INDUSTRIAL FLOORS, SUSPENDED SLABS & PAVEMENTS

Rick Smith
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www.ssiteam.com

Who is SSI?

What Is SSI?

Who Do We Service?

Our Professional Affiliations

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

ANATOMY OF A FLOOR SLAB
Concrete Slab on Ground

- Concrete
- Subbase
- Subgrade
- Vapor Retarder
- Isolation Joint aka - Expansion joint
- Construction Joint aka - Formed joint
- Contraction Joint aka - Control Joint

Saves 5 – 7% on Annual Climate Control Expense

Joint Faulting Due to No Positive Load Transfer

- Retail – Trip Hazards
- Office – Floor Covering Distress
- Industrial – Joint Distress, Wheel and Equipment Damage

Least expensive to build

MOST EXPENSIVE TO MAINTAIN
Non-Reinforced Spec Warehouse in PA

Joints ground flush
Wrong Joint Filler

Non-Reinforced Spec Warehouse in PA

Structural Nosing Repair
Joint Stabilization via Grout or Foam Undergrouting

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

Installing Dowel Baskets
Dowel Baskets Must Be Staked
Cutting Basket Wires Makes the Basket Unstable. 3 Plates Minimum.

Drawback to Dowel Baskets

45% of Joints in Speed Bay were Unstable
Cracks Away from Dowels Are Not Stable

Concrete Slab on Ground

Deformed Reinforcement
Fiber Reinforcement
Smooth Dowel Plate Dowel
Welded Wire Reinforcement?

Per ACI 301 – Supports 12" OCEW

Steel Fiber Placement

Industrial Project in Pennsylvania

Construction Joints

Typical Pour Geometry

Return to Start Before Cold Joint Develops
After Placement

Window of Finishability

Slip Joints

Engineer Found SSI Non-Persuasive

Deficiencies Caused By Shrinkage and Thermal

Two Forces in Play
Drying Shrinkage

Wait as long as possible to fill your joints!

Thermal Expansion and Contraction

ACI 360 Joint Spacing

How much reinforcement

Buildings are Getting Taller

Slab Thickness & Reinforcement
Pavement Thickness & Reinforcement

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

Expansion Joint Issues

- "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 Pavements" by the American Concrete Pavement Association, 1992.
- "Guide for Design and Construction of Concrete Parking Lots" by the American Concrete Institute Committee 330, 2008.

Expansion Joints

- "Design and Construction of Joints for Concrete Streets" by the American Concrete Pavement Association, 1992.
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- "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".
- "Guide for Design and Construction of Concrete Parking Lots" by the American Concrete Institute Committee 330, 2008.

More Steel is Not Better

Typical Courthouse (0.11 – 0.3%)
If Unjointed, Use 5X the Reinforcement Recommended for Jointed Floors

Design Top Mat for Constructability

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.

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 near 2-3/4” CLR

- Joint Free
  - Depth of Reinforcement
    - 1-1/4 – 1-1/2’ CLR
  - Exceptions
    - Wire Guidance Floors.

Dominant Joint Location

DOMINANT JOINT AVOIDANCE
Hybrid Construction Joint

Changes in Material Handling Equipment

Limited Joint Floors

Limited Joint Floors

Limited Joint Floor Applications

Ground Improvement Sites
Specialty Sites

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

Limited Joint Floor Applications

Floors with Strict Curvature Requirements
Suspended Slabs for Robotics

Polished Suspended

Cracking Over Girders

Shrinkage Compensating Concrete

Armored Joint to Protect Edges
Small Wheels Have No Impact on Joint

Concrete Slab on Ground

Industrial Floor Joint Fillers

Curing Compound
Semi Rigid
Semi Soft
Joint Filler
Mineral or Metallic Shave
Pavement Fillers

- Silicone Sealants
- Urethane Sealants

- Divert Roof Drains Under Pavements

- Inadequate Joint Sealing

Concrete Mixture Components

- Sand ASTM C33
- Natural Manufactured Blend
- Aggregate ASTM C33
- Chemical Admixtures
- Mineral Admixtures Fly Ash GGBFS Silica Fume
- Cement ASTM C 150 Type I, II, III, V Now w/5% Inter-ground Limestone

CONCRETE MIX DESIGN
Concrete Components

- Aggregate - Largest, Well Blended Combination Available. Fractured Faces are Better.
- Sand – ACI 302 Blend with Limits on Fineness & Percent Manufactured
- Water – Enough to Produce 2.5 to 3" Slump Prior to Addition of Admixtures

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.

Supplementary Cementitious

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

Walmart – 2005 Sustainability Initiative

- 15 – 25% Fly Ash
- Up to 50% Slag
- Delayed Set
- Delayed Bleed
- Timing of Saw Cuts
- Cleaning Challenges

Cement Standards' Continued

- 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.

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
Mohs Hardness

Amazon – Net-Zero Carbon by 2040
- Petrographic
- Abrasion
- Mohs
- Polished Concrete

DIFFERENTIAL SHRINKAGE & CURLING

All Slabs with Joints or Cracks are Subject to Curl

Slab Lifts-Off Base
Measuring Moisture Gradient

Differential Moisture with and without Intact Vapor Retarder

Curling at Joints
Warm Moist VS Cold Dry Environments

Warm Moist – No Curling Signature (Houston)
Cold Dry – Significant Curling Signature (Eagan, MN)

Slab Curling
Saw Cut Spacing Impacts Curl
With & Without Vapor Retarder

Hygroscopic Salts from Soils
Calcium & Potassium Hydroxides

Refer to ACI 302 & 360

Install it Properly

Strategies
HVLS Fans to Warm Surface and Mix Air
Open Pore Voids by Grinding or Shotblasting, Coating Surface

ViewLinc Sweating Slab Resolution
Measuring Temperature, Humidity, Dew Point and Slab Surface Temperature
Measuring Temperature, Humidity and Dew Point
Control the Rapid Introduction of Highly Saturated Air

Interlock with Exhaust Fans & Louvers

ViewLinc Measures, Records, Reports and Controls Exhaust Fan Operation

PRESLAB CONFERENCE

Preslab Conference

Base Prep

Base Rutted from Construction

Future Slab

Specified Base

Surface Elevation

Compacted Subbase/Subgrade

Rutted Base Material
MAINTENANCE

- **Tailgate VS Pump Proofroll**

- **Impact Echo**

- **Assess Trends**

- **Regularly Inspect Floor**
  - Year 1
    - Inspect 4X per Year
  - Years 2 - 3
    - Inspect 2X per Year
  - Years 4 and Beyond
    - Inspect Annually
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!

Keep it Moving

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

Use pH Neutral Detergents and Well-Maintained Scrubbers

Don't be a Chemist!

Regularly scrub to remove salts, dirt, oils, carbon deposits

INDUSTRIAL PAVEMENTS

Dolly Pad Loads

Dolly Pads & Terminal Tractors
Pavements

Terminal Tractors

Additional 2 or 3” of Concrete

Thank You!

Any Questions?

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