Calcium Chloride Test

What does it measure?

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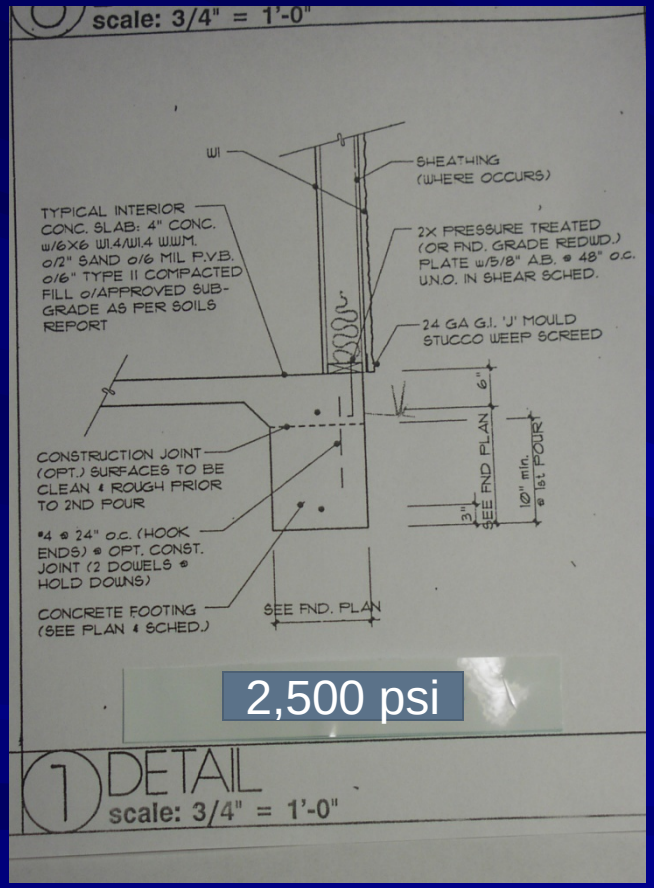
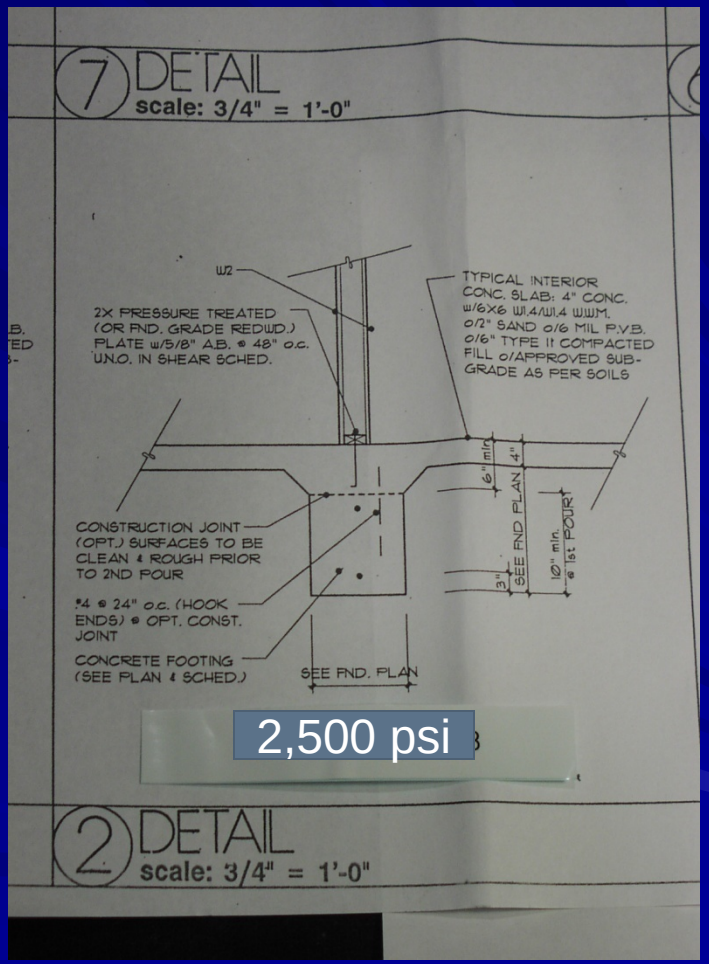
Water? Moisture? Vapor? Transmission? Emission? Capillary?

< 3 lb?

Variety of Structures

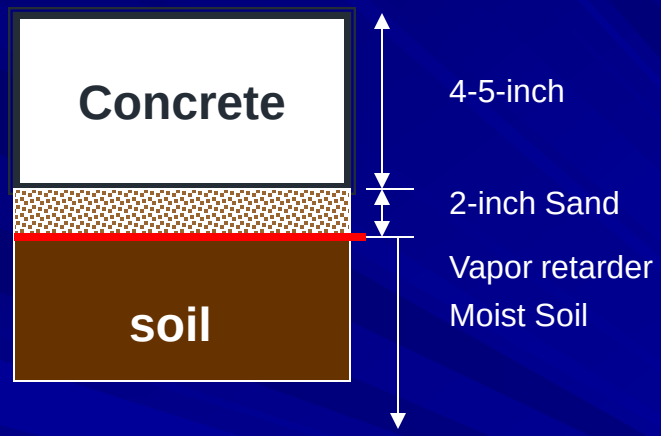
Typical Details





Typical Slab-on-Grade

- Construction Practices
  - Dampen sand prior to concrete placement
    - i.e. ~ 5% water by weight

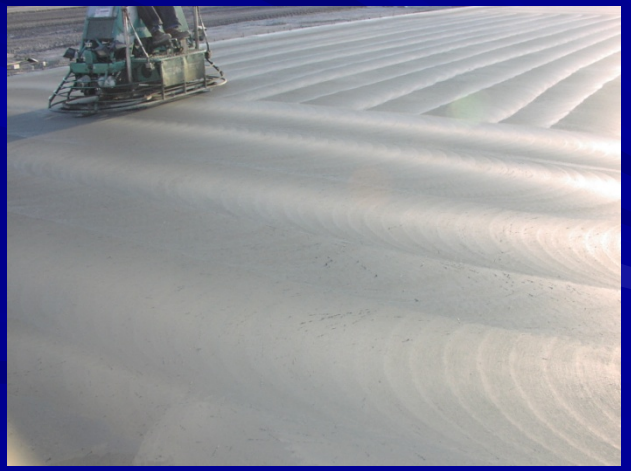


~ 2,500 psi Concrete

- Water content = 250 lb / cu yd
- Water: ~ 6% by weight of Concrete

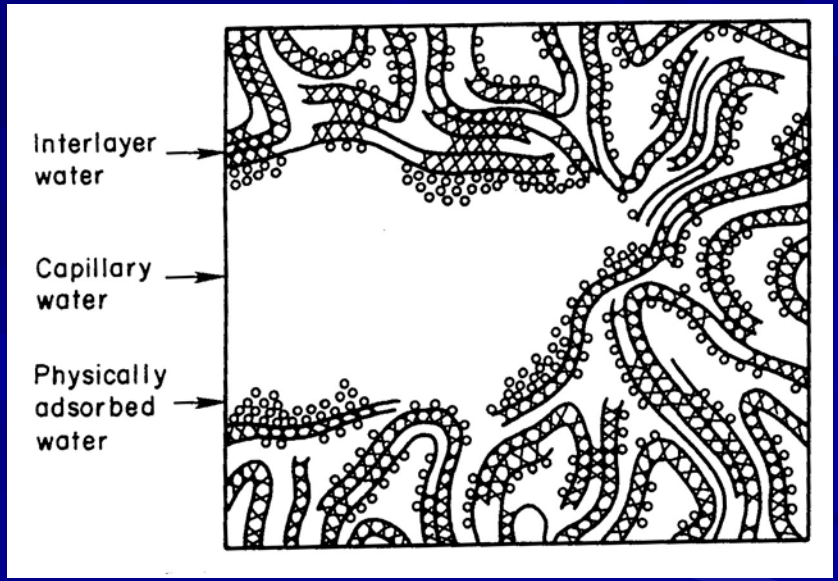
Water lost from Concrete

Bleed water



Water in Hydrated Concrete

- Capillary water
- Adsorbed water
- Interlayer water
- Chemically combined water



Source: Feldman, Sereda, 1970

Slab Ready for Flooring?

800 lb Gorilla!

