BUILD A RELIABLE CEMENT-TREATED SUBGRADE LAYER

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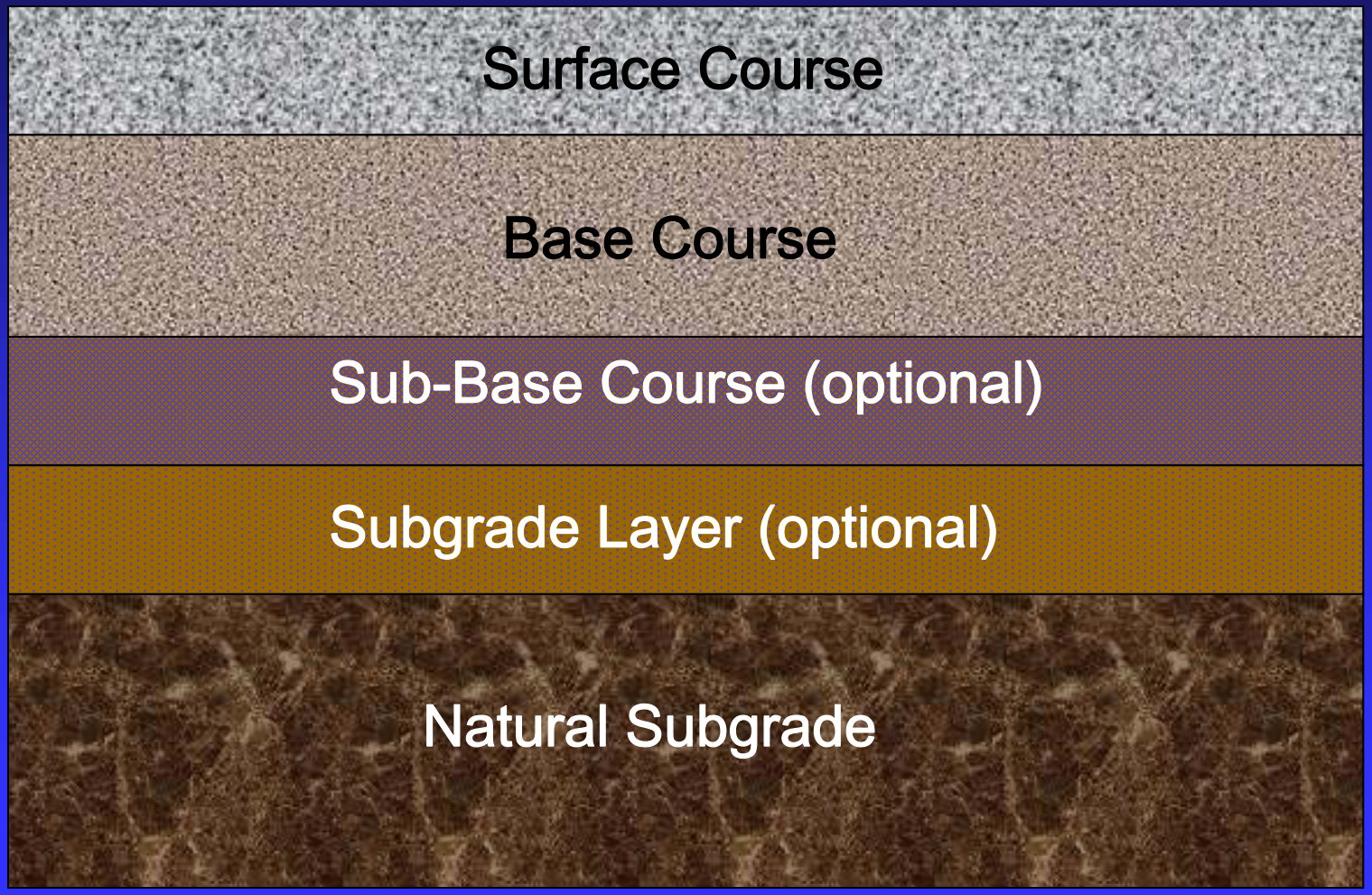
LTRC

Louisiana Transportation Research Center

Pavement Structure



DOTD Specification on Cement-Treated Subgrade Layer

Specification Section	Raw Materials	Cement Content, %	Compaction Moisture	Field Compaction
305 Subgrade Layer	PI≤25%, Sand≤ 79%, Silt ≤69%	150 psi	Optimum ± 2% ? ? ?	95 % of standard or modified proctor

