IMPROVE I-70 KC

J4I1486D

BEYOND HSM?

Traffic Safety Analysis for the Access Justification Report (AJR)

Urban Kansas City I-70, Downtown to I-435

Project Overview - Location

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- Kansas City
- From The Paseo to US 40 in Kansas City
- Approx. 5 miles in length
- Urbanized area

Project Overview

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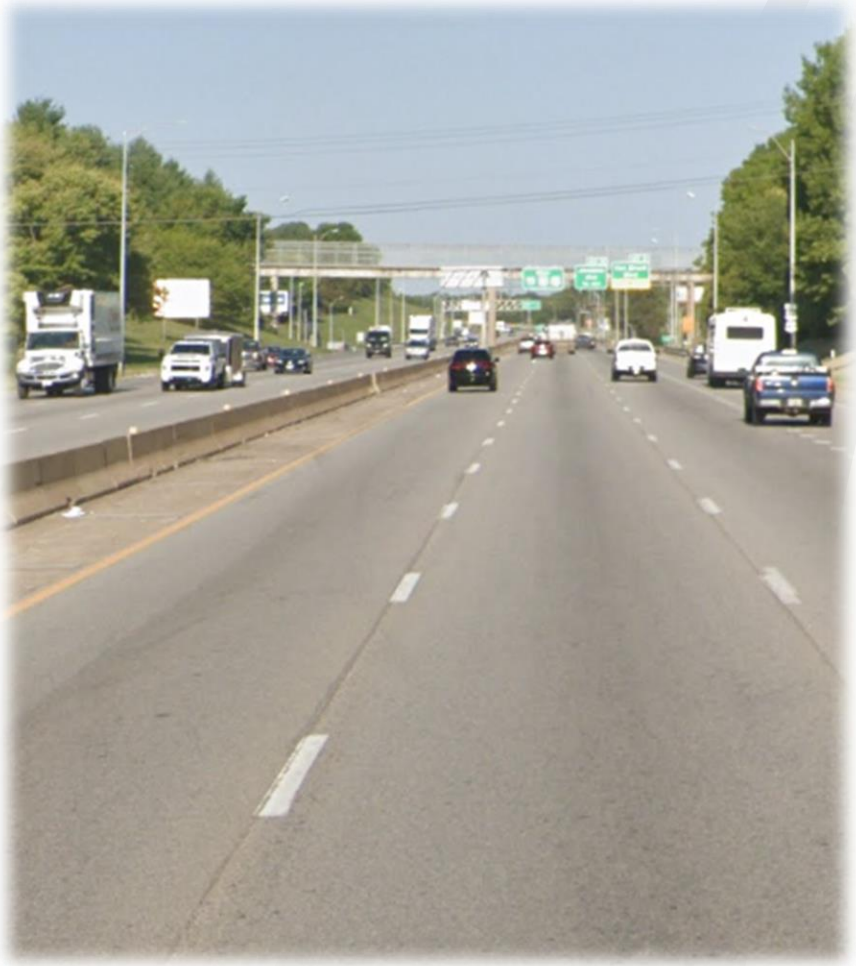
- 12 interchanges
- 25 mainline and overhead bridges
- 6 / 8 thru lanes of pavement
- 96,000 to 120,000 vpd
- 18% trucks
- Heavy AM and PM rush hour traffic
- Heavy pedestrian and transit traffic

- Corridor of concern for serious crashes



Progress in Traffic Safety Analysis

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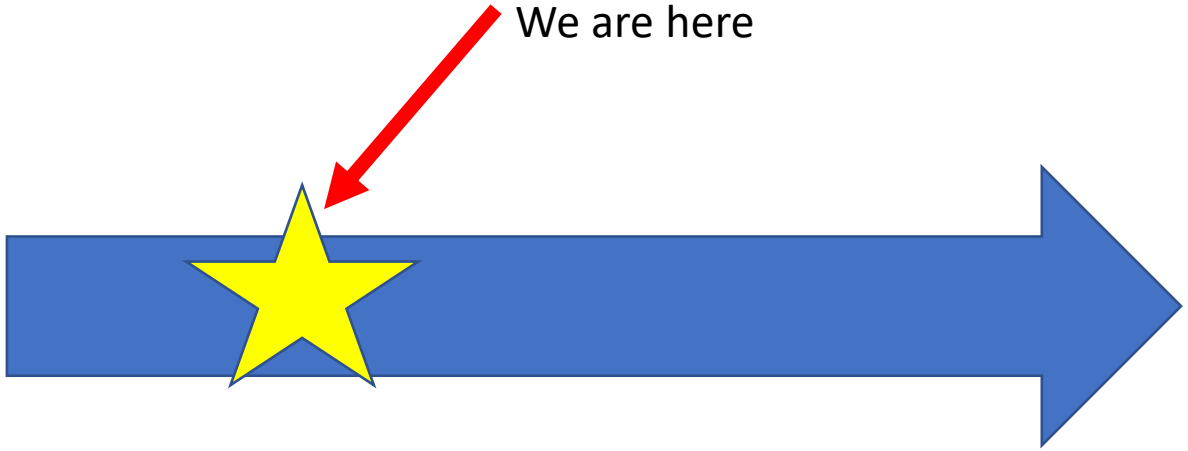

We are making progress in our ability to predict crashes!

