Performance of High Friction Surfacing Demonstrations in the U.S.

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THE TRANSTEC GROUP

HighFrictionRoads.com

Overview

- What are High Friction Surfaces?
- Why HFS for Horizontal Curves?
- SEAHC Demonstration Projects
- NCAT Aggregate Durability Study

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What are High Friction Surfaces?

- High Friction Surfaces (HFS) are pavement surfacing systems with exceptional skid-resistant properties that are not typically acquired by conventional materials
- Generally proprietary resin-based products and processes
- Guidelines from the British Board of Agrément (BBA)

  "…defined as having a minimum skid resistance value (SRV) of 65 measured using the portable Skid-Resistance Tester as defined in TRL Report 176: Appendix E."

HFS Materials

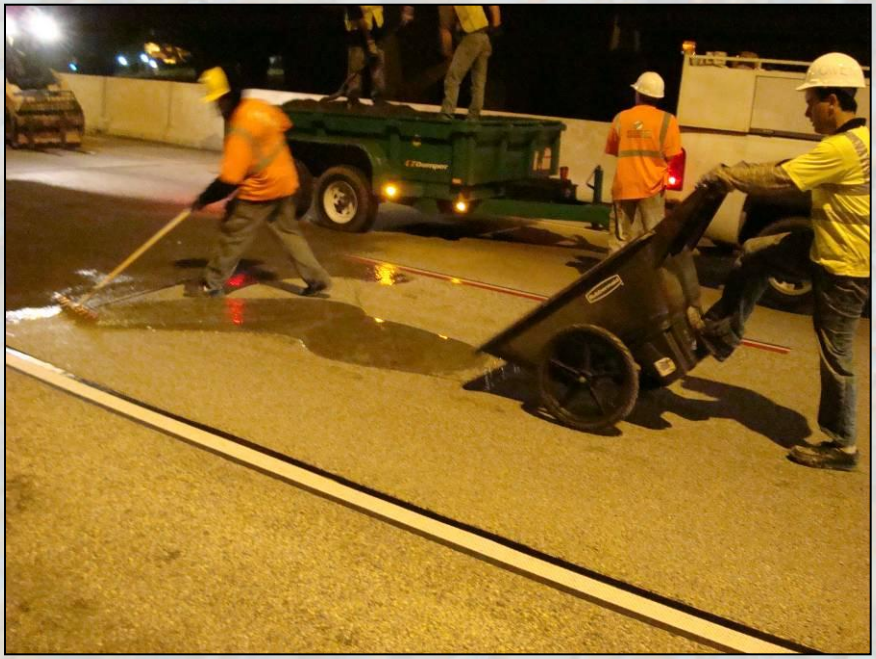
- Aggregates
  - Generally calcined bauxite or flint, but slags, granite, and other materials with high PSV have also been used
  - Generally 3-4 mm maximum size

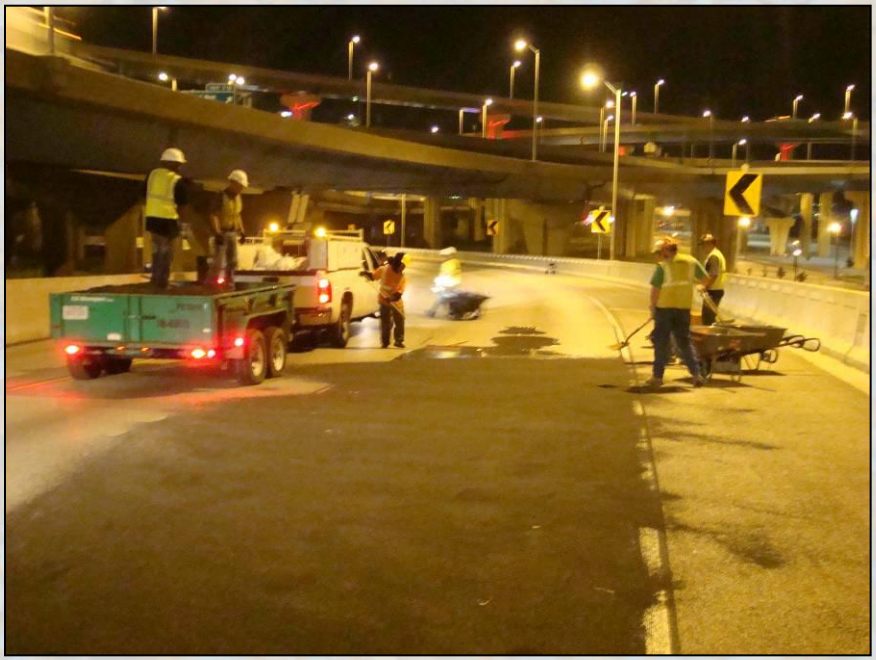
HFS Materials

- Binder system (proprietary blends)
  - Bitumen-extended epoxy resins
  - Epoxy-resin
  - Polyester-resin
  - Polyurethane-resin
  - Acrylic-resin

HFS Installation

- Manually
  - Manual mixing of epoxy material
  - Manual application of epoxy with squeegee
  - Hand broadcast and distribution of aggregate
  - Production rates: 165-420+ m^2/hr (200-500+ SY/hr.)

