INDUSTRIAL FLOORS, SUSPENDED SLABS & PAVEMENTS

Rick Smith
Structural Services, Inc
www.ssiteam.com

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Who is SSI?

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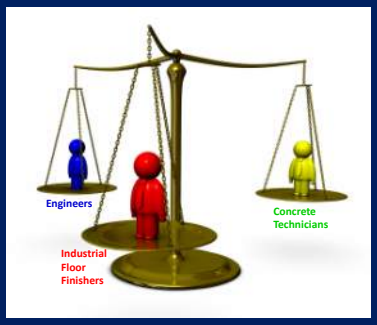
What Is SSI?



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Who Do We Service?

HILLWOOD · ARCO DESIGN/BUILD · NFI Industries · Chick-fil-A · The Home Depot · CP Clarion Partners · Walmart · Duke Realty · Prologis · Trammell Crow Company · NorthPoint Development · RaceTrac · amazon · The Conlan Company · Publix · Clayco · Floor & Decor · ARCO Murray · Choate Construction · Turner Construction Company · Peinado · WT · Havertys · Sprouts · VanTrust · Scannell · Ryan · Seefried Industrial Properties

4

Our Professional Affiliations

- ACI – American Concrete Institute
  - Sustaining Members
  - ACI 302, ACI 330, ACI 360, ACI 117, ACI 223, ACI 640

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ANATOMY OF A FLOOR SLAB

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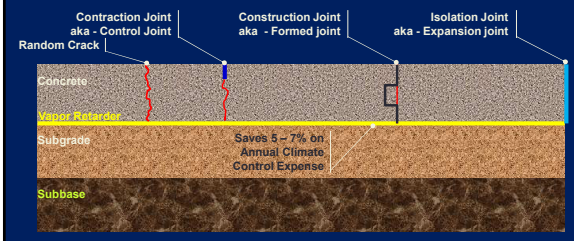
Concrete Slab on Ground



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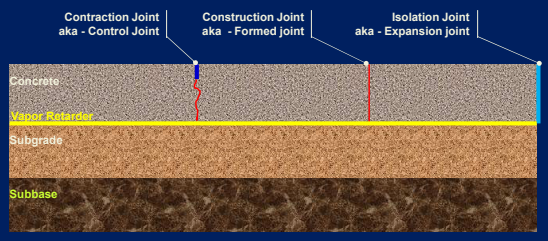
Concrete Slab on Ground



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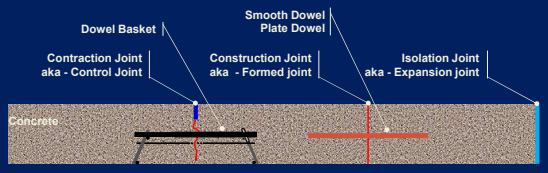
Concrete Slab on Ground



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Curling and Joint Impact

10

Joint Faulting Due to No Positive Load Transfer

Retail – Trip Hazards
Office – Floor Covering Distress

Industrial – Joint Distress, Wheel and Equipment Damage

11

Least expensive to build

MOST EXPENSIVE TO MAINTAIN

12

Non-Reinforced Spec Warehouse in PA

Joints ground flush

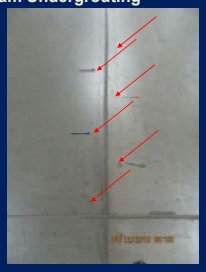
Wrong Joint Filler

13

Non-Reinforced Spec Warehouse in PA

Structural Nosing Repair

Joint Stabilization via Grout or Foam Undergrouting



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Lack of Positive Load Transfer Can Add $1.00 - $2.50 per Square Foot in Traffic Areas to Restore Floor Performance

15

Installing Dowel Baskets

Dowel Baskets Must Be Staked

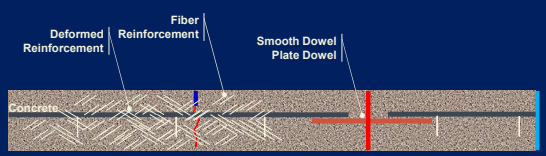
Cutting Basket Wires Makes the Basket Unstable. 3 Plates Minimum.

