CPG Tools for Success

Evaporation Rates on Concrete Surfaces at Placement

Problem: When the evaporation rate exceeds the natural bleeding rate of concrete, surface water is lost too quickly, resulting in **plastic shrinkage cracking** and other surface defects.

Key Factors used to Estimate Evaporation Rates:

- **Air Temperature, Relative Humidity, Concrete Temperature, Wind Velocity**
- The **combination** of these measurements predicts the evaporation rate and potential rate of water loss from the concrete surface (assuming bleed water is present).
- Higher evaporation rates are common in lower relative humidity and higher wind velocities
- Elevated air and concrete temperatures in these conditions typically result in higher evaporation rates

The Critical Threshold

- According to the American Concrete Institute (ACI), at an evaporation rate over 0.2 lb/ft^2/hr, nearly all plastic concrete mixtures have a risk of rapid, early drying, leading to plastic shrinkage cracking. The local concrete market suggests 0.1 lb/ft^2/hr as the threshold to use protection procedures for concrete with Type IL cement. Specialized mixes (such as those containing silica fume and other supplementary cementitious materials like fly ash and slag) can be vulnerable to moisture loss at rates as low as 0.05 lb/ft^2/hr.

Mitigation Strategies - To alter the evaporation rate and protect fresh flatwork from premature shrinkage, contractors may need to protect the surface until conditions are ready for finishing operations.

- **In preconstruction meeting, discuss evaporation rate thresholds and expectations.**
- **Establish the actual onsite real-time evaporation rates** (see page 2)
- **Windbreaks and shades:** Attempting to block the wind and shield the concrete from direct sunlight.
- **Evaporation retarders:** Proper use of topical polymer films that protect the exposed surface; allowing the concrete matrix to firm-up for finishing procedures. Not to be confused with "finishing aids", evaporation retarders are not worked into the surface. Follow all manufacturer's recommendations. Reference CPG 2025 Concrete Language Alert-Finishing Aids, clarification between evaporation retarders & finishing aids.
- **Fog misting:** Increasing humidity above the surface via an ultra-fine spray until formal curing begins.
- **Wetting the subgrade:** Before placing concrete.
- **Cooling the mix:** Using chilled mixing water to lower the initial temperature of the concrete.
- **Work with the engineer and/or ready-mix producer to design the right mix for the right job.** Aggregate gradations, admixtures, etc. can make a difference in workability, finishing and durability.

References & Tools

- **American Concrete Institute (ACI):**
  - **ACI 305R** Hot Weather Concreting & **ACI 305.1** Specification for Hot Weather Concreting
  - They provide the foundational standard for measuring conditions and the well-known *Evaporation Rate Nomograph* to predict moisture loss.
  - ACI SP-338, Ward R. Malisch Concrete Symposium 3.1.2020, "Evaporation", Kenneth C. Hover
- **American Cement Association (ACA):** The ACA Design and Control of Concrete Mixtures is a textbook resource that details Menzel's and Dalton's formulas to define and predict plastic shrinkage cracking.
- **National Ready Mixed Concrete Association (NRMCA):** The NRMCA publishes a brief, actionable guide, CIP 5—Plastic Shrinkage Cracking, nomograph, and a discussion of critical evaporation thresholds.
- **Federal Highway Administration:** Guide for Curing Portland Cement Concrete Pavements
- **Estimated Evaporation Nomograph (NRMCA/ACA)**: See page 2 of this document.
- **PourDay.com:** Free app, iOS & Android. (based on the evaporation nomograph, ACI 305R)
- **Kestrel 5200 Concrete Target Evaporation Rate Solver:** measures real time site conditions

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Tools to Evaluate Concrete Surface Evaporation Rates

Kestrel 5200
Concrete Evaporation Rate

Jobsite Real Time Readings:

1. Air temperature
2. Relative humidity
3. Wind speed
4. Tracks, logs, time stamps data
5. Measure approx. 20 inches above the pavement, every 10 minutes

PourDay.com
iOS and Android Free App

pourday

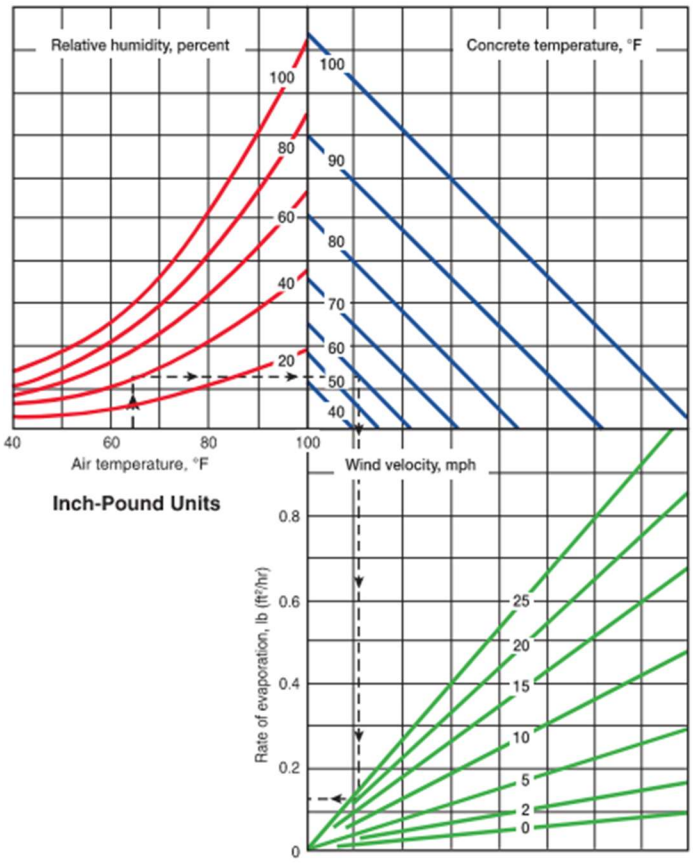
SCAN · POUR SMARTER

pourday.com

PourDay App:

1. Open app on jobsite
2. Uses live weather data by zip code: temp., humidity, wind speed
3. Based on ACI 305R, calculates estimated rates
4. Save data
5. Plan ahead, forecasting

Nomograph for Estimated Concrete Surface Evaporation Rates



To Use Chart:

1. Enter with air temperature, move up to relative humidity
2. Move right to concrete temperature
3. Move down to wind velocity
4. Move left: read approximate rate of evaporation

Nomograph based on equation:
$E = (Tc^{2.5} - r\,Ta^{2.5})\,(1+0.4V)x\,10^{-6}$

Sources: ACI 305R-20, NRMCA CIP#5 Plastic Shrinkage Cracks, ACA Design & Control of Concrete Mixtures, 17th edition, chapter 18.

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