Moisture Vapor Emission Limit

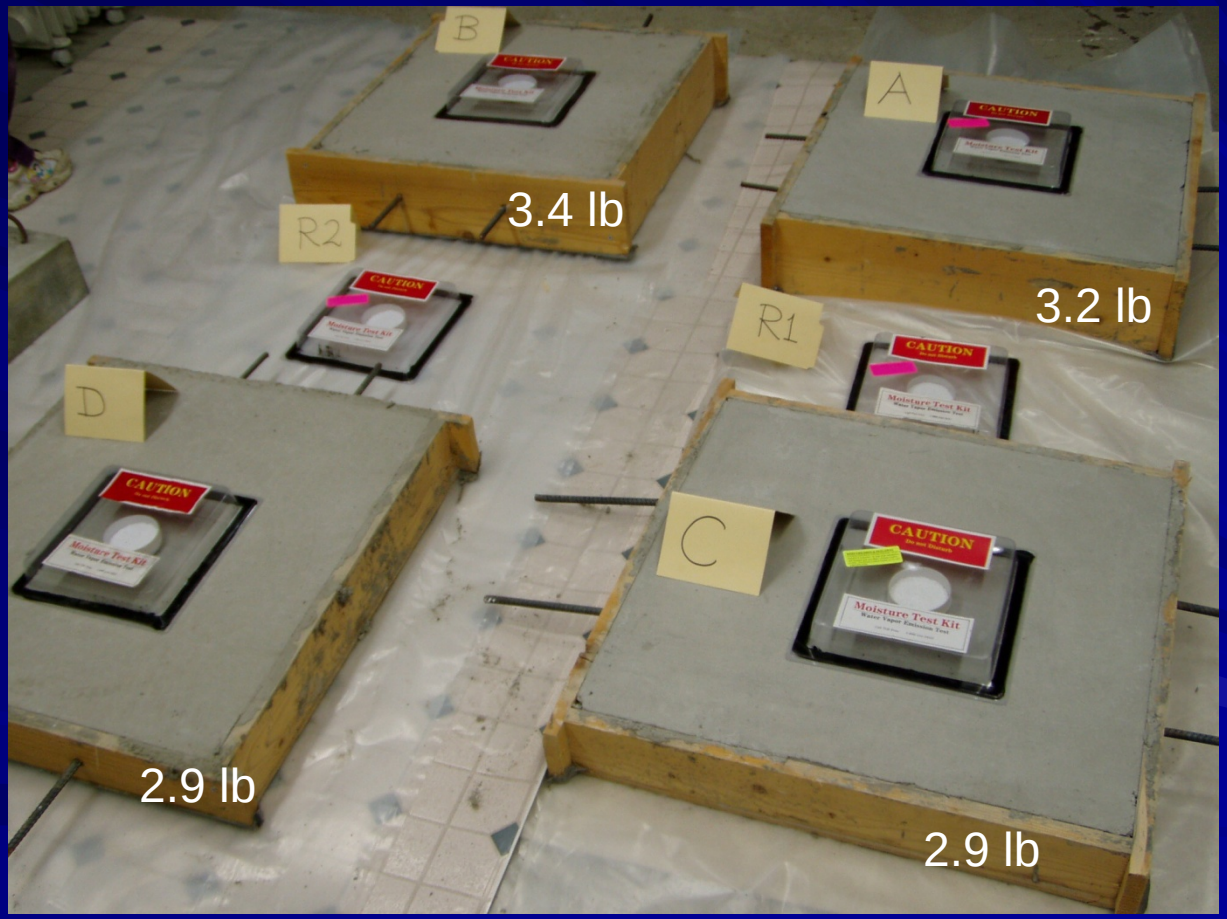
3 %?

3 lb/1000 sq.ft/day?

Concrete Science, Inc

In-House Research

7-Month Age, w/c = 0.40



Mix Design: 4,000 psi, **w/c = 0.4** , 7-sack mix, 15% Fly ash, slump =3-4”

Moisture Flow Through Concrete
Water & Vapor

- A complex phenomenon.

  – Hetrogeneous Material

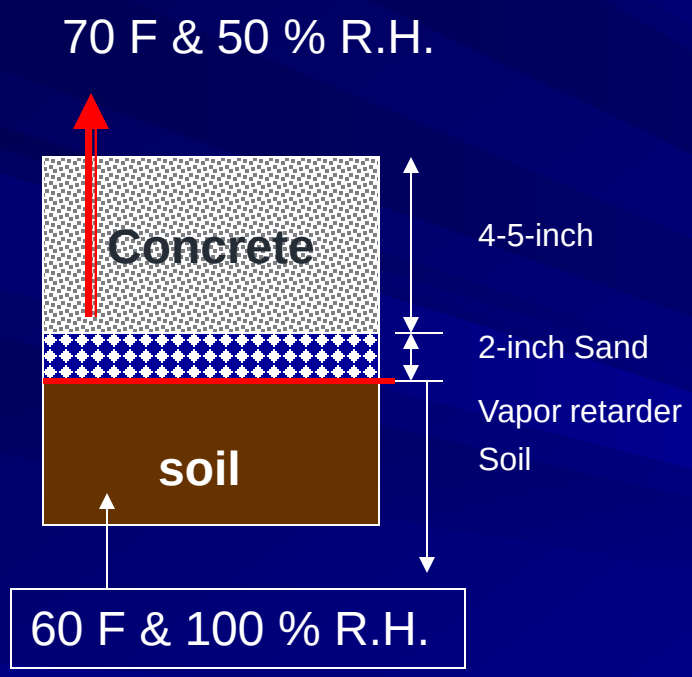
    - Darcy's Law
    - Fick's Law

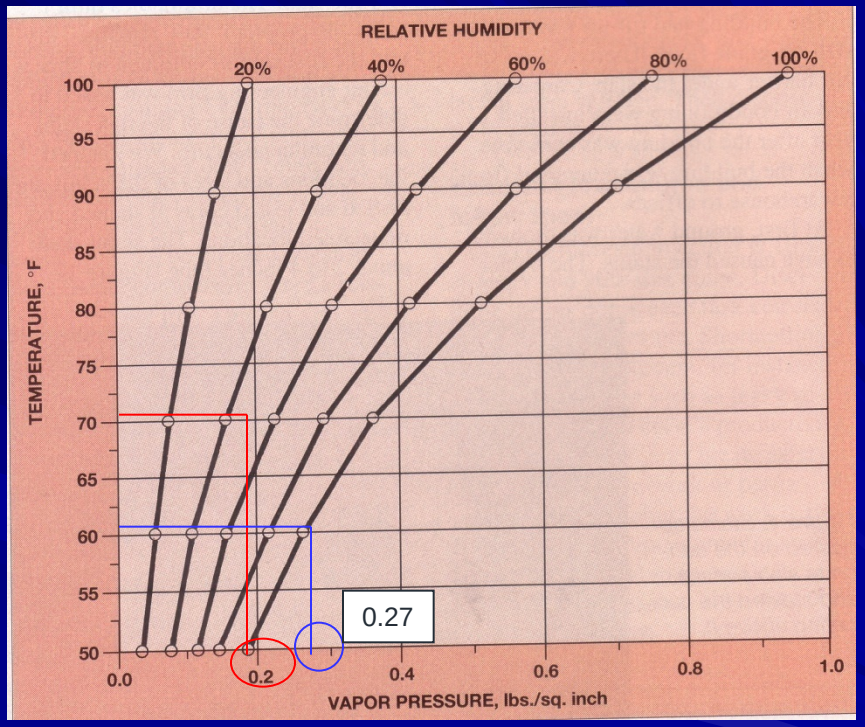
Water Movement
Capillary Flow

- Temperature & Air flow
- Difference in Relative Humidity

Vapor Movement

Vapor Pressure Differential





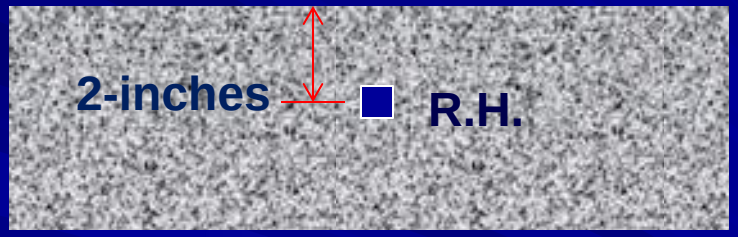
Source: **Ashok Kakade, Harvey Haynes**, Concrete Repair Digest, October 1990

Calcium Chloride Testing

Is it worth it?