16

Drawback to Dowel Baskets

17

Concrete Slab on Ground



18

Welded Wire Reinforcement?

11.1.2 *General requirements*—Unless otherwise specified in this Section or in Contract Documents, requirements of Sections 1 through 5 are applicable for industrial floor slabs.

3.3.2.5(b) *Welded wire reinforcement in elevated formed slabs, slabs on noncomposite steel deck, and members not covered in 3.3.2.5(a)*—Use sheets of welded wire reinforcement. Place and support reinforcement before concrete placement to maintain location within tolerances indicated for nonprestressed reinforcement in ACI 117. If reinforcement less than W4.0 or D4.0 is specified, the continuous support spacing shall not exceed 12 in. perpendicular to the direction of span. Lap splice edges and ends of welded wire reinforcement sheets as indicated in Contract Documents.

11.2.5 *Reinforcement*—If specified, use deformed reinforcing bars, tendons, or deformed or plain welded wire reinforcement in conformance with Contract Documents. Supports shall be used at a spacing to result in reinforcement placement in accordance with Contract Documents. If used, welded wire reinforcement shall have a wire spacing of at least 14 in. in both directions.

Per ACI 301 – Supports 12" OCEW

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Steel Fiber Placement

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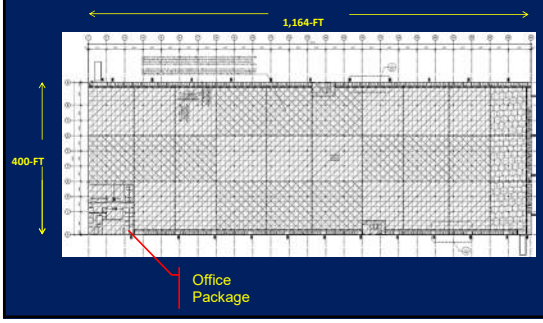
Industrial Project in Pennsylvania



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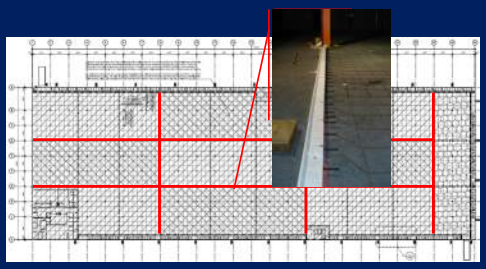
Construction Joints

¾" Round Dowels x 12" OC



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Typical Pour Geometry

What time can we start? Noise Ordinance?
Concrete Production per Hour for Single Plant
Environmental Factors (Sun, Wind, Humidity & Temperature)

23

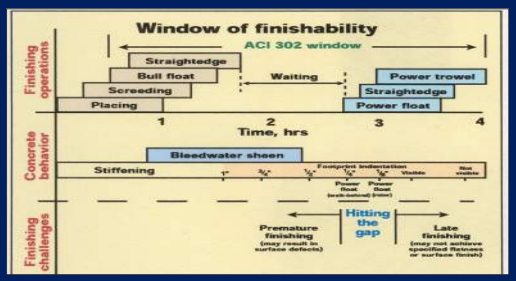
Return to Start Before Cold Joint Develops

24

After Placement

25

Window of Finishability



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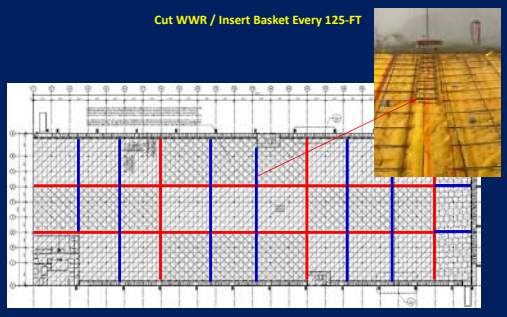
Slip Joints

Cut WWR / Insert Basket Every 125-FT



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Engineer Found SSI Non-Persuasive

28

Deficiencies Caused By Shrinkage and Thermal

8-5-2010
Relative Humidity = 68.3%, Temperature = 79.3°-F
Floor Expands
Joint Filler at Dominant and Construction Joints Extrudes Upward

