FAA-ERDC Interagency Agreement

Research Update

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FAA Working Group Meeting

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US Army Corps of Engineers

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FAA – ERDC Interagency Agreement

<u>Four Projects</u>

•Assessing Material Strength Using Dynamic Cone Penetrometer (DCP) and Vane Shear Tester (VST)

- P.I. – Lulu Edwards/Lyan Garcia

•Field Evaluation of Rigid Pavement Curling and Residual Stresses (*Draft Report Complete*)

- P.I. – Alessandra Bianchini

•Performance Tests for Superpave HMA Mix Design (*Draft Report Complete*)

- P.I. – John Rushing

•Airport Pavement Design Using Geosynthetics

- P.I. – Greg Norwood

Assessing Material Strength Using DCP and VST

OBJECTIVE

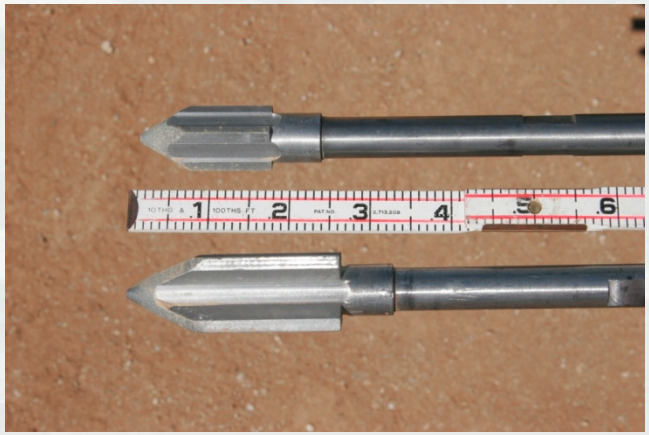
• Provide guidance for implementing DCP in assessment of unbound (granular) pavement materials

PROJECT PLAN

•Compare DCP and VST for construction control

•Analyze DCP for

- o estimating backcalculated stiffness values
- o checking anomalies in HWD results
- o confirming as-built layer thicknesses
- o developing sub-layering profiles



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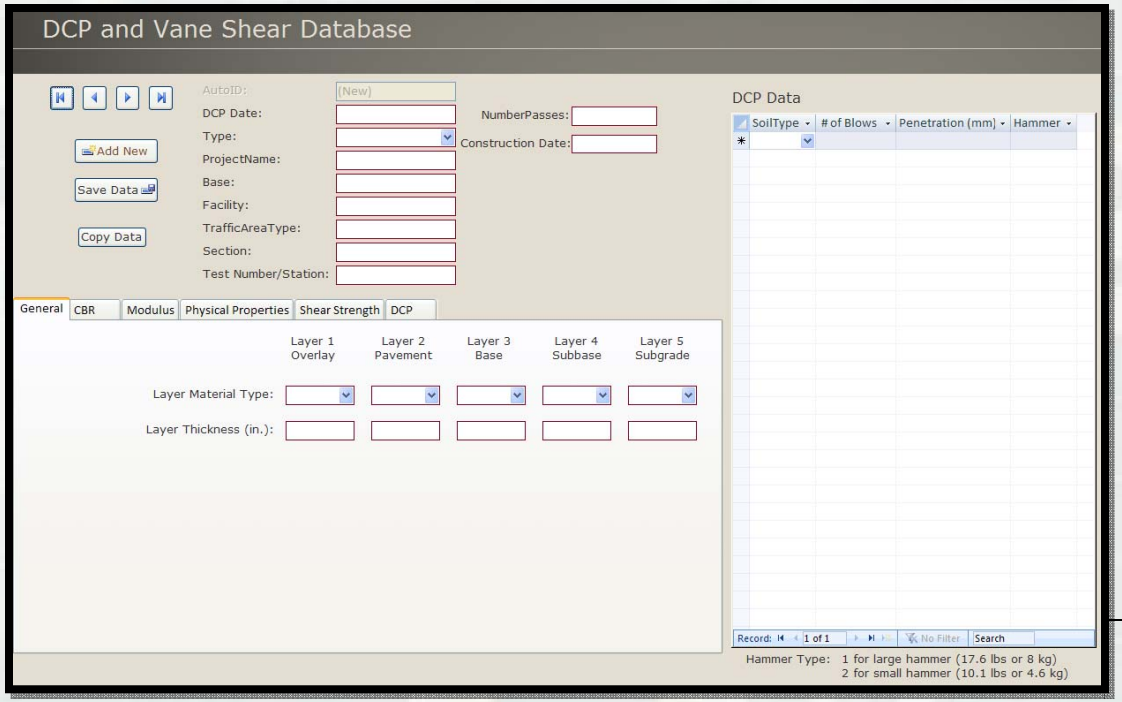
Properties Database

FWD/HWD and Modulus Data

- Resilient modulus
- FWD/HWD data
- Backcalculated modulus values
- Backcalculation method



Material Physical Properties

- Plasticity Index
- Dry density
  - Nuclear
  - Sand cone
- Moisture content
  - Nuclear
  - Oven
- Optimum moisture content
  - Proctor
  - Modified Proctor

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Field evaluation of rigid pavements curling

OBJECTIVE

• Establish correlation between HWD deflections, slab thickness, and temperature deformation;

• Evaluate core-ring and saw-cut testing methods to quantify residual stresses

PROJECT PLAN

• Identify DoD bases with rigid pavement thickness 12 -16in.

