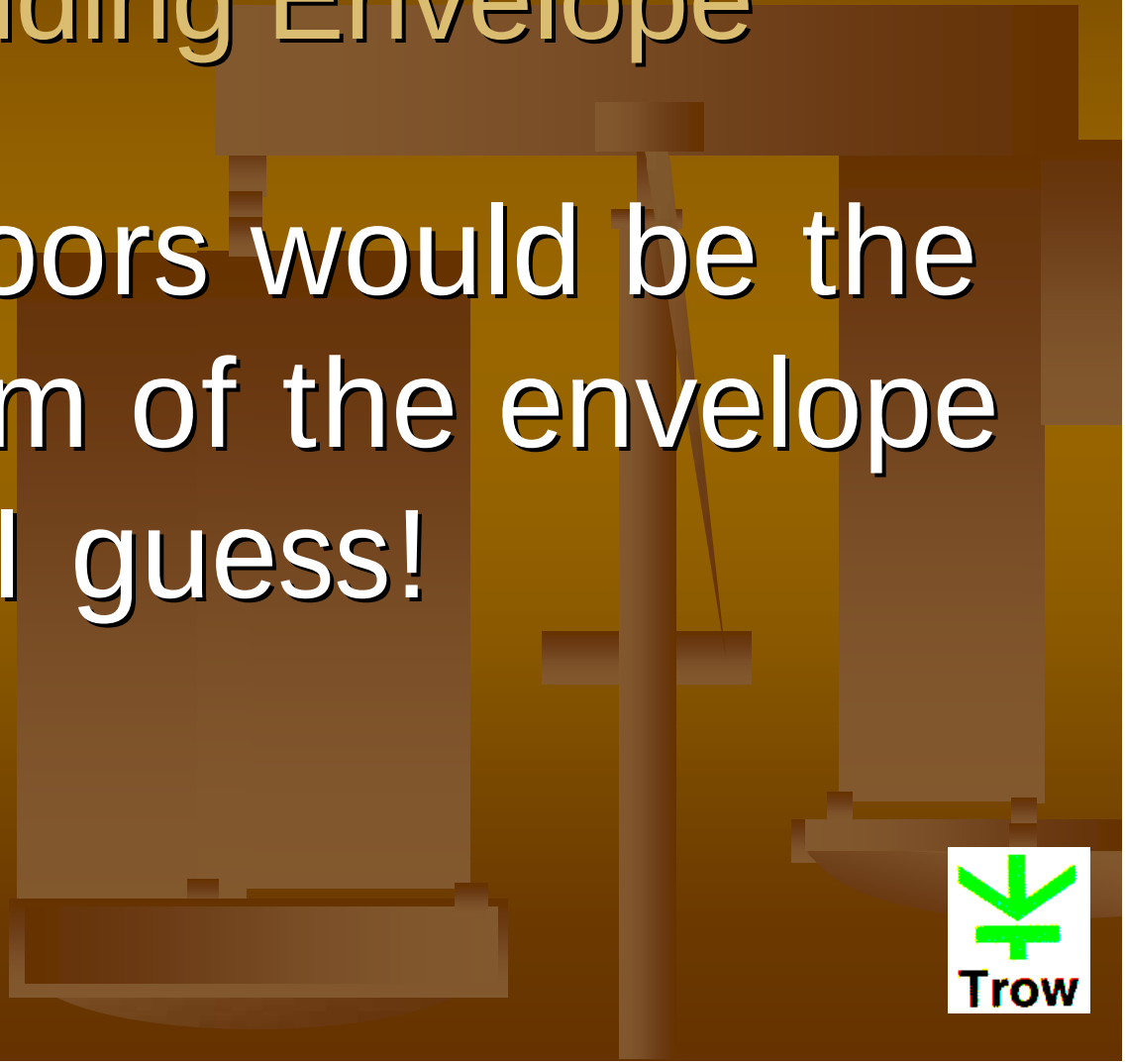
Concrete Floors

Understanding Concrete Properties that may Cause You Grief

Presented by Peter Waisanen, P.Eng.

Concrete Floors as part of The Building Envelope

Concrete floors would be the very bottom of the envelope I guess!



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What this presentation covers

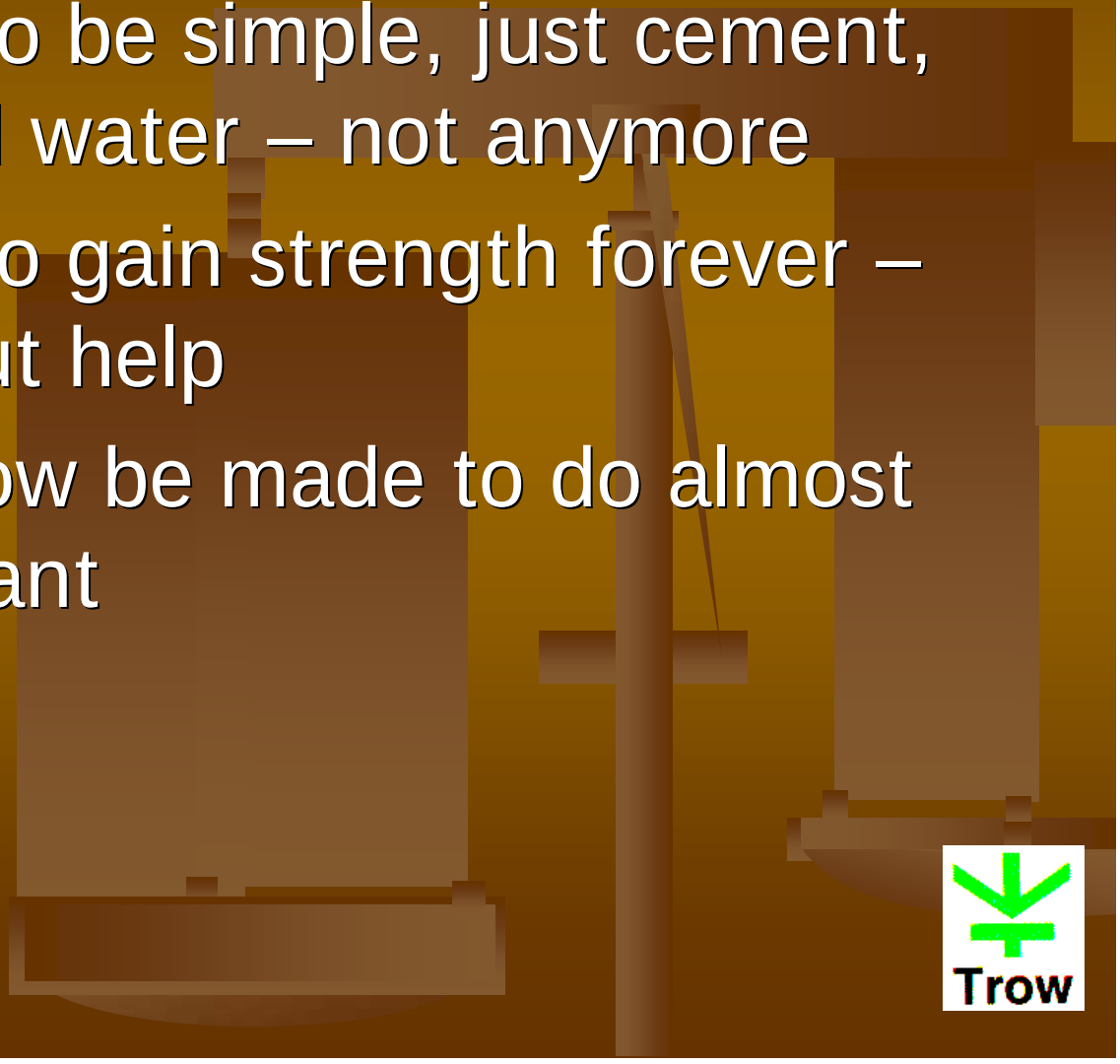
- Parts of a slab
- When and where problems occur
- What kind of problems I have found
- How to avoid the problems

