TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

Project Summary Report 1769-S
Project 0-1769: Identify Design Factors That Affect Driver Speed and Behavior

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PROJECT SUMMARY REPORT

# Design Factors That Affect Driver Speed on Suburban Arterials

Driver behavior is affected by many roadway factors. This project investigated which geometric, roadside, and traffic control device variables have an effect on driver behavior on major suburban arterials. If a direct relationship can be found, then the information could be used to improve selection of design elements. An inherent improvement of safety and operations should be realized when the designer's intended speed matches the operating speed on a facility.

## What We Did . . .

The project was subdivided into two phases. The goal of Phase I was to identify the best data collection method, balancing the need of a large database of study sites (to expand the possibility of finding variables that affect speed) with the need for high quality of data (to expand the possibility of finding statistically valid results). After reviewing several different techniques, two were selected as the most promising.

In the Laser Pilot Study we collected approximately 100 speed profiles of free-flowing vehicles as they approached, traversed, and departed six study sites. We used laser guns, similar to radar guns but far more precise, to track individual vehicles through the study sites.

The Individual Driver Pilot Study used an instrumented test vehicle and six drivers to acquire speed profiles of a predetermined route.

While each of the pilot studies provided insight into the effects of roadway geometric, roadside, and traffic control elements on speed, the Laser Pilot Study provided data at more sites with a greater variety of test conditions for less cost than the Individual Driver Study.

In Phase II we expanded the Laser Pilot Study with modifications to expedite data collection and reduction. We collected speed profiles of free-flowing vehicles on 24 horizontal curves and 36 straight sections. Several areas of Texas were visited for data collection activities such as Houston, Dallas/Fort Worth, San Antonio, Bryan/College Station, and others. In all, we analyzed data from 19 of the horizontal curve sites and all of the 36 straight section sites. Figure 1 shows an example of a typical horizontal curve study site. Figure 2 shows an example of a typical straight section site.

In the first step of the analysis, we determined where speeds were most influenced within the curve or along the straight section. For curves the minimum speeds occurred between the mid and three-quarter point of the curve. For straight sections, the area of maximum speed was not as evident. Most of the highest speeds occurred within the 30 to 70 percent range. The speed at the middle of the straight section was selected for investigation.

Figure 1. An example of a typical horizontal curve study site

In order to determine which design factors influence speed, we used multiple regression techniques to correlate the array of potential variables to the measured 85th percentile speeds. We initially investigated four categories of potential variables: alignment, cross section, roadside, and traffic control device. Table 1 summarizes the findings. Alignment and cross section categories each explained about 25 percent of the variation in the speed data for both the curve sections and the straight sections. Roadside variables were not significant in explaining the speed variability for straight sections and explained about 40 percent of the operating speed on curve sections. The traffic control device variable posted speed limit was the best predictor of operating speed, explaining about 50 percent of the variability for both curve sections and straight sections.

Figure 2. An example of a typical straight section site

After the categorical analyses were complete, all significant variables were combined and investigated further (see "All" category in Table 1). For curve sections, posted speed limit, deflection angle, and access density classes were significant. Figure 3 illustrates the relationship between 85th percentile speed on horizontal curves and deflection angle by access density class (posted speed was assumed to be 56 km/h [35 mph] for this figure).

Posted speed limit was found to be significant in both the curve and straight section cases. However, 85th percentile speed is frequently used to set the posted speed limit. Therefore, another series of analyses were performed that did

**Table 1. Summary of Regression Analyses**

| **CATEGORY**<br>**Potential Variables** | **Curve Sections Significant Variables (Adjusted $R^2$, %)** | **Straight Sections Significant Variables (Adjusted $R^2$, %)** |
|---|---|---|
| **ALIGNMENT**<br>Curve radius, Curve length, Deflection angle, Length of straight section, Potential controlling feature upstream and downstream of site, Distance of potential controlling features | Curve Radius<br>Deflection Angle<br>(21) | Downstream Distance To Control<br>(17) |
| **CROSS SECTION**<br>Lane width, Superelevation, Parking, Bike lane, Median type and width | Median Presence<br>(24) | Average Lane Width<br>(25) |
| **ROADSIDE**<br>Roadside development, Access density, Roadside environment, Pedestrian activity | Access Density Classes<br>Roadside Development<br>(40) | No Variables Found Significant<br>(N/A) |
| **TRAFFIC CONTROL DEVICE**<br>Signals per kilometer, Posted speed limit, Presence of curve/turn warning signs, Presence (and value) of advisory speed signs | Posted Speed Limit<br>(49) | Posted Speed Limit<br>(53) |
| **ALL**<br>[with Posted Speed Limit Considered] | Posted Speed Limit<br>Deflection Angle<br>Access Density Classes<br>(71) | Posted Speed Limit<br>(53) |
| **ALL**<br>[with Posted Speed Limit Considered] | Median Presence<br>Roadside Development<br>(52) | Average Lane Width<br>(25) |

not consider the influence of posted speed limit. The last row in Table 1 summarizes the results. Without speed limit, lane width is the only significant variable for straight sections. For curve sites, the impact of median presence (i.e., no median versus either a two-way left-turn lane (TWLTL) or raised median) now becomes significant together with roadside development (classified as commercial, park residential, or school).

