Stabilization of Silty-Sand with Nontraditional Additives

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Stabilization of SM Sands with Nontraditional Additives

Objectives

- Screen off-the-shelf nontraditional stabilizers
- Determine the benefits for SM soils

Approach

- Develop knowledge base on stabilizers
- Laboratory investigation
- Performance capabilities and guidance criteria

Stabilization of SM Sands with Nontraditional Additives

Categories

Nontraditional Stabilizers

- Acids
- Enzymes
- Lignosulfonates
- Polymers
- Petroleum Emulsions
- Tree Resin

Traditional Stabilizers

- Cement
- Asphalt
- Lime

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Worldwide Soil Types

Soil Type	Percent
SM	44
CL	21
CH	10
SC	8

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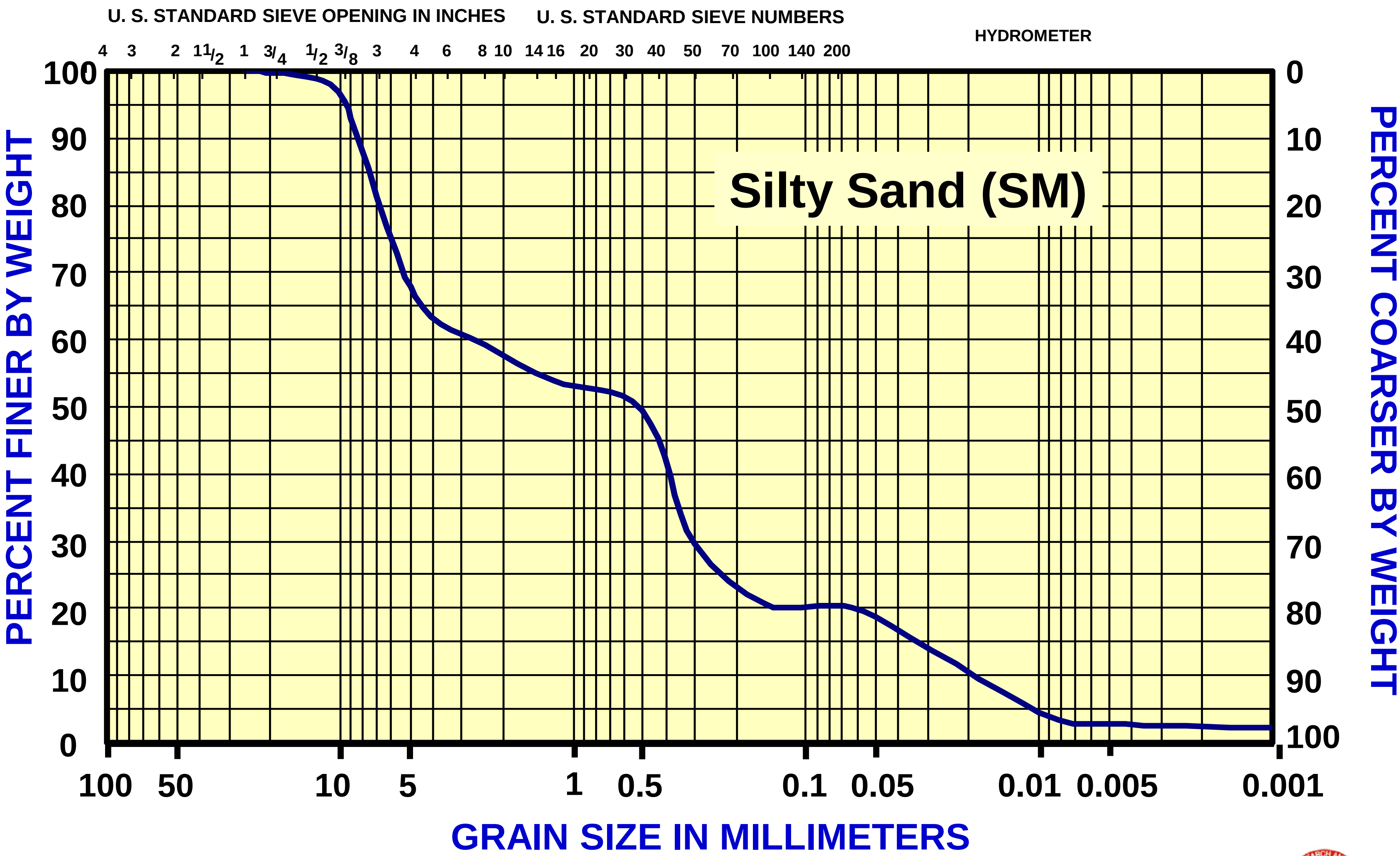
Particle Distribution



