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A Study of Safety Impacts of Different Types of Driveways and Their Density

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Abstract

The recently published Highway Safety Manual (HSM) has defined seven different driveway types based on land use and parking lot size, including major commercial, minor commercial, major industrial-institutional, minor industrial-institutional, major residential, minor residential, and other. Major driveways are defined as having more than 50 parking spaces, while minor driveways are defined as those having fewer than 50 parking spaces. The HSM crash prediction models require the inputs of driveway type and density. However, the actual impacts of different types of driveways on the number of crashes are not clear. The crash modification factors provided were based on few past studies, with high standards of error. The purpose of this research is to develop a method to quantify the impact of driveway types and density on traffic crash frequencies, types, and severities. The different driveway types were collected in the state of Illinois and crashes occurring in the impact area of each driveway were identified from the IDOT crash database (from 2005 to 2009). A cross section comparison was conducted to compare the mean crash frequency and crash rates among different driveways. A further statistical analysis was used to develop a relationship between each driveway type and crash rates.

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).

Keywords: Highway Safety Manual; Driveway Density; Crash Frequency; Crash Rates; Driveway Type

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1. Introduction

The definition of access management in the Access Management Manual (Committee on Access Management 2003) can be summarized as the systematic control of all access points to a roadway. The control of access includes spacing, design, operations of driveways, medians type, interchanges and street connections. Reducing number of driveway and driveway density has been an important access control technique widely used and approved to be effective in roadway safety improvements. All known past studies have widely used access density or driveway density to predict the safety effect of driveway on roadways. The results are a measure of safety that cannot be directly associated to one driveway or type of driveway. For example, safety improvements have been identified for the reduction of driveways per mile, commonly in groups of 5 to 10. Few past studies investigated the difference among different driveway types defined in the recent Highway Safety Manual (HSM). There is a need to separate the effects of each driveway by type for the purpose of expressing the safety impacts that each driveway has on a roadway.

This study investigates the impact of four different driveway types on urban arterial roadways with four lanes and a two-way left turn-lane (TWLTL) using crash data from the state of Illinois and uses a statistical approach to identify the safety impacts.

2. Literature Review

An extensive literature review identified the following factors as having influence on driveway safety: driveway spacing, proximity to and between intersections, signalized intersection spacing and signal coordination, driveway density, road design elements, land use, and median configuration (Dixon, et al. 2012). An important finding by the American Association of State Highway Transportation Officials (AASHTO) was that access control on roadway segments can lower crash frequencies by 50 to 75 percent (AASHTO, 2004).The effects of driveways on safety have been investigated in many past studies (Gluck, et al. 1999; Papayannoulis et al., 1999; Brown et al., 1999; Mouskos et al., 1999; Eisele et al., 2005), usually showing an increase in crashes with an increase in access points per mile with focus on multiple access points (e.g. increasing from 10 to 20 driveways).

The safety impacts of access points per mile have also been documented for many years, showing an increase in crash frequencies as access density increases. Many studies show an exponential increase in crash frequencies as access density increases including access from properties in the form of driveways. The safety impact of access density has also been found to be affected by roadway geometry, operational speed, and traffic volumes (Gluck et al. 1999; Stover et al., 1982; Levinson, 2000; BRW Consulting Group, 1998; Millard, 1993). Roadway geometry effects are most evident with median type and lane configurations, while the severity of crashes will typically increase as speeds increase, and the number of crashes will increase as traffic volumes increase. A study that focused on past research by Levinson, and Gluck (1999) identified access points as the main source of crashes and congestion on roadways. It was determined from over 50 years of research data that crash rates increase as a result of more access points (e.g. driveways) (Levinson, et al. 1997). A study in Minnesota by Staffeld (1953) concluded that when comparing 4 to 20 access points per mile the accident rate more than doubled, while a study by Head (1959) focusing on commercial driveway types also found that crash rates increased as the number of driveways on a roadway increased. The Bureau of Public Roads conducted a study in 1970 that focused on businesses per mile, and concluded that increasing the businesses per mile from 1 to 100 would result in an increase in crash rates from 1.26 to 17.18 accidents per million miles traveled (Cirillo et al., 1970). In more recent years the crash rate vs. access points have been investigated by the Oregon DOT, noting that the crash rates increase in urban areas where access point are common, typically within the city limits and in urbanized areas. However, the study found that access points per mile have a less significant effect when the roadway is divided by a median, typical on a parkway (Urbitran Associates & Levinson et al., 1995). A study in British Columbia (Li, 1993) investigated the impacts of access management with a focus on driveways, and found through statistical modeling that increasing the number of driveways from (10 to 25) to (16 to 40) per mile would result in an increase in crash rates by 85 percent. The different approach was used in the Highway Capacity Manual (HCM) to quantify the impact of access points on roadway capacity. HCM uses adjustment factors for multi-lane highways to predict the flow of traffic on roadways by type when alterations from some base condition are present. The access point adjustment factor uses the number