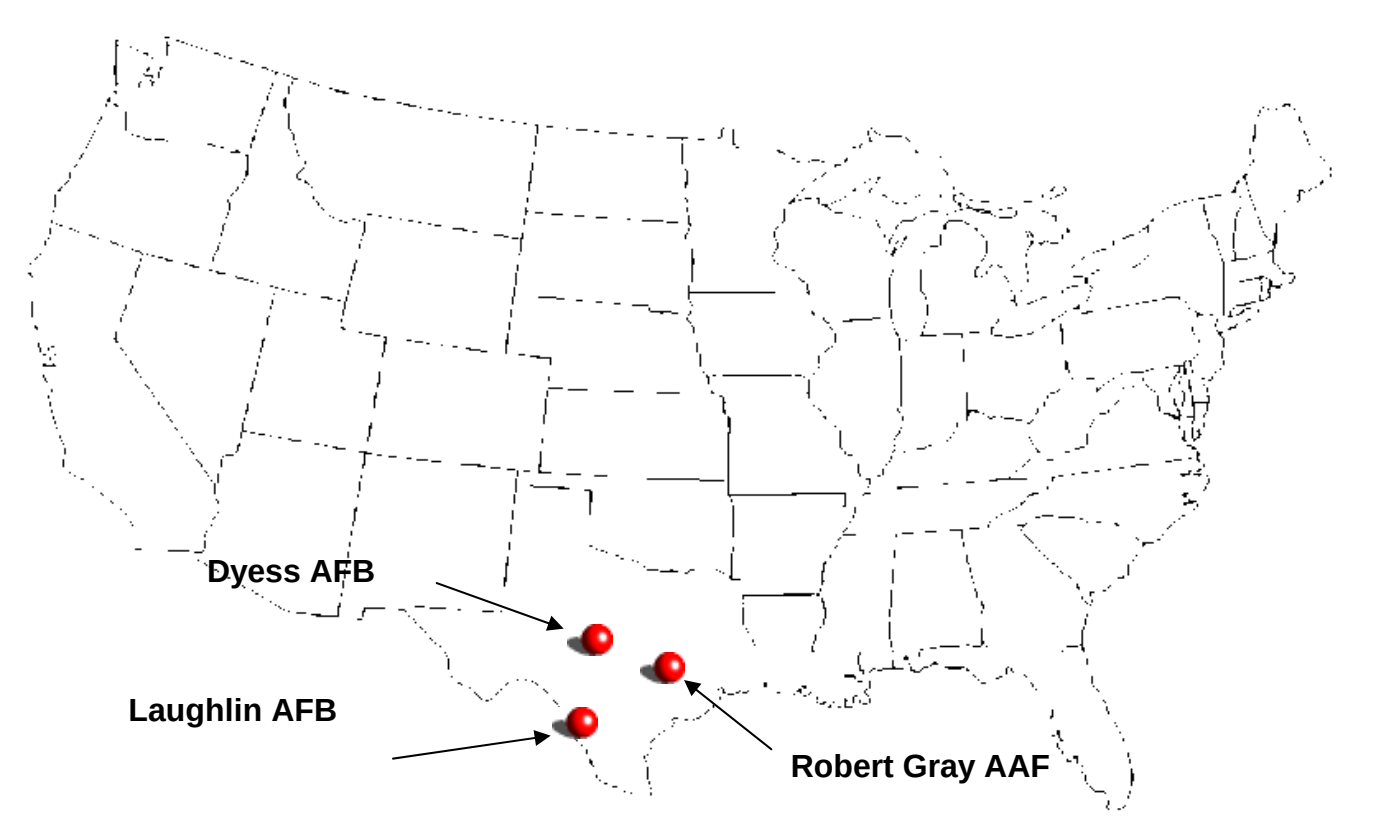
• **Phase I:** HWD testing during end-of-summer months when maximum slab downward curling

• **Phase II:** HWD, core-ring and saw-cut surface testing during winter months when maximum slab upward curling and tensile surface stresses

Selected Testing Sites

- Laughlin AFB, TX – 1 apron; thickness 12.25 in.
- Robert Gray AAF, TX – 3 aprons; thicknesses 13, 14, and 14.5 in.
- Dyess AFB, TX – 2 aprons; thicknesses 15 and 16 in.

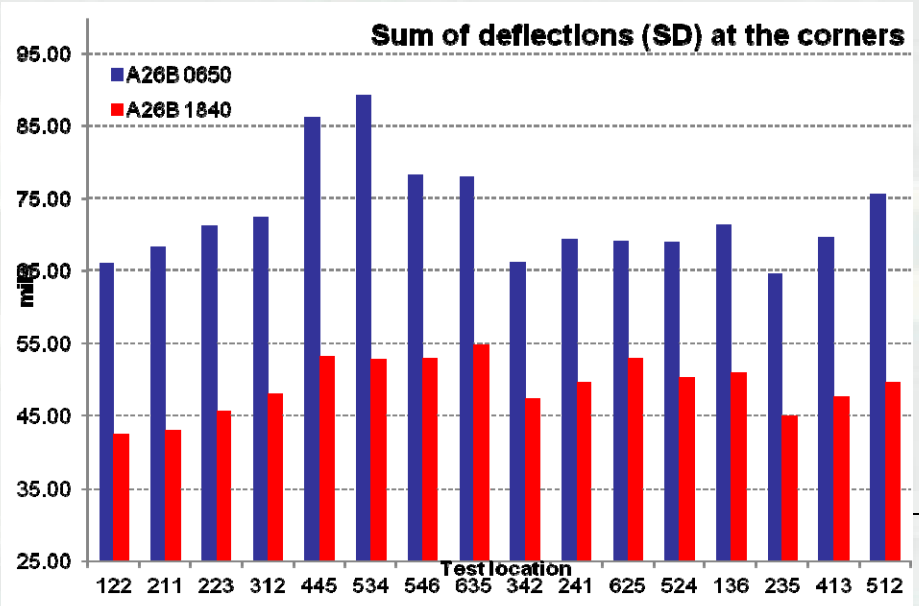
<u>6 slabs for each apron were dedicated to testing</u>