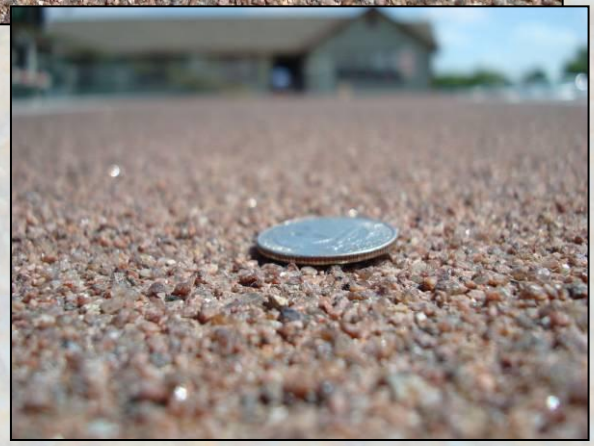




HFS Installation

- Automated (machine-aided)
  - Machine mixing and application of epoxy (limited hand/squeegee work)
  - Machine broadcast/application of aggregate
  - Production rates up to 1920 m^2/hr (2,300 SY/hr.)

HFS Finished Product



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Crashes at Horizontal Curves

- Roughly 28% of all fatal crashes occurred at horizontal curves (source: 2007 NHTSA FARS)
- The average crash rate for horizontal curves it approximately **three times** the crash rate of tangent sections
  - 69% rural
  - 71% on minor arterials (rural and urban)

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FHWA Surface Enhancements At Horizontal Curves (SEAHC) Program

- Goals of SEAHC:
  - Demonstrate the effectiveness of High Friction Surfaces (HFS) in enhancing/restoring friction to reduce lane departure crashes at horizontal curves (and ramps).
  - Measure the properties of HFS and monitor changes and performance over first year
  - Monitor crashes before and after HFS application
- Utilize currently available HFS products
- 3+ year study for each site
- Generally 1-5 sites per State

FHWA SEAHC Demonstrations

- 24 Installations in 10 States
  - Installation, Testing, Monitoring: 19
  - Testing Only: 5
- 5 Different HFS vendors
- 5 Pavement types
  - PCCP
  - Conventional dense-graded HMA
  - Stone Matrix Asphalt
  - Chip Seal
  - Open Grade Friction Course

FHWA SEAHC Demonstrations

FHWA SEAHC Demonstrations

- Data Collection
  - Crash Data:
    - Historical: min. 3 years prior to installation
    - Post-Installation: 3 years following installation
  - Friction
  - Texture
  - Tire-Pavement Noise – OBSI (select sites only)

Friction

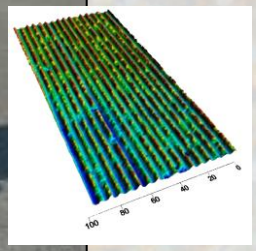
Dynamic Friction Tester (DFT)

Griptester

DOT-provided Locked Wheel Skid Trailer (ribbed and/or smooth tire)

