MICHIGAN CONCRETE ASSOCIATION

Type IL (Portland-Limestone Cement)

Requires Proper Placement, Finishing, and Curing

Steve Waalkes, PE

Tuesday, July 8, 2025

Overview

- Why the switch to Type IL?
- What is different about concrete mixtures containing Type IL?
- Effects on concrete
- How to achieve durable concrete surfaces with Type IL (or other) mixtures

Why the Switch to Type IL?

- In a cement kiln, CO_2 is chemically driven off the carbonate ($CaCO_3$) minerals
- Molten material is rapidly cooled as it comes out of the kiln (clinker)
- Type I (ASTM C150)
  - Up to 5% interground limestone
- Type IL (ASTM C595)
  - Up to 15% interground limestone
- Per ton of finished cement powder, Type IL saves up to 10% in CO_2 emissions

Kiln

Mill

The switch has been going on for a while…

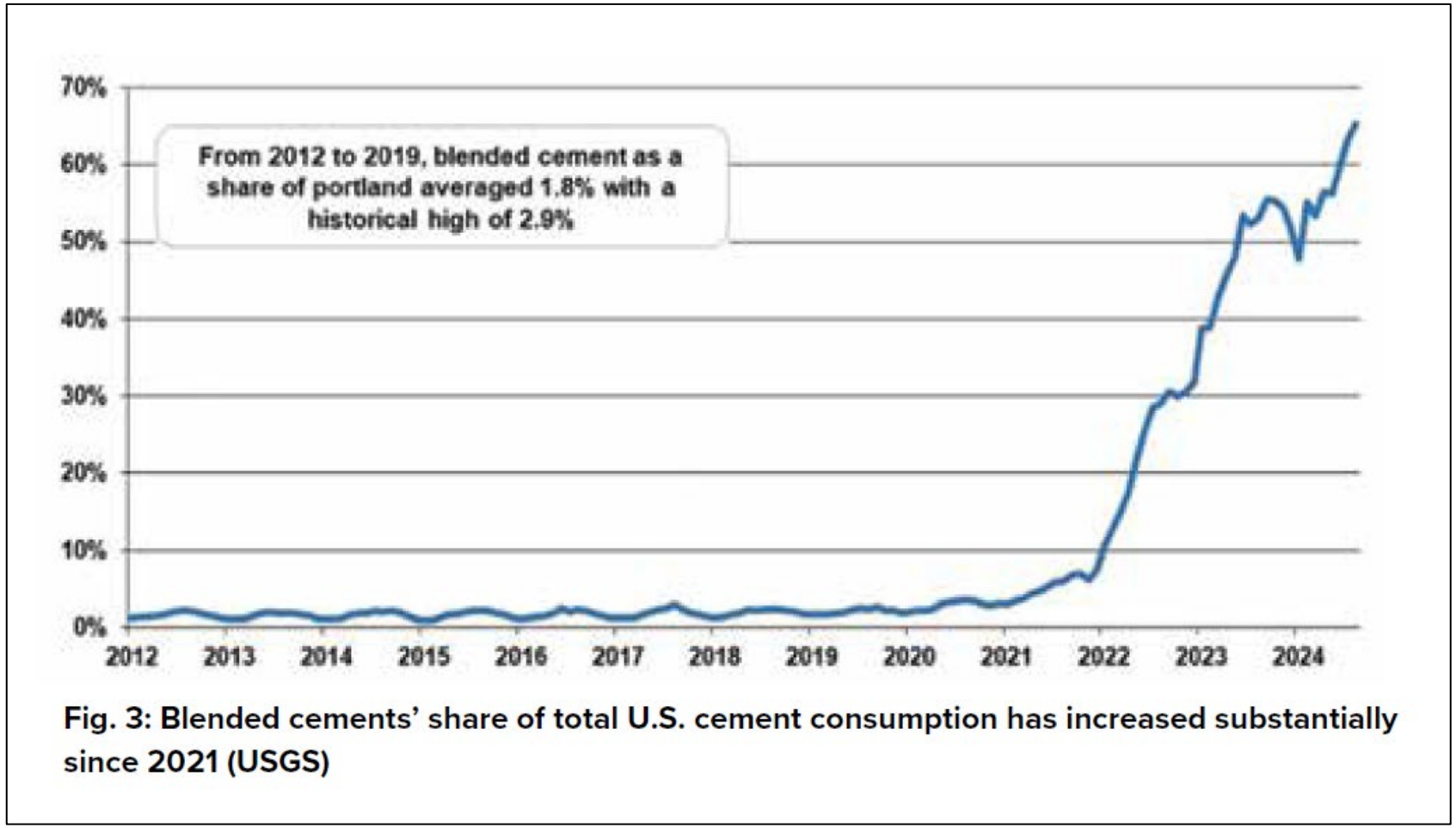


Fig. 3: Blended cements' share of total U.S. cement consumption has increased substantially since 2021 (USGS)

Source: ACI Concrete International magazine, January 2025

What's Different about Type IL concrete mixtures?

