Virginia Center *for* Transportation
INNOVATION & RESEARCH

We bring innovation to transportation.

In-Place Pavement Recycling

Southeast Pavement Preservation Partnership

Louisville, Kentucky

May 29, 2014

Brian Diefenderfer, PhD, PE

Overview

- Why we should recycle
- In-place pavement recycling processes
- Ongoing research in Virginia
- Next steps

Why We Should Recycle our Pavements

- **Economic**
  - Nevada DOT saved $600 million over 20 years
  - Other studies show 30-50 percent cost savings
- **Environment**
  - MTO (Ontario) estimated 50 percent less greenhouse gases emitted
- **Construction**
  - Fixes deterioration causes rather than symptoms
- **FHWA recycled materials policy**

  www.fhwa.dot.gov/legsregs/directives/policy/recmatpolicy.htm

In-Place Recycling Processes

- Hot in-place recycling (HIR)
- Cold recycling
  - Cold in-place recycling (CIR)
  - Cold central-plant recycling (CCPR)
- Full-depth reclamation (FDR)

Increasing depth and level of deterioration

Hot In-Place Recycling

- **All process**
  - **Scarify, rejuvenate, spread / pave, and compact**
- **Surface recycling**
  - **Top 1-2 inches prior to surfacing**
- **Surface remixing**
  - **Top 1-2 inches while adding additional materials prior to surfacing or as the wearing course**
- **Surface repaving**
  - **Top 1-2 inches along with an overlay to create a single thermally-bonded layer**

Cold In-Place Recycling

- **CIR process**
  - **Pulverized in-place**
  - **Recycling agent is added**
  - **Layer is compacted**
    - 2 to 5 inches
    - Within the bound layers (a.k.a. partial depth)
  - **Without addition of heat**
  - **Single-unit vs. multi-unit trains**
- **Recycling agents & additives**
  - **Foamed asphalt, emulsified asphalt**
  - **Cement, lime**


Cold In-Place
Recycling

Cold In-Place Recycling

Photo by Mike Marshall

Cold Central-Plant Recycling

- **Similar to CIR but the recycling agent is added at a mobile plant**

- **Uses**
  - **Alternative to CIR**
  - **When access to deeper layers is needed**
    - Mill, FDR, CCPR
    - Mill, CIR, CCPR
  - **When stockpiles of existing RAP are available**
    - Lane addition, shoulder widening

Cold Central-Plant Recycling

Photo by Wirtgen

CCPR with Existing RAP

- **Virginia has about 4.5 million tons of RAP**

CCPR with Existing RAP

- **Could pave a 12-foot lane at 6 inches for about 2,000 miles**

Full-Depth Reclamation

- **FDR process**
  - **Pulverized in-place**
  - **Recycling agent is added**
  - **Layer is compacted**
  - **Creates a stabilized base course**
    - 4 to 12 inches
    - Includes unbound layers
  - **Without addition of heat**

Full-Depth Reclamation

- **Mechanical stabilization**
  - **Additional aggregate or RAP**
- **Asphalt stabilization**
  - **Foamed asphalt**
  - **Emulsified asphalt**
- **Chemical stabilization**
  - **Cement**
  - **Lime**
  - **Fly ash (type C or F)**
  - **Cement / lime kiln dust**

Full-Depth Reclamation

Full-Depth Reclamation

Pavement Recycling & Preservation

- **Pavement Recycling**
  - **Can include treatments ranging from minor rehabilitation to full reconstruction**

- **Preservation**
  - **Cost-effective treatments to extend the service life of a pavement**
    - Not reconstruction
  - **HIR & CIR**
    - FDR & CCPR