Texture

Circular Track Meter (CTM) – MPD



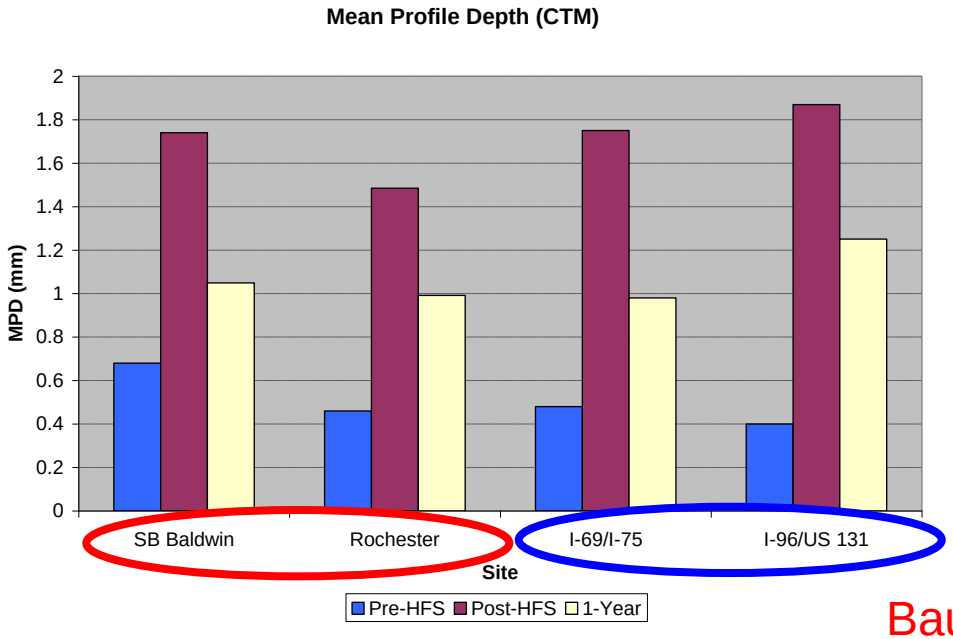
RoboTex – MPD

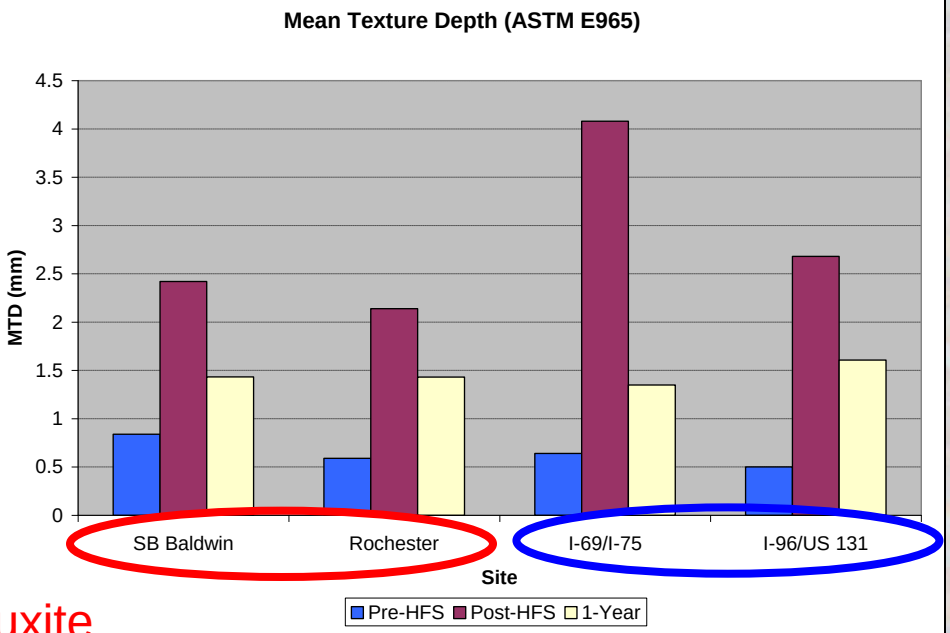
ASTM E965 (“Sand Patch”) – MTD

Michigan

- HFS Vendor/Product: POLYCARB/SAFETYGRID
- Aggregate: Calcined Bauxite and Crushed Flint
- Projects:
  - NB I-75 to NB Baldwin Rd. ramp, Auburn Hills (PCC)
  - NB I-75 to Rochester Rd. ramp, Auburn Hills (HMA)
  - WB I-69 to SB I-75 ramp, Flint (PCC)
  - WB I-96 to NB US 131 ramp, Grand Rapids (PCC)