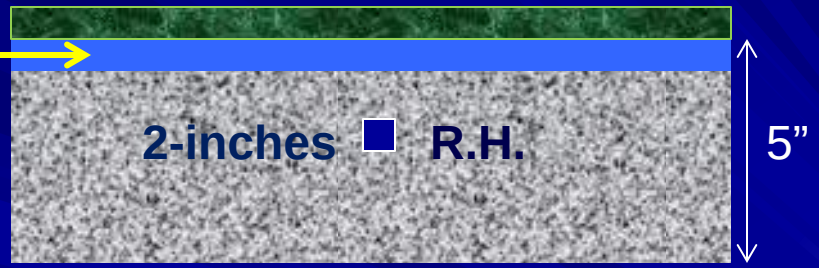
Moisture Vapor Emission Rate Test

Relative Humidity Test

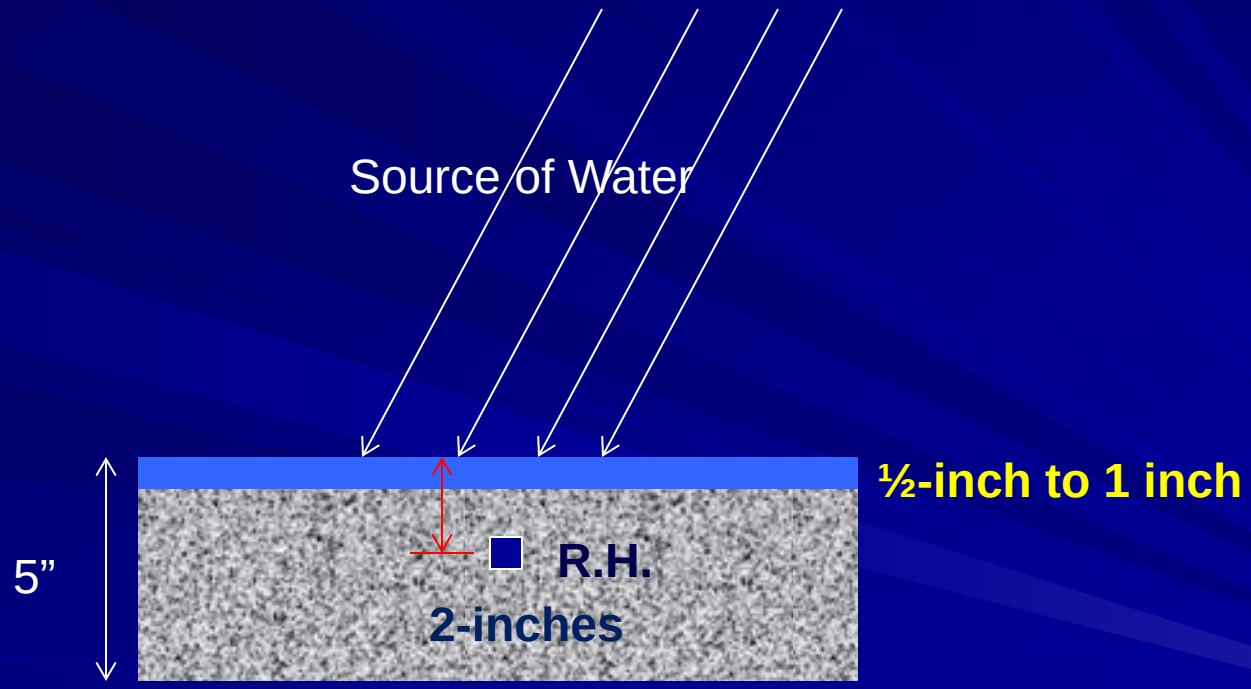


What affects the Flooring Most?

Near surface moisture
½-inch to 1 inch



Possible scenarios?



Water? Vapor? Transmission? Emission? Capillary?

Case 2
Moisture from ambient air?

Case 1
From Concrete?

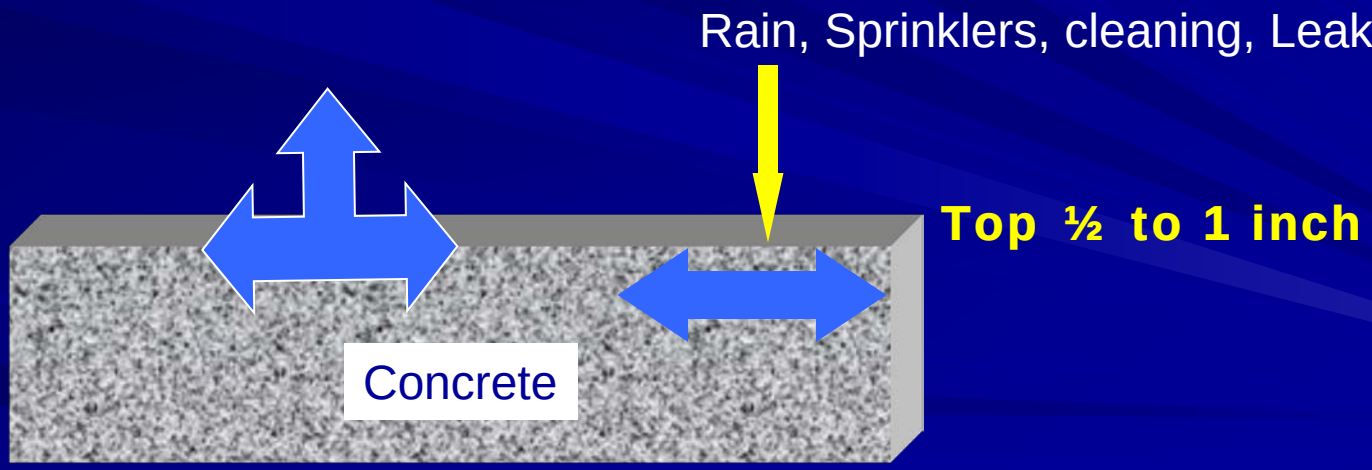
Case 3
Sideways from concrete?

Case 4 & 5:
Upwards from under the slab?
Case 4: Saturated soil
Case 5: Hydrostatic Pressure

