Columbia County
High Friction Surface Treatment

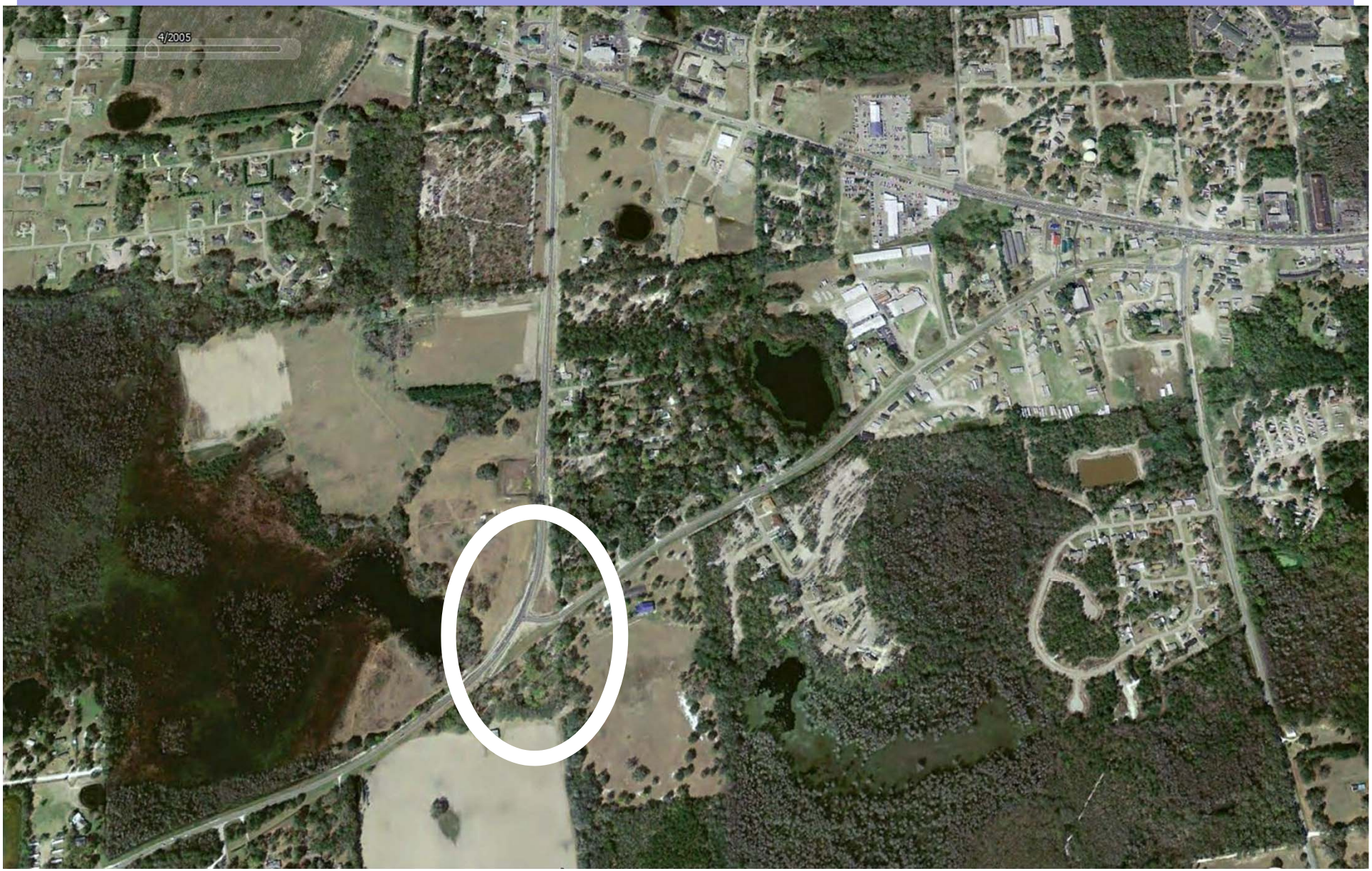
FACERS
Orlando, Florida
June 12, 2018

Chad Williams
Columbia County Florida

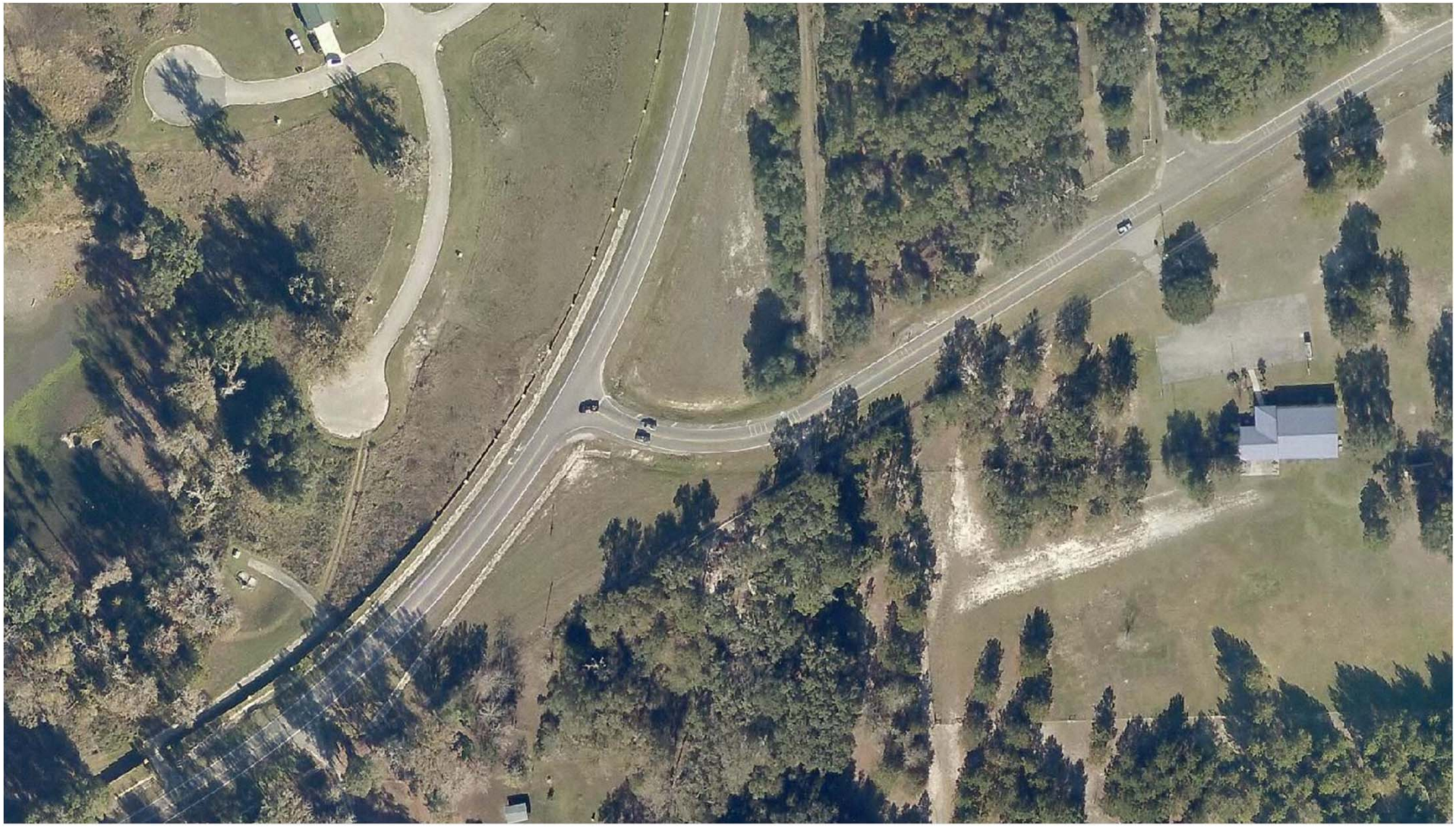
Frank Julian
High Friction Surface Treatment Association

