Performance Based In-Place Recycling Specifications

Northeast and Mid-Atlantic States
In-Place Recycling Conference

August 24-26, 2010 Harrisburg, PA

Texas Transportation Institute

A Member of the Texas A&M University System

Outline

- Project Selection
- Cold In-Place Recycling (CIPR)
- Hot In-Place Recycling (HIPR)
- Environmental Impact
- Research at TTI
- Summary

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Requirements for CIPR and FDR

Requirements	CIPR	FDR
Low to Moderate Traffic	X	X
Rural Road Application	X	
Requires Significant Section	X	
Requires Wearing Course	X	X
No underground conflicts		X

Requirements for HIPR

- Best for rural areas due to long recycling train
- Ideal for AADT's between 1,000 and 10,000
- Pavement should not exhibit extensive cracking
- Limited presence of surface treatments
- Limited foliage concerns

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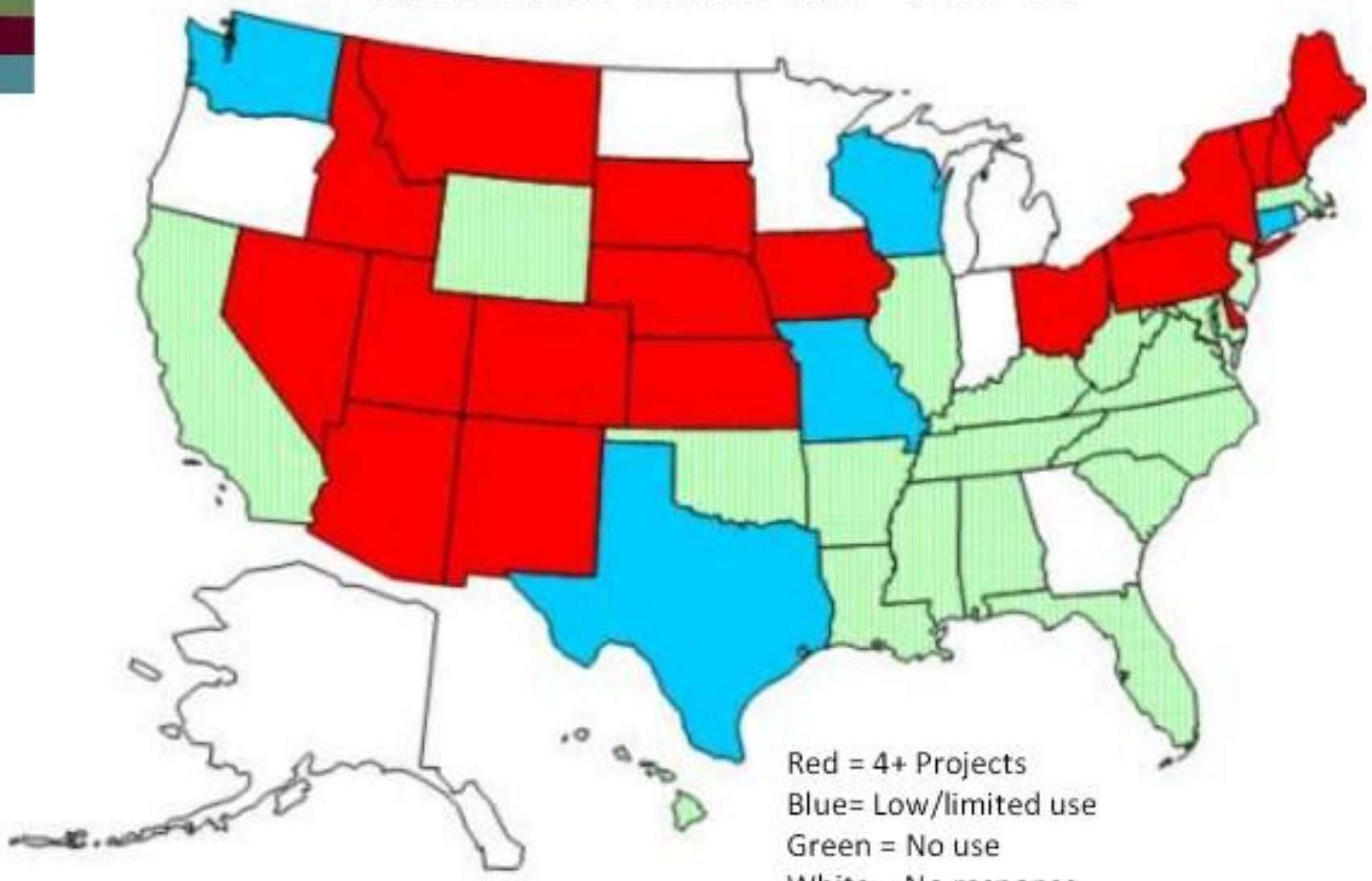
States Use of CIPR