Basic Question

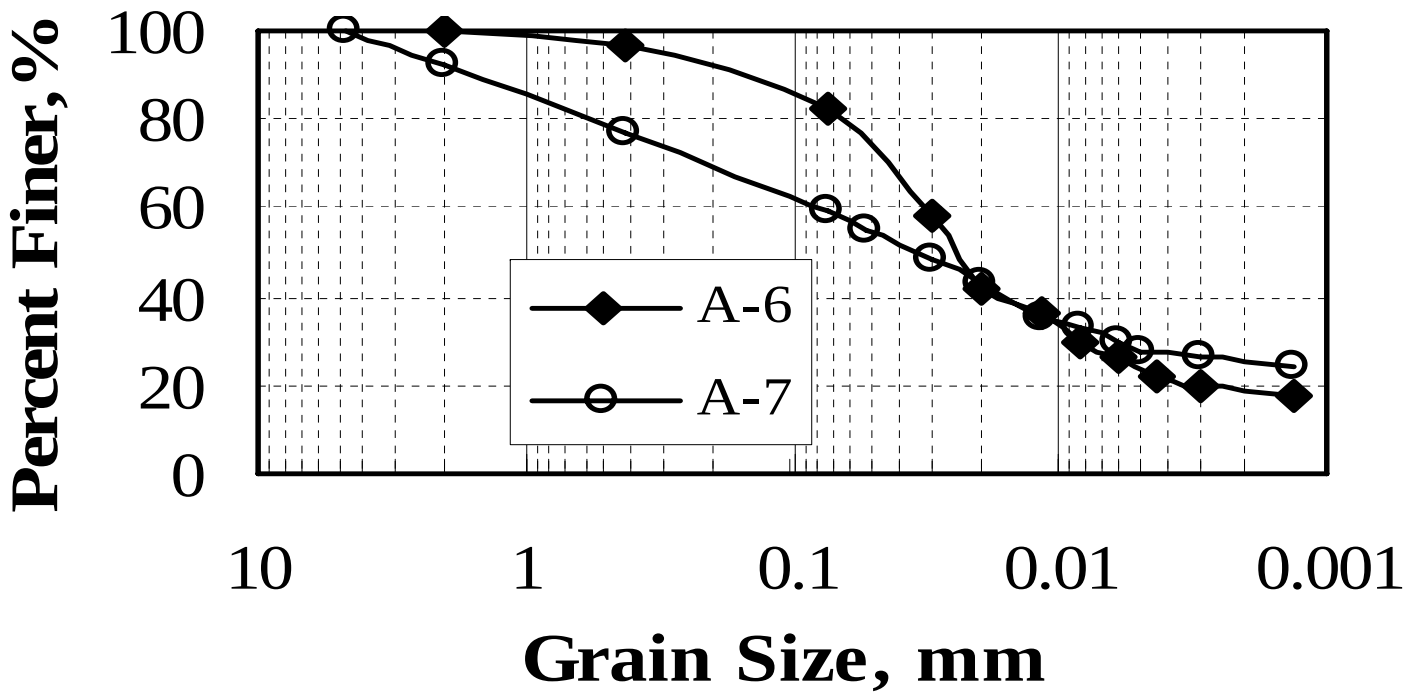
What if wet subgrade soil is cement-treated and also compacted at the field moisture content?

LTRC research project: 03-2GT with State Project No. 736-99-1124

Lab Testing Program

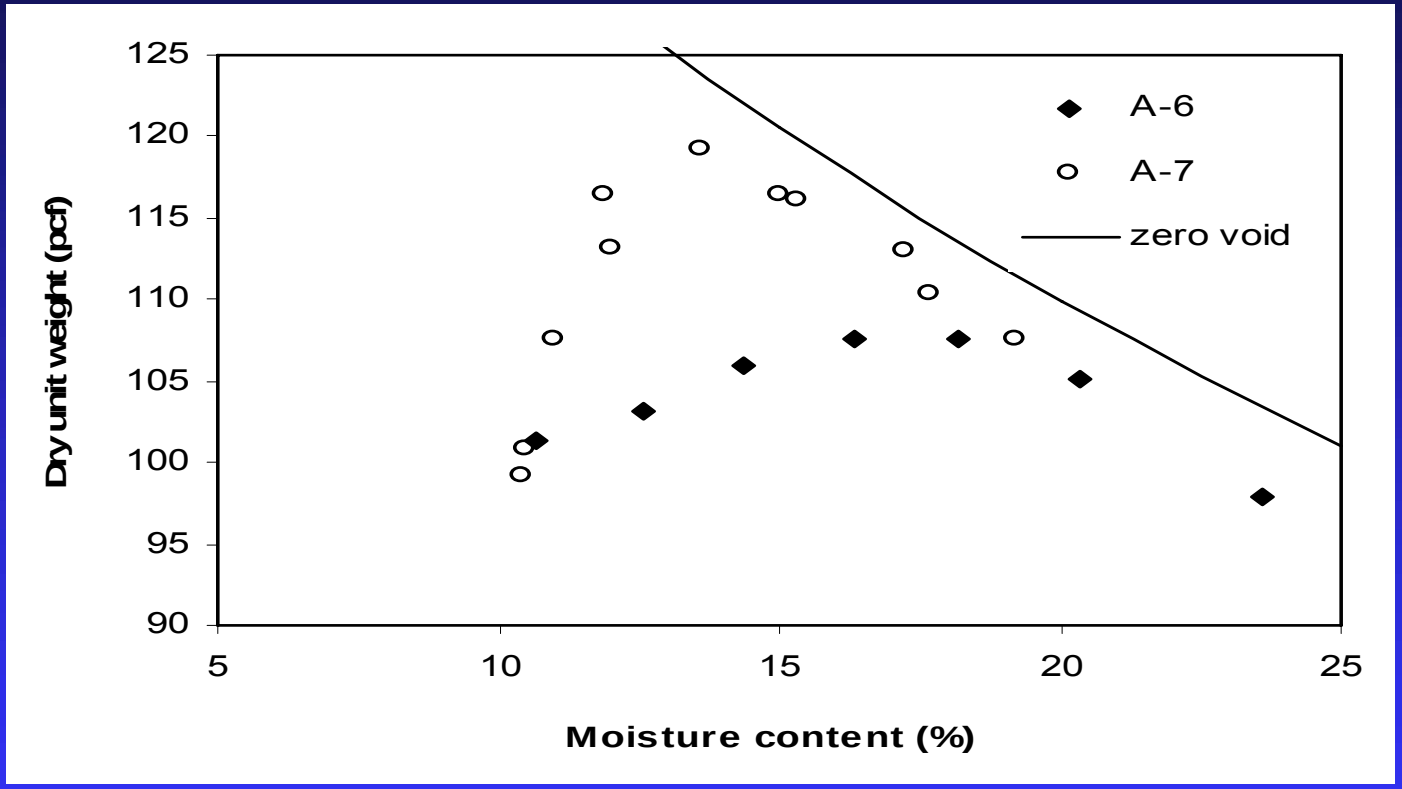
- TR 432 , including both unconfined compressive strength (UCS) and durability (ASTM D1633 and D559)
- Soils, A-6 and A-7 with PI of 12 and 22, respectively

