

Safety Effectiveness of High-Speed Expressway Signals

tech transfer summary

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RESEARCH PROJECT TITLE

Safety Effectiveness of High-Speed Expressway Signals

SPONSORS

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On average, signaling high-speed expressway intersections has only marginal safety benefit.

Objectives

- Analyze the safety benefits of high-speed expressway signals
- Compare the results of typical and state-of-the-art analysis techniques

Problem Statement

High-speed expressways are becoming increasingly common as two-lane roads are improved to handle suburban and rural traffic growth. Characterized by at-grade intersections and at least two lanes of traffic in each direction, these facilities are separated by a median and often have speed limits of 50 mph or greater. As traffic levels increase, stop-controlled intersections are often signalized to improve operational or safety performance. Unfortunately, rather than improving safety, signalization may simply replace right-angle crashes with rear-end collisions, often with similar severities. As high-speed crashes are amongst the most severe, safety performance of these intersections was the focus of this research.

Research Description

Data were assembled for 45 at-grade intersections of four-lane, median-separated highways in Iowa, with speed limits of 55 mph (the highest speed for such intersections in the state). For each intersection, aerial imagery was examined to verify the presence of signal control and to eliminate intersections with unusual geometric characteristics.

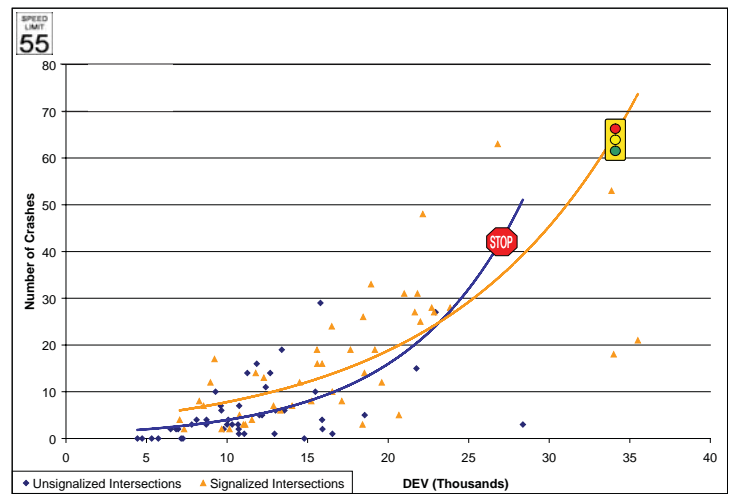
The intersections were studied using three techniques:

- Matched-pairs comparison
- Before-and-after analysis
- Empirical Bayes (EB) adjusted before-and-after analysis

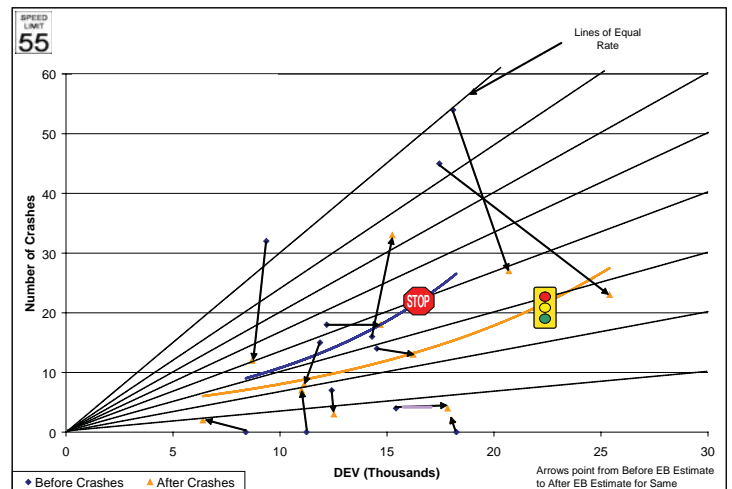
To analyze the safety of the high-speed signalized intersections using matched-pairs comparison, 45 unsignalized sites with similar characteristics were identified and three years of data were assembled. For the before-and-after and EB analyses, three years of before and three years of after crash data were available for 12 locations, signalized between 1994 and 2001. Iowa DOT values for crashes by severity type were used to compute total crash cost savings (or losses) for each method.

Key Findings

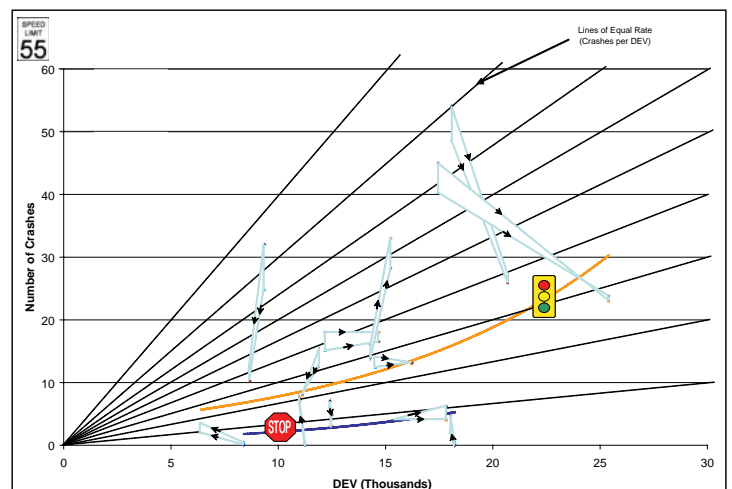
- The matched-pairs analysis resulted in a crash rate of 0.340 crashes per million entering vehicles (MEV) for unsignalized intersections. By comparison, the crash rate for signalized intersections was 0.799 crashes per MEV. Fatal crash rate, fatality rate, and the average crash costs were slightly lower for the signalized intersections.
- Before-and-after analysis resulted in a crash rate of 0.854 crashes per MEV before signalization and 0.754 crashes per MEV after. Fatality rate, fatal and major injury crash rate, and broadside crash rate were lower after signalization. As expected, broadside crash rates were higher prior to signalization, with rear-end rate higher in the after period.
- Adjusted by the EB procedure, a crash rate of 0.792 crashes per MEV was computed before signalization and 0.754 crashes per MEV after. For these data and analyses, the EB adjustment was marginal overall. However, for specific sites, the adjustment resulted in meaningful differences.
- The choice of analysis method and safety performance measurer has significant impacts on the results. Matched-pairs analysis indicated a fairly significant benefit of signalization, at least for major injury and fatal crashes. While before-and-after analysis using 3 years of before-and-after data (a method many safety analysts would be very comfortable with) indicates a marginal safety benefit of signalization (as defined by crash rate), the state-of-the-art EB method reduces the estimate of this benefit.
- The cost analysis (using before-and-after data and EB crash frequency estimates) indicates that the total cost of crashes is much higher for signalized intersections, challenging the use of signals to improve safety at these locations.
- Future work should include a careful examination of the sites to determine if local conditions permit some signals to improve safety while others may not. While all Iowa high-speed signalized expressway intersections were considered in this study, the limited number of study locations suggests that additional data should be obtained from other states to improve the models and confidence in the results.



Comparison of signalized and unsignalized crash frequencies, matched-pair analysis



Comparison of signalized and unsignalized crash frequencies, before-and-after analysis



Comparison of signalized and unsignalized crash frequencies, Empirical Bayes analysis