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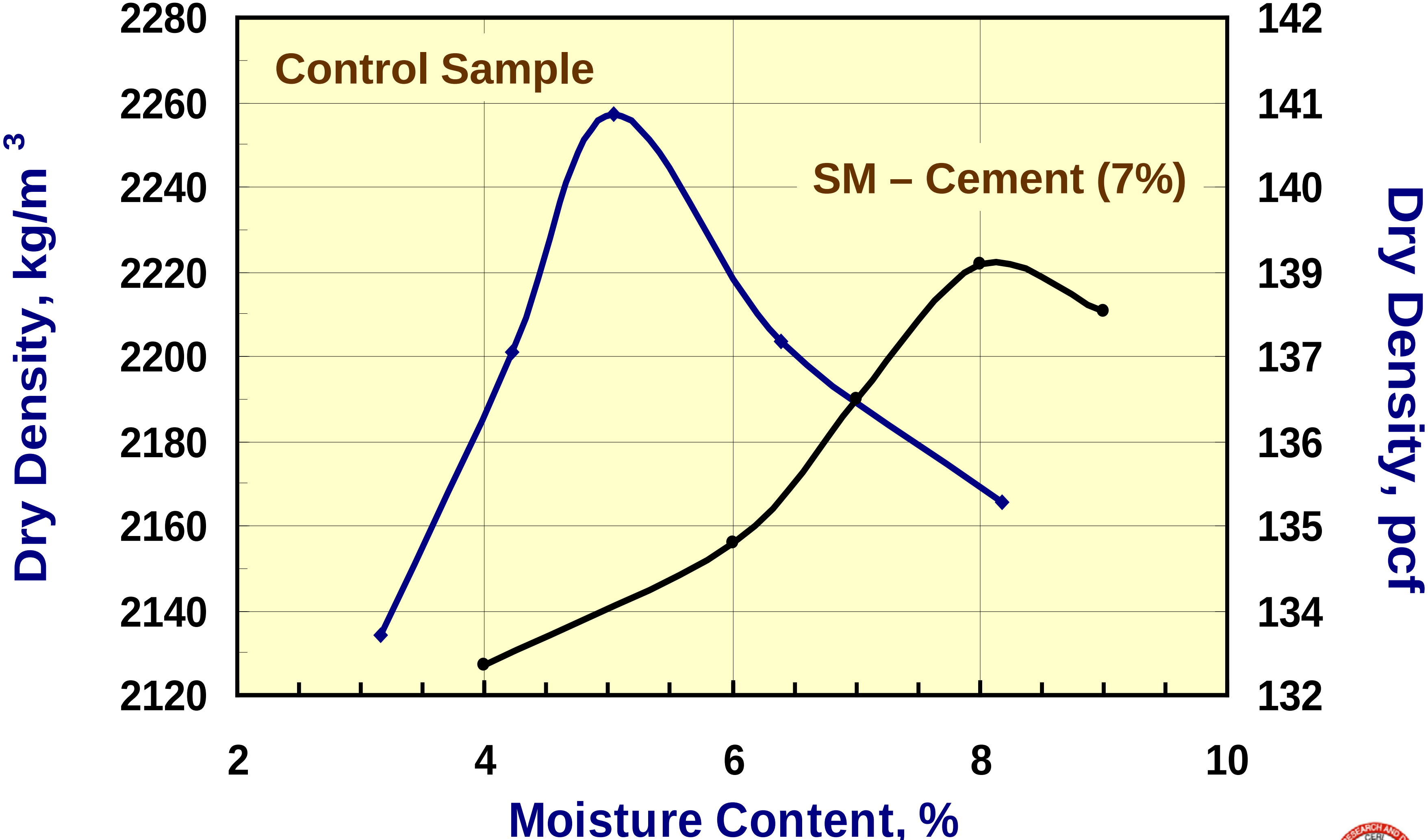
Compaction Curve



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Experiment Design

STABILIZER	Reinforcement Mechanism	LOW	MEDIUM	HIGH
Control	None	X		
Cement	Mechanical/Chemical	X	X	X
Asphalt	Mechanical	X	X	X
Lime	Chemical	X	X	
Acid 1	Chemical	X		
Lignosulfonate 1	Mechanical	X	X	X
Lignosulfonate 2	Mechanical	X		
Enzyme 1	Chemical	X		
Enzyme 2	Chemical	X		
Enzyme 3	Chemical	X		
Enzyme 4	Chemical	X		
Polymer 1	Mechanical	X	X	X
Polymer 2	Mechanical	X	X	X
Polymer 3	Mechanical	X	X	X
Petroleum Emulsion 1	Mechanical	X	X	X
Tree Resin 1	Mechanical	X	X	X

