

**Terrazzo Quality Can Be Impacted by  
Limitations in the Concrete**

**Scott M. Tarr, PE FACI**

NORTH S. TARR  
CONCRETE CONSULTING, P.C.

*Guidance to Concrete Solutions*


 THE NATIONAL  
**TERRAZZO**  
 & MOSAIC ASSOCIATION

**September 14, 2023**

1



2



3

## Today's Agenda

- Water in Concrete – where does it go?
- Curling (warping)
- Fibers
- Type 1L Cement
- Coefficient of Thermal Expansion
  - Delamination
- Moisture Movement and pH
  - Osmotic Blisters
  - Alkali Silica Reactivity (ASR)

4

## Water is Essential to Concrete

1. Mixability, Workability, Consistency, Placeability, Consolidation, Pumpability, Finishability, and Bleed/Setting Behavior
2. Cement Hydration.
3. Curing.

5

## Not Toot Much Water



- Segregation
- Lower Strength
- Lower Wear Resistance
- Surface Issues
  - Dusting
  - Delaminations
  - Popouts
- Shrinkage and Curling

6

## Where Does the Water (Moisture) Go?

- Compare Cement and Epoxy Terrazzo
- Identical Conditions
- Quality Vapor Retarder
- Concrete the Same Age
- Curling Ground Out Before Terrazzo Installation
- Cementitious Continued to Curl and Epoxy Did Not
- Why?

7

Every Truckload Delivers Over 100 Gallons  
of Free Water!



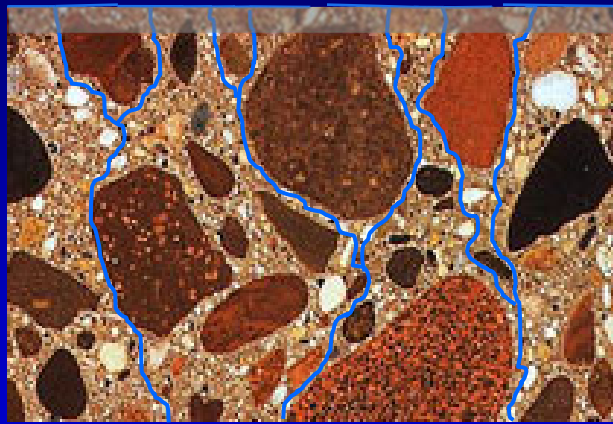
8

### Placement and Bleed



9

### Bleeding Concentrates Alkali Salts at Surface



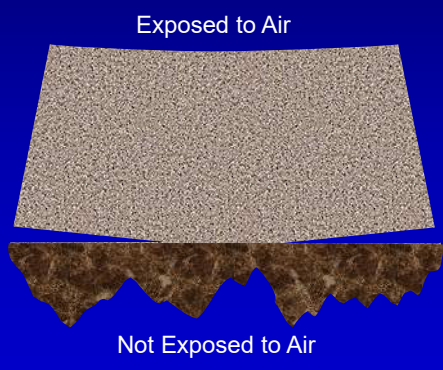
10

### Bleeding Concentrates Alkali Salts at Surface



11

### The Rest of the Water Slowly Evaporates Which Causes Issues



12

## Curling/Warping

How Does One Know if a Joint or Crack is Curled/Warped?

6 foot level or long straightedge

13

## Curling/Warping

Shrinkage – Curling/Warping Relaxation

14

## Curling/Warping

Shrinkage – Curling/Warping Relaxation

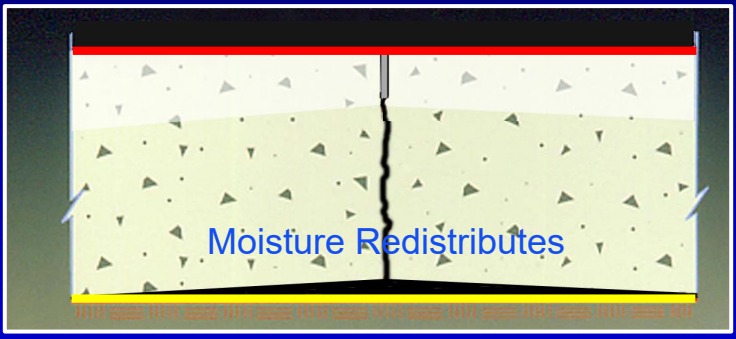


The diagram shows a cross-section of a concrete slab with aggregate represented by small black triangles. A vertical crack runs down the center. The bottom surface of the slab is curved upwards, forming a U-shape. A red oval highlights the bottom edge of the slab, which is shown as a yellow line. Blue lightning bolt symbols on the left and right sides indicate the slab is supported. The background is dark blue.