Case 1

Source: Concrete

- Primary source
  - Concrete
  - External Water Absorbed by Concrete



Case 2

Source: Ambient air

Case 2
Source: Ambient Air
Temp: 65 ˚F, R.H.= 60%

Test # 1 lb/100 sq. ft/day	1.2
Test # 2	1.2
Test # 3	1.7

Case 2
Source: Ambient Air
High Temp: 85 F, Low R.H.= 40%

Test # 1 lb/100 sq. ft/day	1.9
Test # 2	1.9
Test # 3	2.2

Case 2
Source: Ambient Air

Temp: 70 ˚F, R.H.= 46%

Well sealed

- Gain in weight: 0.1 gm
- i.e. 0.2 lb/1000 sq.ft /day

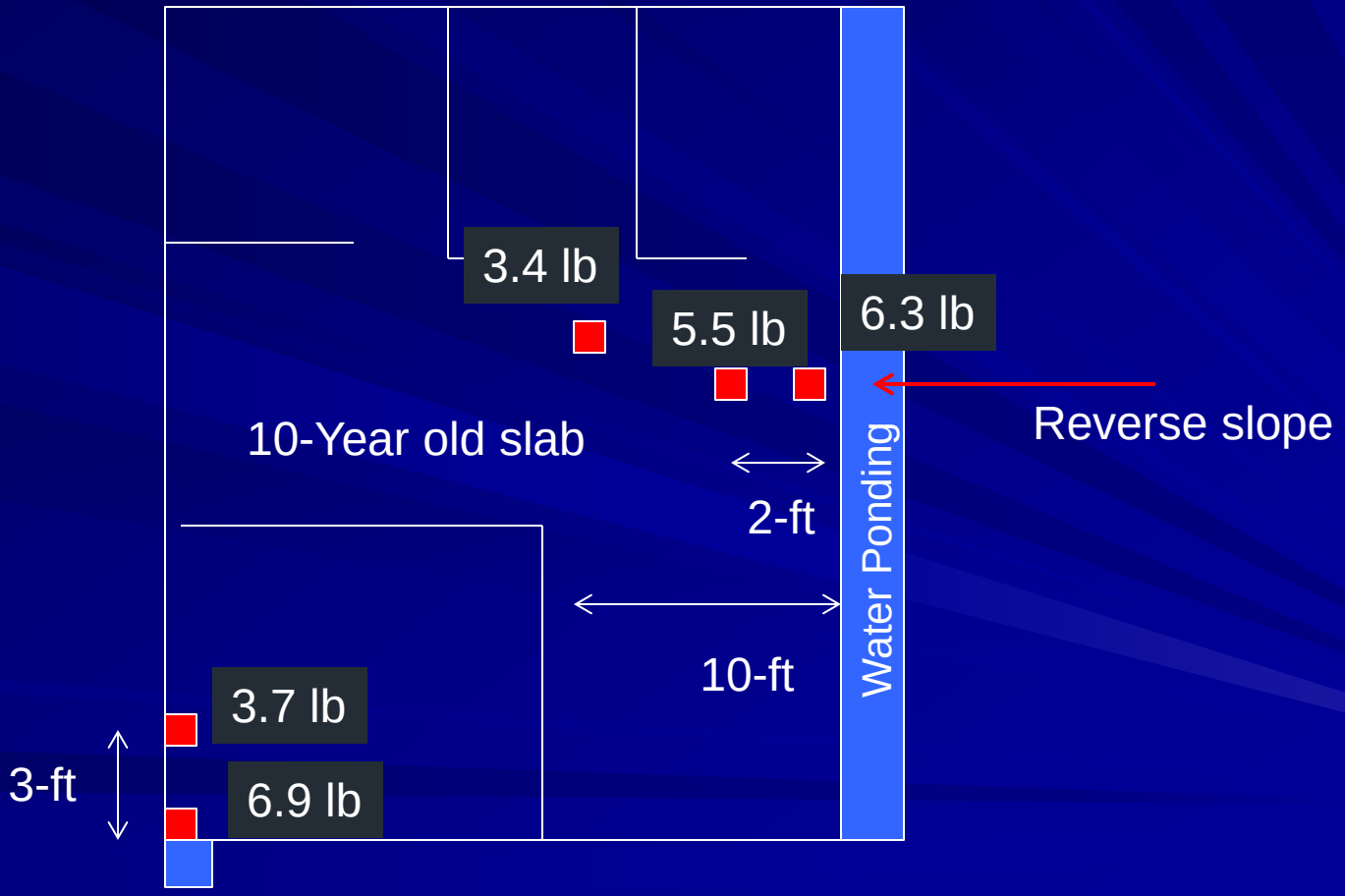
Case 2
Source: Ambient Air

0.2 & 0.3 lb/1000 sq.ft/day

Case 3

Source: Ponding Water

Case 3
Source: Ponding Water

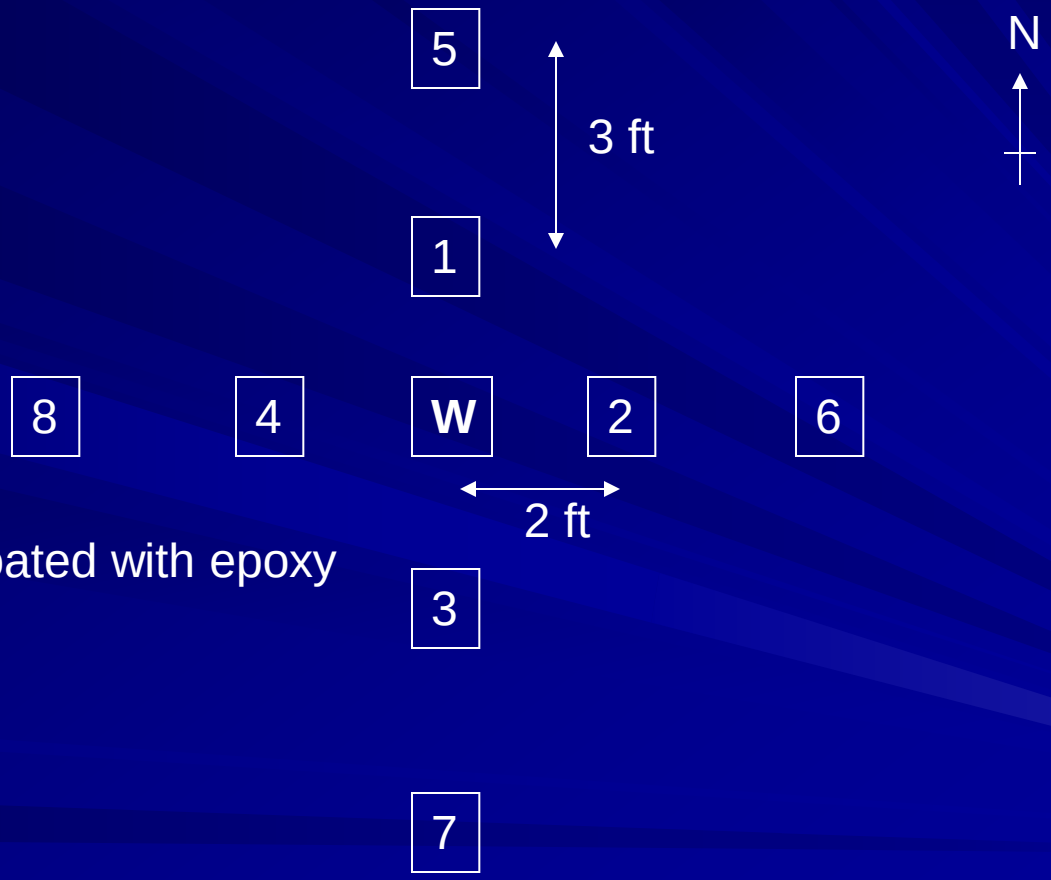


Case 4

Source : Top of slab

Test Layout

20 x 20 ft Room



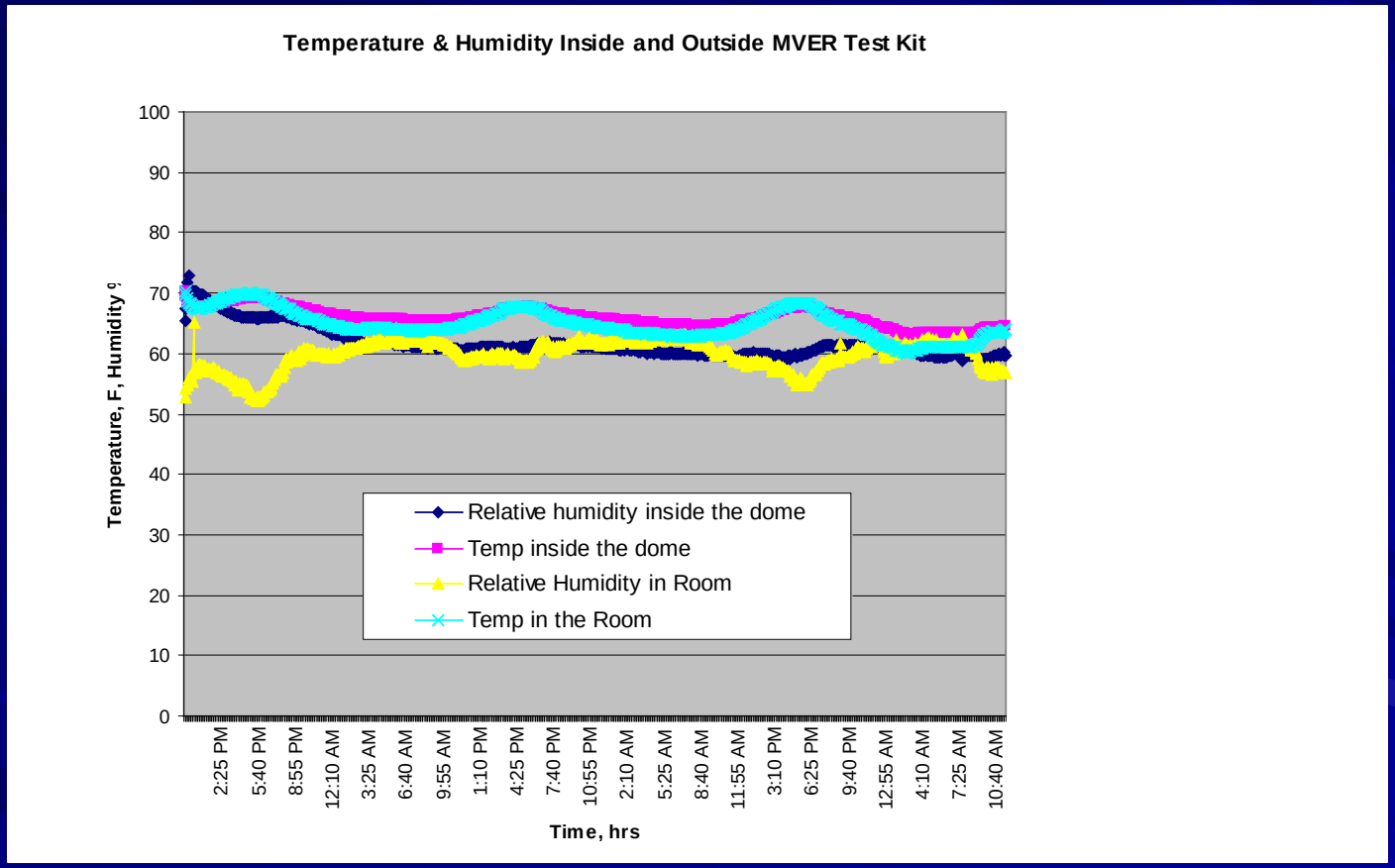
4-inch thick slab coated with epoxy

Source of Water: Top of Slab
4-inch thick slab

- Water Pressure Approx. 0.5 psi
- 7 Days

MVER Tests in Progress

Temperature & Humidity In Room and Inside Test Dome



Increase in MVER Within 2 ft from Source of Water

Test #	Native	7-Day Ponding	Increase in MVER
1	5.2	**13.2**	Not Valid
2	5.6	7.0	1.4
3	6.2	8.7	2.5
4	7.1	9.0	1.9

