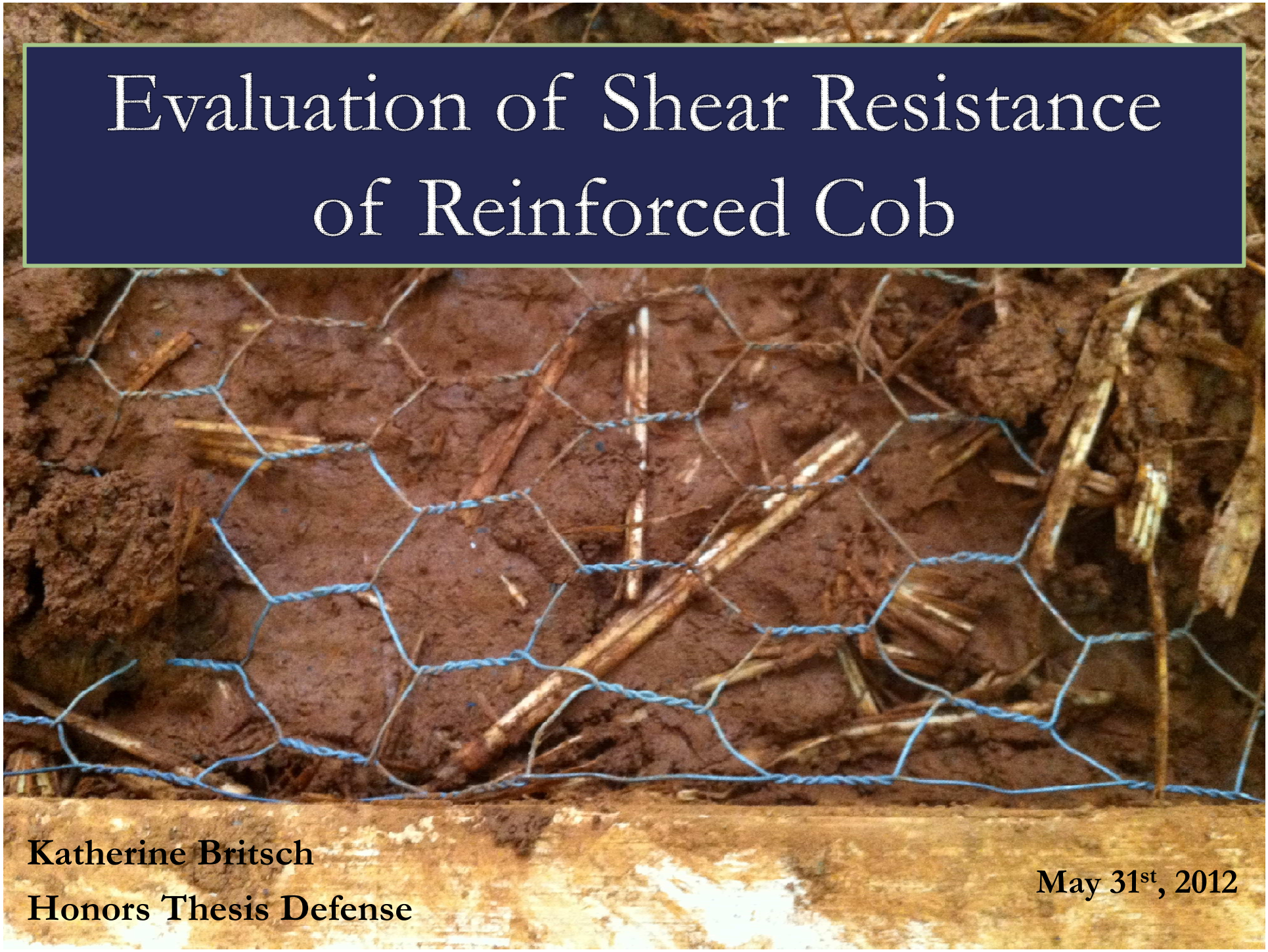
Evaluation of Shear Resistance of Reinforced Cob



Katherine Britsch

Honors Thesis Defense

May 31st, 2012

Introduction

- **What is Cob?**
- **Purpose of Study:**

  To determine if the use of chicken wire as reinforcement in a cob wall has an effect on the shear strength of the wall.
- **Hypothesis:**

  Reinforcement will affect the deformation resisting properties of a wall made of cob.