15

## Curling/Warping

Shrinkage – Curling/Warping Relaxation



The diagram shows the same cross-section of a concrete slab as in slide 15. A red horizontal line is drawn across the top surface of the slab. The text "Moisture Redistributes" is written in blue in the center of the slab. The bottom surface remains curved upwards. The background is dark blue.

16



## Curling/Warping

Shrinkage – Curling/Warping Relaxation

The diagram shows a cross-section of a concrete slab with aggregate. A red line at the top represents the surface profile, which is curved upwards in the center. Yellow arrows point upwards from the center, and red arrows point downwards from the center, indicating moisture movement. The text 'Moisture Redistributes' is written in blue. An inset photograph shows a concrete slab with a visible crack and a white expansion joint strip.

17

## Curling/Warping

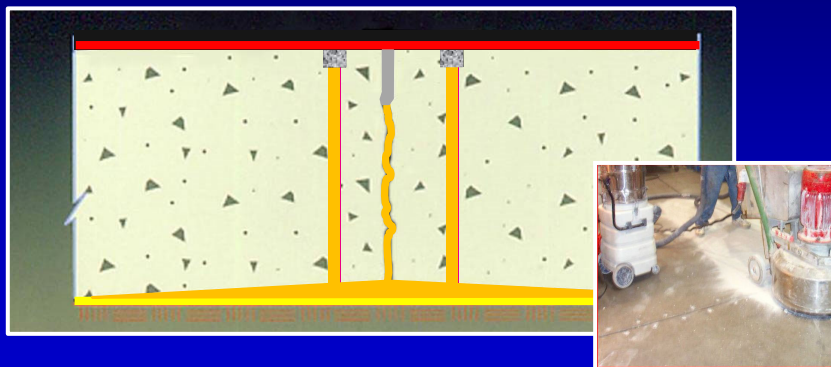
Shrinkage – Curling/Warping Relaxation

The diagram shows a cross-section of a concrete slab with aggregate. A red line at the top represents the surface profile, which is curved upwards in the center. Yellow arrows point upwards from the center, and red arrows point downwards from the center, indicating moisture movement. The text 'Moisture Redistributes' is written in blue. Labels 'Joint Filler Compresses' and 'Bump' point to the center of the slab. An inset photograph shows a wooden floor with a concrete slab and a white expansion joint strip.

18

## Curling/Warping

Shrinkage – Curling/Warping Relaxation  
Solution



19

## How to Stop Curling?

- Shrinkage-Compensated Concrete
- Post-Tensioned Concrete Slab Design
- All Other Concrete Will Dry and Shrink (and Curl)
- How Can We Minimize Shrinkage/Curling
- Optimize Concrete Mix Design
  - Maximize Aggregate Size and Content
  - Minimize Paste Content (Cement and Water)
- Decrease Joint/Crack Spacing?
  - Extended-Joint Slab Designs
  - Reinforcement – Fibers?

20

## Fibers?

- Reinforce Concrete to Result in Many Closely-Spaced Cracks
  - Steel or Polypropylene?
  - Length and Shape of Fibers?
- Cracks Remain Tight if Fiber Design Correct
- Are Tight Cracks an Easier Substrate Than Joints?
- Can Fibers Inhibit Bond?

21

## Type 1L Cement

- Reduction of the Carbon Footprint (Carbon Neutrality Initiative)
  - Reduced Cement Clinker
  - Limestone Fines (up to 15% instead of 5%)
- Potential Impact on Strength?
- Potential Impact on Setting?
- Potential Impact on Bleeding?
- Variation in Limestone Content? (Consistency Throughout Placement)

22

## Slabs Shrink But Do They Expand Too???

- They Can!
  - Concrete Shrinkage and Contraction
    - Loss of Moisture and/or Temperature
  - Concrete Swelling and Expansion
    - Gain of Moisture and/or Temperature
- Curling/Warping Relaxation
- Climatized or Non-Climatized?