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Specimen Preparation

SM Soil Preparation

Additive Preparation

Soil-Additive Mixing

Sample Molding

Sample Compaction

Sample Curing

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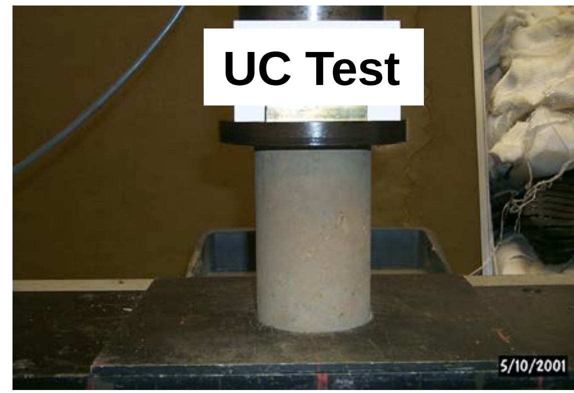
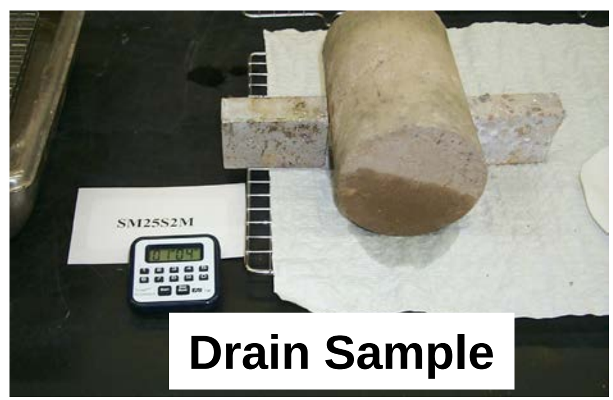
Laboratory Test

UC TEST

DRY TEST



WET TEST



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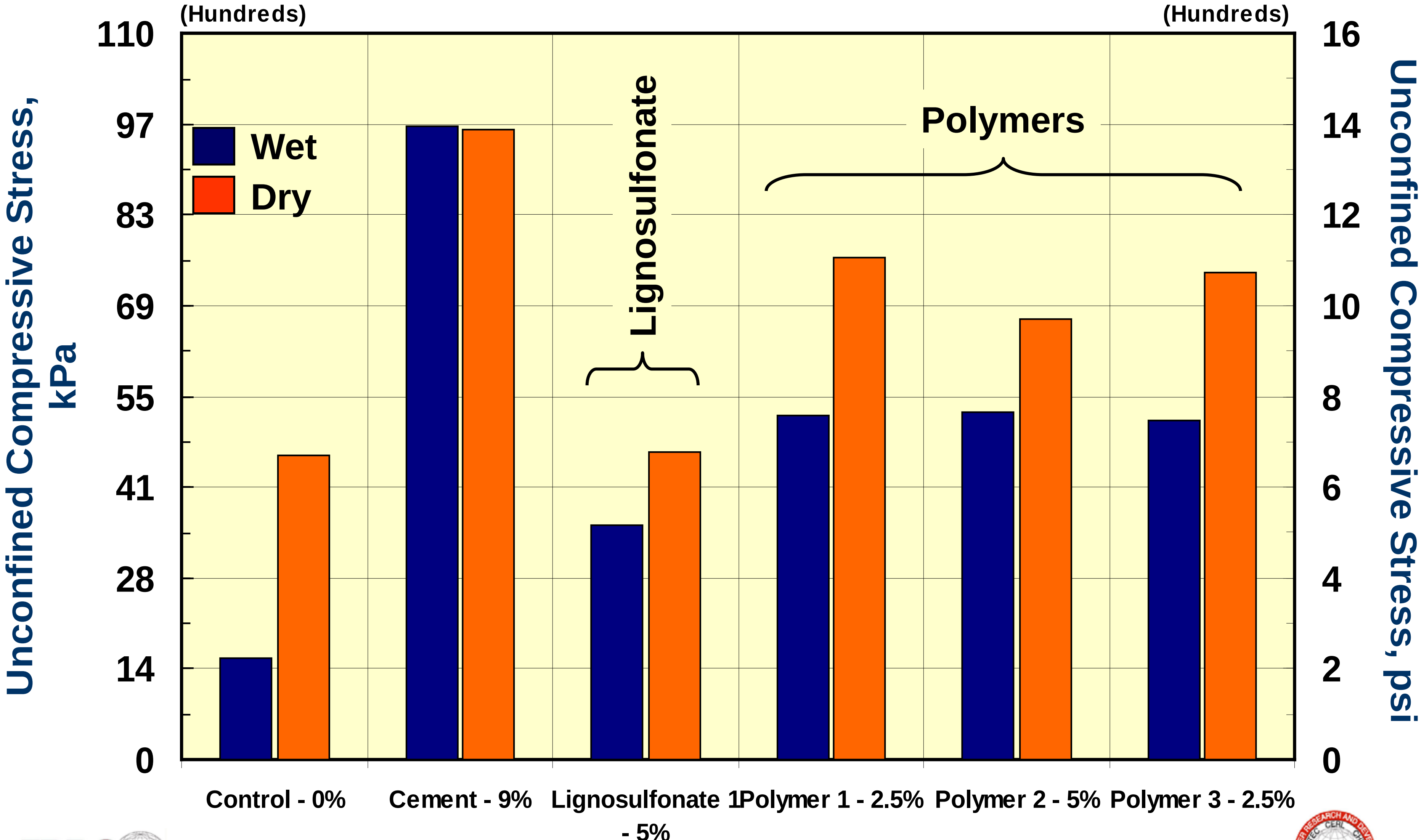
Effect of Stabilizer Type



