Research Experience for Undergraduates at UNC Charlotte
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A Study on the Performance of Deep Layer Subgrade Stabilization

Contents

- Introduction
- Literature
- Past, Present, Future
- Process
- Results
- Questions

INTRODUCTION

- Scope of Project:
  - Stabilization: a method of soil property improvement to strengthen the performance of the soil as a underlying foundation to a loaded pavement surface.
  - Traditional Calcium based stabilizers:
    Portland Cement, Lime, Fly ash

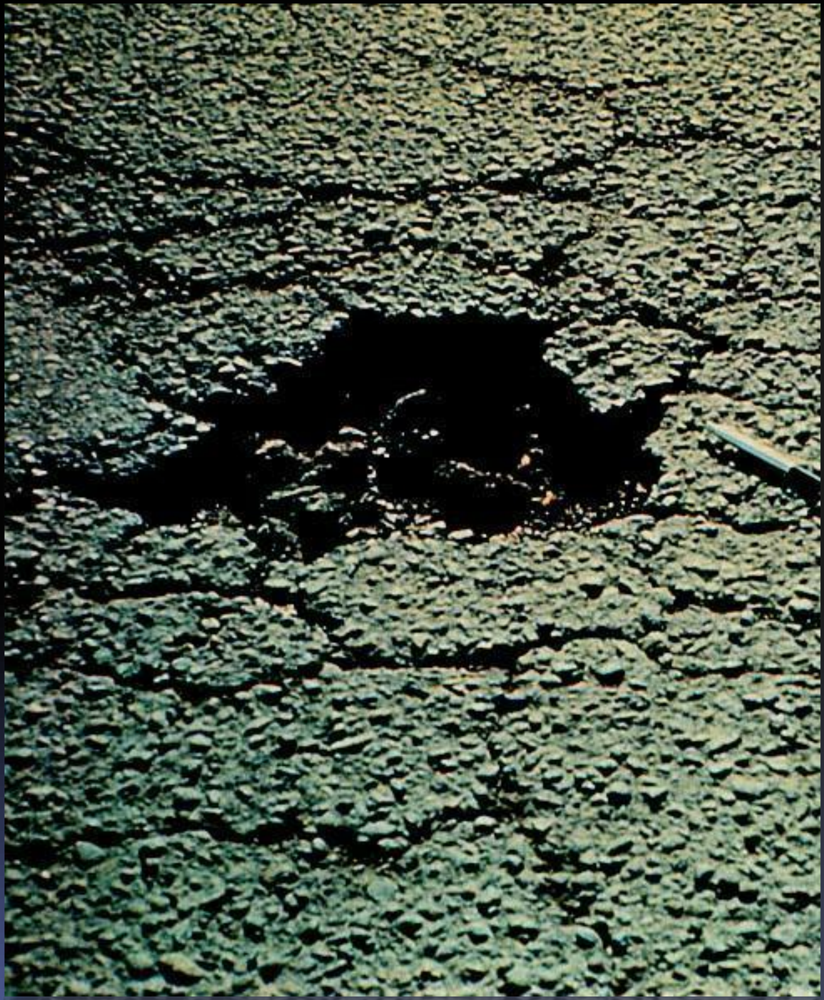
WHY STABILIZE?

- High Axle Loads
- High traffic volumes
- Antiquated roadway design
- Reduce maintenance costs
- Ride quality

Pavement rutting

Failure Causes

- Loss of base or subgrade support
- Fatigue failure from HMA stress or stabilized layer failure
- Infiltration of moisture
- Tensile cracks (bottom-up)



Fatigue Cracking

INTRODUCTION

- Scope of Project
  - NC 16 Denver, NC (NCDOT & UNCC)

INTRODUCTION

- Scope of Project : Lime
  - 2800 feet designated for Lime Stabilization
  - 4 Sections: 700 feet each
  - 16 Subsections respectively
  - 2 Control Sections @ 8"
  - 2 Deep Sections @ 12" & 16"
- Scope of Project : Cement
  - 2685 feet designated for Cement Stabilization
  - 4 Sections: 600, 735, 750, 600 feet in length
  - 16 subsections respectively
  - 2 Control Sections @ 7"
  - 2 Deep Sections @ 10" & 14"