Specification / Information Review

- Arizona
- California
- Colorado
- Iowa
- Kansas
- Nevada
- New Mexico
- Pennsylvania
- South Dakota
- Utah
- Vermont
- Wisconsin
- Ontario
- FHWA
- ARRA
- PCCAS

Specification Sections

- Description
- Materials
- Mix Design
- Construction QC/QA
- Equipment
- Climatic Conditions
- Measurement/Payment
- Layer Coefficient

Description

- Partial Depth (Cold In-Place)
- Full Depth (FDR)

Description (General)

- Milling existing asphalt pavement
- Mixing the millings with an emulsion
- Placing
- Compacting

Materials - Binders

State	Asphalt Binder
Arizona	HFE-XXP
California	Emulsified RA
Colorado	HFE (Polymer) / emulsified RA
Iowa	Contractor select
Kansas	Emulsified asphalt / asphalt RA
Nevada	CMS-2S
New Mexico	HFE-150P
Pennsylvania	MS, CMS, SS, CSS, HMFS / polymer grades
South Dakota	Emulsified asphalt
Utah	Shown on plans

Materials - Additives

State	Additive
Nevada	1.5% quicklime slurry
New Mexico	1.5% hydrated lime slurry
Utah	1.5% quicklime slurry

Mix Design

State	Method
Arizona	Contractor performed
California (Project)	Marshall stability, retained stability, emulsion, cement
Iowa	Gyratory compactor, Marshall stability, retained stability, raveling test
Vermont	50 blow Marshall

QC/QA - Gradation

State	% Passing			
	2-in	1 ½-in	1 ¼-in	1-in
Arizona			100	
California				100
Colorado			100	
Nevada		100		
New Mexico			100	90 - 100
South Dakota			100	95
Utah		100		
Wisconsin	97			

QC/QA – In-Place Density

State	Density Requirement
Arizona	Specified in plans
California	95 to 105% of max density on test strip
Colorado	100% of field mixed/lab compact
New Mexico	96% of field mixed/lab compact
South Dakota	97%of target density
Utah	96% of field mixed/lab compact

QC/QA – Surface Tolerance / Smoothness

State	Smoothness Requirement
Arizona	1/4-in longitudinal
California	1/4-in transverse
Colorado	3/16-in transverse & 3/16-in longitudinal
Nevada	1/4-in transverse & 1/4-in longitudinal
New Mexico	1/4-in transverse
South Dakota	0.04-ft transverse
Utah	3/8-in transverse

Equipment (Typ.)

- Self propelled machine 12-ft in width
- Capability to crush and screen material
- Capable of processing and spreading material in one pass
- Capable of producing homogeneous material
- One pneumatic roller at least 25-tons
- One double drum roller at least 10-tons
- Rotary broom on site

Climatic Conditions – Do Not Construct

- Ambient air temperature
  - ex. below 45 to 65°F
- Pavement temperature below
  - ex. below 50 to 70°F
- Over night temperature at or below freezing
- Weather is rainy or foggy
- When proper mixing, spreading and compaction cannot be accomplished
- Between specific months
  - ex. October 1 to April 30

Climatic Conditions – Curing Conditions

- No vehicles on material until 2-hrs have passed
- Surface treatment/wearing course placed when moisture content is below a certain point
  - Free moisture content – below 1.0 to 1.5%
  - Total moisture content – below 1.5 to 3.0%
- Wearing course must be placed within a certain timeframe
  - Between 14- to 30-days