Cement:

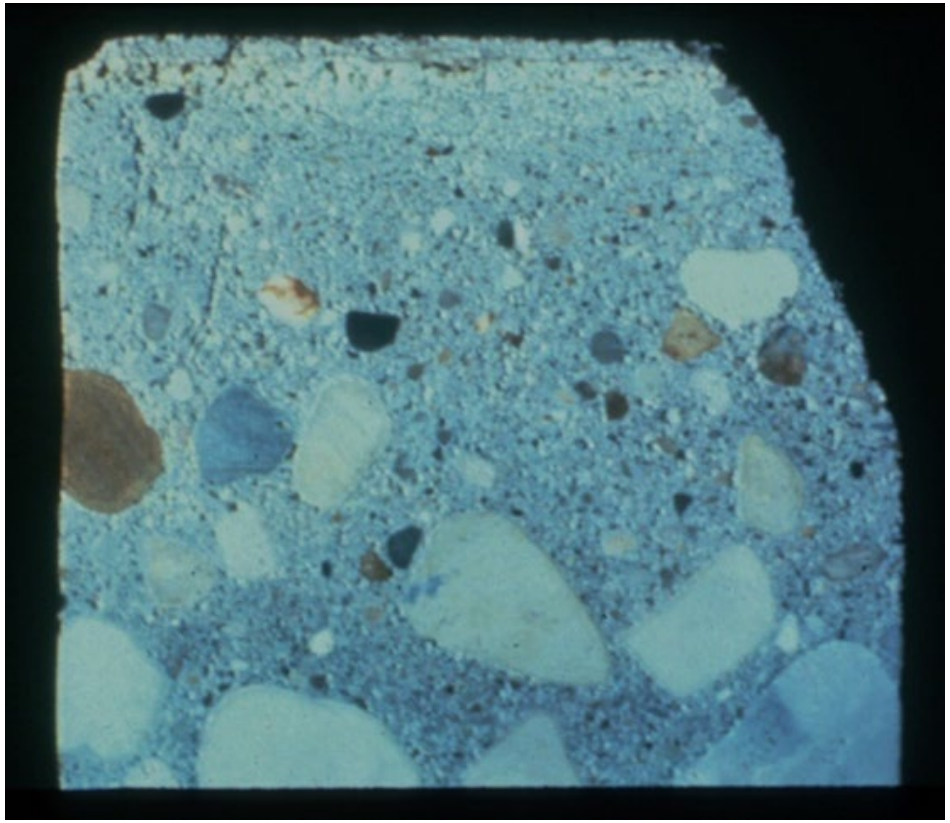
- Obviously more inert limestone powder
- Finer grind (higher Blaine fineness)

Concrete:

- Slower / less / no bleed water
- Later finishing, later strength gain

What is Bleeding, and Why is that a thing?

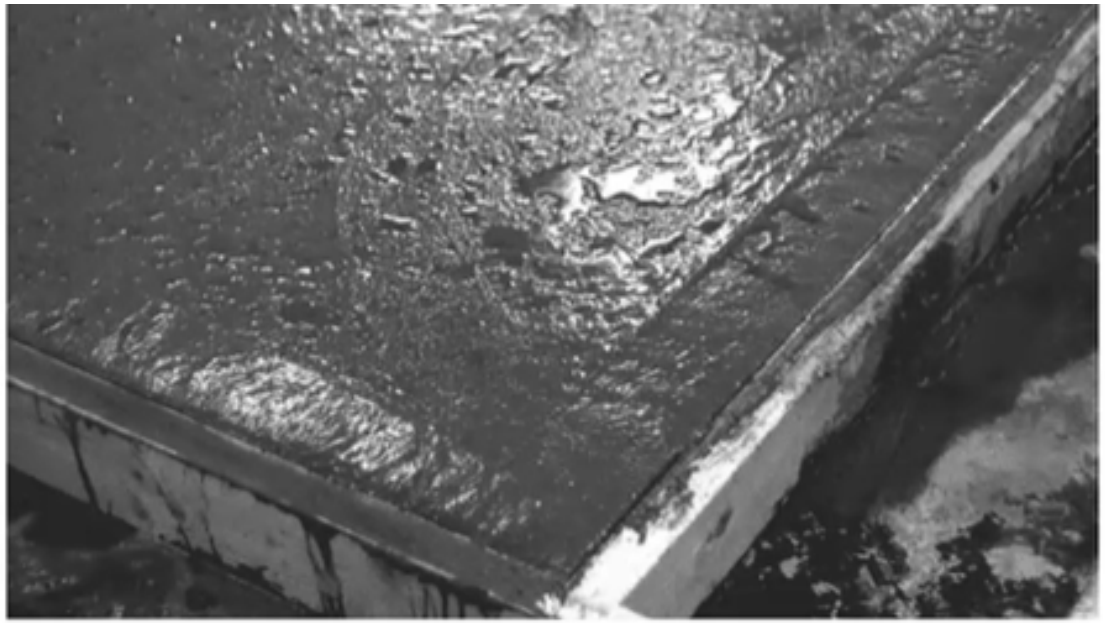
- Bleeding is settlement (sedimentation) of the heavier particles in fresh concrete (liquid)
- Cement (clinker) is heaviest, then sand and stone, then water, and finally air
  - Air bubbles are held in suspension due to surface tension
- The fineness of the cement as well as presence of air entrainment (and fibers) can all affect amount and rate of bleeding



What does slower / less / no bleed mean?