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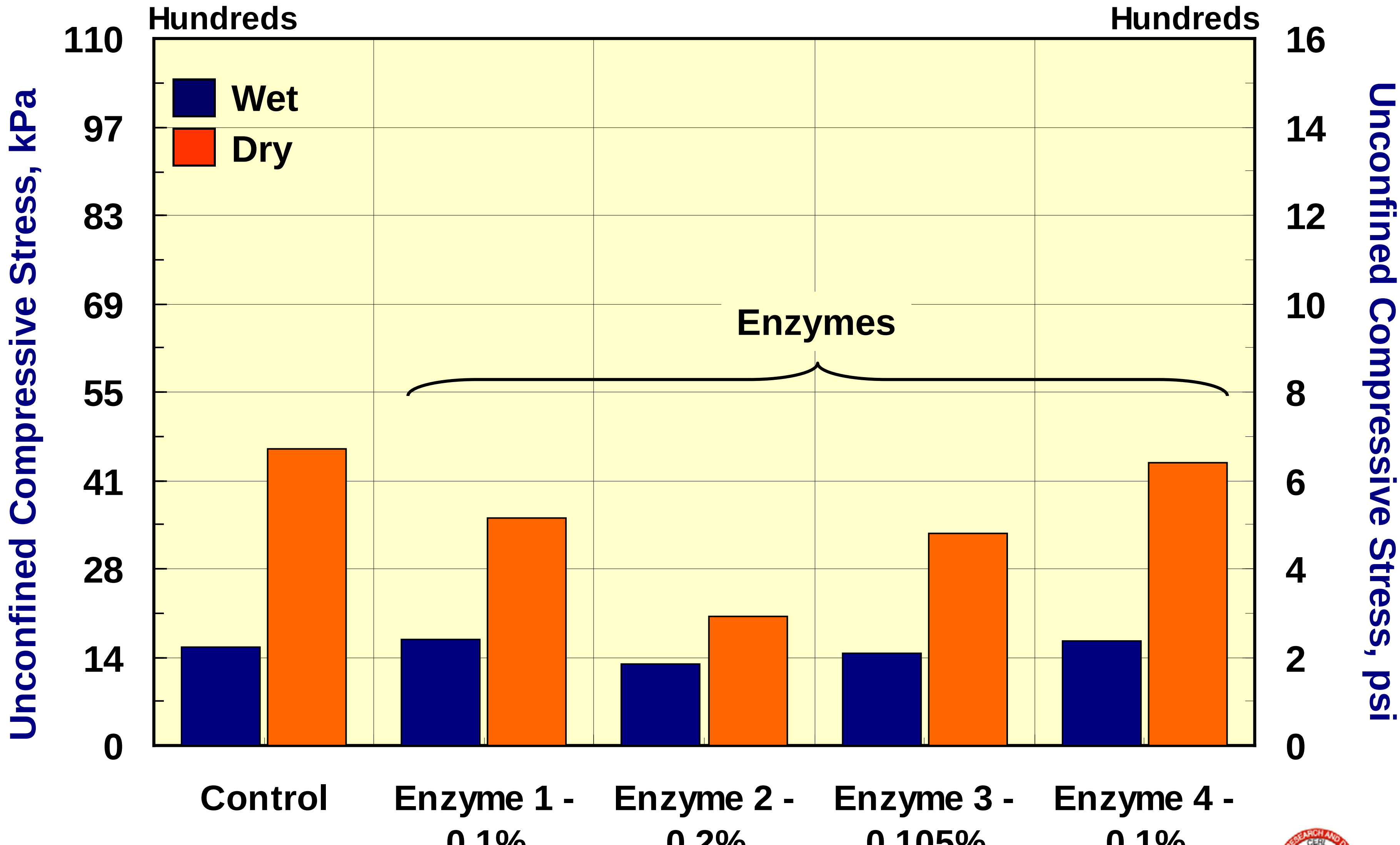
Effect of Stabilizer Type



