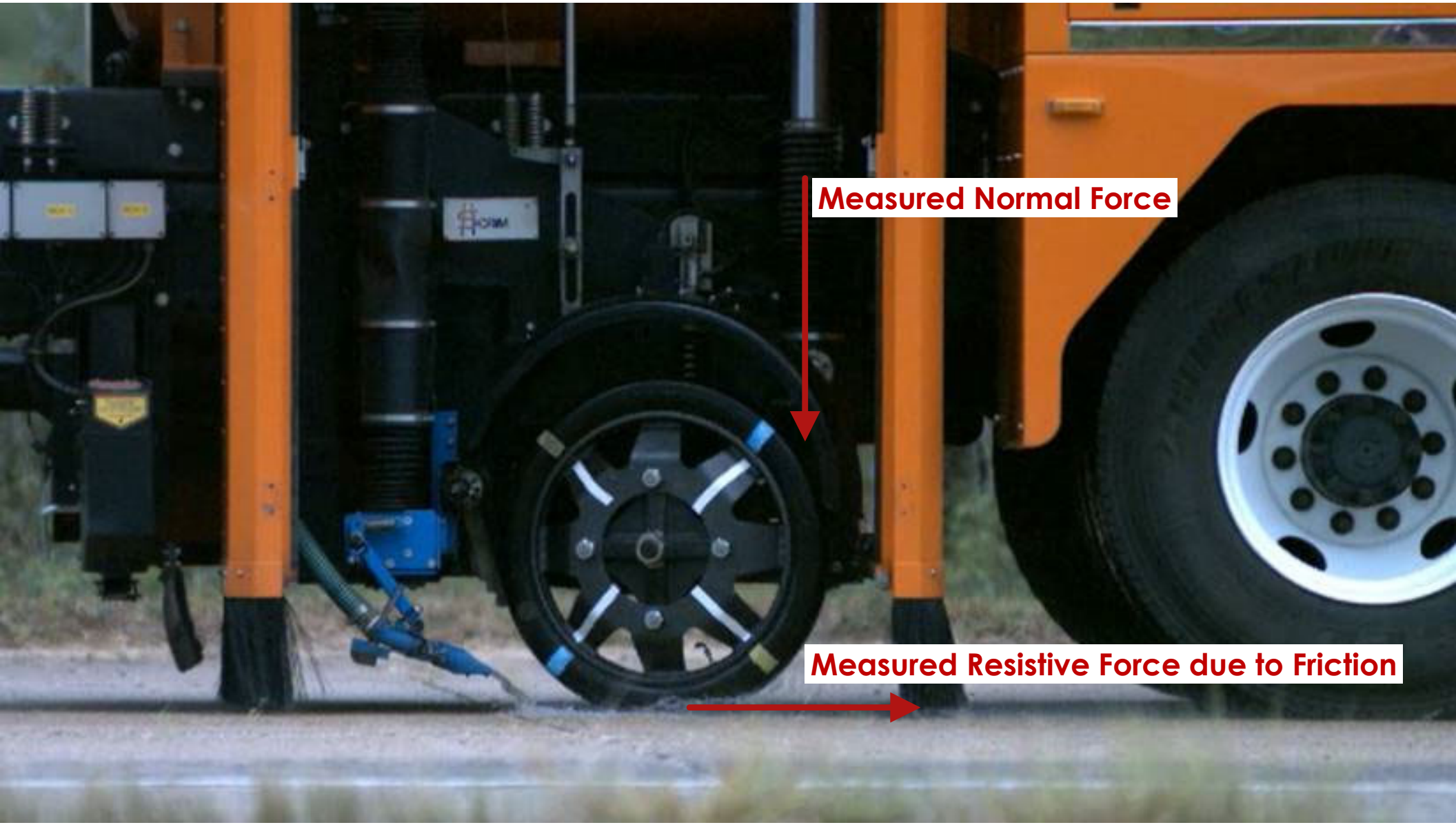