2004

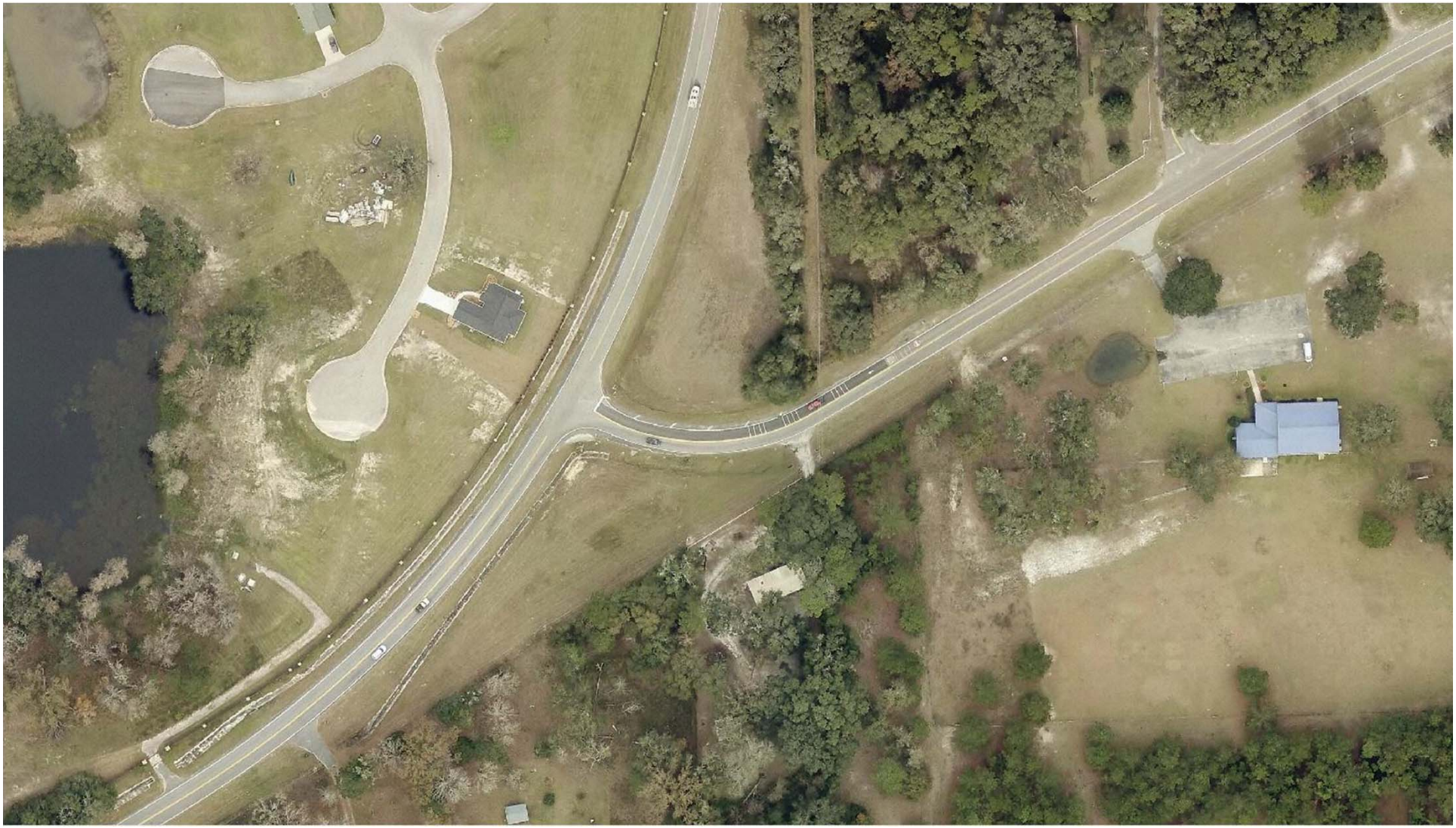
2005



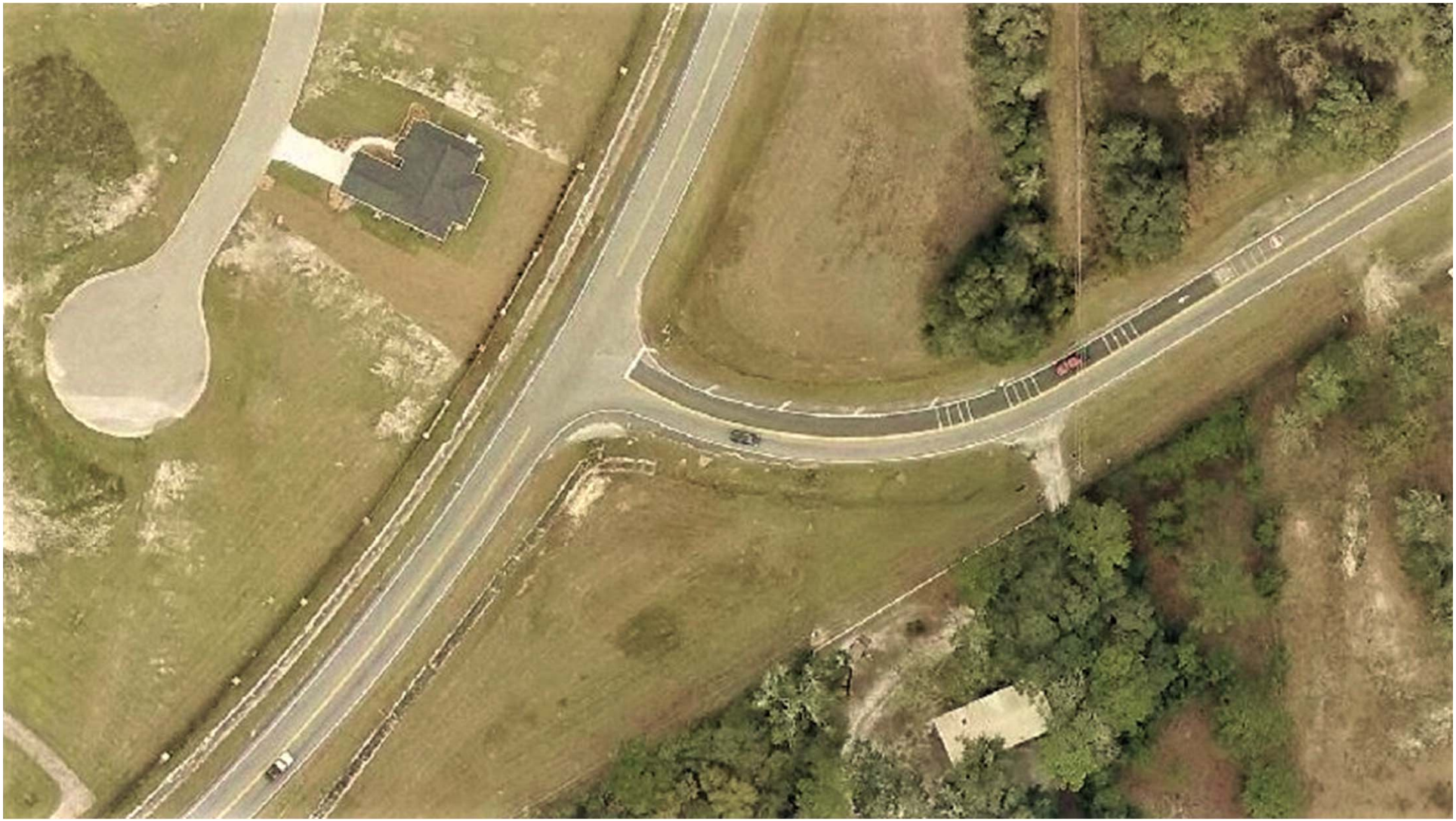
2016



2019



2019



Crashes

Between 2013 and 2017 this intersection had 20 reported crashes with:

4 injury crashes
16 PDO crashes

Crashes

Crash Type	Date	Light	Direction	Severity	Surf Cond
Head On	9/3/2014	Daylight	EW	Injury	Dry
Head On	9/16/2016	Daylight	NS	Injury	Wet
Rollover	8/31/2013	Dark - Not Lighted	W	PDO	Wet
Rollover	11/5/2014	Dark - Not Lighted	E	PDO	Dry
Rollover	5/31/2015	Daylight	E	PDO	Dry
Off Road	12/28/2013	Dark - Not Lighted	W	PDO	Dry
Off Road	12/28/2013	Dark - Not Lighted	W	PDO	Dry
Off Road	1/18/2014	Dark - Not Lighted	W	Injury	Dry
Off Road	12/13/2017	Daylight	W	PDO	Dry
Left Leaving	10/5/2017	Daylight	N	PDO	Dry
Left Rear	3/17/2017	Daylight	E	PDO	Dry
Right Angle	1/23/2015	Daylight	SW	PDO	Wet
Right Angle	1/5/2017	Daylight	SW	PDO	Dry
Right/Left	8/22/2016	Dawn	E	PDO	Dry
Rear End	12/2/2014	Dark - Not Lighted	W	PDO	Dry
Rear End	12/18/2014	Daylight	W	Injury	Dry
Rear End	3/14/2016	Daylight	W	PDO	Dry
Rear End	11/1/2016	Daylight	E	PDO	Dry
Rear End	4/16/2017	Daylight	N	PDO	Dry
Animal	11/5/2016	Dark - Not Lighted	N	PDO	Dry

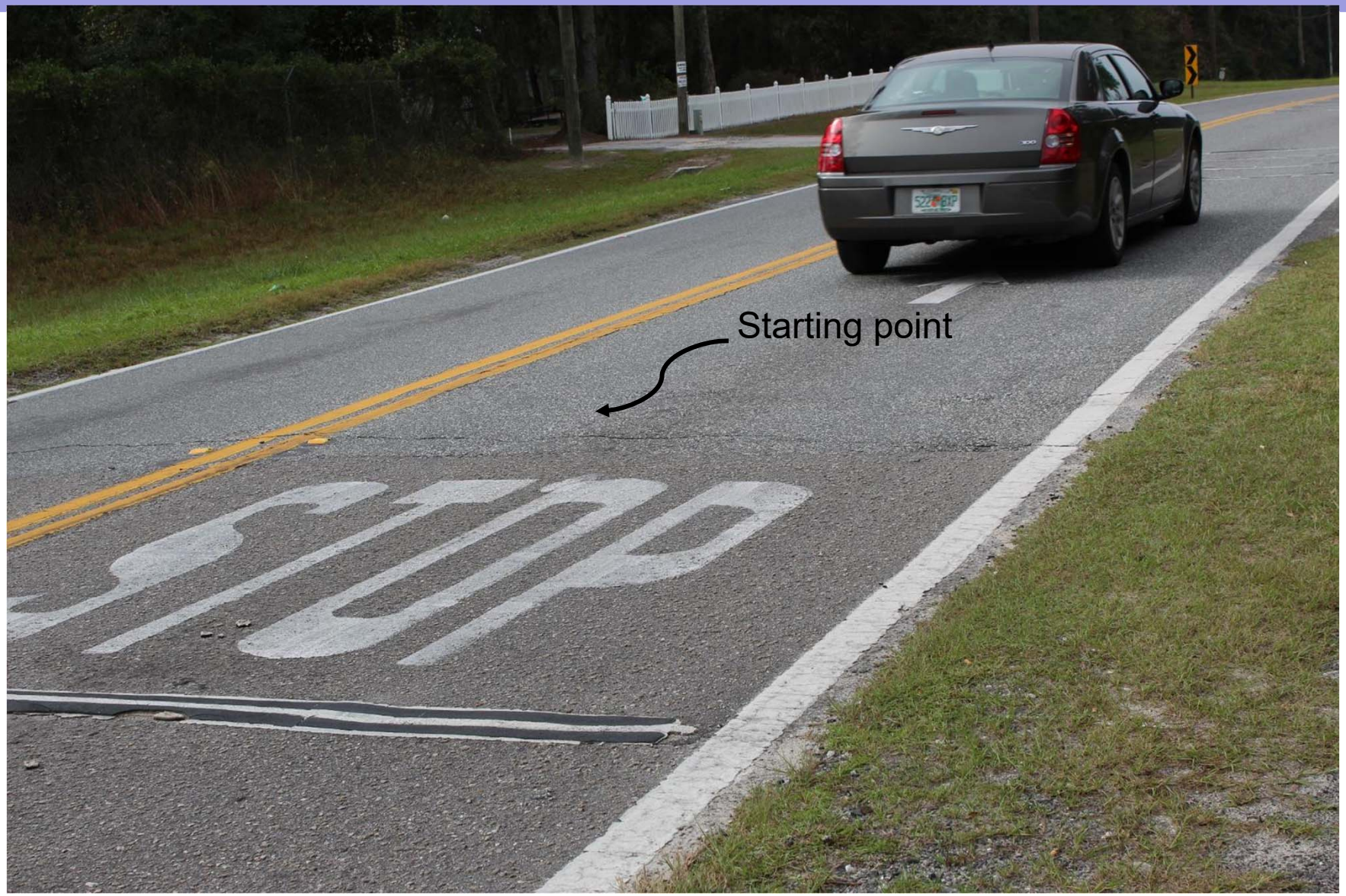
Approach to the Curve
See any road clues of what is over the crest?