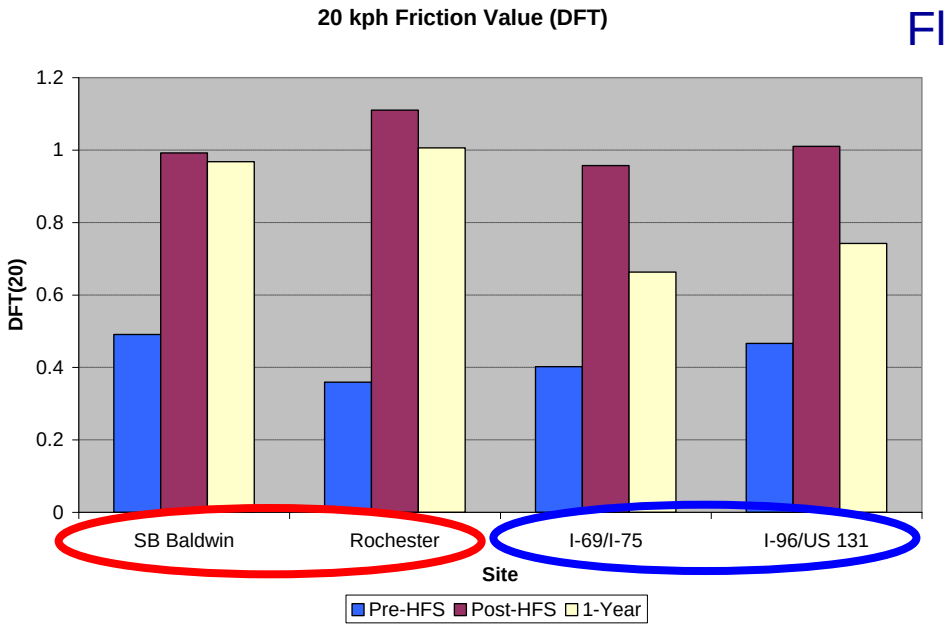
Michigan – PRELIMINARY Results

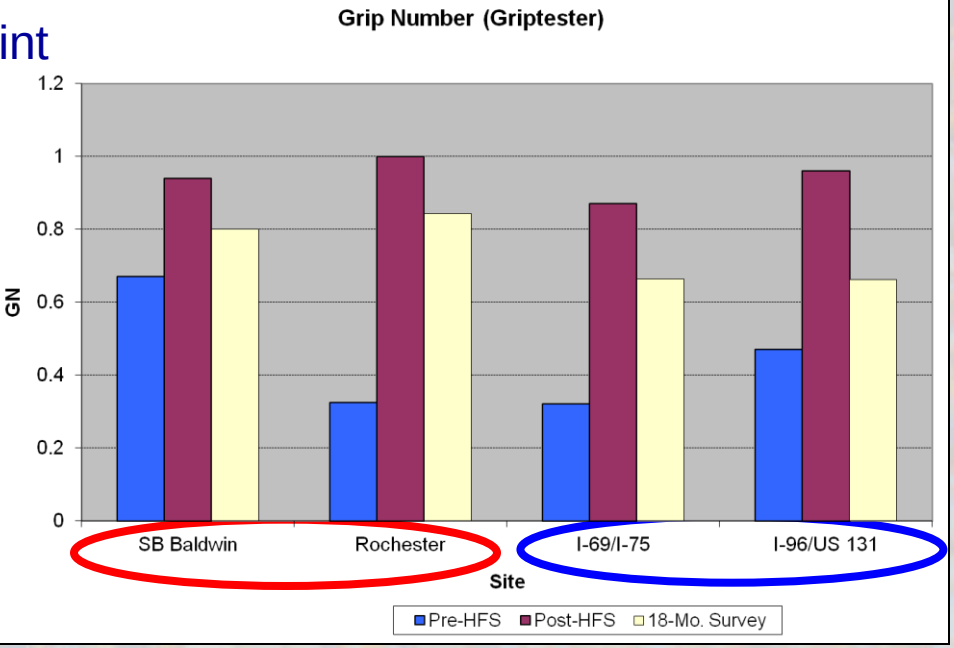




Bauxite

Flint



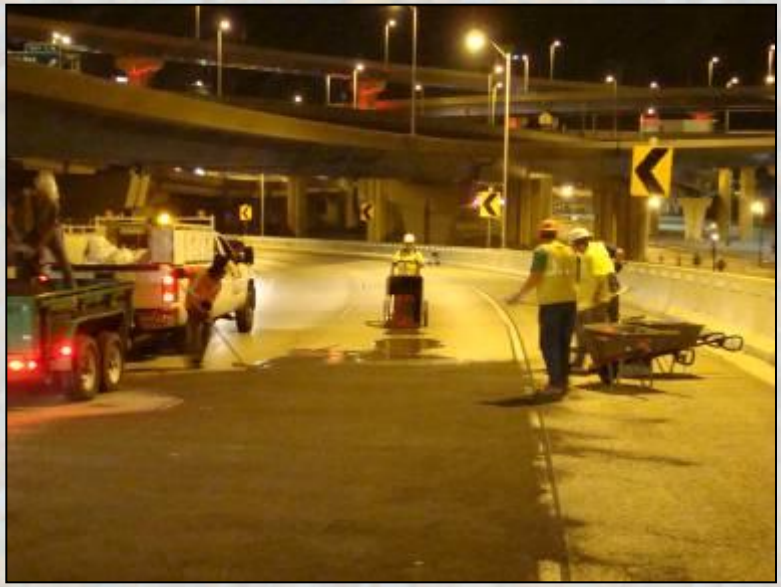


Michigan - performance

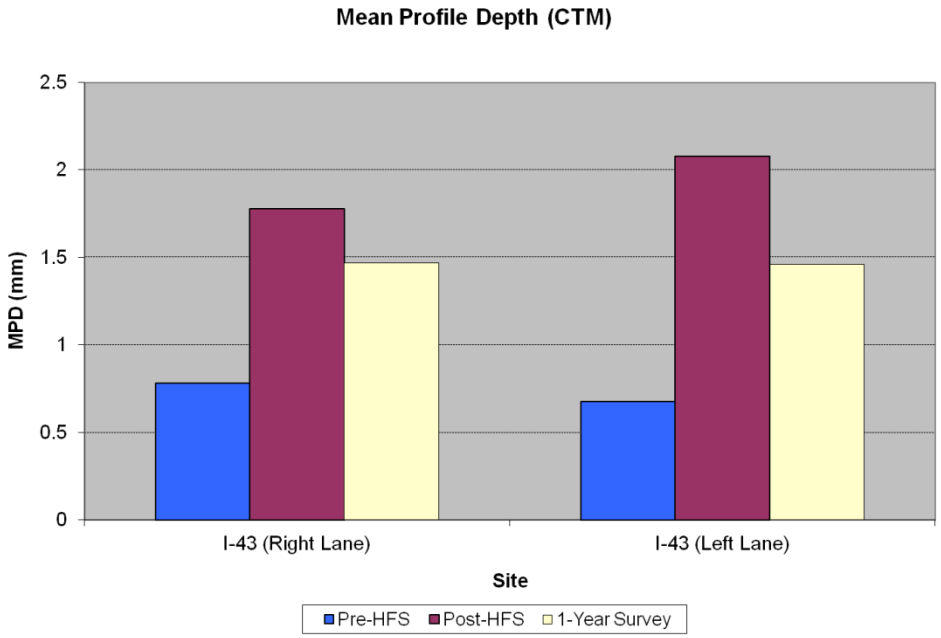
Wisconsin

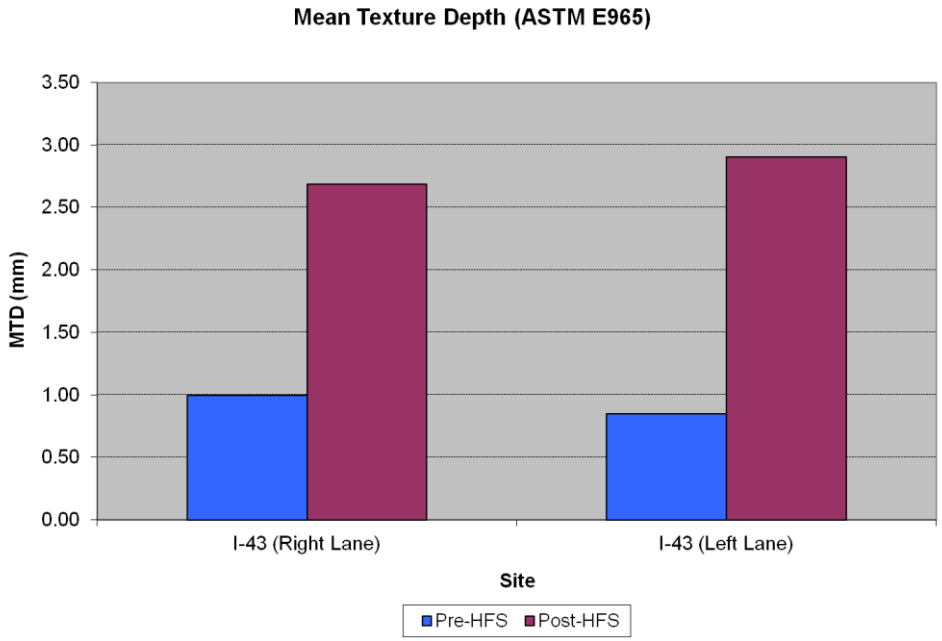
- HFS Vendor/Product: Traffic Management USA / Safe-T-Grip
- Aggregate: Calcined Bauxite
- Projects:
  - EB I-94/I-794 to NB I-43 (Marquette Interchange W-N ramp)
  - SMA Pavement