INTRODUCTION

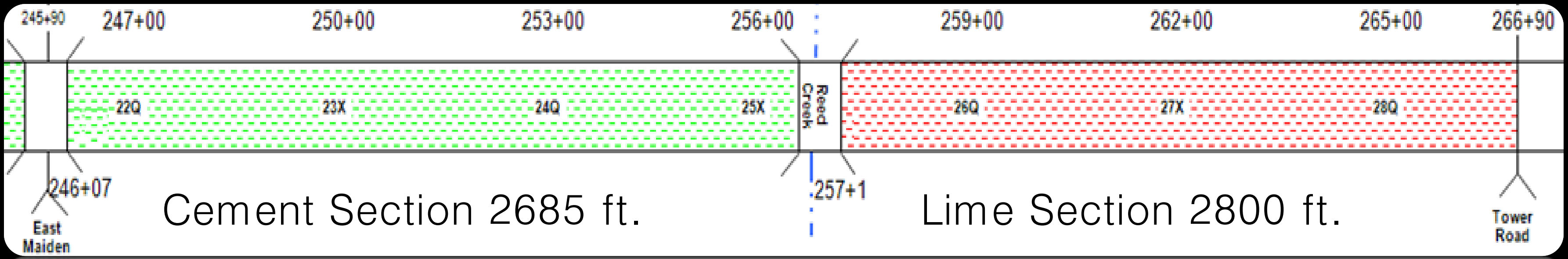
- Objectives
  - Comparison of initial cost and expected life of different layer systems for pavement endurance.
  - Track data of the changes in material engineering properties and field performance of the different stabilization methods and systems.
  - Make a recommendation as to the most effective method of subgrade stabilization based upon pavement performance in relation to a cost benefit analysis of the studied stabilized systems.

INTRODUCTION

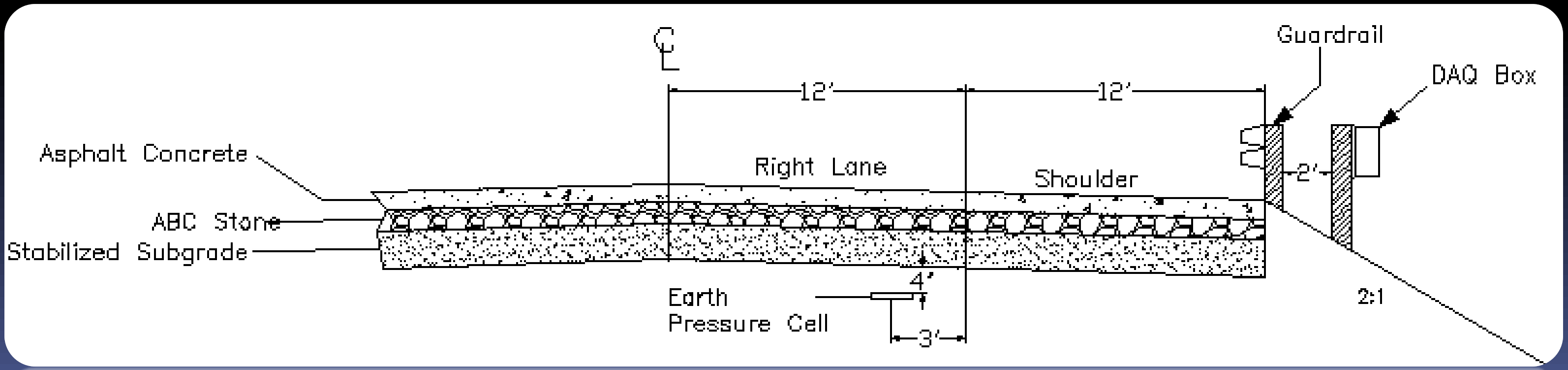
- Soil Modification
  - Short-term cation exchange mechanism
  - Flocculation of soil particles
  - Reduction of Soil Plasticity
  - Reduces soil swelling and shrinking tendencies
  - Increase Workability
- Soil Stabilization
  - Long-term Pozzolanic reactions (Calcium)
  - High pH needed to solubilize silicates and aluminates from soil
  - Continued flocculation and strength increase

Introduction

NC-16 Survey Overview



Cross-Section



Literature

- Soil Classification
  - Clay or Silt: 35% or more of mass smaller than 75µm
  - Sand or Gravel: 35% or less of mass smaller than 75µm

  - Subgrade: 25% or more of mass smaller than 75µm
  - Base: 25% or more of mass larger than 75µm