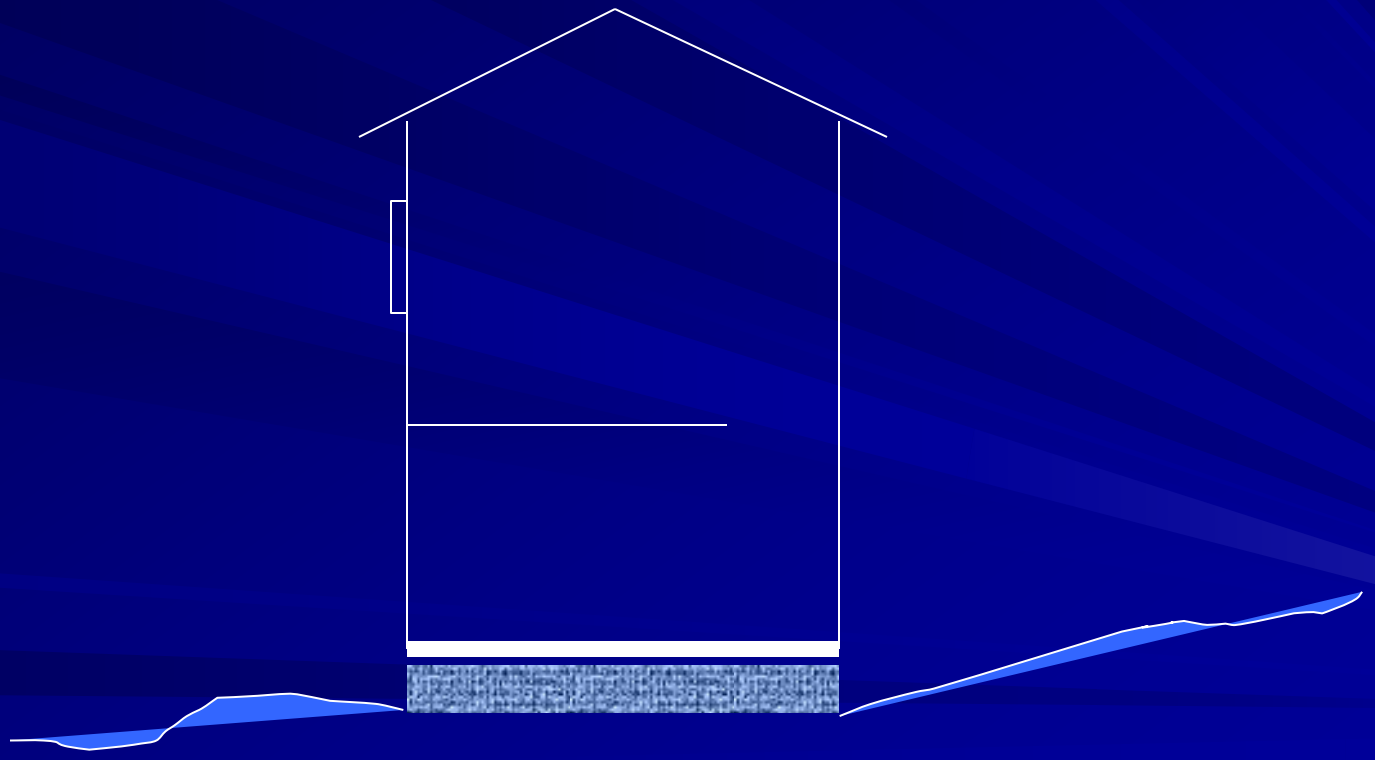
Increase in MVER Within 5 ft from Source of Water

Test #	Native	7-Day Ponding	Increase in MVER
5	6.1	8.0	1.9
6	6.6	7.5	0.9
7	7.2	7.9	0.7
8	6.7	6.9	0.2

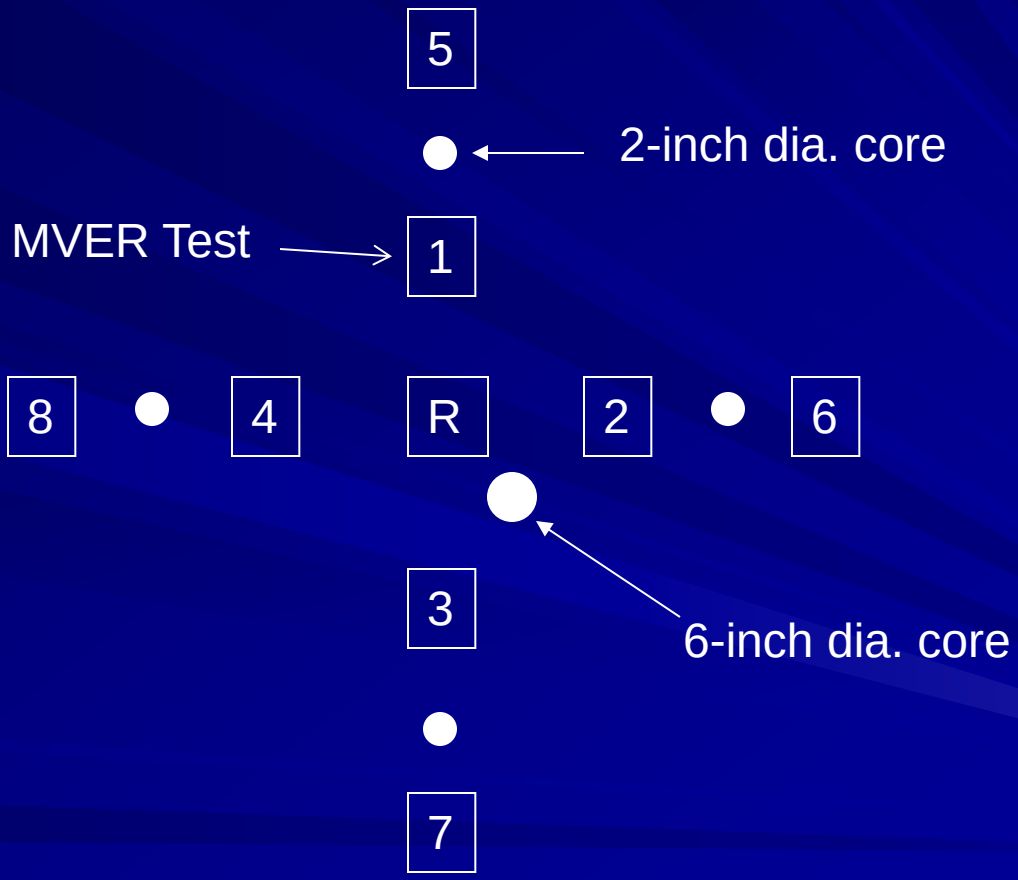
Average Increase in MVER
7-Day Test

- **Within 2 ft** from water Source
  - 1.9 lb
- **Within 5 ft** from the water source
  - 0.9 lb

Case 4
Saturated soil

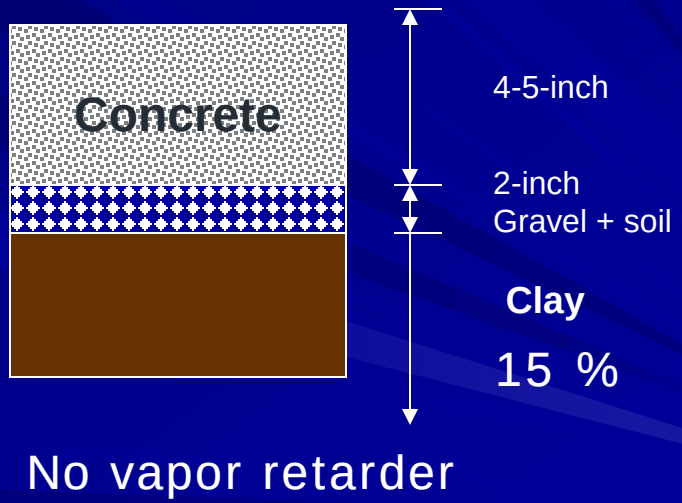


Layout of MVER Tests
20 x 20 ft Room



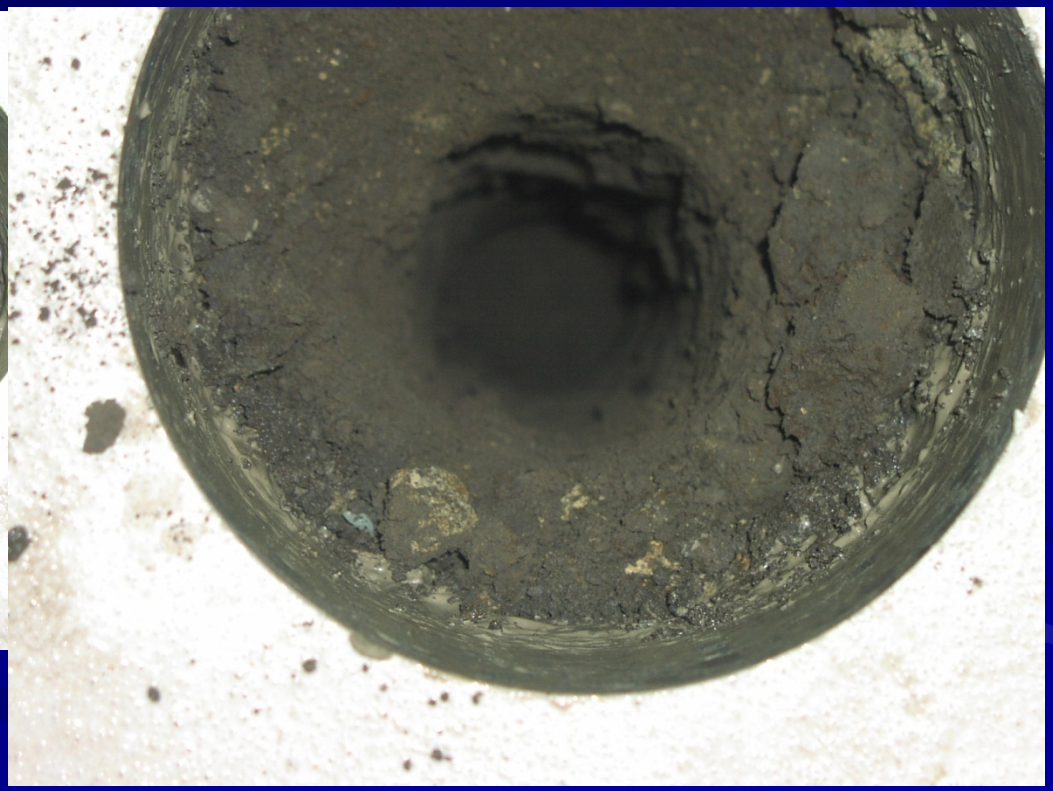
Cross Sectional Details

- ~ 3,000 psi, 45 year old



No vapor retarder

Details at 6-inch Core



Case 4
Source of Water under the slab

- Water was introduced in subgrade soil for 7 days.