Where Problems Can Occur

- During Slab Design
- During Construction
- After Slab Construction

Concrete Has Changed

- Concrete used to be simple, just cement, sand, stone and water – not anymore
- Concrete used to gain strength forever – now, not without help
- Concrete can now be made to do almost anything you want



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Parts of a Slab

Excellent floor with appropriate jointing and only minimal curling

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Parts of a Slab

Construction joint showing dowels bars and control joint with crack below it

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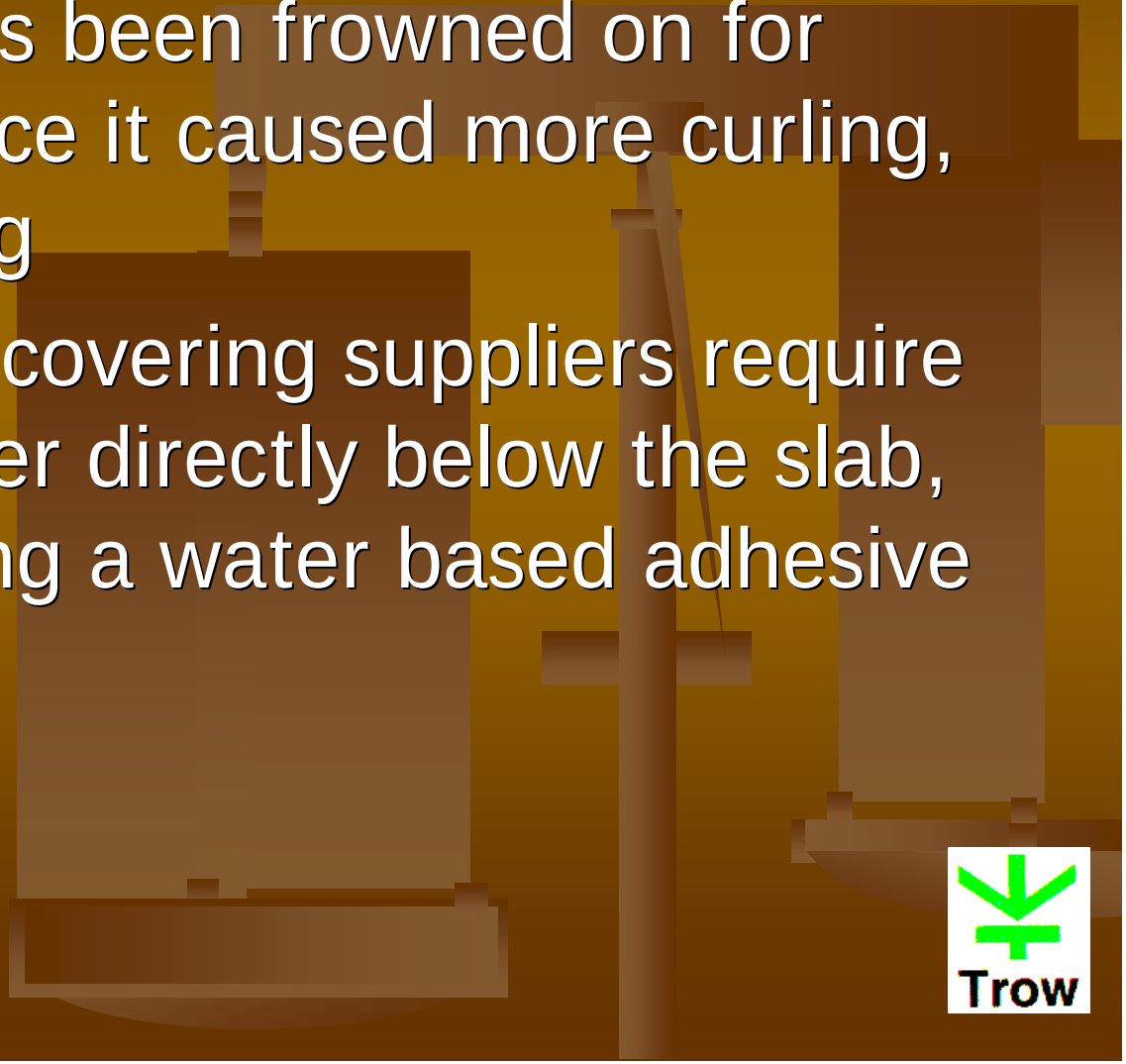
Design Issues

- LEED design concepts have increased the use of SCM's
  - SCM's change the properties of concrete
  - SCM's have been used for decades
- What kind of floor covering is going on top affects what you put below
- How much strength do you really need?
- Super flat floors

Plastic below the slab?

- This practice has been frowned on for many years, since it caused more curling, delayed finishing
- Now most floor covering suppliers require a vapour retarder directly below the slab, especially if using a water based adhesive



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Armstrong Flooring

- Excerpt from Armstrong Installation Std. for On-Grade Concrete:
  - The concrete slab must be protected from ground moisture with a 4” capillary break subbase and an effective and intact vapor retarder having a maximum permeance of 0.3 perms....
  - For below grade concrete the maximum allowable permeance drops to 0.1 perms.

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When to install vinyl?

- Even with careful mix design and placement of an appropriate vapour retarder it takes a long time to dry out the concrete to a level to accept vinyl adhesives
- The literature says it takes one month per inch of thickness to dry to a level where water based adhesives will survive

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How do you know it is ready?