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Two Forces in Play

30

Drying Shrinkage

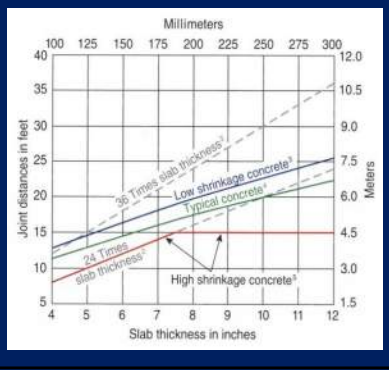
Wait as long as possible to fill your joints!!!

31

Thermal Expansion and Contraction

32

ACI 360 Joint Spacing



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HOW MUCH REINFORCEMENT

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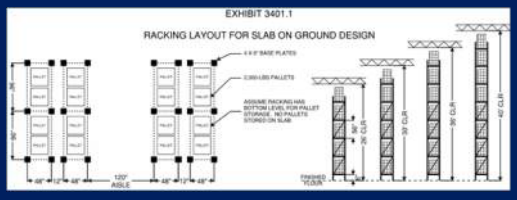
Buildings are Getting Taller



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Slab Thickness & Reinforcement

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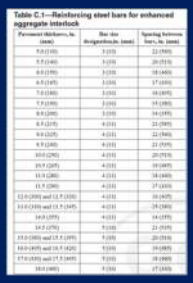
Pavement Thickness & Reinforcement

- ACI 330.2R-17
  - Guide for the Design and Construction of Concrete Site Paving for Industrial and Trucking Facilities



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Expansion Joint Issues

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Expansion Joints

- "Design and Construction of Joints for Concrete Streets" by the American Concrete Pavement Association, 1992.
- "Design and Construction of Joints for Concrete Highways" by the American Concrete Pavement Association, 1992.
- "Guide for Design and Construction of Concrete Parking Lots" by the American Concrete Institute Committee 330, 1997.
- "Proper Use of Isolation and Expansion Joints in Concrete Pavement" by the American Concrete Pavement Association, 1992.
- American Concrete Institute (ACI) publication ACI 224.3R-95 "Joints in Concrete Construction".
- "Expansion Joints in Exterior Pavements?", Concrete International, January 2006.
- "Guide for Design and Construction of Concrete Parking Lots" by the American Concrete Institute Committee 330, 2008.

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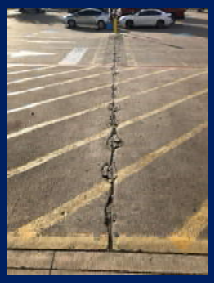
Expansion Joints



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More Steel is Not Better

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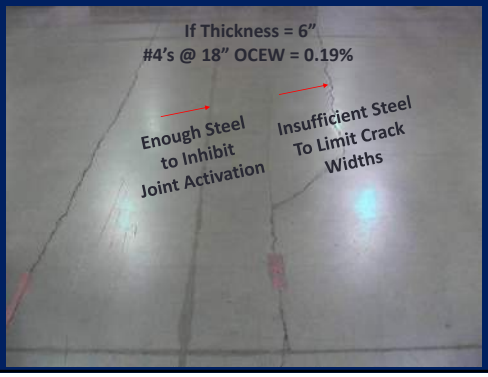
Typical Courthouse(0.11 – 0.3%)



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If Unjointed, Use 5X the Reinforcement Recommended for Jointed Floors

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Design Top Mat for Constructability

44

Crack Width Serviceability

- Limit Stress to Reinforcement
- Design for Crack Widths of 15 ± 10-MILS
- If Thickness = 6", #4's @ 6" OCEW, 1-1/2" Clear.

45

Where to Locate the Reinforcement?

- Jointed Floors
  - Suggested Saw Cutting Depth
    - Early Entry T/5 ± ¼"
    - Wet Cutting T/4 ± ¼"
    - Fiber Enhanced T/3 ± ¼"
  - Depth of Reinforcement
    - T/5 + 1-1/4"
      - Example – If slab is 7" thick, locate rebar 2-3/4" CLR
- Joint Free
  - Depth of Reinforcement
    - 1-1/4 – 1-1/2" CLR
  - Exceptions
    - Wire Guidance Floors.