Basic Properties - Gradation



Soil	Sand, %	Silt, %	Clay, %	LL, %
A-6	8	64.5	27.5	34
A-7	41.5	30.6	27.9	37

- Standard Compaction

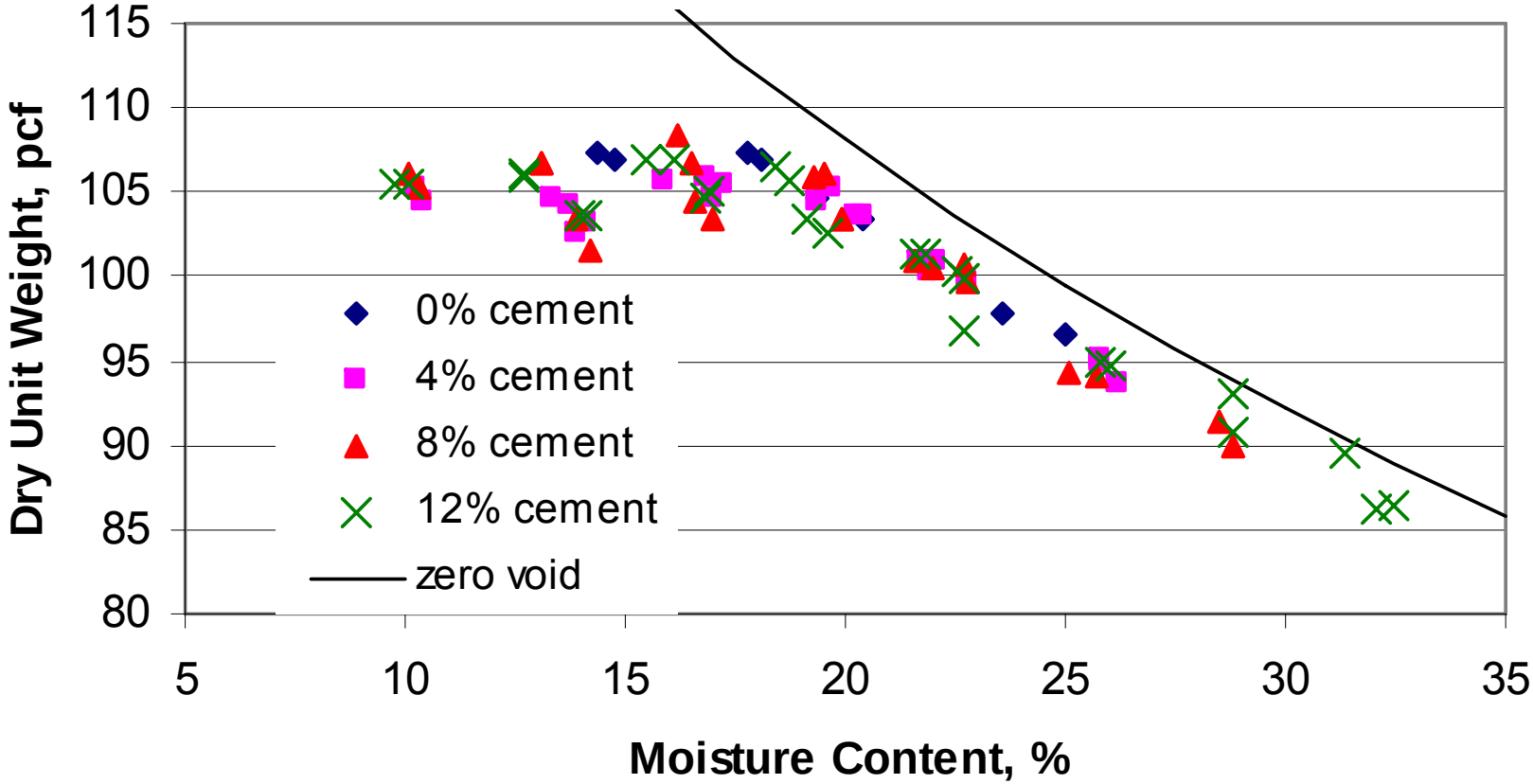


Soil	Optimum Moisture Content, %	Maximum Dry Density, pcf
A-6	17.5	108.0
A-7	13.5	119.0

