Safety Benefits of Access Spacing

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Abstract

The spacing of driveways and streets is an important element in roadway planning, design, and operation. Access points are the main source of accidents and congestion. Their location and spacing affects the safety and functional integrity of streets and highways. Too many closely-spaced street and driveway intersections increase accident potential and delays, while too few inhibit access and over-concentrate traffic.

More than 40 years of research has indicated that accident rates increase with the number of intersecting roadways or driveways per mile. As early as 1953, research results showed that accident rates generally increased with both the frequency of access and the average daily traffic; however, the greatest increases resulted from increasing the number of access points per mile. More recent studies in Oregon, Florida, Colorado, and elsewhere found similar relationships.

The consistent pattern of the research results from the above and numerous other studies is clear; the greater the frequency of driveways and streets, the greater the rate of traffic accidents. Increasing the spacing and providing a greater separation of conflict points reduce the number and variety of events to which drivers must respond. This translates into fewer accidents, travel time savings, and preservation of capacity.

The spacing of driveways and streets is an important element in the planning, design, and operation of roadways. Access points are the main source of accidents and congestion. Their location and spacing directly affect the safety and functional integrity of streets and highways. Too many closely-spaced street and driveway intersections, for example, increase accident potential and delays and preclude effective traffic signal coordination. Too few inhibit access and over-concentrate traffic.

This paper describes the results of many research studies that identified the safety benefits of access spacing. These findings provide a basis for establishing sound access spacing practices.

Overview of Research

More than 40 years of research has documented the basic relationships between access and safety. Roadways with full control of access consistently have lower accident rates than other roadways. Accident rates generally increase with greater frequencies of intersections and driveways. Interstate highways with complete control of access consistently experience less than half of the accident rate of other roadways. Arterial roadways with many driveways may have double or triple the accident rates of roadways with wide spacings between access points.

- An early (1953) study by Staffeld on rural two-lane highways in Minnesota found that accident rates generally increased with both the frequency of access and the average daily traffic[1]. Roadways with more than 20 access points per mile had more than double the rates of roadways with less than 4 access points per mile.
- Schoppert (1957) found that the number of access points along rural two-lane highways is a reasonably good predictor of the number of potential accidents within an ADT group[2].

- Head (1959) found that accident rates increased as the number of commercial driveways per mile and/or commercial units per mile increased[3].
- Cribbins (1967) found that as the number of access points and their volumes increased, the total accident and injury rate increased[4].
- A comprehensive study of accident rates on two-lane rural highways was conducted by the Bureau of Public Roads in 1970[5]. Results of the study showed a dramatic increase in accident rates on non-interstate highways as the number of businesses per mile with direct access increased. An increase in the number of businesses per mile, along two-lane rural highways, from 1 to 100 increased the accident rate per million VMT from 1.26 to 17.18.

The growing number of commercial establishments along arterial highways over the past 15 years has been accompanied by increased traffic volumes, congestion and accidents. This led several states and communities to implement access management programs and to conduct additional studies of accidents in relation to access spacing.

A 1995 study by Portland State University for Oregon DOT showed how the accident rates along U.S.1, Coastal Highway, correlate with the number of access points per mile[6]. The results are shown in Figure 1. They show a close and generally consistent relationship between the number of access points per mile and the accidents per million vehicle miles traveled.

As expected, the higher accident rates occur within the city limits where urban development not only results in higher driveway densities, but probably higher driveway volumes as well. The low number of accidents per mile on the Parkway section is explainable by the presence of a continuous non-traversable median. Provisions for U-turns are found at each end of the Parkway section. Comparison of the Parkway section with the section within the city limits illustrates the effective-