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DOMINANT JOINT AVOIDANCE

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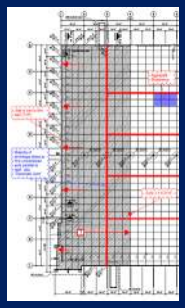
Dominant Joint Location



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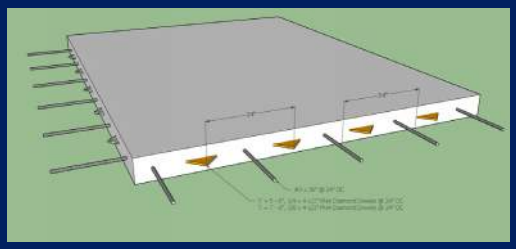
Hybrid Construction Joint



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Changes in Material Handling Equipment




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Limited Joint Floors


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Limited Joint Floors

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Limited Joint Floor Applications

Very Heavy Loads on Hard Wheels

Pile Supported Slabs

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Ground Improvement Sites

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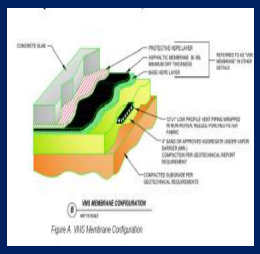
Specialty Sites

- Stone Columns
- Controlled Modulus Columns
- Piles
- Vapor Mitigation Sites



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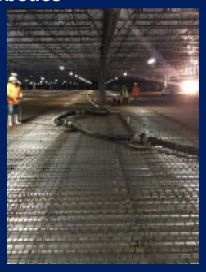
Limited Joint Floor Applications

Floors with Strict Curvature Requirements

Suspended Slabs for Robotics



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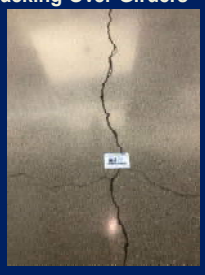
Polished Suspended

Cracking Over Girders



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Shrinkage Compensating Concrete

Armored Joint to Protect Edges

Small Wheels Have No Impact on Joint

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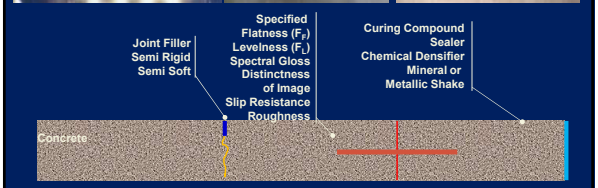
Concrete Slab on Ground



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Industrial Floor Joint Fillers

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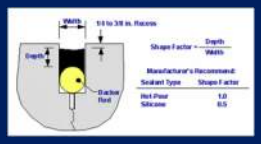
Pavement Fillers

- Silicone Sealants
- Urethane Sealants



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Pavement Fillers

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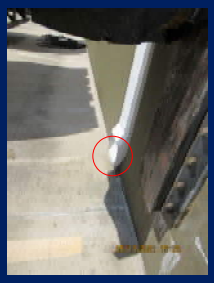
Divert Roof Drains Under Pavements



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Inadequate Joint Sealing

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CONCRETE MIX DESIGN

65

Concrete Mixture Components

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Concrete Components

Cement – Enough to Coat the Aggregates, Make Strength and Provide Good Set Time

Aggregates – Largest, Well Blended Combination Available. Fractured Faces Are Better.

Sand – ACI 302 Blend with Limits on Fineness & Percent Manufactured

Air < 3%

Water – Enough to Produce 2.5 to 3" Slump Prior to Addition of Admixtures

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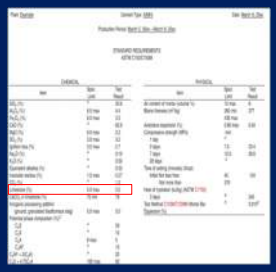
Cements Standards

ASTM C 150

- Type I For use when the special properties specified for any other type are not required.
  - Type IA Air-entraining cement for the same uses as Type I where air-entrainment is desired.
- Type II For general use, more especially when moderate sulfate resistance is desired.
- Type III For use when high early strength is desired.
- Type IV For use when a low heat of hydration is desired.
- Type V For use when high sulfate resistance is desired.