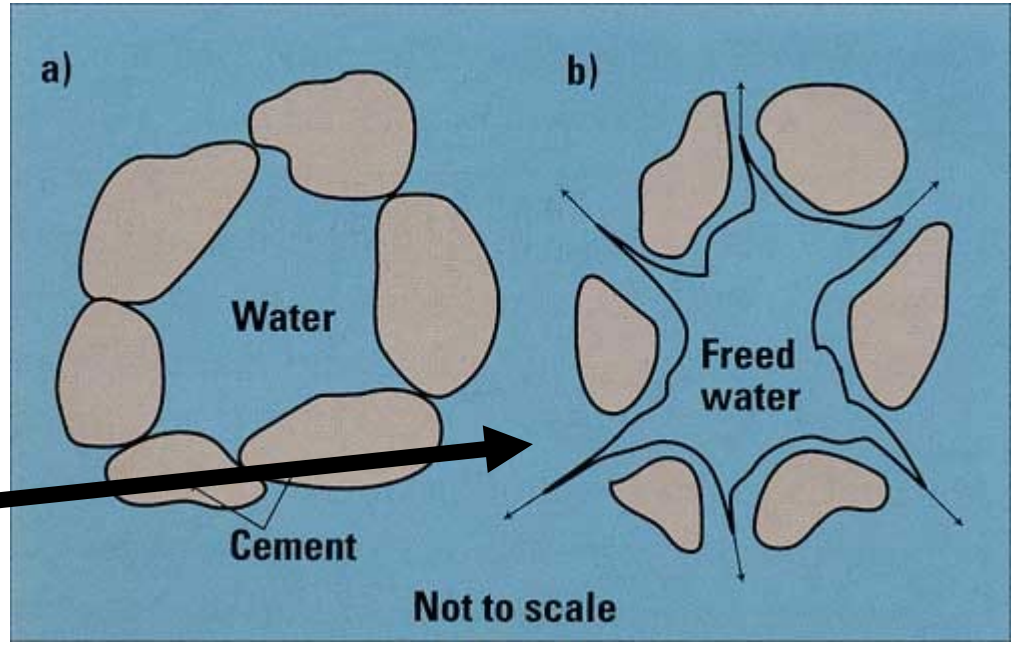
Finer cements (and SCM's) can slow down or reduce the bleed rate of freshly placed concrete

- Slower bleed rates:
  - Possible "early" finishing, trapping bleed water below the surface, causing potential delamination
- Less or no bleed water:
  - Possible waiting for bleeding, but evaporation causes surface to dry out, leaving unhydrated cement, porous/weak paste, susceptible to scaling



So What Do We Do Now?

1. Start with adequate w/cm ratios
   - suggest 0.45 max
2. Once at desired slump and w/cm ratio, DO NOT ADD WATER
   - To the mixer, or
   - To the surface
3. Use water reducing admixtures (slump enhancers) instead of water, to achieve desired workability



ADDING WATER

Wet burlap drag

- Specs prohibit adding water to slab by spray, wand, brush or other methods
- Wet burlap drag is allowed
- Decrease moisture if slurry or small bubbles develop on trailing edge of burlap

ADDING WATER (READY MIX)

- Watch the amount of added water!
- Added water not to exceed max w/cm (check batch tickets)
- If water added, mix for additional 30 revolutions

Adding 1 gallon / cu. yd:

- Increases workability ~1"
- Lowers strength ~200 psi
- Increases drying shrinkage ~10%
- Increases permeability ~ 50%

FINISHING

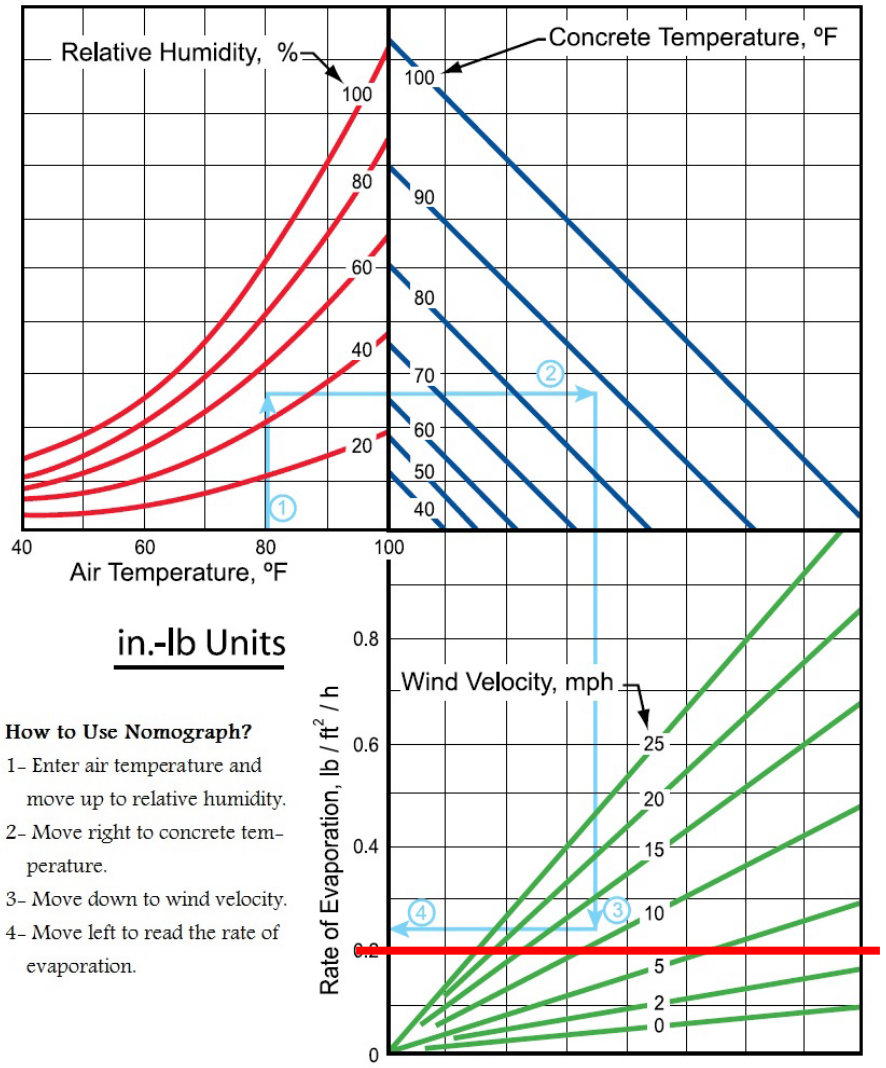
Hand float and straight edge

- Remove small imperfections
- Tight surface with few holes
- Extensive finishing can damage integrity of slab
- Do not add free water

So What Else Do We Do Now?

