

# Concrete Surface Defects

Causes & Prevention



# Concrete Slab Surface Defects: Causes, Prevention, Repair



# Types of Surface Defects

- ▶ Blisters
- ▶ Cracking
- ▶ Crazing
- ▶ Delamination
- ▶ Discoloration
- ▶ Dusting
- ▶ Popouts
- ▶ Scaling and Mortar Flaking

# Blisters

- ▶ Bumps formed by rising water or air trapped under a finished surface.
- ▶ Width: 5 mm to 100 mm
- ▶ Depth: 3 mm

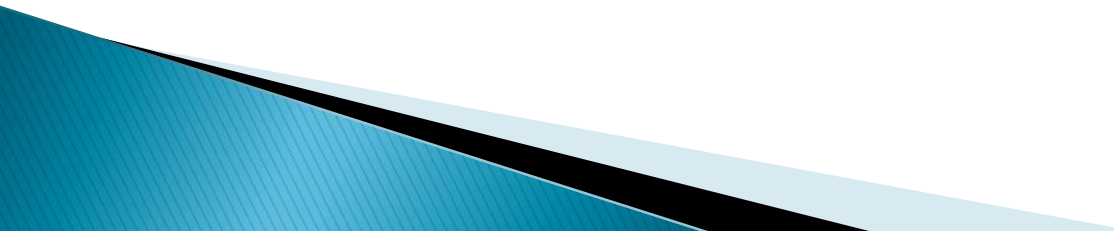


# Blisters

- ▶ 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
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# Blister

- ▶ 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 more than 3% for interior slabs







# Cracking

- ▶ Common Types:
  - Plastic shrinkage
  - Drying shrinkage
  - Settlement
  - Thermal

# Plastic Shrinkage Cracking

- ▶ Caused by rapid evaporation of water from the surface before the concrete sets
  - Wind
  - Low humidity
  - Temperature stress
  - Low W/C ratio
- ▶ Cracks – Varying length and spacing. Deepest penetration is to mid-point of slab.



# Plastic Shrinkage



# Drying Shrinkage Cracking

- ▶ Concrete shrinks about 1.6 mm for every 3 m length (1/16 in. in 10 ft)
- ▶ Drying shrinkage dependent on water content of concrete
- ▶ Control joints predetermine location of drying shrinkage cracks



# Drying Shrinkage Cracking Prevention

- Use largest coarse aggregate possible
- Do not use excessive amounts of sand
- Avoid high-shrinkage aggregates
- Use water-reducing admixtures
- Avoid calcium chloride
- Provide proper jointing
  - $t/4$  or  $t/3$  – transverse joints
  - $t/3$  – longitudinal joints
  - $t/2$  – architectural re-entrant corner

# Settlement Cracks

- ▶ Develop over embedded items, e.g. reinforcement
- ▶ Causes:
  - Shallow cover over embedments
  - Insufficient consolidation
  - Uncontained high slump mix

# Crazing

- ▶ “Chicken wire” pattern of fine cracks
- ▶ Does not penetrate much below surface. Usually does not affect concrete service life.
- ▶ Visible when concrete is drying after surface has been wet

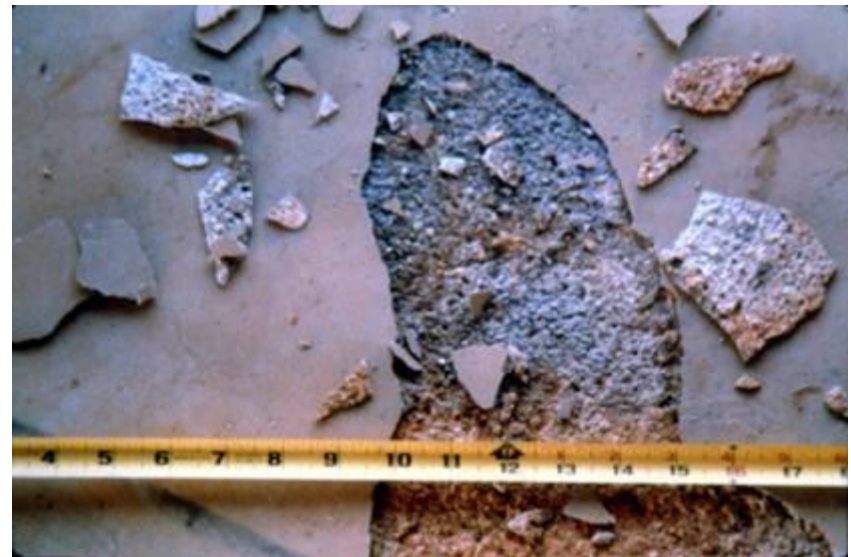


# Crazing

- ▶ Causes:
  - Rapid surface drying after setting
  - Applying dry cement to surface during finishing
  - Poor water management after placement