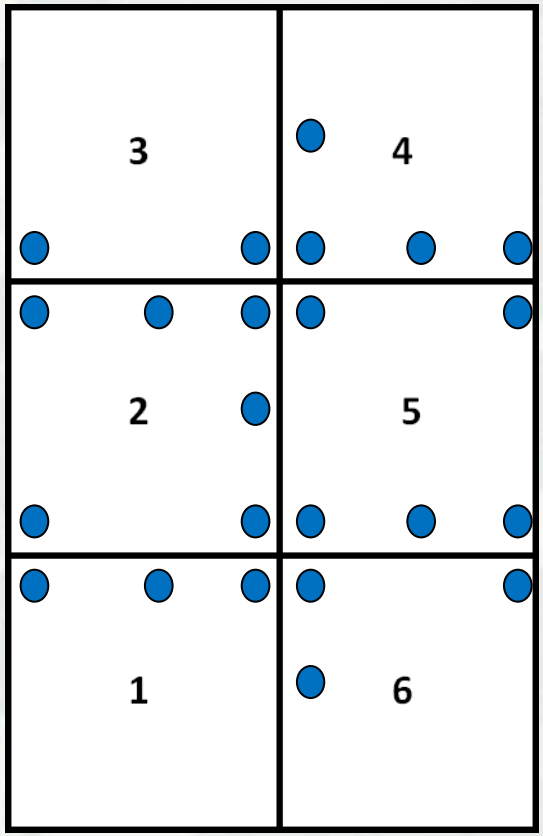


Field evaluation of rigid pavements curling

<u>Phase I</u> ***(HWD testing)***

- Main objective: correlate temperature to deflection at the corner as indicator of slab curling
- HWD Testing: on each apron 2 testing sessions
  - early morning (cooler temperatures)
  - late afternoon (higher temperatures)
- Conducted statistical analysis on data
  - Established influence of thickness
  - Relationship between ISM and temperature



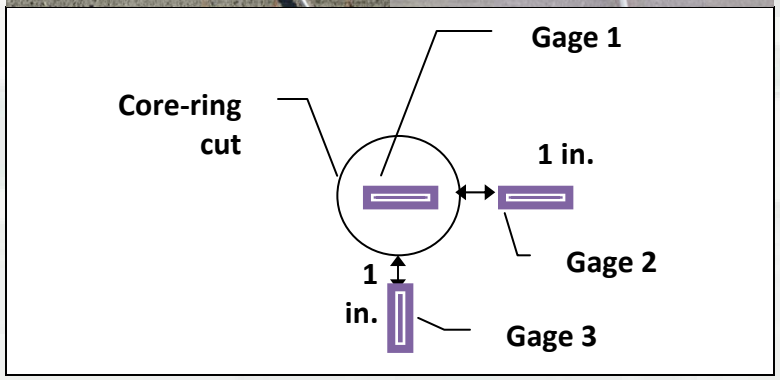


Test locations

Test methods for residual stresses

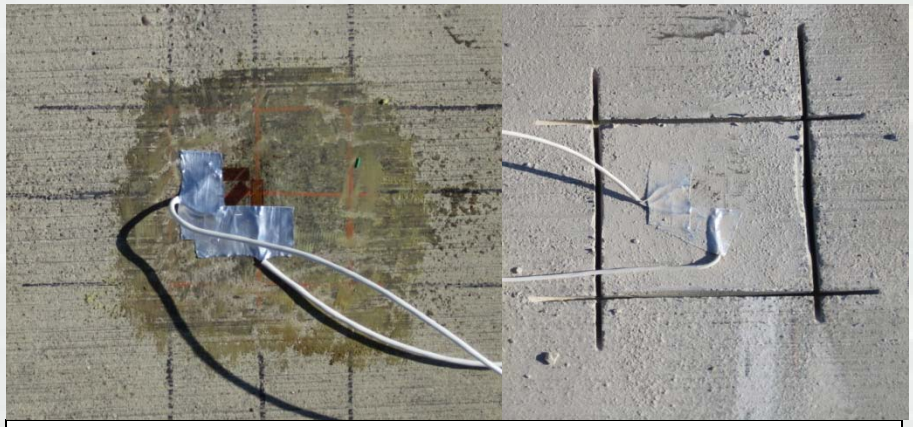
Core-Ring Method

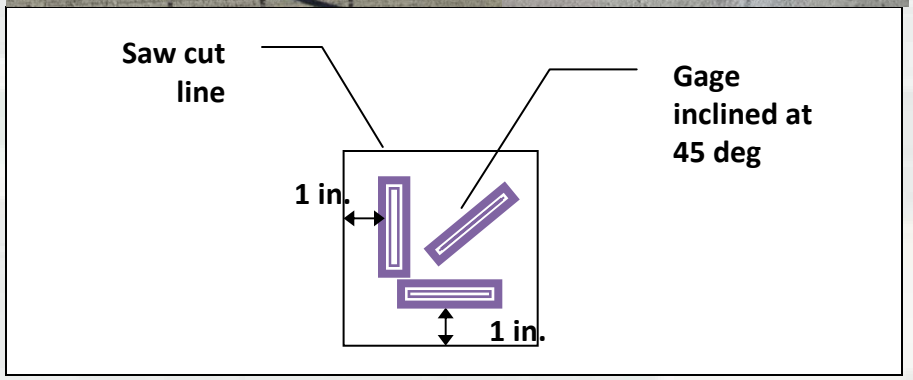
- *½ in strain gages*
- *4in. Ring diameter;1.25 in. cut depth*
- *external gages connected to data logger during the cut*
- *45 min recording time after cut completion*



