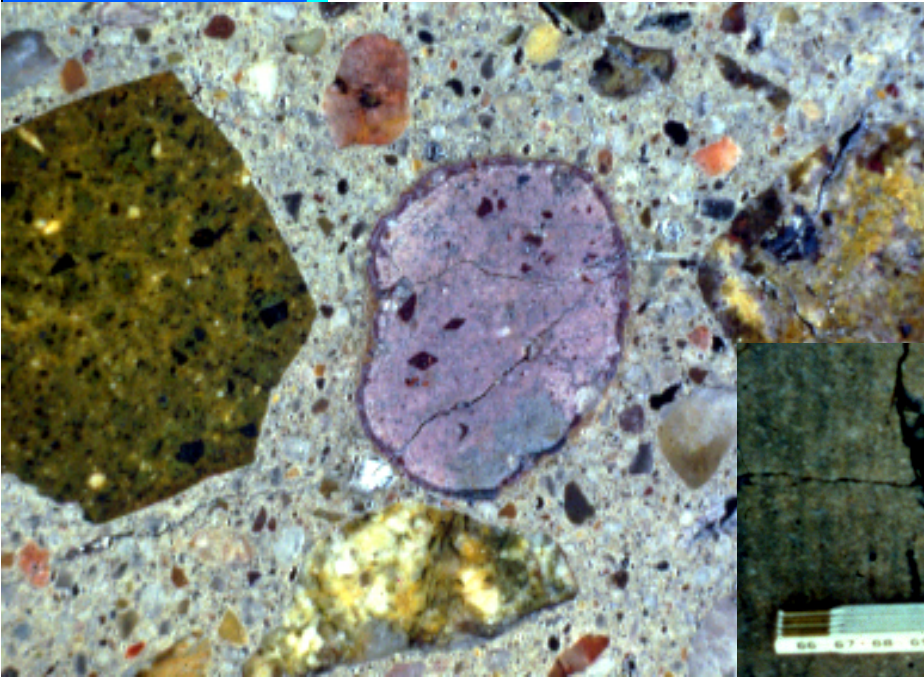
## Freeze-Thaw Failure





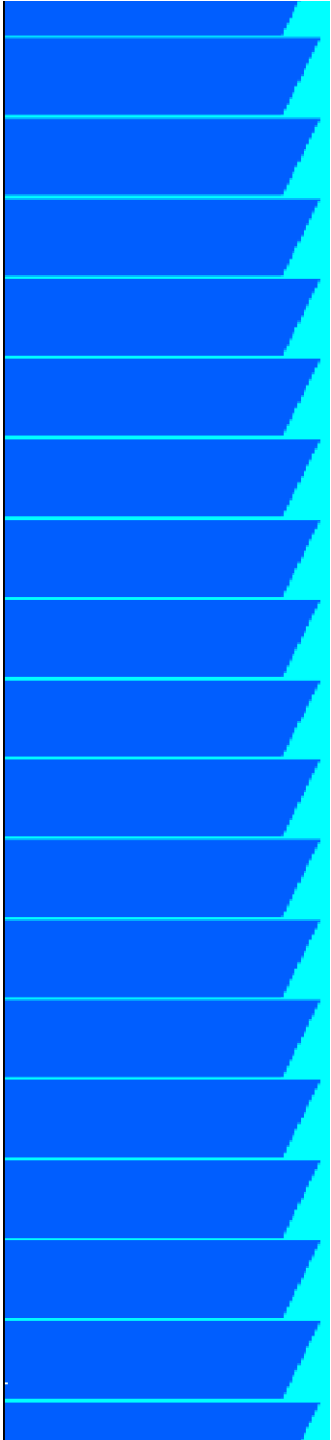
# Durability

## Alkali-Aggregate Reactivity

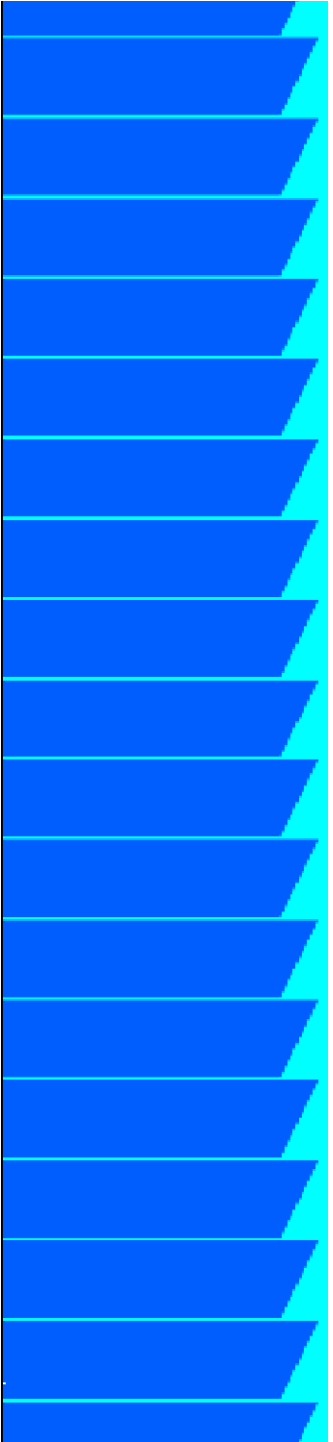


# Durability Corrosion





- When troubleshooting concrete problems it is important to relate the symptom to causes of distress and deterioration.



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