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Abridgment

Guidelines for Treatment of Right-Turn Movements on Rural Roads

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A survey of state departments of transportation conducted to identify the criteria currently used in selecting road designs to accommodate right-turning vehicles on rural roads revealed that the decisions are based primarily on judgment. The survey also identified factors to be considered in establishing criteria. Field work identified the range of traffic and roadway conditions encountered at selected rural locations and the effectiveness of the treatments. Guidelines were developed through an analysis of survey responses, field data, and judgment. They are based on the peak-hour (or design-hour) volumes for right-turning traffic and total traffic on the approach to the right-turn treatment. Guidelines are available for two- and four-lane roadways. Other factors to be considered are noted.

The objective of the research reported in this paper was to develop guidelines for the treatment of right-turn maneuvers on rural roads that would be applicable for a wide range of conditions at intersections. The treatments considered were a radius, a 150-ft taper, and a full-width turn lane. The volumes and speeds of right-turning and through traffic were the primary factors considered, and the research was limited to treatments for nonsignalized intersections. Information on which to base the guidelines was obtained from a survey of state departments of transportation, conversations with traffic engineers in Virginia, and studies of selected rural intersections.

SURVEY OF STATE DEPARTMENTS OF TRANSPORTATION

The survey of state departments of transportation (DOTs) was conducted by telephone. If a policy or procedure was in use, a written document was requested. Responses were obtained from 41 of the 48 contiguous states. Of the 25 states without criteria, most consider special right-turn treatment on a project-by-project basis. Whereas several states seldom consider special treatment for right turns in rural areas, 39 percent, or 16, of the state DOTs contacted used some form of criteria. Five guidelines were based on volume conditions, 4 on roadway type, 2 on capacity, and 5 on rule of thumb at intersections. The guidelines should provide efficient use of treatments for right-turn movements and consistent treatment of right-turn movements throughout the state.

Based on the literature review and survey, the following parameters were selected for consideration in the guidelines: (a) total or through traffic volume, (b) right-turn traffic volume, (c) speed prior to the intersection, (d) traffic conflicts due to right-turning vehicles, (e) capacity analysis, and (f) accident history.

FIELD WORK AND ANALYSIS

The traffic data were collected in two stages: a 48-h count and two 2-h peak-period observations. For the 48-h traffic count, counters were placed prior to the intersection for total volume counts on the approach to the study site and at the intersection for right-turn volume counts. The average daily traffic count and peak 2-h period were determined through a computer analysis. In the next stage, observations were made during two 2-h peak periods to obtain volume counts for all approaches, traffic conflicts due to right-turning vehicles, and speed data on the study approach. Data were collected over 15-min intervals by using a procedure developed by Glauz and Migletz (1).

Twenty-one sites were selected under three classifications. Eight sites were four-lane arterials intersecting two-lane roads, 8 were intersections of two-lane arterials and two-lane roads, and 5 were intersections of two secondary roads. There were 7 sites for each right-turn treatment. There were 11 T-intersections and 10 cross (or four-legged) intersections. There was variability in the lengths and widths of right-turn treatments, and the minor roadway was controlled by a stop sign.

The data analysis used the Statistical Package for the Social Sciences (2) and consisted of two stages: (a) the Pearson correlation to identify parameter pairs that were strongly related and (b) a regression analysis to define the linear relations between these pairs. The study sites were grouped in three ways: by site classification, by type of right-turn treatment, and by right-turn treatment and number of lanes on the major approach. The third grouping was most useful in developing the guidelines.

The analyses indicated that the strongest correlations were between peak-hour-volume right-turn conflicts (PHV conflict) and peak-hour-volume percentage of right turns (PHV % right turns) and between PHV conflict and PHV right turns. The peak-hour period was selected because it is the recommended design period in the American Association of State Highway Officials "Blue Book" (3). There was a strong interest in using PHV total and right-turn volumes. For existing intersections, the

use of conflicts requires trained personnel and man-hours for observation, whereas volume counts require only mechanical counters. For proposed intersection sites, an estimate of conflicts adds uncertainty, since it would be based on forecast volume data. However, the correlations were not as strong for PHV total and PHV right turn. For these reasons, no clear-cut guidelines resulted from the field data.

GUIDELINES FOR RIGHT-TURN MOVEMENTS

In view of the above, guidelines were developed by using a synthesis of the field data, guidelines of state DOTs, and engineering judgment. The field data provided the basic framework for the guidelines, but the standards used by other state DOTs, especially Iowa and Idaho, were strong influences. Finally, where the first two items were insufficient, engineering judgment was used.