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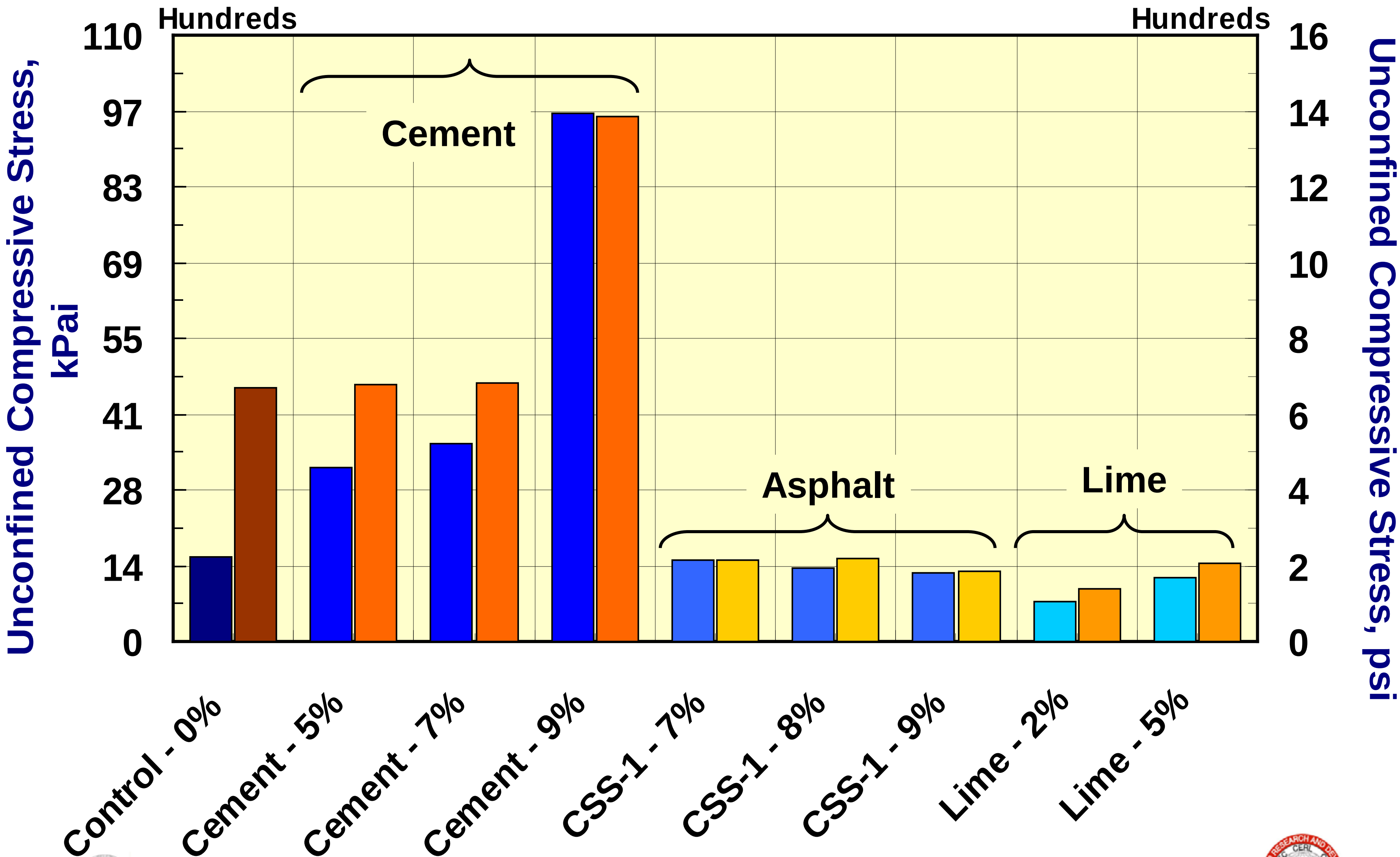
Effect of Stabilizer Type