History of Cob

Timeline

- 8000 BC: Earliest Known Use of Cob-like Dwellings
- 1200s: Cob Used in English Homes
- 1400s: Cob Construction in England Becomes Widespread
- 1800s: Industrialization Phases Out Cob
- 1989: Oregon Cob Revival

Construction Methods

- Monolithic
- Built by Feel and Sight
- Oregon Cob: Increased Straw Content

Relevant Research

- **Strength and Composition of Willamette Valley Cob: An Earthen Building Material**
  - Quinn Pullen, 2009
  - Tested cob mixtures from Willamette Valley suppliers
  - Length of straw fibers had impact on strength of material
- **Strengthening the Structural Behavior of Adobe Walls Through the Use of Plaster Reinforcement Mesh**
  - Saritas and Turanli, 2011
  - Tested adobe with 1% straw content
  - Reinforced adobe wall had increased deformation capacity

Materials

- **Soil: Silt**
  - Medium to High Plasticity
  - 20% Gravel Content

- **Soil: Kaolinite**
  - Powdered
  - Moisture Content of 35% Once Hydrated
  - PL=30; LL=47

- **Sand**
  - Purchased from Aggregate Production Plant
  - Natural, River Run, Washed Sand

- **Straw**
  - Grass Seed Straw
  - Purchased at Local Feed Store

Methods

- Mixing

Silt Cob

Kaolinite Cob

Methods

- **Mixing**
  - Used Tarp Method to obtain homogenous mixture

Methods

- Mixing
  - Used Feet to Mix in Straw

Methods

- **Compaction**
  - Cob Placed by the Handful
  - Wooden Mold
  - Three Layers on Geotextiles on top of Steel Plate

Methods

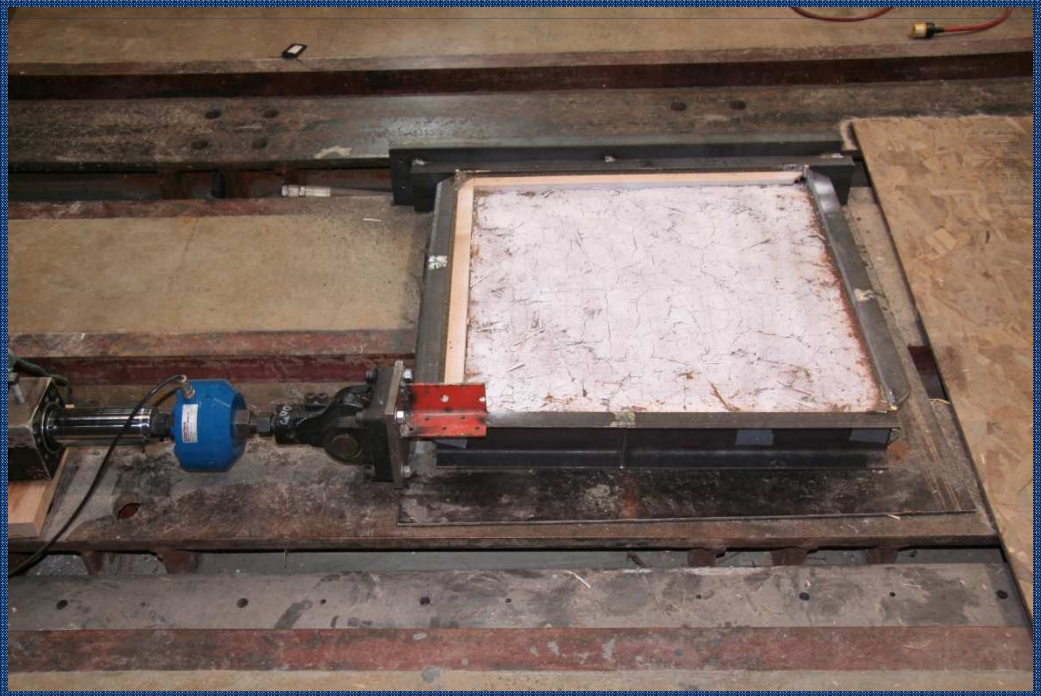
- **Drying**
  - 72 hours @ 75°C

Cob in Oven Prior to Drying

Cob After Drying

Methods

- **Testing**
  - 32-in x 33-in Simple Shear Box
  - Servo-Hydraulic Test System for Shear Loading
  - Dual Camera System with Imaging Software for Collecting Data

