STAFF REPORT

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To: Edina Transportation Commission

From: Joseph Totten, Traffic Safety Coordinator
Sean Hayford Oleary, Traffic Safety Intern

Subject: Effects of Vertical Reflective Strips on Stop Sign Compliance

Information / Background:

The purpose of this study was to measure the impact on driver behavior of installing a vertical reflective strip on the post of a stop sign at an all-way stop intersection. The intent was to measure speed of vehicles, as well as how frequently drivers slowed or stopped immediately adjacent to the stop sign.

The intersection studied was W. 42nd St. and Alden Dr. S., a 3-leg, all-way stop intersection in a residential neighborhood, adjacent to Weber Park and Golden Years Montessori School. That intersection is highlighted on the map to the right, and pictured below. The intersection has been the subject of neighborhood concerns that drivers are not complying with the stop signs.

Two separate video recordings were taken of westbound traffic at 42nd and Alden in Spring 2016. The first recording was done between Monday, March 28th and Wednesday March 30th. The second recording was done between Monday, May 2nd and Wednesday, May 4th. Due to weather conditions in the March video, both Wednesday recordings were excluded from the final analysis.

In the following sections, the study and its results are described. The appendix details the statistical basis for the results and conclusions.

Design of Study and Data Recorded

To identify the immediate stop sign area, a 20 foot distance was marked out on the pavement, from 10 feet beyond the stop sign to 10 feet behind the stop sign. Behavior was observed when the front bumper was between these two painted dots, and the time between them was measured to calculate speed. In the image to the right, the front and rear dots are circumscribed in white, with the stop sign in red.

Each set of three-day video recording was reviewed, and each westbound vehicle was individually observed and timed at 1x speed. The following information was recorded for each observation:

Variable Name	Description
is_mon	A variable to note if the observation took place on Monday, as opposed to Tuesday (Wednesday was excluded)
time	The timestamp of the observation
TbtwDots	Time where the front bumper of the vehicle was between the painted dots
Stop	Variable to note if the vehicle made a complete stop between the two dots
MinSpeed	Variable to note if the minimum speed observed was between the two dots
AfterBar	Variable to note if the observation was from after the vertical reflective strip was installed.
Nighttime	Variable to note if the observation occurred at night.
CalcSpeed	The calculated speed, in miles per hour, between the two dots (calculated from TbtwDots).

Measuring both the "MinSpeed" and "Stop" variables were fairly subjective, and recorded in the opinion of the observer. The MinSpeed was recorded as "1" (yes) when the vehicle appeared to reach their lowest speed between the two dots — even if that lowest speed was nowhere near a complete stop. A "Stop" variable was recorded when the wheels of the vehicle had even a moment of complete lack of movement, or if the suspension of the vehicle was clearly activated the vehicle appeared to stop.

Results

First, the data was tested to confirm whether the day of week affected the results — helping to verify that Weber Park sporting events, etc. were not significantly affecting driver behavior. There was no significant difference found between Monday and Tuesday observations.

The main analysis was testing whether the before/after status of the observation was significant in predicting three factors:

1. If the driver stopped completely
2. If the driver reached their minimum speed in the immediate stop sign area
3. How fast the driver was going in the immediate stop sign area.

No statistically significant effect was found on either drivers' tendencies to stop completely, or on their speed. There was a statistically significant effect found on their tendency to reach their minimum speed within the immediate stop sign area. However, this is not an indication of any practical impact; the R2 in this analysis was 0.0017. This means that less than 0.2% of the variation in whether or not the vehicle reached their minimum speed near the stop sign could be predicted by whether or not it was after the reflective strip went in.

These results are described in more detail in the appendix.

Other Comments

Complete stops were rare. Only 212 of 1,938 observed vehicles — 10.9% — made complete stops at the stop sign.

However, it appears that this is an intentional choice not to comply with the stop sign, rather than a driver being distracted or unable to see the stop sign. In 1,422 of 1,938 observations (73%), the driver had their minimum speed in the immediate stop sign area. The relatively low speeds also bolster the idea that drivers are responding to the stop sign, but not doing so by stopping completely: of 1,938 observations, only 4 exceeded 20 mph in the immediate stop sign area. In an additional 161 cases, the vehicle went through the stop sign area exceeding 10 mph.

Although these speeds may be unacceptably high, they do strongly indicate that even reckless drivers are still acknowledging the stop sign, as their speed is well below the 30 mph speed limit of the street.