- The old way is to measure the Moisture Vapour Emission Rate of the slab with the Calcium Chloride test
  - It doesn't really tell you much
- RH probe is the best
  - You need between 75 and 80% RH measured at 40% of the depth of the slab
- With no Vapour Retarder the numbers don't matter, since ground vapour will govern

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The Best Way to Measure RH

- The Wagner Rapid RH probe stays in the floor and can monitor RH for weeks if required
- This is actually the reader unit which plugs into the sensor in the floor

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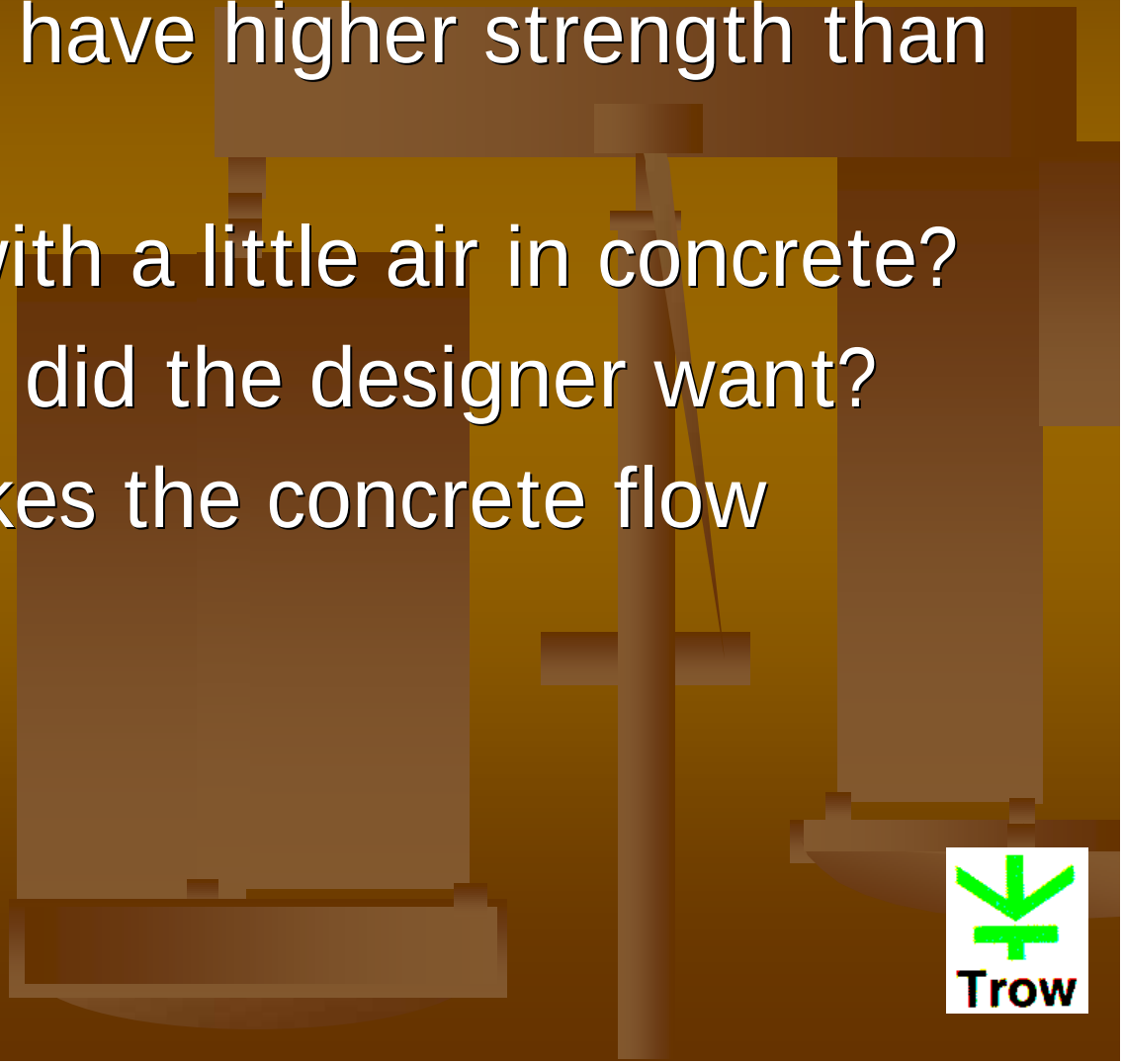
Concrete Supply

- Isn’t it better to have higher strength than specified?
- What’s wrong with a little air in concrete?
- How much fiber did the designer want?
- More water makes the concrete flow better, right?



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High Strength leads to….

- Excessive curling at joints
- Excessive shrinkage
- Large vertical movements under load
- Low load transfer across joints

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Eventually leads to….

Slab fractures

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And…..

Excessive joint wear

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As well as…

Slab broken below dowel at construction joint due to excessive movement of joint

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How to fix excessive curling

- Fill the void under the slab with grout or foam
- This stabilizes the slab

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How to fix excessive curling

Foam visible at bottom of core

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How to fix excessive curling

