

High Friction Surface Treatments

-Florida Practices and Safety Performance Analysis



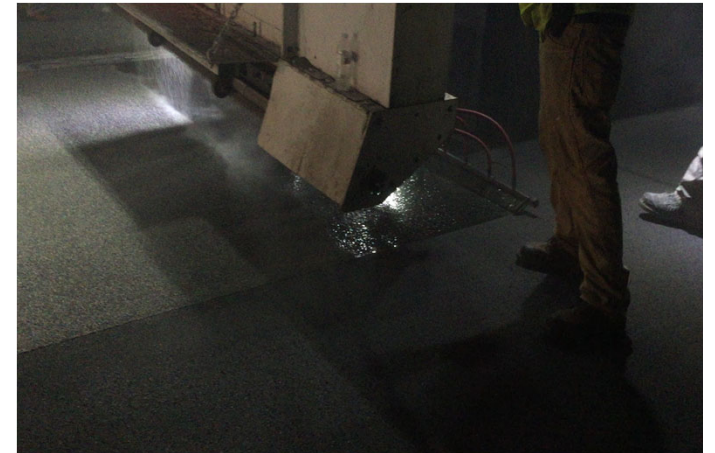
Guangming Wang, Ph.D, P.E.

Agenda

- Background
- Florida Practices
- Safety Performance Analysis
- Challenges
- Summary

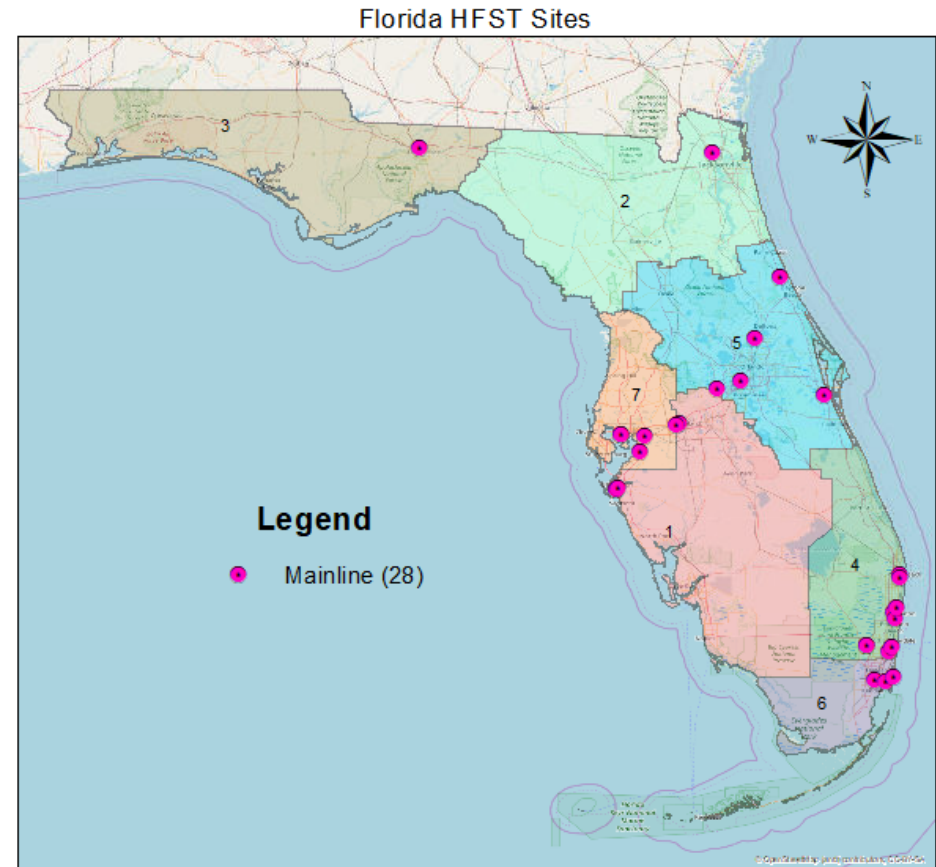
What is a High Friction Surface Treatment (HFST)?

- High-quality, polish-resistant aggregates + polymer resin binder.
- Most HFSTs were applied on curves/ramps where require higher friction demand.
- FHWA EDC innovation
- Estimated service life is 7-10 years



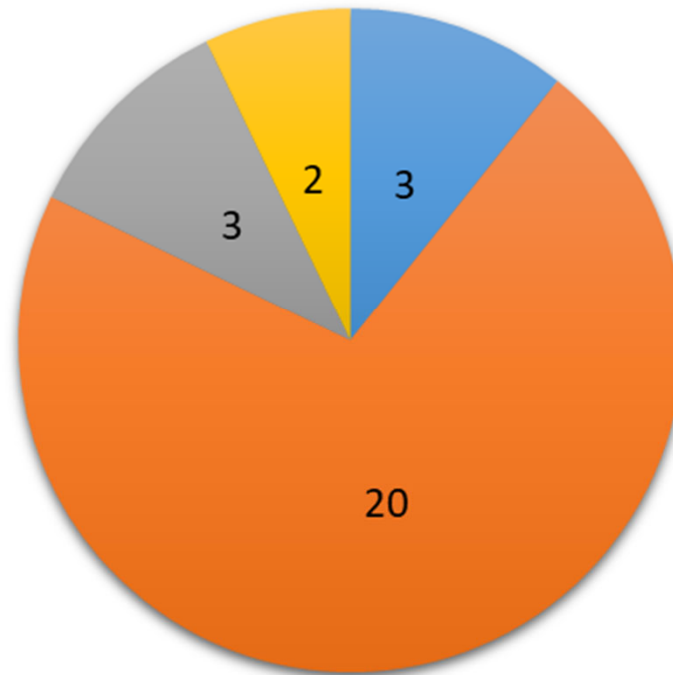
FDOT HFST Project History

- HFST was introduced to Florida in 2006
- 28 Mainline projects (Dev333)



Distribution of Type of HFST Projects

Summary of Florida HFST Mainline Projects
(2006-2019)



■ Curve ■ Ramp ■ Tangent ■ Intersection

Lessons Learned



HFST Guide Documents

High Friction Surface Treatment Guidelines

Project Selection, Materials, and Construction



Dev333

HIGH FRICTION SURFACE TREATMENT. (REV 1-17-17)

The following new Section is added after Section 330:

SECTION 333 HIGH FRICTION SURFACE TREATMENT

333-1 Description.

This work consists of furnishing and applying a high friction surface treatment (HFST) in accordance with this Section and in conformity with the lines and details shown in the Plans.

The Contractor shall be responsible for providing a manufacturer's representative at the construction site in order to train Department, Construction, Engineering & Inspection (CEI), and Contractor personnel prior to surface treatment and shall require the manufacturer's representative to be available during application of the surface treatment as necessary.

333-2 Materials.

333-2.1 **General:** Use a two part polymer resin binder treatment capable of retaining a bauxite aggregate topping under vehicular traffic conditions.

333-2.2 **Polymer Binder:** The polymer resin binder shall consist of a thermosetting modified polymer compound and shall meet the following requirements:

Property	Requirement	Test Method
Viscosity	7 – 30 poises	ASTM D-2556
Gel Time	10 minutes min.	ASTM C-881 (60 gram mass)
Ultimate Tensile Strength	2,000 – 5,000 psi	ASTM D-638 (Type 1 Specimen)
Elongation at break point	30 – 70%	ASTM D-638 (Type 1 Specimen)
Durometer Hardness (shore D)	60 - 80	ASTM D-2240
Compressive Strength	1,000 psi min 3 hours, 5,000 psi min at 7 days	ASTM C-579
Cure Rate (dry time)	3 hours max	ASTM D-1640
Water Absorption	1.0% max	ASTM D-570
Adhesive Strength at 24 hrs	250 psi min or 100% substrate failure	ASTM C-1583

333-2.3 **Aggregate:** The aggregate shall be a calcined bauxite consisting of a 1-3mm gradation. The aggregate shall be clean, dry, and free from foreign matter. The aggregate will be delivered to the construction site in packaging that is clearly labeled; which protects the aggregate from any contaminants on the jobsite and from exposure to rain or other moisture. The aggregate shall meet the following requirements:



HFST Application in Florida

Manual Application – No longer acceptable



Automated Application – Now required for enhanced consistency and longevity

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HFST SharePoint Site

The screenshot displays the SharePoint interface for the HFST site. At the top, there are navigation tabs: BROWSE, ITEMS (selected), and LIST. Below this is a navigation bar with the FDOT Central Office logo and several menu items: Chief Engineer Home, Home, Estimates, Specifications (highlighted), Final Plans, Product Evaluation, Utilities, Local Programs, and Cost Risk Analysis. The main heading is "Developmentals".