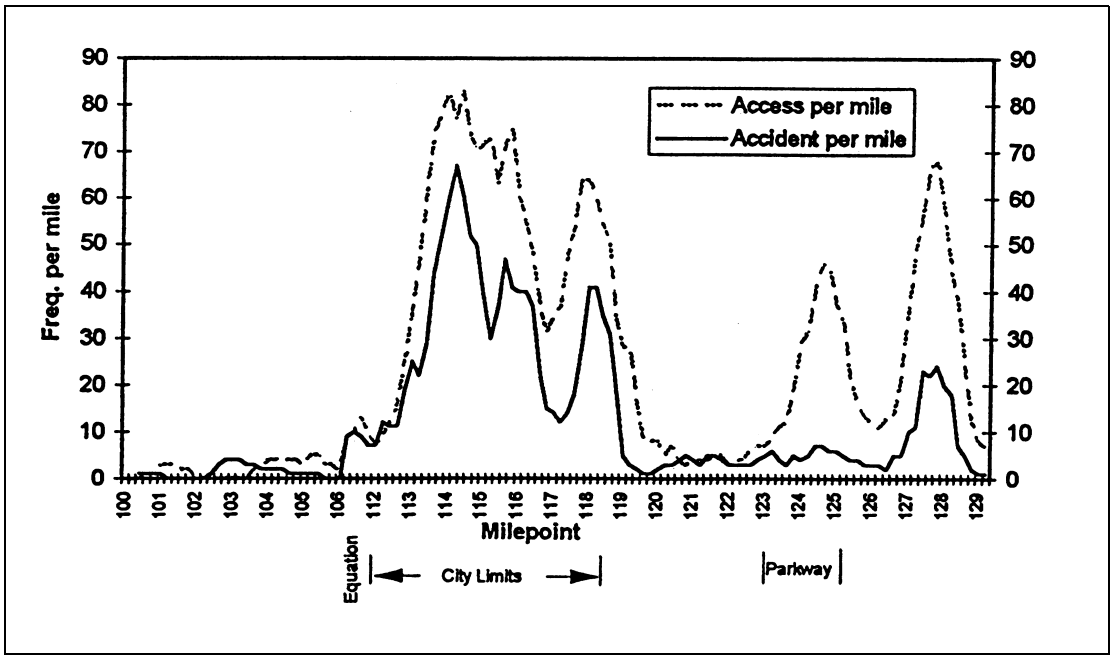

Figure 1: Relationship between accident rates and number of access points per mile on US 101, Oregon

ness of a non-traversable median in reducing accidents despite frequent access connections.

Figure 2 shows how the number of accidents per mile is related to driveway density along Route 7 in Norwalk and Wilton, Connecticut[7]. The data suggest a linear relationship.

Figure 3 illustrates the relationship between access frequency and mid-block accident rates for rural two-lane roadways in Michigan. The accident rate increases directly with the average number of intersections per mile since closer intersection spacing increases friction among vehicles. For the same number of intersections per mile, urban facilities exhibit a higher accident rate; this reflects the higher probability of an accident because of the increased activity[8].

Studies conducted in Florida show an approximate doubling of accident rates, when there are more than 20 to 30 driveways per mile[9,10].

A comprehensive study of how access type, access density, traffic volume and road geometry influence accidents was conducted in British Columbia in 1993[11]. The study covered approximately 750Km of the provincial primary arterial highway network. The individual and joint effects of access and geometric variables on accidents were statistically modeled from which estimated access and accident relationship curves were constructed for each highway category. An