4. If the concrete can't be finished right away, use an evaporation retarder
5. If surfaces look like they need water during finishing, use a colloidal silica finishing aid instead of water
6. Check evaporation rates and SPRAY WITH CURING COMPOUND WITHIN 30 MINUTES OF TEXTURING!!
7. Consider using a silane sealer

Evaporation Chart



-ACI 305 Chart

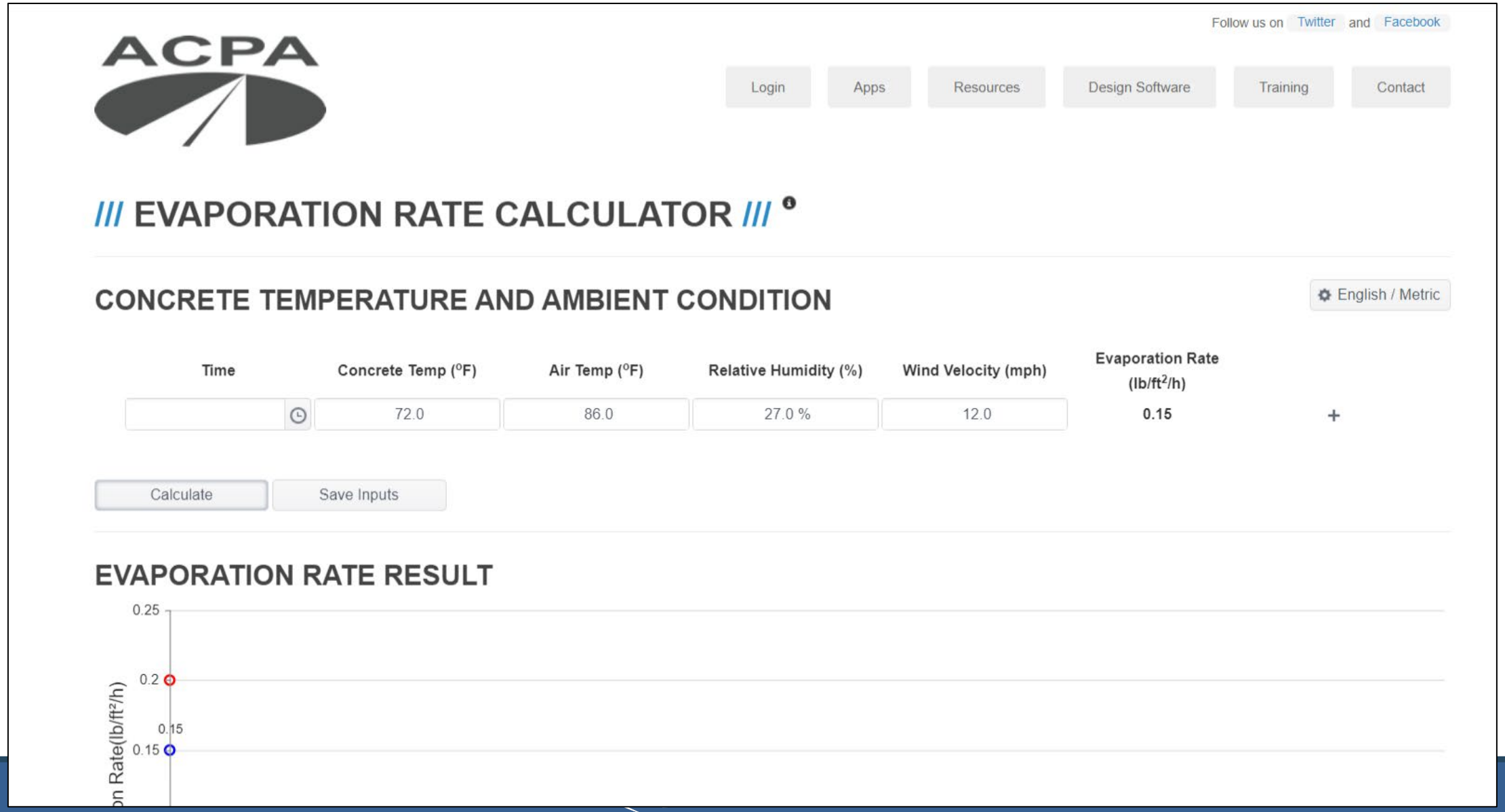
-Apps on the web to help too!

ACPA.org

0.20 lbs/sq ft/hr is the published limit to prevent shrinkage cracking

0.10 to 0.20 lbs/sq ft/hr → trouble!