An explanation of how this was accomplished for two-lane highways is given below. Figure 1 shows the regression lines for the radius and lane treatments and the positions of the study sites, where R, L, and T indicate radius, lane, and taper sites, respectively. The R^2 value for the radius line is 0.6 and that for the lane line is 0.2. Since the R^2 value for the taper line was less than 0.1, this line was not used. The area below the radius suggests a radius treatment, the area between the two lines suggests a taper treatment, and the area above the lane line suggests a lane treatment.

When the guidelines of state DOTs and judgment were used, the guidelines for right-turn movements took the form of Figure 2. The taper range was expanded on the Y-axis by using data from other guidelines, and the lines were leveled off at the points of maximum total PHV for the field sites. The volume conditions for the respective treatments for two-lane highways are indicated.

It was noted that there were more PHV right turns on highways with speed limits under 55 mph. These roads had radius treatments and residential or commercial development close to the roadside without available right-of-way for any special treatment. An adjustment was needed to accommodate these sites effectively in the guidelines.

For two-lane highways with posted speeds of 45

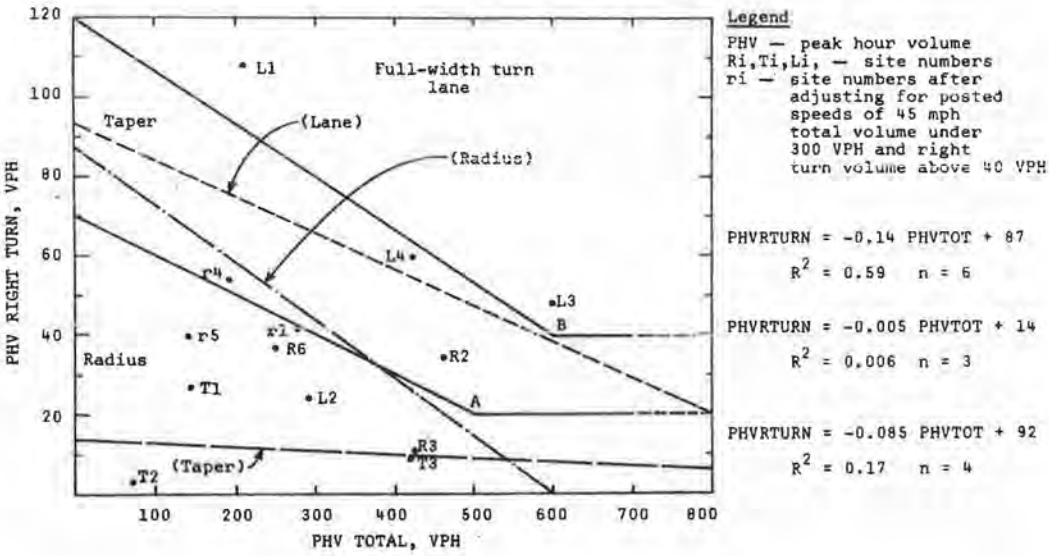


Figure 1. Development of guidelines for right-turn treatment: two-lane road.