23

## Temperature Expansion Pavement Blow-Ups



24

# Joint Movement Due to Moisture and Temperature Fluctuations



25

**Concrete Slab Repair: Getting Flat is One Thing, Staying Flat is Another!**

**Warping Behavior**

**References**

**World of Concrete**

26



27



28



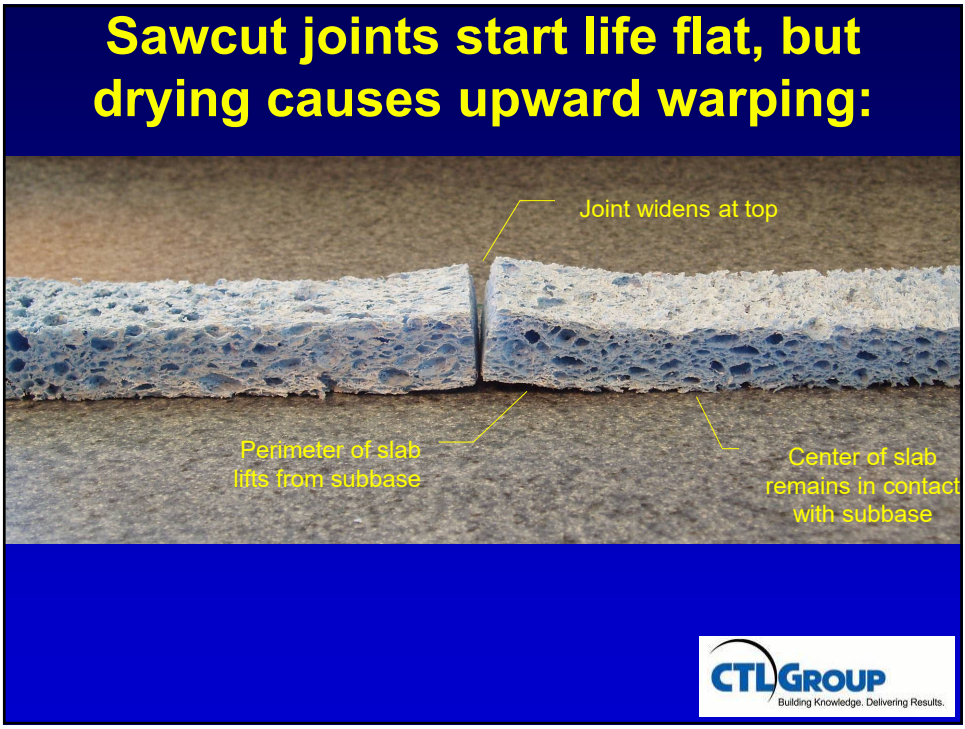
29

**Concrete *is* a Sponge. When uniformly moist, a slab is flat.**

A rectangular piece of concrete with a porous, sponge-like internal structure. The concrete is light-colored and has a highly textured, porous appearance. It is placed on a dark, textured surface. The image is framed by a blue border.

**CTLGROUP**  
Building Knowledge. Delivering Results.

30



31



32



## Floor Covering Failure Due to Warping Relaxation



The photograph shows a room with several chairs. The floor is covered with a light-colored material, possibly a carpet or tile, which has become uneven and warped. A prominent dark, irregular shape is visible on the floor, indicating a failure or damage. The room is brightly lit, and the chairs are arranged in rows.