Missing Chevron and scaring on side slope

“T” Intersection where multiple crashes impacted the wall

“T” Intersection where multiple crashes impacted the wall

Where to Start HFST Application



Installation December 13, 2018

Installed December 13, 2018

Picture taken April 30, 2019

Installed December 13, 2018

Picture taken April 30, 2019

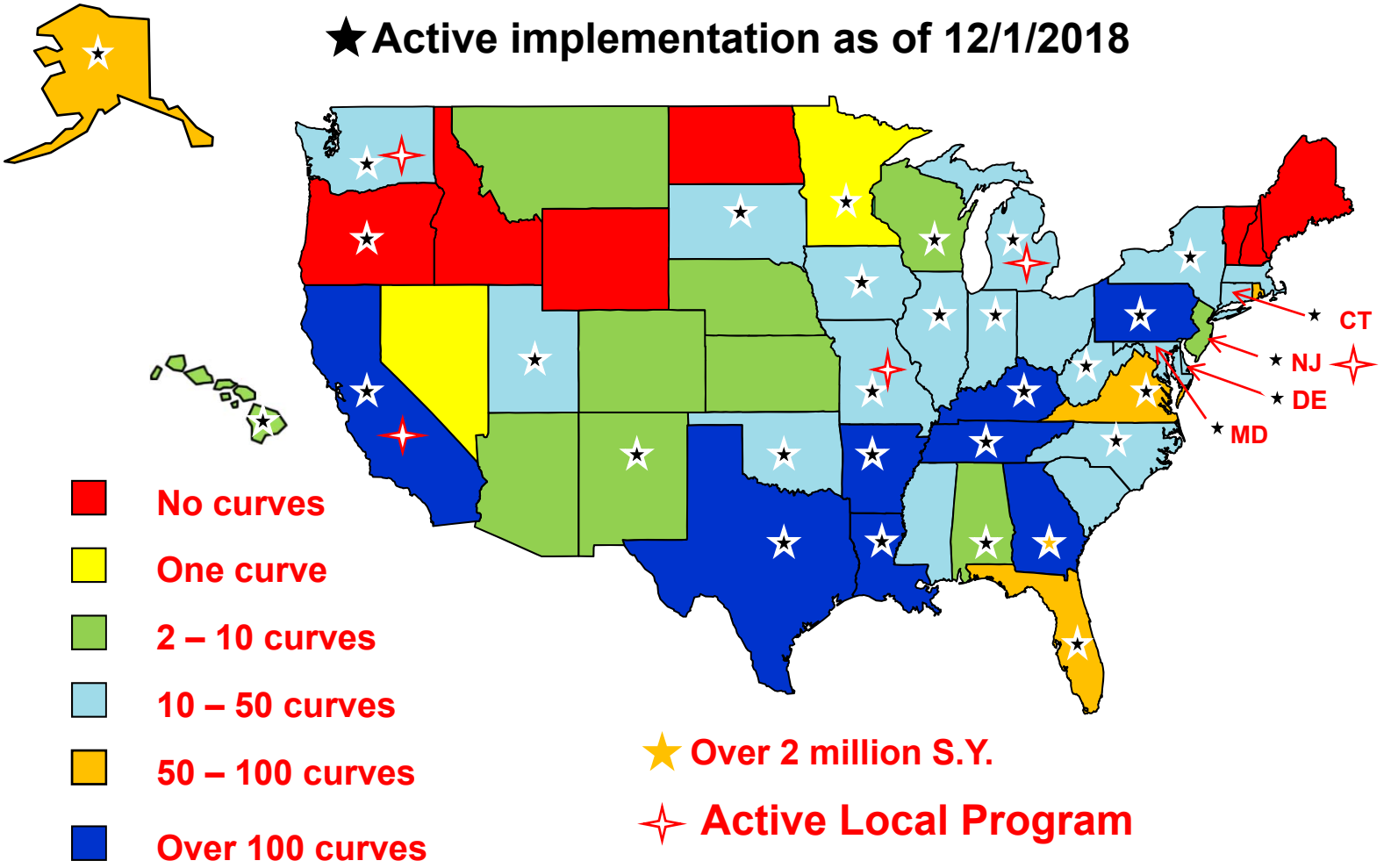

STOP
STOP
DBi

Installed December 13, 2018

So, Why HFST for this Location?

- Safety!
- Is the answer physics or driver error?
- The approach alignment provides the impression the alignment will continue straight.
- Other than signs, this location lacks alignment visual clues until topping the crest.
- The short radius results in emergency braking in the curve into the apex which easily allows a lane violation
- Does not have superelevation so the curve relies totally on friction to keep vehicles in their lane.
- Braking in a curve results in a “Circle of Friction” which accelerates pavement polishing and the need for more friction to satisfy braking friction and side friction.
- At this location the pavement is polished and is missing macrotexture in critical spots

State DOT HFST Status



Why Use HFST?

- What defines HFST and makes it unique
- How much of safety improvements do we see after HFST installations
- Where is HFST necessary
  - ➢ tire forces in curves and braking that require higher friction capability
- What is the functional life

So, What Makes HFST Unique?

1. A surface treatment that has extremely high friction values that results in significant crash reductions.
2. Friction will last a longer period of time than conventional pavements
3. Uses a Polymer (epoxy) binder to address shear and tensile forces developed in curves and braking actions

What defines HFST?

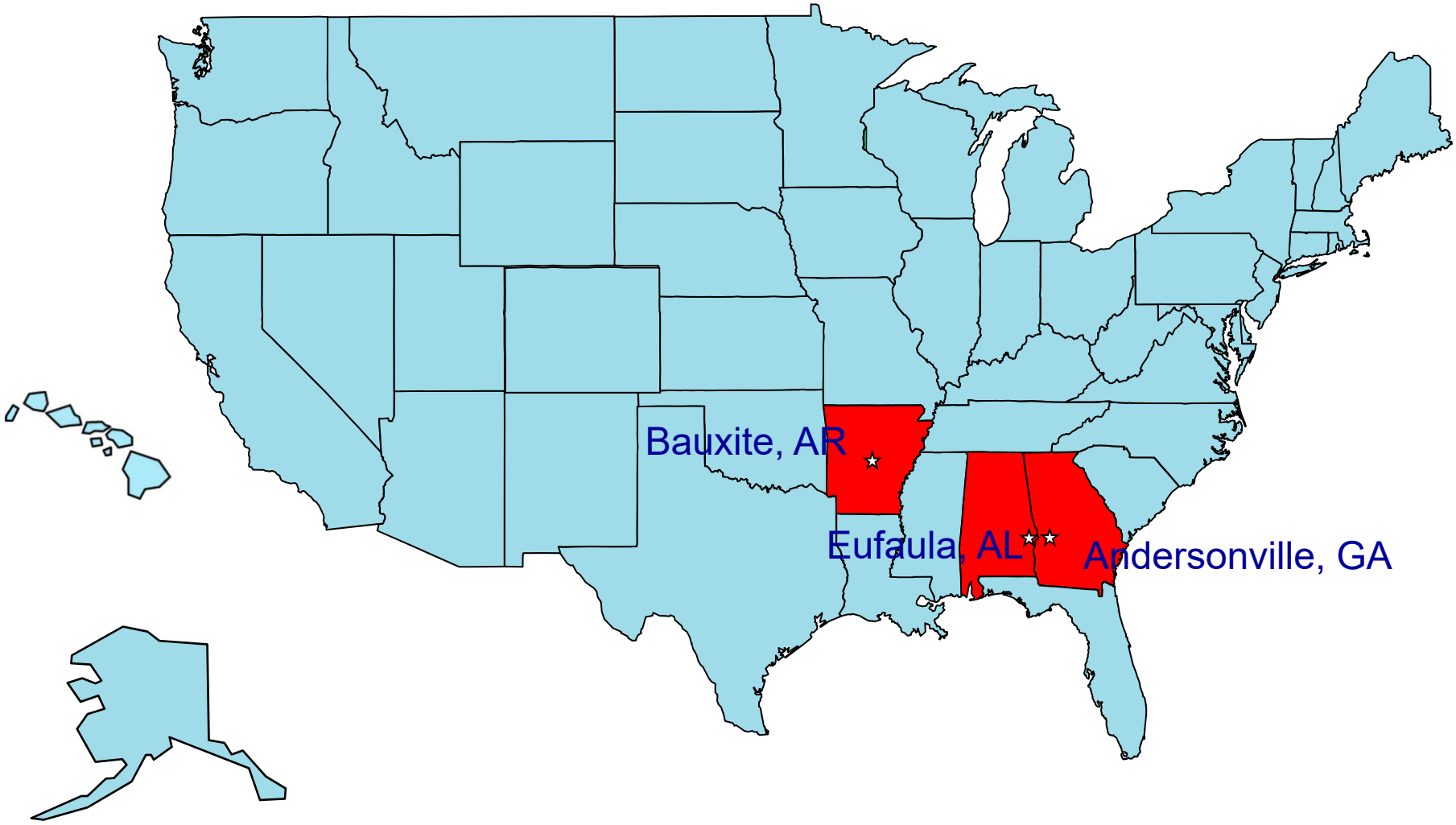
3 mm aggregate pavement surfacing overlay systems used for spot **Safety Treatments**

The aggregate that defines HFST is Calcined Bauxite which provides the highest resistance to polishing and friction durability.

What defines HFST?

- Calcined Bauxite purpose is to provide frictional properties for the HFST.
- Good combination of macrotexture and microtexture.
- Wears well under repeated wheel passes.
- Calcined Bauxite is refractory grade (87% aluminum oxide) which is heated up to between 1600 -1800 degrees Celsius in a rotary kiln.

Bauxite Mining in the USA



What defines HFST?

AASHTO PP 79-14 "Standard Practice for High Friction Surface Treatment for Asphalt and Concrete Pavements" requires **Calcined Bauxite.**

In-place friction characteristics must meet a minimum requirement of 65 FN40R when tested in accordance to AASHTO T242 upon completion of the installation.

Some State requirements exceed 65

Why use HFST?