Grinding slab at joint removes bump and reduces impact damage to forklifts

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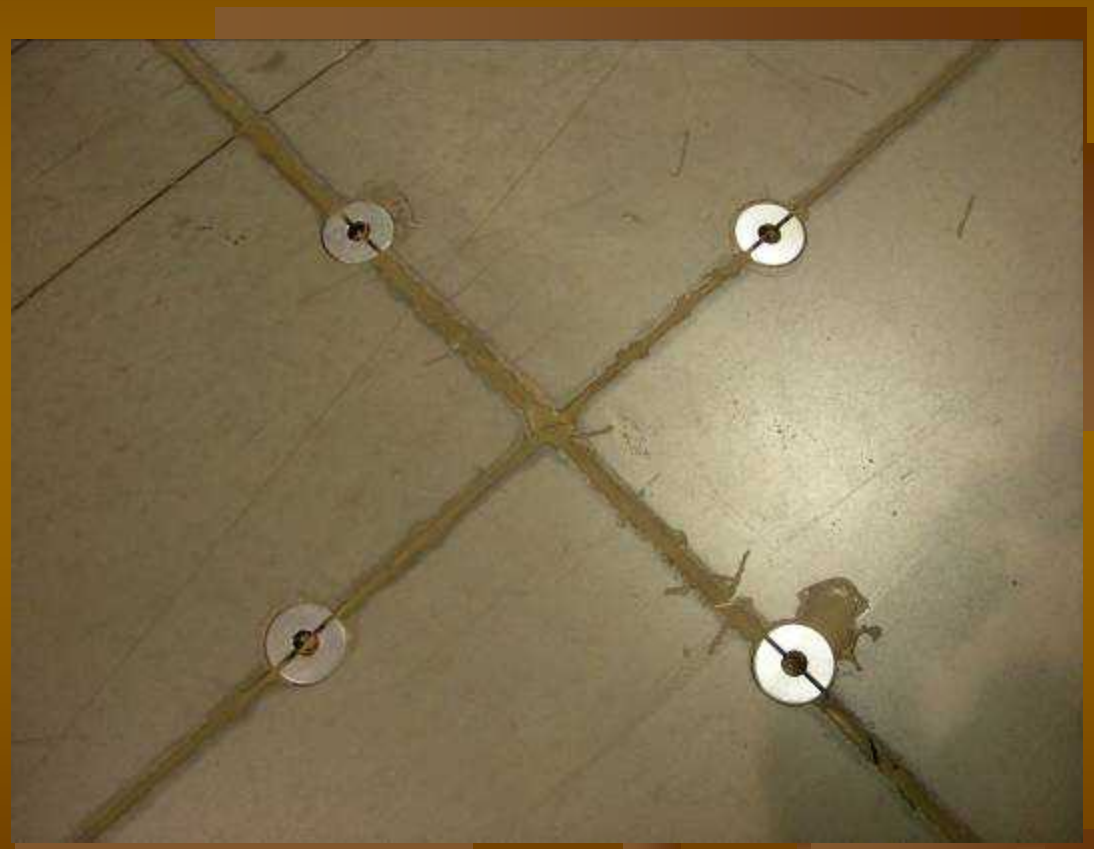
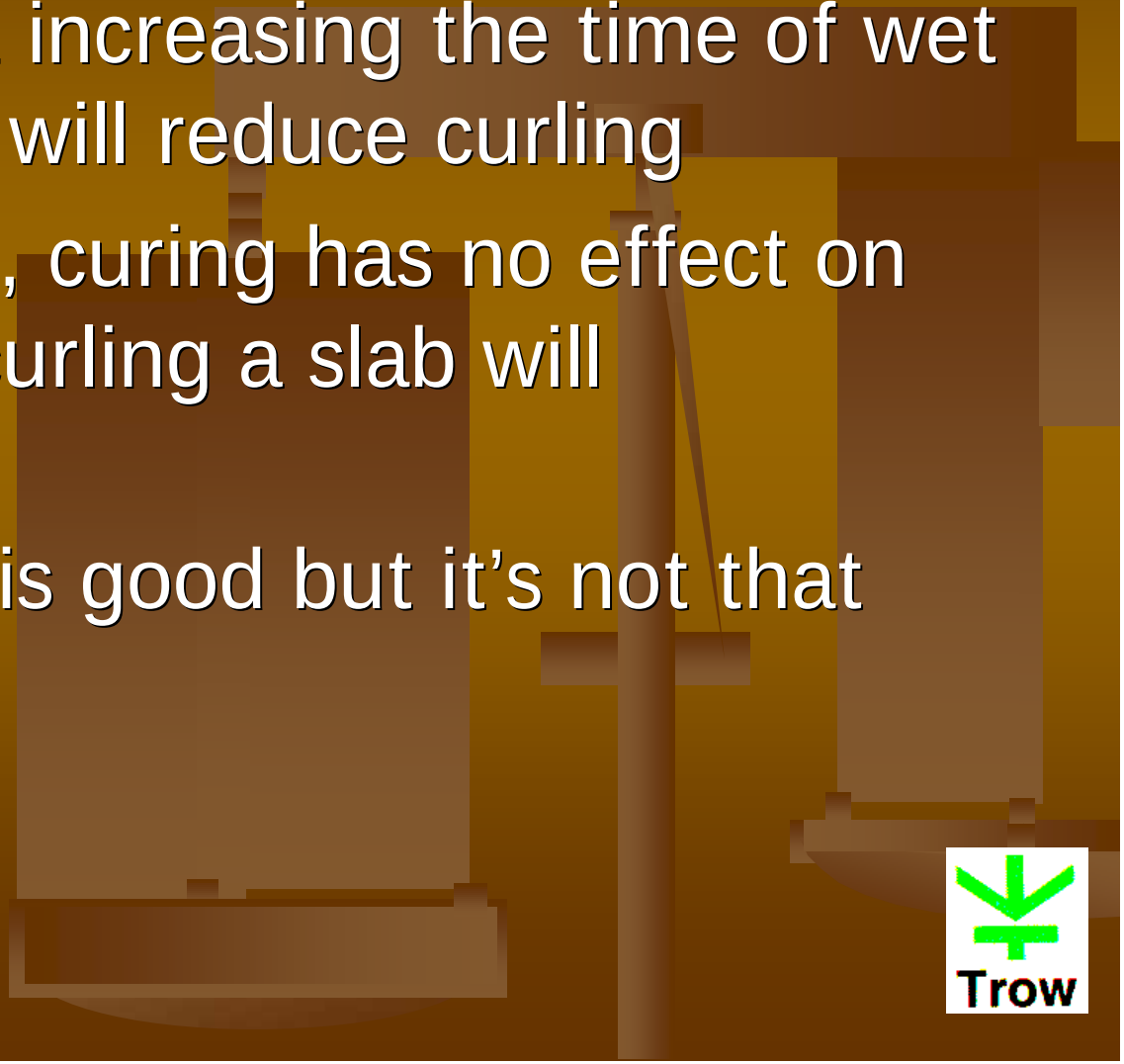
How to stabilize a moving joint

- Use the SD-7 Joint Saver from Surface Dynamics Canada
- United Floor Co. handles installation
- They say you can even grind down the surface after installation



Curling and Curing

- Some think that increasing the time of wet curing of a slab will reduce curling
- They are wrong, curing has no effect on the amount of curling a slab will experience
- Curing the slab is good but it's not that good



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What's Up With Air?

- If you're not using mechanical finishing equipment or steel trowels use as much air as you want, i.e., driveways, sidewalks
- The literature says anything over 3% is too much for finished interior concrete slabs
- What if it is just entrapped air?
- What is the problem with air?

The Problem with Air

- Excessive air in concrete can make the concrete appear ready to finish prior to the bleeding process being complete
- Finishing early can trap bleed water below the surface, and it's worse with traprock
- We have measured air contents of failed concrete as high as 17%, and it wasn't supposed to have any air.
- Most non-air entrained concretes have between 1 and 2% entrapped air

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High Air makes…

- ...crazing to go crazy
- This concrete is actually delaminated
- Top ¼ inch is separate from base concrete