Sawcut Method

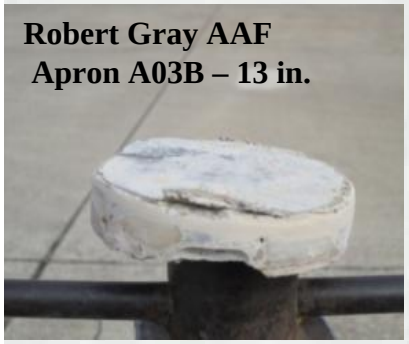
- *½ in. strain gages*
- *4x4in. Sawcut square;1.25 in. cut depth*
- *gages connected to data logger during the cut*
- *45 min recording time after completion of 4 cuts*





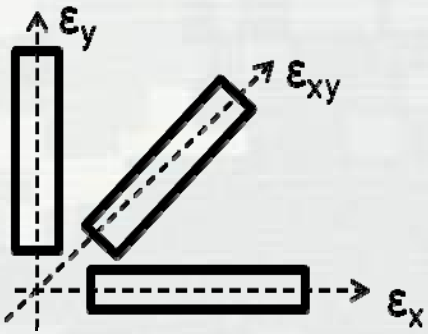
Advantages/Disadvantages

Core-Ring Method



- Partial coring (independent of the concrete age)
- Wear of the core bit
- Impossibility of using water (due to gage arrangement)
- Gage instability (frequent)
- Interpretation of the strain results
- Difficulty in representing the stress field
- Stress computation and interpretation

Saw-Cut Method



- Easier to execute in the field
- Test repeatability
- Less frequent gage instability (than core-ring test)
- Allows computation of principal stresses

Additional Research

- Recommendations for future research
  - Evaluate concrete heating during the cuts
  - Evaluate/improve cut sequence
  - Specific analysis on the saw blade wear
  - Couple the test with computational tools/analysis
  - Development of criteria to accept/reject test data

Performance Tests for Asphalt Designed Using the Superpave Gyratory Compactor

OBJECTIVE

• Develop recommendations for HMA performance test to accompany P-401 Superpave mix design procedure

APPROACH

• Evaluate common HMA performance tests using wide range of mixture performance (36 mix designs)

- Triaxial repeated load
- Triaxial static creep
- Dynamic modulus
- Asphalt Pavement Analyzer (APA)

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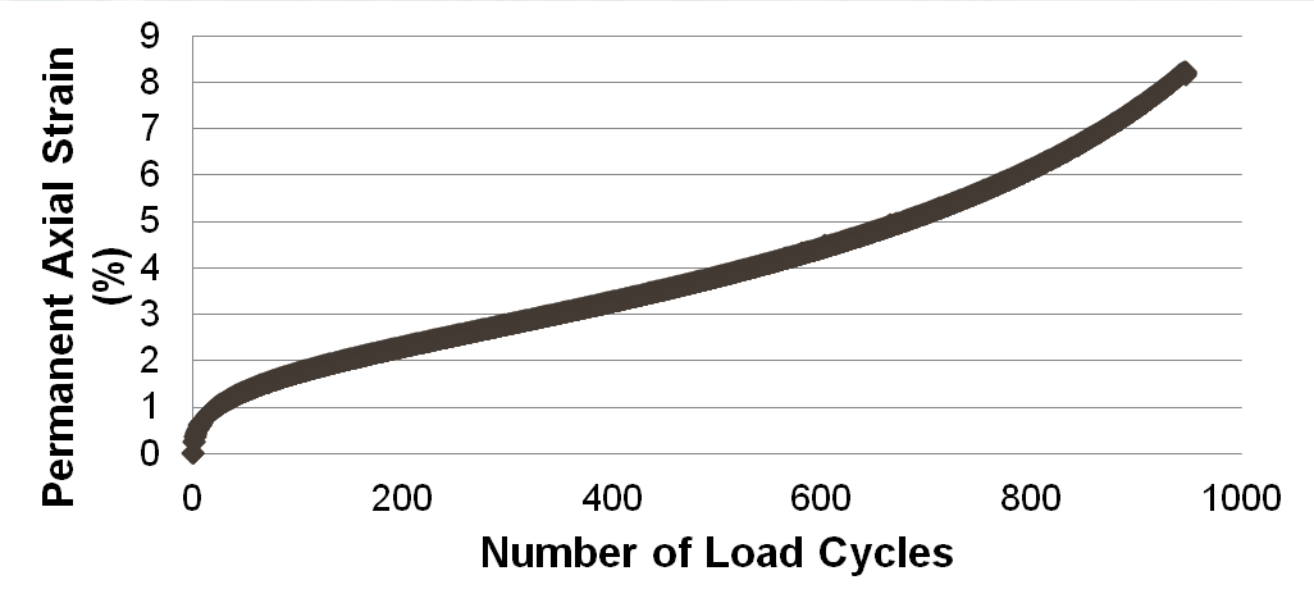
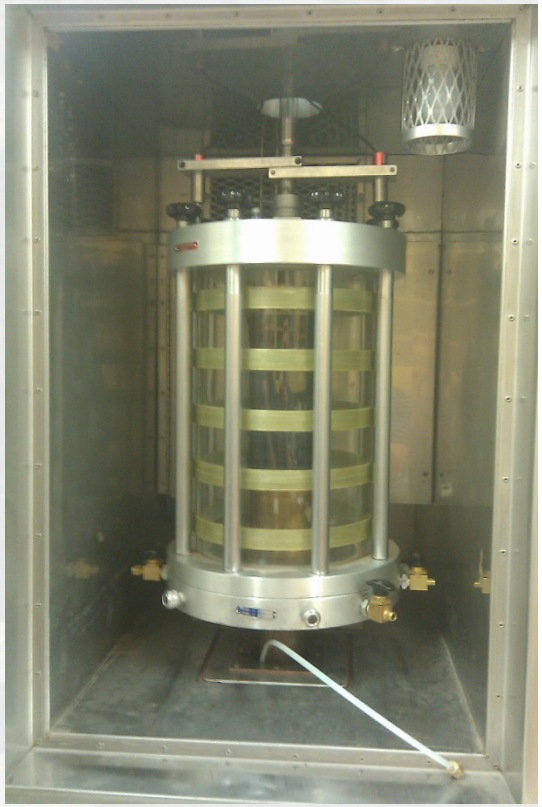
Selected Performance Tests