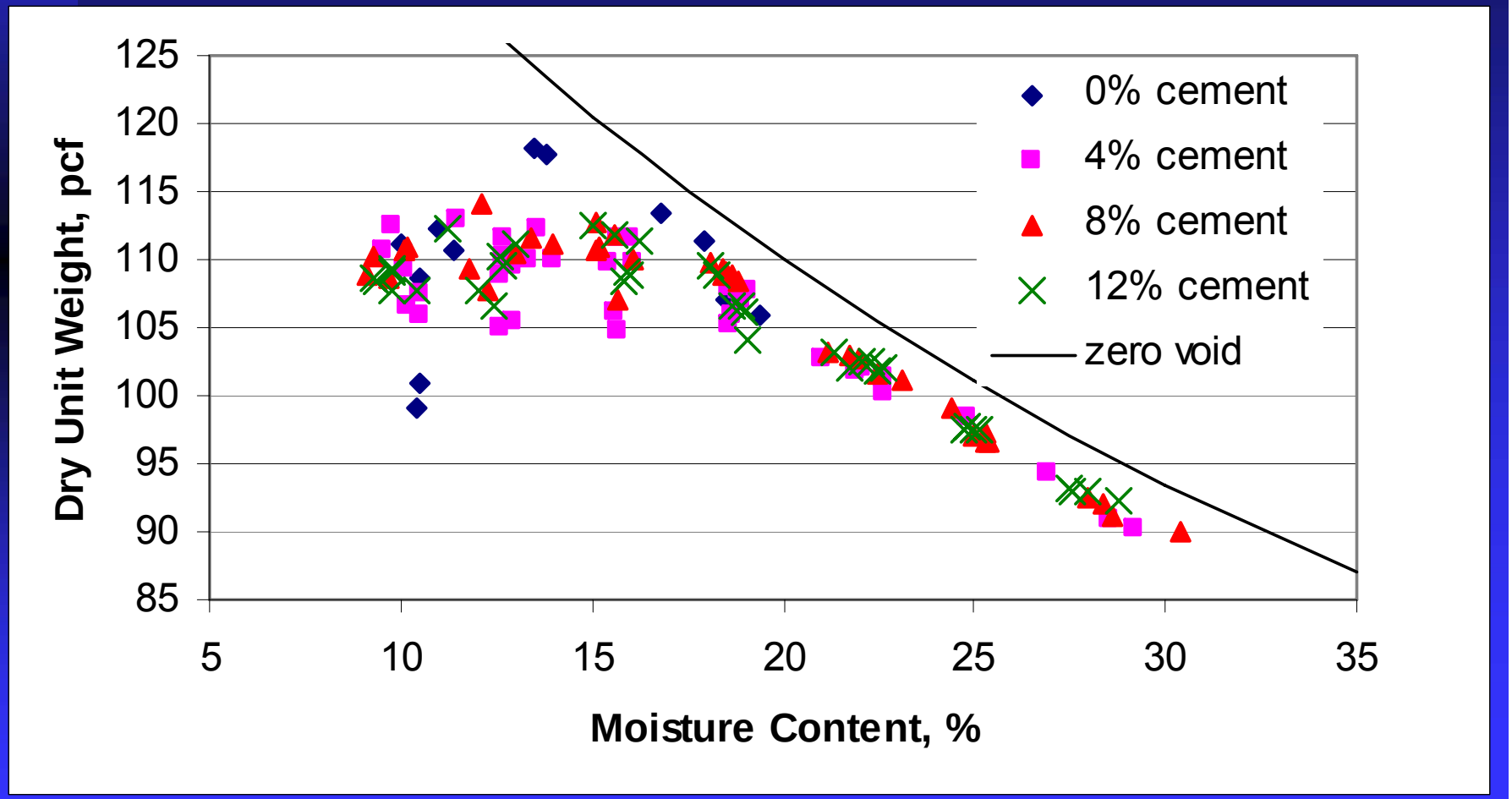
Testing Factorial

Soil type	Optimum moisture, %	Cement, %	Molding moisture, %	Curing, days
A-6	17.5	4, 8, 12	8.5 - 29.5 (too wet to mold)	7, 28
A-7	13.5	4, 8, 12	7.5 – 25.5 (too wet to mold)	7, 14, 28