Interestingly, the majority of speed studies on horizontal curves, regardless of the functional classification, have identified horizontal curve radius or degree of curvature as a key variable for explaining the variation of speed on a curve. However, in this study the statistical evaluation demonstrated that deflection angle is the horizontal curve variable that best contributes to explaining the variation in speeds on a horizontal curve when speed limit is included in the model.

## What We Found . . .

Posted speed limit was found to be significant in both the curve and straight section cases. However, 85th percentile speed is frequently used to set the posted speed limit. Therefore, another series of analyses were performed that did not consider the influence of posted speed limit. The last row in Table 1 summarizes the results. Without speed limit, lane width is the only significant variable for straight sections. For curve sites, the impact of median presence (i.e., no median versus either a TWLTL or raised median) now becomes significant together with roadside development (classified as commercial, park residential, or school). Interestingly, the majority of speed studies on horizontal curves, regardless of the functional classification, have identified horizontal curve radius or degree of curvature as a key variable for explaining the variation of speed on a curve. However, in this study the statistical evaluation demonstrated that deflection angle is the horizontal curve variable that best contributes to explaining the variation in speeds on a horizontal curve when speed limit is included in the model.

## The Researchers Recommend . . .

The following recommendations were developed based upon the findings and conclusions made within this study. The following key findings could be included in future editions of the Department's design manual and appropriate training courses:

- On suburban arterial horizontal curves, higher speeds should be expected when the access density is less than 12 pts/km (19.3 pts/mi) and when a median (e.g., TWLTL or raised) is used. In addition, high deflection angle values are associated with lower speeds, and higher speeds are associated with higher posted speed limit values.

- On suburban arterial straight sections away from a traffic signal, higher speeds should be expected with greater lane widths.

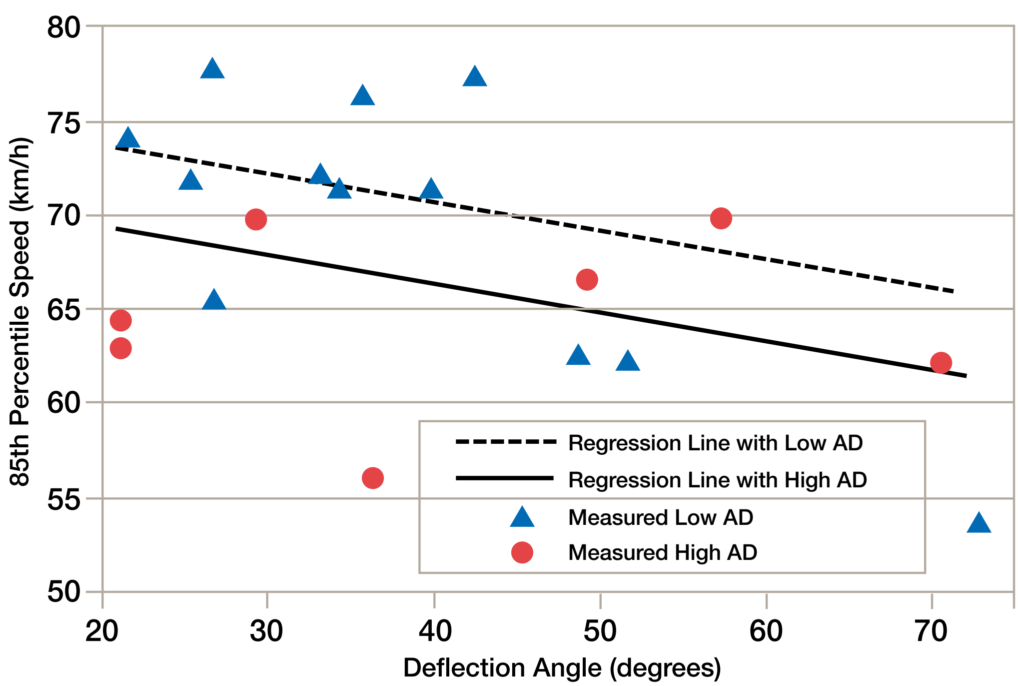


Figure 3. Deflection Angle versus 85th Percentile Speed for Horizontal Curve Sites (Posted Speed Assumed to Be 56 km/h [35 mph])

## For More Details . . .

The research is documented in Report 1769-3, *Design Factors That Affect Driver Speed on Suburban Arterials*

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**To obtain copies of the report, contact Dolores Hott, Texas Transportation Institute, Information & Technology Exchange Center, (979) 845-4853, or e-mail d-hott@tamu.edu. See our catalog on-line at http://tti.tamu.edu.**

## TxDOT Implementation Status
## November 2000

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TxDOT feels that the research project established baseline information regarding the impact of design features on driver speed on suburban arterials. The research provides supplemental information for designers and planners that will help in the analysis of how certain geometric design features may affect driver speed. The researchers identified posted speed, lane width, deflection angle, median presence, adjacent development, and access point density as being associated with the speed selected by drivers on four-lane suburban arterials. TxDOT implementation of this research will be instituted by use of the derived information as a supplemental design tool and a training tool to enhance the understanding of the trade-offs that are present when selecting roadway features.

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