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Supplementary Cementitious

- Fly Ash
- Ground Granulated Blast Furnace Slag
- Metakaolin
- Silica Fume

69

Walmart – 2005 Sustainability Initiative

- 15 – 25% Fly Ash
- Up to 50% Slag

- Delayed Set
- Delayed Bleed
- Timing of Saw Cuts
- Cleaning Challenges

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Cement Standard's Continued

ASTM C595 Blended Cements

- This specification pertains to blended hydraulic cements for both general and special applications, using slag, pozzolan, limestone, or some combination of these, with Portland cement or Portland cement clinker or slag with lime.
  - Type IS Portland blast-furnace slag cement.
  - Type IP Portland-pozzolan cement.
  - Type IL Portland-limestone cement.
  - Type IT Ternary blended cement.
- Portland Blast-furnace Slag Cement - Portland blast-furnace slag cement shall be a hydraulic cement in which the slag constituent is up to 95% by mass of the blended cement. Portland blast-furnace slag cement with a slag content equal to or exceeding 70% by mass, is permitted to contain hydrated lime.
- Portland-pozzolan Cement - Portland-pozzolan cement shall be a hydraulic cement in which the pozzolan constituent is up to 40% by mass of the blended cement.
- Portland-limestone Cement - Portland-limestone cement shall be a hydraulic cement in which the limestone content Is more than 5% but less than or equal to 15% by mass of the blended cement.

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Amazon - Net-Zero Carbon by 2040

Traditional Tests

- Compressive
- Flexural
- Air
- Slump

Subjective Tests

- Mixability
- Placeability
- Finishability
- Bleeding
- Setting
- Saw Cutting
- Appearance
- Long Term Observations

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Mohs Hardness

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Amazon – Net-Zero Carbon by 2040

- Petrographic
- Abrasion
- Mohs
- Polished Concrete

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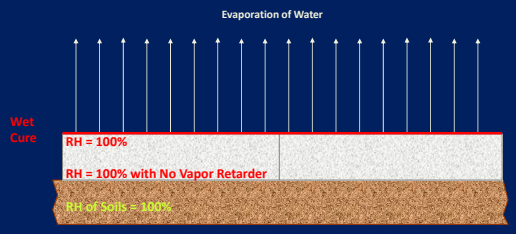
DIFFERENTIAL SHRINKAGE & CURLING

75

All Slabs with Joints or Cracks are Subject to Curl



Newly Placed Concrete

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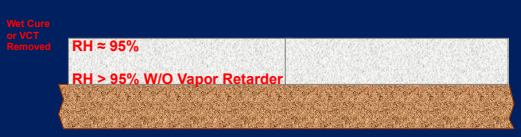
All Slabs with Joints or Cracks are Subject to Curl



Newly Placed Concrete

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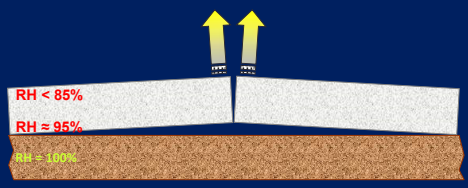
Slab Lifts-Off Base



During and After Drying

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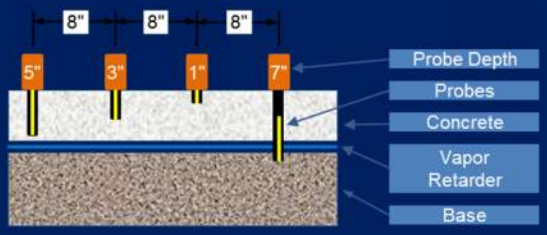
Measuring Moisture Gradient



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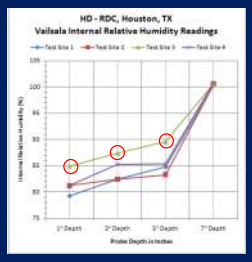
Differential Moisture with and without Intact Vapor Retarder