Training Options

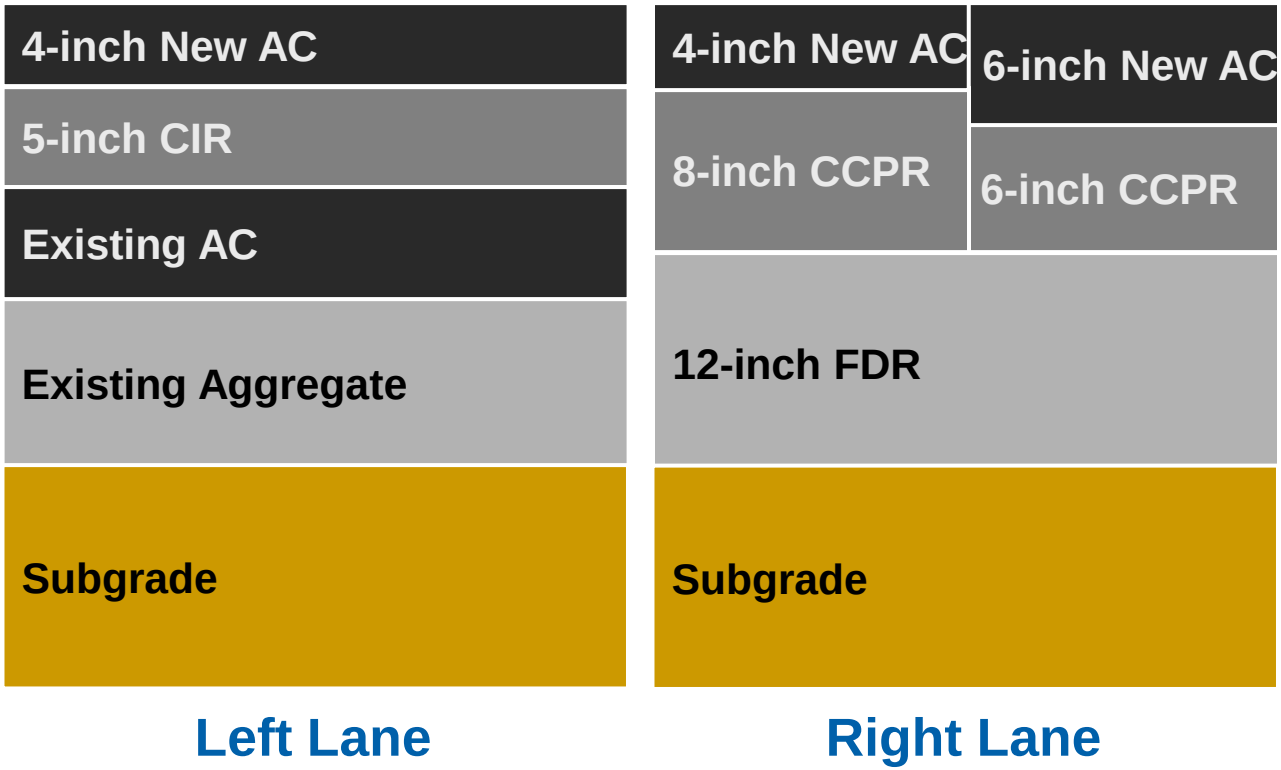
- **NCPP**
  - **Checklists**
  - **Regional workshops**
- **NHI**
  - **131050 & 131050A**
    - Asphalt Pavement In-Place Recycling Techniques
    - Instructor-led (fee) web-based (free)
  - **134114**
    - Inspector Training for CIR
    - Web-based (free)
    - HIR and FDR available soon(ish)