# Delaminations

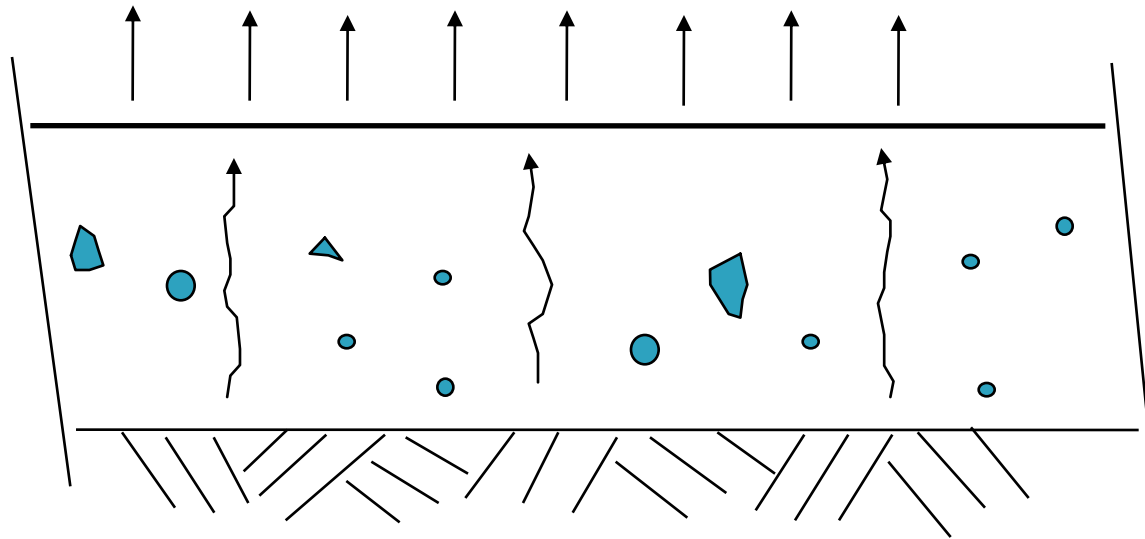
- ▶ Essentially big blisters:
- ▶ Surface mortar is separated from underlying concrete by rising water and air that are trapped beneath a finished surface.