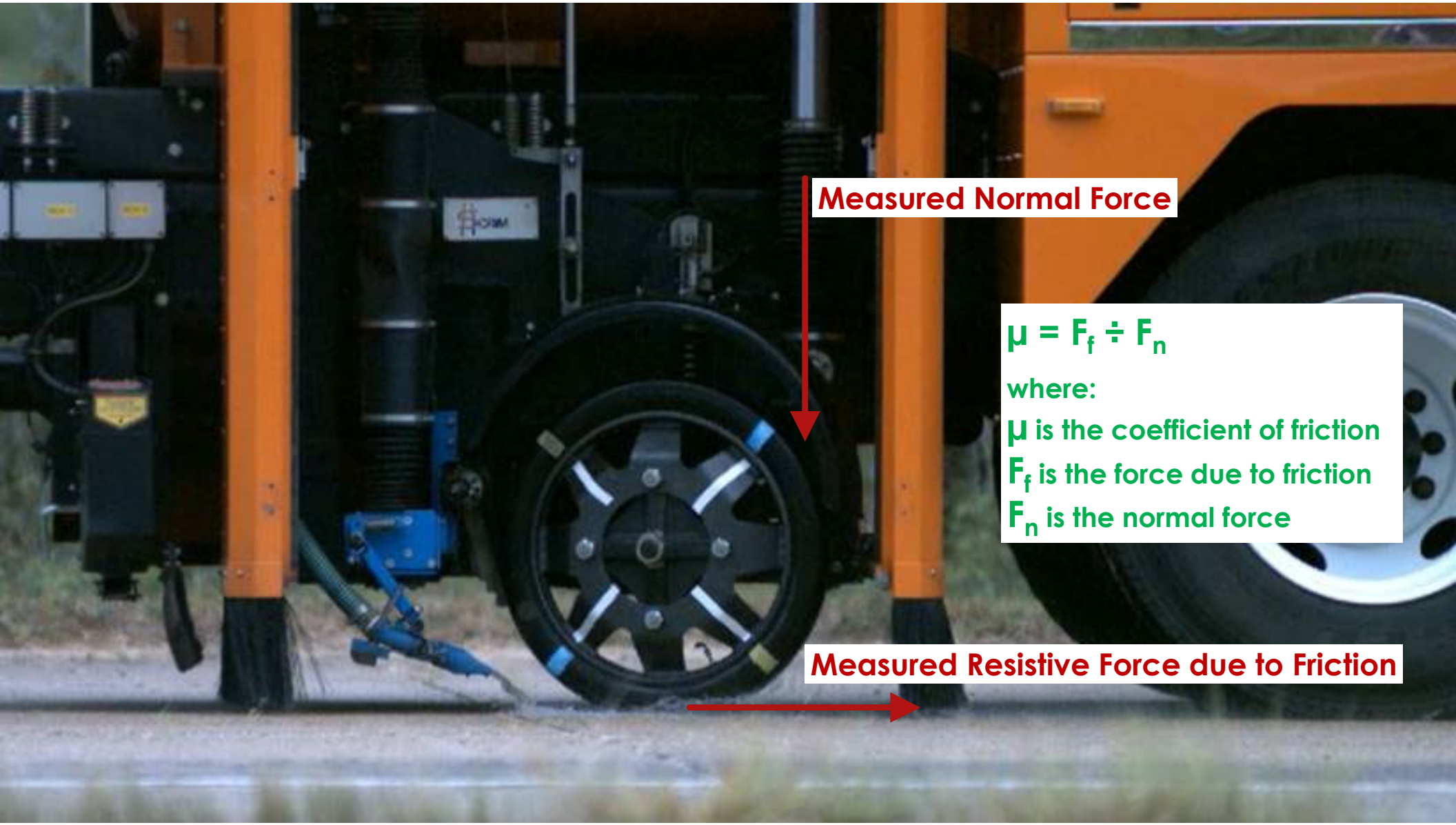
Preservation & Friction