Literature

- Lime Stabilization
  - Quicklime (CaO) – Exothermic reaction
  - Hydrated Lime ($Ca(OH)_2$)
  - $Na^{+} < K^{+} << Mg^{++} < Ca^{++}$
  - $Ca^{++} + OH^{-} + SiO_2$ (Silica) $\rightarrow$ CaSiHydrate
  - $Ca^{++} + OH^{-} + Al_2O_3$(Alumina) $\rightarrow$ CaAlHydrate
  - Flocculation & Agglomeration displaces water layer

LITERATURE

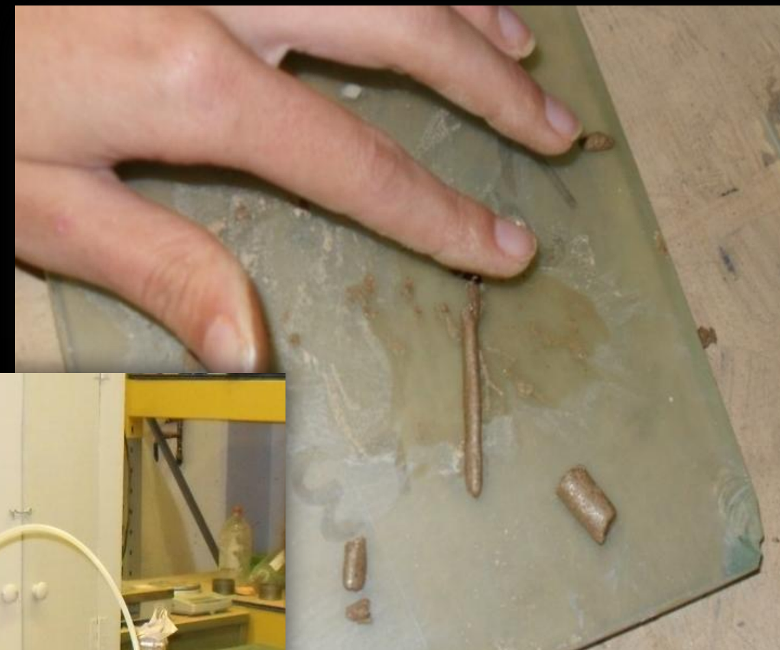
- Cement Stabilization
  - Cement provides the silica and aluminates
  - Bonds under same mechanisms as lime
  - Not pH dependent
  - Primary structural base layer – flexible pavements
  - Subbase layer – rigid pavements
  - Used in fine or granular soils

PAST, PRESENT, FUTURE

- Lab Testing – Lime
  - Soil Classification
  - pH Testing
  - Optimal Moisture Content
  - Unconfined Compression
  - Resilient Modulus
  - Instrument Implementation