Virginia In-Place Pavement Recycling Research

- I-81
- NCAT test track
- NCHRP 9-51

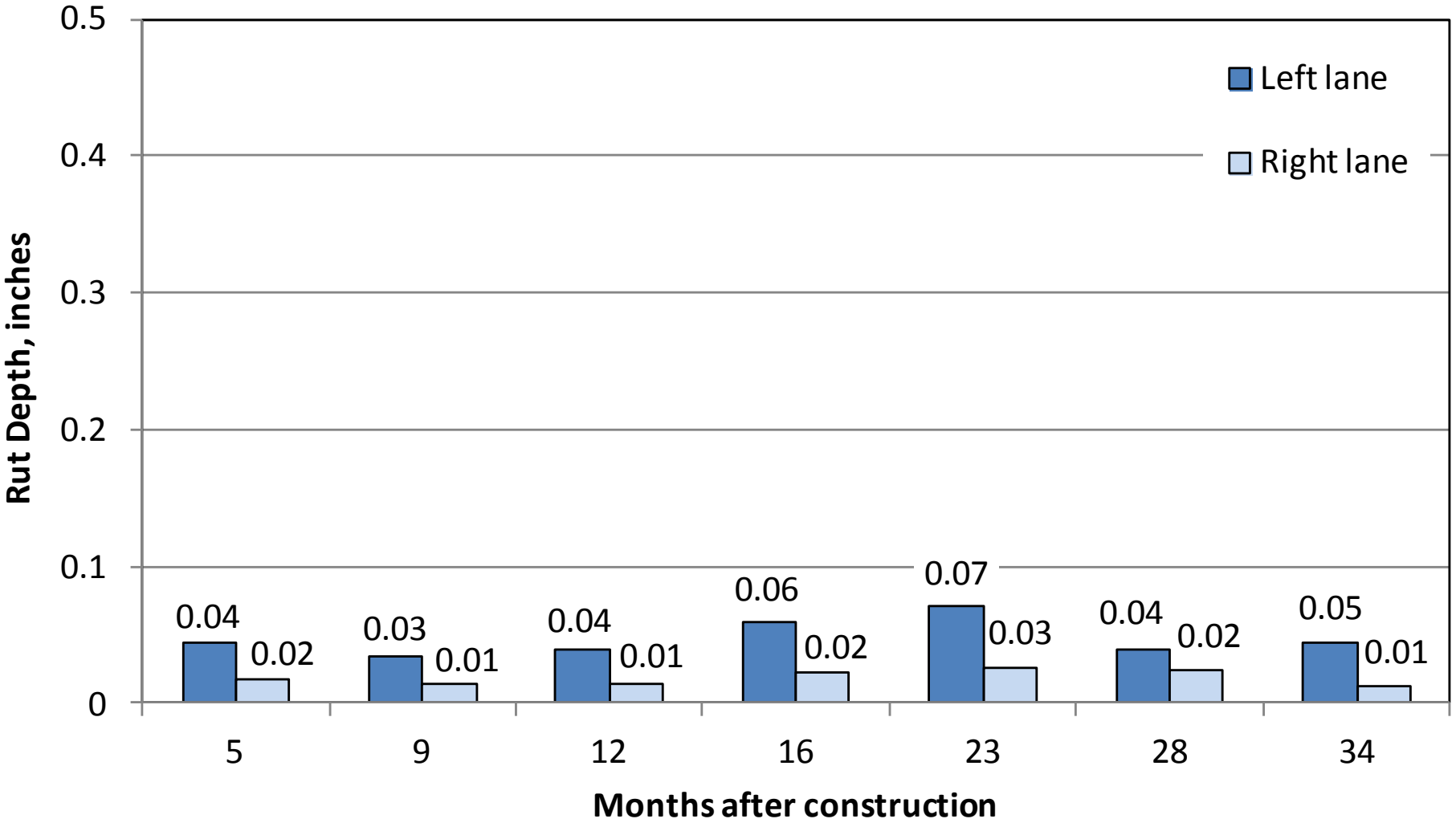
I-81 Pavement Recycling, 2011

