

A photograph of two construction workers in blue coveralls and hard hats working on a large, flat roof. They are using a hose to apply a waterproofing material. The background shows a cityscape under a clear sky.

Evaluation of Waterproofing Systems Using Wireless Embedded Moisture Sensors

Harry L. White 2nd

NYSDOT Transportation Research

Waterproofing Membranes

- If They Work:
 - Block Salts from Bare Reinforcing Bars to Prevent
 - Expanding steel volume
 - Concrete pops
 - Concrete cracks
 - Accelerated corrosion
- If They Leak:
 - Trap Salts Near Bare Reinforcing Bars to Promote
 - Expanding steel volume
 - Concrete pops
 - Concrete cracks
 - Accelerated corrosion



Roll-On Membranes



Roll-On Membranes

Torch Applied



Spray Applied



stirling lloyd

THE TECHNOLOGY OF PROTECTION

www.stirlinglloyd.com

Spray Applied

stirling lloyd

THE TECHNOLOGY OF PROTECTION

www.stirlinglloyd.com



Rosphalt Asphalt Overlay



Rubberized Asphalt



Liquid Concrete Overlay



Thin Polymer Concrete Overlay



Onboard computerized blending system on Polycarb's truck.



Side view of Polycarb's truck (note resin and catalyst storage tank).



Beginning the epoxy "pour."



Crew uses squeegee and roller to distribute product across deck.



Aggregate is carried from hopper by conveyor and distributed over the epoxy.



Material is disbursed by hand to areas where epoxy comes through.

How to Evaluate Membranes?

- Visual
 - Can't see below the surface
- Ground Penetrating Radar (GPR)
 - Expensive equipment
 - Specialized training
- Wired Moisture Sensors
 - Equipment failure
 - Deterioration
 - Vandalism

Conventional Moisture Measurement

- Probing Methods
 - test probes
 - surface
 - drill hole
- RF Field Methods
 - gross assessment
 - surface sensitive



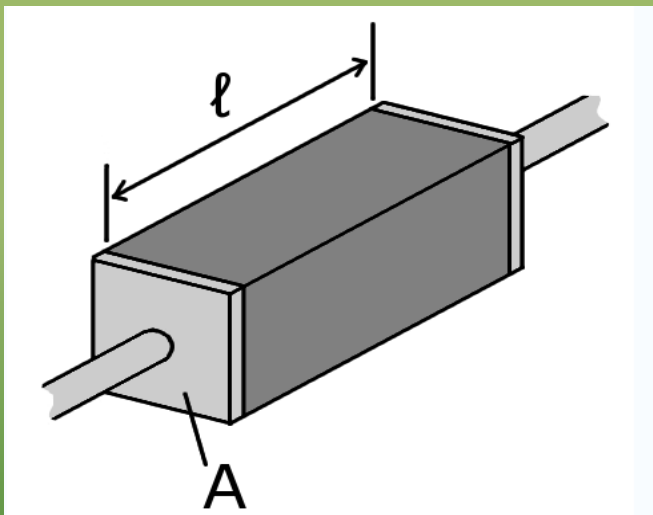
Wireless Sensor



How Long Will They Last?

- No Batteries
- No Moving Parts
- Stainless Steel Contacts
- Sensor Should Outlast the Structure

What are We Measuring?