- Triaxial repeated load (52 specimens)
  - Confined uniaxial repeated loading
- Triaxial static creep (52 specimens)
  - Confined uniaxial static loading
- Dynamic modulus (78 specimens)
  - Low-strain compression using temperature and frequency sweep
- Asphalt Pavement Analyzer (52 specimens)
  - Simulative wheel tracking test

Repeated Load

- Permanent Deformation versus Number of Load Cycles
  - 0.1 s pulse, 0.9 s rest
  - Confining pressure = 40 psi
  - Axial stress = 200 psi
  - Temp = T_{eff} (43°C)





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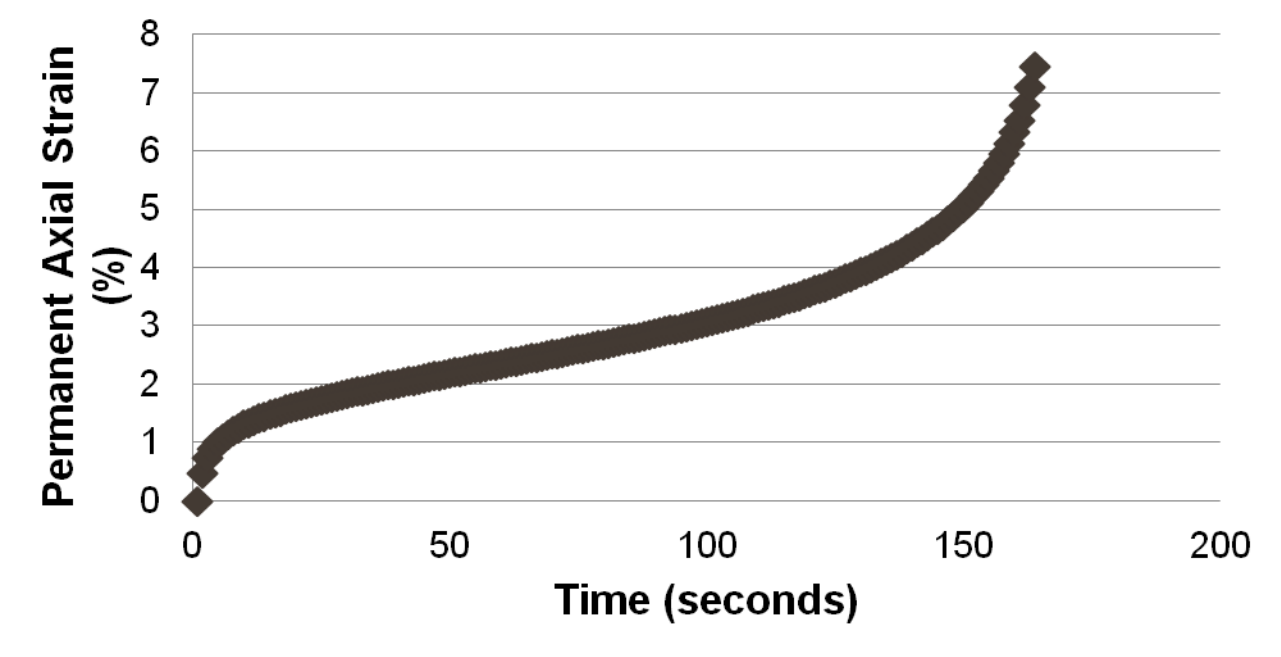
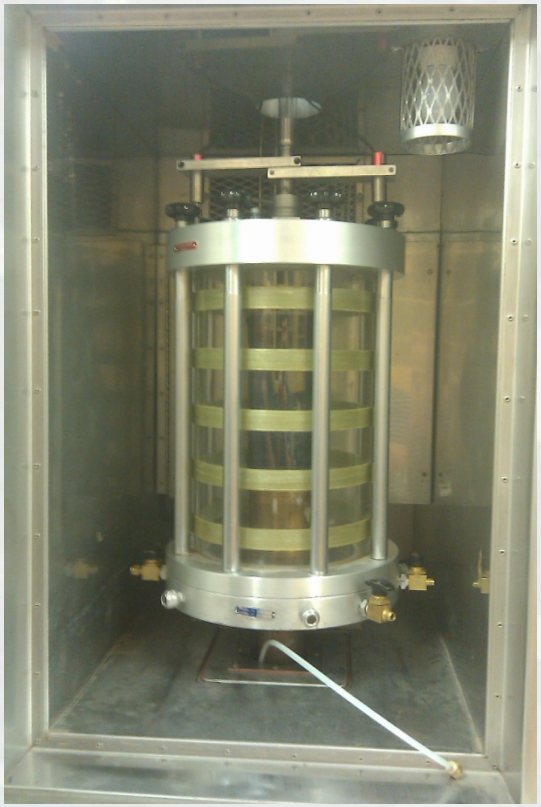
Static Creep

