SAFETY EVALUATION OF FLASHING YELLOW ARROW INDICATIONS CONSIDERING INTERSECTION GEOMETRIC CHARACTERISTICS

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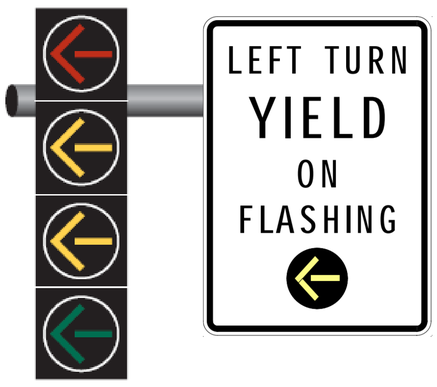
Introduction and Scope

Flashing yellow arrow indications (FYA) have been increasingly adopted to improve left-turn operations. Past studies have reported a wide range of FYA effects, but it has not been until recently that agencies have accumulated enough data to conduct comprehensive safety evaluations of FYA.

This poster presents preliminary data as part of an ongoing comprehensive study aimed at improving understanding of FYA operations in terms of crash rates, types, and severity as a function of traffic. design, and operational elements.



We highlight overall frequencies of left-turn crashes observed before and after FYA was implemented at locations with permissive, permissive-protected, and protected left-turn phases.

Data and Methodology

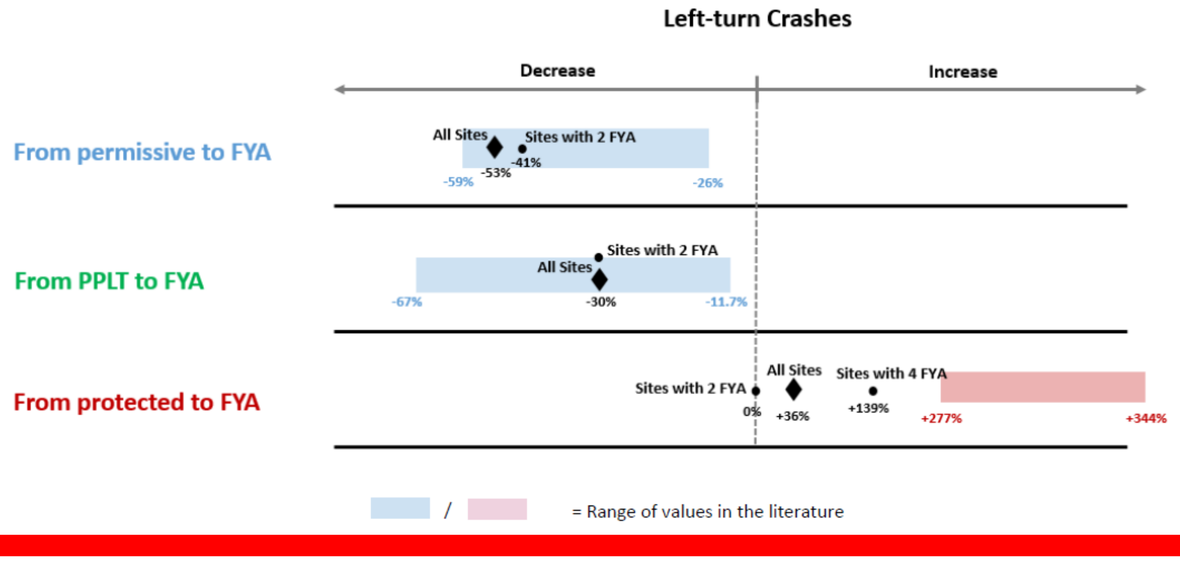
Preliminary results from 51 four-leg intersections in Utah are included in this analysis, where at least one approach of the intersection changed to FYA:

Left-Turn Phase Before FYA	Approaches with FYA Change			Total Intersections
	One	Two	Four	
Permitted	5	8	1	14
Permitted-Protected	2	15	2	19
Protected	2	10	6	18
Total	9	33	9	51

- The exact date FYA was installed at each location was obtained from written logs inside intersection cabinets.
- Crash types were limited to angle, front-to-rear, head-on, and sideswipe same and opposite directions for crashes within 250 feet from the intersection.
- This is an ongoing effort. Additional locations and historical data from untreated sites (without FYA) are being collected for a before-after study with comparison groups.

Left Turn Crashes

Left turn crashes are often severe and account for a significant proportion of intersection crashes. Signal phase changes from permissive, protected, or permissive-protected to FYA result in different effects on safety, as shown in this research and in other literature.