Change in MVER

7 days of Water in Subgrade

Temp. 65˚F, R.H. 60%

Test #	7-Day Water Ponding	7-Day of watering subgrade	Increase in MVER
1	Invalid	-	-
2	7.0	6.8	-0.2
3	8.7	8.2	-0.5
4	8.0	8.7	0.7

Change in MVER

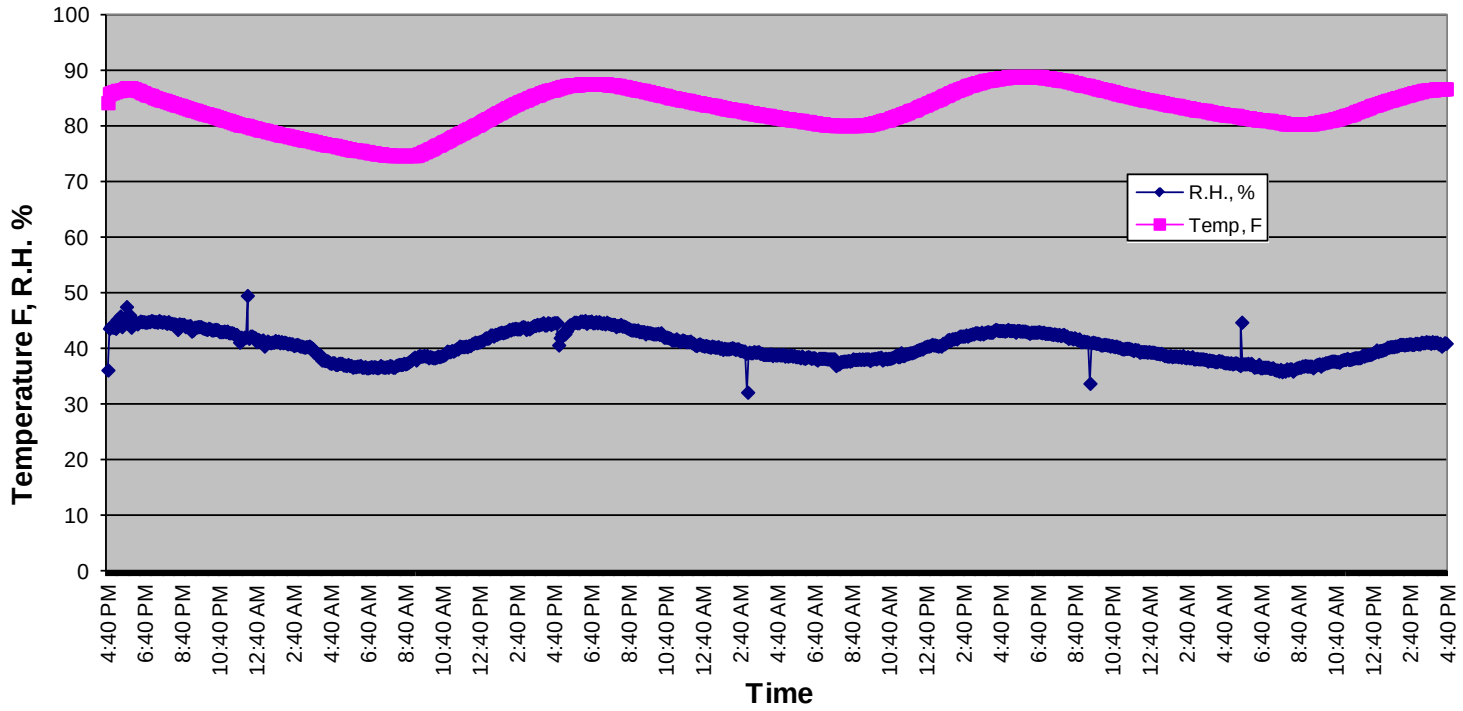
7 days of Water in Subgrade

Temp. 65˚F, R.H. 60%

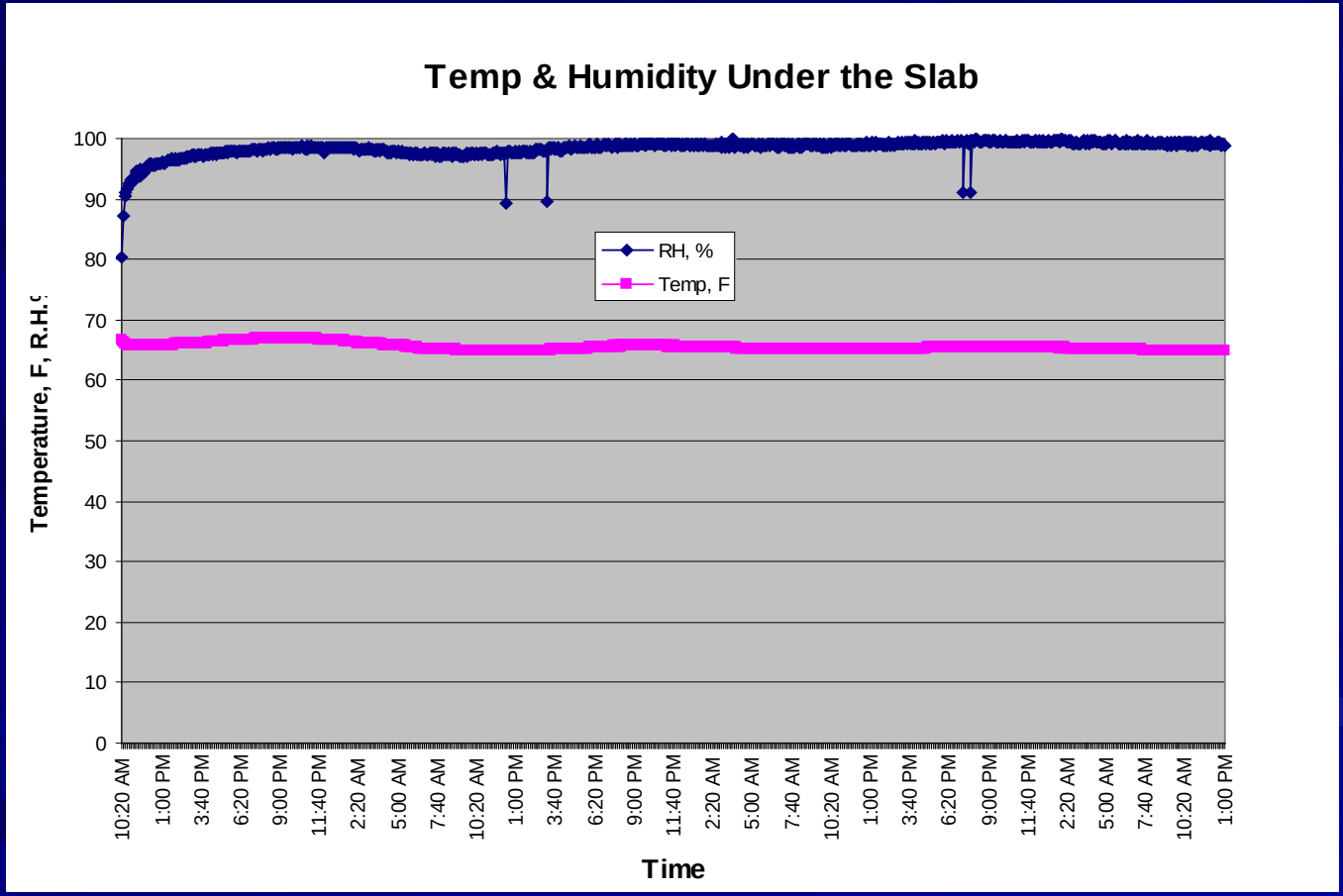
Test #	7-day of Water Ponding	7-Day of watering Sub grade	Increase in MVER
5	8.0	9.0	1.0
6	7.5	6.7	-0.8
7	7.9	7.7	-0.2
8	6.9	6.5	-0.4