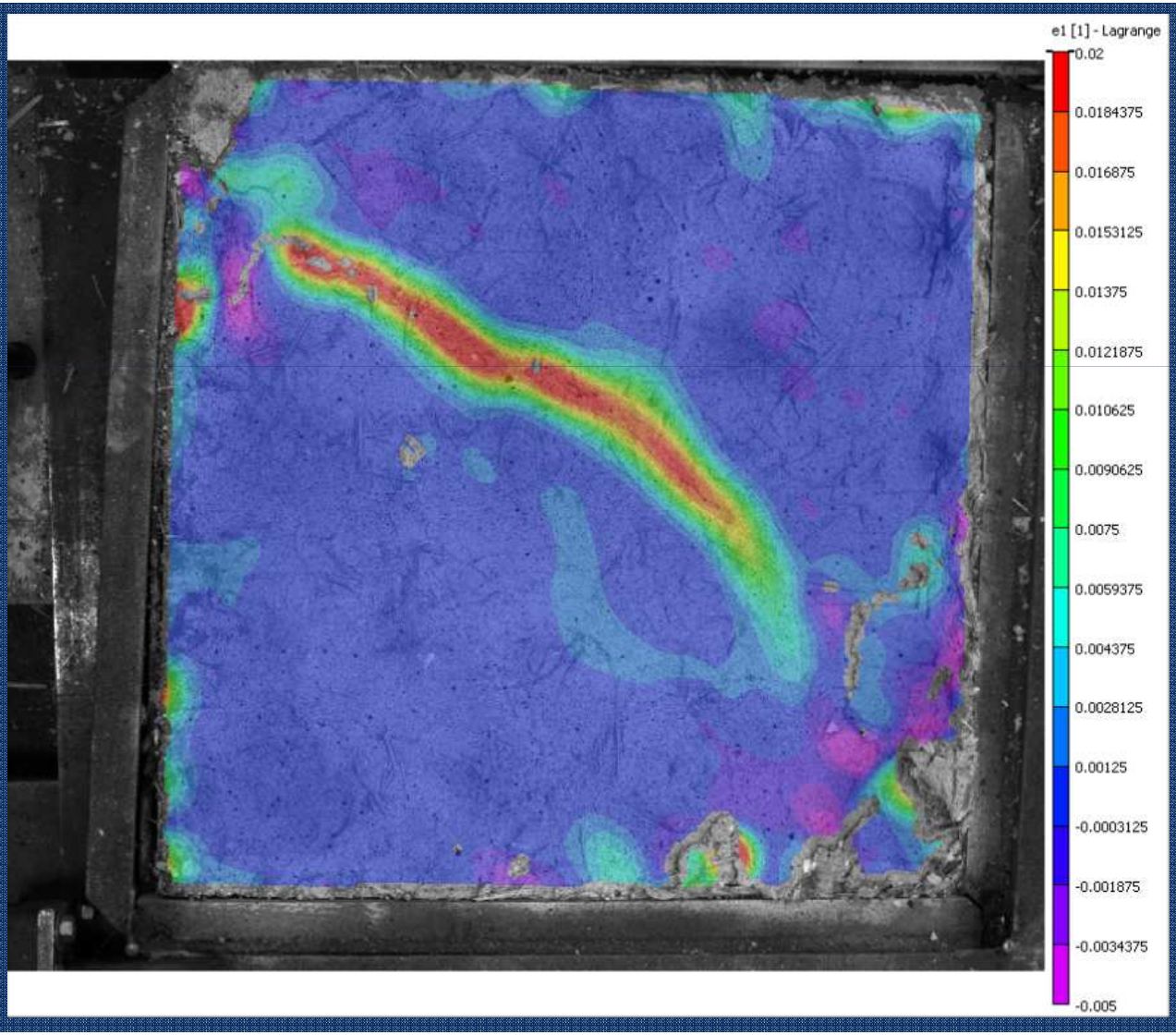


Methods

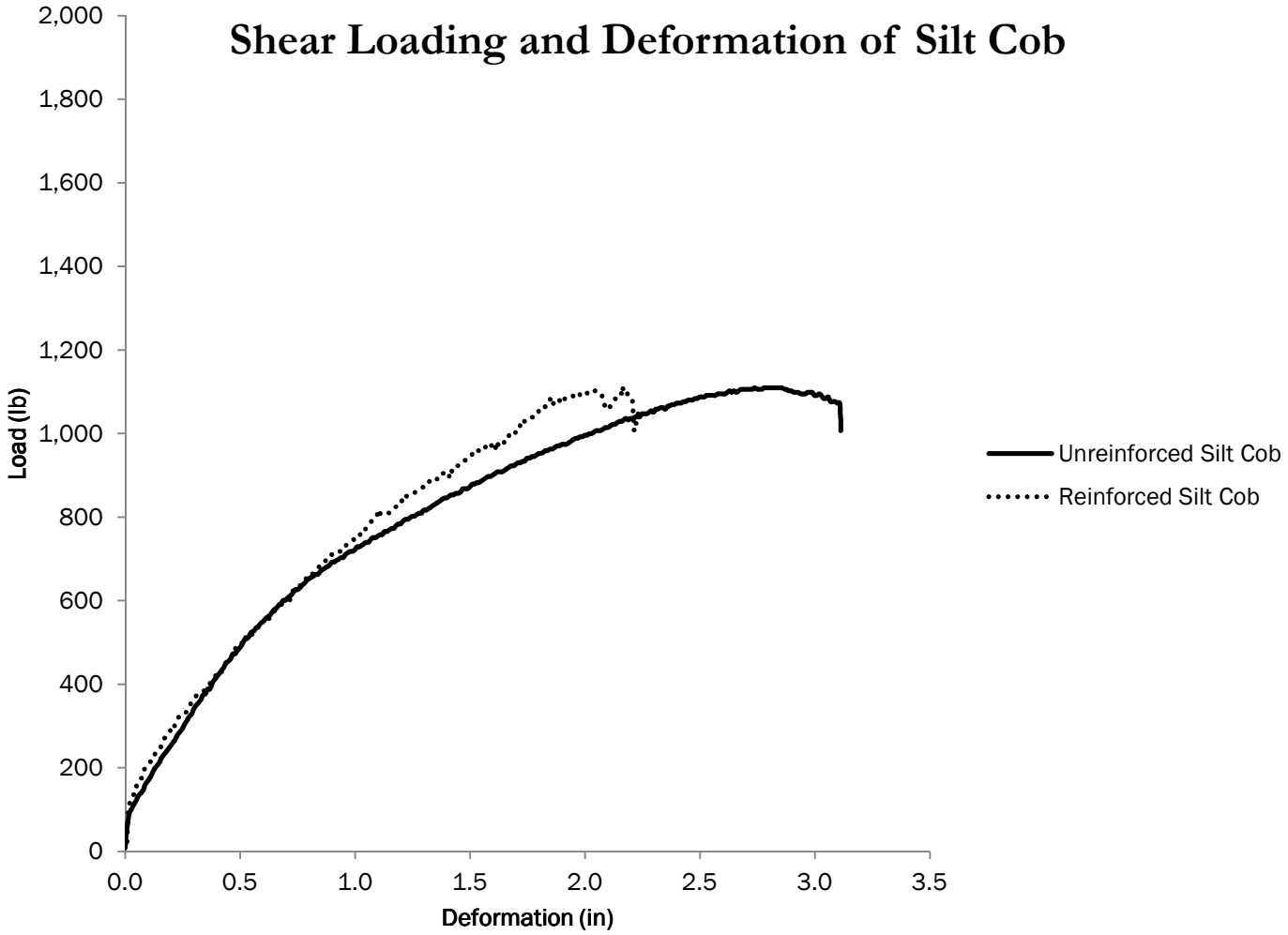
- Testing
  - Wooden Shims and Sand Used to Facilitate Full Contact with Load Frame