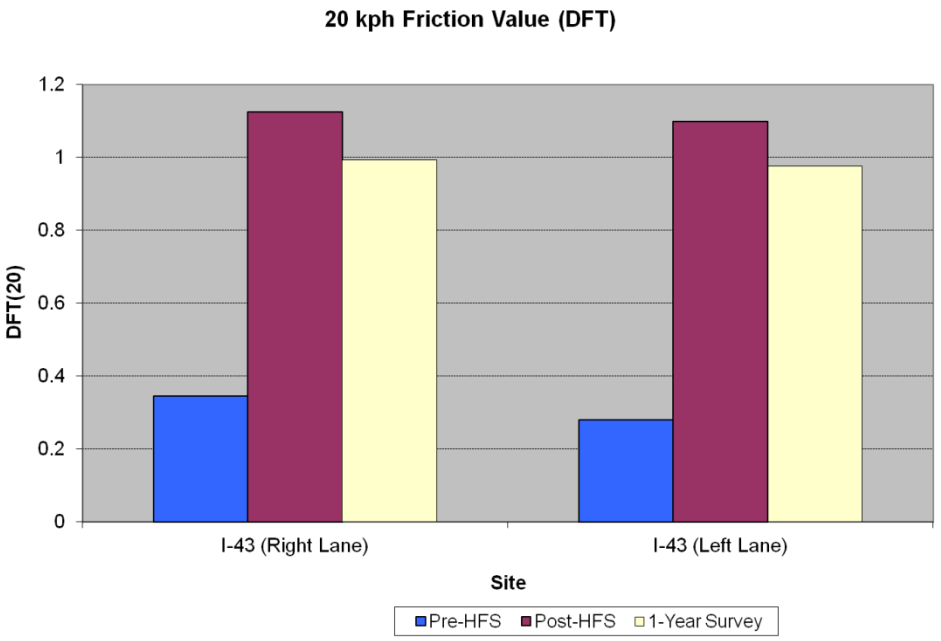
Wisconsin

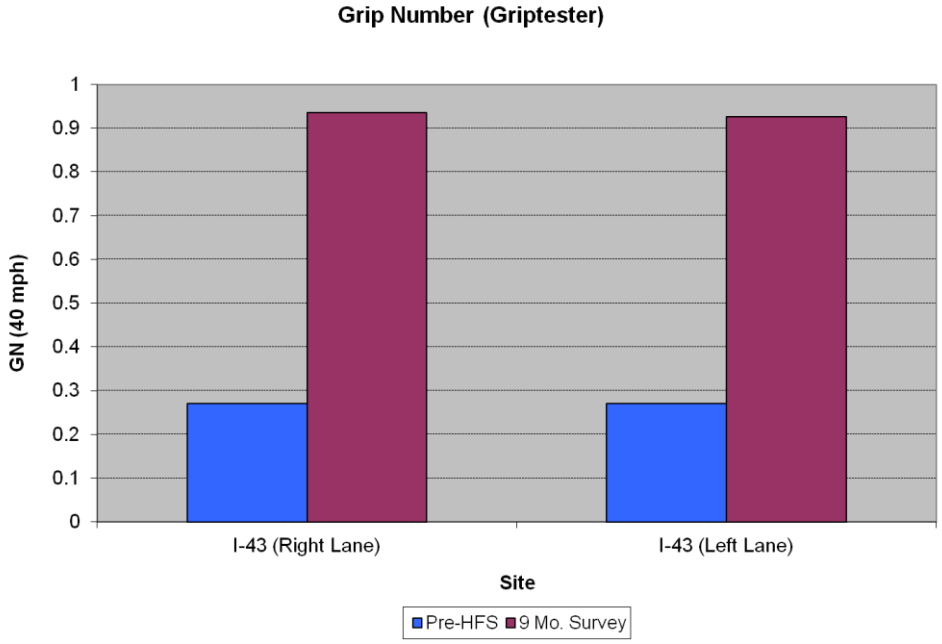


Wisconsin

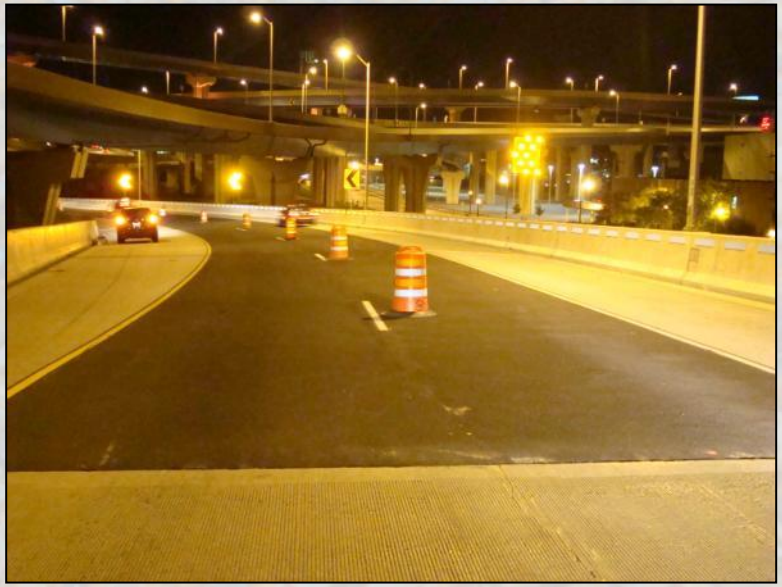

Mean Profile Depth (CTM)
MPD (mm)
2.5
2
1.5
1
0.5
0
I-43 (Right Lane)
I-43 (Left Lane)
Site
Pre-HFS
Post-HFS
1-Year Survey