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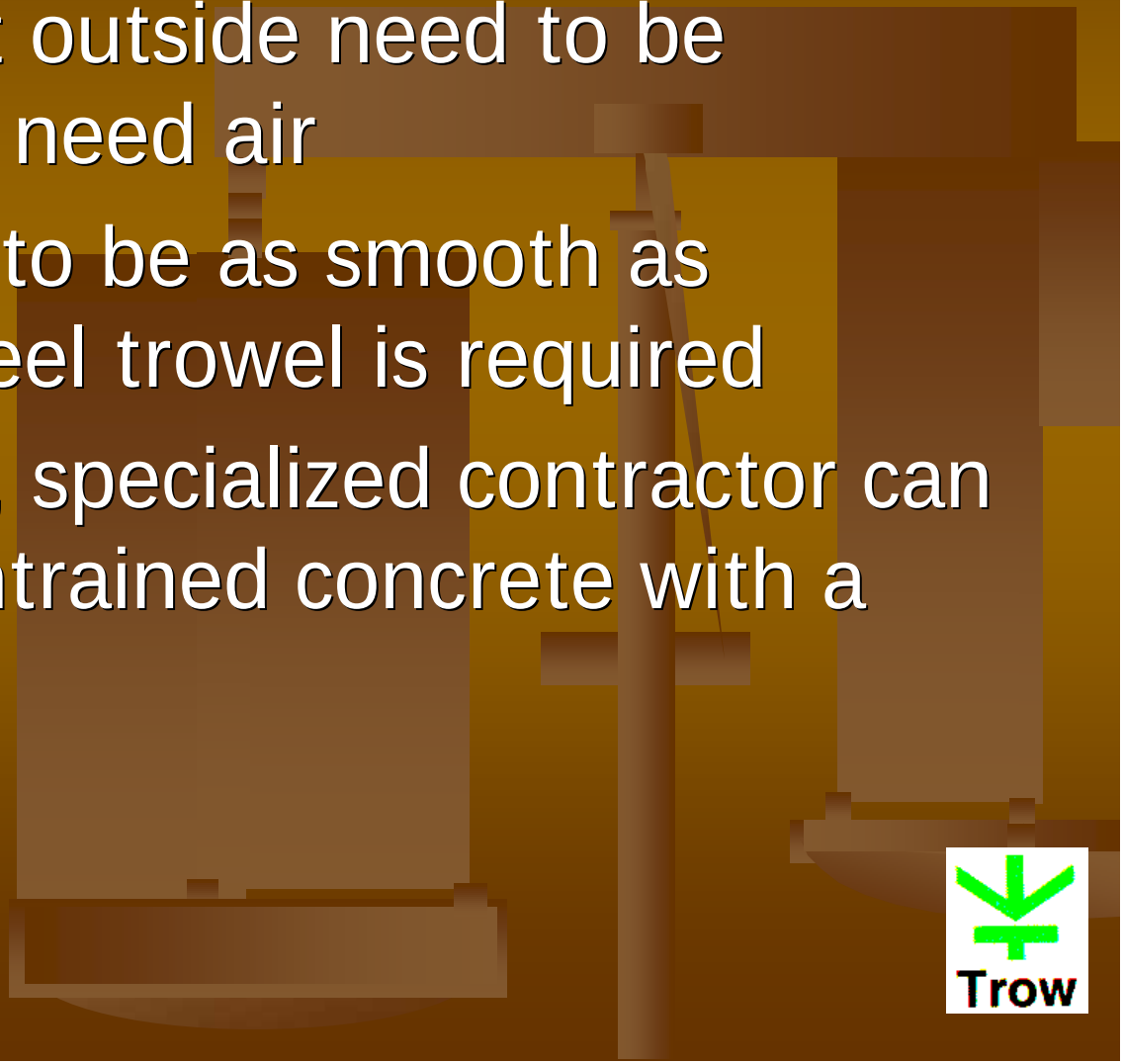
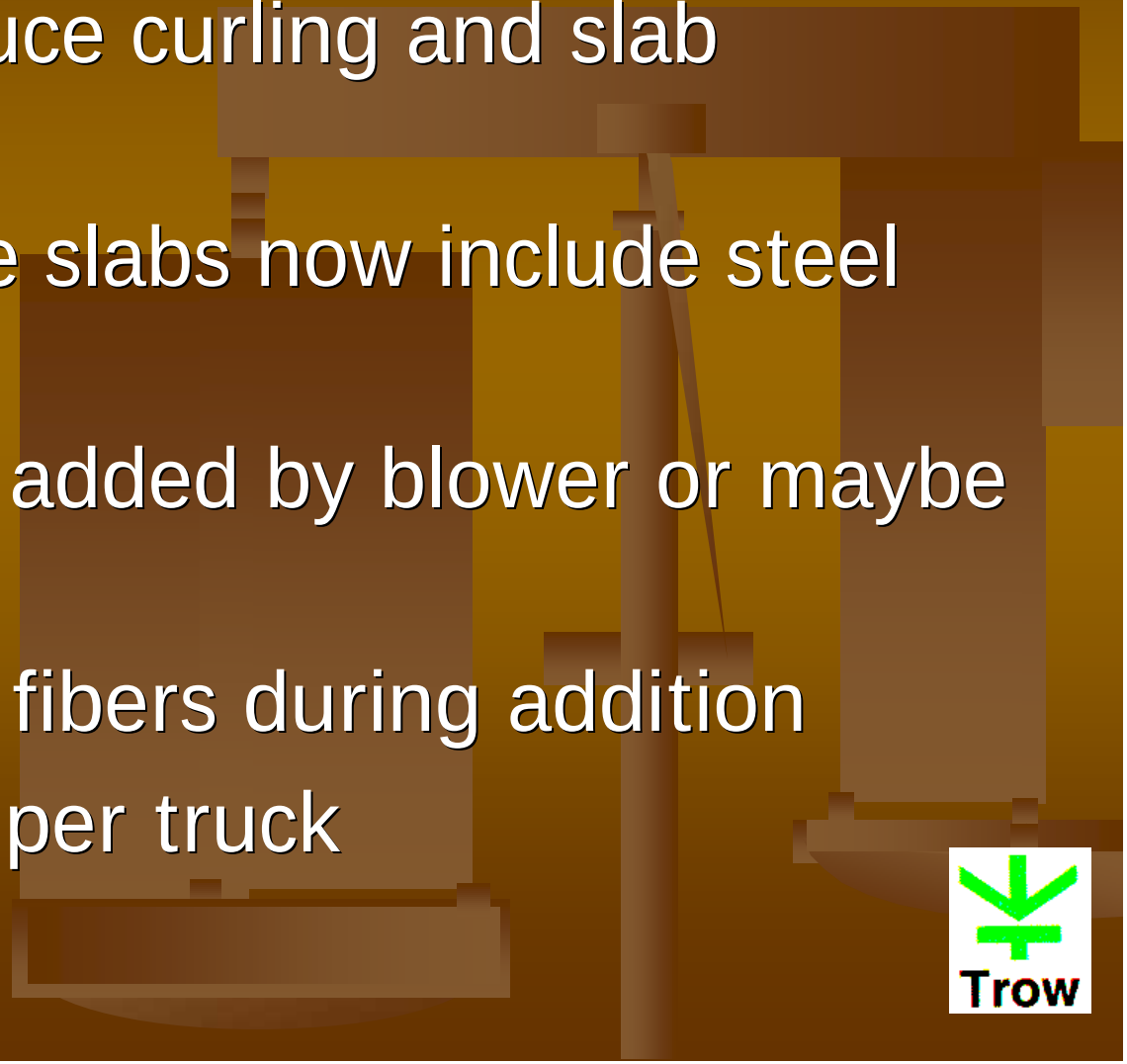
What about Skateparks

- Skateparks built outside need to be durable so they need air
- They also need to be as smooth as possible so a steel trowel is required
- An experienced, specialized contractor can finish this air-entrained concrete with a steel trowel



Fiber in Your Diet

- Steel fibers reduce curling and slab thickness
- Most warehouse slabs now include steel fiber
- Fiber should be added by blower or maybe conveyor
- Avoid balling of fibers during addition
- Count the bags per truck