On the left side, there are sections for "Quick Links" (Department Contacts, Department Resources, Public Notices, Technology Resources), "Documents" (Shared Documents, Emergency Information), and "Lists".

The main content area shows a list of items with the following columns: ID, Project Number, Spec Name, Letting Date, and Additional Information. A search bar and "SAVE THIS VIEW" button are also present.

✓	ID	Project Number	Spec Name	Letting Date ↓	Additional Information
	549	439123-1-52-01	Dev333 High Friction Surface Treatment	1/27/2021	We request the use of Developmental Spec 333: High Friction Surface Treatment on the NB (documentation for project 436236-1). Being the purpose of project 439123-1 intersection in within the existing limits of the current HFST limits. We also are proposing to maintain the e: are going to maintain), the limits of the pavement with HFTS that is going to be replaced, th

- SharePoint Site:

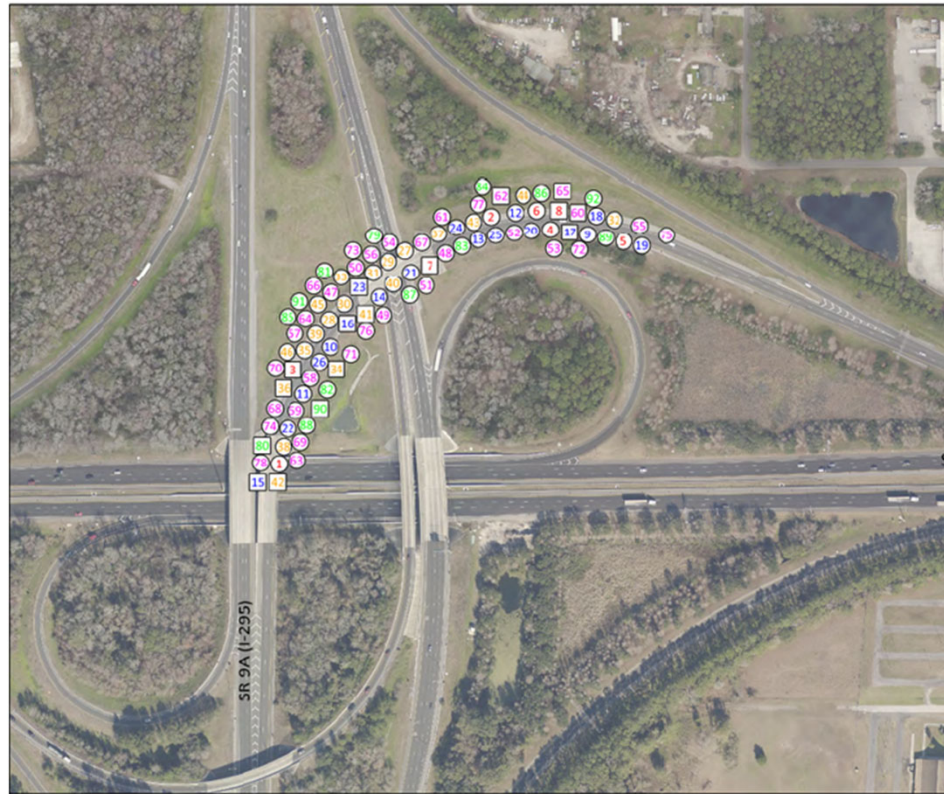
<http://cosp.dot.state.fl.us/sites/stateengineer/ProgMgmt/SpecDevel/Lists/Developmentals/Allitemsg.aspx#InplviewHashe7b4c0d8-2027-4b99-aca7-06a31ed09537=ShowInGrid%3DTrue>

Preliminary Assessment

- Crash Analysis
 - Safety Study Reports with Crash Diagram and Benefit to Cost Ratios
 - Friction Report
 - Cross-Slope/Drainage Path Report
 - Pavement Condition Report

Crash Diagram

- Crash Diagram
 - Last 3/5-year crash events
 - Wet vs dry crashes
 - Roadway departure crashes



Benefit-Cost Analysis

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION SAFETY OFFICE ANNUAL BENEFIT COST ANALYSIS								Yellow cells require information from you. Gray cells are automatically tabulated.				
1. SUBMITTED BY:				WPA NO.:				S.N.:				
2. DATE SUBMITTED:		08/31/16		SKID (I.D.):				SPEED:		mph		
3. FM PROJECT NO.:		428807-1		5. PRIORITY:				S.R.:		9A U.S. RD.:		
4. ALTERNATIVE NO.:				SECTION:		72001300		LGTH:		0.076 NOCE:		
6. COUNTY:		Duval		END M.P.:		0.240						
7. BEGINNING MILE POST:		0.164										
8. DESCRIPTION OF LOCATION/FACILITY TYPE:		The ramp from SR 104 (Dunn Ave.) to Southbound I-295 is a single lane loop ramp. The ramp is 15 feet wide and is superelevated.										
9. CAUSE OF CRASH PROBLEMS (LIST AND DISCUSS):		Single vehicles are losing control at the gore of the onramp to I-295.										
10. PROPOSED IMPROVEMENTS (LIST AND DISCUSS):		Proposed improvement is to add 400 feet of High Friction Surface Treatment (HFST) to the ramp at the gore area. This should help vehicles maintain control and prevent crashes with the guardrail and crashes with vehicles in the southbound through lanes of I-295.										
COMMENTS/CRASH REDUCTION METHOD:		CMF obtained from CMF Clearinghouse. CMF = 0.653 (CRF = 34.7%) CMF ID: 7808										
HIGH CRASH LISTINGS:												
11. CRASH TYPES		NO. OF CRASHES					CRF %	TOTAL TO BE PREVENTED	14. CRASH INFORMATION FOR FACILITY			
A. FATAL AND SERIOUS INJURY		2010	2011	2012	2013	2014		A. COST PER CRASH:	\$ 153,003			
		-	3	1	3	2	35%	3.12	B. CRASH CLEANUP:			
								0.00	\$ 100 per year			
								0.00	C. INTEREST (DISCOUNT) RATE:			
								0.00	4.0%			
								0.00	15. ANNUAL COST OF IMPROVEMENTS			
SUBTOTAL: CORRECTED SEVERE INJURY CRASHES:								3.12	TYPE COST LIFE (YR) CRF COST/YR			
B. MINOR INJURY CRASH TYPES		NO. OF CRASHES					CRF	PREVENTED	A. R.O.W.:			
								0.00	B. P.E.C.E.I.:			
								0.00	\$ 3,266 7 0.1660008 \$ 544			
								0.00	C. STRUCTURE:			
								0.00	\$ 40,828 7 0.167 \$ 6,902			
								0.00	D. ROADWAY:			
								0.00	E. PAVEMENT:			
								0.00	F. SIGNAL:			
								0.00	G. LIGHTING:			
								0.00	H. SUBTOTAL:			
								0.00	\$ 44,094 7 \$ 7,347			
								0.00	I. CHANGE IN MAINTENANCE:			
								0.00	\$ -			
								0.00	J. CRASH CLEANUP:			
								0.00	\$ 104			
								0.00	K. TOTAL ANNUAL COST:			
								0.00	\$ 7,454			
								0.00	16. BENEFIT/COST:			
								0.00	12.91			
D. TOTAL CRASHES (ALL TYPES)		-	3.00	1.00	3.00	2.00			17. NET PRESENT VALUE			
12. TOTAL TO BE PREVENTED		-	1.04	0.35	1.04	0.69		3.12	A. CURRENT YEAR			
									B. PROJECT COMPLETION			