Let's bash HSM! (ISATe specifically)

ISATe doesn't understand sideslopes
ISATe doesn't understand fixed objects
ISATe doesn't understand vertical alignment
ISATe doesn't understand congestion
ISATe doesn't understand lighting
ISATe doesn't understand pedestrians

Longer road = more crashes
More traffic = more crashes

What does ISATe understand?

Lane/Shoulder widths

Curves

Guardrail

Ramp locations

If you put a bunch of people on a road, some of them will crash

A different approach

A modular approach

- Use what works well
- Toss what doesn’t
- Add what works better

Baseline crashes

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If you build it, they will crash

- Uses ISATe
- Crashes that occur because the road exists
- Straight, flat road with no access

Horizontal Curves

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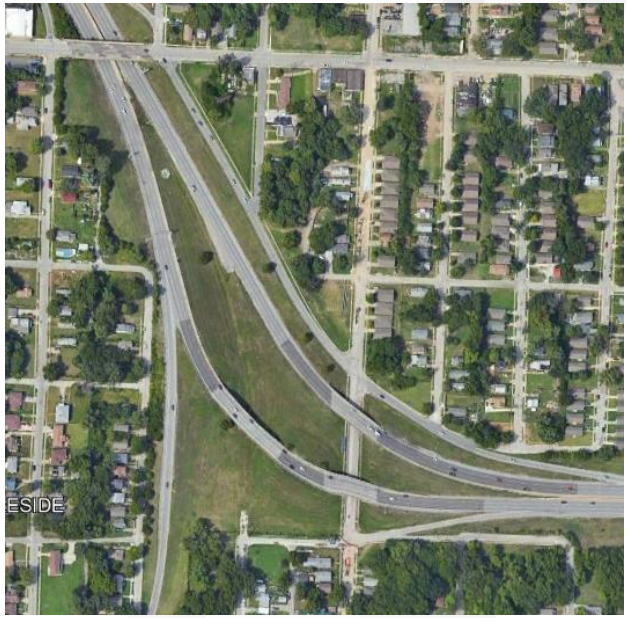
- ISATe based
- Only looked at Benton & Jackson Curves