Stabilization of SM Sands with Nontraditional Additives

Effect of Wet and Dry Conditions

Disintegration

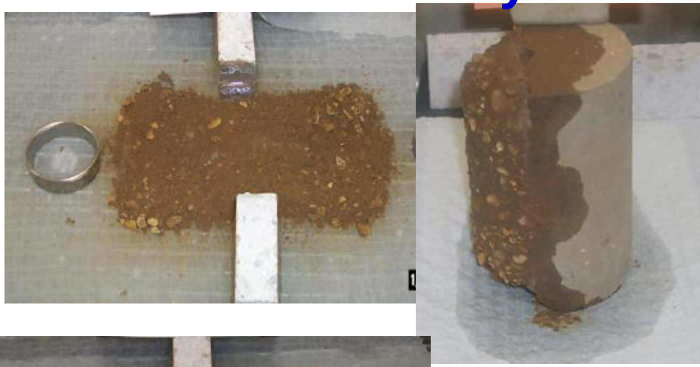
- Loss UC strength
- Alter cross section area

Waterproofing

- Prevent loss of fines
- Potential for dust control

Control

Enzyme 2



Tree Resin 1

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Effect of Wet and Dry Conditions

Poor Performers

- Enzymes
- Acid 1
- Lignosulfonate 2

Excellent Performers

- Polymers
- Cement

Enzyme 1

Acid 1

Lignosulfonate 2

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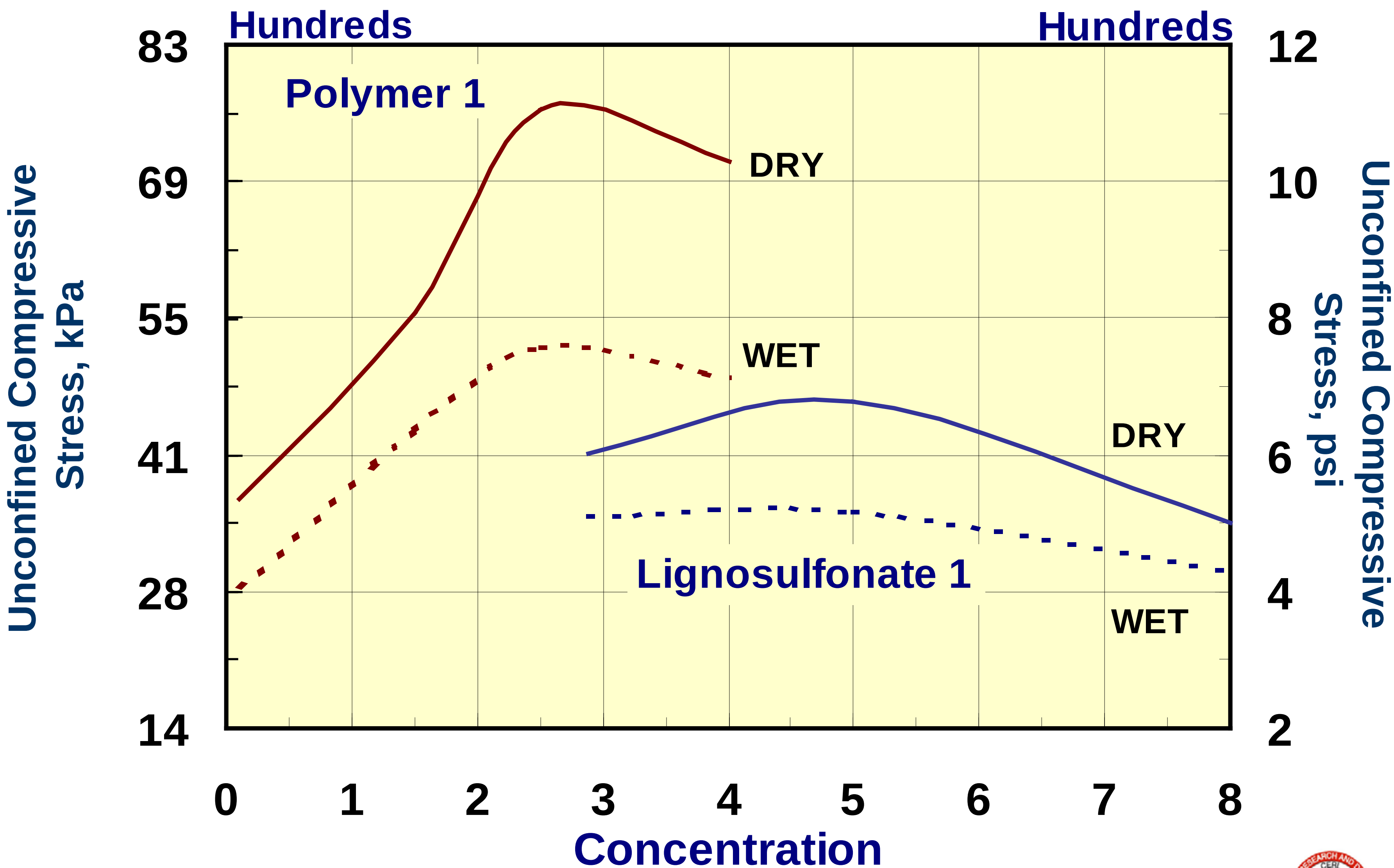
Effect of Additive Quantities



