City Engineers Association of Minnesota
January 26, 2011

“Appearance,” The Success or Failure Measurement of a Project

Presented by:
Matthew J. Zeller, PE
Executive Director
Concrete Paving Association of MN
651-762-0402

Thomas P. Venema, PE, LEED AP
Vice President / Principal Engineer
American Engineering Testing, Inc.
651-659-1369
Surface Defects and Concrete Appearance

1. Popouts
2. Surface Scaling
3. Finishing Appearance
4. Discolorations
Popouts

- A popout is a hole in the concrete surface left after an aggregate particle has expanded, worked itself loose, and taken a part of the surface mortar with it.
  1. Physical Expansion
  2. Chemical Popout ASR (Alkali-Silica Reaction)
     - Affects both coarse and fine aggregate
Physical Expansion

- Lightweight porous rock freezes, expands, and fractures
- Typically shale, iron oxide, dolostone and porous chert in Minnesota.
- D-cracking
Early Stages of a Popout Surface Mortar Fracture
Popout – Shale Aggregate
D-Cracking
Chemical Popout

1. Alkali Silica Reaction (ASR)
   This is a chemical reaction that causes expansion of the particles and reaction rims.
ASR Sand Popouts
Frequency of Popouts and Why

1. Aggregate – coarse and fine sources
2. Allowable percentages
3. Some popouts are considered acceptable

ACI – American Concrete Institute
ASTM – American Society for Testing and Materials
Mn/DOT – Minnesota Department of Transportation

• They do not harm the slab structurally
Potential Popouts per Square Yard

- ASTM C-33 – Class 4S, 5S
  - 20-30 popouts
- Mn/DOT 3137 General Use
  - 15-20 popouts
- Mn/DOT 3137 Bridge Super Structure
  - 5-10 popouts
- Mn/DOT specifically gives limits for shale, ASTM C-33 does not.
Surface Scaling

• The top mortar surface of the concrete scales off
  1. Patches can be a few feet in diameter
  2. Pock mark appearance
  3. Nearly the entire surface
Driveway Scaling
Surface Scaling
Low / Inadequate Air Entrainment
Surface Scaling - Causes

1. Weakened mortar paste at the surface
   A. Over finishing / poor finishing practices
   B. High water to cement ratio mix
   C. Low air entrainment in the surface and base concrete
   D. Lack of proper and timely curing
Surface Scaling - Causes (cont’d)

2. Late fall placement – inadequate strength gain – not fully cured before being subjected to freezing and thawing.
3. De-icing salts at an early age.
Repairs – or Replace

• Popouts
  1. Drill out remaining aggregate in the hole
  2. Fill with a cementitious or epoxy patch
  3. Noticeable on color

• Scaling – if the base concrete is adequate
  1. Sandblast or pressure wash surface to good concrete
  2. Cover with a patch material
  3. Can have problems with adherence bonding

• How to avoid / minimize problems