Lane & Shoulder widths

ISATe based

Number of through lanes (n):		10	10	10	10	10	10	10	10	10	10	10	9	9	8	8	9
Freeway segment description:		Segment 1 - Station 0 to 10.5	Segment 2 - Station 10.5 to 21	Segment 3 - Station 21 to 28	Segment 4 - Station 28 to 40	Segment 5 - Station 40 to 52	Segment 6 - Station 52 to 57	Segment 7 - Station 57 to 61.5	Segment 8 - 61.5 to 95.5	Segment 9 - Station 95.5 to 97.5	Segment 10 - Station 97.5 to 118	Segment 11 - Station 118 to 137	Segment 12 - Station 137 to 140	Segment 13 - Station 140 to 156	Segment 14 - Station 156 to 171	Segment 15 - Station 171 to 193	Segment 16 - Station 193 to 200
Segment length (L), mi:		0.068	0.303	0.076	0.474	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
Alignment Data																	
Horizontal Curve Data ◄See note																	
1	Horizontal curve in segment?:	No	No	No	No	No	No	No	No	No	No	Both Dir.	Both Dir.	Both Dir.	No	No	No
	Curve radius (R_1), ft:											5721	5721	5721			
	Length of curve (L_{c1}), mi:											0.476	0.476	0.476			
	Length of curve in segment ($L_{c1,ms}$), mi:											0.114	0.336	0.026			
2	Horizontal curve in segment?:											No	No	No			
	Curve radius (R_2), ft:																
	Length of curve (L_{c2}), mi:																
	Length of curve in segment ($L_{c2,ms}$), mi:																
3	Horizontal curve in segment?:																
	Curve radius (R_3), ft:																
	Length of curve (L_{c3}), mi:																
	Length of curve in segment ($L_{c3,ms}$), mi:																
Cross Section Data																	
Lane width (W_L), ft:		11	11	11	11	11	12	12	12	12	12	12	12	12	11	11	12
Outside shoulder width (W_o), ft:		8	8	8	8.4	10	10	10	10	8	10	10	10	10	8	11	11
Inside shoulder width (W_i), ft:		10	10	10	9.5	9.5	12	12	12	11.54	11.54	12	12	12	10	10	8
Median width (W_m), ft:		22	22	22	21	22	26	26	26	26	26	26	26	26	22	22	19
Rumble strips on outside shoulders?:		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Length of rumble strips for travel in increasing milepost direction, mi:	0.068	0.303	0.076	0.474	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
	Length of rumble strips for travel in decreasing milepost direction, mi:	0.068	0.303	0.076	0.474	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
Rumble strips on inside shoulders?:		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Length of rumble strips for travel in increasing milepost direction, mi:	0.068	0.303	0.076	0.474	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
	Length of rumble strips for travel in decreasing milepost direction, mi:	0.068	0.303	0.076	0.474	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
Presence of barrier in median:		Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center
1	Length of barrier ($L_{b,1}$), mi:	0.068	0.303	0.076	0.252	0.074	0.108	0.573	0.183	0.235	0.142	0.35	0.336	0.271	0.322	0.096	0.133
	Distance from edge of traveled way to barrier face ($W_{ett,b,1}$), ft:	10	10	10	10	9.5	12	12	12	11.54	11.54	12	12	12	10	10	8
2	Length of barrier ($L_{b,2}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,b,2}$), ft:																
3	Length of barrier ($L_{b,3}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,b,3}$), ft:																
4	Length of barrier ($L_{b,4}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,b,4}$), ft:																
5	Length of barrier ($L_{b,5}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,b,5}$), ft:																
Median barrier width (W_b), ft:		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Nearest distance from edge of traveled way to barrier face (W_{ett}), ft:																	
Roadside Data																	
Clear zone width (W_{cz}), ft:		30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Presence of barrier on roadside:		None	Some	Some	Some	Full	Full	Some	Some	Some	Some	Some	Some	None	None	None	Full
1	Length of barrier ($L_{rb,1}$), mi:		0.198	0.076	0.047			0.069	0.18	0.103	0.067	0.114	0.282	0.25	0.07		
	Distance from edge of traveled way to barrier face ($W_{ett,rb,1}$), ft:		10	10	10			10	10	10	10	10	10	14	8		
2	Length of barrier ($L_{rb,2}$), mi:		0.152					0.211	0.028	0.043	0.052		0.095	0.138			
	Distance from edge of traveled way to barrier face ($W_{ett,rb,2}$), ft:		10					10	10	10	10		22	14			
3	Length of barrier ($L_{rb,3}$), mi:							0.047		0.036							
	Distance from edge of traveled way to barrier face ($W_{ett,rb,3}$), ft:							10		8							
4	Length of barrier ($L_{rb,4}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,rb,4}$), ft:																
5	Length of barrier ($L_{rb,5}$), mi:																
	Distance from edge of traveled way to barrier face ($W_{ett,rb,5}$), ft:																
Distance from edge of traveled way to barrier face, increasing milepost ($W_{ett,inc}$), ft:						10	10										11
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{ett,dec}$), ft:						10	10										11
Ramp Access Data																	
Travel in Increasing Milepost Direction																	
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No	Lane Add	No	No	No	No	No	No	No	No	Lane Add	No	No	Lane Add	No	Lane Add
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ra1}$), mi:	999		0.2	0.33	999	999	999	999	999	999		0.31	0.44		0.28	
	Length of ramp entrance ($L_{ra,inc}$), mi:																
	Length of ramp entrance in segment ($L_{ra,ms,inc}$), mi:																
	Entrance side?:																
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	S-C Lane	No	S-C Lane	S-C Lane	No	Lane Drop	No	No	Lane Drop	No	No
	Distance from end milepost to downstream exit ramp gore ($X_{e,ra1}$), mi:	999	999	999	0.32			999			0.37		999	0.27		999	999
	Length of ramp exit ($L_{ra,inc}$), mi:					0.133	0.133		0.142	0.142							
	Length of ramp exit in segment ($L_{ra,ms,inc}$), mi:					0.038	0.095		0.117	0.025							
	Exit side?:					Right	Right		Right	Right							
Weave	Type B weave in segment?:	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Length of weaving section ($L_{wea,inc}$), mi:																
	Length of weaving section in segment ($L_{wea,ms,inc}$), mi:																
Travel in Decreasing Milepost Direction																	
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	S-C Lane	No	No	No	S-C Lane	Lane Add	Lane Add	No	Lane Add	S-C Lane	No
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ra1}$), mi:	999	999	999	0.32			999	999	0.23				0.32			999
	Length of ramp entrance ($L_{ra,dec}$), mi:					0.133	0.133				0.085					0.096	
	Length of ramp entrance in segment ($L_{ra,ms,dec}$), mi:					0.038	0.095				0.085					0.096	
	Entrance side?:					Right	Right				Right					Right	
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	No	No	No	No	No	Lane Drop	No	No	Lane Drop	No	No
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ra1}$), mi:	999	999	999	999	999	999	999	999	999	999		0.34	0.4		0.28	999
	Length of ramp exit ($L_{ra,dec}$), mi:																
	Length of ramp exit in segment ($L_{ra,ms,dec}$), mi:																
	Exit side?:																
Weave	Type B weave in segment?:	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
	Length of weaving section ($L_{wea,dec}$), mi:																
	Length of weaving section in segment ($L_{wea,ms,dec}$), mi:																

Congestion

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No ISATe!