December 6, 2023


Measured Resistive Force due to Friction


Measured Normal Force
Measured Resistive Force due to Friction


Measured Normal Force
$\mu = F_f \div F_n$
where:
μ is the coefficient of friction
F_f is the force due to friction
F_n is the normal force
Measured Resistive Force due to Friction

Presentation Items

Kentucky Transportation Cabinet (KYTC) perspective on continuous pavement friction measurement

- **Why** is KYTC collecting continuous friction data?
- **What** are KYTC's data analysis results so far?
- **How** can preservation treatments help KYTC in the area of pavement friction?

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  To prevent transportation related fatalities and serious injuries in KY
- Fatalities (K crashes) and serious injuries (A crashes) occurring on KY roadways have an annual economic impact of over $10 **B**illion
- 60%-70% of KY's yearly highway fatalities are the result of Roadway Departure

Why is KYTC collecting continuous friction data?

- From 2013-2017:
  - 1,250+ KA crashes were the result of Roadway Departure on WET pavement
  - 250+ KA crashes per year due to Roadway Departure on WET pavement
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- A 5% reduction of KY's K & A Roadway Departure crashes occurring on WET pavement would save the public over $28 Million per Year
- **This is an opportunity**!

What are KYTC's data analysis results so far?

KYTC's data analysis results so far

- Key Notes :
  - Using GPS coordinates, collected data is snapped to KYTC's LRS
  - Once snapped, we have a very robust data set consisting of:
    - Collected data (friction, texture, curve radius, grade, cross slope, IRI, etc.)
    - Most recent 5-year crash data
    - AADT
    - Route System designation (Interstate, Parkway, State Primary, or State Secondary)
    - # of lanes and lane width
    - Shoulder type and shoulder width
    - Posted Speed Limit

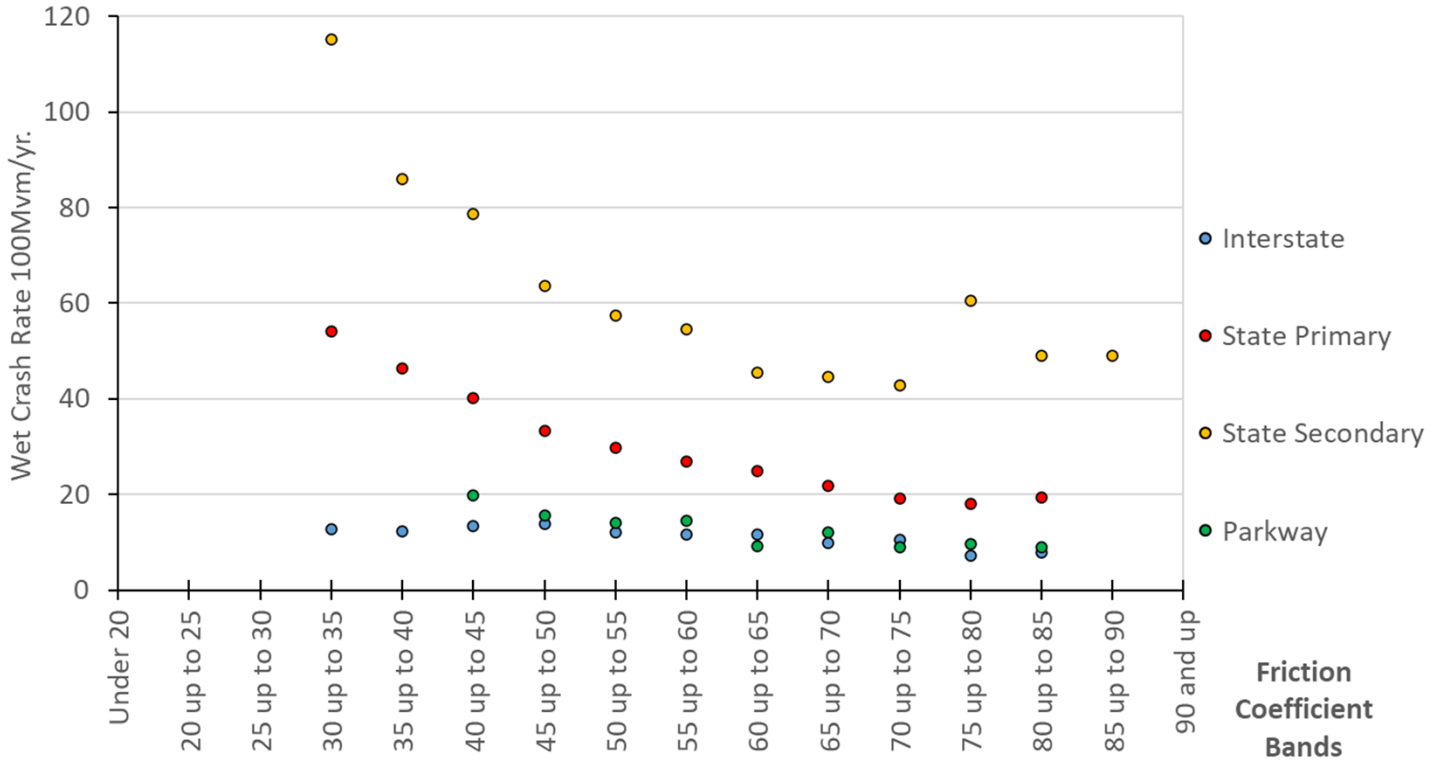
KYTC's data analysis results so far

- Key Notes :
  - Each row of the integrated data set represents 0.005 mile (26.4 ft) along KY's network
  - Rolled up data into 0.1-mile segments and assigned to a **Site Category**
    - **C1** curves (radius < 300 ft)
    - **C2** curves (radius 300 – 700 ft)
    - **C3** curves (radius 700 – 1200 ft)
    - **C4** curves (radius 1200 – 2000 ft)
    - **Intersection** (526 ft total length centered at the intersection – i.e. 264 ft on either side)
    - **Non-Event** (any segment that did not include any of the above – i.e. tangents)

      NOTE: if a 0.1-mile segment included both a tangent and curve (or tangent and intersection), the entire segment was labeled as a curve (or intersection)