Friction Report



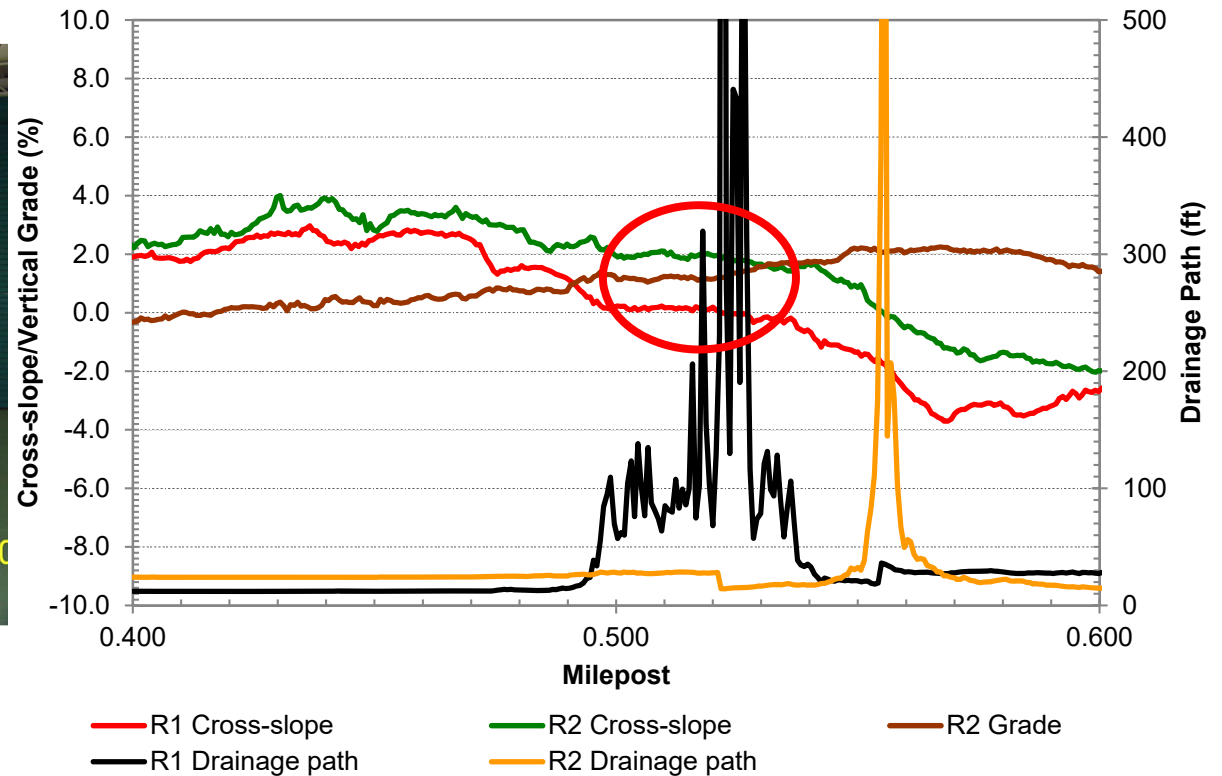
Locked Wheel Tester



Cross Slope/Drainage Path



MPSV

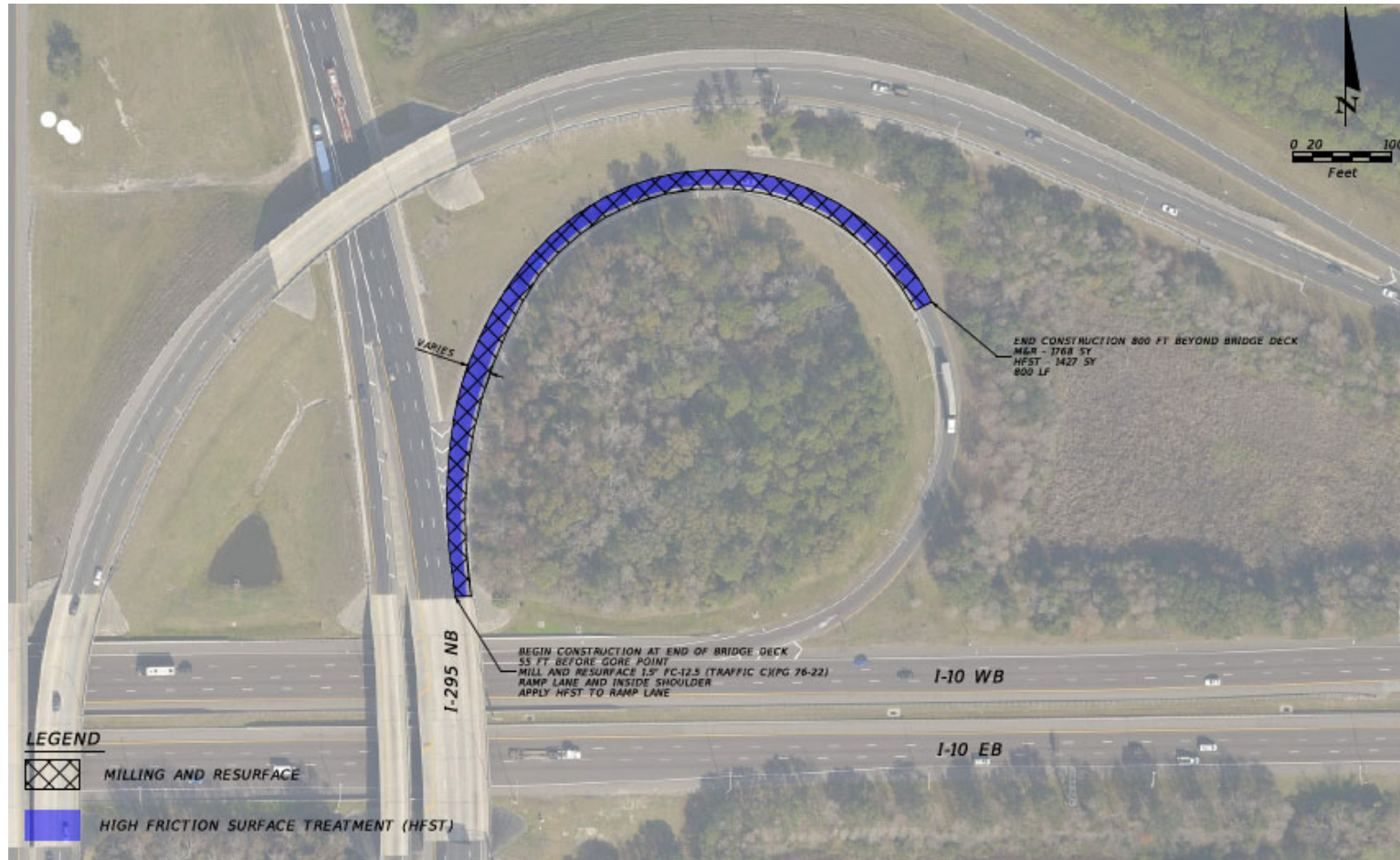


Pavement Condition Report

- Pavement Condition Evaluation
 - DGAC or Concrete
 - Overall Rating of “Good” and Higher
 - Rutting ≤ 0.25 ”
 - No structural damage
 - $\leq 6\%$ cracks