Traffic Data
Proportion of AADT during high-volume hours (P_{hv}):

New York City Congestion

≠

Kansas City Congestion

Congestion

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No way to account for bottlenecks in ISATe

Congestion

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SHRP2 L07

				2026		2045		2026		2045	
	Link	Name	Length	PHV AM	PHV PM	PHV AM	PHV PM	Density AM	Density PM	Density AM	Density PM
EASTBOUND	215	5E	614.98	3006	6006	3138	6904	12.69	65.29	13.25	72.74
	8	22E	343.40	2362	5845	2496	7042	13.34	62.75	13.96	36.74
	315	22E	383.99	2362	5845	2496	7042	10.04	49.16	10.46	27.12
	320	23E	246.77	2308	5449	2439	6621	13.01	67.58	13.60	33.36
	306	24E	498.36	2308	5449	2439	6621	13.01	71.14	13.71	33.43
	325	24E	1580.39	2446	5955	2592	7151	10.49	52.64	10.90	27.19
	330	24E	1288.36	2446	5955	2592	7151	10.51	41.10	10.98	27.51
	335	24E	498.36	2311	5893	2450	7086	13.12	52.13	10.28	27.50
	307	25E	472.86	2311	5893	2450	7086	13.12	53.07	10.34	27.66

	No-Build	Preferred Build
Evaluated Length (mi)	5.50	5.45
Total Crashes	542	472
Fatal and Injury Crashes	183	159
Property-Damage-Only Crashes	359	313
Percent Fatal and Injury Crashes (%)	33.8%	33.8%
Percent Property-Damage-Only Crashes (%)	66.2%	66.2%

Ramp Spacing

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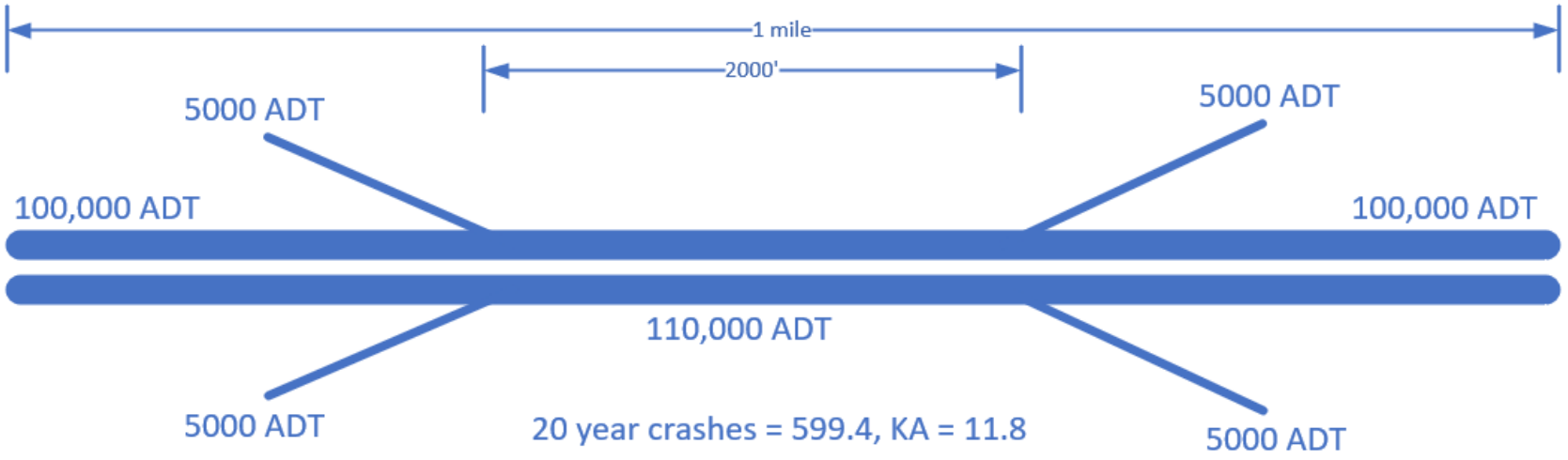
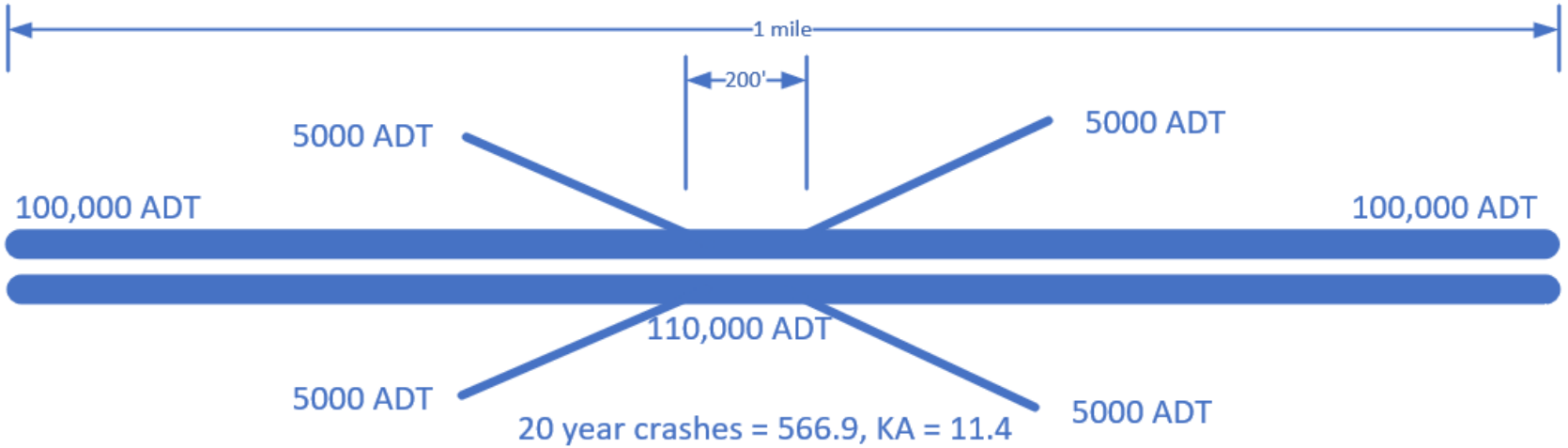
How ISATe understands weaving distance