KYTC's data analysis results so far

- Compared WET crash rates with Friction Coefficient bands for each Route System



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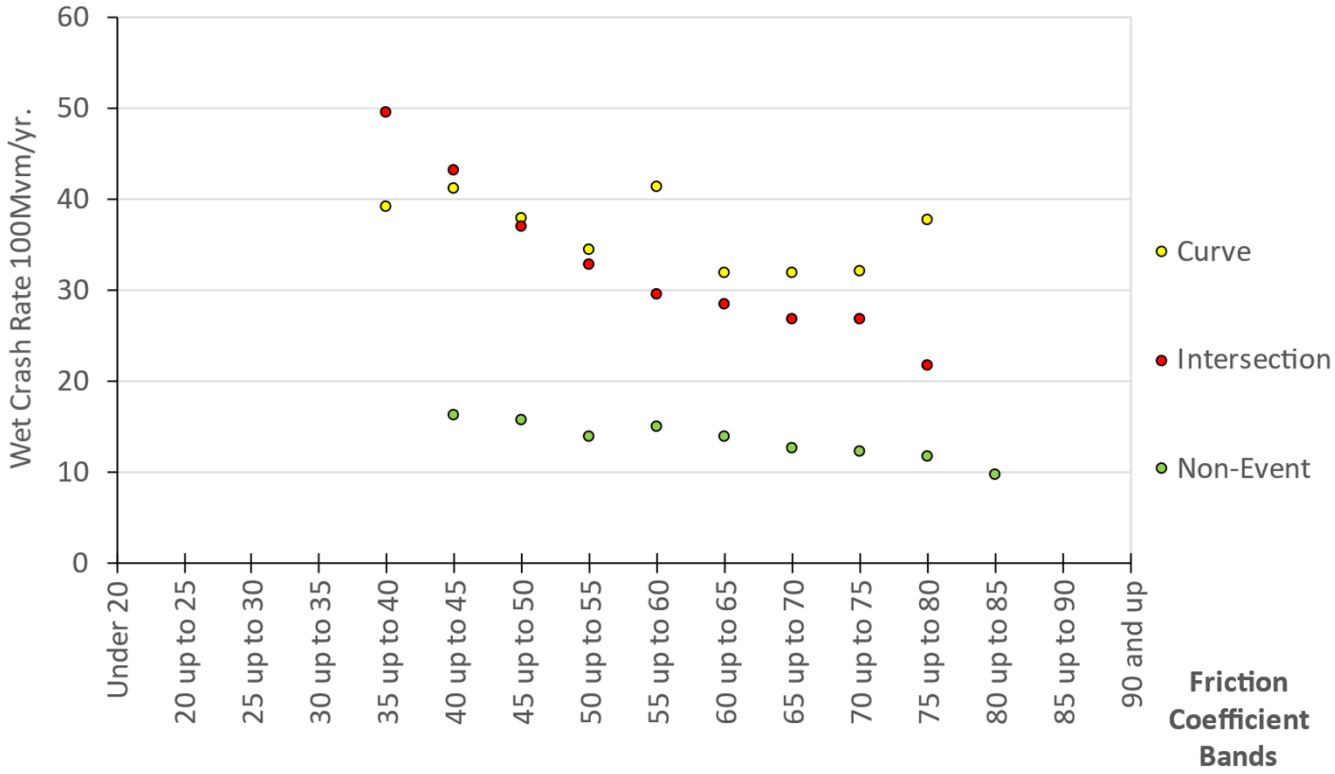
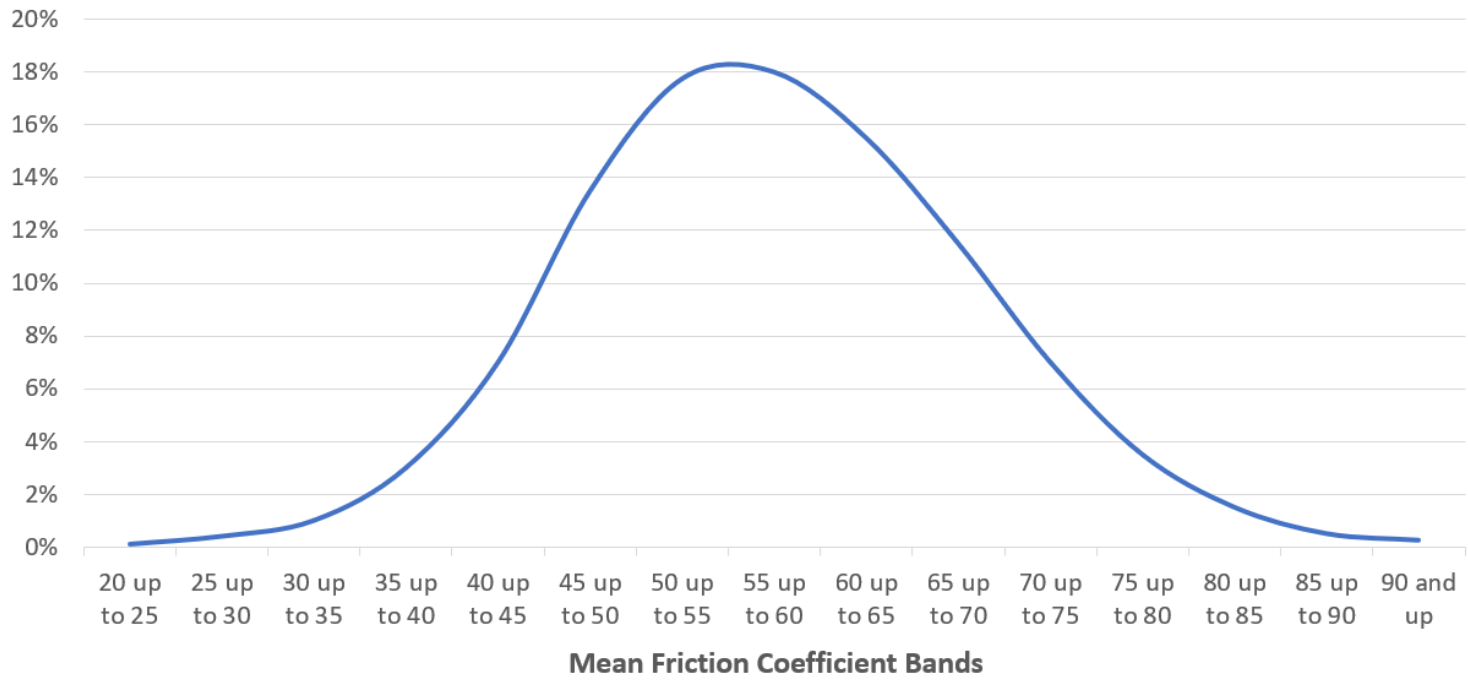


