| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| FHWA/TX-03/4027-2 | | |

| 4. Title and Subtitle | 5. Report Date |
|---|---|
| ENGINEERING COUNTERMEASURES TO REDUCE RED-LIGHT-RUNNING | August 2002 |
| | 6. Performing Organization Code |

| 7. Author(s) | 8. Performing Organization Report No. |
|---|---|
| James Bonneson, Karl Zimmerman, and Marcus Brewer | Report 4027-2 |

| 9. Performing Organization Name and Address | 10. Work Unit No. (TRAIS) |
|---|---|
| Texas Transportation Institute<br>The Texas A&M University System<br>College Station, Texas 77843-3135 | 11. Contract or Grant No.<br>Project No. 0-4027 |

| 12. Sponsoring Agency Name and Address | 13. Type of Report and Period Covered |
|---|---|
| Texas Department of Transportation<br>Research and Technology Implementation Office<br>P.O. Box 5080<br>Austin, Texas 78763-5080 | Research:<br>September 2000 - August 2002 |
| | 14. Sponsoring Agency Code |

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Project Title: Signalization Countermeasures to Reduce Red-Light-Running

16. Abstract

Red-light-running is a significant problem throughout the United States and Texas. It is associated with frequent and severe crashes. Engineering countermeasures represent a useful means of combating the red-light-running problem because they are passively applied (in contrast to enforcement countermeasures which are considered to be overt and punitive) and are in the direct control of the agency responsible for the signal. The objective of this research project was to describe how engineering countermeasures can be used to minimize the frequency of red-light-running and associated crashes at intersections.

This report documents the work performed, findings, and conclusions reached as a result of a two-year research project. During the first-year, engineering countermeasures were identified and implemented at 10 intersections in five Texas cities. Before-after studies of red-light-running frequency were then conducted at each intersection. Also, the three-year crash history for each intersection was compared to its observed frequency of red-light-running. The findings from these studies indicate that the frequency of red-light-running decreases in a predictable way with decreasing approach flow rate, longer clearance path lengths, longer headways, and longer yellow interval durations. The crash data analyses indicate that right-angle crashes increase exponentially with an increasing frequency of red-light-running. Models for computing an intersection approach's red-light-running frequency and related crash rate are described. Guidelines for selecting appropriate engineering countermeasures and evaluating their performance are provided.

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Signalized Intersections, Change Interval, Yellow Interval, Red-Light-Running | No restrictions. This document is available to the public through NTIS:<br>National Technical Information Service<br>5285 Port Royal Road<br>Springfield, Virginia 22161 |

| 19. Security Classif.(of this report) | 20. Security Classif.(of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 122 | |

*Evaluation*

The effectiveness of the countermeasures listed in Table 4-3 were evaluated using a "log-odds ratio" test, as described by Griffin and Flowers (*35*). This test compares the ratio of the red-light-running frequency of the "after" study period to that of the "before" period. This ratio is computed for both the sites receiving a countermeasure (i.e., the treated sites) and those not receiving a countermeasure (i.e., the control sites). The ratio of these two ratios represents the "relative change" due to the countermeasure with respect to any change found at the control sites. To determine if this relative change is significant, it can be used to compute a "z-statistic" that follows the standard normal distribution. This statistic can be used to identify the probability of falsely rejecting the null hypothesis (i.e., that there is no change). The results of the analysis are listed in Table 5-7.

The information listed near the bottom of Table 5-7 indicates that, overall, the mix of countermeasures appear to have resulted in a 48 percent reduction in red-light-running. This reduction is statistically significant. It should also be noted that red-light-running *increased* overall by 45 percent at the control sites (= 1.45 × 100 - 100), as indicated by the statistic in column 6.

Several of the countermeasures reduced red-light-running. The use of yellow LEDs in Mexia is associated with a 49 percent reduction in red-light-running. The sample size is too small to be certain that this reduction is significant (i.e., there is a 31 percent chance that more observations would indicate that there is truly no reduction due to the use of LEDs). Nevertheless, it represents the "best estimate" of the effect of this countermeasure.

The increase in yellow duration at the College Station and Richardson sites is associated with a decrease in red-light-running. The last two rows of Table 5-7 combine the data from these two sites. Analysis of this data indicates that a change in yellow duration is associated with a 70 percent reduction in red-light-running. This reduction is statistically significant.

The findings from the study in Corpus Christi were difficult to interpret due to an unexpected deviation from the study plan. The deviation was that an unintended change was made to the yellow duration at the control site prior to the "after" study. The trend in the data associated with this city suggests that the combined use of back plates and increased yellow duration is associated with an 18 percent reduction in red-light-running. The increase in cycle length is associated with a 25 percent increase in red-light-running. This effect of cycle length is contrary to the findings presented in a previous section. However, these trends are likely biased by "regional" changes in red-light-running, as were found in the other cities. Hence, the findings from this city are difficult to properly interpret without data from a control site.