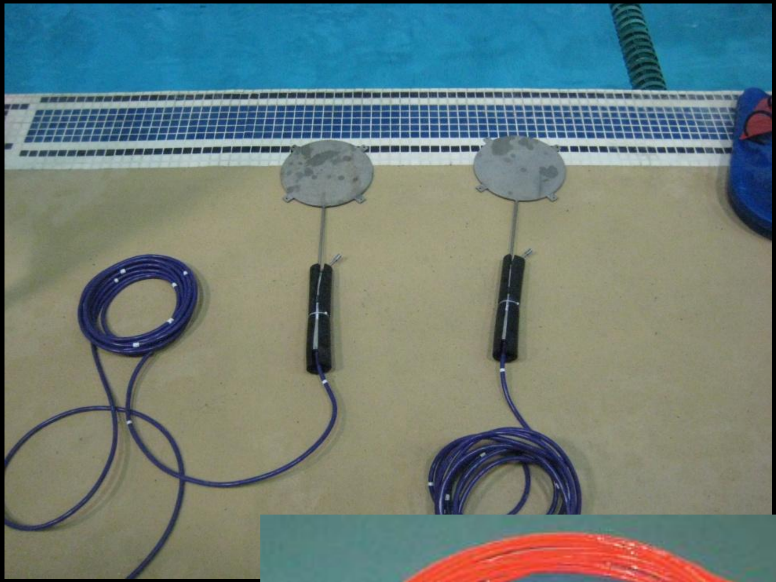
Process

Process



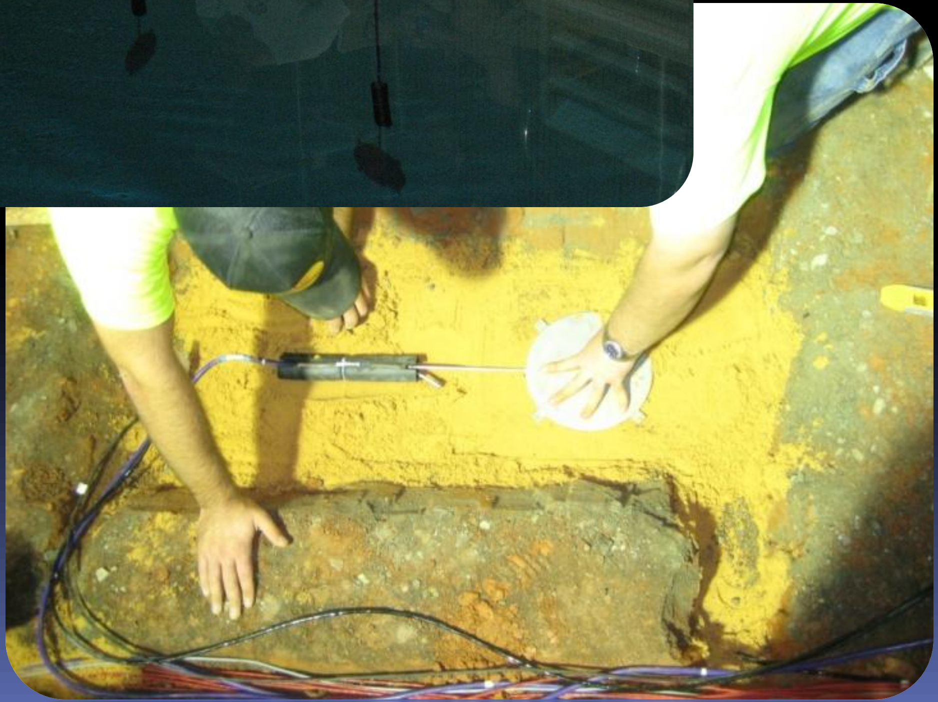
INSTRUMENTATION

- Pressure Cell
  - Hydraulic filled plate measures change in voltage by pressure transducer

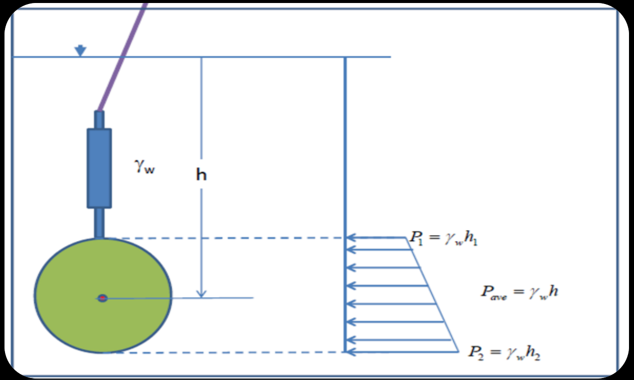


- Strain Gauges
  - Measures the strain between base and subgrade levels

Instrumentation



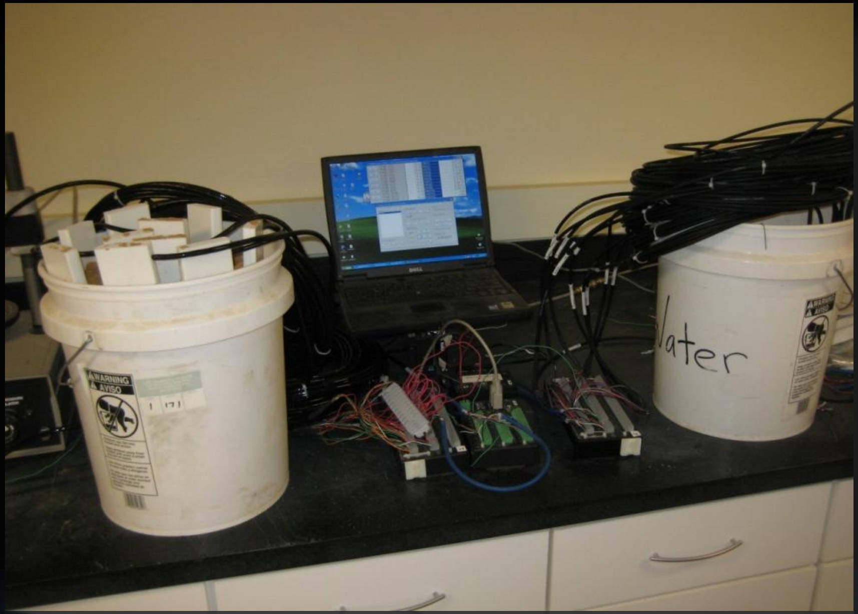
- Calibration
  - Dead Weight Cal.