Ramp Spacing

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NCHRP 687

Ramp Spacing Safety Analysis - Modifed Preferred Build

Basic Route Data									2026 Volumes, vpd			2045 Volumes, vpd			For en-ex only	
User Entries									*User Entries*			*User Entries*			*User Entries*	
Route	Start	End	Segment Type	Painted gore-to-gore distance (ft) S	Upstream cross street to starting ramp gore point (ft)	Downstream cross street to ending ramp gore point (ft)	Calculated length L	Segment Length (mi) L	MAX. Painted gore-to-gore distance (ft) S_2	upstr ramp	dnstrm ramp	upstr fwy	upstr ramp	dnstrm ramp	upstr fwy	system ramp?	continuous Aux?
EB 70	Paseo	Brooklyn	**en-ex**	783	896	607	2286	0.43	2600	3264	1951	57592	3840	2132	63072	no	yes
EB 70	Brooklyn	Prospect	ex-ex	1027	0	765	1792	0.34	2200	1951	4054	60856	2132	4250	66912		
EB 70	Prospect	Truman	**en-ex**	1448	842	0	2290	0.43	2600	2527	10015	54851	2884	10499	60530	no	yes
EB 70	Truman	18th	ex-ex						2200								
EB 70	18th	23rd	**en-ex**						2600							no	yes
EB 70	23rd	27th	**en-ex**	1616	594	780	2989	0.57	2600	1032	1031	47363	1340	2449	52915	no	yes
EB 70	Jackson	Van Brunt	**en-ex**	2167	1029	777	3973	0.75	2600	0	2046	49826	3745	2145	54621	no	yes
EB 70	Van Brunt	US 40	**en-ex**	1339	557	975	2871	0.54	2600	3491	1414	49744	3894	1482	56221	no	yes
WB 70	US 40	Van Brunt	**en-ex**	1346	874	651	2871	0.54	2600	2301	4214	52872	2503	4417	58195	no	yes
WB 70	Van Brunt	Jackson	**en-ex**	1963	1067	942	3973	0.75	2600	2237	3929	50959	2423	4195	56281	no	yes
WB 70	27th	23rd	**en-ex**	1386	691	912	2989	0.57	2600	1949	3226	49267	2043	1088	54509	no	yes
WB 70	18th	Truman	en-en	1231	996	0	2227	0.42	2200	4170	7078	47990	4371	7420	53060		
WB 70	Truman	Propsect	**en-ex**	1054	741	1066	2861	0.54	2600	7078	2755	52160	7420	2966	57431	no	yes
WB 70	Prospect	Brooklyn	en-en	1168	0	842	2010	0.38	2200	6030	1835	56483	6320	2280	61885		
WB 70	Brooklyn	Paseo	**en-ex**	780	607	896	2283	0.43	2600	1835	2191	62513	2280	2297	68205	no	yes

Results

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Predictive Safety Results Summary, 20-Year Crashes

	Eval Length (mi)	Number of Crashes				Eval Length (mi)	Number of Crashes			
		PDO	F&I	Tot	EPDO		PDO	F&I	Tot	EPDO
No Build						**Modified Preferred Alternative**				
Mainline (Base*)	4.3	1,382	578	1,959	58,401	4.3	1,321	599	1,919	60,415
Ramps (Base*)	5.4	49	40	88	3,952	4.6	45	36	81	3,619
Horizontal Curves	1.8	784	520	1,304	52,161	1.7	548	366	914	36,659
Lane/Shoulder Widths	4.3	-17	56	39	5,470	4.3	-116	-67	-183	-6,699
Roadside Features (to be updated)										
Ramp Lane / Shoulder Widths	5.4	10	16	25	1,549	4.6	2	3	6	337
Congestion	5.5	359	183	542	18,425	5.5	313	159	472	16,010
Ramp Spacing	7.9	380	106	485	10,809	6.7	192	63	255	6,412
CD Roads	0.0	0	0	0	0	1.3	20	11	31	1,107
Total No-Build Crashes		**2,946**	**1,497**	**4,443**	**150,768**		**2,326**	**1,170**	**3,496**	**117,860**