Proposed Application Limits



Statewide HFST Tracking System

High Friction Surface Treatment



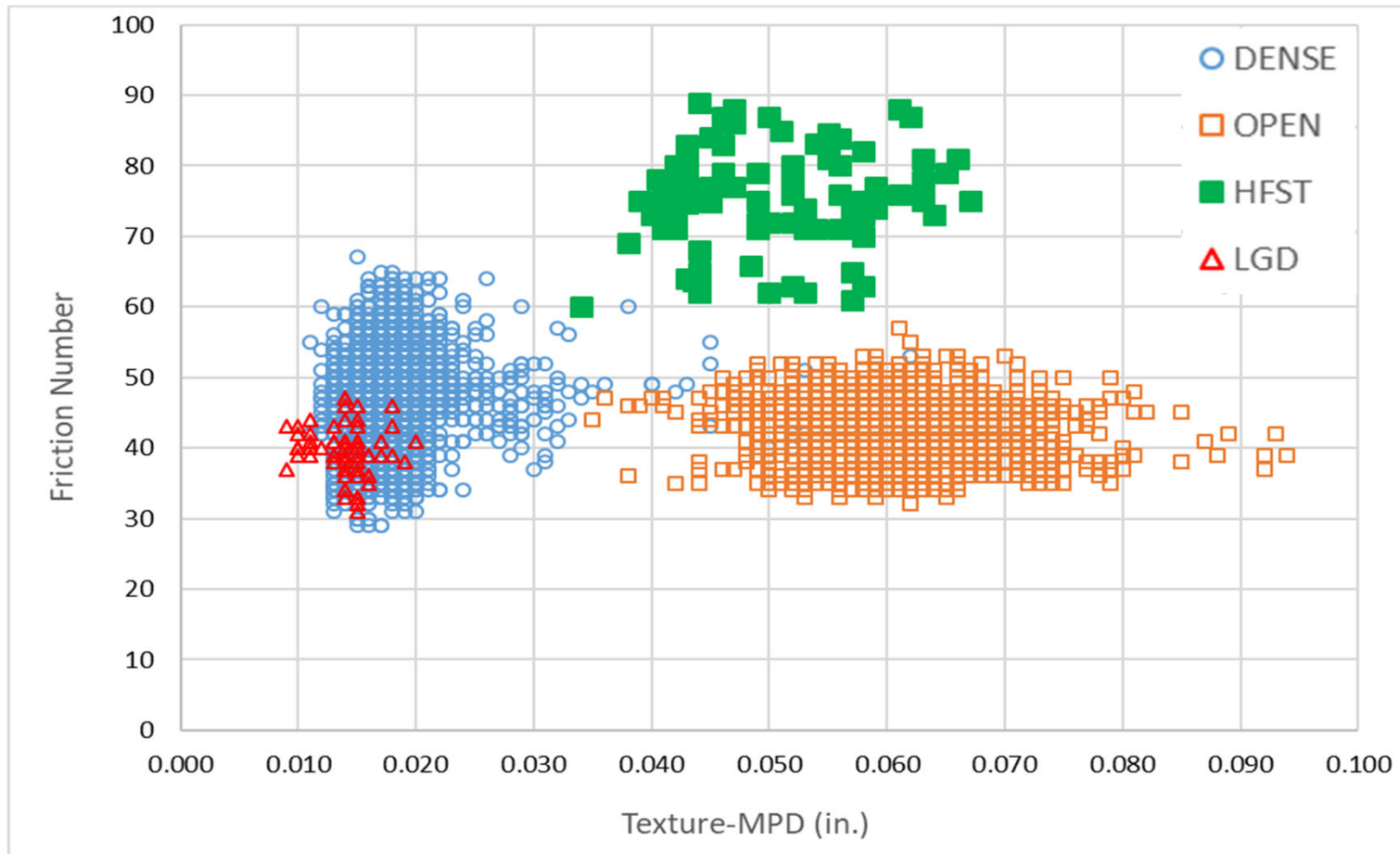
All Items



Map

U	District	Financial Project	RoadwayID	County	State Road Number	US Number	Section Description	Latitude	Longitude	Contract Number	Begin Station
U	1	42952615201	13010000	Manatee	SR 4	US 41	SR 45(US 41 - 14th St West) at SR 684 Cortez Rd - Intersection	27.46160	-82.57525	T1531	147406
U	1	42327715201	16180301	Polk	SR 25	US 192	Ramp: WB Ramp from US 192 W to SB SR 25 (US 27) Ramp	28.34638	-81.67526	T1384	40870
U	4	43400315201	86070090	Broward	SR 9	I-95	I-95 NB Off Ramp to WB SR 810 (Hillsboro Blvd)	26.31946	-80.11572	E4P68	
U	4	No FIN	86075037	Broward	SR 93	I-75	EB Royal Palm On Ramp to NB I-75	26.08583	-80.36196		
U	4	42194715201	86075038	Broward	SR 93	I-75	SR 93/I-75 NB Off Ramp to Royal Palm Blvd	26.08743	-80.36074	T4171	
U	4	42194615201	86230000	Broward	SR 822	I-95	SR 822 (Sheridan	26.03341	-80.16709	T4171	