- Permanent Deformation versus Time (static loading condition)
  - Constant load
  - Confining pressure = 40 psi
  - Axial stress = 200 psi
  - Temp = T_{eff} (43°C)





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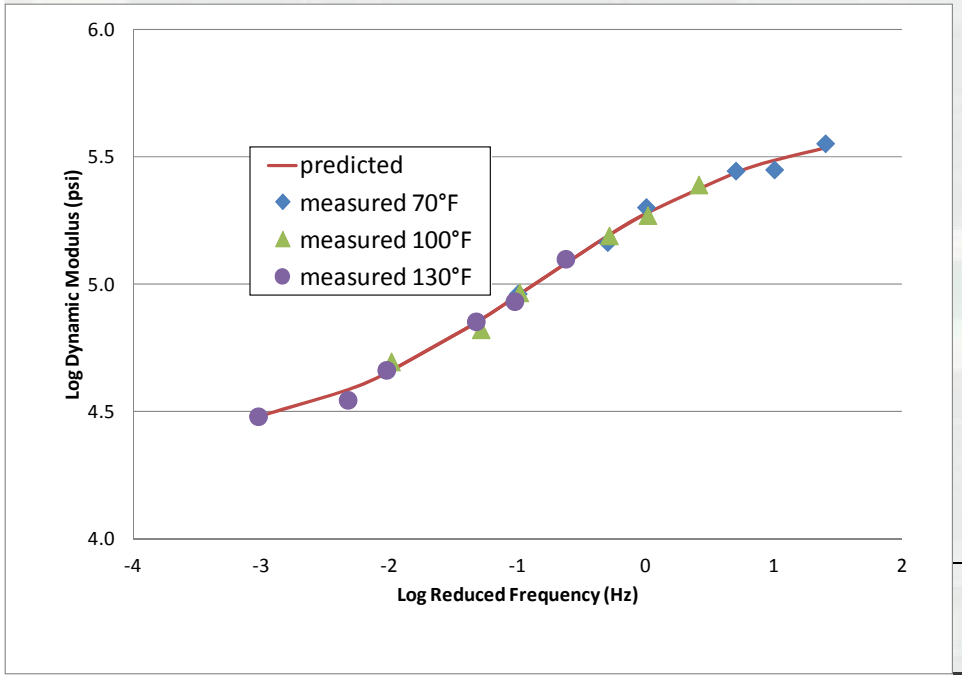
Dynamic Modulus

- Mixture Response over Temperature/Frequency Sweep
  - 21º, 38º, 54º C
  - 25, 10, 5, 1, .5, .1 Hz
  - AASHTO TP 62-07
  - AASHTO PP 62-09



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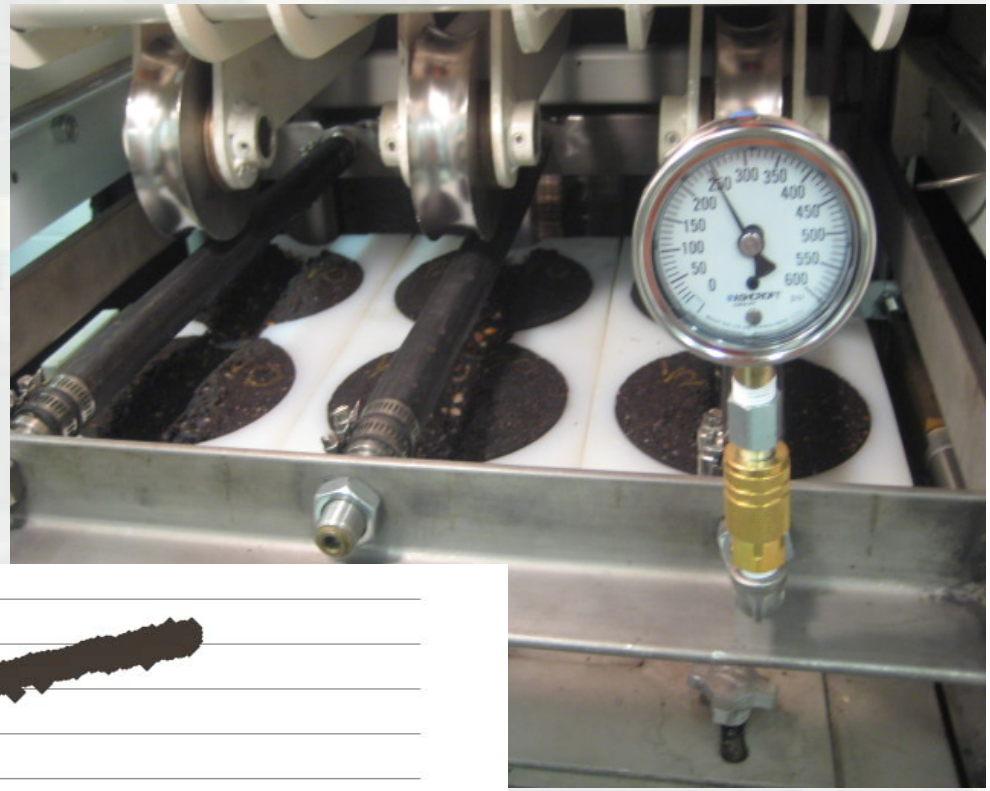
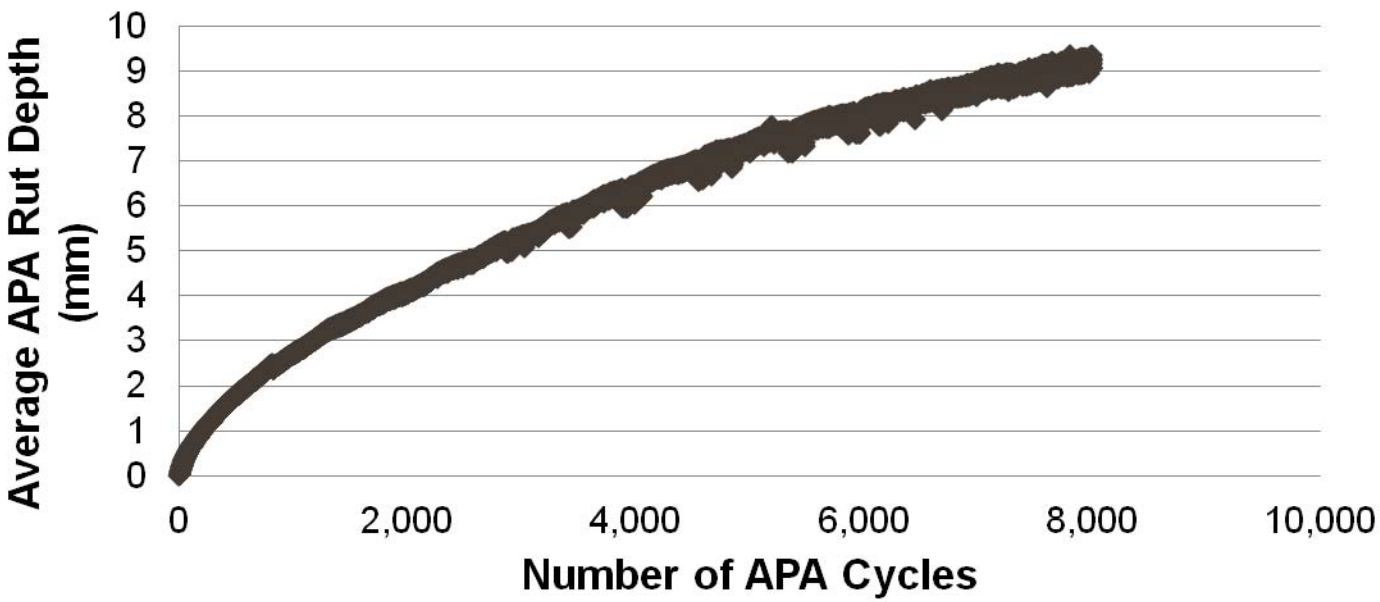
Asphalt Pavement Analyzer