Evaporation Rate Calculators



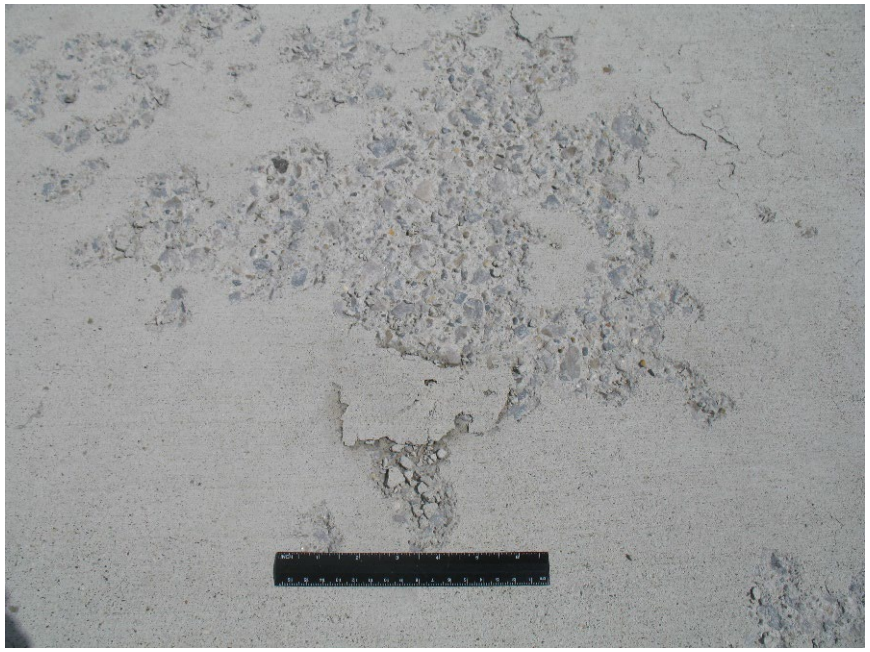
High Evap. Rates, Lack of Curing, and Scaling

Date	Location	Issue	Evap. Rate
20-May-20	Kalamazoo	Permeable/Crazing	0.35
2-Nov-20	Fremont	Scaling	0.39
3-Nov-20	Fremont	Scaling	0.35
4-Nov-20	Fremont	Scaling	0.32
5-Nov-20	Fremont	Scaling	0.23
6-Nov-20	Fremont	Scaling	0.25
9-Nov-20	Fremont	Scaling	0.23
15-Feb-21	Kalamazoo	Scaling	0.25
17-Feb-21	Kalamazoo	Scaling	0.08
23-Feb-21	Kalamazoo	Scaling	0.28
24-Feb-21	Kalamazoo	Scaling	0.27

Date	Location	Issue	Evap. Rate
25-Feb-21	Kalamazoo	Scaling	0.22
3-Mar-21	Kalamazoo	Scaling	0.25
4-Mar-21	Kalamazoo	Scaling	0.23
5-Mar-21	Kalamazoo	Scaling	0.22
11-May-21	Jenison	Scaling	0.12
7-Jun-21	Holland	Permeable surface	0.10
8-Jun-21	Holland	Permeable surface	0.10
18-Aug-21	Oak Park	Scaling	0.10
19-Aug-21	Oak Park	Scaling	0.10
31-Aug-21	Oak Park	Scaling	0.19
1-Sep-21	Oak Park	Scaling	0.22
24-Jun-22	Newaygo	Scaling	0.15

What is Scaling?

- Is the loss of the concrete's surface mortar surrounding the aggregate particles
- The aggregate is exposed and hardened mortar peels away from the surface of the concrete
- It is primarily a physical action caused by hydraulic pressures from water cyclically freezing and thawing within the concrete
- When the pressures exceed the internal tensile strength of the concrete, scaling will result



What Causes Scaling?

Finishing Techniques:

- Do not finish in the presence of bleed water
- Do not bless the surface
  - Increases surface w/cm ratio
- Do not use steel trowels on exterior flatwork