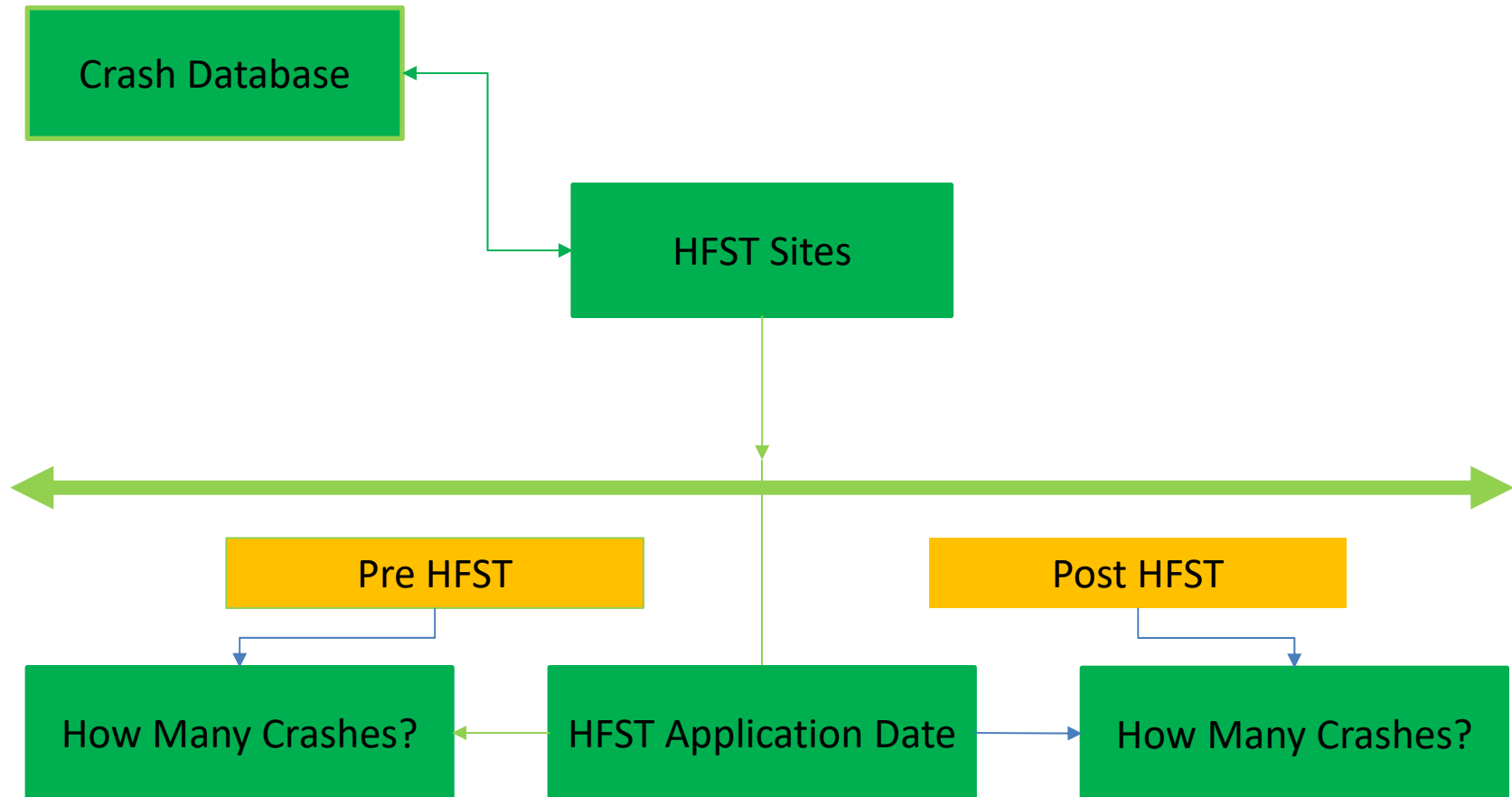
Friction and Texture Performance



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Methodology



Access Crash Performance Analysis Tool

Refresh HFST/Crash Table

Refresh Project Status

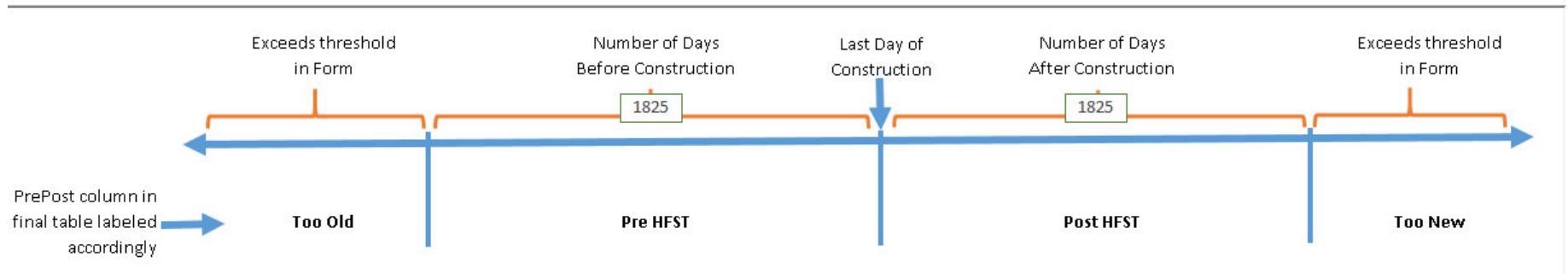
Refresh Final List

Refresh Final List for Wet