$$R = \frac{\rho L}{A}$$

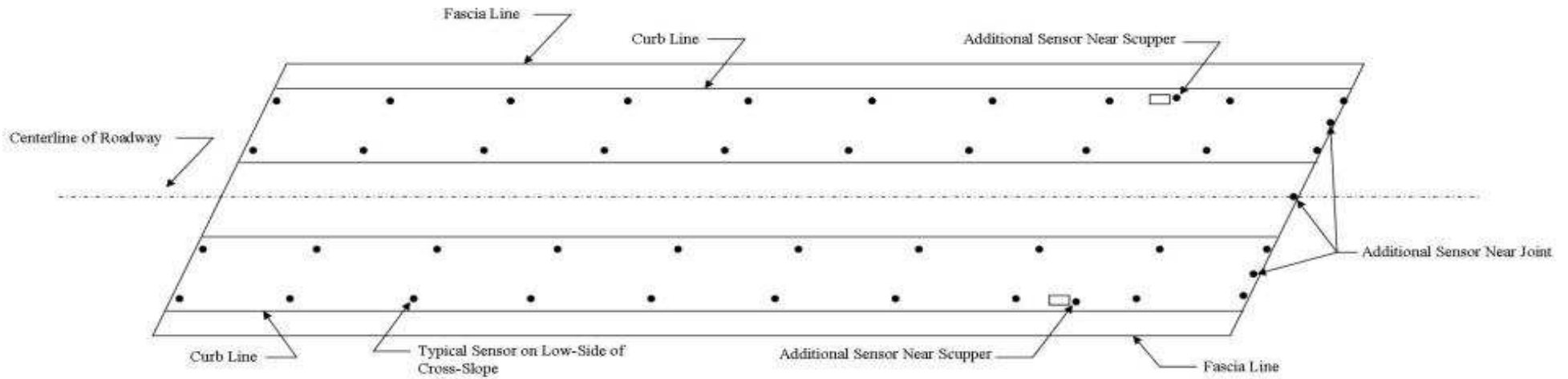
ρ = resistivity

L = length

A = cross sectional area

- Conductivity is $\frac{1}{R}$

Installation Procedure



Plan
Typical Sensor Layout

Typical Test Layout for Deck Evaluation

Drilling Hole for Sensor



Sensor in Hole



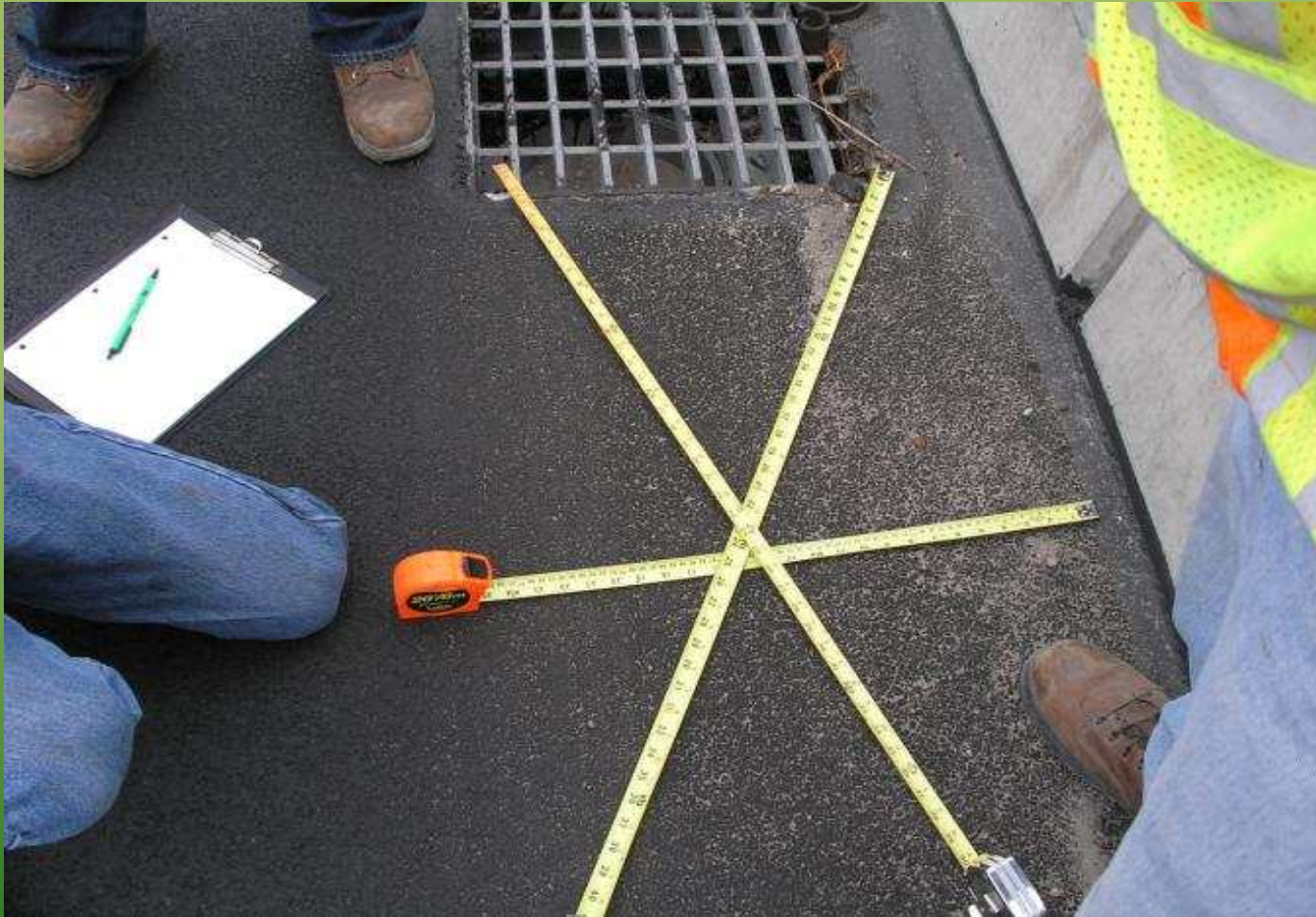
Topping with Mortar



Preparing for Membrane Application



Triangulate Sensor Location



Assemble Interrogation Device



Locate Buried Sensor



HydroTracker Data

Rte 32 Oriskany NY

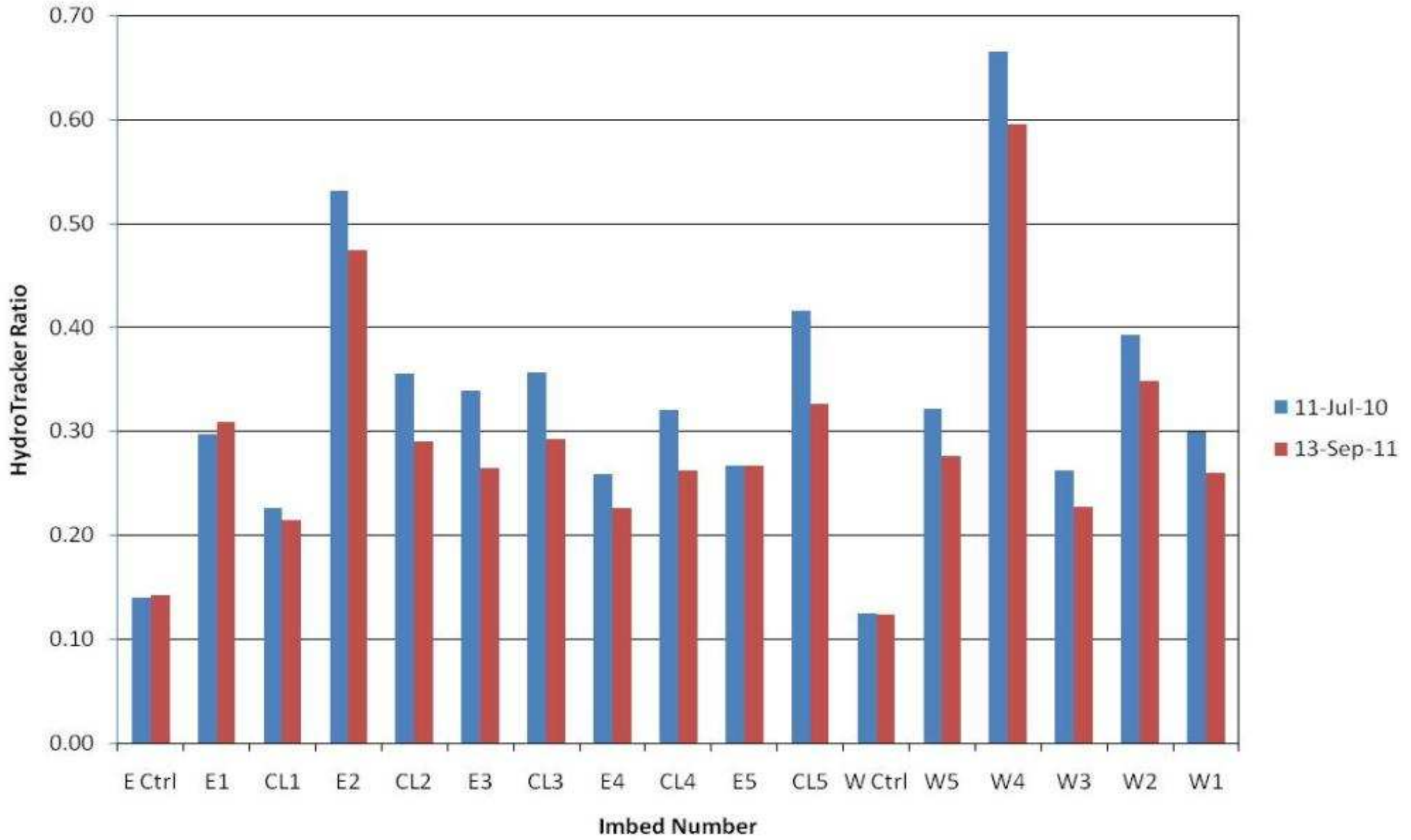
J Foley

13-Jul-10

13-Sep-11

Map	Imbed	Test	Ref	Calc	% H2O	Test	Ref	Calc	% H2O
E Ctrl	E Ctrl	140	1000	0.14	-0.2	143	1000	0.14	-0.1
E1	E1	297	1000	0.30	2.7	309	1000	0.31	3.0