Results

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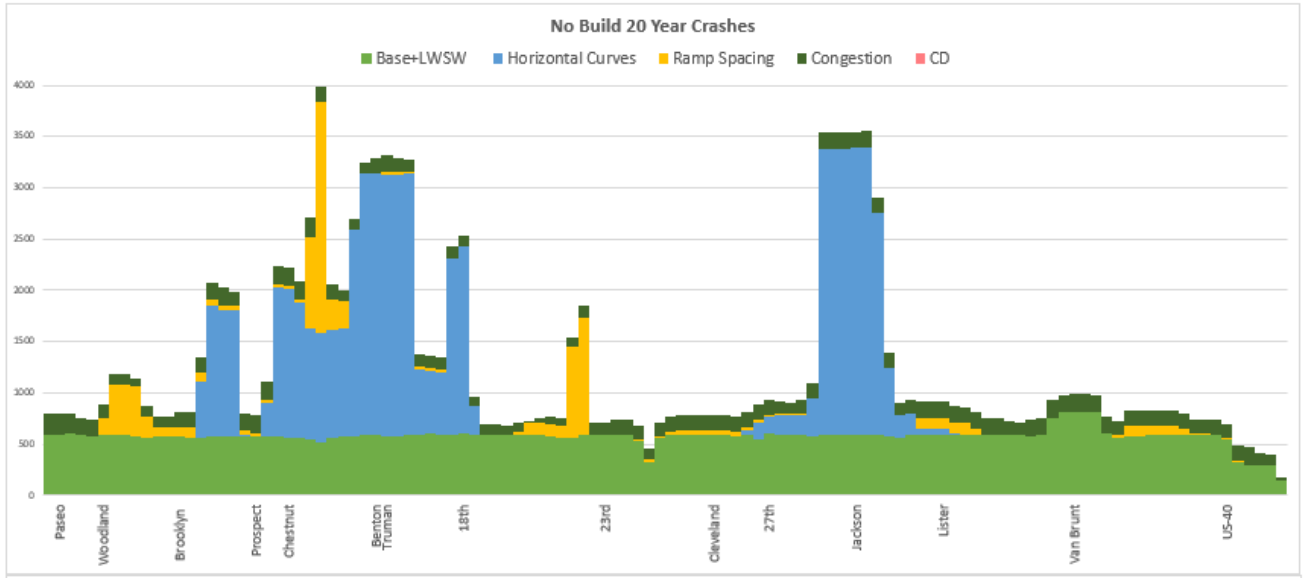
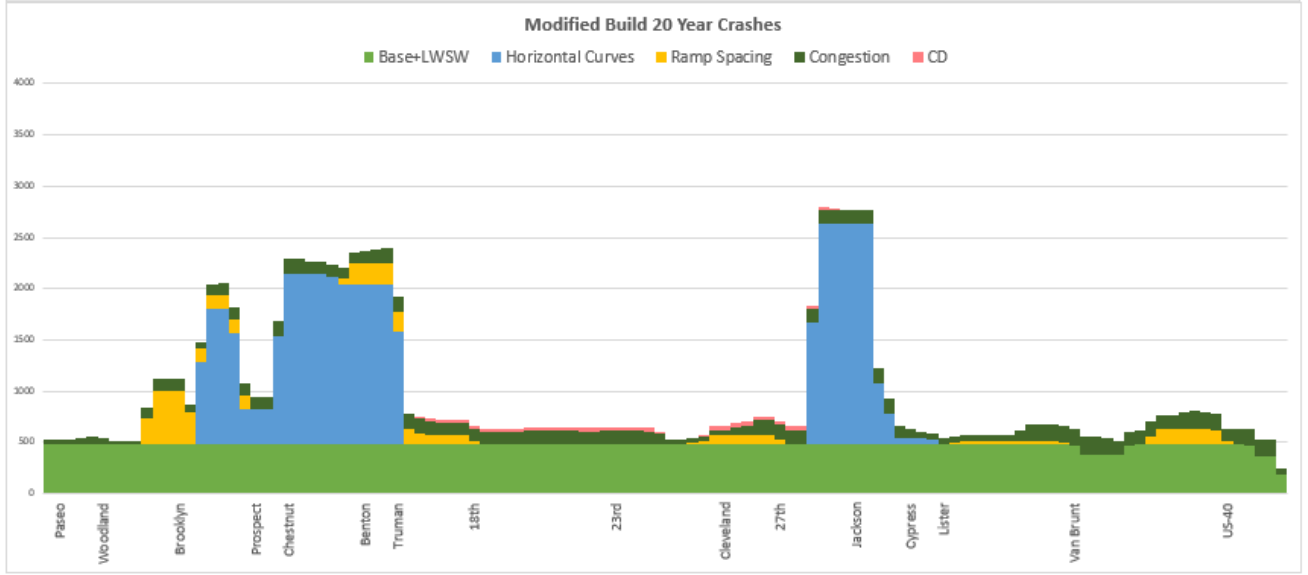
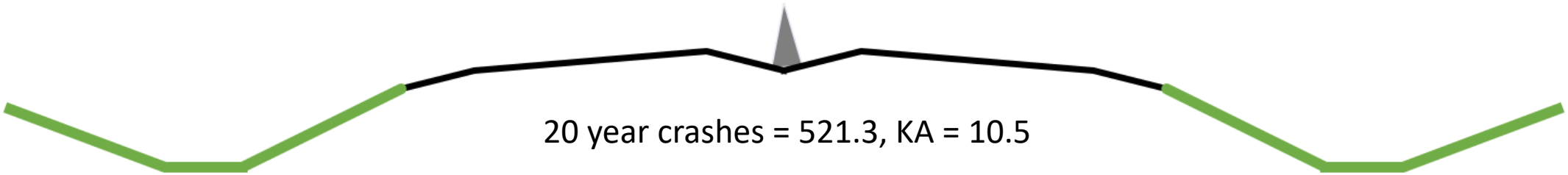