Measurement / Payment

- Payment based on square yard or unit price per station
- Payment may include bituminous materials on a volume or weight basis

Layer Coefficients

State	Layer Coefficient
California	Gravel Factor – 1.5
Kansas	0.25 – 0.28
NCHRP 224	0.35 (0.22 – 0.49)
Nevada	0.26
New Mexico	0.25
Wisconsin	0.10-0.25 (depends if stabilized)

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- New Mexico
- Ohio
- Utah
- Washington
- British Columbia
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Description (ARRA)

- Surface Recycling
- Remixing
- Repaving

Materials - Binders

State	Asphalt Binder
British Columbia	Emulsified recycling agent / Recycling agent
Colorado	Asphalt rejuvenating agent
New Mexico	Emulsified recycling agent (blend meet PG binder grade)
Ontario	Select material to provide blend that meets 50 to 80 pen
Utah	Emulsified recycling agent
Washington	Emulsified recycling agent / PG 58-22

Mix Design

State	Method
Kansas	Air voids, TSR, rutting resistance, thermal cracking
New Mexico	Must meet specifications for HMA – Section 423
Ohio	Marshall stability, penetration
Washington	Superpave, air voids

QC/QA – In-Place Density

State	Density Requirement
British Columbia	97% of lab density
Colorado	92 to 96% of maximum theoretical
New Mexico	92 to 98% of maximum theoretical
Ontario	Lab compacted air voids between 2.5% and 5.5% (75b Marshall)

QC/QA – Surface Tolerance &Thickness

State	Surface Tolerance	Thickness
Colorado	Profile Index – dependent upon roadway traffic volume	
New Mexico	1/8-in transverse 1/8-in longitudinal	As specified
Ontario		2-in max, 1.5-in typ

Equipment (Typ.)

- Remove all material from pavement surface - broom
- Self propelled
- Enclosed combustion area
- No open flame in direct contact with pavement
- Capable of heating pavement to desired temperature
- Capable of scarifying the heated pavement to the desired depth

Equipment (Typ.)

- Requirements on laydown temperature of material
  - Typ. Min. 190°F to 230°F
  - Typ. Max. 300°F to 315°F
- Scarification does not break the aggregate particles
- Heating does not char the asphalt surface
- Uniformly distribute material
- Rolling operation must obtain the desired pavement density

Climatic Conditions – Do Not Construct

- Ambient air temperature
  - ex. below 40 to 50°F
- Pavement temperature below
  - ex. below 50°F
- When roadway surface is wet
- Weather conditions prevent proper placement
- Between specific months
  - ex. October 16 to May 14

Measurement / Payment

- Payment based on square yard or unit price per station
- Payment may include bituminous materials on a volume or weight basis

Layer Coefficients

State	Layer Coefficient
None	None Available
Suggested Value	0.40 – 0.44

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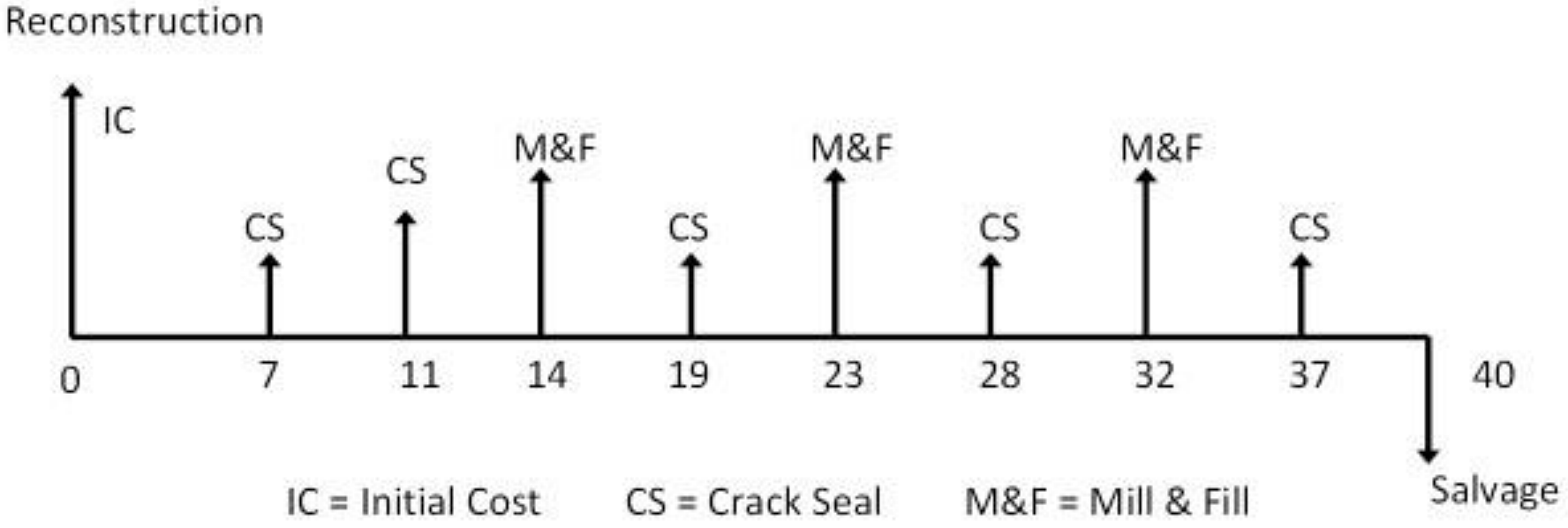
Value of Recycling – Percent Savings Relative to Conventional Construction – Initial Construction*