- The 3 run average, SN40 wet value on the concrete pavement was 52
- The 3 run average, SN40 wet value on the HFST was 85
- Regardless of the speed, the stopping difference was **25% - 30%.**

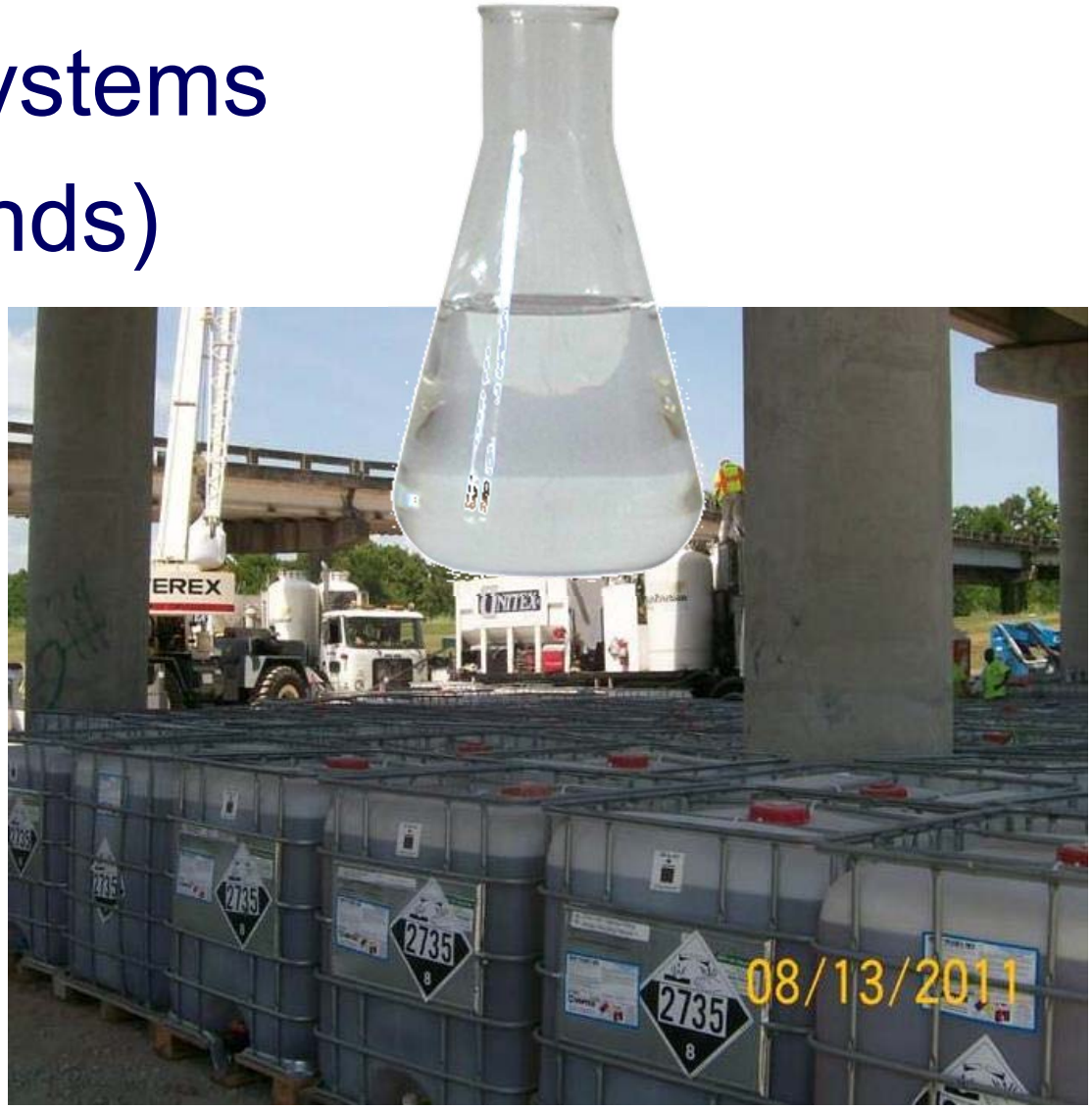
Texas Transportation Institute Friction Test Results

What defines HFST?

Resin Binder Systems

(proprietary blends)

- Epoxy
- Polyester
- Acrylic



What defines HFST?

HFST is not a pavement treatment that happens to have safety benefits!

HFST is a great safety treatment that happens to be a pavement!

To be applicable,

- **HFST must still provide the function of a pavement for durability,**
- **And reduce crashes for a significant period of time to distinguish its' unique value.**

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Where Can HFST Benefit Safety?

1. **Horizontal curves**
2. **Approach to intersections**
3. **Grades**

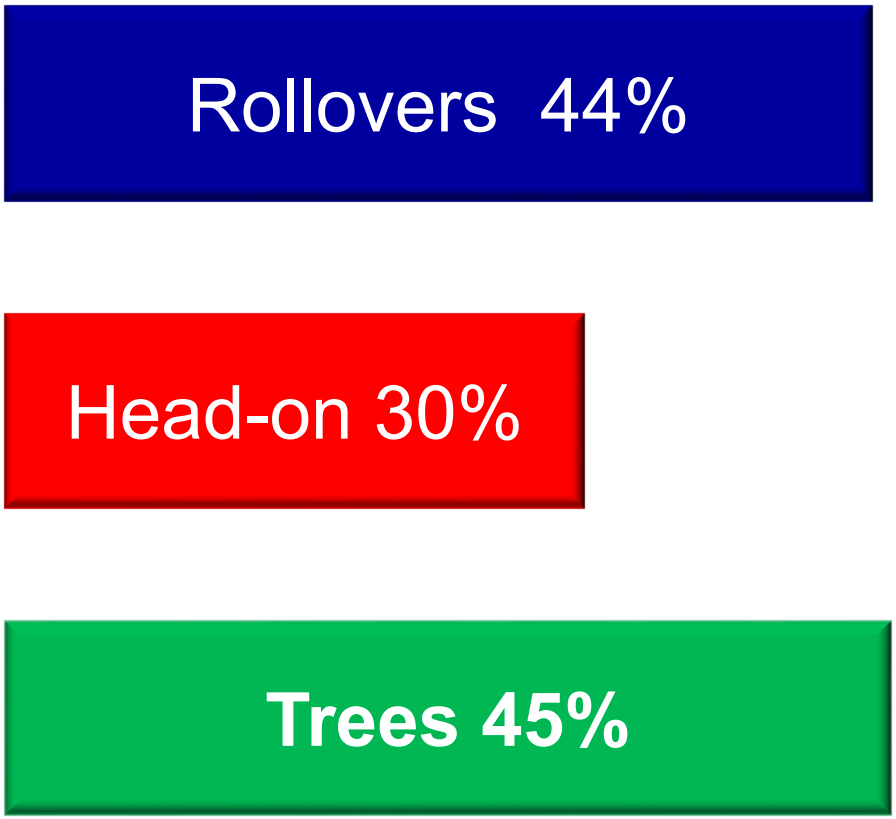
When the pavement has:

- Marginal friction effected by weather
- Low friction
- Friction values not compatible with approach speeds and geometrics (friction demand)

Crash Type Fatalities % in Curves

Average Annual Roadway Departure Fatalities

Most Harmful Event (FARS 2013-2015)



Bellevue Washington

Between 1997 to 2002,
22 crashes including four rollovers,
wet conditions and excess speed were factors

Bellevue Washington

HFST was installed October 2004
Two crashes occurred between
October 2004 and June 2008

Pennsylvania Success Story

Pennsylvania Project Summary Installed 10/27/12

Traffic

SR 2017 - 9,000 AADT
SR 2024 - 4,600 AADT

Crashes

3 yrs. prior to install - 26
3 yrs. after installation - 1

Skid Number

Before Install - 22
After Install - 75

Slide Courtesy of Pennsylvania DOT

Penn DOT News Release
"Like a Miracle"

Currently PennDOT has installed 300 HFST installations on 2 lane roads.

A study of 47 locations with 3 to 5 years of post installation crash history showed:

- 91% reduction in wet weather crashes
- 76% reduction in RwD crashes
- 63% reduction of injury crashes
- 100% reduction in fatalities (8 to 0)