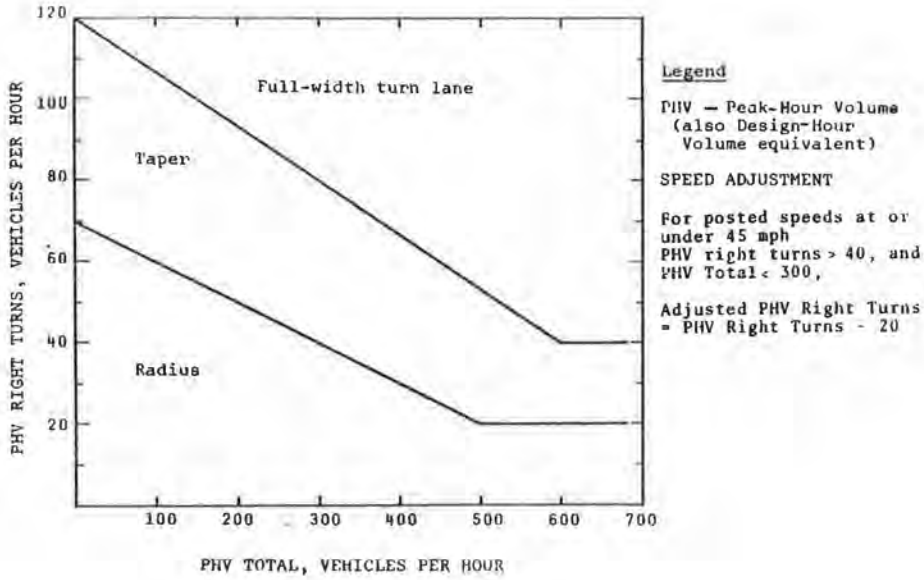
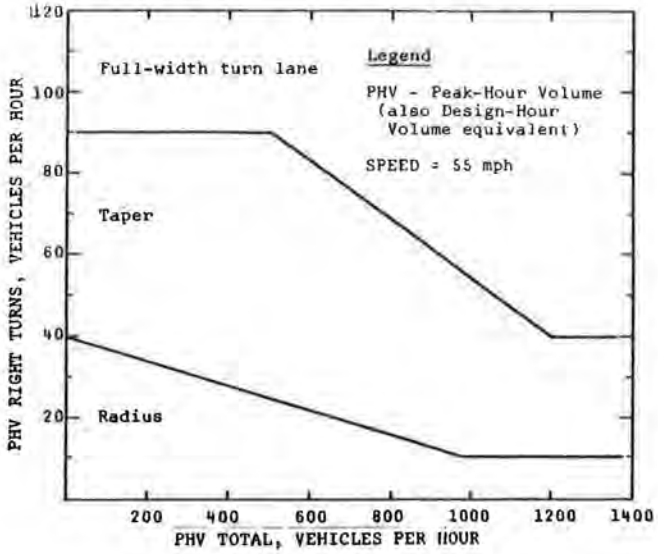


Figure 2. Guidelines for right-turn treatment: two-lane highway.

Figure 3. Guidelines for right-turn treatment: four-lane highway.



mph or less, more than 40 PHV right turns, and PHV total of less than 300, the adjusted number of PHV right turns = PHV right turns - 20.

The guidelines for four-lane highways were developed in a similar manner and are shown in Figure 3. These high-level-of-service facilities were divided highways with 55-mph speed limits.

CONCLUSIONS

Although the original intent of the study was to eliminate judgment in developing the guidelines, this could not be done where field data were lacking. The synthesis approach placed emphasis on the field data.

The guidelines are to be used as an aid in the selection of right-turn treatments for new facilities based on forecast demand and for intersection improvements. Site-specific factors of concern that were not addressed are sight distance, grade, availability of right-of-way, and angle of turn. It is suggested that methods that reflect the special concerns be used in lieu of the guidelines for these cases. It is important that this sort of flexibility be a part of the guidelines.

ACKNOWLEDGMENT

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The opinions, findings, and conclusions are mine and not necessarily those of the sponsoring agencies.

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Abridgment

Motorist Response to Selected Driveway Systems

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The results of a human-factors laboratory study conducted at a shopping mall in Bryan, Texas, to evaluate the influence of driveway layout on driveway selection by motorists are presented. The 200 licensed drivers who participated in the studies were shown one of four driveway layouts and asked a series of questions concerning use of the driveway(s) in the layout. The studies revealed that the physical layout of driveways can influence motorists' expectations and interpretation of traffic operations at the driveways. In particular, motorists will perceive that certain driveways are one-way and others are two-way, depending on the physical layout. Certain driveway layouts also imply to some motorists that particular maneuvers (such as left-turn exit or left-turn entry) are prohibited. The studies also found that individual drivers may interpret and respond to particular driveway layouts differently. Most motorists, however, are very reluctant to violate the basic promise of traffic flow in the United States—i.e., keep to the right. In terms of driveway operations, this means that motorists will tend to use driveways that they perceive to be to their right.

Much attention has been given to the design and operation of individual driveways. All states and most cities closely regulate the design and operation of individual driveways in the interest of improved traffic safety and flow (1). In most cases, however, these regulations do not specifically address the fact that most driveways are part of a "driveway system", or a group of driveways serving the same land development (2), and, accordingly, what happens at one driveway will influence operations at all other driveways in the system. Thus, more emphasis should be given to a "systems approach" in designing and operating driveways. Unfortunately, very little is known about how particular driveway systems are perceived by motorists and how these systems perform.

HUMAN-FACTORS STUDY

A human-factors study was developed to investigate the influence of driveway system layout on driveway selection by entering and exiting motorists. The study was conducted at a regional shopping mall in Bryan, Texas (Bryan has a metropolitan area popula-