- Laboratory Wheel Tracking Device
- 250 psi hose pressure
- 8,000 cycles or failure
- Records cumulative rut depth per cycle





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Summary

- Each method appropriately ranks mixture performance and could be used as a performance test to supplement P-401mix design
- APA is most efficient test method and is the only test method that could be used for quality assurance
- Preliminary criterion of <10 mm rutting after 4,000 APA cycles using 250 psi hose pressure
- Additional research is needed using more binder grades and aggregate sources, as well as field-compacted mixtures

Airport Pavement Design Using Geosynthetics

OBJECTIVE

• Evaluate airfield pavement designs incorporating geosynthetics as a structural element

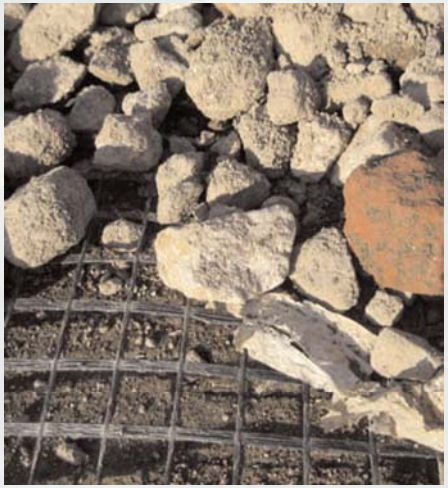
APPROACH

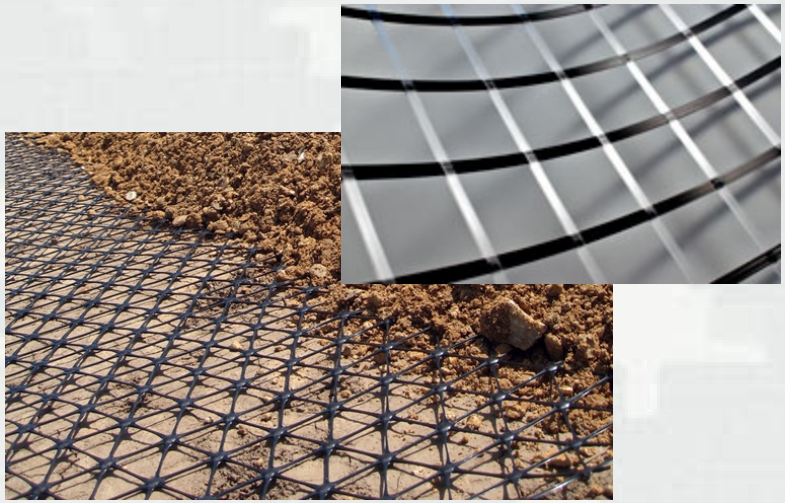
• Evaluate correlation between geosynthetic index properties and pavement performance

•Small-scale testing of geosynthetic reinforced pavements using simulated aircraft loads