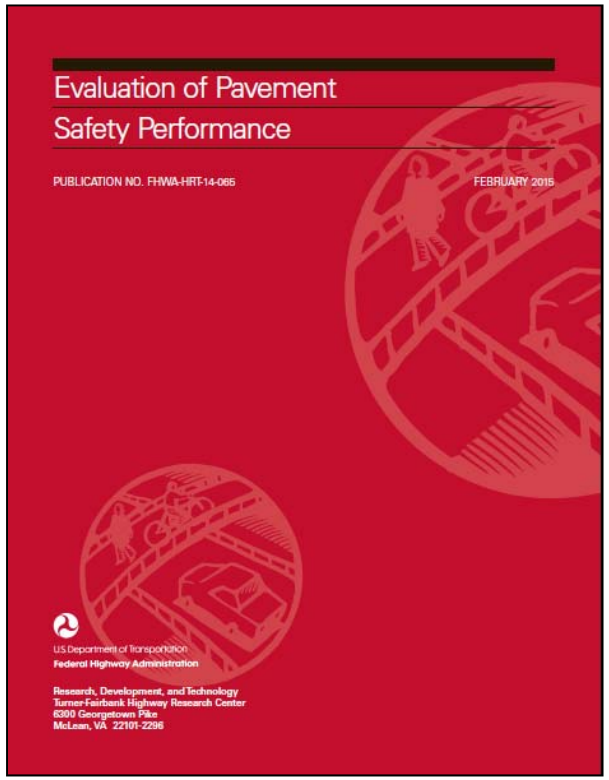
HFST Safety Effectiveness Study

Total Crashes

- Ramps CMF = 0.48
- Curves CMF = 0.63

Wet Road Crashes

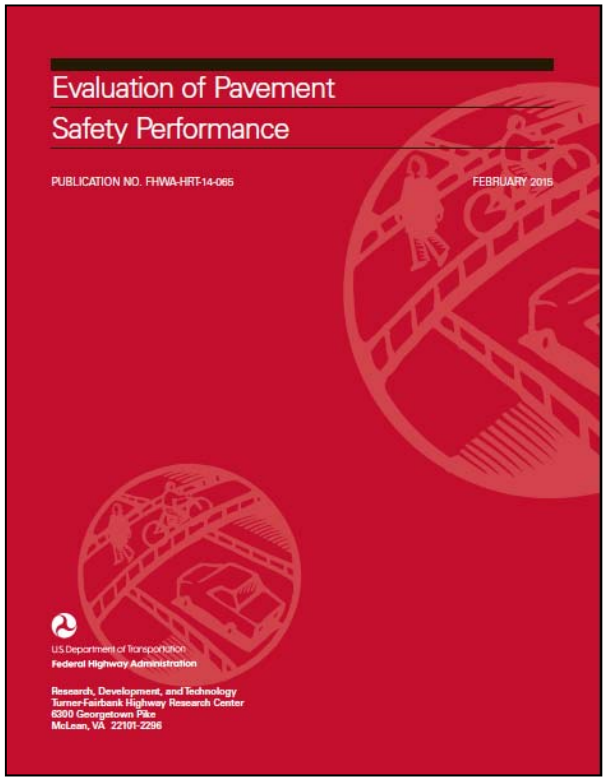
- Ramps CMF = 0.21
- Curves CMF = 0.37



Details: 8 State Naïve Study

http://www.fhwa.dot.gov/publications/research/safety/14065/14065.pdf

HFST Safety Effectiveness Study



Total Crashes

- Ramps CMF = 0.65
- Curves CMF = 0.76

Wet Road Crashes

- Ramps CMF = 0.14
- Curves CMF = 0.48

Details: Study with comparison sites

http://www.fhwa.dot.gov/publications/research/safety/14065/14065.pdf

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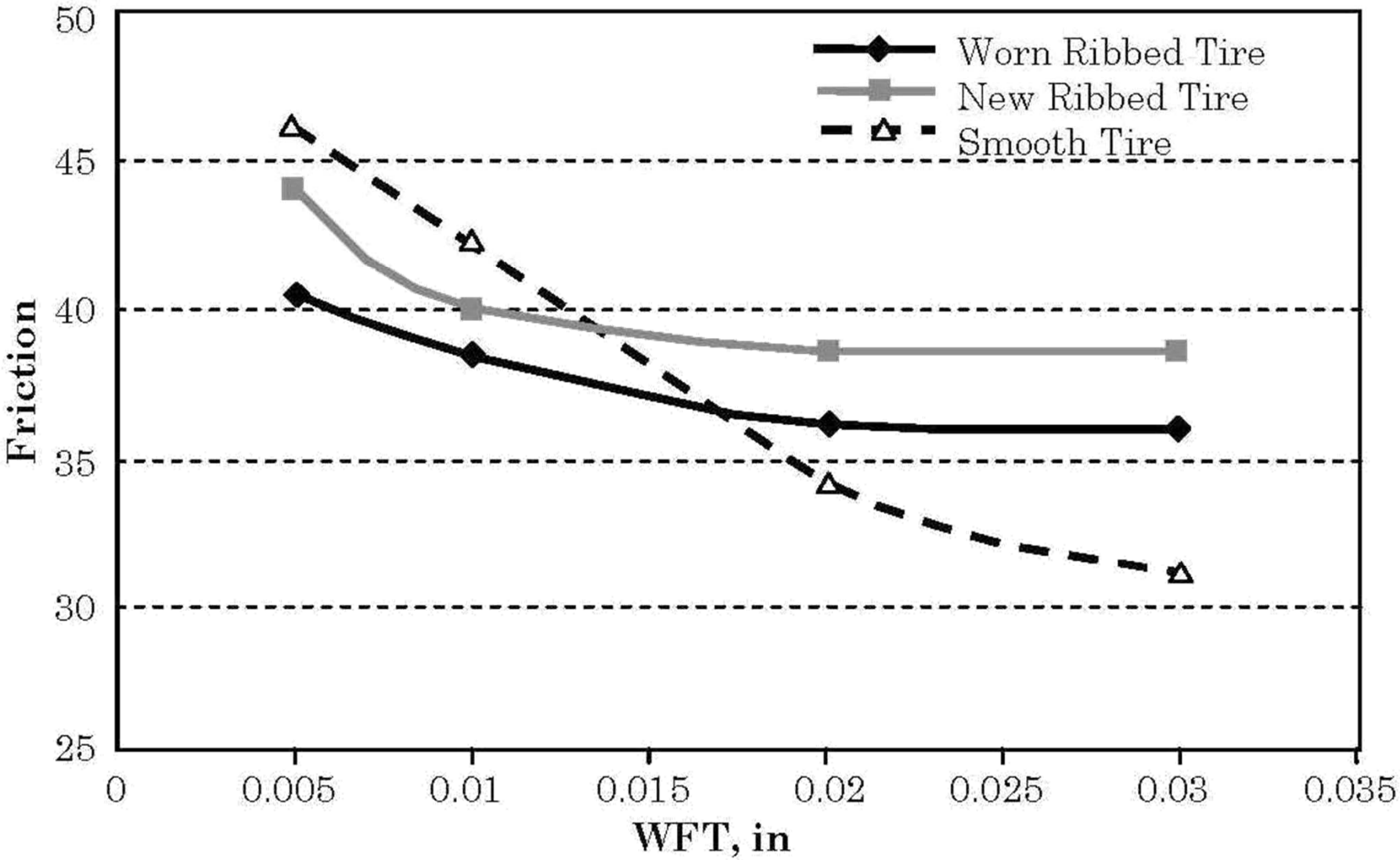
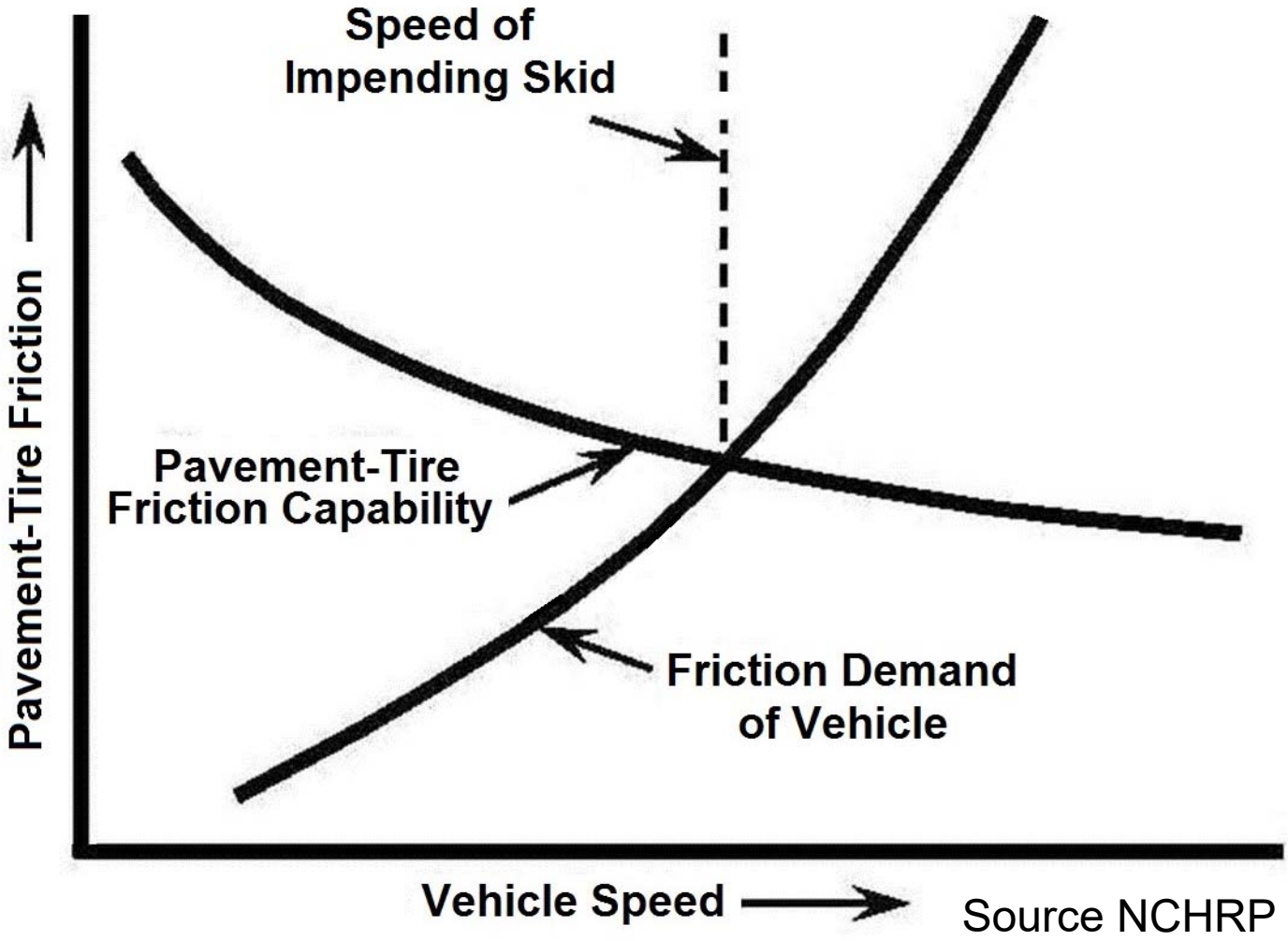
Water Film Thickness Effects