Surface Condition

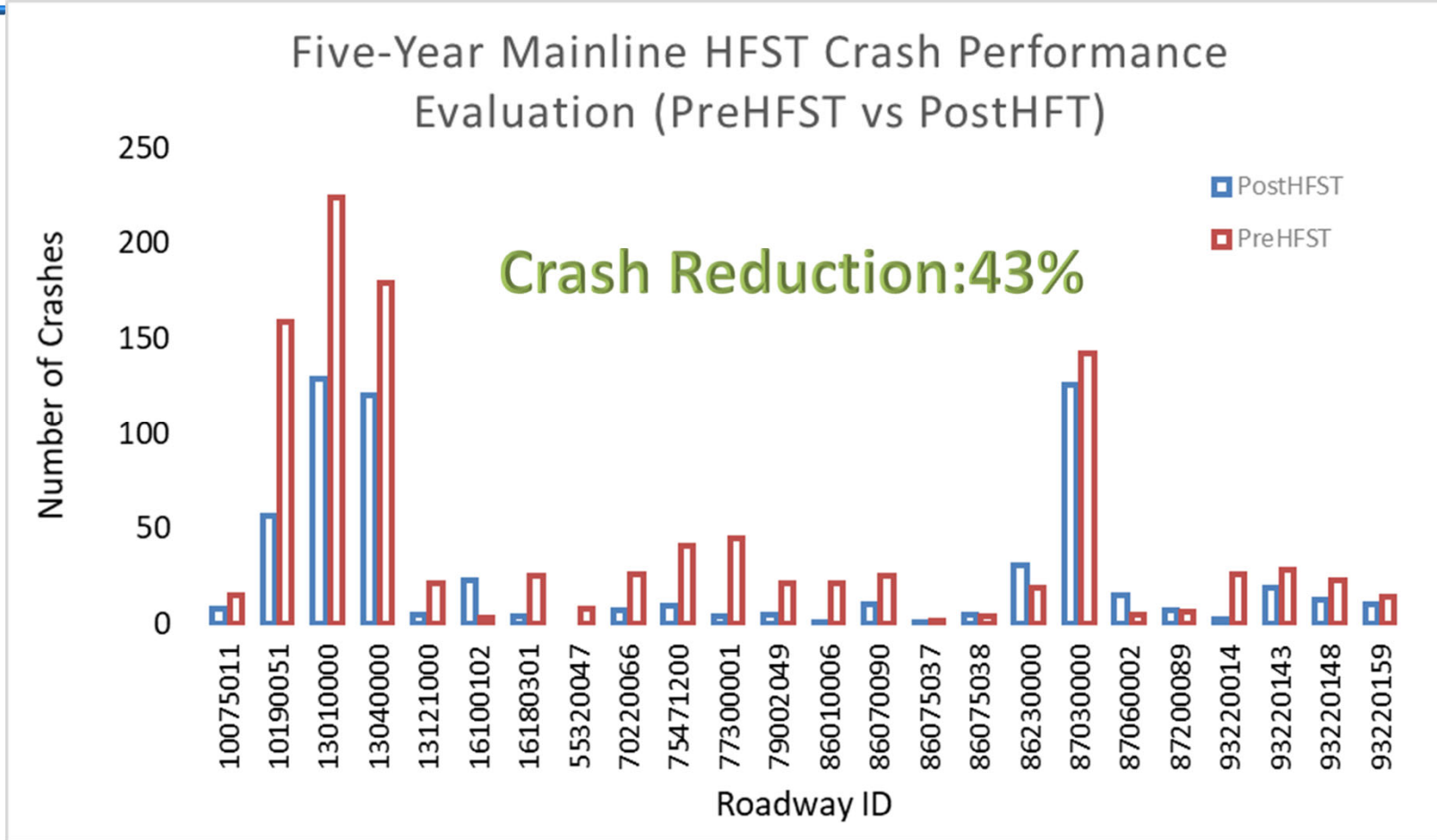
OCrashDate

NCrashDate

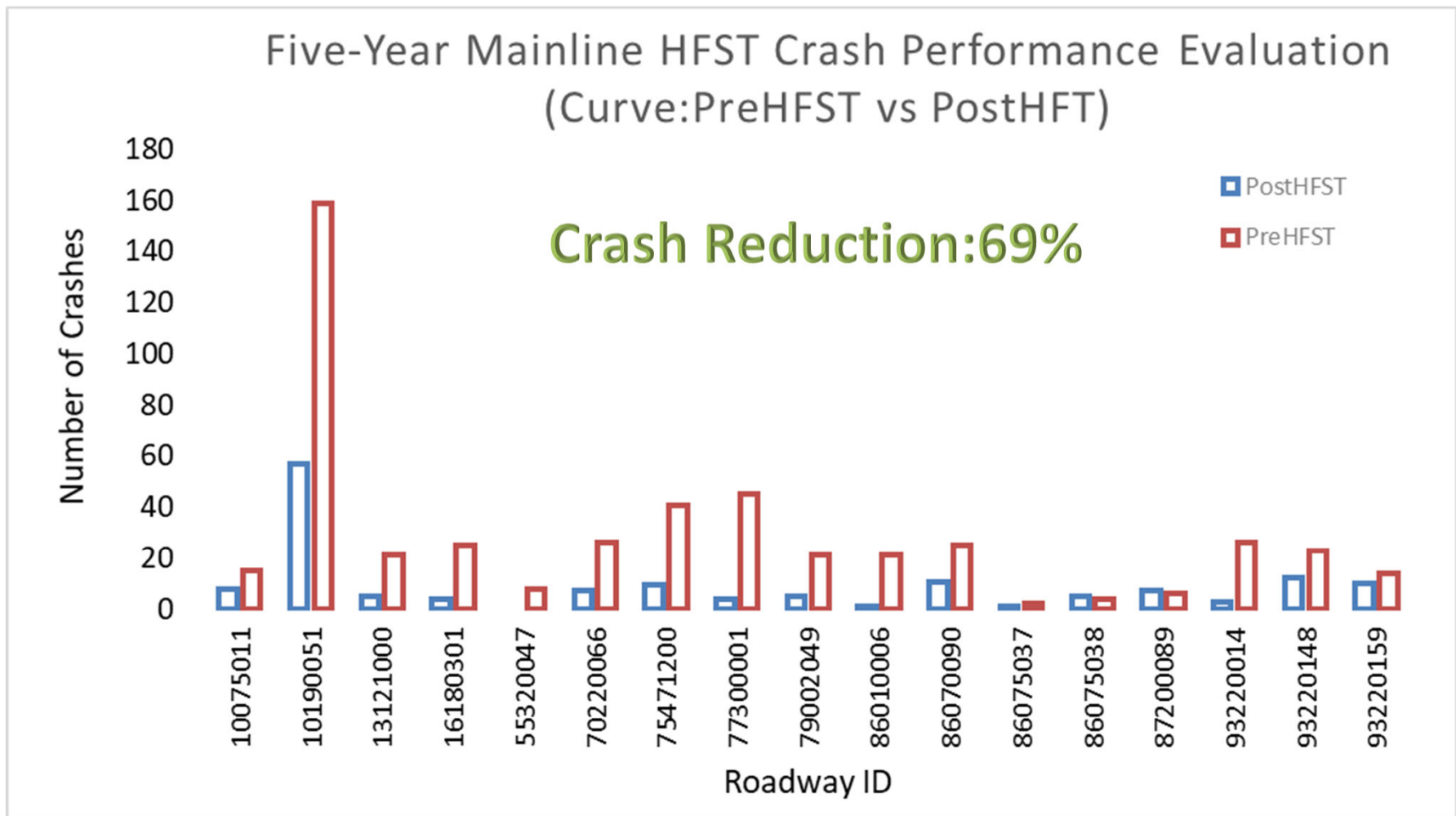
Last Date of Available Crash Data



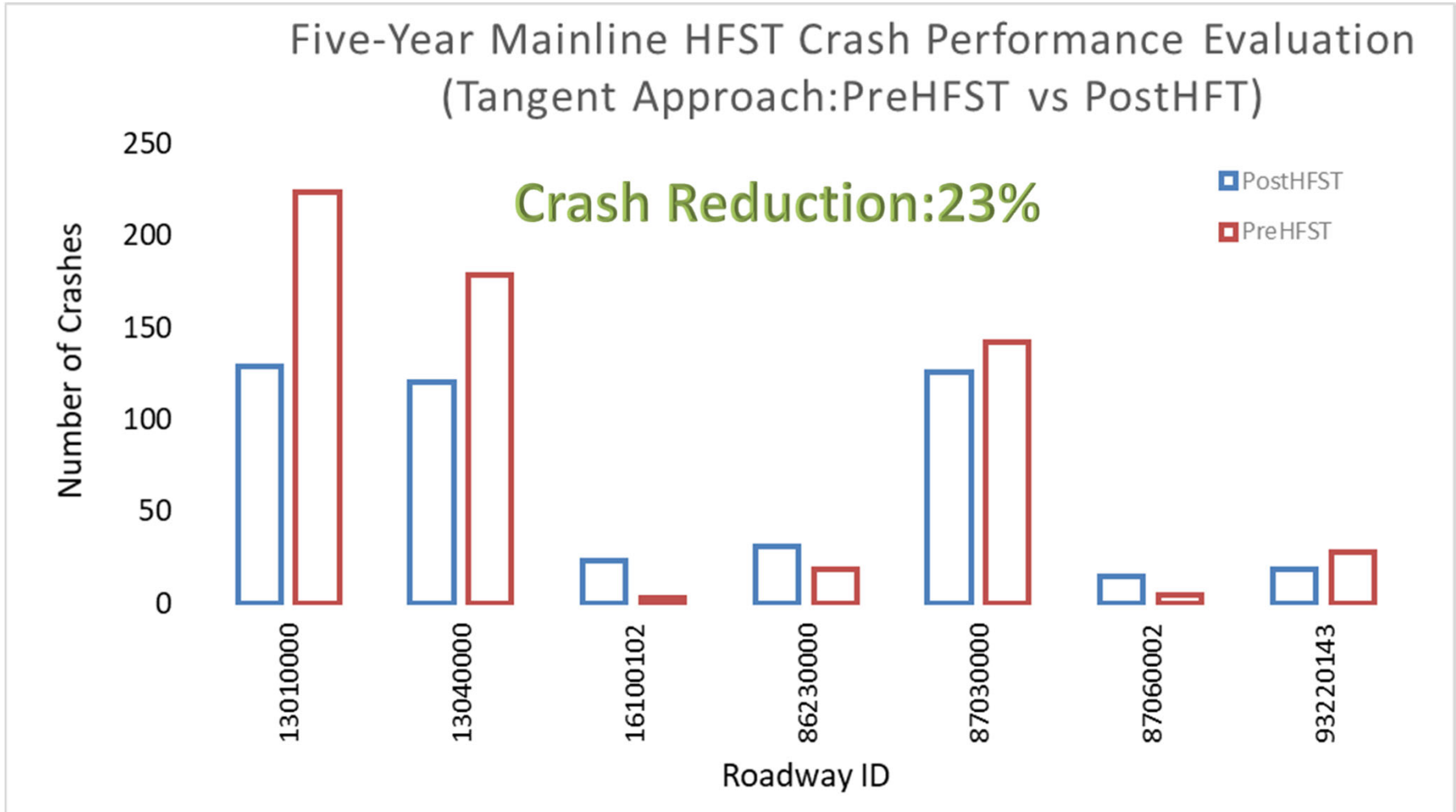
All Facility Types (Wet/Dry)



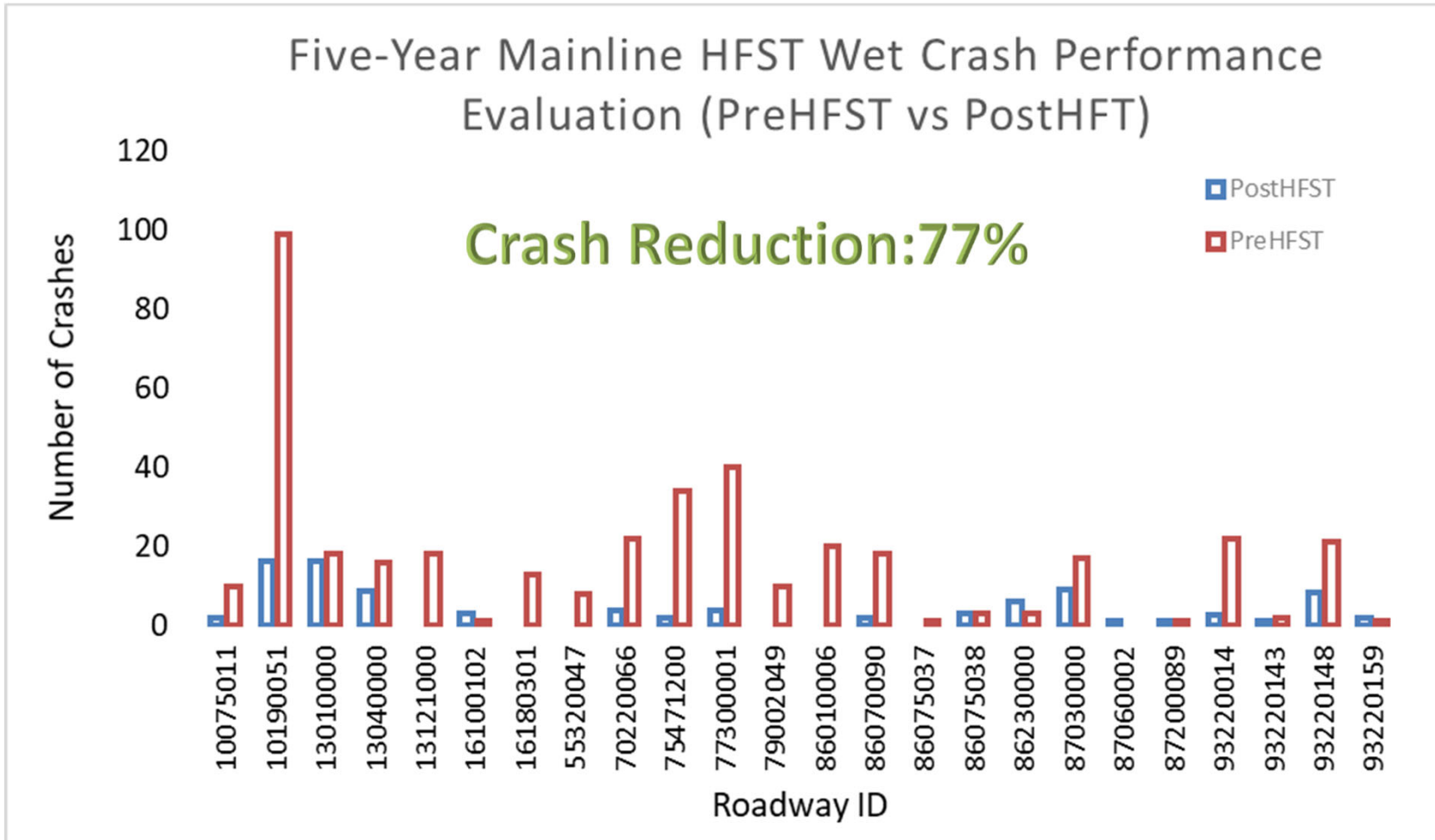
Curve Ramps (Wet/Dry)