Geosynthetics Tested

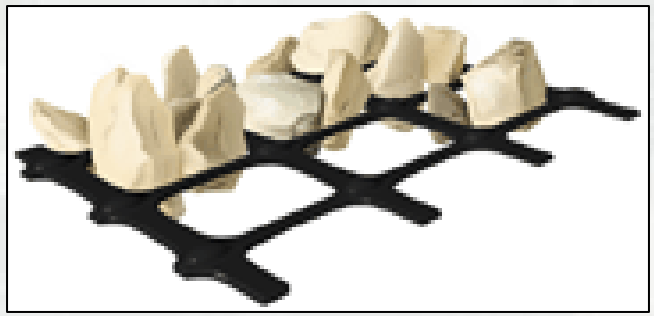
- Geogrids
  - Biaxial
    - Woven polyester
    - Punched and drawn
    - Welded
  - Triaxial
    - Punched and drawn
- Geotextile
  - High strength woven

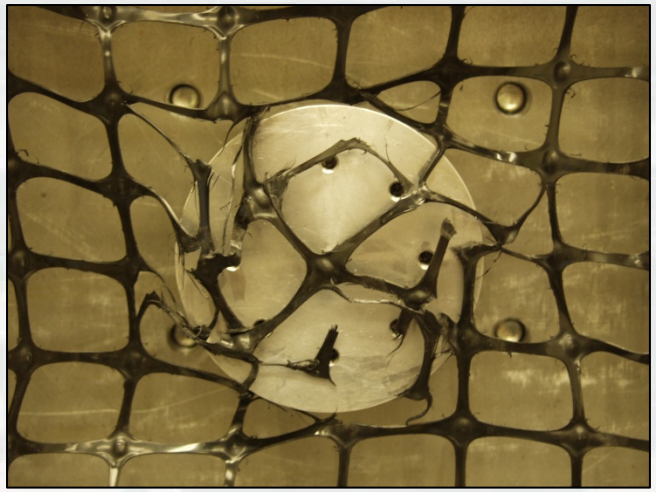




Geosynthetic Property Tests

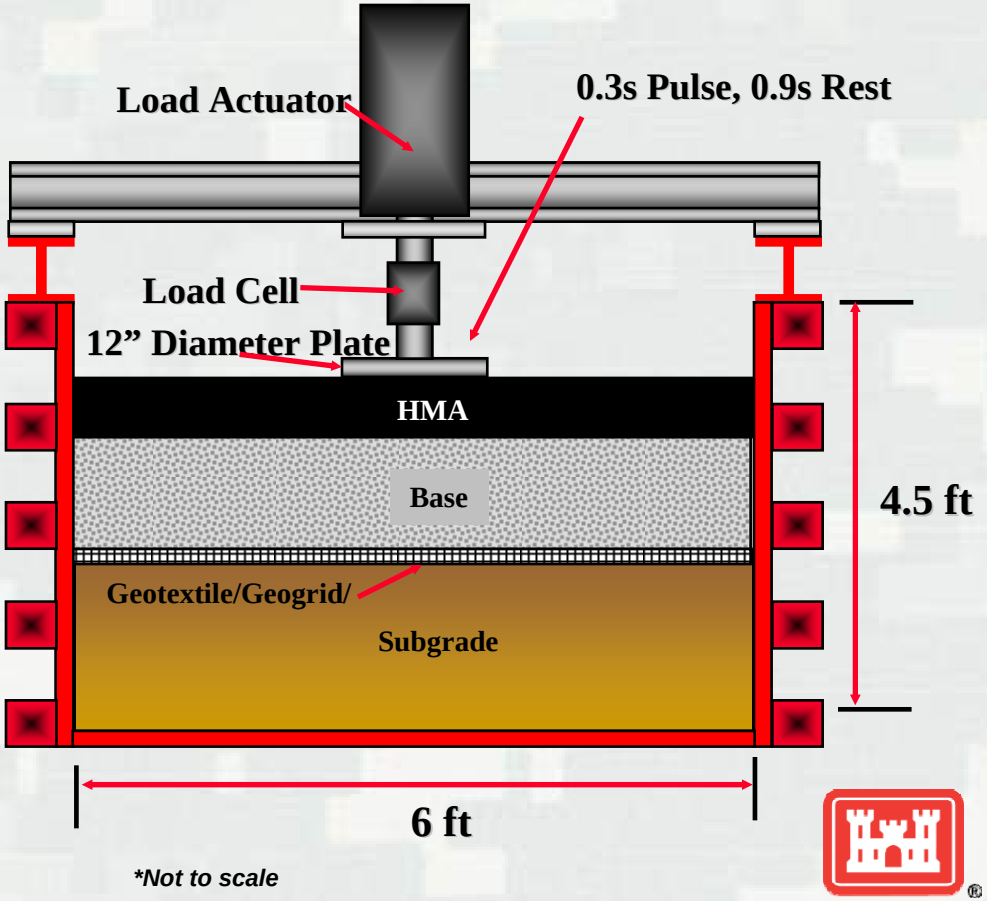
- Aperture Size
- Rib/Junction Thickness (ASTM D1777)
- Tensile Properties (ASTM D6637)
- Aperture Stability (USACE Method)
- Tensile Creep (ASTM D5262)
- Junction Efficiency (ASTM D7737)
- Flexure Strength (ASTM D1388)
- Resistance to Installation Damage (ASTM 6637)
- In-air Cyclic Tension Tests (ASTM D7556)
- Interface Shear Stiffness (ASTM D7499)





Scaled Pavement Testing

- Evaluate performance of different geosynthetics in a simulated pavement structure
  - Permanent surface deformation
  - Traffic Benefit Ratio (TBR)



Questions?

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