Source NCHRP 108



Conceptual Relationship
(Friction Demand, Speed and Friction Availability)



Source NCHRP 108

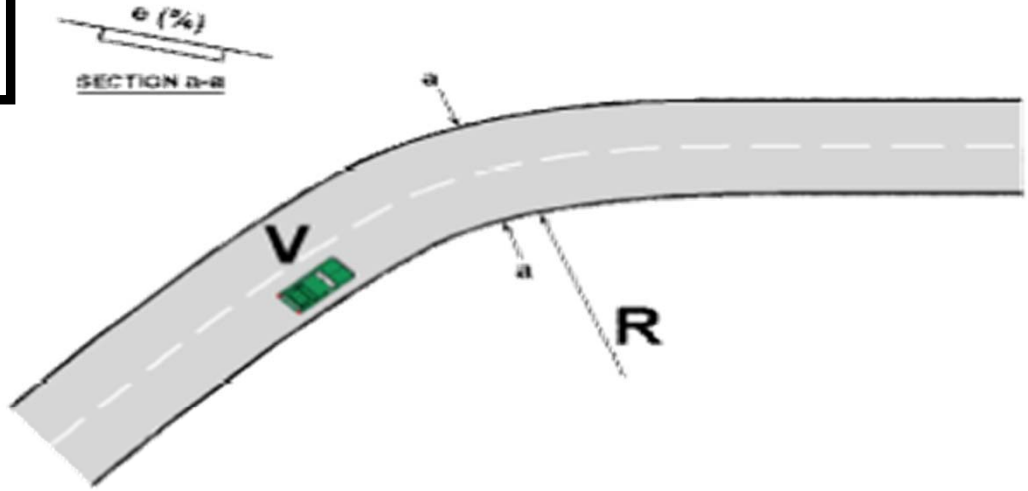
Basis for AASHTO Curve Design Model is Driver Comfort

Although the curve design policy stems from the laws of mechanics, the values used in design depend on practical limits and factors determined empirically over the range of variables involved.

AASHTO Horizontal Curve Design Model

$$R = V^2/15(e + f)$$

$$e + f = V^2/15\,R$$



e = superelevation

f = side friction factor

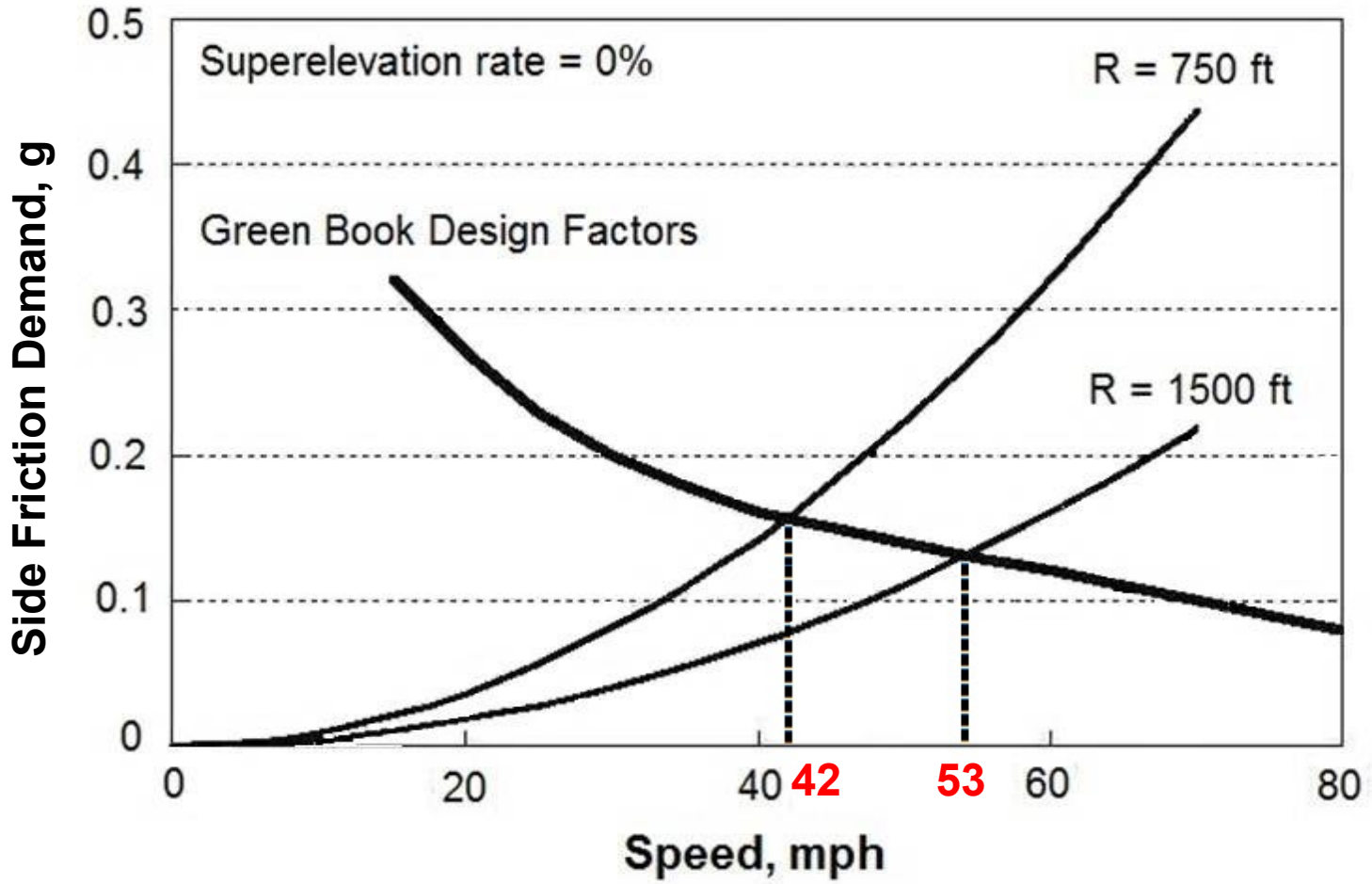
V = design speed (mph)