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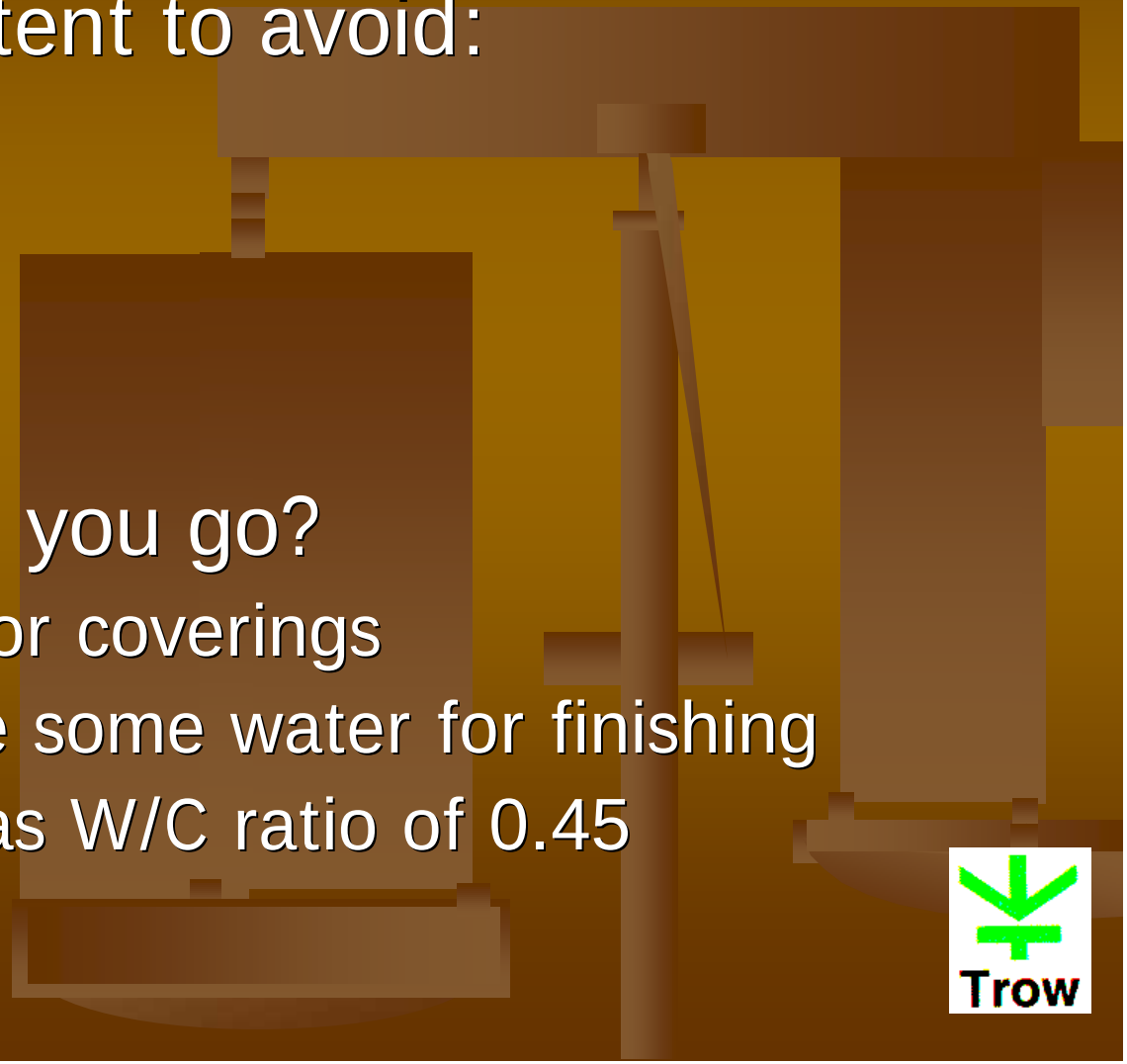
Water Issues

- Limit water content to avoid:
  - Low strength
  - High shrinkage
  - Weak surface
  - Vinyl failures
- How low should you go?
  - Depends on floor coverings
  - There has to be some water for finishing
  - Can go as low as W/C ratio of 0.45



Cold Weather Construction

Suspended slab placed with inadequate protection from freezing temperatures

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Cold Weather Construction

- Yes, this is concrete that is supposed to be for an office slab

Vinyl on Concrete Slab-on-Grade

Vinyl adhesive bleeding through joints

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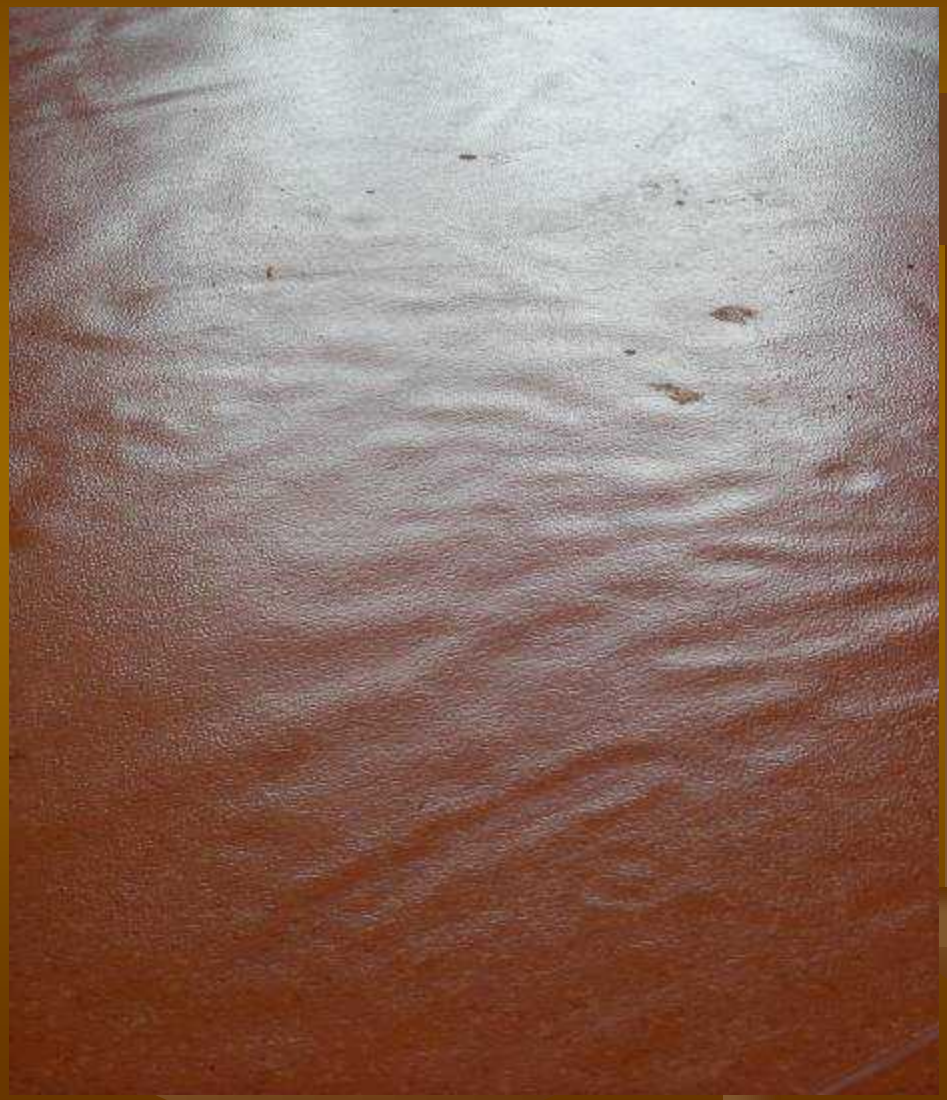
Vinyl on Concrete