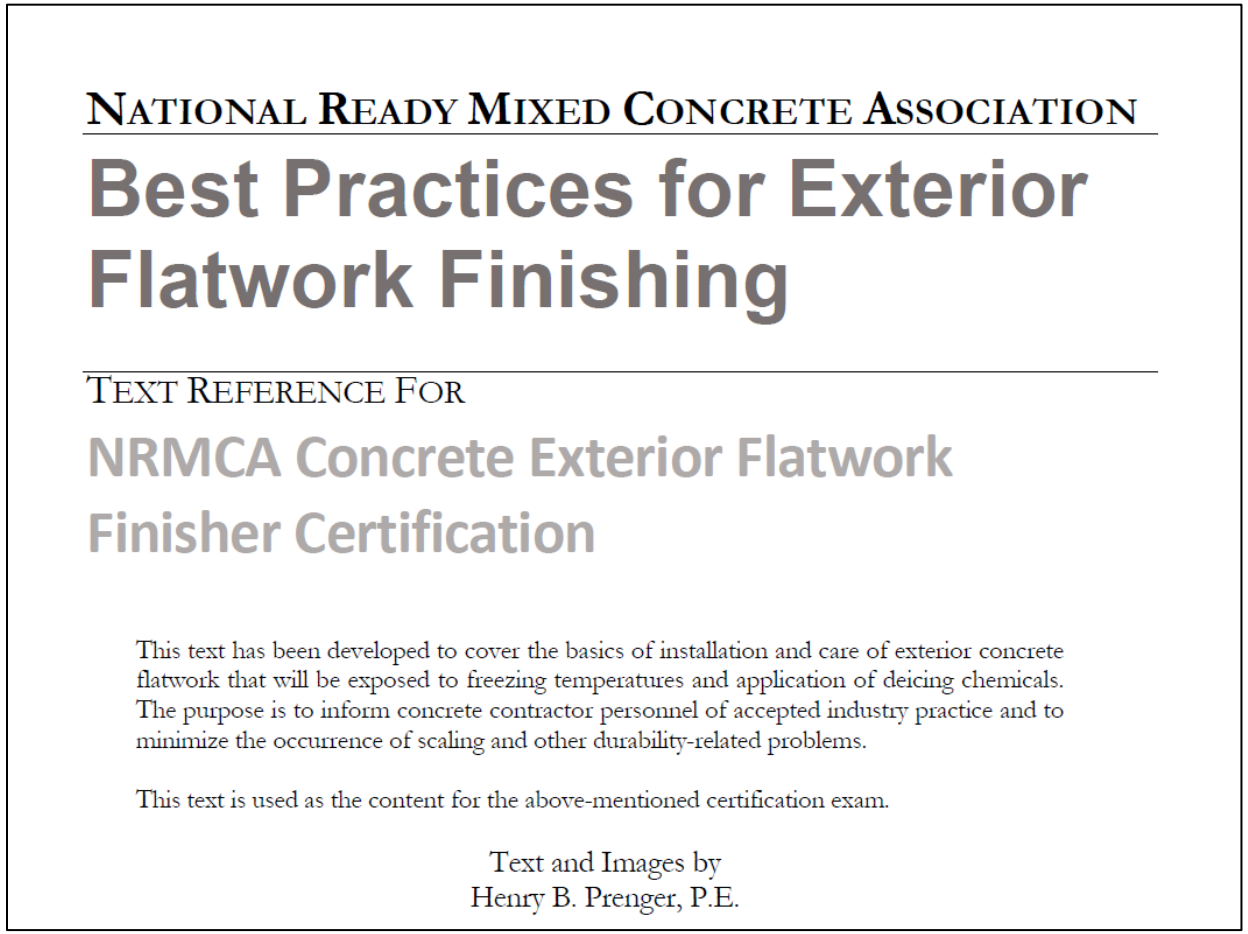
What Causes Scaling?

Weak/Porous Paste Layer:

- Higher evaporation
- Late or lack of curing application
- Do not use steel trowels on exterior flatwork

What Training or Certification Could Help?

- MCA Exterior Concrete Finisher
- NRMCA Concrete Exterior Flatwork Finisher
- ACI Flatwork Finisher
- MCA 101, 201, + other training



NATIONAL READY MIXED CONCRETE ASSOCIATION

Best Practices for Exterior Flatwork Finishing

TEXT REFERENCE FOR

NRMCA Concrete Exterior Flatwork Finisher Certification

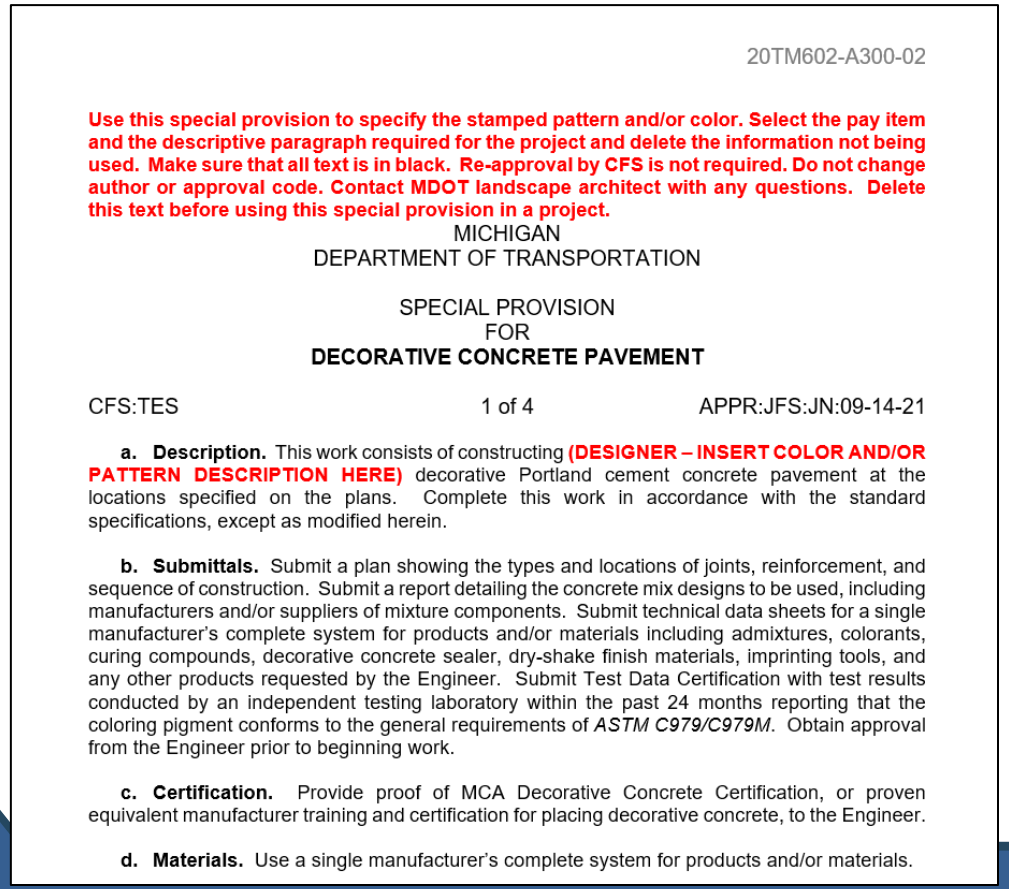
This text has been developed to cover the basics of installation and care of exterior concrete flatwork that will be exposed to freezing temperatures and application of deicing chemicals. The purpose is to inform concrete contractor personnel of accepted industry practice and to minimize the occurrence of scaling and other durability-related problems.