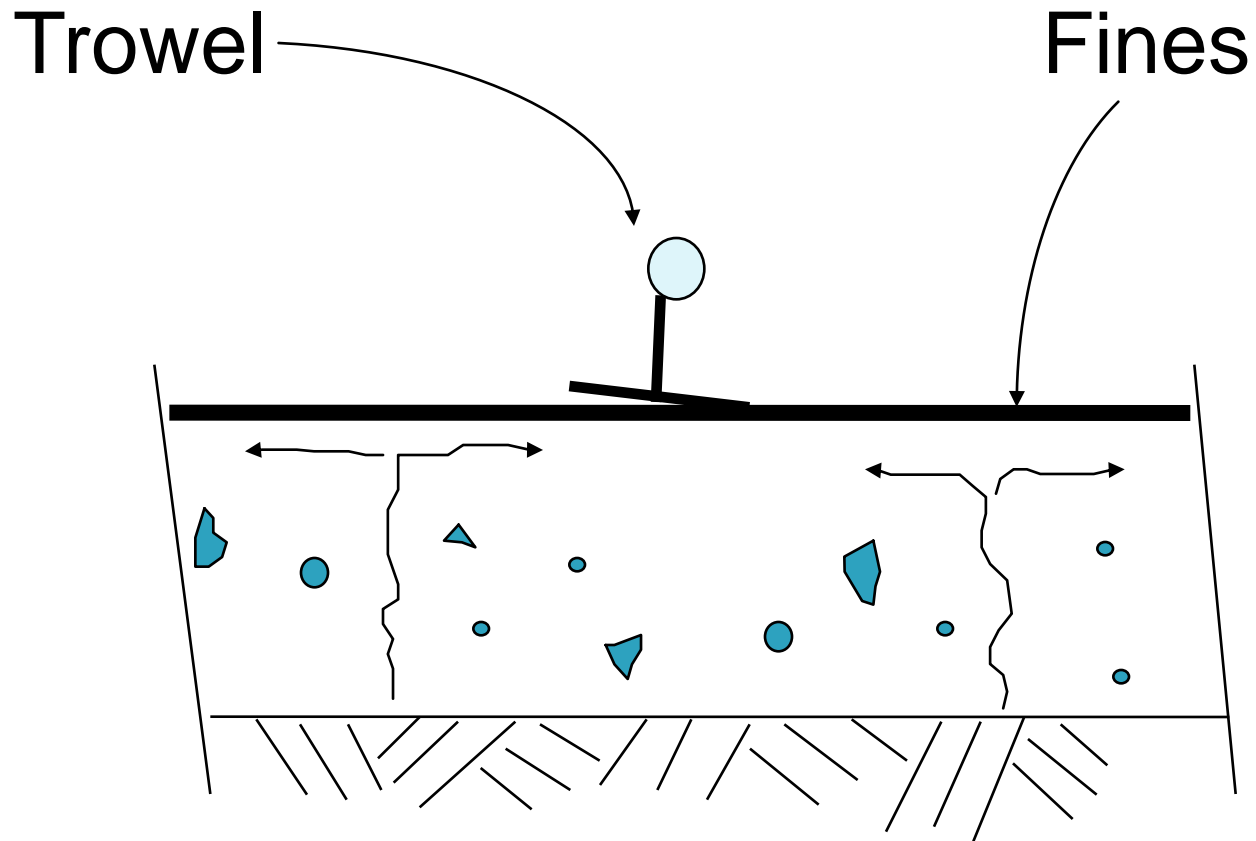
# Fresno Trowel

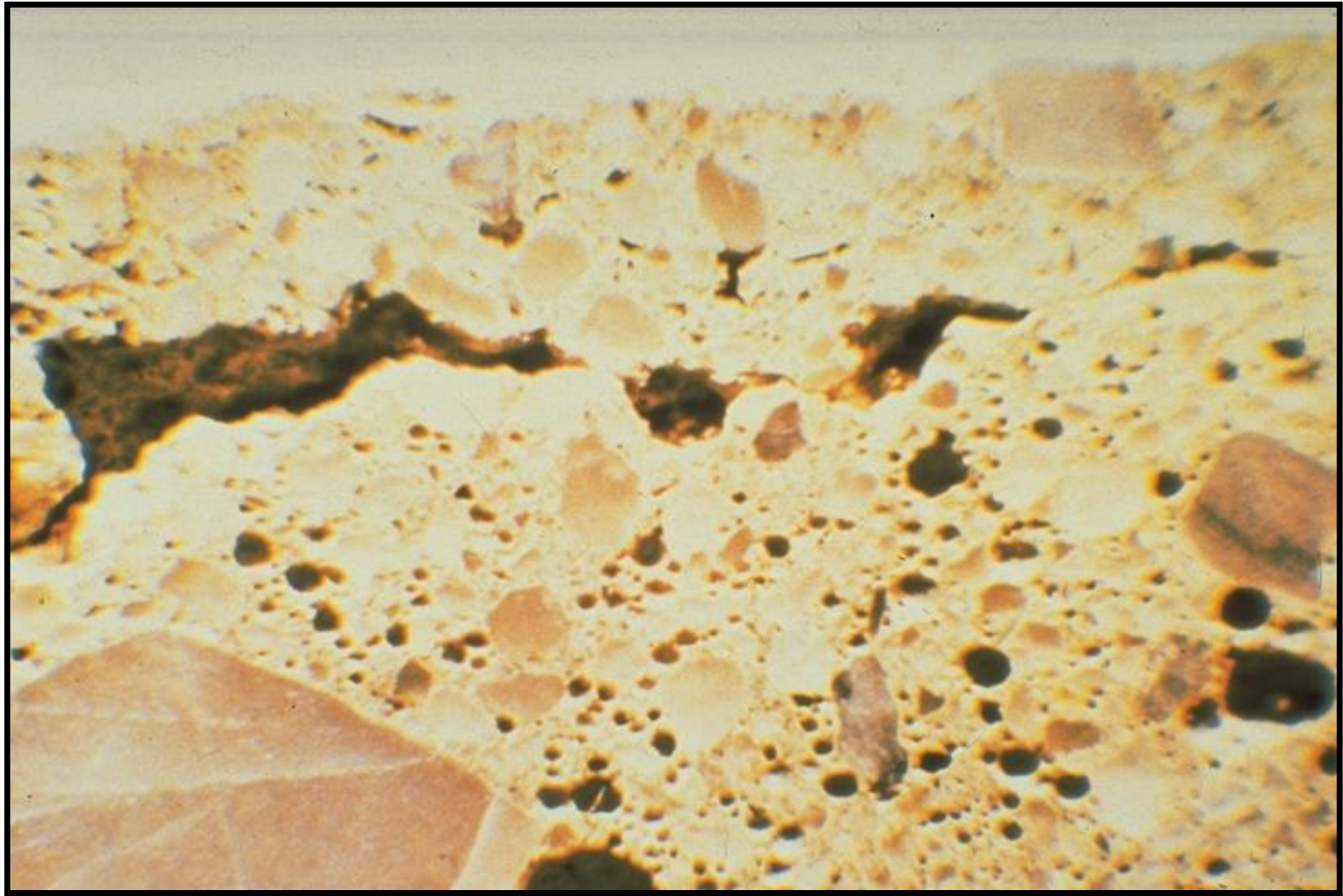


# Evaporation



# Sealing the surface





# Dusting

- ▶ Development of a fine, powdery material that easily rubs off the surface.



# Dusting

- ▶ Causes:

- Troweling bleed water into surface
- Rainfall
- Spreading dry cement on surface
- Freezing of the surface
- Dirty aggregate
- Low cement content
- Too wet a mix
- Carbonation caused by unvented heaters

# Dusting

- ▶ Remedies:
  - Grinding
  - Floor hardeners

# Popouts


- ▶ Conical fragment that breaks from the concrete surface. A fractured aggregate particle is often at the bottom of the hole.
- ▶ Most appear in first year.
- ▶ Typical size: 5 mm to 50 mm  
(1 / 4 in. to 2 in.)



# 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

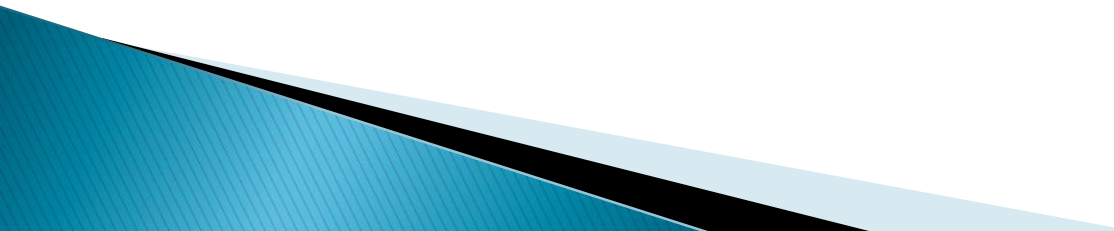
- Use low slump, low water content mix
  - Use durable crushed stone or beneficiated aggregate
  - Slope the slab surface to drain water properly
  - Use supplementary cementitious materials to control ASR induced popouts
  - Good curing regimen
  - Salt management
  - Sealer Application
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# Scaling