- AADT = 23,000 (28 percent trucks)
- 7.2 lane miles

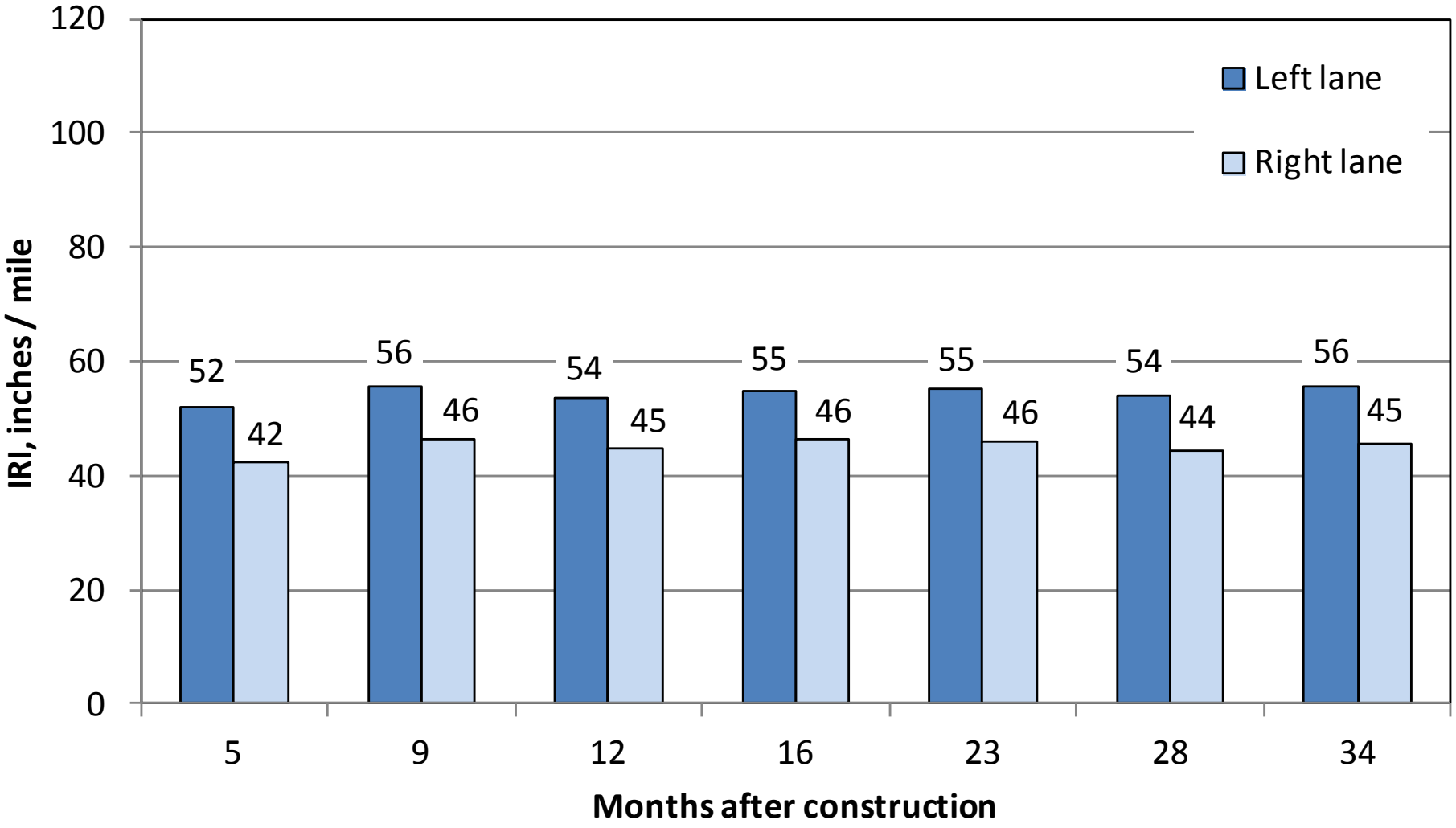


Lane Closure

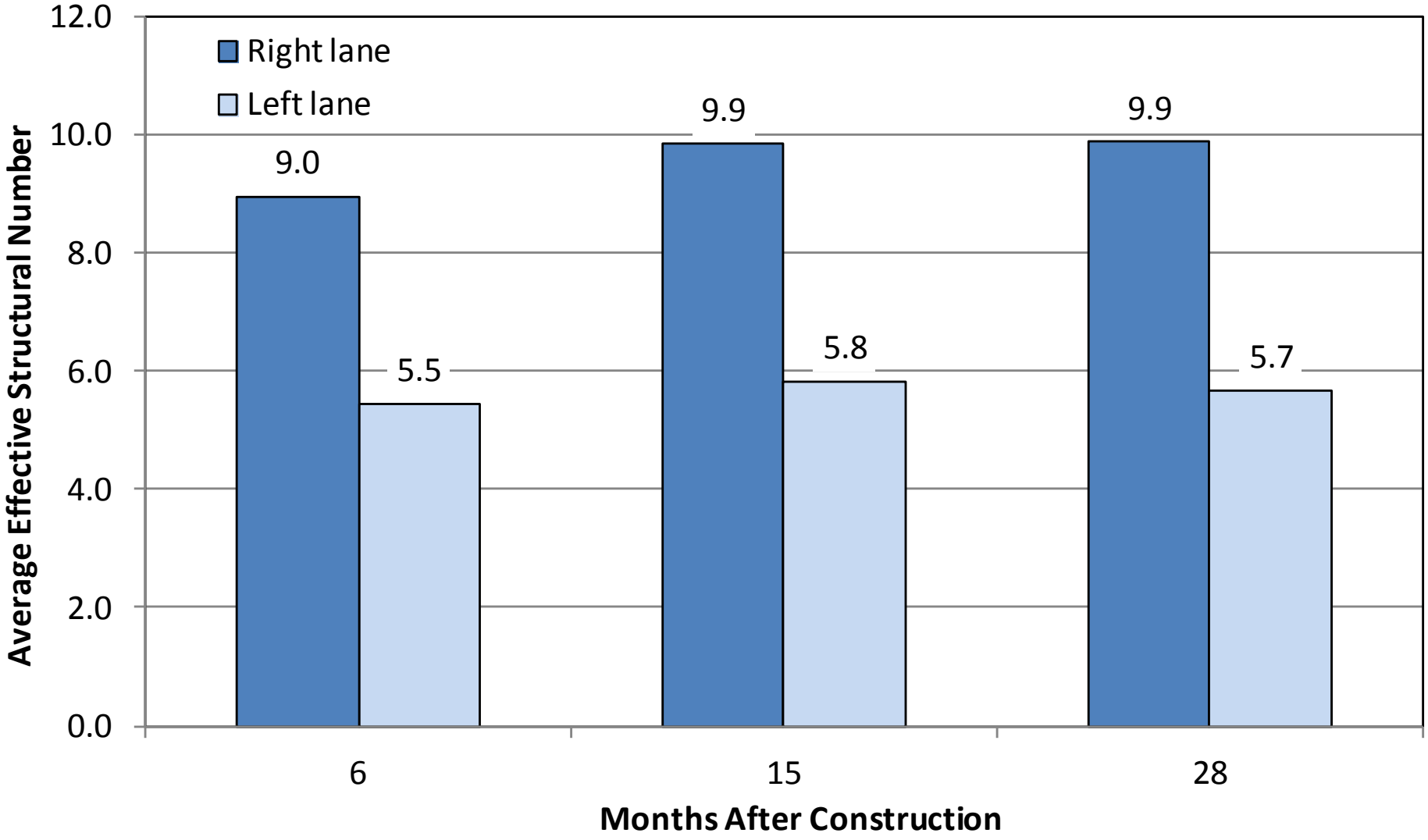
Rut Depth


0.5
0.4
0.3
0.2
0.1
0
Rut Depth, inches
Left lane
Right lane
0.04
0.02
0.03
0.01
0.04
0.01
0.06
0.02
0.07
0.03
0.04
0.02
0.05
0.01
5
9
12
16
23
28
34
Months after construction