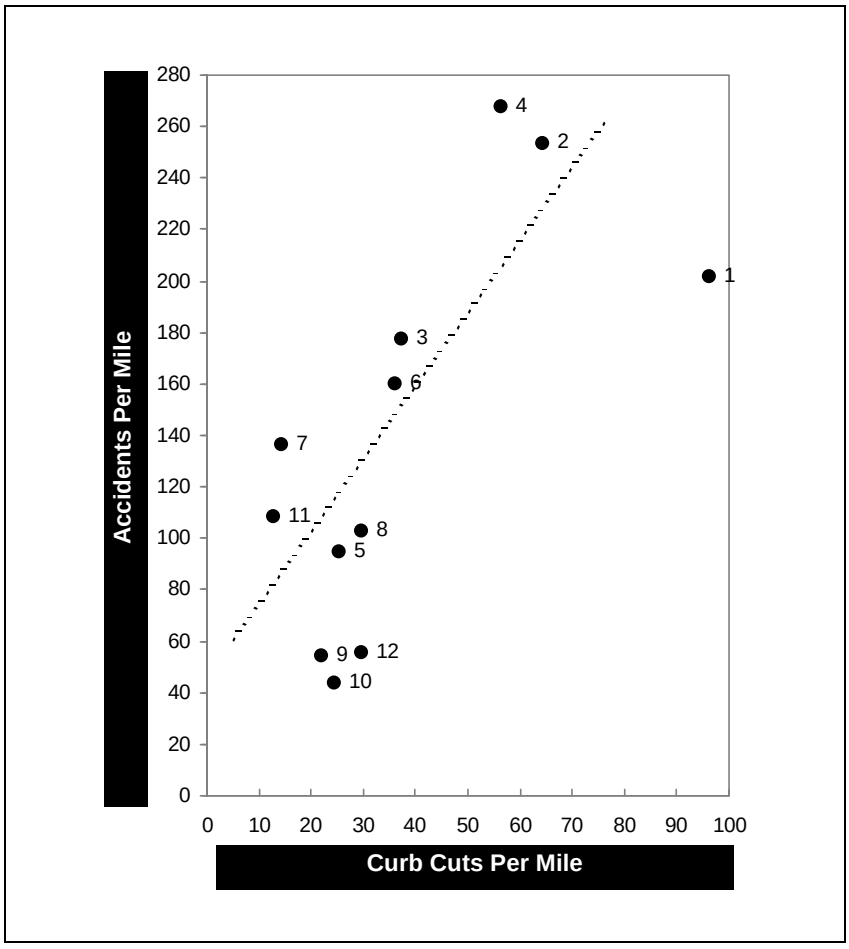

Figure 2: Relationship between Route 7 curb cuts and accident rates per mile, Norwalk-Wilton, CT

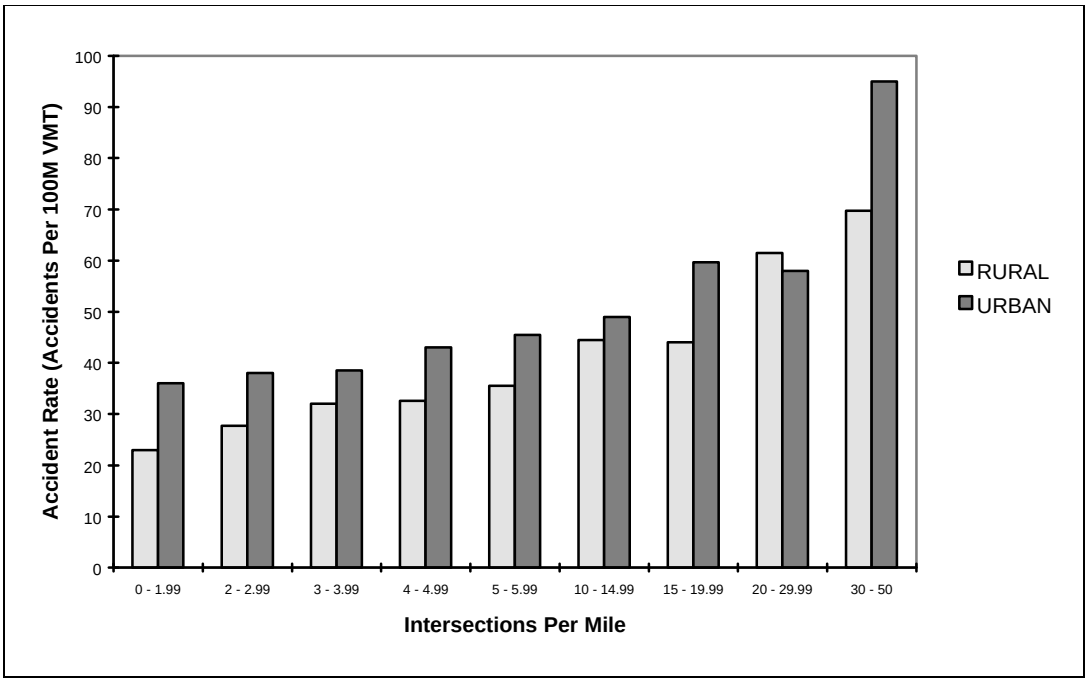

Figure 3: Access related mid-block accidents by trunkline cross section, two-lane undivided roadways, Michigan

increase from 10 to 25 driveways per Km (16 to 40 per mile) resulted in an estimated 85% increase in the accident rate.