This text is used as the content for the above-mentioned certification exam.

Text and Images by
Henry B. Prenger, P.E.

Examples of Certifications Already Required

- MCA / ACI Level 1 Concrete Field Testing Technician
  - Testing Technicians (sampling, temp, slump, air, cylinders); also Inspectors for Construction Engineering Prequalification
- MCA Level 2 Advanced Concrete Technician
  - Mix design & adjustments, JMF & QC Plan submittals
- MCA Decorative Concrete Finisher
- Other specialty ACI certifications
  - Self Consolidating Concrete Testing
  - Concrete Strength Testing



20TM602-A300-02

Use this special provision to specify the stamped pattern and/or color. Select the pay item and the descriptive paragraph required for the project and delete the information not being used. Make sure that all text is in black. Re-approval by CFS is not required. Do not change author or approval code. Contact MDOT landscape architect with any questions. Delete this text before using this special provision in a project.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
DECORATIVE CONCRETE PAVEMENT

CFS:TES 1 of 4 APPR:JFS:JN:09-14-21

a. Description. This work consists of constructing **(DESIGNER – INSERT COLOR AND/OR PATTERN DESCRIPTION HERE)** decorative Portland cement concrete pavement at the locations specified on the plans. Complete this work in accordance with the standard specifications, except as modified herein.

b. Submittals. Submit a plan showing the types and locations of joints, reinforcement, and sequence of construction. Submit a report detailing the concrete mix designs to be used, including manufacturers and/or suppliers of mixture components. Submit technical data sheets for a single manufacturer's complete system for products and/or materials including admixtures, colorants, curing compounds, decorative concrete sealer, dry-shake finish materials, imprinting tools, and any other products requested by the Engineer. Submit Test Data Certification with test results conducted by an independent testing laboratory within the past 24 months reporting that the coloring pigment conforms to the general requirements of *ASTM C979/C979M*. Obtain approval from the Engineer prior to beginning work.

c. Certification. Provide proof of MCA Decorative Concrete Certification, or proven equivalent manufacturer training and certification for placing decorative concrete, to the Engineer.

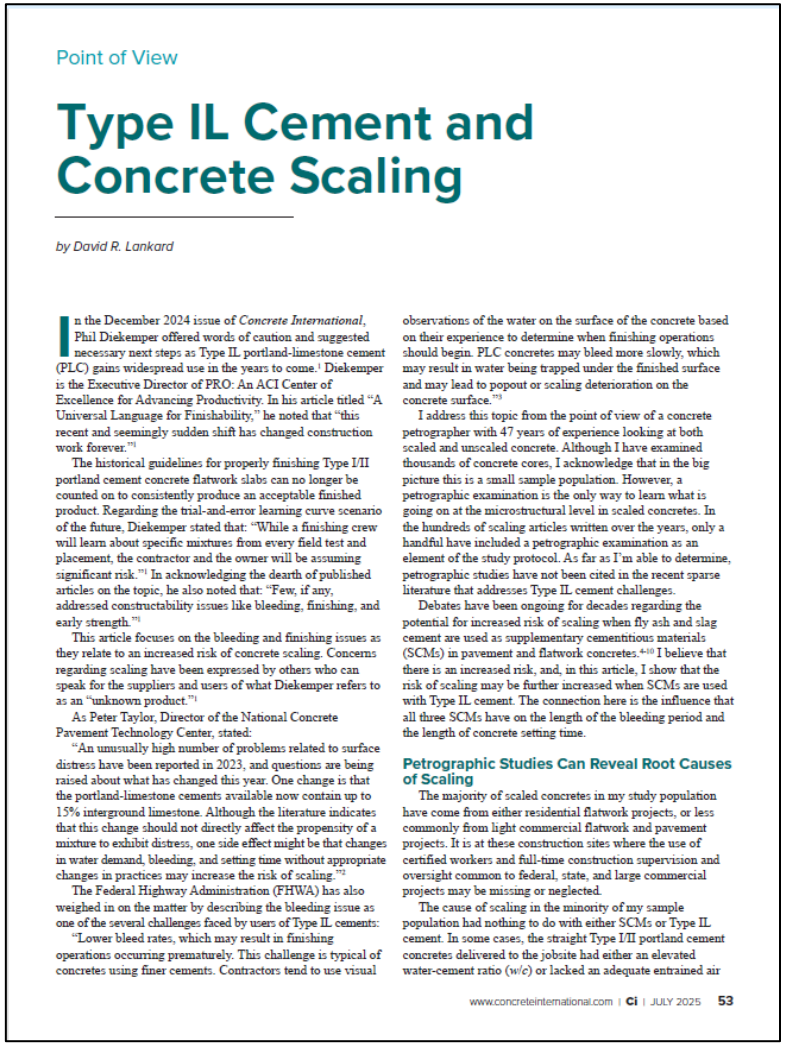
d. Materials. Use a single manufacturer's complete system for products and/or materials.