Results

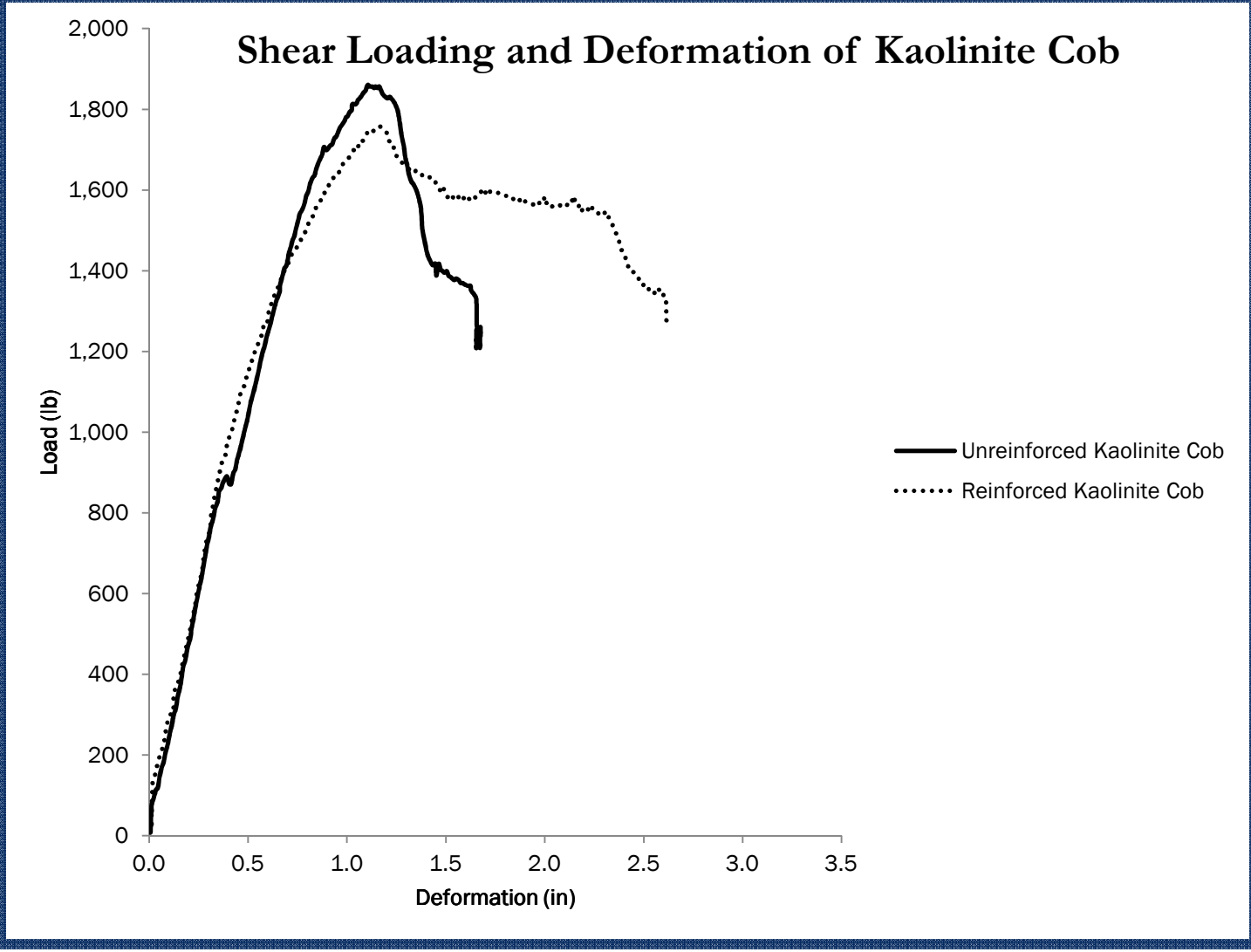
- Shear Stress



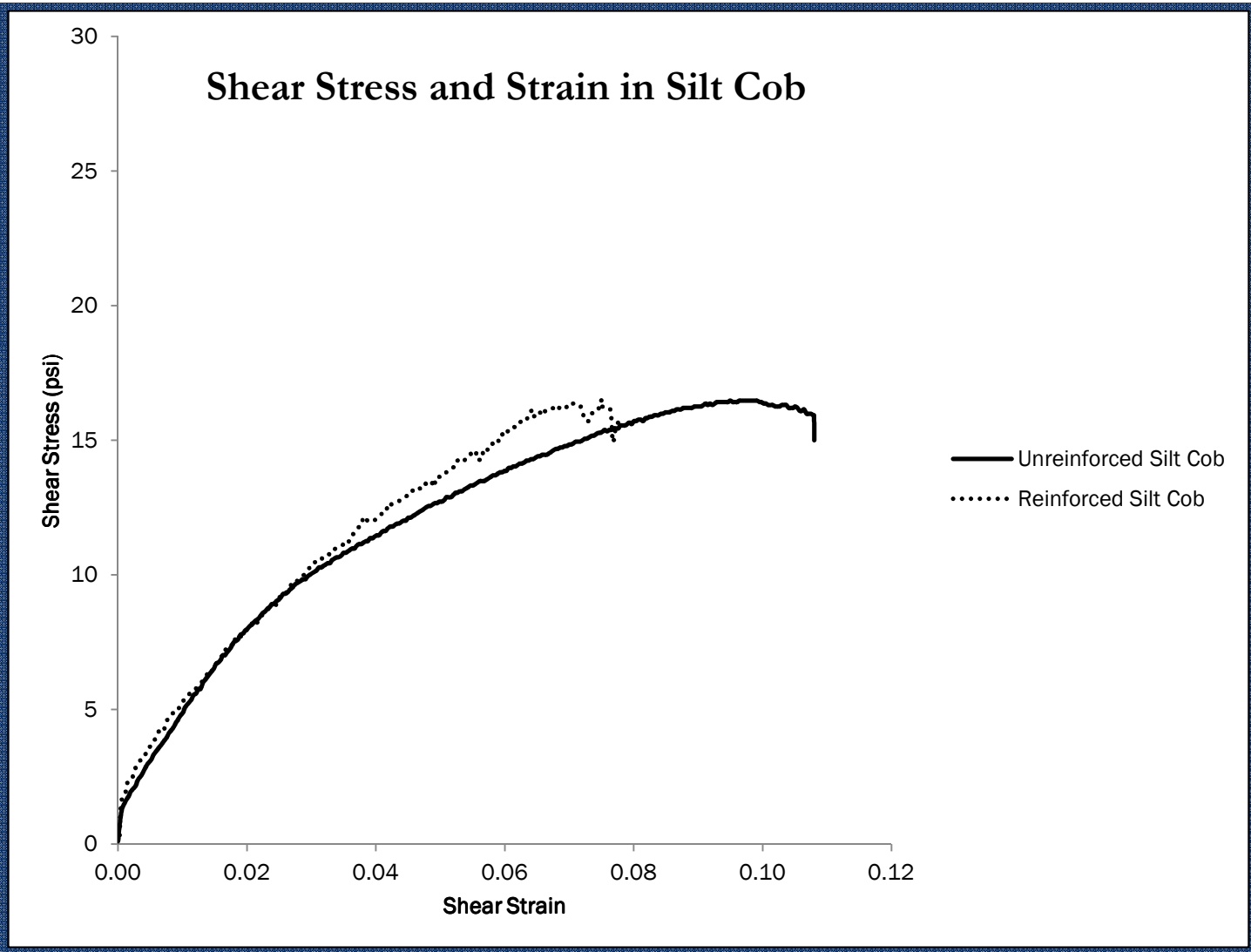
Results


Shear Loading and Deformation of Silt Cob
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Load (lb)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Deformation (in)
Unreinforced Silt Cob
Reinforced Silt Cob