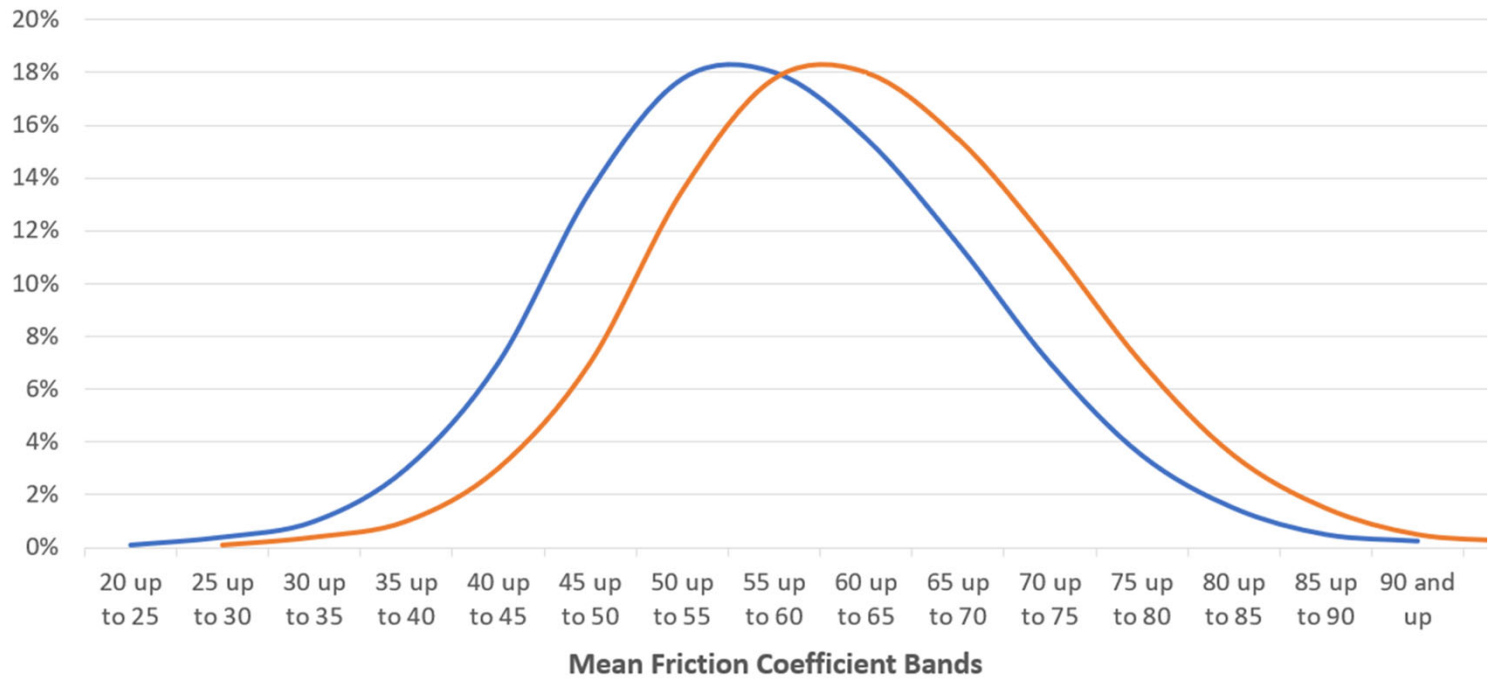
KYTC's data analysis results so far

- Friction Distribution across KYTC's network



KYTC's data analysis results so far

- KY's network (blue line) / typical Friction Distribution of other agencies (orange line)