Mean Texture Depth (ASTM E965)
MTD (mm)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
I-43 (Right Lane)
I-43 (Left Lane)
Site
Pre-HFS
Post-HFS


20 kph Friction Value (DFT)
DFT(20)
1.2
1
0.8
0.6
0.4
0.2
0
I-43 (Right Lane)
I-43 (Left Lane)
Site
Pre-HFS
Post-HFS
1-Year Survey


Grip Number (Griptester)
GN (40 mph)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
I-43 (Right Lane)
I-43 (Left Lane)
Site
Pre-HFS
9 Mo. Survey

Wisconsin - performance



Preliminary Crash Reduction Results

- Michigan
  - Site 1
    - 3 yr before: 26 crashes (8 wet)
    - 1 yr after: 4 crashes (1 wet)
  - Site 2
    - 3 yr before : 55 crashes (15 wet)
    - 1 yr after: 16 crashes (2 wet, 3 snow/ice)
  - Site 3
    - 3 yr before : 22 crashes (7 wet)
    - 1 yr after: 2 crashes (1 icy)
  - Site 4
    - 3 yr before : 25 crashes (12 wet)
    - 1 yr after: 3 crashes (1 wet, 1 icy, 1 alcohol)

Overall, 60% crash reduction in first year!

Preliminary Crash Reduction Results

- Wisconsin - Marquette Interchange W-N Ramp
  - "Ramp closed virtually every time it rains"
  - 2008-2010: 81 crashes (59 wet – 73%; 2 icy – 2%)
  - Since Sept. 2011: 2 crashes (dry conditions, driver inattention, truck lost control)

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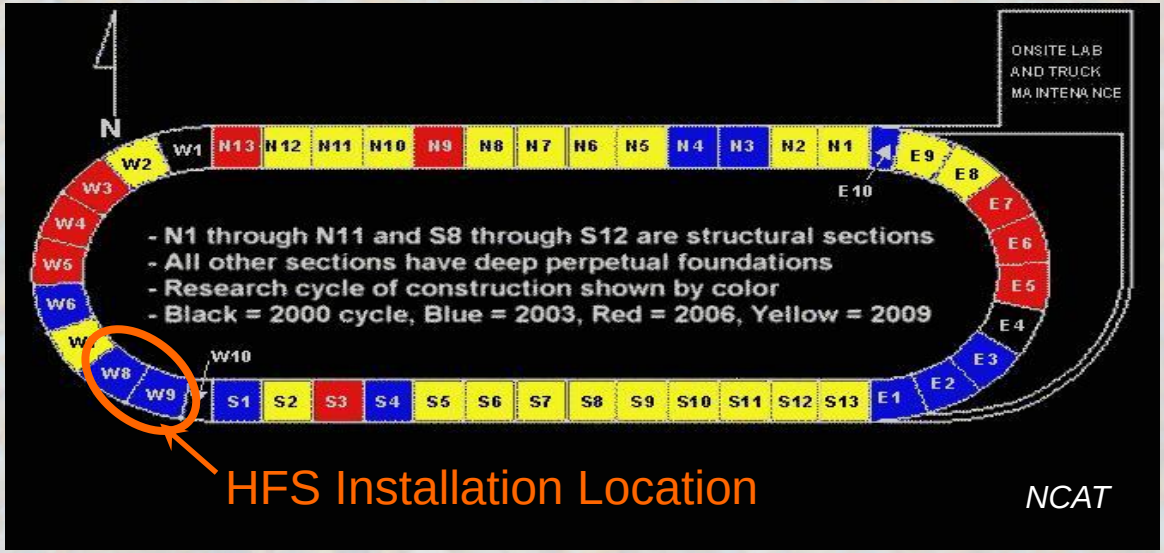
NCAT Aggregate Durability Study

- Purpose: Test the durability of various aggregate types under the same conditions
  - Installed on similar sections NCAT Test Track on a curve
  - Installed by same HFS supplier using the same resin, crew, and equipment
  - Exposed to the same traffic and climatic conditions
- 2+ Million ESAL applications (April-October 2011)
- Laboratory Testing of smaller samples of each
- Aggregates Tested:
  - Granite, Bauxite, Flint: 30 m (100') each
  - Basalt, Silica, Steel Slag, Emery, Taconite: 4.5 m (15') each