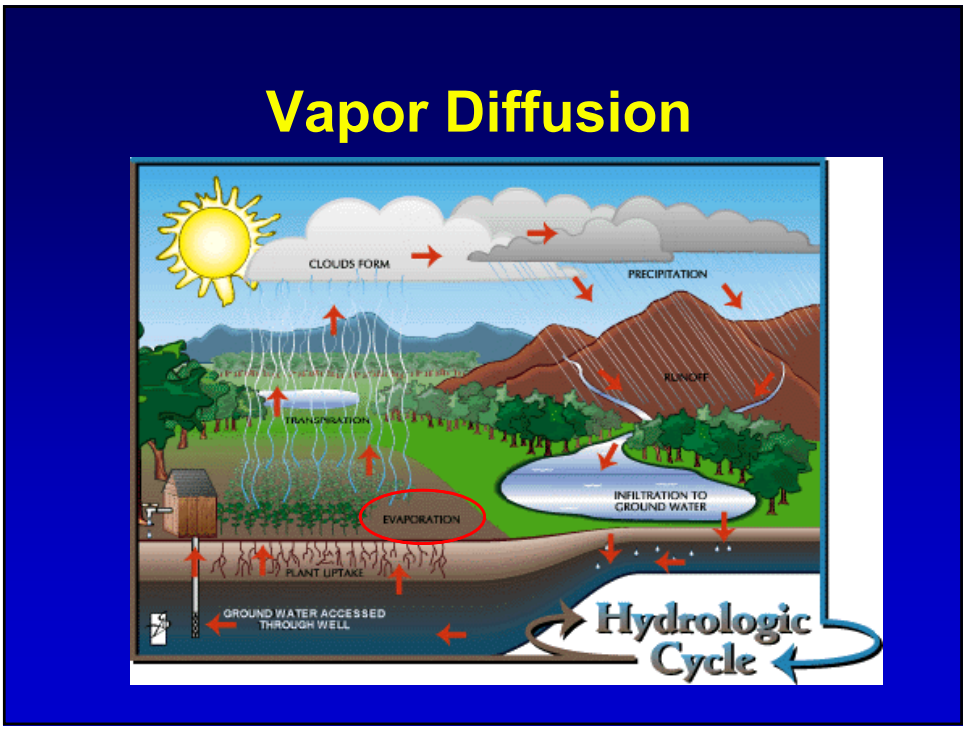
33



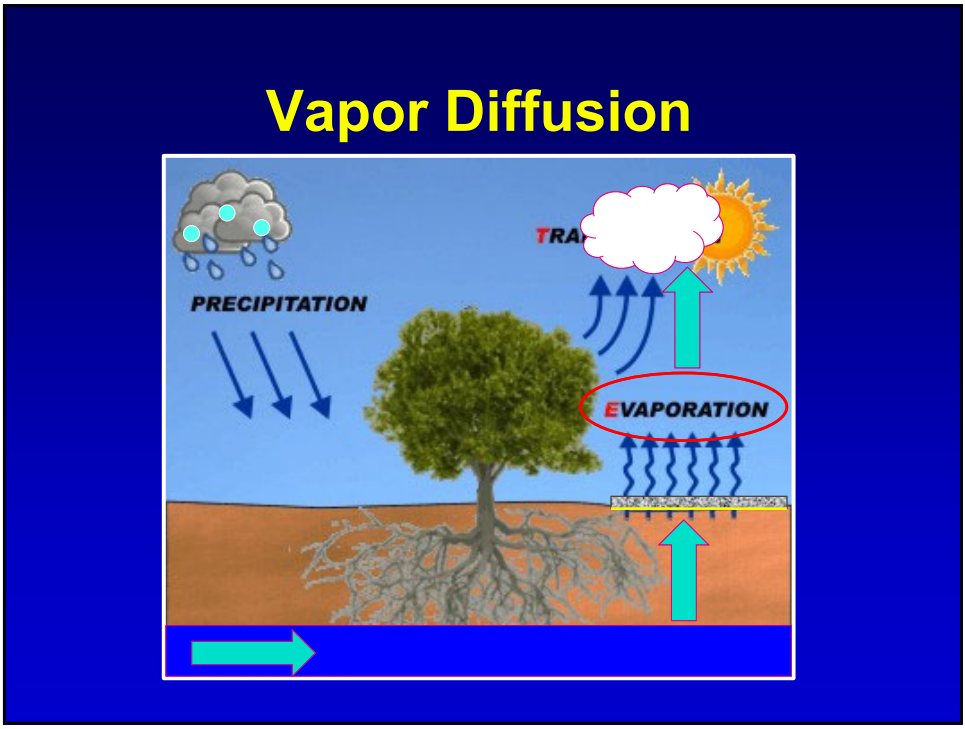
34



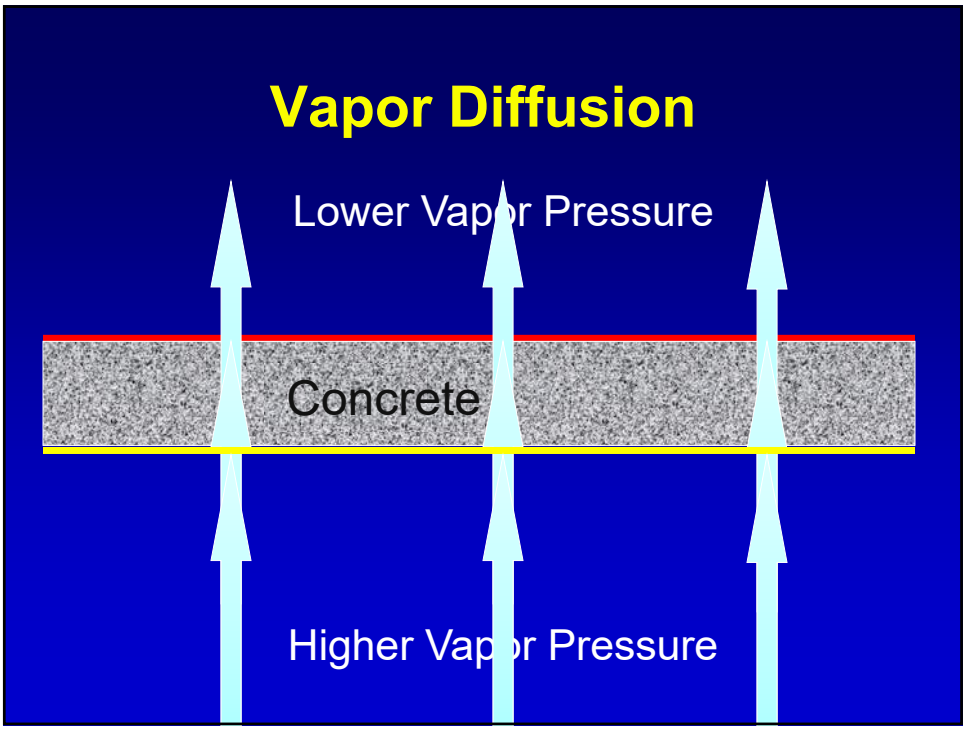
35



36



37



38



39



40



41


## Considerations for Toppings Moisture Vapor and pH




Resistance  
Meter




Mass  
Loss



**CaCl**  
ASTM F1869