Crash Frequency

Naïve Before-After Results

Sample Group (# of intersections)			Σintersection-years		Σcrashes		Naïve Comparison with unequal periods of duration		Overall change in observed of LT crashes		Overall contribution of LT crashes to all crash types	
			Before	After	Before	After	Change in crash frequency for all intersections	Std Dev	%	Std Dev	Before	After
All Locations	Permitted to FYA	14	70	36.25	245	56	-62.2 (reduction)	13.2	-53% (reduction)	7%	29%	14%
	Permitted-protected to FYA	19	95	55.75	468	199	-83.4 (reduction)	21.9	-30% (reduction)	6%	30%	20%
	Protected to FYA	19	95	53	272	214	+57.7 (increase)	19.2	+36% (increase)	13%	19%	22%
Only with 2 opposing FYA	Permitted to FYA	8	40	24.8	124	42	-28.8 (reduction)	10.6	-41% (reduction)	11%	27%	14%
	Permitted-protected to FYA	14	70	41.5	376	172	-71.4 (reduction)	20.4	-30% (reduction)	7%	29%	21%
	Protected to FYA	10	50	26.4	127	63	0.2 (not significant)	-	<1% (not significant)	-	22%	16%
FYA in all four approaches	Protected to FYA	7	35	15.4	99	102	+59.8 (increase)	12.0	+139% (increase)	34%	15%	26%

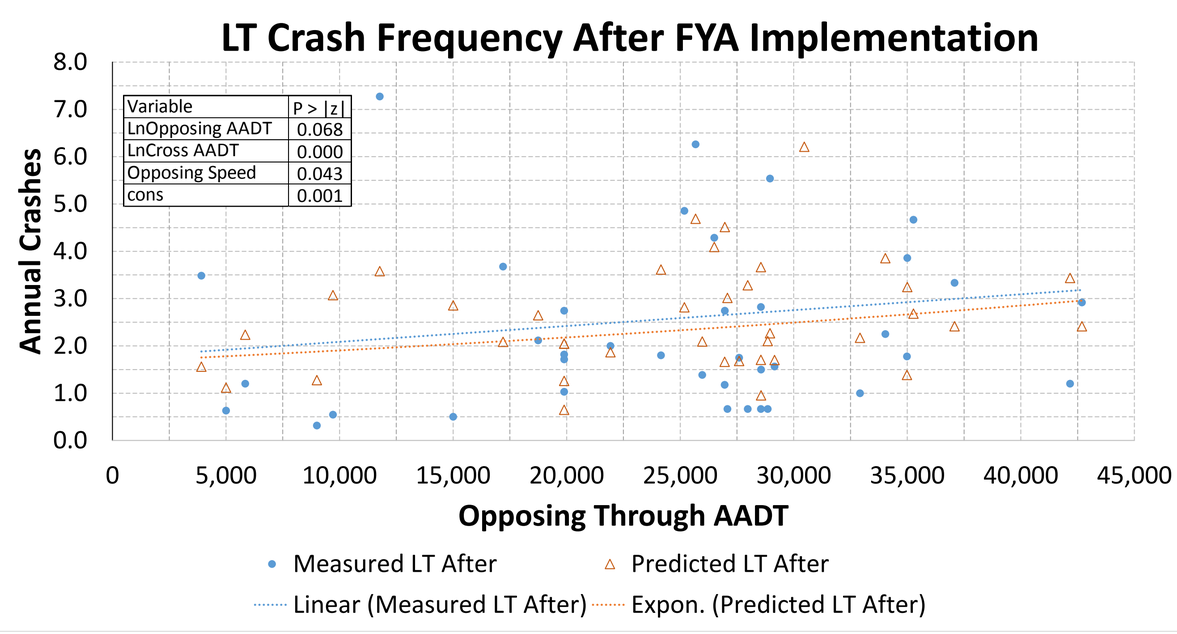
Effect of lead-lag FYA

- Utah DOT expressed that using lagging FYA sometimes resulted in a "perceived yellow trap"
- Utah DOT made a decision to change all FYA phases from lagging to leading

Site ID	FYA Approaches	LT Phasing Before	Lag Period			Lead Period		
			Duration (months)	Crashes	LT Crashes/Year	Duration (months)	Crashes	LT Crashes/Year
4650	4	Protected	7	54	93	18	18	12
257	4	Protected	34	9	3	18	3	2
4140	2	Protected	15	5	4	18	1	1
1804	2	Protected	24	15	8	18	7	5
1802	2	Protected	17	8	6	18	0	0
1046	2	PPT	51	63	15	18	5	3
5342	2	Permitted	48	9	2	18	1	1
7798	2	Permitted	36	13	4	18	1	1

Crash Frequency Models

$$\hat{\lambda}_{All} = \exp[-10.4015 + 0.4337(Ln\text{Opposing AADT}) + 0.6084(\text{LnCross AADT}) + 0.0326\text{OpposingSpeed}]$$



$$\hat{\lambda}_{All} = \exp[-9.347 + 0.3397(Ln\text{Opposing AADT}) + 0.6167(\text{LnCross AADT}) + 0.0342\text{OpposingSpeed} - 0.5138\text{OpposingProt} - 0.5672\text{FYA4Approaches}]$$

Variable	P > |z|
LnOpposing AADT	0.151
LnCross AADT	0.002
Opposing Speed	0.051
Opposing Protected	0.093
FYA4Approaches	0.092
cons	0.008

Acknowledgments

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