- ▶ Loss of surface mortar caused by hydraulic pressure from water freezing within concrete



# Scaling – Prevention

- Use low water content mix
  - Slope the slab surface to drain water properly
  - Good curing regimen
  - Salt management
  - Sealer Application
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Develop good strength before wet freezing conditions – try to avoid placement in cold weather; otherwise keep blankets on for extended period

# Mortar Flaking

- ▶ A form of scaling over coarse aggregate (“popoffs vs. popouts”)
- ▶ Excessive and early moisture loss from the surface is accentuated over aggregate. Thin mortar layer breaks off upon freezing in a saturated condition



# Scaling and Mortar Flaking

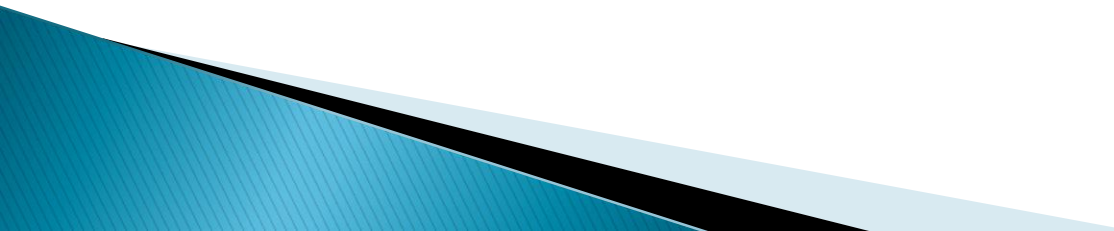
- ▶ Prevention:

- High-quality, **air-entrained** concrete
- Proper finishing and curing
- Proper drainage
- Sufficient air drying before winter

- ▶ Remedy:

- ▶ Sealer can help reduce further deterioration

# Finishing Operations for Exterior

- ▶ Place
  - ▶ Consolidate
  - ▶ Float
  - ▶ Texture
  - ▶ Cure
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»» Questions???

Comments???