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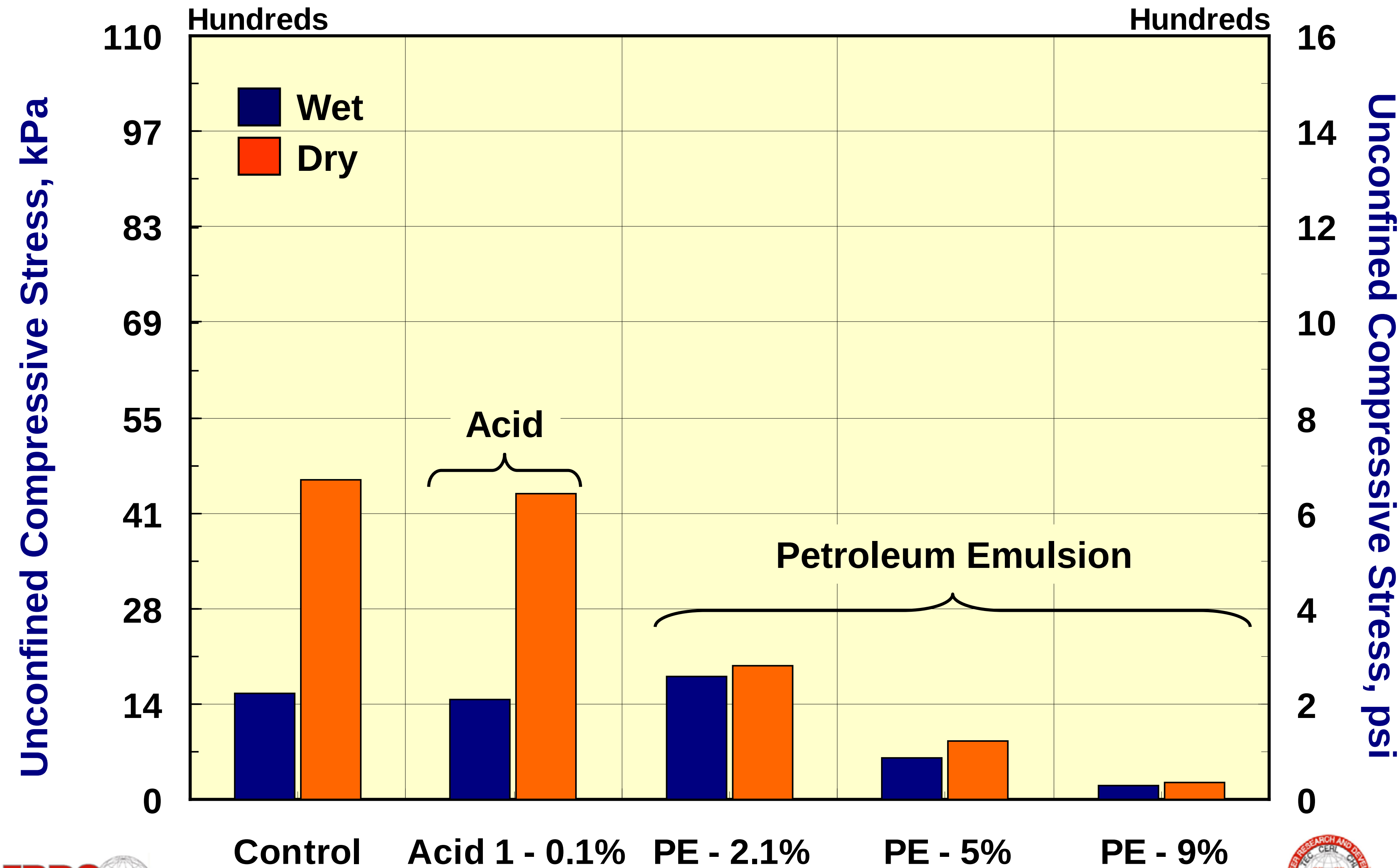
Effect of Additive Quantities