NCAT Aggregate Durability Study

NCAT Aggregate Durability Study

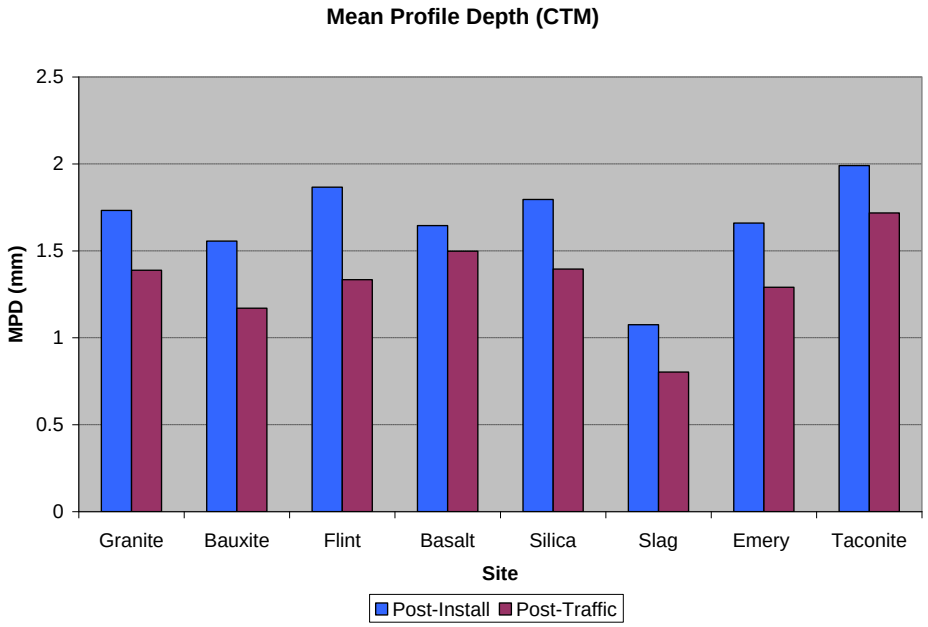


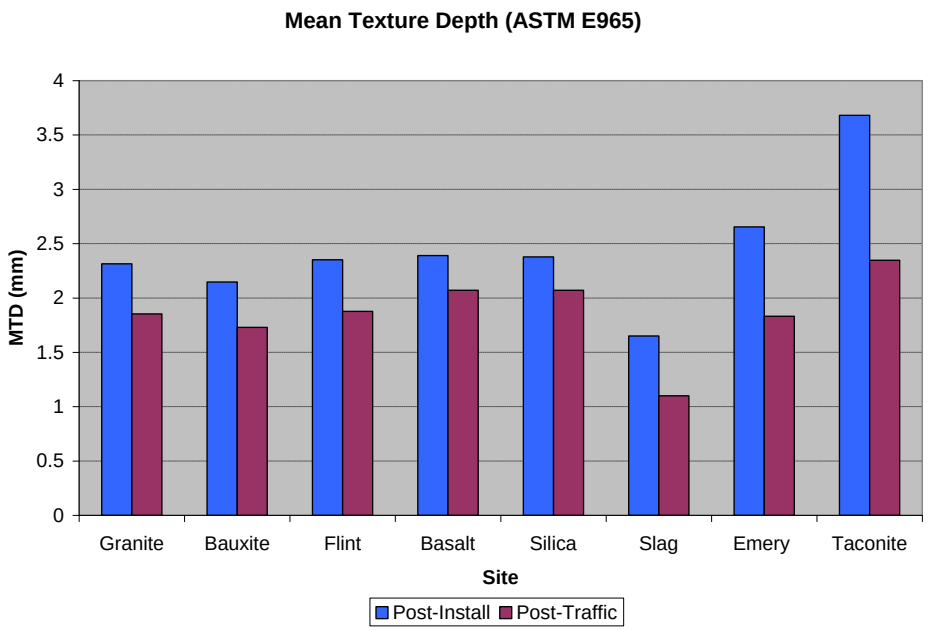
NCAT Aggregate Durability Study

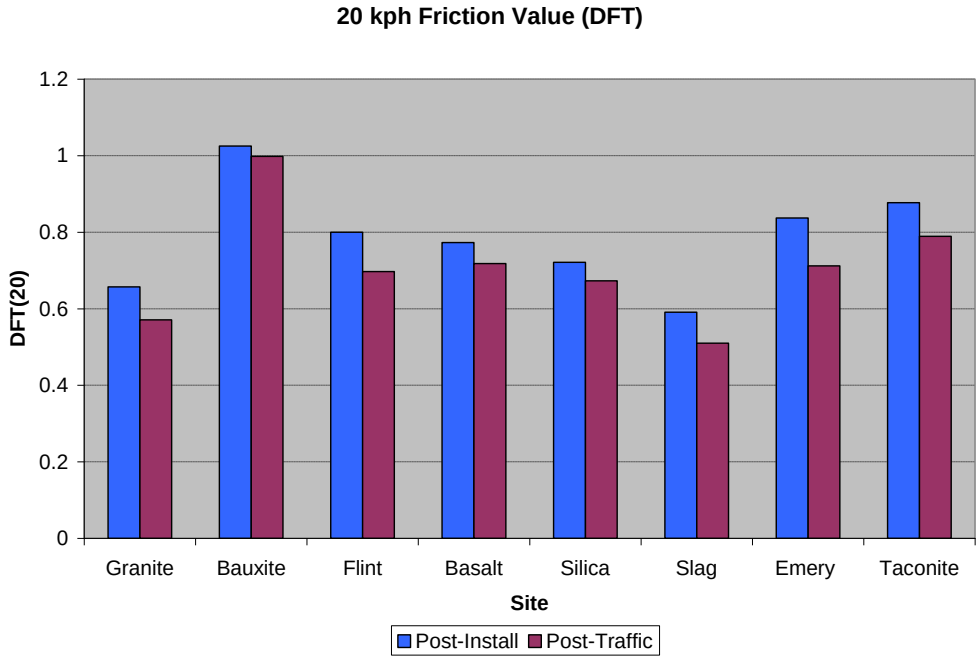
NCAT Aggregate Durability Study

- Laboratory Testing
- Three Wheel Polishing Device
  - Friction and Texture tested at 70k and 140k cycles
  - 2 replicates for each aggregate type