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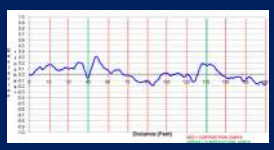
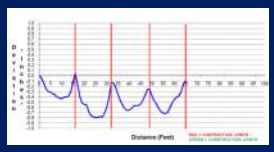
Curling at Joints
Warm Moist VS Cold Dry Environments

Warm Moist – No Curling Signature (Houston)



Cold Dry – Significant Curling Signature (Eagan, MN)



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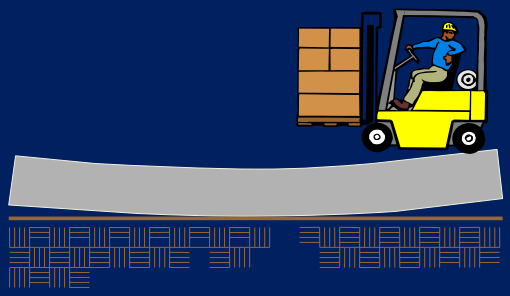
Slab Curling



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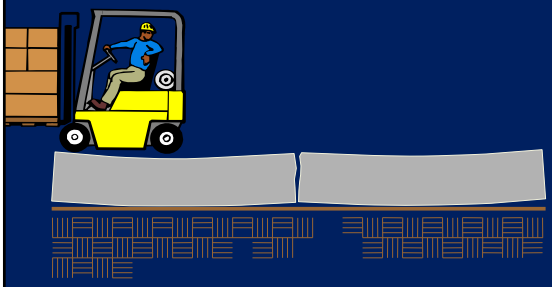
Slab Curling



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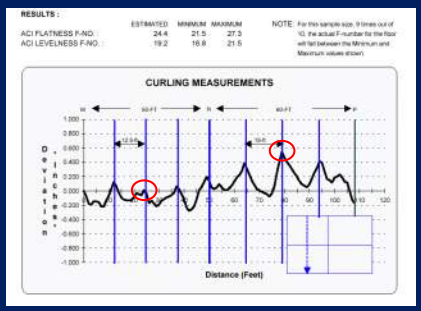
Saw Cut Spacing Impacts Curl



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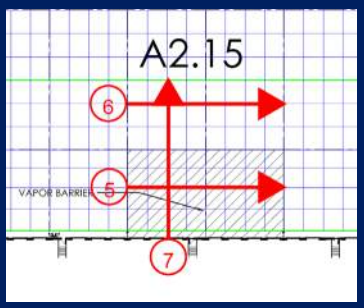
Curling Profiles
Vapor Retarder VS No Vapor Retarder



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Moisture Injected Base

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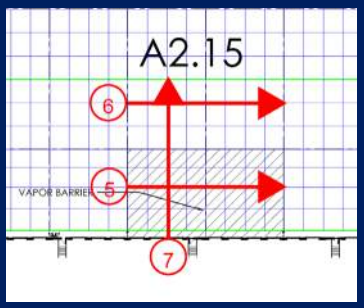
Curling Profiles
Vapor Retarder VS No Vapor Retarder



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Vapor Retarder to No Vapor Retarder

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Migrating to Vapor Retarders

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Vapor Retarder

Moisture Sensitive Flooring & Adhesivies

Sweating Slab Avoidance

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With & Without Vapor Retarder

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With & Without Vapor Retarder

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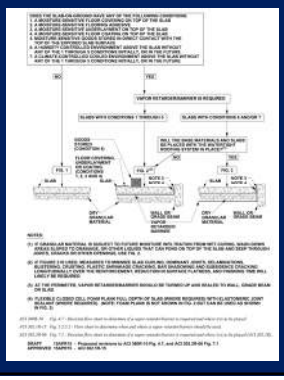
Refer to ACI 302 & 360



