Perpetual Pavement Research at the NCAT Test Track

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What is a Perpetual Pavement?

• 35+ years of service
• Minimal structural improvements
• No deep structural distresses
  – Problems at surface easily and quickly remedied
No Bottom-Up Cracking
No Deep Structural Rutting
NCAT Test Track – Perpetual Experiments

1.7 mile
46 – 200 ft sections

N9
14” AC

N8
10” AC

N4
PG 76-22

N3
PG 67-22
Test Sections – Experiment 1

N3 (PG 67-22)

1.2 Surface Mix 1

1.8 Upper Intermediate Mix 1.7

2.7 Lower Intermediate Mix 2.3

2.1 Upper Base Mix 1.8

1.3 Lower Base Mix 2

6 Aggregate Base 6

Survived 30 million ESALs with excellent performance

N4 (PG 76-22)

1

2.3

2.3

1.8

2

6

Subgrade Soil

Designed with 1993 AASHTO Guide to Fail after 10 Million ESALs
FWD Testing

[Diagram showing FWD testing setup with various labeled points and equipment like Random location, Offset, IWP, BWP, OWP, Edge stripe, Pressure plate, Strain gauge, etc.]
AC Modulus at 20°C

- N3-2003: 12%
- N4-2003: 20%
- N3-2009
- N4-2009
Rutting Performance

![Rutting Performance Chart]

- **Rut Depth, mm**
- **Failure Line**: 13.0 mm
- **X-axis**: Million Equivalent Single Axle Loads
- **Y-axis**: Rut Depth, mm
- **Dates**: 10/20/03 to 09/08/11
- **Legend**:
  - N3
  - N4

The chart indicates the rutting performance over time, with failure marked at a rut depth of 13.0 mm.
Cracking Performance

Crack Map (Trucking Percent Complete via Height of Gray Map Date Box)

Longitudinal Distance from Far Transverse Joint (feet)

N3

Crack Map (Trucking Percent Complete via Height of Gray Map Date Box)

Longitudinal Distance from Far Transverse Joint (feet)

N4
Forensic Trenching
Strains at 90th percentile are about 2.18 times the lab endurance limit.
Strain Distributions for Perpetual Design

[Graph showing strain distributions with different percentile values and microstrains.]

- **No Fatigue**
- **Fatigue**

Curves represent different years and conditions, indicating the distribution of strain over time.
Section Performance - IRI

- **N8-non perpetual**
- **N9-perpetual**

- Conventional Mill & Inlay with Fabric
- HPM Mill & Inlay

**2006 Test Track**

**2009 Test Track**

ESALs

IRI, in./mile
N8 After 1st Rehabilitation @ 3.5 MESAL
N8 After 1\textsuperscript{st} Rehabilitation @ 3.5 MESAL
Cash Flow Diagram

Discount Rate = 2%

Initial Construction

32% Increase

N9

N8

Conventional mill & inlay

Resurfacing

N8

HPM mill & inlay

N8
Summary – Experiment 1

• Sections originally designed for 10 million ESAL were perpetual
  – AASHTO ‘93 overdesign
• Sections increased modulus vs time
  – Aging, but no subsurface cracking
• Excellent performance
  – Rutting < 8 mm
  – IRI < 1 m/km
  – Minor top-down cracking
• Lab-determined endurance limit conservative
Key Findings – Experiment 2

• Perpetual pavement outperformed conventional pavement
  – Ride quality
  – Cracking
  – Rutting
  – Measured pavement responses
  – Backcalculated moduli

• Conventional mill & inlay not effective treatment

• HPM mill & inlay has performed well

• Perpetual pavement initial cost 32% higher than conventional, but 26% lower LCC

• Perpetual consumed far less natural resources
  – Non-perpetual required additional 27 cm of AC to survive
Acknowledgements