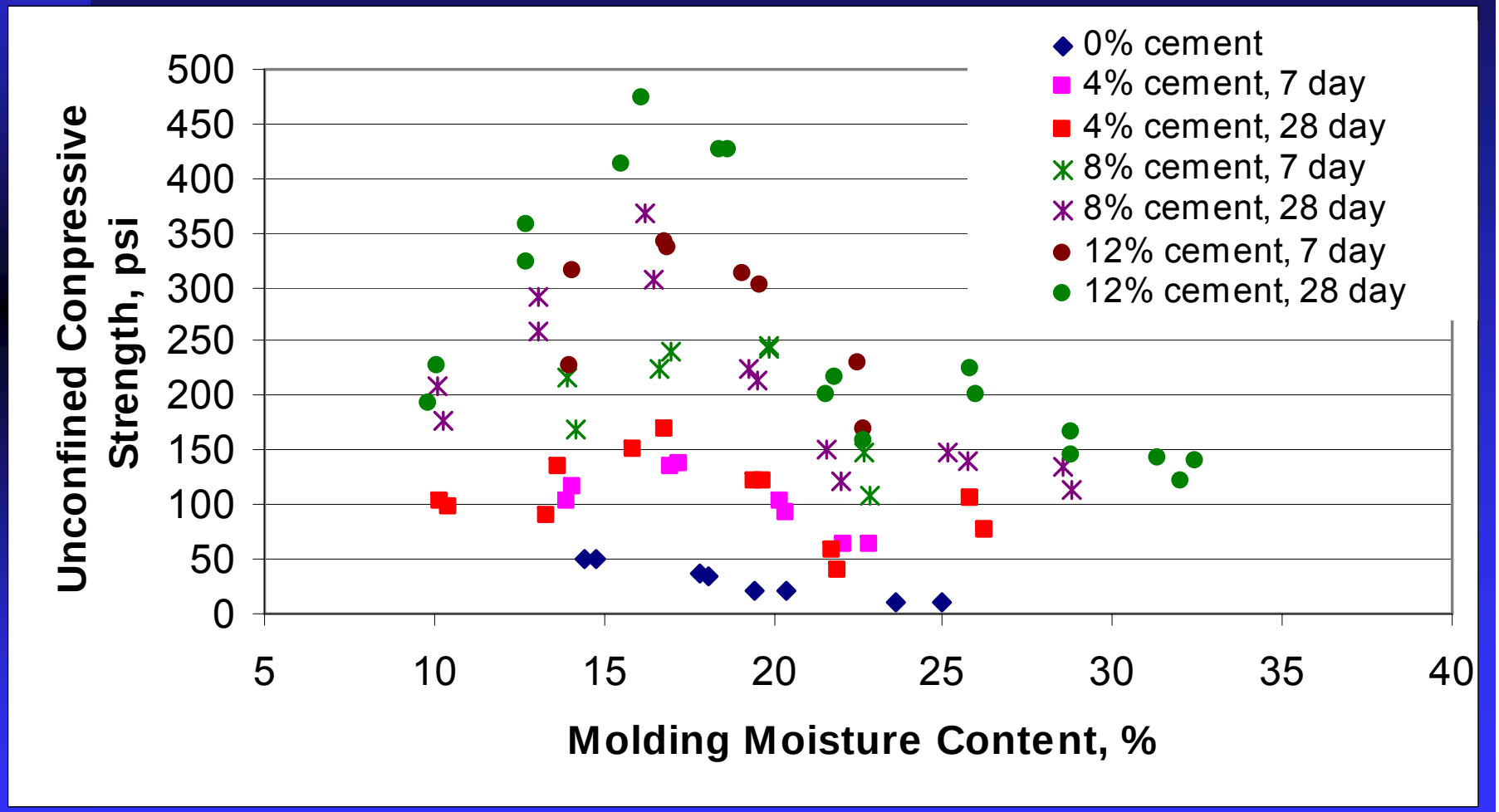
Sample Compaction: A-6



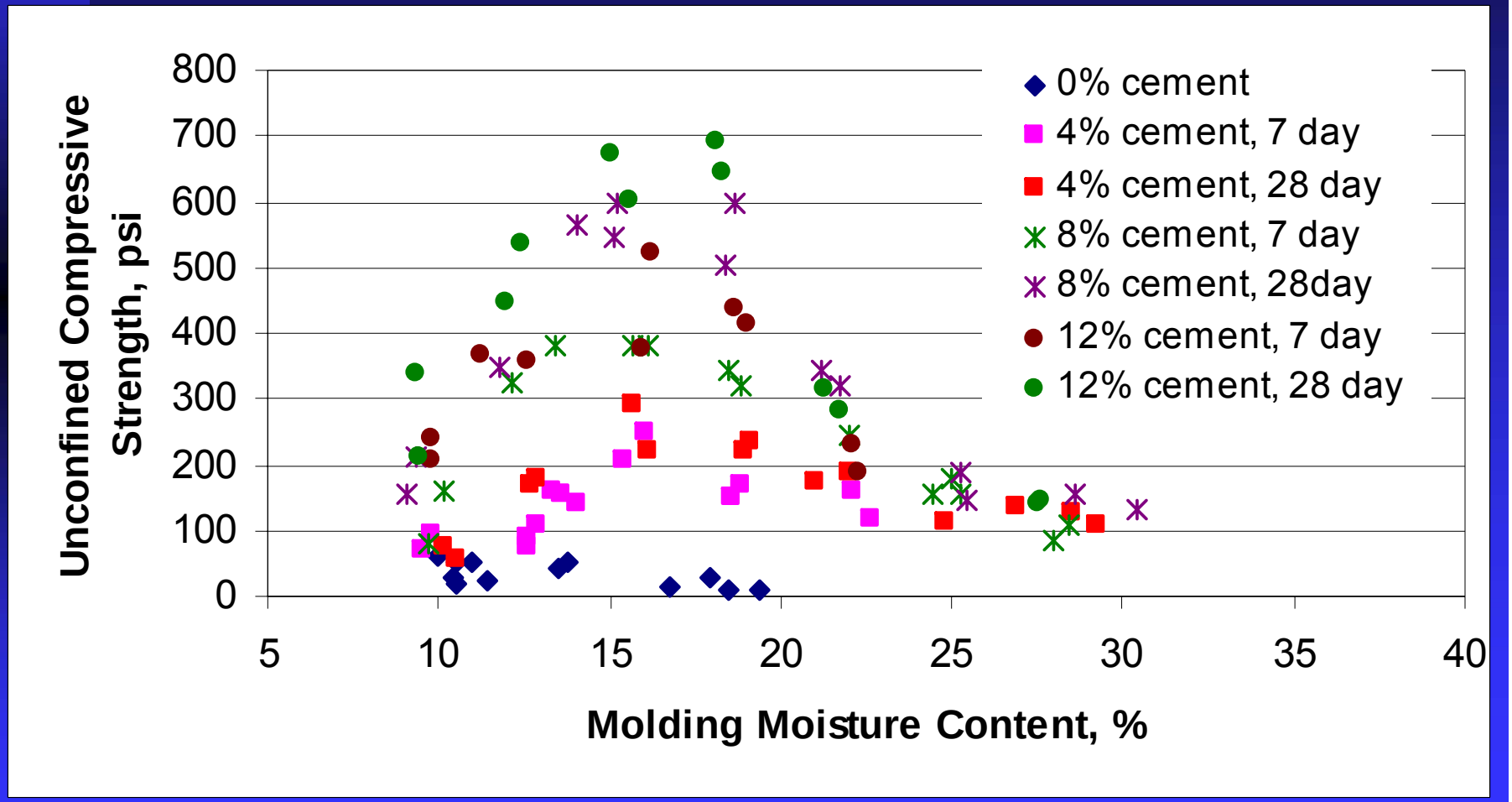
Sample Compaction: A-7



Sample Compaction: A-6



Sample Compaction: A-7



Data Analysis

- Major influence factors
  - Cement content
  - Molding moisture content
  - Curing time