Increased the Ambient Temperature

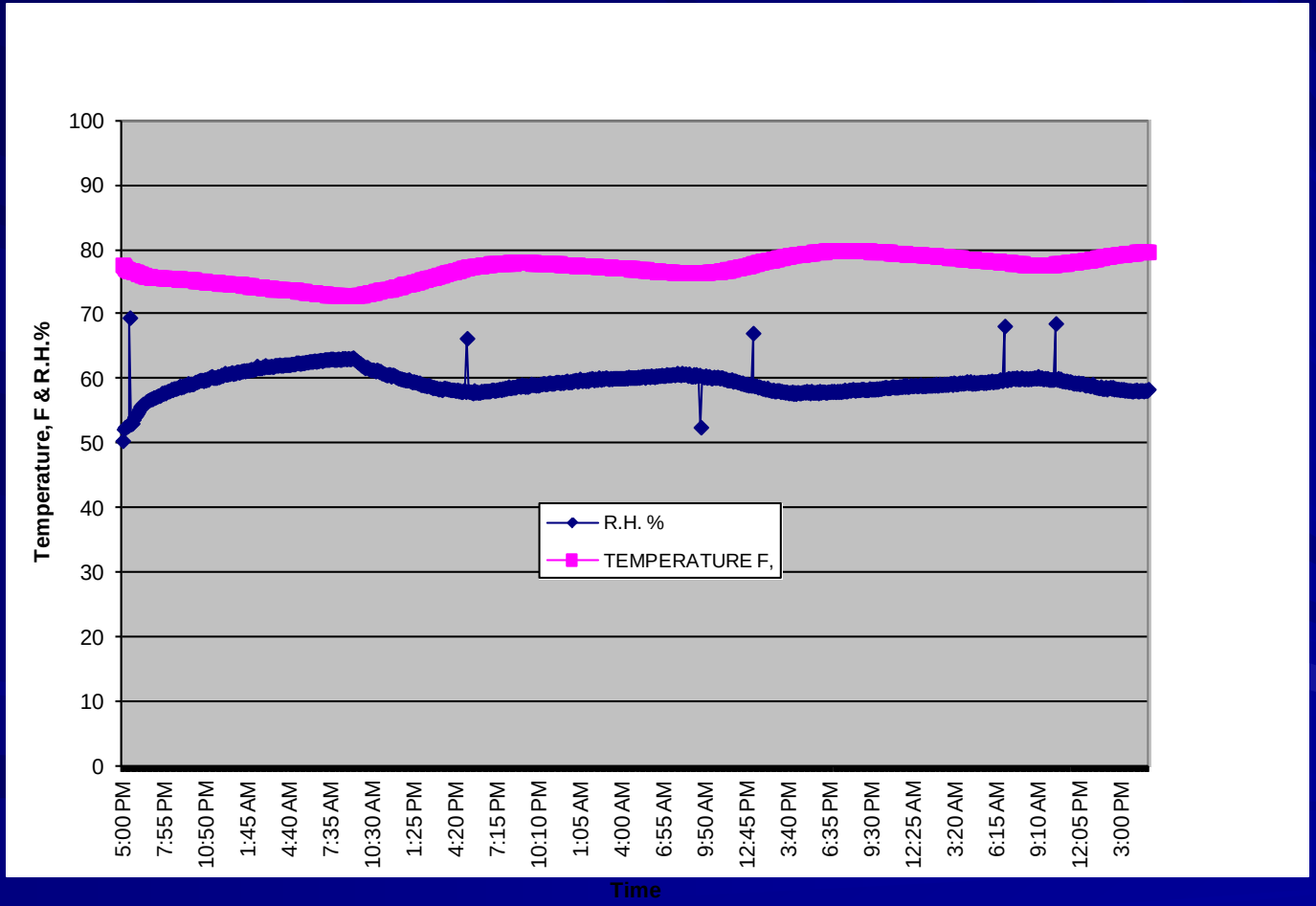
Temp & Humidity
High Ambient Room Temperature



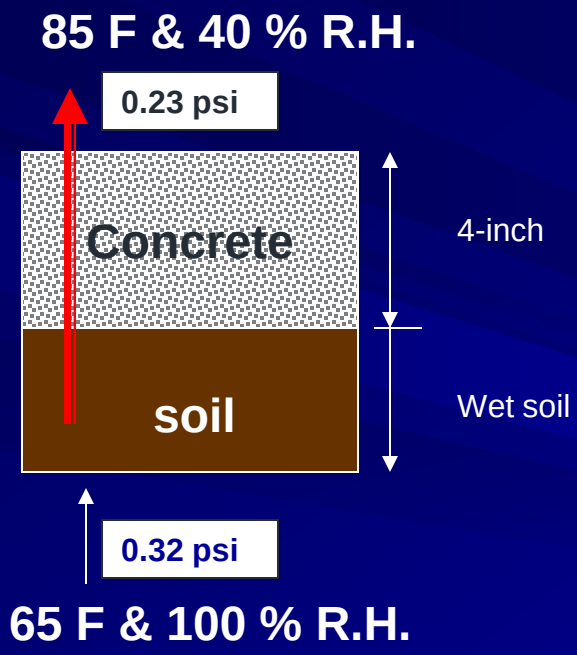
Temperature & Humidity Below the Slab (Soil)

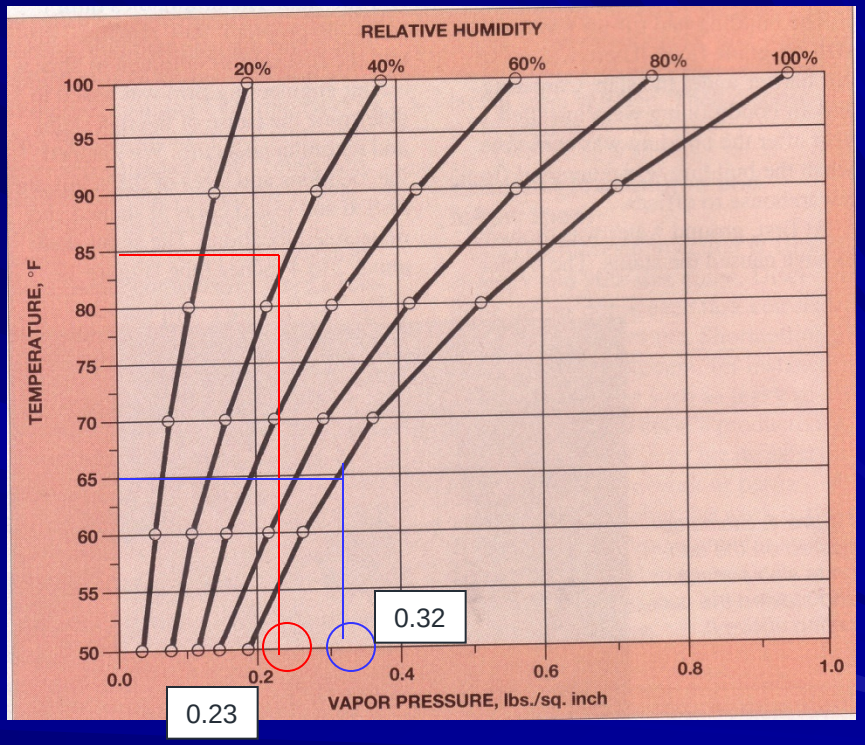


Temperature & Humidity
Inside Dome due to High Room Temp



Vapor Drive
Vapor Pressure Differential





Source: **Ashok Kakade, Harvey Haynes**, Concrete Repair Digest, October 1990

Increase in MVER

High Temp & Low Humidity

Temp 85˚F, R.H. 40%

Test #	7-day of Water Ponding	7-day of Water in subgrade **85˚F, 40% R.H**	Increase in MVER
1	Invalid	-	-
2	7.0	9.9	2.9
3	8.7	9.9	1.9
4	8.0	11.6	3.6