Implications and Conclusions

The research results suggest consistent patterns -- the greater the frequency of driveways and streets, the greater the number of accidents. The specific relationships, however, vary reflecting variations in road geometry (curvature, lane-width, presence or absence of turning lanes and medians), travel speeds, and driveway and intersection traffic volumes.

The access spacing implications are clear. Increasing the spacing between access points, and providing a greater separation of conflicts, is desirable to reduce the number and variety of events to which drivers must respond. This translates into fewer accidents, shorter travel times, and preservation of capacity.

Access spacing, therefore, has become an integral part of contemporary access management actions. These plans have produced important safety benefits. Access management plans for 4.35 miles of Arapahoe Road and 5.16 miles of Parker Road in the Denver metropolitan area were implemented in advance of actual development as part of Colorado statewide access management programs[12]. The plans installed physical medians along both roads to separate opposing directions of travel and to limit crossings to designated locations; generally confined full movements to signalized intersections spaced at ½ mile intervals; provided right-turn only access at ¼ mile intervals, although a limited number of special access points were allowed at other locations; and incorporated additional auxiliary right-turn and left-turn lanes at all accesses where medium to high turning volumes were expected within 20 years. The two roads carried more traffic per lane at double the peak hour speeds with half of the accident rate found on several arterials without

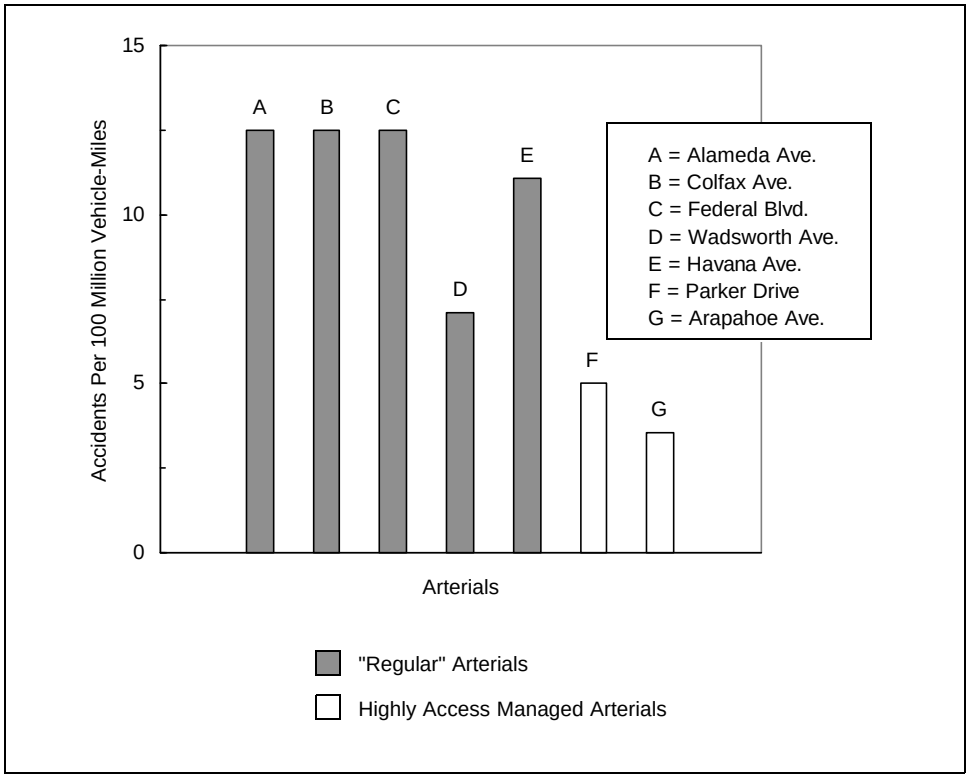

Figure 4: Accident reduction due to access management in Denver, Colorado

access controls. Figure 4 summarizes the reported accident rates.

Wide access spacings allow drivers to better respond to changing conditions by providing more time for driver perception, reaction, and navigation. Both driver behavior and vehicle dynamics are important determinants of access spacing designed to promote safety.

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