- Installation
  - 14 pressure cells
    - 8 cells in subgrade
    - 6 cells in base

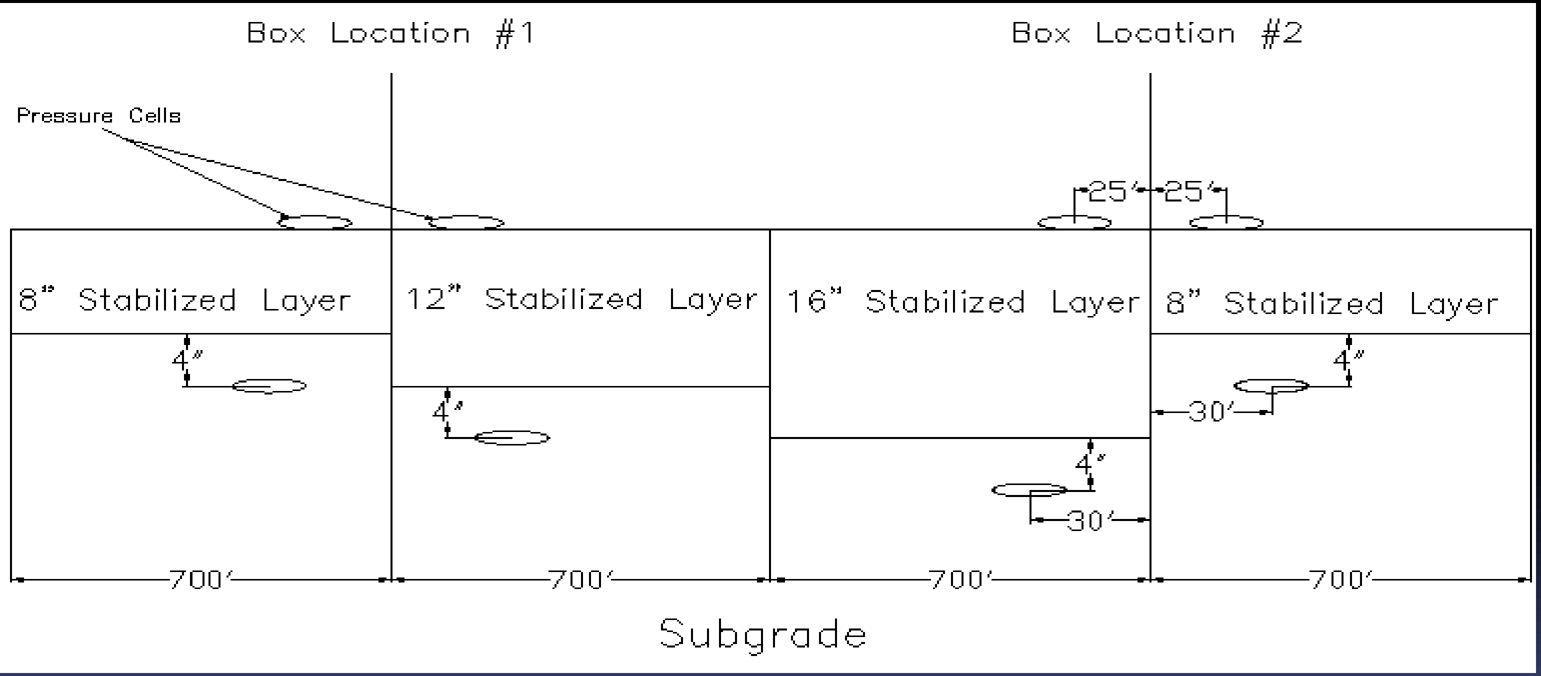
INSTRUMENTATION

- Temperature Sensors
  - Calibrated w/ thermometer in water
- Moisture Reflectometers
  - Tested in soil of known moisture content



INSTRUMENTATION

- Pressure Cell Placement



INSTRUMENTATION

- Box Placement
  - Data acquisition
  - Data reading
  - 2 Moisture reflectometers
  - 2 Temperature sensors
  - 4 Pressure Cells

RESULTS

- Comparative strength increase gained from lime and cement stabilization
- The resultant performance of the pavement relative to each stabilization method
- Environmental and Axle load effects on pavement and subgrade performance

QUESTIONS