Superpave In-Situ Stress/Strain Investigation (SISSI)

AN OVERVIEW
AND A LOOK AT RESULTS

Mansour Solaimanian, Ph.D., P.E.
Pennsylvania Transportation Institute
The Pennsylvania State University

NESMEA Meeting
Burlington, Vermont
October 19, 2005
Outline

1. Overview of the Project and Objectives
2. Instrumentation
3. Measurements & Data Collection
4. Analysis of Results
5. Implementation

NESMEA, October 19, 2005
“SISSI” Project

Superpave  In-Situ  Stress/Strain  Investigation

➢ Sponsored by PENNDOT
Advisory Panel

- Apple, Roger
- Bhajandas, Amar
- Colella, Frank
- Cominsky, Ron
- Hoffman, Gary
- Liddick, Gaye
- Long, Michael
- Mattson, Gene
- Rottet, Tod
- Ramirez, Tim
- Rosenberger, Carlos
- Siddiqui, Zahur
- Speece, Christopher

Technical Manager: Dan Dawood
Contract Manager: Robert Garrett
Research Team

- Mansour Solaimanian
- Shelley Stoffels
- Dennis Morian (Quality Engineering Solutions)

- David Anderson
- Researchers and Many Students
Project Objectives

- Validation/Calibration of Superpave mixture and structural design procedures and models
- Calibration of AASHTO Pavement Design Guides
  - Regional basis
- Gather long-term pavement performance data
- Develop long-term performance database

NESMEA, October 19, 2005
Site Selection

- Eight sites
- Two pavement types
  - Structural overlays
  - New full-depth asphalt construction
- Two traffic levels
  - Under 30 million ESAL’s
  - Over 30 million ESAL’s
- Two climatic zones
  - North and south of I-80
Location of Sites
SISSI
SUPERPAVE
TEST SITE
START
07 1001 31
Construction Years

Year 2000
Tioga County, US 15
Mercer County, I-80

Year 2001
Perry County, US 22/322
Warren County, US 6

Year 2002
Somerset County, PA TP
Delaware County, US 202

Year 2003
Blair County, SR 1001

NESMEA, October 19, 2005
Outline

1. Overview of the Project and Objectives
2. Instrumentation
3. Measurements & Data Collection
4. Analysis of Results
5. Implementation

NESMEA, October 19, 2005
On-Site Instrumentation

- Dynamic - Pavement response to load
  - Vertical stress - unbound layers
  - Horizontal strain - all layers
  - Deflection – layer interface

- Environmental - Pavement
  - Temperature profile
  - Moisture in unbound layers
  - Frost depth
Multi-Depth Deflectometer (MDD)
Multi-Depth Deflectometer (MDD)
Strain Gage and Pressure Cell

NESMEA, October 19, 2005
TEMPERATURE - FROST DEPTH

Thermocouples
Frost Gage (Resistivity Probe)
Moisture Content Measurement

NESMEA, October 19, 2005
Measurement Summary

Measurements → Field

Measurements → Performance

Measurements → Laboratory

NESMEA, October 19, 2005
Measurement Summary

- Performance
  - Transverse Profile
  - Distress
    - Manual
    - Video logging
  - Longitudinal Profile

NESMEA, October 19, 2005
Environmental Data Collection
Dynamic Data Collection

NESMEA, October 19, 2005
Truck for Pavement Loading

NESMEA, October 19, 2005
Data Collection
Wander Measurement
Falling Weight Deflectometer
**Transverse Profile**

- Simple, low cost
- Easily transportable
- Measurements each time dynamic test conducted
Distress Survey

NESMEA, October 19, 2005
Performed at Different Temperatures:

-20  20  60  135

Pavement Temperature, °C
Dynamic Modulus Test
Outline

1. Overview of the Project and Objectives
2. Instrumentation
3. Measurements & Data Collection
4. Analysis of Results
5. Implementation

NESMEA, October 19, 2005
Distress Analysis

NESMEA, October 19, 2005
Distress Analysis

NESMEA, October 19, 2005
Distress Analysis

FIGURE 2 Instrumentation Location Distress Map

SITE: Warren
Instrumentation Location: one
Surface Temperature (°C)
Before Survey: ______
Surveyed By: Venky
After Survey: ______

0 ft 5 10 15 20 25 30 35 40 45 50 ft

COMMENTS:

50 ft 55 60 65 70 75 80 85 90 95 100 ft

1 – Fatigue Cracking  4 a- Longitudinal Cracking – Wheel path  4 b- Longitudinal Cracking – Non-wheel path
6 L – Transverse Cracking (Low) M – Medium  H-High

NESMecA, October 19, 2005
Distress Analysis

County: Delaware  Highway: SR202  Location: 1  - 24 feet

Depression, m

Distance from edge of Pavement, cm

03-30-2005
03-22-2004
11-10-2004

NESMEA, October 19, 2005
Temperature Variation – Freeze Cycles

County: Delaware  Highway: SR202  Location: 1

Date

Temperature (°C)

44 mm  116 mm  360 mm  604 mm
848 mm  1092 mm  1336 mm  1580 mm

NESMEA, October 19, 2005
Temperature Variation – Freeze Cycles

County: Warren       Highway: SR 6       Location: 2

Date

Temperature (°C)

36 mm       337 mm       581 mm       825 mm
1069 mm      1313 mm      1557 mm

NESMEA, October 19, 2005
Pavement Freezing Depth

County: Perry       Highway: SR 322       Location: 2

Milli Volts

Depth (mm)

NESMEA, October 19, 2005
Pavement Response to Load

Pavement Response (Horizontal Strain) vs. Time

NESMEA, October 19, 2005
Pavement Response to Load – Position Effect

Average Tensile Strains

Horizontal Strain

NESMEA, October 19, 2005
Pavement Response to Load – Position Effect

Horizontal Strain

NESMEA, October 19, 2005
Pavement Response to Load – Position Effect

Vertical Deflection (MDD)

NESMEA, October 19, 2005
Pavement Response to Load – Seasonal Effect

Tensile Strain at the Top of Binder
(Front Load Configuration)

Tensile Strain (ue) vs. Attempted Vehicle Speed (mph)

- February 02
- September 02

NESMEA, October 19, 2005
Laboratory Testing - Binder

NESMEA, October 19, 2005
Laboratory Testing – Master Curve

NESMEA, October 19, 2005
Laboratory Testing - Binders

SISSI Site Asphalt Binders

MIN. G*/sin£ = 1.0 kPa·s
Laboratory Testing – Mix Modulus

![Graph showing the modulus of Specimen M327311 at different temperatures (4 C, 10 C, 25 C, and 40 C) across various frequencies (Hz)].

Modulus, MPa vs. Frequency (Hz)
Outline

1. Overview of the Project and Objectives
2. Instrumentation
3. Measurements & Data Collection
4. Analysis of Results
5. Implementation
Layer Thicknesses for One of SISSI Sites

- Measured Thicknesses
  - 12.5-mm HMA Wearing Course: 1.6"
  - 19-mm HMA Binder Course: 2.6"
  - 37.5-mm HMA Base Course: 5.7"
  - Leveling Course: 4.3"
  - Rubblized Concrete: 8.0"

NESMEA, October 19, 2005
AASHTO Design Guide – Predicted Distress
Thank You!