*Abridgment*

# Roadside Hazards on Nonfreeway Facilities

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The increasing emphasis on highway safety, due in part to the Highway Safety Act of 1966 and the more recent congressional hearings on highway safety, design, and operations, is directed primarily toward improving the Interstate Highway System. Numerous safety improvement projects around the country are applying the clear roadside concept to existing Interstate facilities, an effort certainly warranted by the fact that 16 percent of all vehicle-kilometers of highway travel occurs on this system. However, additional attention to highway safety is warranted on non-Interstate systems, which carry the remaining 84 percent of all travel and account for more than 91 percent of highway fatalities. In both a technical and financial sense, however, the design and operational features for reducing single-vehicle accidents on freeways are not directly applicable to nonfreeway facilities. This is especially true for the largest class of single-vehicle accidents, those involving fixed objects along the roadside.

## CONCEPT OF A ROADSIDE HAZARD

Most research on the roadside environment has been directed toward specific types of items. Previous reports (1, 5) have discussed the elements of the roadside environment and have referred to them jointly as roadside hazards. The extensive use of photographs in these reports to depict the poor design and installation of roadside elements creates the impression that any reasonably capable engineer should be able to identify and correct these hazards on existing roadways and eliminate them from future designs. Notwithstanding some conceptual development (3), the technical literature does not contain a comprehensive, definitive statement for determining whether a particular object is in fact a roadside hazard. In the absence of a formal definition, engineers could respond that they know a roadside hazard when they see one. In a somewhat circular vein, a roadside hazard could be described as any element that conflicts with the much-publicized 9.1-m (30-ft) clear roadside recovery area. Inasmuch as these two indirect criteria do not apply to nonfreeway facilities, the following set of definitions are proposed

Roadside furniture: Includes all fixed or semipermanent objects, both publicly and privately owned, that are located off the traveled portion of the roadway but that are within 9 m (29.5 ft) of the nearest edge of the traffic lanes.

The definition is intended to include the general category of fixed objects and certain objects of a less permanent nature (e.g., temporary signs, debris left by traffic accidents). The limitation of roadside furniture to objects within 9 m (29.5 ft) of the traveled roadway is admittedly arbitrary but not particularly critical in the subsequent concept development.

Roadside obstacle: Any element of roadside furniture that, because of its size, rigidity, design, or manner of placement, causes an impacting vehicle and its occupants traveling at prevailing highway speeds to be severely decelerated (or redirected) or causes the interior of such a vehicle to be seriously violated.

This definition recognizes the extent to which roadside furniture impedes the operation of a vehicle after it has departed from the traveled way. The severe deceleration noted in the definition has not been quantified, although the numerical criteria suggested by research involving attenuators (6) may be appropriate. According to this definition, unprotected bridge piers, most trees, and some drainage facilities are roadside obstacles. Although a completely safe roadside environment would be one that was free of all obstacles, it is apparent that the elements fitting this definition do not have a uniform accident experience.

Roadside hazard: Any roadside obstacle that, because of its placement and the design and operational characteristics of the adjacent roadway, has an above-average probability of being struck and causing severe occupant injury.

The concept of a roadside hazard combines the severity

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level characteristic of an obstacle with the likelihood of impact. While severity of impact at a given speed is most closely related to design characteristics of the obstacle, the probability of impact is more closely related to several roadway and obstacle parameters, including roadway geometrics and obstacle position. For example, previous research (2, 7) has found that accident experience is higher on horizontal curves than on tangent sections.

## CHARACTERISTICS OF SINGLE-VEHICLE, FIXED-OBJECT ACCIDENTS

Although the suggested definitions may be lacking in certain respects, they do clearly indicate that the probability of impact and the accident severity for particular fixed objects are the important considerations. These characteristics were initially examined by using the 236 000 accidents in the Maryland accident record system for 1970 to 1972. To analyze single-vehicle, fixed-object (SVFO) accidents required that a modified accident data base be established based on the following criteria:

1. Only one vehicle was involved,
2. The accident occurred on a Maryland route or a U.S. route in Maryland, and
3. The fixed object was coded for manner of collision.

For the 3-year period, 19 743 accidents (8.4 percent of the statewide total) met these criteria.