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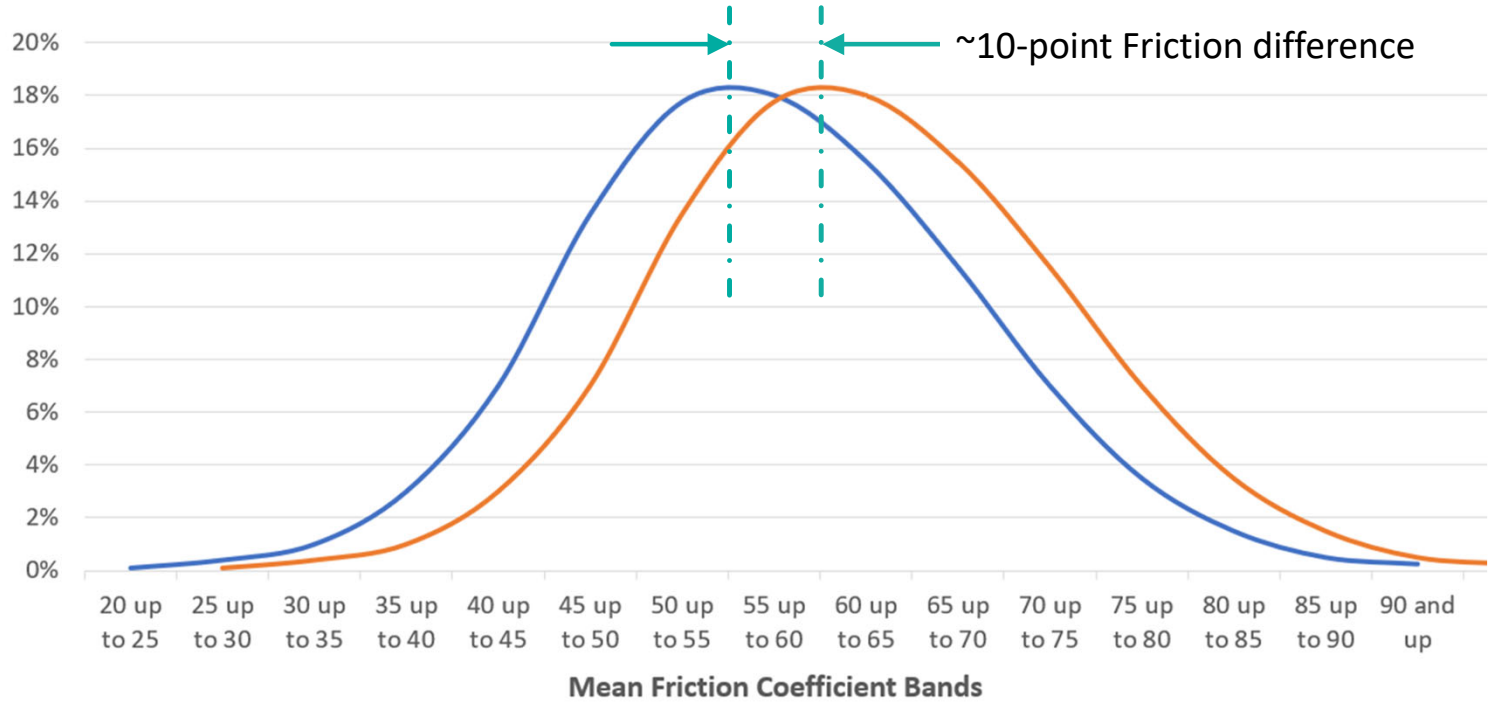


KYTC's data analysis results so far

- SPF = Safety Performance Function (crash prediction model)
- Developed an overall network-level SPF
  - Included interaction terms for Friction and Texture (mean profile depth)
  - Included categorical variables for District, Site Category, and Route System
  - Included adjustment variables for speed at collection, curve radius, gradient, IRI, air temperature, and AADT
- Calculated "what-if" scenarios
  - Change in predicted crashes and resulting crash rates (and associated 95% confidence intervals) over a 5-year period using a 10-point increase in Friction