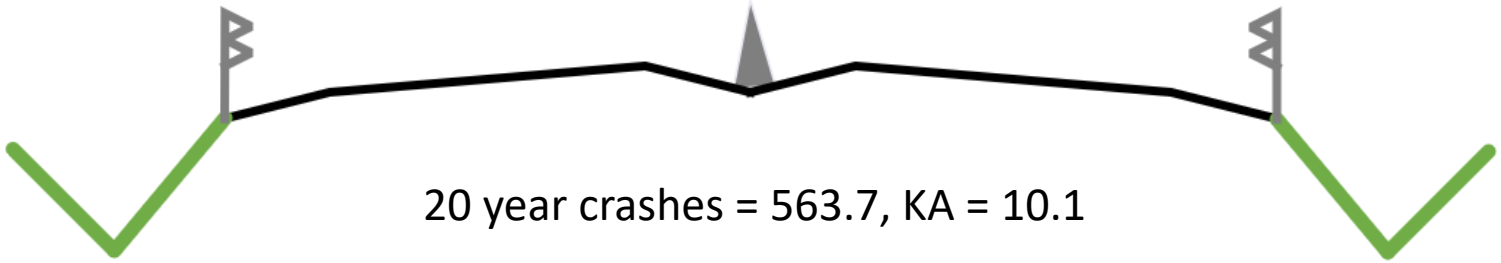


Guardrail vs. Clear Zone

Which is safer?



20 year crashes = 521.3, KA = 10.5



20 year crashes = 563.7, KA = 10.1

Sideslope

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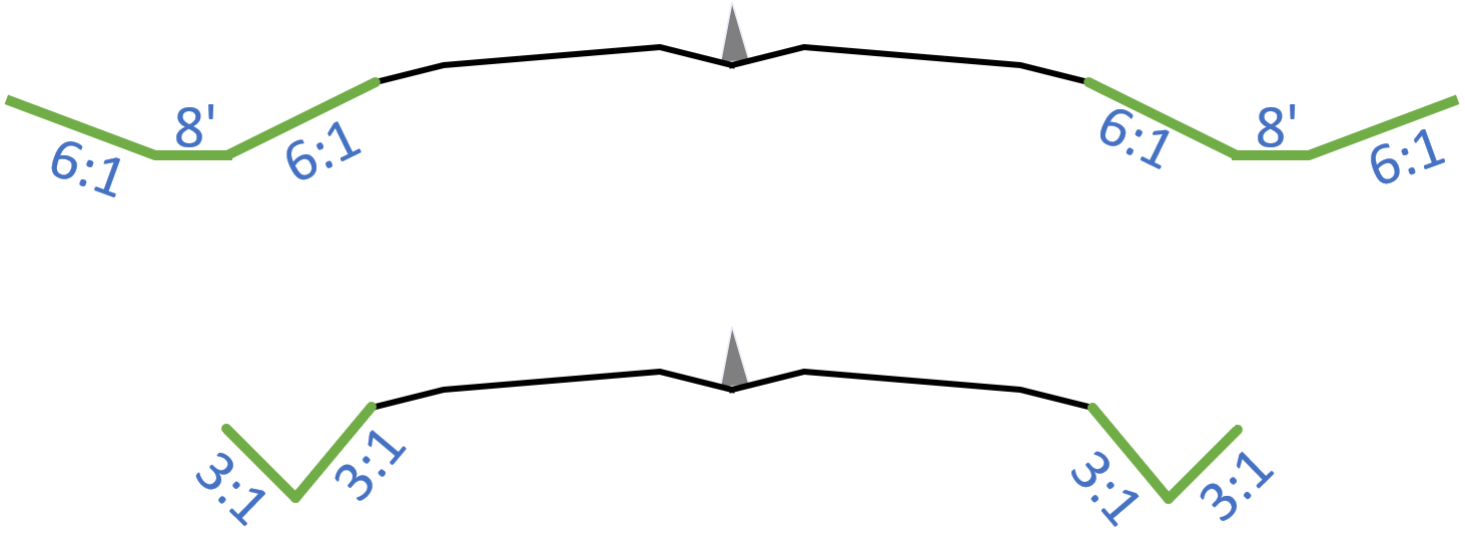