Several general characteristics describe these SVFO accidents. Passenger cars were involved in 88 percent of the accidents. Approximately 73 percent of the SVFO accidents were reported as "non-intersection related," as opposed to 45 percent for all other accidents on Maryland and U.S. routes. In comparison with other accidents, a higher percentage (60 versus 47) occur on two-lane roads without access control. Analysis of the records indicates that SVFO accidents occur most frequently on weekends, during the hours of darkness, under adverse pavement conditions, during inclement weather, and on horizontal curvature. Vehicle speed was cited as a probable cause in 44 percent of the accidents. Driving under the influence of alcohol was listed as the probable cause in 8 percent of the SVFO accidents, although in 27 percent the drivers were characterized as "had been drinking." In 10 percent of the SVFO accidents an unknown vehicle was considered at fault.

The severity index (SI) for all SVFO accidents is 0.44, considerably higher than the SI of 0.34 for other accidents on Maryland and U.S. routes. From the modified data base, the SI was evaluated for each of the 14 types of fixed object used in the accident record system. Accidents involving trees had the highest severity index (0.61), followed closely by those involving utility poles (0.59). The most frequently struck objects were utility poles, which accounted for more than 16 percent of all SVFO accidents. The severity and frequency data were combined by using a ranking procedure (4). Based on this procedure, which represents the highest level of sophistication that can be obtained solely from the record system, utility poles are the most serious roadside hazard.

## ACCIDENT SITE INVESTIGATIONS

Because the record system does not provide information sufficient for evaluating the engineering aspects of SVFO accidents, the modified accident data base was used to choose locations for field study. The selection procedure (4) identified 105 study sections, ranging in length from 0.8 to 6.4 km (0.5 to 4.0 miles) and having a total length of 270 km (168 miles). Although the sections accounted for only 3.4 percent of the total Maryland and U.S. highway distances, 13.5 percent (2664) of the reported SVFO accidents occurred on these routes. The combined study sites have 3.3 SVFO accidents/km/year (5.3/mile/year), approximately four times the statewide average. At some sites, utility poles are involved in half of all SVFO accidents. Other sections, lacking bridges, curbs, or guardrail, obviously have no accidents involving these objects. Overall, the study sites experienced approximately the same relative accident frequencies and characteristics as the modified data base.

Field investigations were conducted at 75 percent of the study sections, and photographic logs were used to examine the remaining sites. The investigations identified those fixed objects involved in reported accidents as well as those that had been struck but were not included in the accident record system. On some routes, it was difficult to locate the specific objects cited in the accident record probably because of inaccurate coding of mileposts and the use of nondescriptive collision codes. This problem has been corrected in the current accident record system.

The field investigations identified several characteristics that were common to many of the SVFO accident sites.

1. Narrow highway right-of-way. Many of the rights-of-way were 9.1 to 12.2 m (30 to 40 ft) wide. This restricts the lateral placement of features maintained by the highway administration as well as utility poles, which frequently share the highway right-of-way.
2. Curves. Thirty-five percent of the SVFO accidents occurred on curves, the majority involving objects on the outside of the curve.
3. Lateral placement. Comparatively few of the SVFO accidents on two-lane roads involved objects farther than 4.5 m (14.8 ft) from the edge of the roadway. The most serious problems occurred with respect to trees, which were occasionally at the edge of the pavement.
4. Outdated designs. Many of the objects struck, most notably drainage facilities and guardrails, were not in accord with currently accepted design practices. In some cases, this increases the likelihood of them being struck, but, more commonly, it increases the severity of a collision.
5. Treatment. In many cases, the treatment of obstacles was inadequate. This problem was especially noticeable at terminals of bridges and drainage headwalls, and side slopes were too steep.
6. Combination effects. In some instances, isolated obstacles were placed adjacent to continuous objects (e.g., ditches, guardrail) in a manner that increased the likelihood that they would be struck. The redirecting effect of continuous objects should obviously be considered in the location of roadside elements.

## PLANS FOR CONTINUING RESEARCH

The preliminary work on this research, consisting of the accident record evaluation and the field site investigations, has verified that SVFO accidents on nonfreeway facilities warrant increased consideration. The continuing phases of this research will attempt to make the definitions of roadside obstacles and hazards more operational by developing criteria for distinguishing them. To facilitate a continuing program of roadside improvement, the roadside hazard identification procedures will be designed for use with photographic logs.

At this stage of the research, it is not possible to state with certainty which roadside obstacles are the most hazardous. Because the technical literature fails to adequately discuss roadside hazards on nonfreeway facilities, the preliminary findings in Maryland cannot be compared to the situation in other states. Although the problems found in this study are serious, there is no reason to believe that the situation in Maryland differs significantly from that nationwide.

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