**RH**  
ASTM F2170



**Meter**  
ASTM F2659



Plastic Sheet



Surface RH  
(Hood Test)

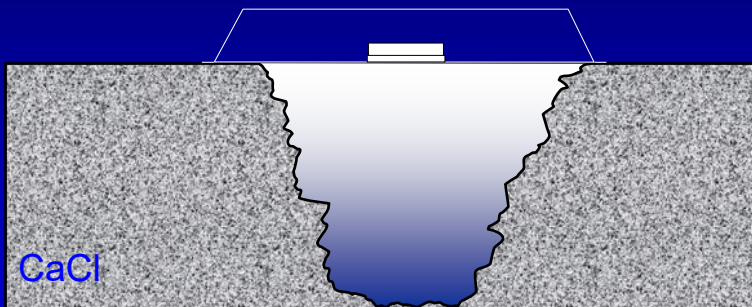


Mat  
Bond

42

# Considerations for Toppings Moisture Vapor and pH

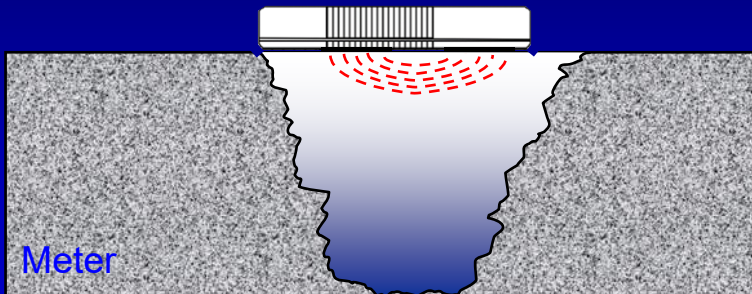
What Moisture is Measured?