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Install it Properly

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Strategies

HVLS Fans to Warm Surface and Mix Air

Open Pore Voids by Grinding or Shotblasting, Coating Surface

95

ViewLinc Sweating Slab Resolution

Measuring Temperature, Humidity, Dew Point and Slab Surface Temperature

Measuring Temperature, Humidity and Dew Point

96

Control the Rapid Introduction of Highly Saturated Air

Interlock with Exhaust Fans & Louvers

ViewLinc Measures, Records, Reports and Controls Exhaust Fan Operation

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PRESLAB CONFERENCE

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Preslab Conference

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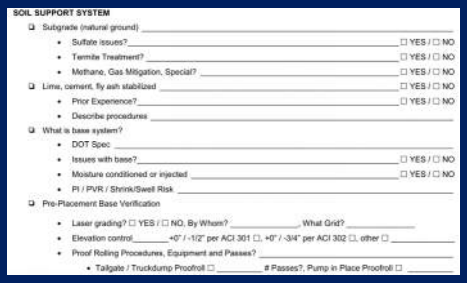
Base Prep



SOIL SUPPORT SYSTEM

- Subgrade (natural ground) _____
  - Sulfate issues? _____ ☐ YES / ☐ NO
  - Termite Treatment? _____ ☐ YES / ☐ NO
  - Methane, Gas Mitigation, Special? _____ ☐ YES / ☐ NO
- Lime, cement, fly ash stabilized _____ ☐ YES / ☐ NO
  - Prior Experience? _____ ☐ YES / ☐ NO
  - Describe procedures _____
- What is base system?
  - DOT Spec _____
  - Issues with base? _____ ☐ YES / ☐ NO
  - Moisture conditioned or injected _____ ☐ YES / ☐ NO
  - PI / PVR / Shrink/Swell Risk _____
- Pre-Placement Base Verification
  - Laser grading? ☐ YES / ☐ NO, By Whom? _____, What Grid? _____
  - Elevation control _____ +0" / -1/2" per ACI 301 ☐, +0" / -3/4" per ACI 302 ☐, other ☐ _____
  - Proof Roling Procedures, Equipment and Passes? _____
    - Tailgate / Truckdump Proofroll ☐ _____ # Passes?, Pump in Place Proofroll ☐ _____

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Proof Roll

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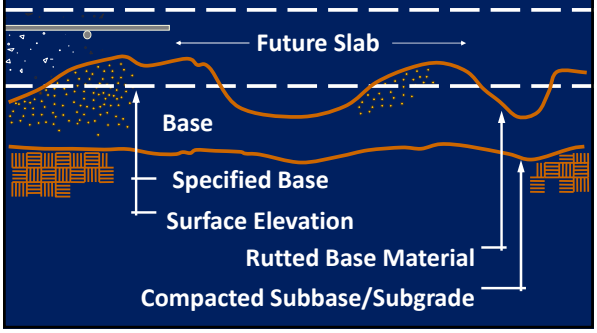
Base Rutted from Construction



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Tailgate VS Pump Proofroll

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104

Impact Echo

105

Assess Trends

106

MAINTENANCE

107

Regularly Inspect Floor

- Year 1
  - Inspect 4X per Year
- Years 2 - 3
  - Inspect 2X per Year
- Years 4 and Beyond
  - Inspect Annually

108

Use the Right Brushes

- No Heavy Gauge Silica Carbide
- No Silica Carbide Impregnated
- No Steel Impregnated Cylinder Brushes
- No backup pad holders without the pad!

109

Keep it Moving

- Keep the machine moving or lift the brushes!
- Use Soft Nylon, Natural Fiber of Light Duty Polypropylene Brushes for Daily Cleaning

110

Use pH Neutral Detergents and Well-Maintained Scrubbers

Don't be a Chemist!

Regularly Scrub to Remove Salts, Dirt, Oils, Carbon Deposits

111

INDUSTRIAL PAVEMENTS

112

Dolly Pad Loads

113

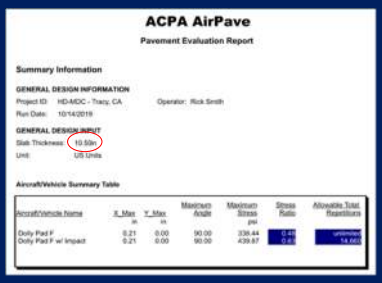
Dolly Pads & Terminal Tractors

114

Pavements

115

Additional 2 or 3" of Concrete



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Terminal Tractors

Adds 2" of Thickness

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Thank You!

Any Questions?

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