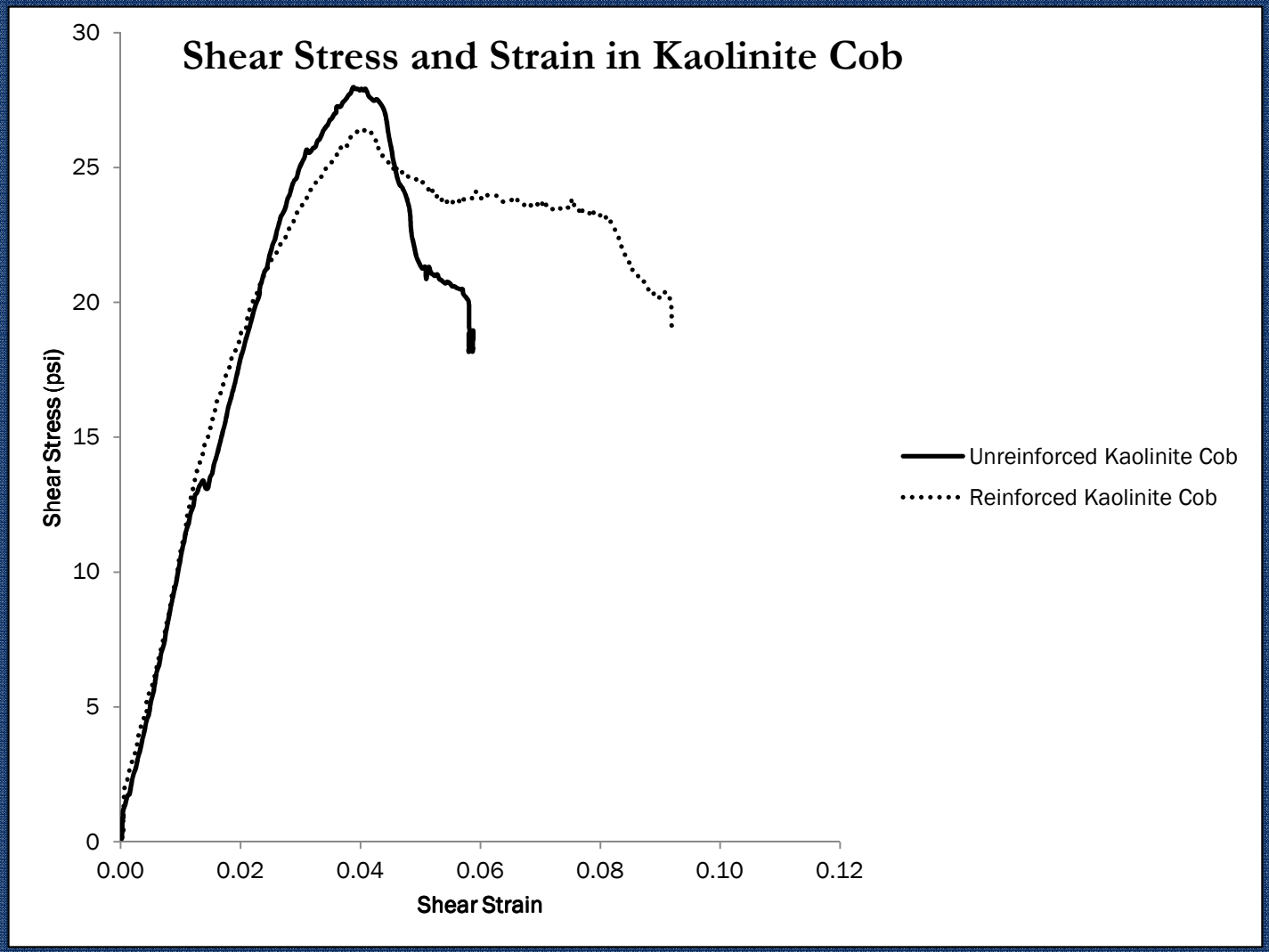
Results


Shear Loading and Deformation of Kaolinite Cob
Load (lb)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Deformation (in)
Unreinforced Kaolinite Cob
Reinforced Kaolinite Cob

Results


Shear Stress and Strain in Silt Cob
Shear Stress (psi)
30
25
20
15
10
5
0
0.00
0.02
0.04
0.06
0.08
0.10
0.12
Shear Strain
Unreinforced Silt Cob
Reinforced Silt Cob

Results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0.12
Shear Strain
Unreinforced Kaolinite Cob
Reinforced Kaolinite Cob