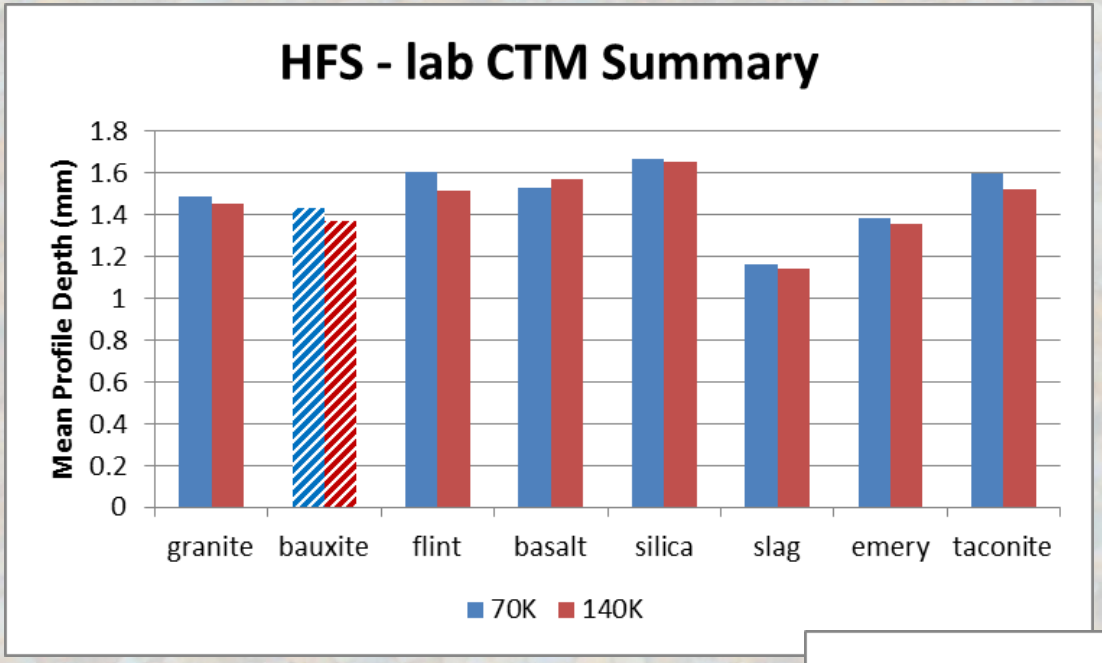
NCAT – PRELIMINARY Test Track Results





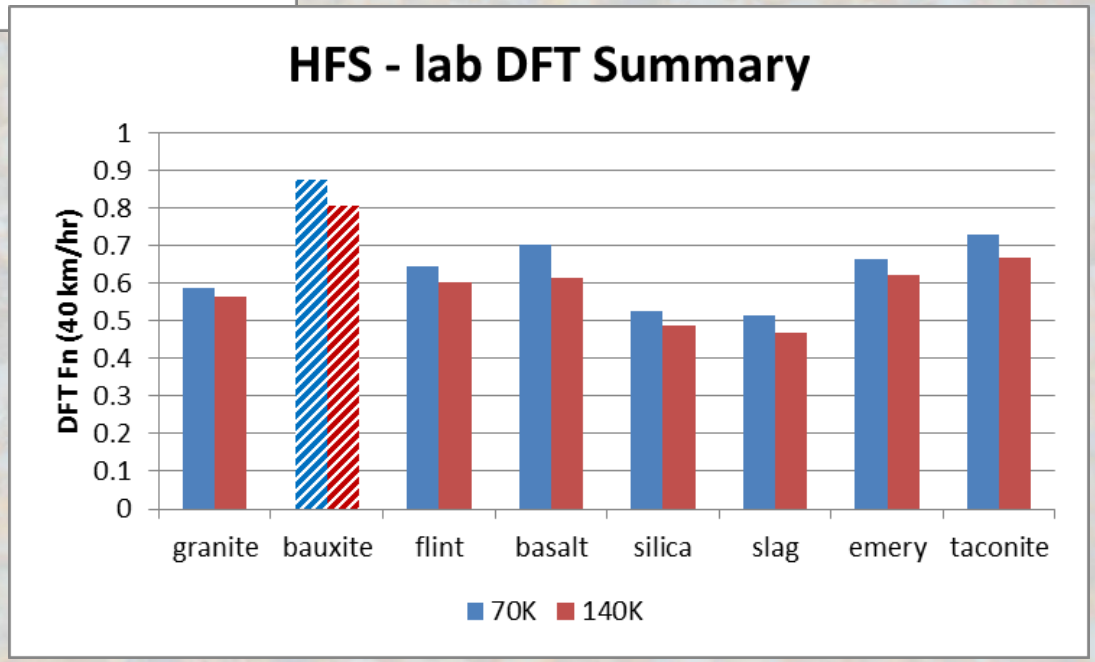


NCAT – PRELIMINARY Laboratory Results



MPD

DFT(40)



SEAHC - General Observations

- Underlying pavement must be in good condition
  - No alligator/block/map cracking
  - Cracks will reflect through regardless of the pavement type
- HFS products used to date have adhered well to all pavement types – HMA/SMA, Chip Seal, OGFC, and PCC
  - PCC pavement must be shotblast and cleaned prior to application
- HFS naturally “sheds” aggregate for the first few weeks/months after installation
  - Friction and texture depth after measure installation artificially high

SEAHC - General Observations

- HFS appears to perform well under snowplow wear, but poorly under studded tires / chains.
  - Double-layer HFS may be necessary for these locations
- Calcined Bauxite is the “premium” aggregate for HFS, but other aggregates have also performed satisfactorily
  - Selection of aggregate should be governed by traffic and environmental conditions

SEAHC - Summary

- HFS vendors are continually seeking to improve application equipment and installation practices
- HFS vendors have been extremely supportive and are the key element to the successful projects to date
- FHWA continues to support HFS as a solution for enhancing safety on pavement surfaces
- ATSSA has provide an industry “home” for HFS and is currently working on specifications for its use

ATSSA Webinar for HFS on October 10th


THANK
YOU!