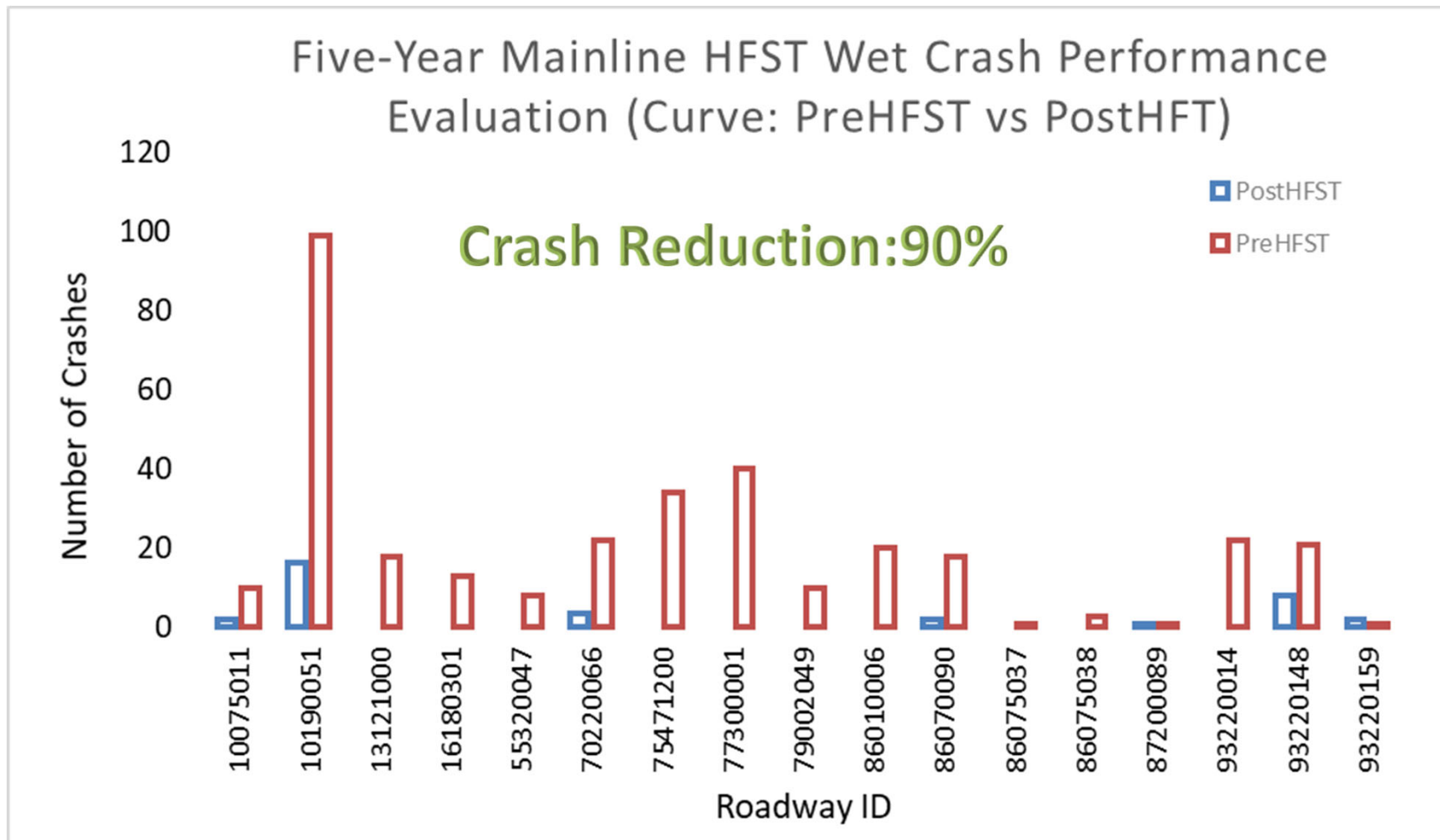
Tangent Approaches (Wet/Dry)



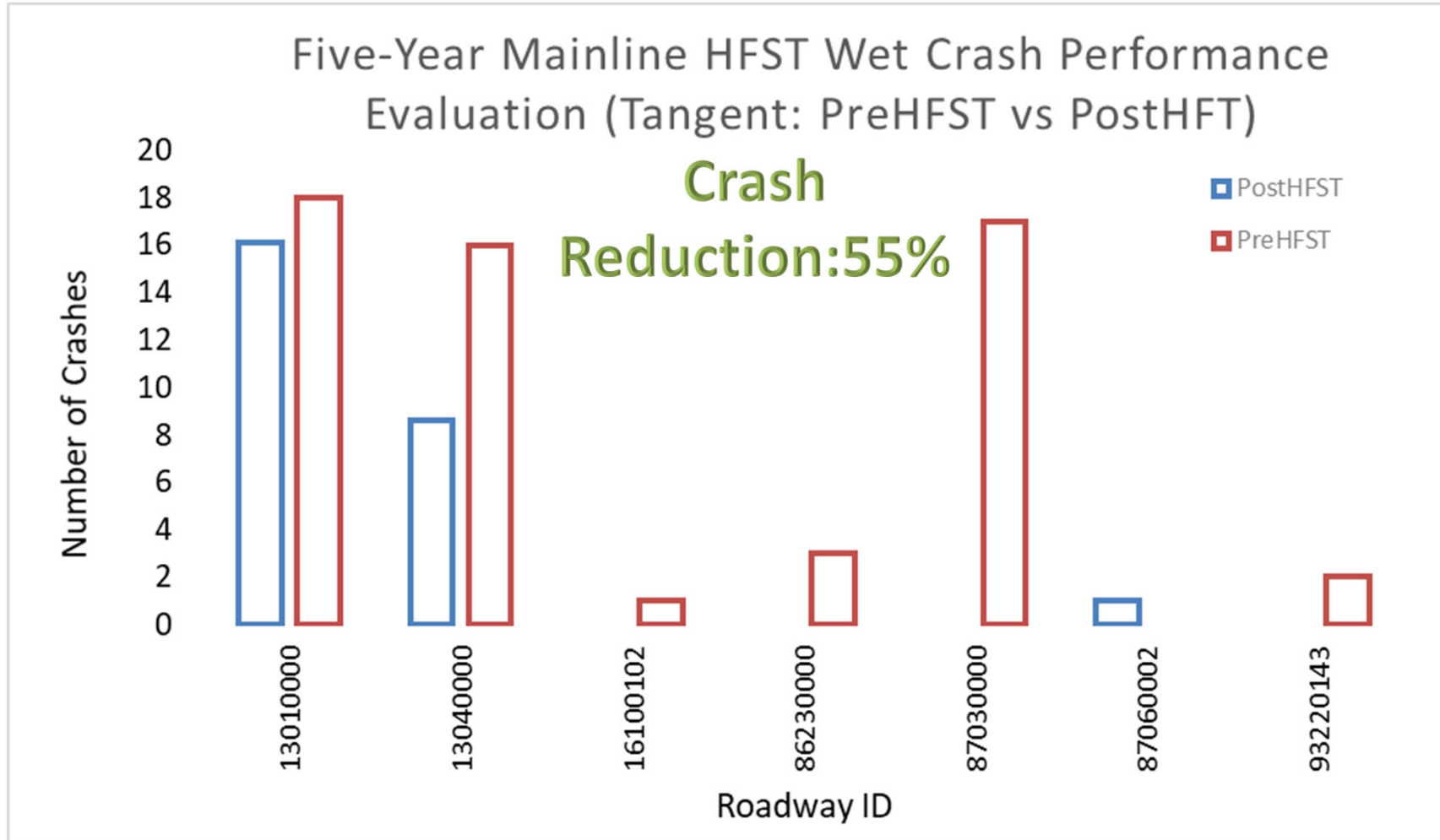
All Mainline HFSTs (Wet Only)