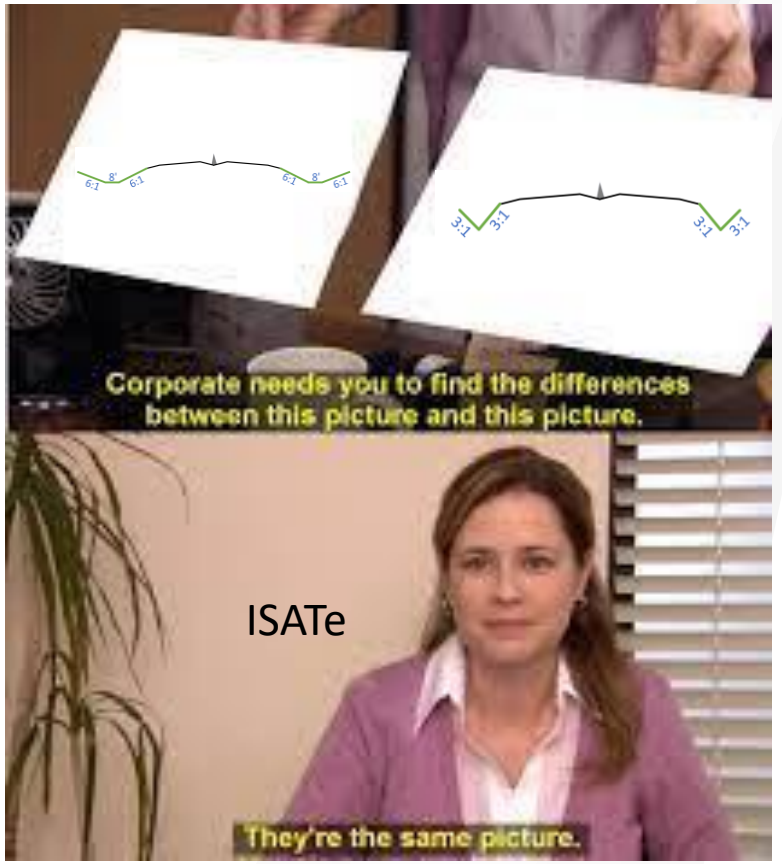

ISATe

Pedestrians

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- Vehicle #1, operated by Driver #1 was travelling eastbound on Interstate 70.
- Driver #1 only had a Missouri Identification card.
- Driver #1's blood tested positive for the presence of Cannabinoids (marijuana) in her
- Pedestrian #1 walked in front of Vehicle #1 causing the crash to occur.
- Pedestrian #1's blood tested positive for the presence of Methamphetamines.
- Pedestrian #1 died as a result of the collision events.
- No outside factors were determined to have contributed to the collision.

- Vehicle #2 was disabled in the #4 lane and was being pushed by the pedestrian, who was standing at the driver's door area, onto the shoulder.
- Driver #1's blood alcohol concentration was .214% at the time of the collision.
- Vehicle #1 struck Vehicle #2 and the pedestrian.
- The pedestrian died as a result of the injuries he sustained in the collision.

Lighting?
Frequency of grade-separated crossings?
Ability to see across highway?

- Driver #2 was operating Vehicle #2.
- Driver #2 had a valid Nebraska Operators license.
- Vehicle #1 was driving eastbound in the innermost lane when it hit Pedestrian #1 who was walking southbound across I-70. Driver #2 then ran over Pedestrian #2.
- Jackson County Medical Examiner's Forensic Toxicology records revealed Pedestrian #1 to have Ethanol (0.186 %(w/v)), Delta-9-THC (11.1 ng/mL), and THC-COOH (301 ng/mL) in his system at time of death. The Medical Examiner's Report stated the cause of death was multiple blunt force injuries.

1. Vehicle 1, operated by Driver 1, was westbound on Interstate 70.
2. The pedestrian walking in the westbound lanes of Interstate 70.
3. Drive 1 struck the Pedestrian with the front right portion of her vehicle.
4. The Pedestrian sustained fatal injuries as a result of the collision.

1) An unknown vehicle was traveling westbound on Interstate 70.
2) The unknown vehicle struck the Pedestrian.
3) The Pedestrian sustained fatal injuries as a result of the collision.

Lighting

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Are these results reliable

- Do we double count some crashes: Probably.
- Do we miss some crashes: Yes.
- Do we miss out on the cumulative evaluation abilities of HSM: Yes.

Questions?

Project Questions:

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