Increase in MVER

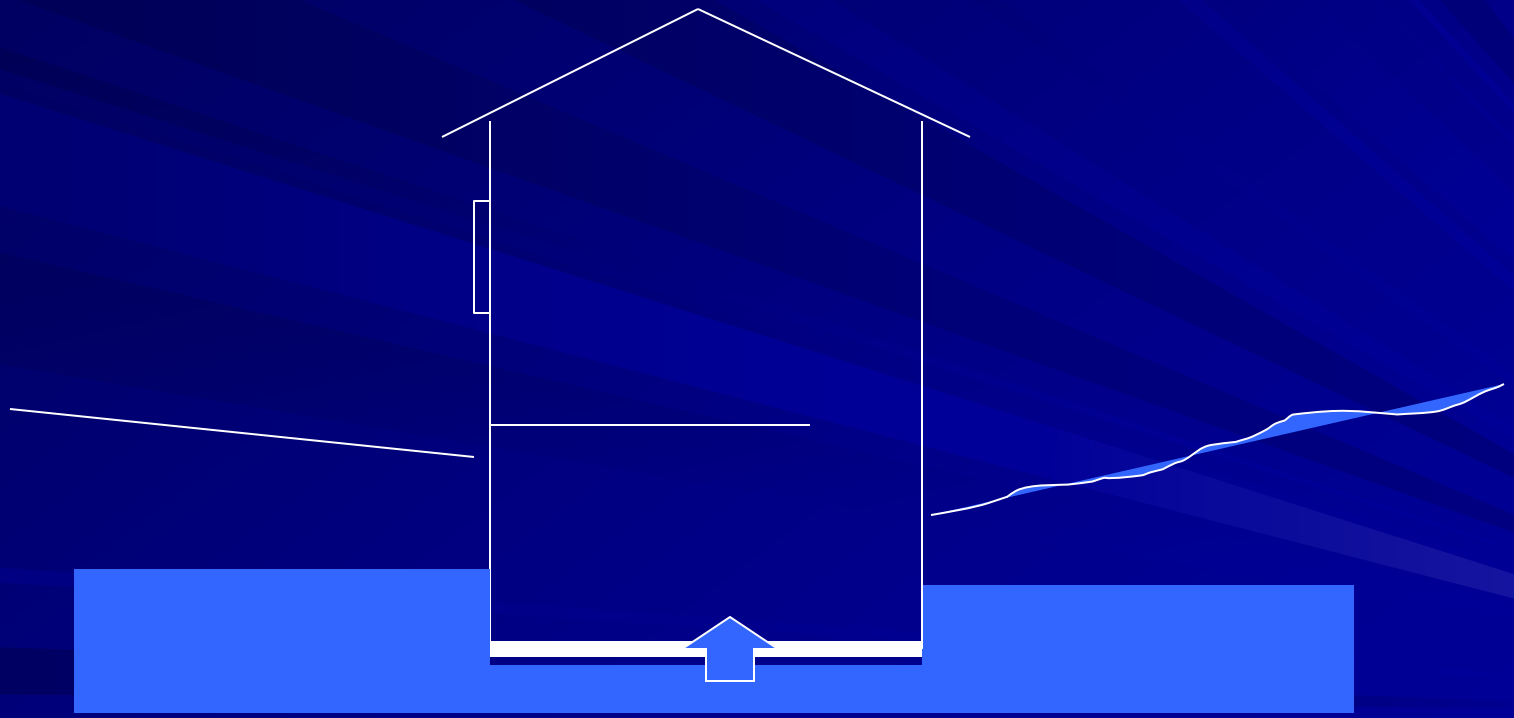
High Room Temp & Low Humidity

Temp 85˚F, R.H. 40%

Test #	Native	7-day of Water in subgrade **85˚F, 40% R.H**	Increase in MVER
5	8.0	8.8	0.8
6	7.5	9.3	1.8
7	7.9	7.6	-0.3
8	6.9	8.8	1.9

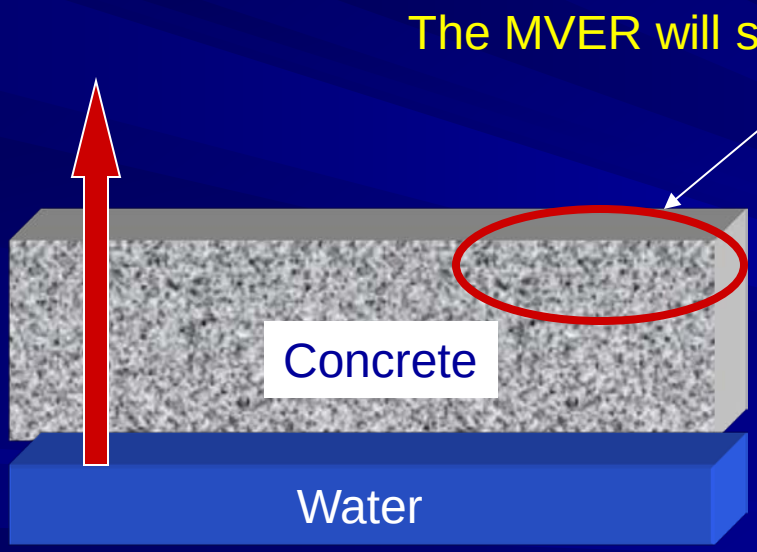
Case 5

Hydrostatic pressure



Moisture Transmission
>>> 10 lb/1000 sq. ft/ day

- Concrete is a medium
  - Primary source of water is not concrete



Sources of Water

1. Hydrostatic Pressure
2. Irrigation water
3. High water table
4. Plumbing leak under slab

Project Inspection

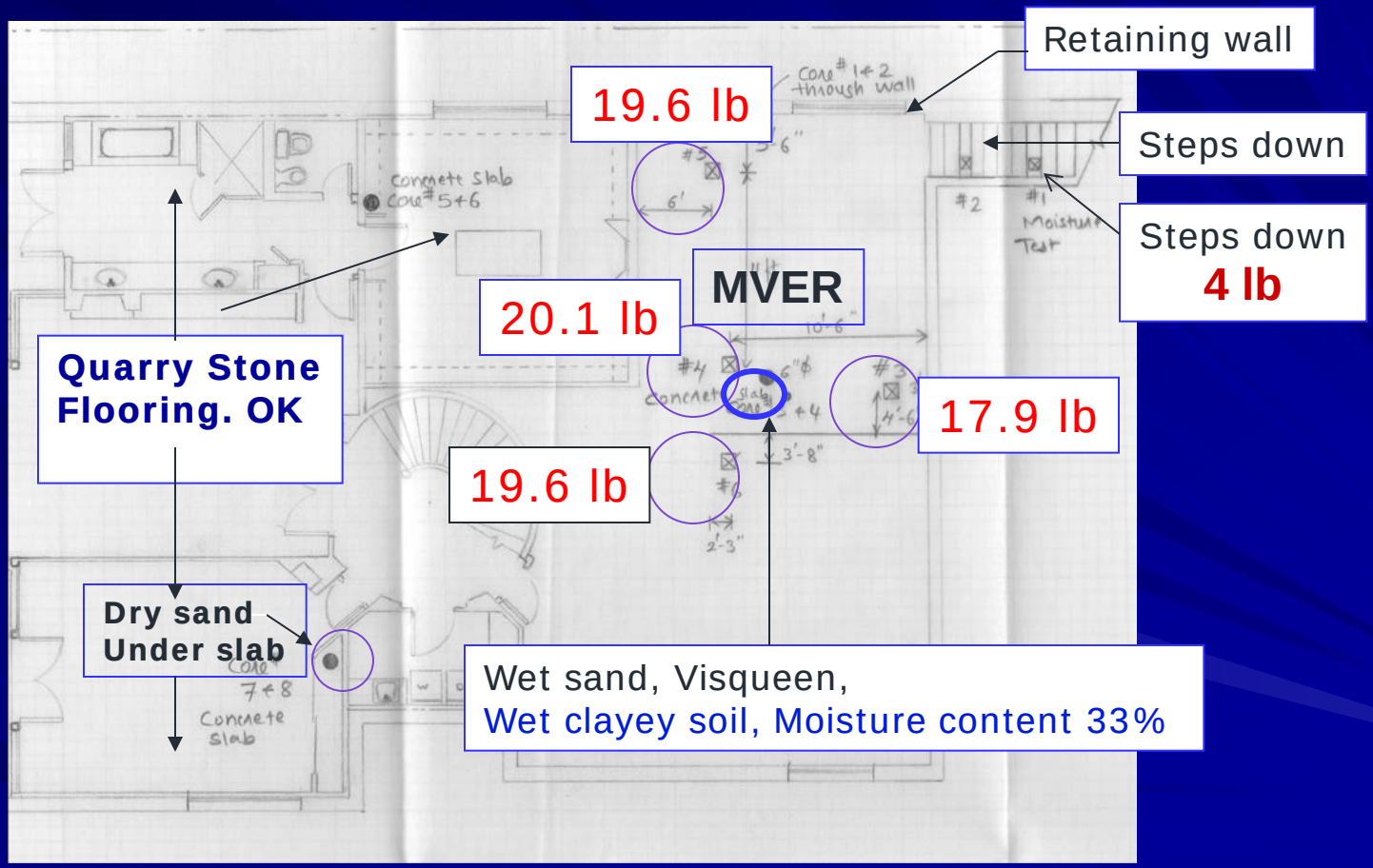
Underground Basement

with water leaks below the slab

Underground Basement

Plan view of the House

Basement ~ 10 ft below ground



Vinyl Flooring

Basement slab

Summary

What Does Calcium Chloride Test Measure?

- The test measures vapor emission from **near surface** of concrete.
- When sealed correctly, the influence of moisture from the ambient air is minor.
- The increase in vapor emission from a localized ponding on the surface or from the side is limited to a short distance from the source of water.
- Relatively high vapor emission rate can be attributable to the water from the top or from under the slab.

Thank You!

Any .....?

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