Specifications

- MDOT mixtures typically very durable
  - Prequalified aggregate sources
  - Minimum cementitious contents
  - Use of SCM's encouraged or required in high performance mixtures
  - One-time water addition allowed before placement begins
- MDOT construction specs require curing compound application
  - 200 sq ft per gallon or 25 syds per gallon
- Non-MDOT (commercial, industrial, residential) can follow ASTM
  - In many cases will still use MDOT quality materials

References

- ACI Concrete International magazine, July 2025, "Type IL Cement and Concrete Scaling," by David R. Lankard
- National Concrete Consortium MAP Brief Summer 2023, " Revisiting Concrete Scaling," by Peter Taylor, National Concrete Pavement Technology Center.
- NRMCA CIP 2, "Scaling Concrete Surfaces"



Point of View

Type IL Cement and Concrete Scaling

by David R. Lankard

In the December 2024 issue of *Concrete International*, Phil Diekemper offered words of caution and suggested necessary next steps as Type IL portland-limestone cement (PLC) gains widespread use in the years to come.[1] Diekemper is the Executive Director of PRO: An ACI Center of Excellence for Advancing Productivity. In his article titled "A Universal Language for Finishability," he noted that "this recent and seemingly sudden shift has changed construction work forever."[1]

The historical guidelines for properly finishing Type I/II portland cement concrete flatwork slabs can no longer be counted on to consistently produce an acceptable finished product. Regarding the trial-and-error learning curve scenario of the future, Diekemper stated that: "While a finishing crew will learn about specific mixtures from every field test and placement, the contractor and the owner will be assuming significant risk."[1] In acknowledging the dearth of published articles on the topic, he also noted that: "Few, if any, addressed constructability issues like bleeding, finishing, and early strength."[1]

This article focuses on the bleeding and finishing issues as they relate to an increased risk of concrete scaling. Concerns regarding scaling have been expressed by others who can speak for the suppliers and users of what Diekemper refers to as an "unknown product."[1]

As Peter Taylor, Director of the National Concrete Pavement Technology Center, stated:

"An unusually high number of problems related to surface distress have been reported in 2023, and questions are being raised about what has changed this year. One change is that the portland-limestone cements available now contain up to 15% interground limestone. Although the literature indicates that this change should not directly affect the propensity of a mixture to exhibit distress, one side effect might be that changes in water demand, bleeding, and setting time without appropriate changes in practices may increase the risk of scaling."[2]

The Federal Highway Administration (FHWA) has also weighed in on the matter by describing the bleeding issue as one of the several challenges faced by users of Type IL cements:

"Lower bleed rates, which may result in finishing operations occurring prematurely. This challenge is typical of concretes using finer cements. Contractors tend to use visual observations of the water on the surface of the concrete based on their experience to determine when finishing operations should begin. PLC concretes may bleed more slowly, which may result in water being trapped under the finished surface and may lead to popout or scaling deterioration on the concrete surface."[3]

I address this topic from the point of view of a concrete petrographer with 47 years of experience looking at both scaled and unscaled concrete. Although I have examined thousands of concrete cores, I acknowledge that in the big picture this is a small sample population. However, a petrographic examination is the only way to learn what is going on at the microstructural level in scaled concretes. In the hundreds of scaling articles written over the years, only a handful have included a petrographic examination as an element of the study protocol. As far as I'm able to determine, petrographic studies have not been cited in the recent sparse literature that addresses Type IL cement challenges.

Debates have been ongoing for decades regarding the potential for increased risk of scaling when fly ash and slag cement are used as supplementary cementitious materials (SCMs) in pavement and flatwork concretes.[4-10] I believe that there is an increased risk, and, in this article, I show that the risk of scaling may be further increased when SCMs are used with Type IL cement. The connection here is the influence that all three SCMs have on the length of the bleeding period and the length of concrete setting time.

Petrographic Studies Can Reveal Root Causes of Scaling

The majority of scaled concretes in my study population have come from either residential flatwork projects, or less commonly from light commercial flatwork and pavement projects. It is at these construction sites where the use of certified workers and full-time construction supervision and oversight common to federal, state, and large commercial projects may be missing or neglected.

The cause of scaling in the minority of my sample population had nothing to do with either SCMs or Type IL cement. In some cases, the straight Type I/II portland cement concretes delivered to the jobsite had either an elevated water-cement ratio (*w/c*) or lacked an adequate entrained air

MCA Issued a Technical Bulletin in July 2024

1. Proper finishing and curing are essential
2. As with any new/changed material, mixes need to be tested and verified to confirm effects on fresh and hardened properties such as:
    a. Air content
    b. Slump
    c. Bleed potential
    d. Set time; and
    e. Compressive strength
3. Adjust mix as needed: proportions of cementitious materials, aggregates, admixture dosages, etc.

www.miconcrete.org/concrete-scaling

Summary

- Concrete surfaces are durable, long-lasting, cost effective and aesthetically pleasing if:
  - They are designed & specified properly
  - They are constructed properly – especially curing!
  - They are inspected to ensure compliance with the project specifications
  - They are maintained and taken care of properly

LTU CTM Program

https://ltu.edu/programs/concrete-technology-management-with-business-administration/

MICHIGAN CONCRETE ASSOCIATION

QUESTIONS?

Steve Waalkes, P.E.
616-633-9629
steve@miconcrete.org

MCA Merch Store

MCA MERCH STORE NOW OPEN!

Rep the Industry. Wear MCA. Shop official MCA gear built for the jobsite—and beyond.

VISIT THE STORE

MCA Training Center Renovation

MCA TRAINING CENTER RENOVATION

The MCA Board has approved renovating our existing training facility! Learn more about the history of the training center and what the renovation includes.

LEARN MORE AND SPONSOR