Ride Quality

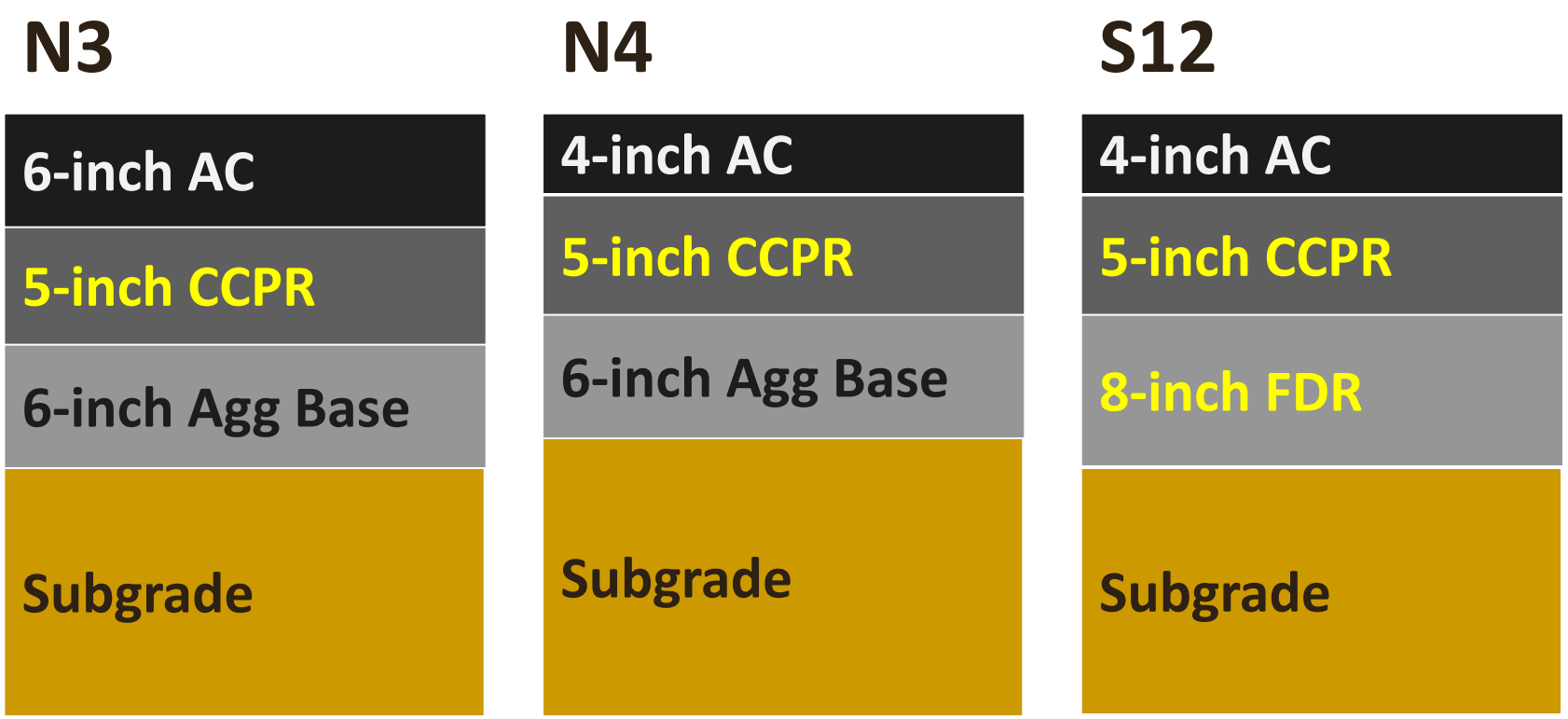


FWD

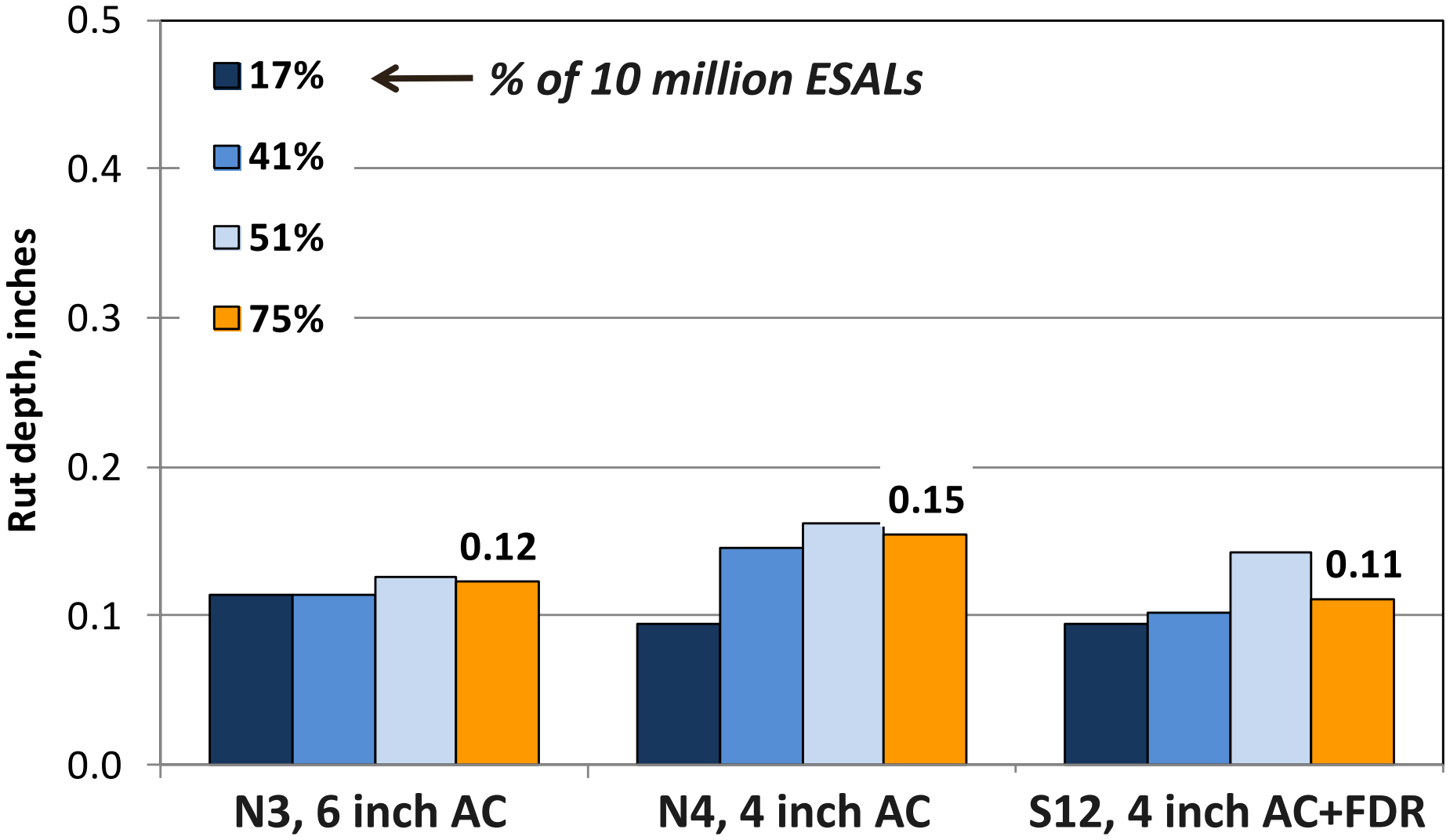

12.0
10.0
8.0
6.0
4.0
2.0
0.0
Right lane
Left lane
9.0
5.5
9.9
5.8
9.9
5.7
6
15
28
Average Effective Structural Number
Months After Construction