- Rutting and bubbling are signs of failure



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Vinyl on Concrete

Adhesive has re-emulsified

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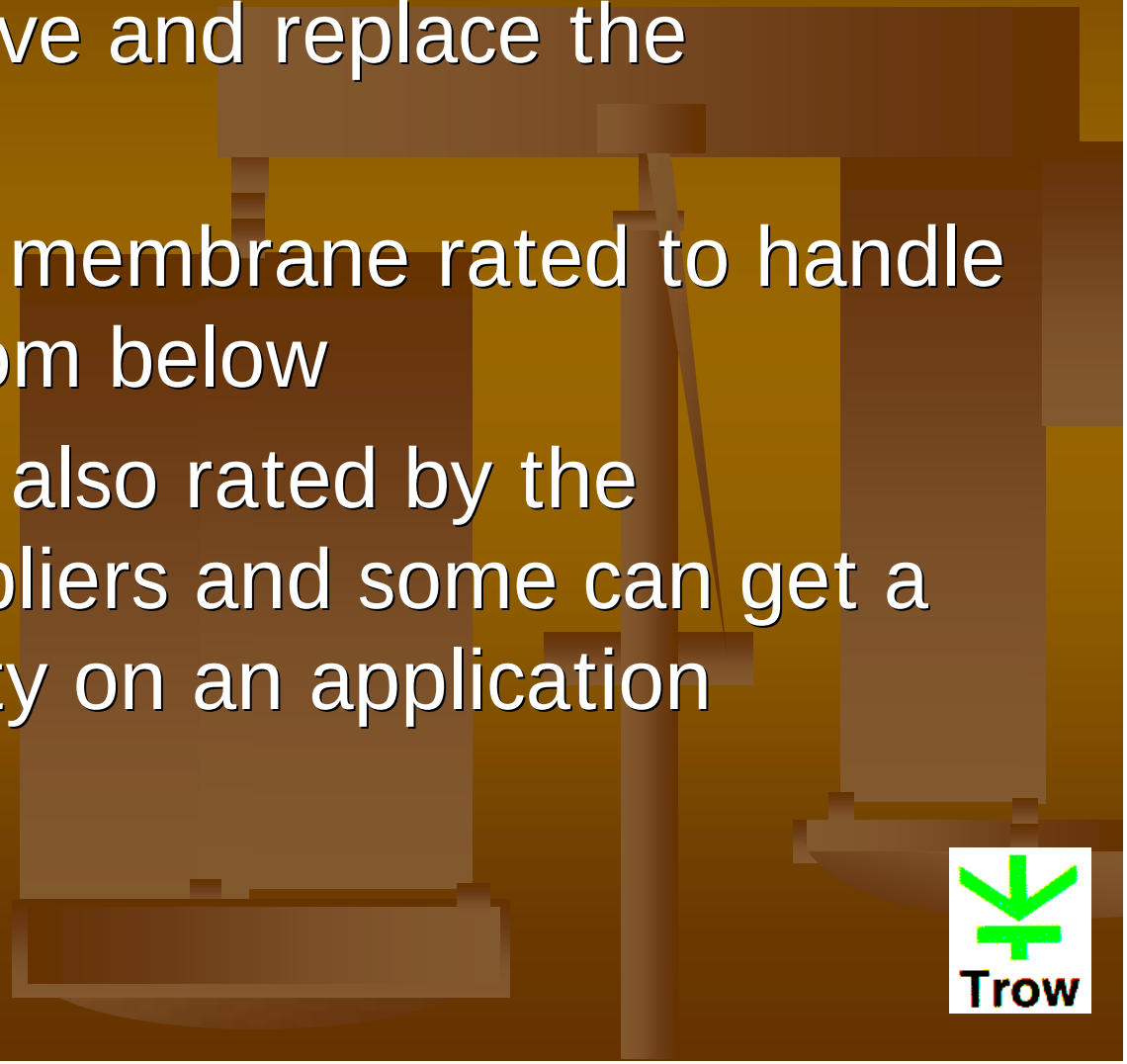
How to fix a wet slab?

- You could remove and replace the concrete or,
- Apply a surface membrane rated to handle the moisture from below
- Contractors are also rated by the membrane suppliers and some can get a 15 year warranty on an application



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Or…Do It Right in the First Place

- Install a vapour retarder below the slab
- My U of T prof told me to insulate the slab instead, like in Sweden
- In the hospital project we reviewed earlier the slab at the perimeter of the walls was insulated for the first 4 feet
- There were no adhesive failures in this area

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Accelerated Construction

Slab damaged during placement due to leaks in unfinished roof.

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Accelerated Construction

Tile installed before heat turned on with continuous grouted joints.

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The Right Concrete but…

Interior concrete exposed to exterior weather leads to scaling.

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…At the Wrong Time

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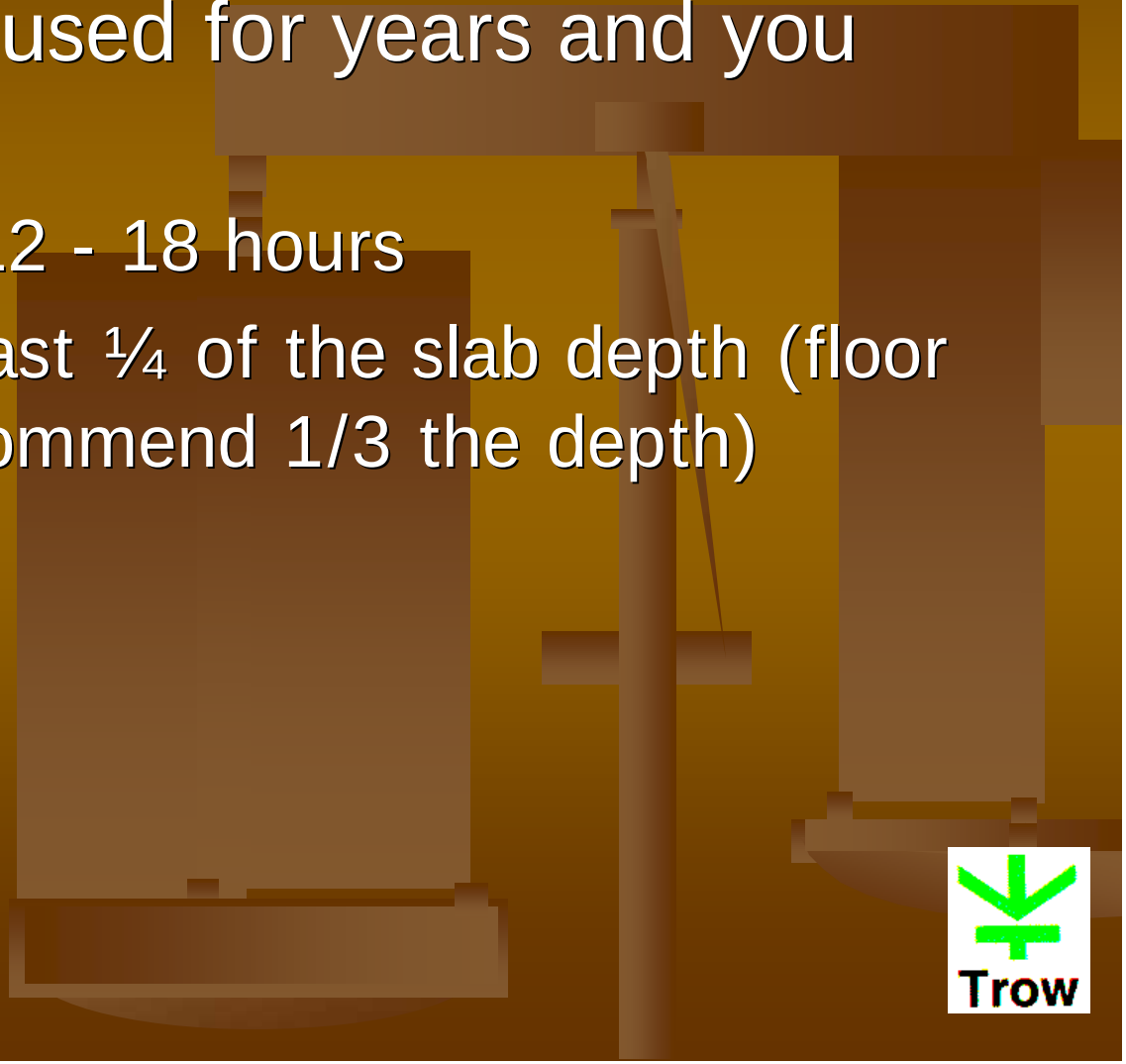
What about control joints?