	CIPR	FDR	HIPR - Remix
Energy, BTU	22	16	25
AC Consumed, tons	16	-2	35
Aggregate Consumed, tons	33	72	44
Price, $	23	52	16**
CO_{2eq}, lb	30	60	22

*equivalent square yards

**Based on limited information

Life Cycle Assessment Format



- 40-year period was selected
- 4-percent discount rate

Value of Recycling – Percent Savings Relative to Conventional Construction – LCA*

	CIPR	FDR	HIPR - Remix
Energy, BTU	9	25	10
AC Consumed, tons	6	14	13
Aggregate Consumed, tons	14	63	18
Price, $	14	48	10**
CO_{2eq}, lb	13	54	10

*equivalent square yards

**Based on limited information

Performance Specifications

Method Specifications — End Result – QC/QA

Performance Related — Performance Based — True Performance

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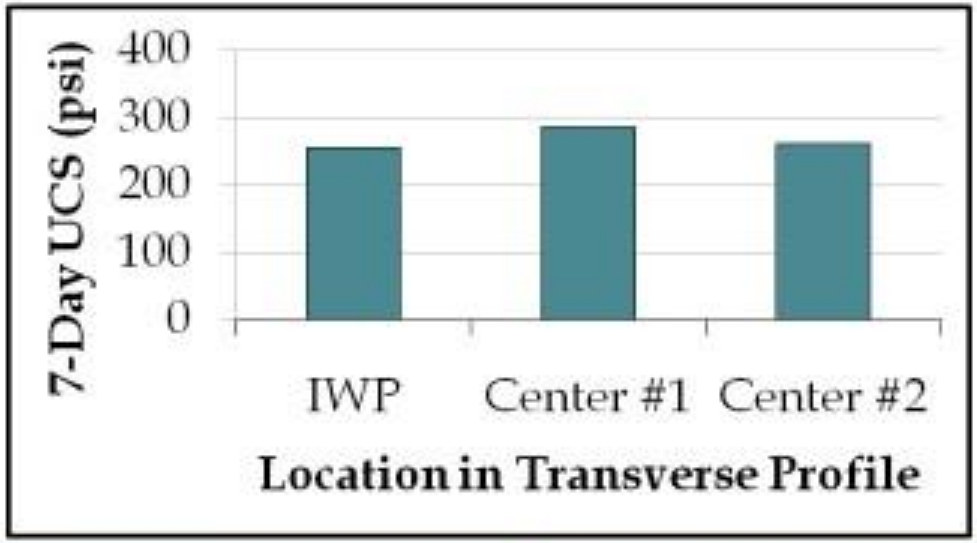
New Technologies to Establish the Uniformity of Stabilizer Application

- X, Y, Z direction
- Tools available
  - pH type test
  - PFWD or Seismic
  - Strength test
  - Other