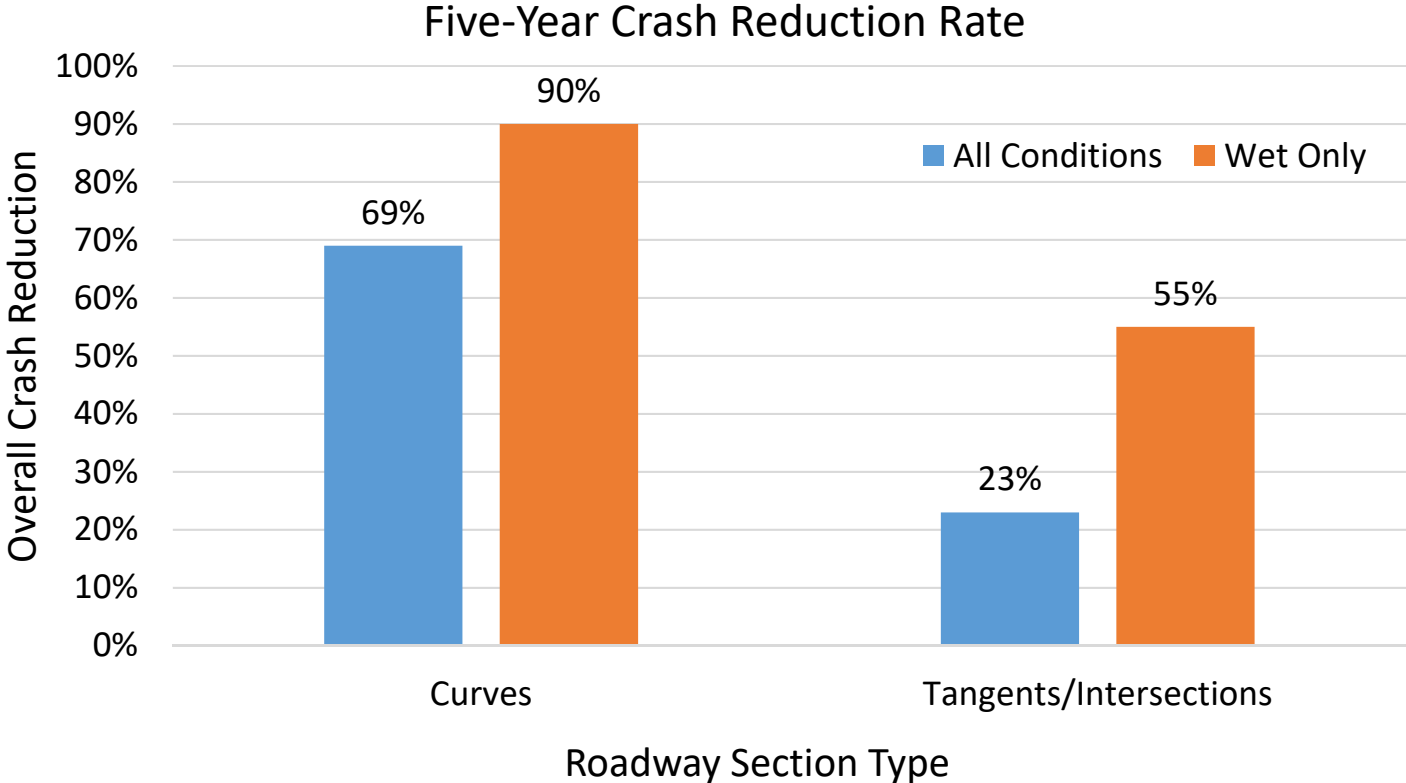
Mainline for Curve Ramps under Wet Conditions



Mainline for Tangent Approaches under Wet Conditions



Crash Performance (333 Specification)



Royal Palm Boulevard/I-75 NB Ramp-2006 (Cont.)

- Built in 2006
- Still in Service (13 yrs)
- High FN
- Yearly crash rate reduced 45%
- Safety reported reduced driving speed



- A ramp to north I-75 in District 4 was treated with HFST in 2006 and still performs well with more than 60 of FN.

Friction Number (FN)		
Northbound Ramp		Test Date
Lane 1	Material	
35	Asphalt (FC-2)	4/11/2006
104	HFST	5/23/2006
66	HFST	3/8/2010
67	HFST	11/8/2013
68	HFST	12/6/2016

I-275 Southbound Off-Ramp at Memorial Highway to TIA



I-275 Southbound Off-Ramp at Memorial Highway to TIA (Cont.)

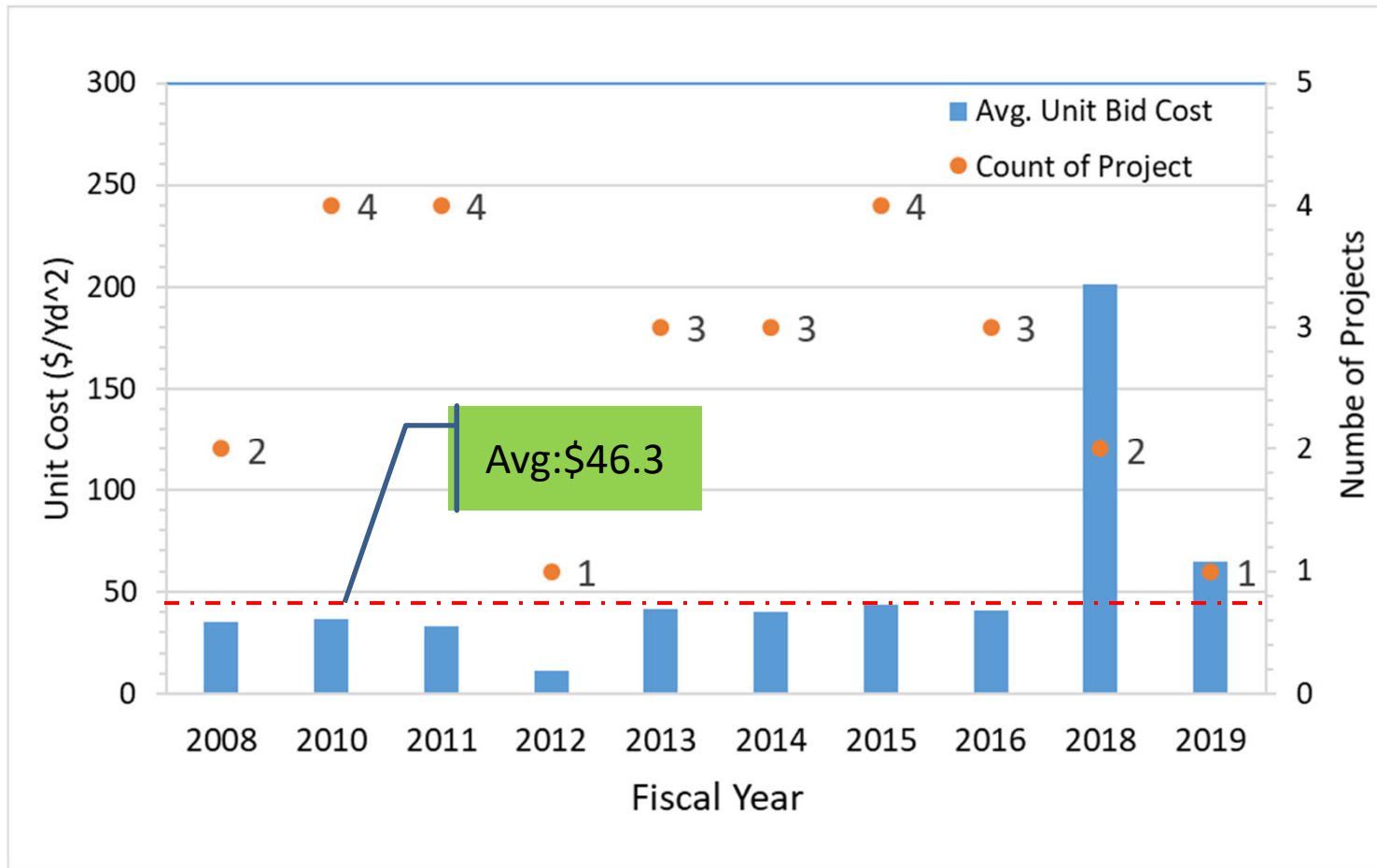
Number of Crashes			
Crash Type	Before HFST	First HFST Treatment	Second HFST Treatment
	(1/1/2010 to 10/31/2012)	(12/1/2012 to 9/30/2015)	(11/1/2015 to 6/30/2017)
wet	50	5	2
Off Roadway	6	2	1
Total Crashes	56	26	8

Crashes Per Year				Percent Reduction
Crash Type	Before HFST	First HFST Treatment	Second HFST Treatment	
	(1/1/2010 to 10/31/2012)	(12/1/2012 to 9/30/2015)	(11/1/2015 to 6/30/2017)	
wet	17.6	1.8	0.8	93%
Off Roadway	2.1	0.7	0.4	74%
Total Crashes	19.8	9.2	3.2	69%

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High Cost



Challenges (Cont.)

➤ M & R Strategy



SUMMARY

- HFST is a great safety treatment
- HFST is the most cost-effective on tight curves

HFST should be recommended to be applied on locations where demand high friction, especially on locations with high frequency of accidents.

Thank You!

Questions?

