Evaluation of the Effectiveness of Converging Chevron Pavement Markings

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Introduction

Chevron pavement markings have seen rising interest in the U.S. as a means to reduce speeds at high-speed locations in a desire to improve safety performance. In Atlanta, there are two freeway-to-freeway ramps where chevron markings are being used. This poster presents an investigation into the effectiveness of the markings in reducing vehicle speeds on the two locations in Atlanta.

Study Objectives

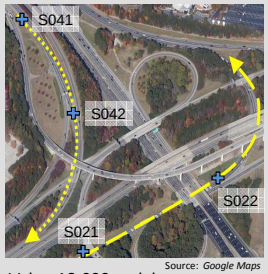
This research aims to evaluate the effectiveness of the chevron markings based on a statistical comparison of speeds before and after the installation of the markings at the two pre-selected sites in Atlanta. It also aims to quantify the potential impact of the treatment on safety and to understand the mechanism by which the treatment influences safety.

Study Sites

Site A – Interstate 75/85 interchange
- Treatment Ramp – I-75S to I-85N
- Control – I-85S to I-75N

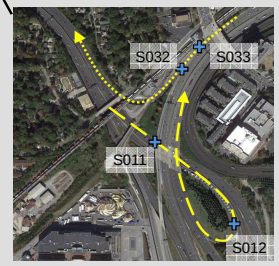
Site B – Interstate 75/285 interchange
- Treatment Ramp – I-285E to I-75N
- Control – I-75S to I-285W

Source: *Google Maps*



Source: *Google Maps*

Vol. = 18,600 vpdpl
Min. R = 500 ft
V_{S021} = 60 mph
V_{S022} = 45 mph



Source: *Google Maps*

Vol. = 18,600 vpdpl
Min. R = 150 ft
V_{S011} = 51 mph
V_{S012} = 31 mph

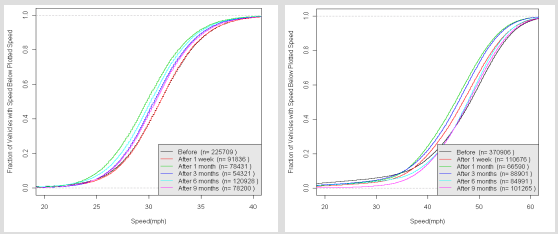
Data Description

- Streaming Per-Vehicle Record (PVR) data and binned vehicle data was recorded in the field and periodically downloaded for analysis.
- PVR record data for each vehicle included: *time stamp, lane number, vehicle class, vehicle speed, vehicle length, time headway,* and *distance between axles*.
- Data were collected between March 2008 and February 2009.
- The study compared speed distributions during six time-periods including:
  - Before the treatment (5 weeks of measurements)
  - One week after the treatment (1 week)
  - One month after the treatment (1 week)
  - Three months after the treatment (2 weeks)
  - Six months after the treatment (1 week)
  - Nine months after the treatment (1 week)

Data Analysis

Cumulative Speed Distribution Functions

- Vehicle speeds shifted to lower levels for 1, 3, 6, and 9 months after treatment, with the largest change observed after 1 month.
- By the 9th month, the largest observed shift at any percentile is on the order of 0.5 to 1 mph.

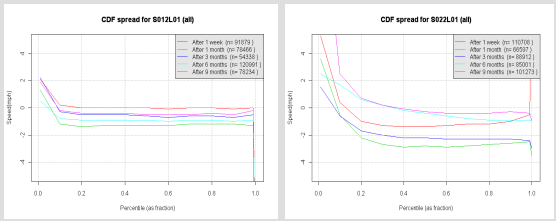


(a) (b)

CDF plot with PVR data (*n* denotes number of data points in the parentheses corresponding to each period): (a) Station S012, Lane 1, and (b) Station S022, Lane 1

Analysis of Speed Difference

- Speed reductions are observed over a broad percentile range; from approximately the 5th to past the 99th percentile.