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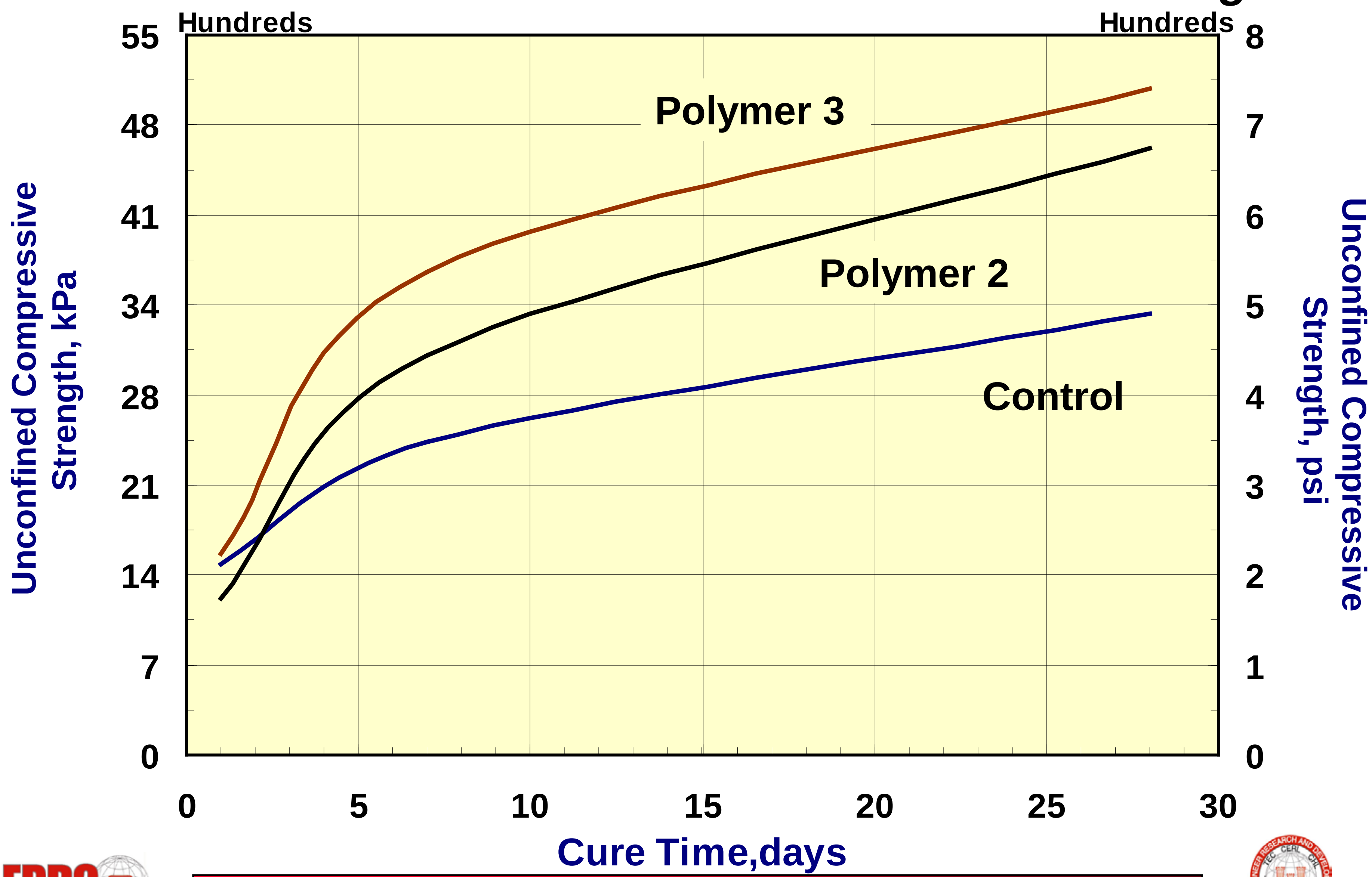
Effect of Curing Time



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Repeatability of Tests

Samples

- Wet Condition – 3 samples
- Dry Condition – 3 samples

Variability

- Height – 2.54 to 5.08 mm
- Water Content – 0 to 0.5 %
- Dry Density – 0-19 kg/m^3
- UC Strength – 0-110.3 kPa

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Summary

Conclusions

- Polymers and cement excellent stabilizers
- Waterproofing potential
  - Petroleum Emulsion 1
  - Tree Resin 1
  - Lignosulfonate 1
- Optimum additive quantity
  - Enzymes < 1
  - Lignosulfonates – 5%
  - Petroleum Emulsion – 2%
  - Polymers – 2.5 to 5%
  - Tree Resin – 9%
- Nontraditional stabilizers gain strength quicker

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Summary

Recommendations

- Evaluate long-term performance
- Conduct field condition and traffic loading
- Establish stabilization mechanisms