  - Sample dry density

Water Cement Ratio

$$R = \frac{w}{C}$$

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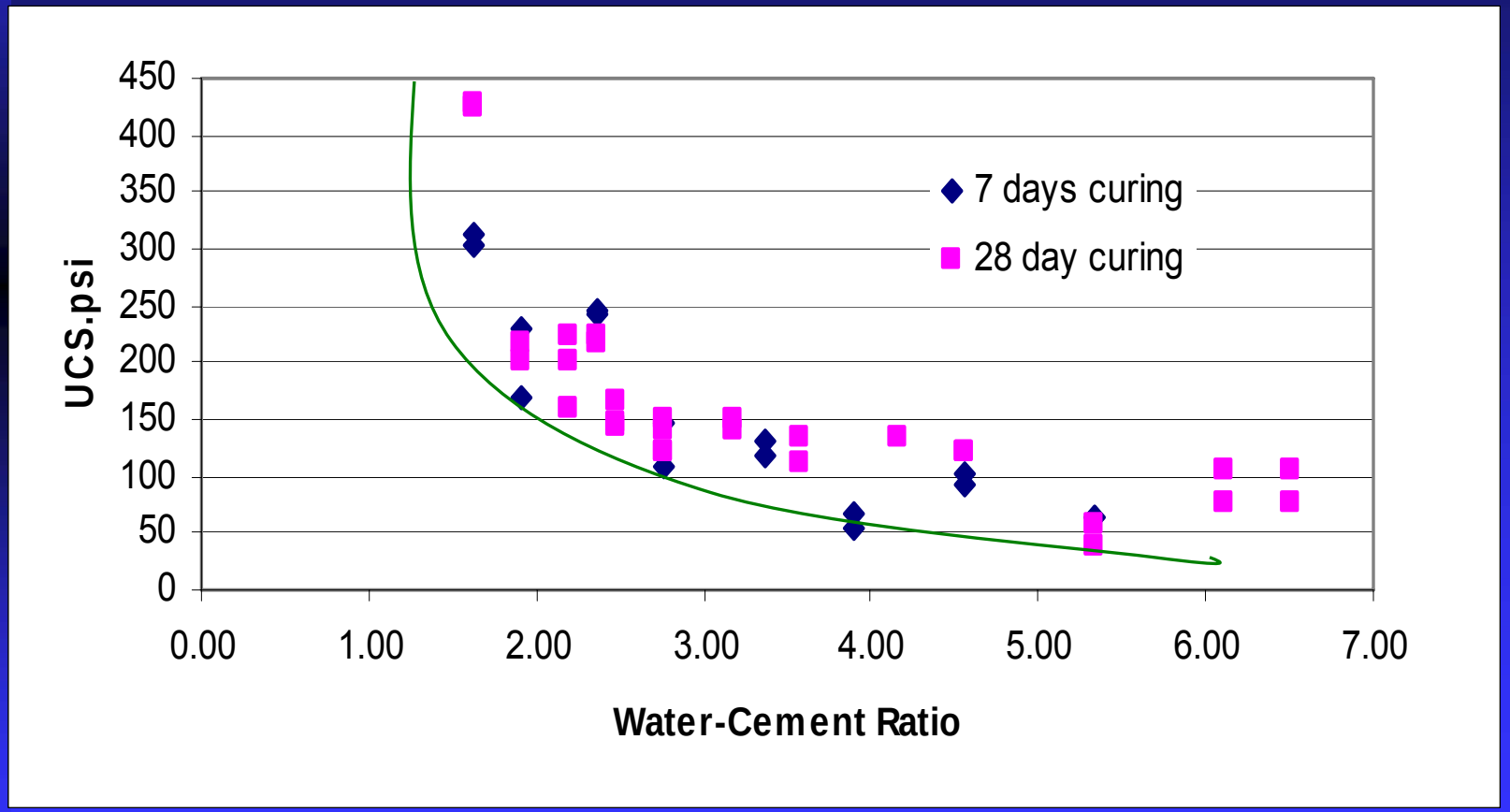
"w" is the molding moisture content in the percent of dry soil weight;

"C" is the cement content used in soil in the percent of dry soil weight.