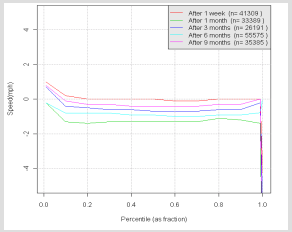


(a) (b)

Spread between CDF plots with PVR data for all vehicles: (a) Station S012, Lane 1, and (b) Station S022, Lane 1

Lead Vehicle Analysis

- Any vehicle with a headway of 5s or more is considered a leading vehicle for this analysis.
- Although sample size (n) is almost halved, the magnitude and direction of the shifts of the percentile speed differences for the leading vehicles are similar to the spread overall.



Spread between CDF plots with PVR data at Station S012 Lane 1 for leading vehicles

Monte Carlo Analysis

- Accounts for sampling differences and potential distributional difference between the data collected over different time periods.
- Mean effect of the chevrons is limited to 0.5 to 2.0 mph reduction in speed as the vehicles enter the controlling ramp geometry.

Speed Measurement	Ramp Type	Detector	Before Treatment (95% CI) (mph)	Nine Months After Treatment (95% CI) (mph)	Mean Diff Ninth Month - Before (95% CI) (mph)	Mean Diff Significant at 95% level
Downstream Detector Mean	Site A Treatment	S012 Left Lane	31.74 (31.55,31.92)	31.55 (31.34,31.75)	-0.19 (-0.47, 0.09)	No
		S012 Right Lane	32.42 (32.25,32.60)	32.13 (31.97,32.29)	-0.29 (-0.53, -0.06)	Yes
	Site A Control	S032 Left Lane	40.37 (40.13,40.61)	40.55 (40.31,40.78)	0.18 (-0.15, 0.51)	Yes
Reduction Between Detectors	Site A Treatment	S011 to S012 Left Lane	-20.28 (-20.63, -19.92)	-21.91 (-22.28, -21.55)	-1.64 (-2.15,-1.13)	Yes
		S011 to S012 Right Lane	-21.06 (-21.43, -20.70)	-22.31 (-22.65, -21.97)	-1.24 (-1.74,-0.74)	Yes
	Site A Control	S033 to S032 Left Lane	-16.99 (-17.55, -16.44)	-17.16 (-17.75, -16.56)	-1.05 (-1.79,-0.32)	Yes
Downstream Detector Mean	Site B Treatment	S022 Left Lane	48.03 (47.65,48.41)	48.47 (48.16,48.78)	0.44 (-0.05,0.93)	No
		S022 Right Lane	48.16 (47.76,48.57)	47.68 (47.37,47.99)	-0.48 (-0.99,0.03)	No
	Site B Control	S042 Left Lane	51.54 (51.20,51.88)	52.39 (52.08,52.71)	0.85 (0.39,1.32)	Yes
		S042 Right Lane	52.59 (52.22,52.97)	54.07, (53.76,54.39)	1.48 (0.99,1.96)	Yes
Reduction Between Detectors	Site B Treatment	S021 to S022 Left Lane	-12.32 (-12.90,-11.75)	-13.63 (-14.09,-13.16)	-1.30 (-2.04,-0.56)	Yes
		S021 to S022 Right Lane	-11.61 (-12.23,-10.99)	-14.16 (-14.63,-13.70)	-2.55 (-3.32,-1.77)	Yes
	Site B Control	S041 to S042 Left Lane	-0.22 (-0.72,0.28)	-3.22 (-3.66,-2.78)	-3.00 (-3.67,-2.33)	Yes
		S041 to S042 Right Lane	-0.68 (-1.21,-0.15)	-3.04 (-3.52,-2.56)	-2.36 (-3.08,-1.64)	Yes

Crash Data Analysis

- A cursory crash analysis indicated that the ramps had crash reductions of over 60 percent.
- Crash analysis on control sites are currently being conducted to come to a statistically-significant conclusion.

Conclusions & Further Research

- Chevrons had a minimal impact on vehicle speeds.
- Effect on speed was most pronounced immediately after the chevron implementation. By 9th month, magnitude of effect dropped to under 1 to 2 mph for the mean speed and most vehicle speed percentiles.
- Cursory crash analysis indicates that there are large crash reductions on treatment ramps. Statistical analysis using additional sites are currently being performed to validate findings.

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