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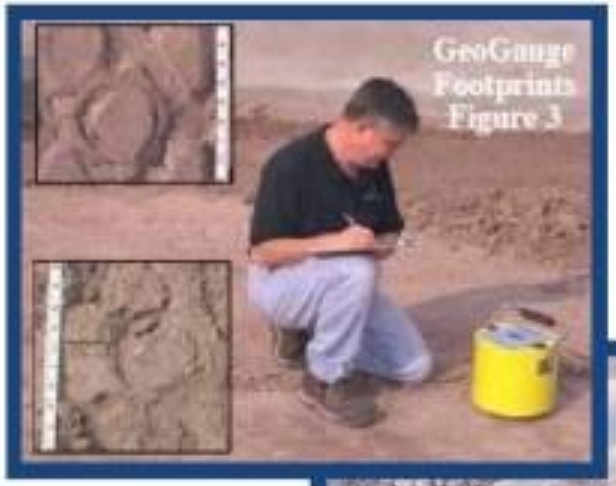
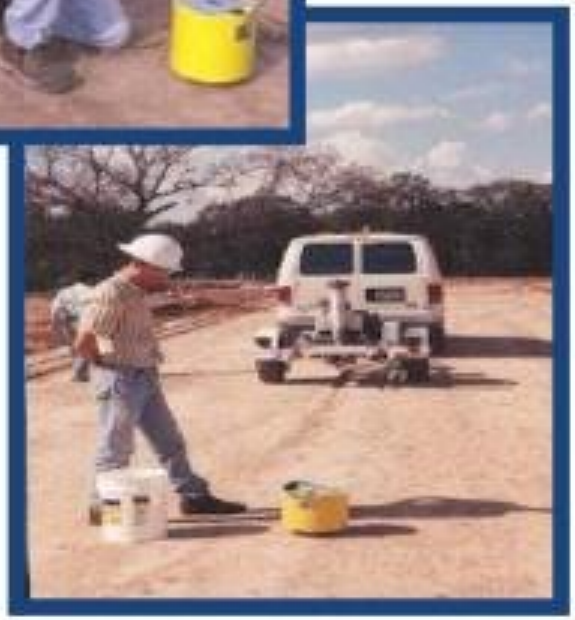
Deflection/Stiffness Systems