KYTC's data analysis results so far

- % Decrease in crash rates: +10-point friction; by site category for each route system (statewide)

	Site Category	CMF (+1 friction)	% Decrease in Crash Rates	Impact Rank
State Secondary	C1	0.9606	33.09 (27/38)	1
	C4	0.9654	29.70 (26/31)	2
	Non-Event	0.9707	25.71 (24/26)	4
	Intersection	0.9713	25.26 (24/26)	5
	C2	0.9721	24.66 (21/27)	6
	C3	0.9725	24.36 (21/26)	7
State Primary	C1	0.9695	26.64 (21/33)	3
	C4	0.9743	22.92 (20/25)	8
	Non-Event	0.9797	18.55 (18/20)	10
	Intersection	0.9803	18.06 (17/19)	11
	C2	0.9811	17.40 (15/21)	13
	C3	0.9815	17.07 (14/20)	14

	Site Category	CMF (+1 friction)	% Decrease in Crash Rates	Impact Rank
Interstate	C1	0.9758	21.69 (15/29)	9
	C4	0.9807	17.73 (14/20)	12
	Non-Event	0.9861	13.06 (12/15)	15
	Intersection	0.9867	12.54 (11/14)	17
	C2	0.9875	11.84 (8/16)	18
	C3	0.9879	11.48 (8/15)	19
Parkway	C1	0.9867	12.55 (5/21)	16
	C4	0.9916	8.12 (3/12)	20
	Non-Event	0.9970	2.92 (0/6)	21
	Intersection	0.9976	2.33 (-1/+5)	22
	C2	0.9984	1.55 (-3/+7)	23
	C3	0.9988	1.15 (-4/+6)	24