43

# Considerations for Toppings Moisture Vapor and pH

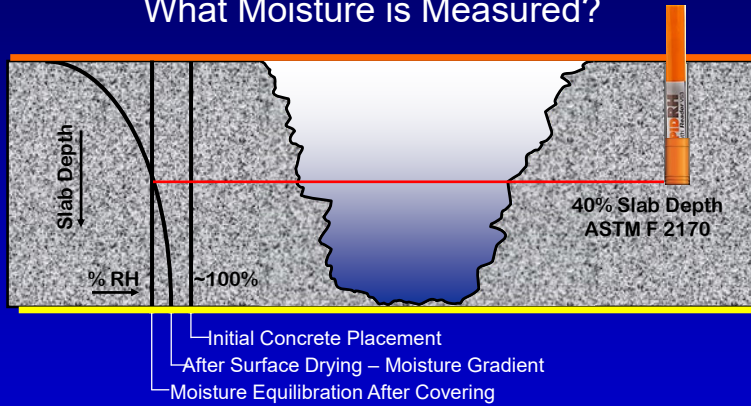
What Moisture is Measured?



44

## Considerations for Toppings Moisture Vapor and pH

What Moisture is Measured?



If Moisture is High Enough to Condense to a Liquid Beneath the Floor Covering, pH Can Result in Damage

45

## Considerations for Toppings Moisture Vapor and pH

pH

Is a measure of hydrogen ions in solution



46



47



48





49



50

## Considerations for Toppings Moisture Vapor and pH

When we Perform the pH Test...

- We are Performing Chemistry
- We add Water to Create a Solution
- We Assume the Concrete Contains Enough Moisture to Create an Identical Solution Under the Finish Flooring
- If the Concrete is Sufficiently Dry, the pH Test is Not Representative
- A "Dry" Material has NO pH

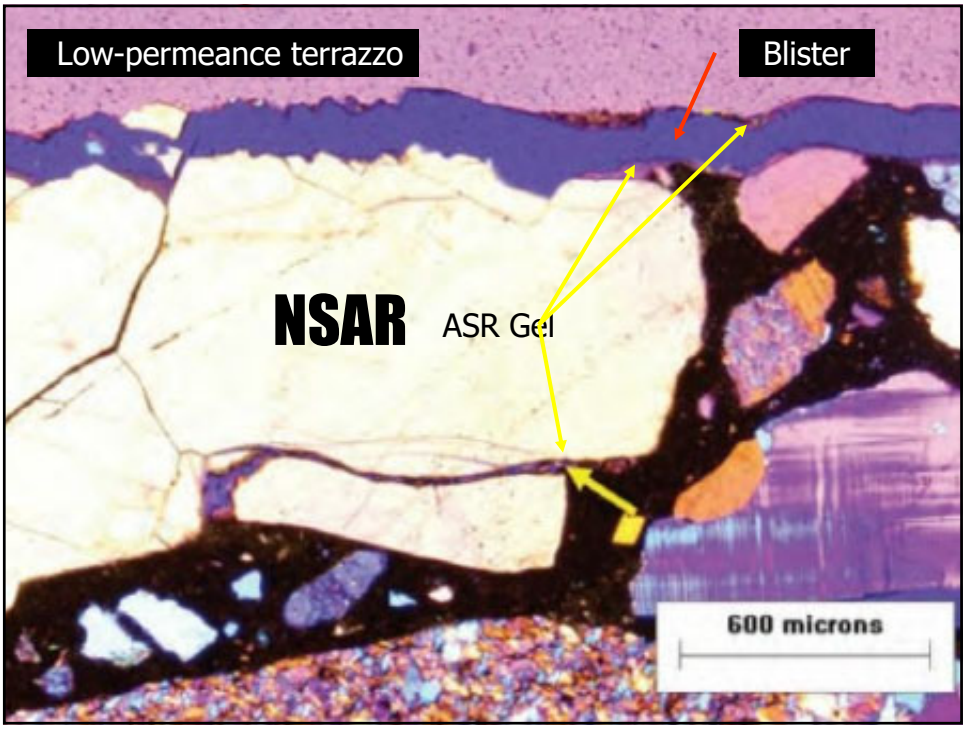
Is the pH Test Valid?

51

## Osmotic Blisters



52



53



54