Portable FWD

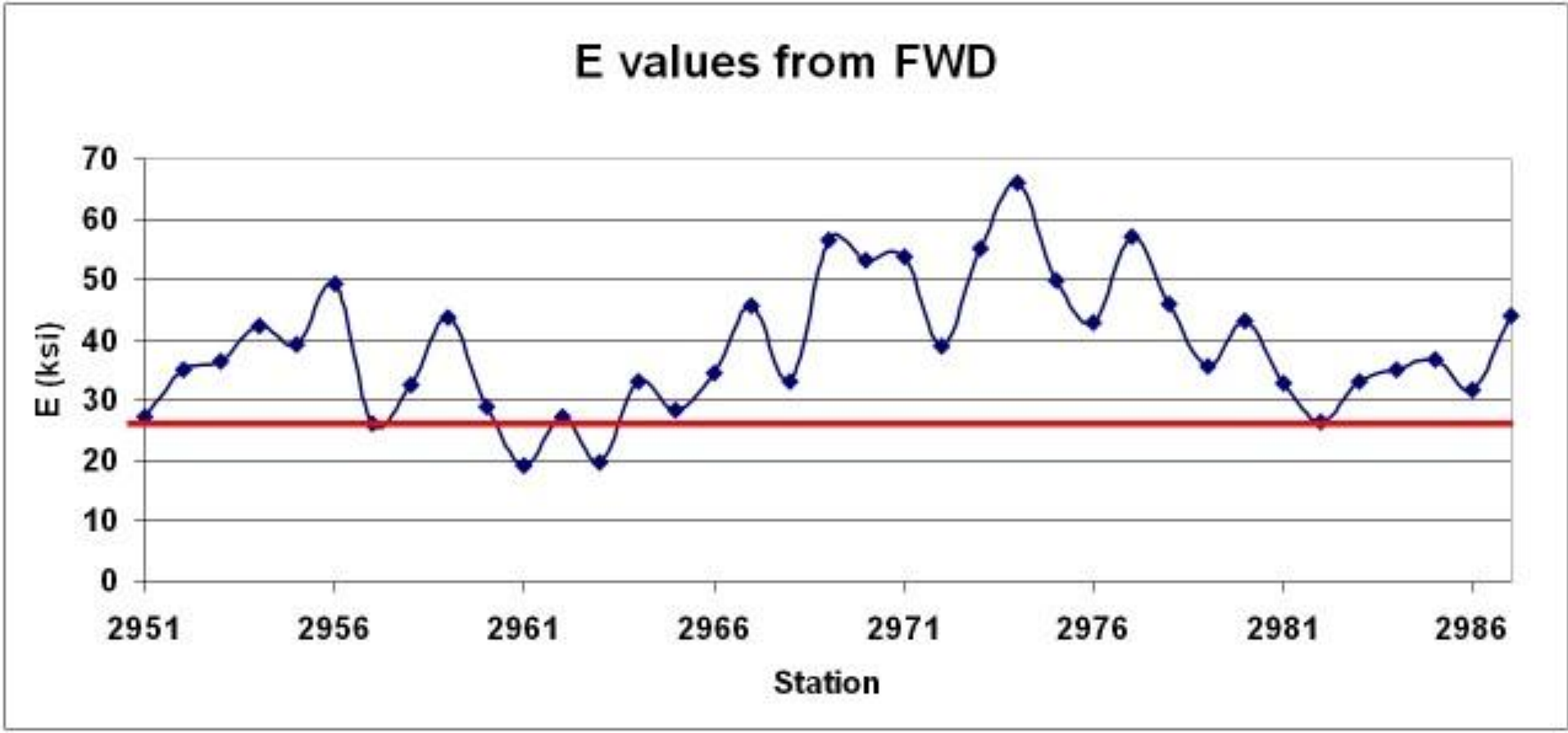
Testing During and After Construction

- Humboldt GeoGauge
- Falling Weight Deflectometer
- Both devices worked well
- Both measure stiffness of stabilized layer