Conclusion

This analysis does not demonstrate a statistically significant effect on frequency of full stops at the stop sign, or on the speed of vehicles in the immediate stop sign area. Although it does technically demonstrate a small effect on drivers reaching their minimum speed within the immediate stop sign area, the practical significance of this effect is extremely small.

In addition to this small effect, the statistically significant "MinSpeed" variable was only measuring the pattern of speed, and not the speeds themselves, or the legal compliance with the stop sign.

The reflective strips do not show a meaningful improvement in driver behavior and are not recommended for further installation.

Appendix: Regression Results

Observations and Variables

A total of 2,697 observations were recorded. Only motor vehicles with four or more wheels were observed, with bicycles and motorcycles excluded. After eliminating observations of vehicles who were stopping for reasons unrelated to traffic (for example, a school bus dropping off students), and excluding the Wednesday observations, 1,938 data points were used for further analysis.

The following variables were recorded:

Variable Name	Description
is_mon	Dummy variable to note if the observation took place on Monday. (1 = Monday)
time	The timestamp of the observation (string)
TbtwDots	Time where the front bumper of the vehicle was between the painted dots (seconds, to the nearest decisecond)
Stop	Dummy variable to note if the vehicle made a complete stop between the two dots (1 = Stopped)*
MinSpeed	Dummy variable to note if the minimum speed observed was between the two dots (1 = Yes)**
AfterBar	Dummy variable to note if the observation was from after the vertical reflective strip was installed. (1 = After)
Nighttime	Dummy variable to note if the observation occurred at night — as measured based on civil twilight and civil dawn. (1 = Nighttime)
CalcSpeed	The calculated speed, in miles per hour, between the two dots (calculated from TbtwDots).

* Measuring the stop variable was highly subjective. In general, a stop was recorded if the vehicle's wheels were observed having made a complete cessation of movement (even if only momentarily). If the vehicle's wheels were not plainly visible, a stop was recorded if the suspension caused the vehicle to rock and a stop appeared to take place in the opinion of the observer.

** Minimum speed was measured only if the minimum speed within the frame was observed between the two painted dots. However, this measures the pattern of the speed, not the absolute speed. A vehicle going a very high speed may have braked briefly right behind the stop sign and been recorded as a MinSpeed = 1, while a vehicle going a continuous, slow speed throughout the entire frame would have been recorded as MinSpeed = 0.

Analysis and Results

Regression analyses were done to determine whether there were statistically significant differences between the before and after conditions. In each case, "AfterBar" was the independent variable, while the impact on multiple dependent variables was measured through separate regressions. For "MinSpeed" and "Stop," logistic regression was used to describe the change in odds.

In only one case was AfterBar a statistically significant variable at the 0.05 level, although the explanatory value was low.

Minimum Speed Between Dots (MinSpeed)

AfterBar was statistically significant on the dependent variable of MinSpeed, and the impact was a ~24% increase in the odds of the driver stopping in the stop sign area. However, the pseudo R2 was only 0.0017 — indicating that only about 0.17% of the variation in minimum-speed compliance was explained by the before/after status of the observation.

Variable	Odds ratio	SE	p-value	95% CI
(Intercept)	2.403	0.204	0.000	2.034-2.839
AfterBar	1.237	0.132	0.047	1.003-1.525

Table 1: Logistic regression of minimum speed dummy variable. Pseudo $R^2 = 0.0017$

Complete Stops (Stop)

AfterBar was not statistically significant in the number of complete stops, and the R2 was very low. Additionally, analysis of complete stops is unreliable given the small number of complete stops. (See "Other Comments" on page 4.)

Variable	Odds ratio	SE	p-value	95% CI
(Intercept)	0.106	0.013	0.000	0.082-0.137
AfterBar	1.242	0.196	0.170	0.911-1.692

Table 2: Logistic regression of complete stop dummy variable. Pseudo $R^2 = 0.0014$

Calculated Speed (CalcSpd)

AfterBar was not statistically significant on the calculated speed, and the coefficient was very small. The adjusted R2 was 0.0005.

Variable	β (mph)	SE	p-value	95% CI
(Intercept)	6.518	0.103	0.000	6.316-6.719
AfterBar	-0.180	0.127	0.156	-0.429-0.068

Table 3: Regression of calculated speed in the immediate 20' stop sign area. Adj. $R^2 = 0.0005$