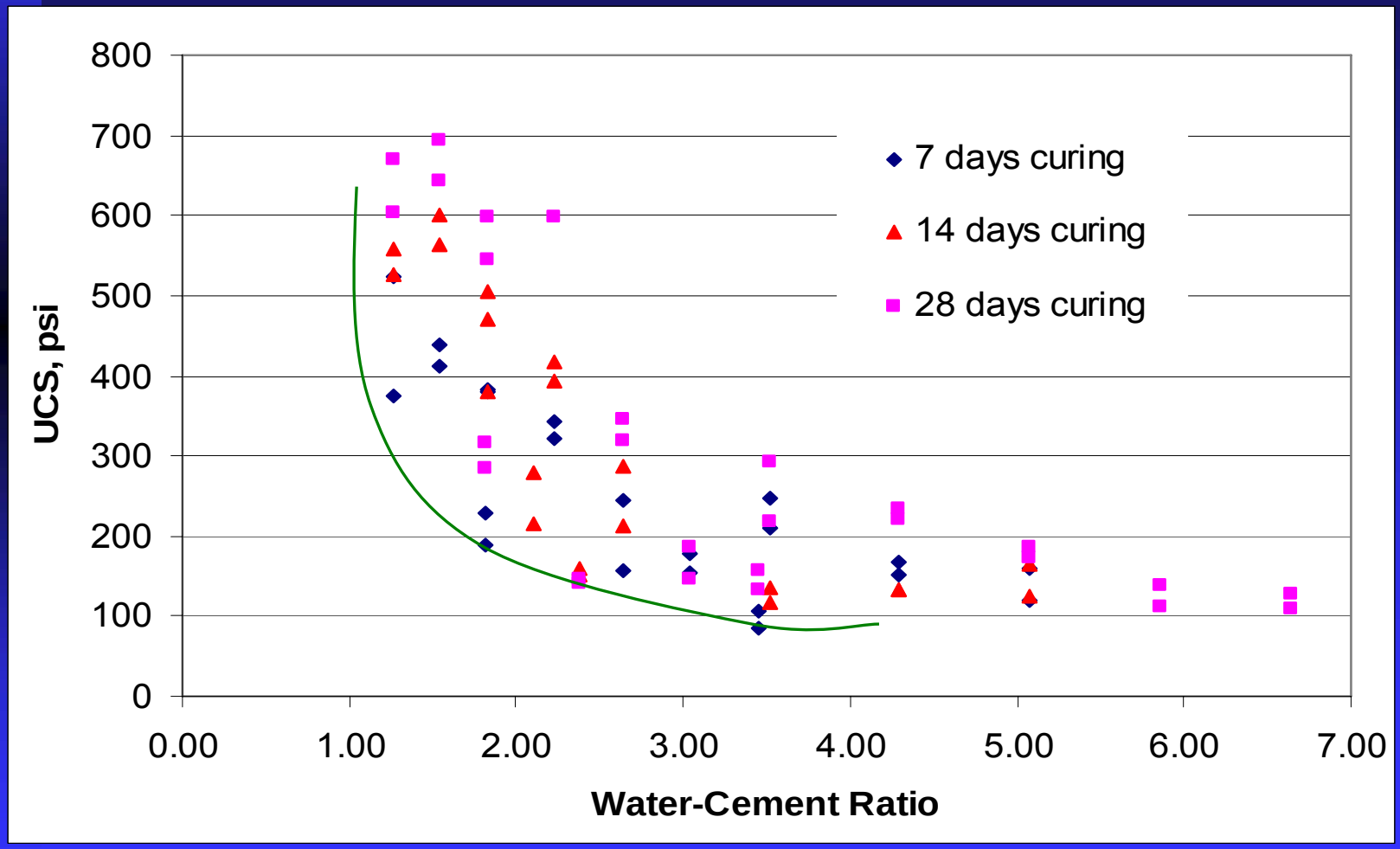
Correlations

Independent Factors	Dependent Factors	
Cement Content: ↑	Water cement ratio ↓	Strength ↑
	dry side of compaction curve	Wet side of compaction curve
Molding Moisture Content: ↑	Water cement ratio ↑; Dry density ↑	Strength ↑
	Water cement ratio ↑; Dry density ↓	Strength ↓

Correlation: A-6



Correlation: A-7



Simple Correlation

Target value of UCS (7 day curing)	Water-Cement Ratio
50 psi	5.0
100 psi	3.0
150 psi	2.0
200 psi	1.75

Only GOOD on the wet side of a compaction curve

Procedure Recommended

Laboratory

Step 1: Select representative subgrade soil sample from the roadway to be stabilized.

Step 2: Determine its Plastic Index (PI) and optimum moisture content, w_{wo}. If PI < 25, follow the procedure described here.

Step 3: Select the target value in the term of unconfined compressive strength (UCS) for the treated subgrade layer.

Laboratory - continued

Step 4: Determine the corresponding Water-Cement Ratio, R_{wc} using the correlation above; interpolate if needed.