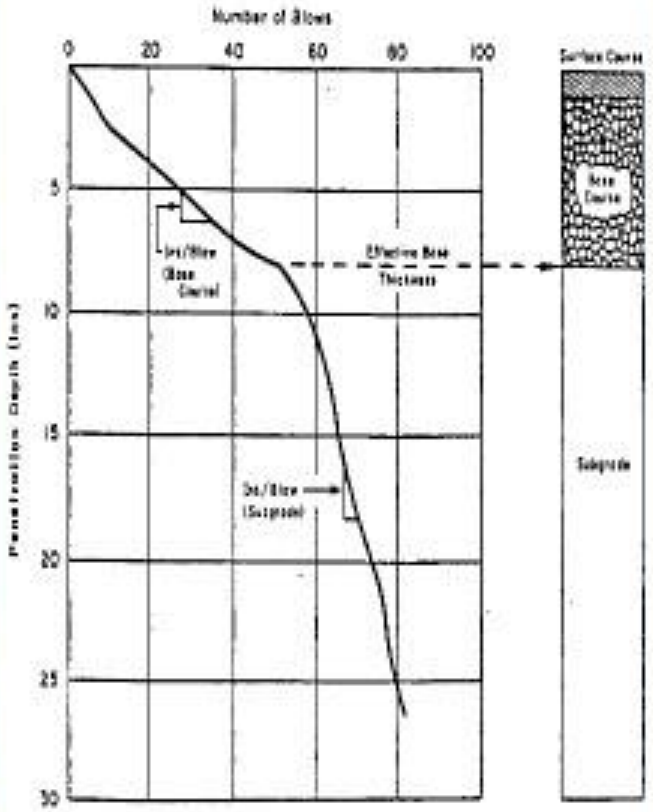




Comparison on Measured Modulus versus Value Assumed in Design



Dynamic Cone Penetrometer



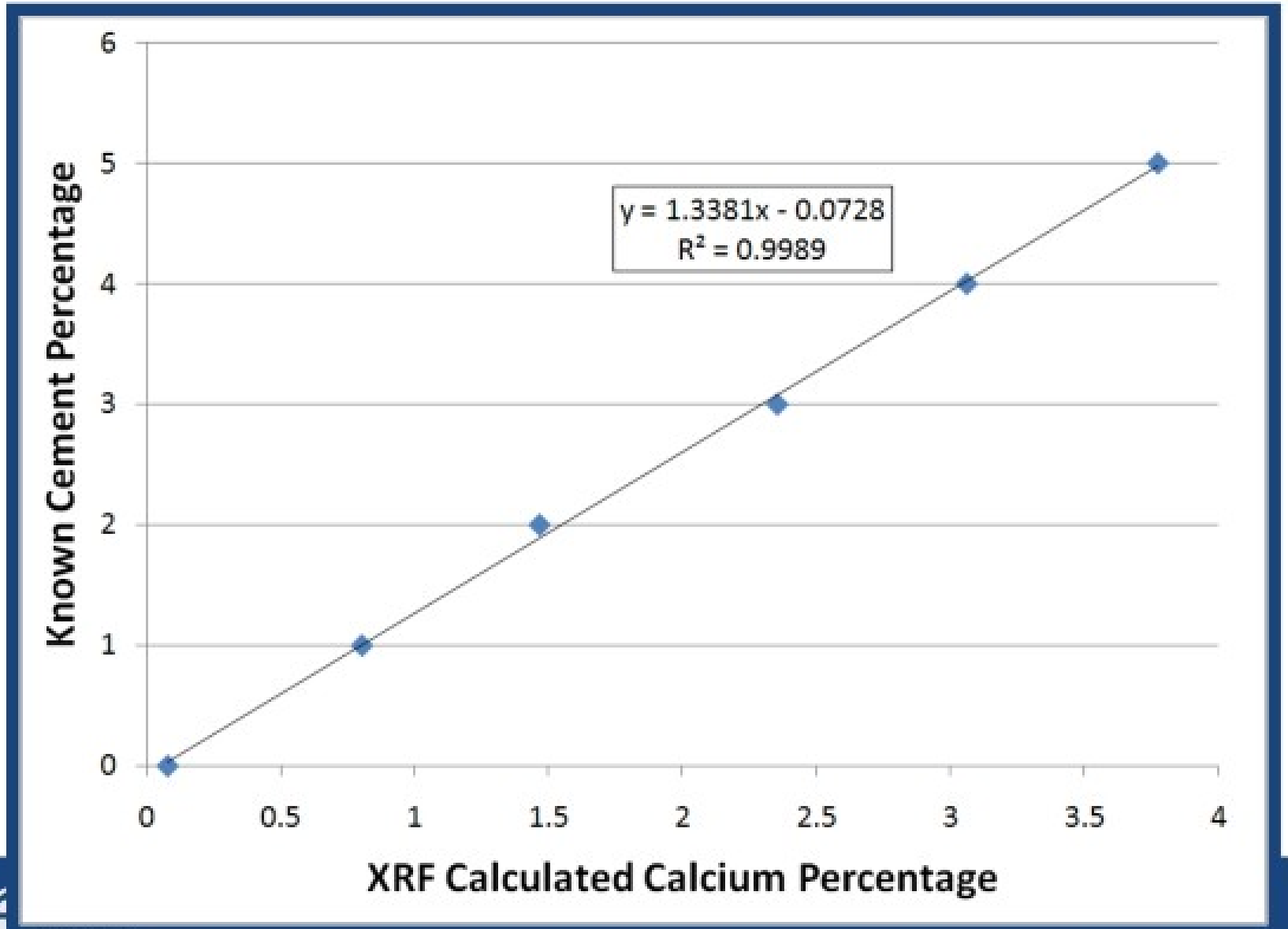
Measures both layer stiffness (from penetration rate) and layer thickness (change in penetration rate)