NCAT Recycled Sections

NCAT Recycled Sections

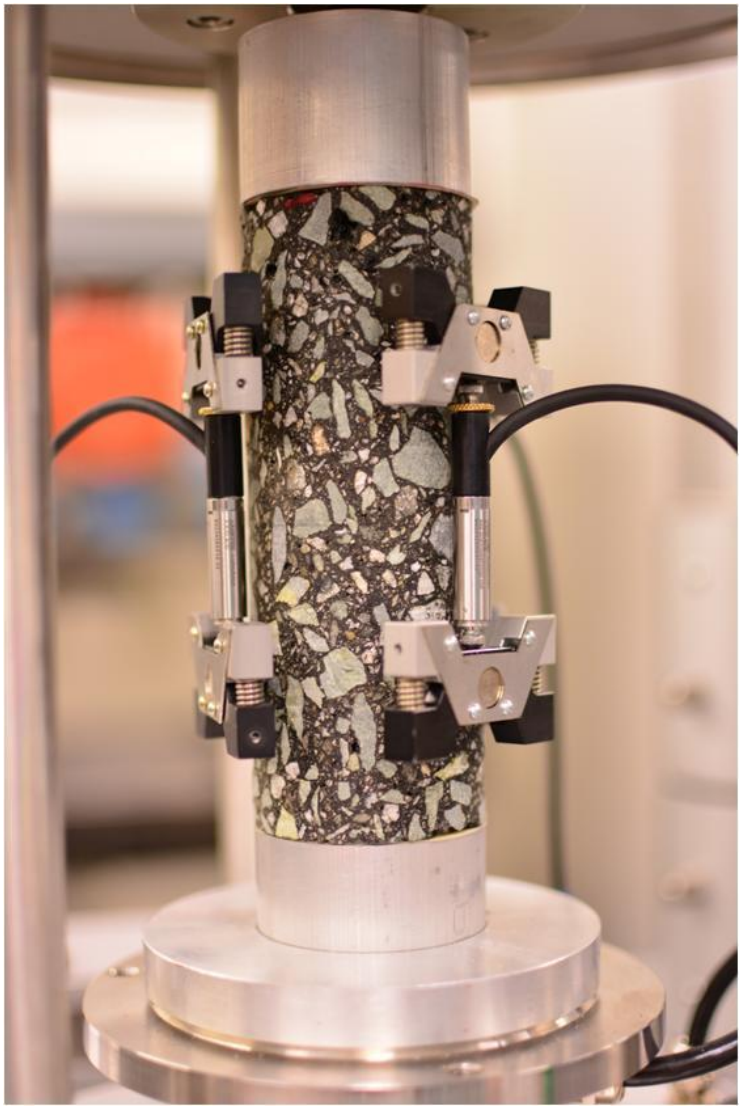


Rutting


0.5
0.4
0.3
0.2
0.1
0.0
Rut depth, inches
17%
41%
51%
75%
% of 10 million ESALs
0.12
0.15
0.11
N3, 6 inch AC
N4, 4 inch AC
S12, 4 inch AC+FDR

NCHRP 9-51

- ***Material Properties of CIR and FDR Asphalt Concrete for Pavement Design***
  - **Developing design inputs for Pavement-ME**
- **Partners**
  - **University of MD, VDOT, Colas Solutions, Wirtgen**
- **Looking for projects in Southeast US**
  - **Constructed in 2012 or 2013**
  - **Asphalt emulsion or foamed asphalt**



Next Steps

1. Think recycling
2. Number of projects
3. Design inputs for pavement designers
4. Document long-term performance

Virginia Center *for* Transportation
INNOVATION & RESEARCH

We bring innovation to transportation.

Brian Diefenderfer, PhD, PE

brian.diefenderfer@vdot.virginia.gov