Step 5: Calculate the cement content in percent at the optimum moisture content of the soil as follows:

$$C_{wo} = \frac{w_{wo}}{R_{wc}}$$

Laboratory - continued

Step 6: Mold the specimens of the cement-soil mixture with the cement content C_{wo} determined at the optimum moisture content, w_{wo} according to the LA DOTD's standard procedure and cure them for 7 days to check the target value of UCS.

or

Step 5(optional): Use TR 432 to determine the cement content for the target value of UCS and skip Step 6.

Field Construction

Step7: Adjust the cement content $C_{wf} = C_{wo} + \Delta C_{wf}$ used according to the field moisture content at construction, C_{wf}, as follows.

$$\Delta C_{wf} = \frac{w_{wf} - w_{wo}}{R_{wc}}$$

Where the variables in the formula are as defined before.

Note: if $w_{wf} < w_{wo}$, water is required to be added in the field.

Field Construction - continued

Step 8: Compact the wet cement-stabilized subgrade to reach a 100% of dry density at the corresponding field moisture content, determined by lab test.

Step 9 (optional for emergency): In cases where the field soil is different from the one tested in the laboratory, the cement content can be determined directly as follows.

$$C_{wf} = \frac{w_{wf}}{R_{wc}}$$

Help Needed

- Field test data is needed to validate the correlation and procedure developed from the lab test
- Variation of correlations with soil types
- Information needed
  Soil type, gradation, PI, water-cement ratio used in the field, UCS of samples mixed and molded in the field and/or laboratory.

Contact Information

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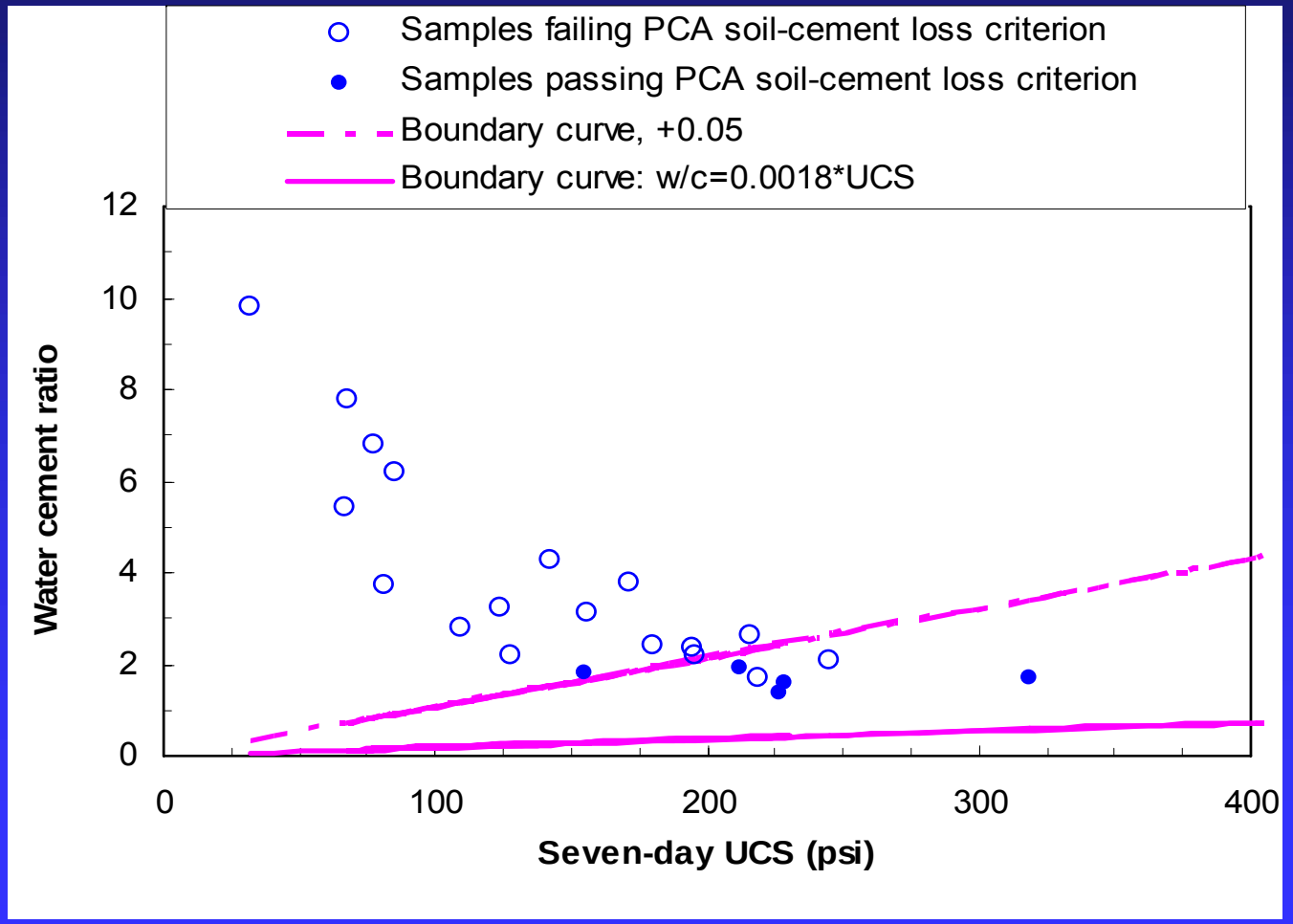
Durability of Cement Stabilized Soils



Questions?