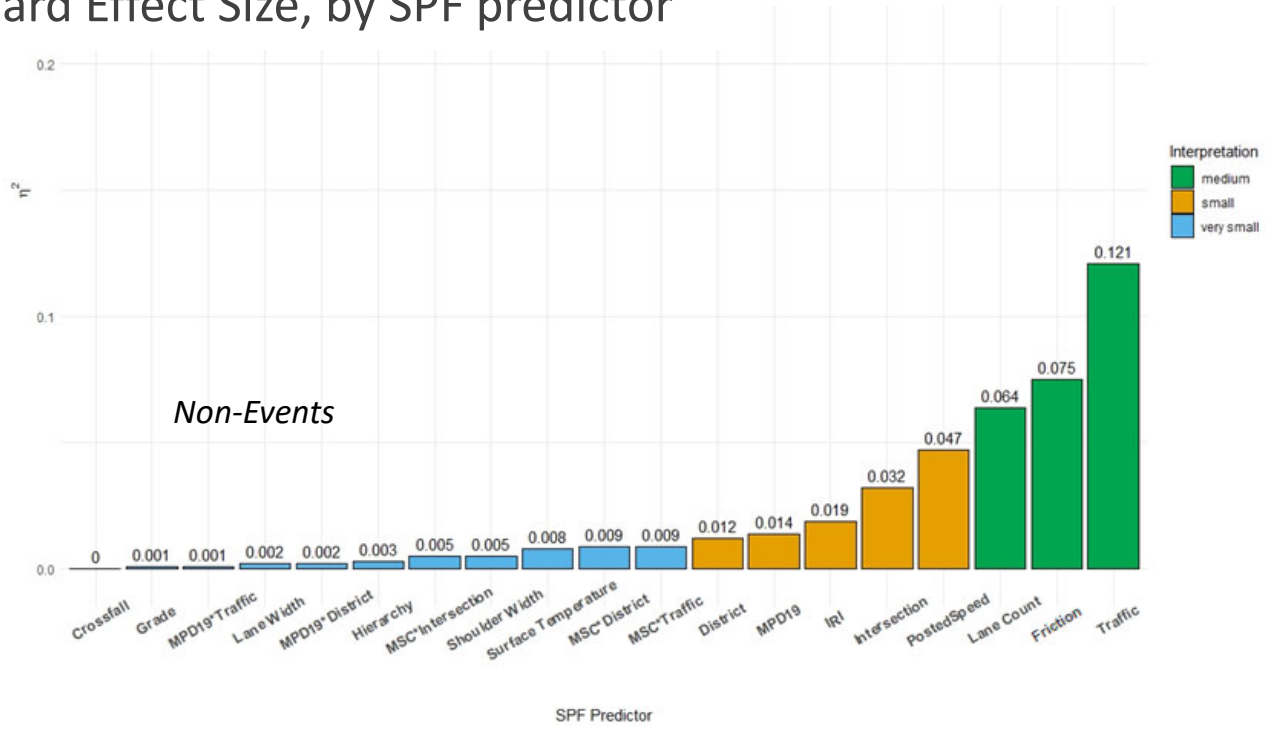
KYTC's data analysis results so far

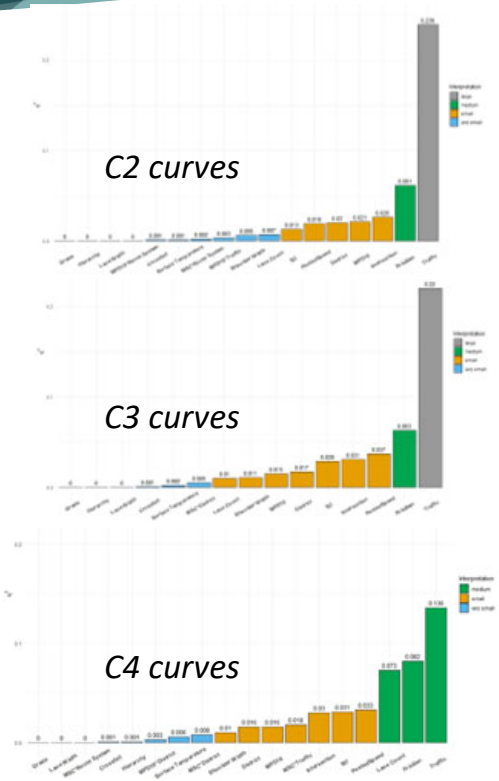
- % Decrease in crash rates: +10-point friction; by site category for each District

District	C1	C4	C2	Non-Event	Intersection
D1	**40.99** (35.42, 46.08)	**40.20** (37.50, 42.78)	**38.15** (34.94, 41.19)	**37.80** (35.69, 39.85)	**37.28** (35.24, 39.25)
D11	**37.69** (32.04, 42.88)	**36.86** (34.23, 39.38)	**34.69** (31.6, 37.64)	**34.32** (32.28, 36.31)	**33.77** (31.88, 35.61)
D4	**36.95** (31.25, 42.17)	**36.10** (33.80, 38.32)	**33.91** (31.00, 36.70)	**33.54** (32.16, 34.90)	**32.98** (31.70, 34.24)
D8	**34.07** (28.06, 39.58)	**33.19** (30.60, 35.68)	**30.89** (27.73, 33.91)	**30.51** (28.77, 32.20)	**29.92** (28.32, 31.49)
D9	**32.38** (26.22, 38.03)	**31.48** (28.80, 34.05)	**29.12** (25.87, 32.23)	**28.73** (26.84, 30.57)	**28.13** (26.36, 29.86)
D12	**31.85** (25.58, 37.58)	**30.93** (28.09, 33.66)	**28.56** (25.14, 31.82)	**28.16** (26.08, 30.19)	**27.56** (25.60, 29.47)
D7	**30.29** (24.02, 36.04)	**29.35** (26.79, 31.82)	**26.93** (23.74, 29.98)	**26.52** (24.95, 28.06)	**25.90** (24.50, 27.28)
D10	**29.17** (22.75, 35.05)	**28.22** (25.30, 31.02)	**25.75** (22.34, 29.02)	**25.34** (23.14, 27.48)	**24.71** (22.69, 26.68)
D5	**28.56** (22.10, 34.49)	**27.61** (24.92, 30.20)	**25.12** (21.79, 28.31)	**24.70** (22.91, 26.46)	**24.07** (22.50, 25.61)
D6	**27.53** (20.95, 33.57)	**26.56** (23.69, 29.32)	**24.04** (20.58, 27.35)	**23.62** (21.48, 25.69)	**22.97** (21.01, 24.89)
D3	**26.77** (20.16, 32.83)	**25.79** (23.10, 28.38)	**23.24** (19.88, 26.46)	**22.81** (21.15, 24.44)	**22.16** (20.66, 23.63)
D2	**24.83** (18.06, 31.05)	**23.83** (21.07, 26.48)	**21.21** (17.75, 24.52)	**20.77** (19.20, 22.32)	**20.11** (18.66, 21.53)

KYTC's data analysis results so far

- Standard Effect Size, by SPF predictor





How can preservation treatments help KYTC in the area of pavement friction?

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  - All pavements polish
    - Some will polish quickly
    - Some will polish slowly
    - Some will reach a relatively high terminal friction
    - Some will reach a relatively low terminal friction
  - Pavements that polish to a concerning level around mid-life are prime candidates for a preservation treatment

KYTC's future opportunities

- Over time, we expect to better manage friction across the KY network
  - Preservation treatments will be an important tool to accomplish this
- If we can achieve a 10-point increase in average friction across the network, we expect to see a minimum of a 10% reduction in ALL crashes (not just WET Roadway Departure crashes)
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- **This IS a MAJOR opportunity**!

HSIP

Thank You

Questions?