- Wet saws were used for years and you needed to...
  - Sawcut within 12 - 18 hours
  - Sawcut to at least ¼ of the slab depth (floor contractors recommend 1/3 the depth)



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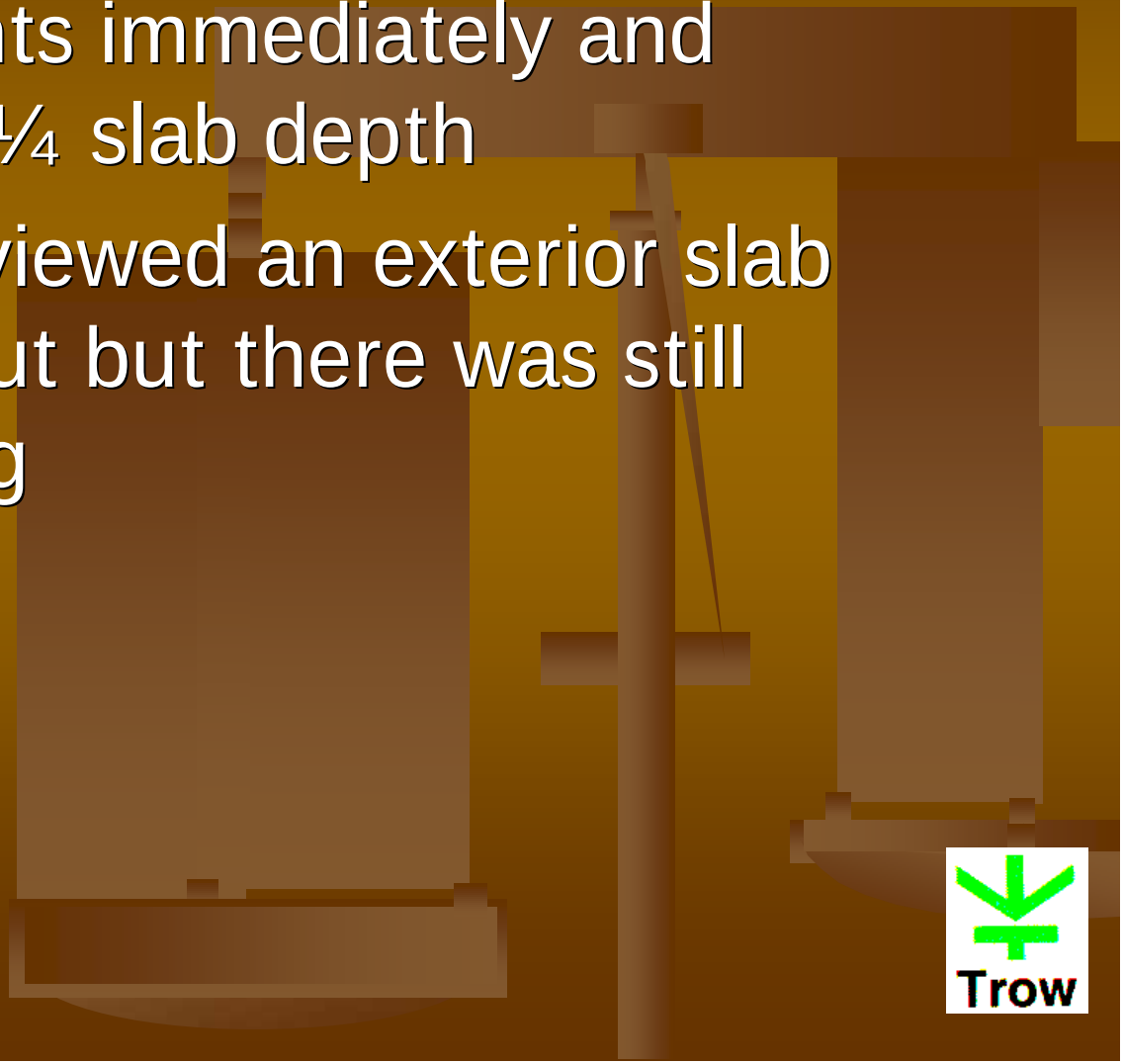
Today Soff-Cut is Standard

- You can cut joints immediately and shallower than ¼ slab depth
- However we reviewed an exterior slab that was Soff-Cut but there was still random cracking



Where slab is tied to caisson

- We have seen this in a few projects
- As the slab shrinks it will apply stress at ends of rebar
- Corner cracks could occur at columns
- Sawcuts at end of bars would help

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Joint Alignment

- Do not terminate a control joint in the middle of the slab
- This is a brand new, 12 inch thick, reinforced slab

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Super Flat Floors

- Construction joints not normally dowelled
- On one project the racking design was changed after construction
- Traffic now travelled across the undowelled, zero load transfer joints
- Joints deteriorating rapidly due to large movements under load
- Random cracks also deteriorating

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When should joints be filled?

- Concrete shrinks for a long time
- Joints should not be filled until after 90 days
- Rigid filler will debond and be useless as in photo

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How not to repair a joint spall

- This slab is less than 5 years old
- This joint spall was filled with repair grout and lasted < 1 month
- The joints were not maintained through the repair

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Summary

- Organize a pre-pour meeting to discuss slab with all parties
- If installing a vinyl surface (or anything impermeable) be very careful about moisture condition of slab
- Check for air when casting cylinders
- Stronger concrete is not always better
- Fill joints after 90 days, but 120 better

Hopefully I can keep you out of court!

(Or assist you if you need to go there)

If you need help call:

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