CL1	E2	226	1000	0.23	1.4	215	1000	0.22	1.2
E2	E3	532	1000	0.53	7.1	474	1000	0.47	6.0
CL2	E4	356	1000	0.36	3.8	290	1000	0.29	2.6
E3	E5	339	1000	0.34	3.5	265	1000	0.27	2.1
CL3	E6	357	1000	0.36	3.9	293	1000	0.29	2.7
E4	E7	259	1000	0.26	2.0	226	1000	0.23	1.4
CL4	E8	321	1000	0.32	3.2	263	1000	0.26	2.1
E5	E9	267	1000	0.27	2.2	267	1000	0.27	2.2
CL5	E10	257	618	0.42	4.9	327	1000	0.33	3.3
W Ctrl	W Ctrl	125	1000	0.13	-0.5	124	1000	0.12	-0.5
W5	W5	211	656	0.32	3.2	276	1000	0.28	2.3
W4	W4	149	224	0.67	9.6	140	235	0.60	8.3
W3	W3	262	1000	0.26	2.1	228	1000	0.23	1.5
W2	W2	393	1000	0.39	4.5	349	1000	0.35	3.7
W1	W1	300	1000	0.30	2.8	260	1000	0.26	2.0

HydroTracker Readings
Route 32 over CSX
BIN 1074460



Program Objectives

- Verify the Effectiveness of Various Membranes
 - Various superstructure types
 - Various traffic conditions
 - Various Regional locations
- Determine Areas Most Prone to Failure
- Long-Term Monitoring
 - May be years for complete study: Failures reported immediately
- Correspond to Condition Rating

Anticipated Results

- Waterproof Membranes to be Evaluated
- Prioritize Deck Treatments
 - Cost
 - Performance
 - Ease of application
- Predict Life-Spans for Planning Purposes
 - Program repairs
 - Program replacements

PDH Questions

- What other options are there to determine membrane effectiveness?
- How big are the sensors?
- What is the sensor actually measuring?
- Where does the membrane typically leak?
- Why is it important to know if the membrane has failed?

Thank you for your Attention