Measuring Stabilizer Content with XRF

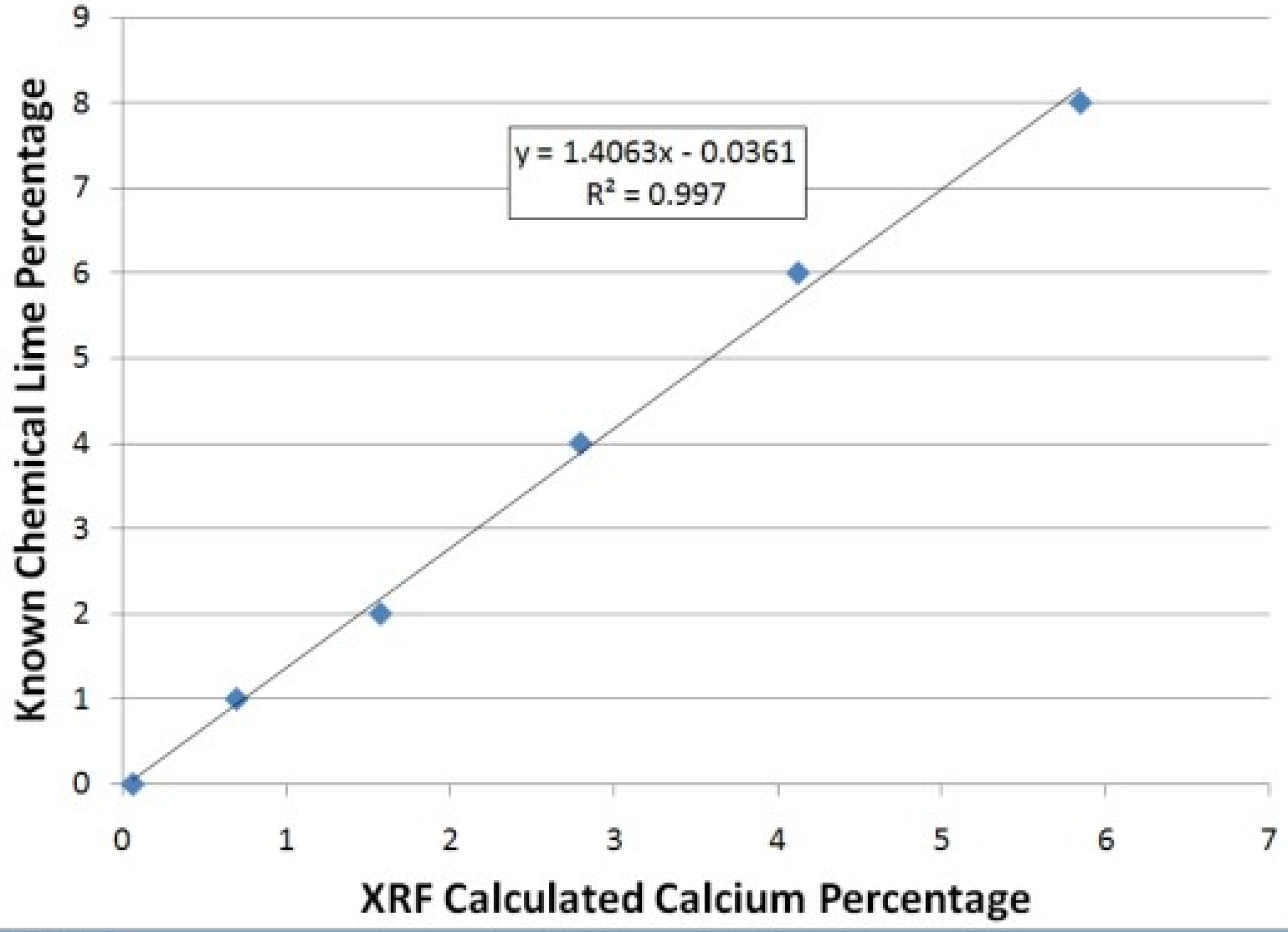
Lab tests conducted on

- 40% Kaolinite/60% Quartz sand
- 0-5% Cement
- 0-8% Chemical Lime
- 3 XRF measurements on each

XRF Results with Cement-treated Soil



XRF Results with Lime-treated Soil



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Summary

- Procedure currently in use
- Take deflections after 5 days
- Investigate failing areas with DCP
- Simple targets based on design assumptions
- FWD works well
  - Repeatable and consistent
- No accounting for temperature or age.
- Portable FWD has repeatability issues
  - To be resolved

Questions