Analysis

- Ductility
  - Used Percent Elongation as an Indicator

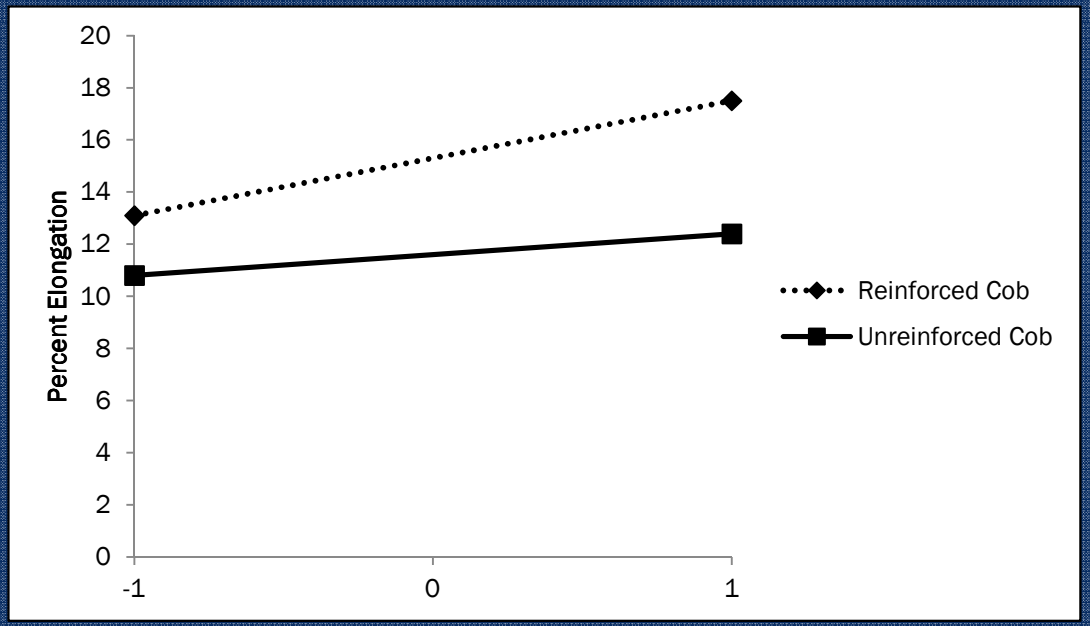
Cob Sample	Length of Sample Before Loading (in)	Deformation at Failure (in)	Percent Elongation
Unreinforced Silt	28.9	3.11	10.8
Reinforced Silt	28.9	2.21	7.7
Unreinforced Kaolinite	28.5	1.63	5.7
Reinforced Kaolinite	28.5	2.30	8.1

Analysis

- **Ductility**
  - Used Response Surface Methodology to determine significance

Soil Type	Reinforcement	Response Variable (Percent Elongation)
-1 (Silt)	-1 (No)	10.8
1 (Kaolinite)	-1 (No)	12.4
-1 (Silt)	1 (Yes)	13.1
1 (Kaolinite)	1 (Yes)	17.5

Reinforcement-Soil Plasticity Interaction Plot



Analysis

- **Ductility**
  - Calculated Effects, Interaction, and Estimated Regression Coefficient

RSM Results

Effect of Soil Type (Plasticity)	3.7
Effect of Reinforcement	3.7
Interaction Between Soil Type and Reinforcement	2.8
Estimated Regression Coefficient for Effect of Reinforcement	1.85

Discussion

Load Capacity

- Kaolinite reinforced panel had lower peak load than unreinforced panel
- Silt cob panels had approximately the same peak load

Stiffness

- Approximated by slope of estimated elastic region of stress-strain curve
- Kaolinite cob appears to be stiffer than silt cob

Ductility

- Positive main effect indicates that increasing reinforcement increases ductility

Sources of Error

- Orientation of Chicken Wire
- Hinge Strength

Conclusions

- **Trends**
  - Percent elongation is greater for the reinforced cob, suggesting it could sustain greater deformations before catastrophic failure.

Fractured Silt Cob

Fractured Kaolinite Cob

Further Research

- **Other Meshes**
  - Snow Fence
  - Plaster Reinforcement Mesh
  - Various Configurations of Chicken Wire
- **Other Fibers**
  - Rope Strands
  - Tree Branches

Questions?

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