R = radius of curve (ft)

US Customary	Metric
$R = \frac{V^2}{15\,(e+f)}$	$R = \frac{V^2}{127\,(e+f)}$
where R = Radius of circular curve (ft) V = Design speed (mph) e = Superelevation f = Side "friction" or comfort	where R = Radius of circular curve (m) V = Design speed (km/h) e = Superelevation f = Side "friction" or comfort

Example of Variable Friction Demand

Relationship between curve speed and side friction demand for two radii

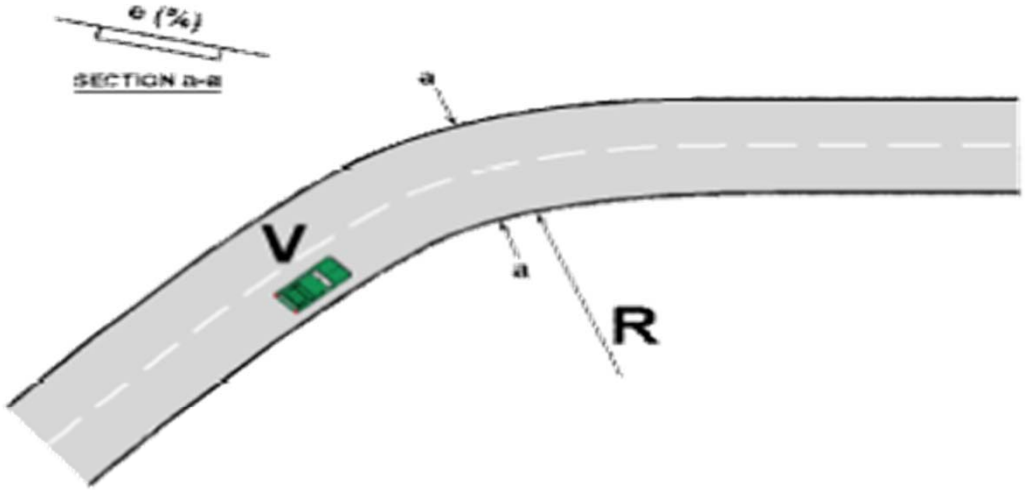


Source TRR 2075

HC Operating Speed Model

$$f = (V^2/15\,R) - e$$

f = friction demand
V= operating speed (mph)



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Texas Curve Margin of Safety

Margin of Safety = Friction Supply – Friction Demand

Curve Locations:

- Point of Curvature (PC)
- Middle of Curve (MC)
- Point of Tangency (PT)

Curve Properties:

- Radius
- Superelevation
- Grade

Slide Courtesy of TxDOT

Contributing Factors for Friction Demand

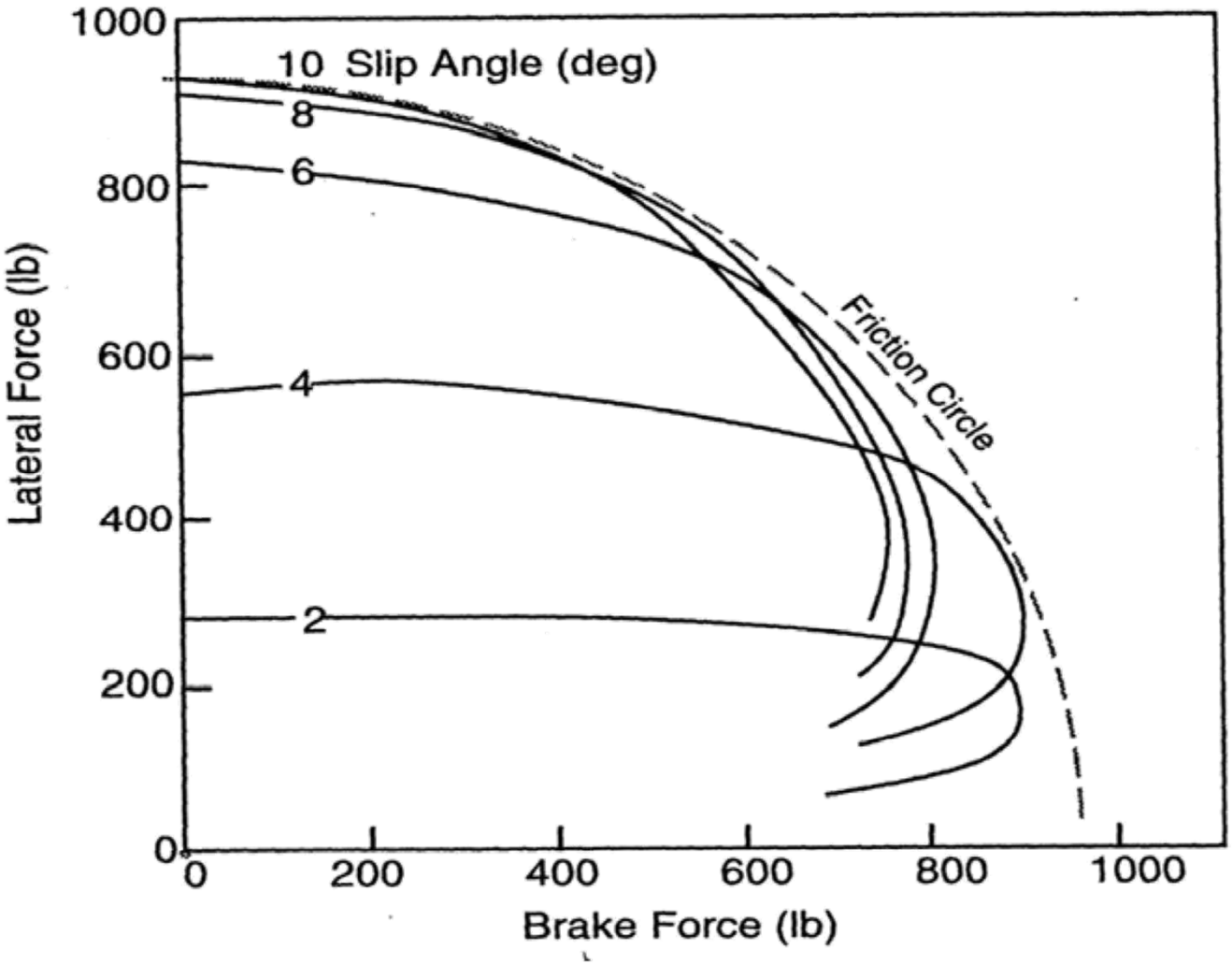
- Road Geometry
  - ➢Vehicle Speeds
- Driver Actions
- Trucks
  - Tires coefficient of friction is about 70% of passenger cars
  - Tires have about 10% higher friction demand

Driver Induced Friction Demand

"Where practical, the maximum side friction factors used in design should be conservative for dry pavements and should provide an ample margin of safety against skidding on pavements that are wet as well as ice or snow covered. The need to provide skid-resistant pavement surfacing for these conditions cannot be overemphasized because superimposed on the frictional demands resulting from roadway geometry are those that result from driving maneuvers such as braking, sudden lane changes, and minor changes in direction within a lane. In these short-term maneuvers, high friction demand can exist but the discomfort threshold may not be perceived in time for the driver to take corrective action."

2011 AASHTO Greenbook

Lateral Verses Longitudinal Forces



Source NCHRP 108

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How Long Does HFST Last?

- The most significant issue is existing pavement condition
- We are expecting 10+ years based on accelerated test track results and current project experience
- But it depends on having a good specification and a good installation

Ft. Lauderdale, Florida
Royal Palms @ I-75 Entrance Ramp

Royal Palms Blvd. @ I-75
(Installed June 2006)

High Friction Surface Treatment Guidelines

Project Selection, Materials, and Construction

FDOT

NCAT Florida Test Sections (Curve)

NCAT Test Track
Auburn University

NCAT Florida Test Sections (Curve)