POSTED SPEED AS AN INFLUENCE OF DRIVEWAY SPACING

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ABSTRACT

Effort has been made in this paper to summarize driveway spacing requirements followed in 14 different states with respect to the posted speed of the roadway and the summarized data was then examined for similarities and trends.

High posted speed values are associated with roadways which give preference to mobility over access, hence it was expected that high posted speed values would warrant longer spacing between driveways.

Driveway spacing with respect to posted speed for 14 different states were collected from their websites, access management manuals, etc. The collected data was then tabulated under eight speed categories. The tabulated values were then averaged, some states had two spacing values for one speed category, one of which was normally higher than the other, these higher spacing values were averaged together and the lower spacing values were averaged separately, hence every speed category had two averaged spacing values. The averaged spacing values were then graphed.

From the plotted graph it was found that the spacing value increases as the posted speed of the roadway increases.

The increase in driveway spacing values with the increase in posted speed is consistent with other characteristics of the roadway which would also warrant higher

spacing values, such as stopping sight distance, speed differential, functional classification of the roadway, etc.

It was concluded that, as the posted speed of a roadway increases its driveway spacing value also increases, which in turn would vouch the credibility of posted speed as a good criteria for determining spacing values. The credibility could be supported by the fact that nearly 14 states have chosen a similar pattern in choosing driveway spacing values with respect to posted speed of roadways.

INTRODUCTION

Driveway spacing is an important element in the planning, design, and operation of roadways. One of the main reasons for congestion and accidents on a roadway is its access points. This paper summarizes the different driveway spacing requirements followed by 14 states with respect to the posted speed of the roadway, and examined those requirements for similarities and for trends.

This section would try to answer two questions:

* What is Driveway Spacing?

*Why is Driveway spacing important?

Driveways are also referred to as “accesses” or “connections”, a connection can be defined as “A driveway, street, turnout, or other means of providing for the right of access to or from controlled access facilities” (http://www.waco-texas.com), therefore driveway is a connection.

What is Driveway Spacing?

Before discussing driveway spacing, it may be useful to define driveway spacing, because it may help in understanding and also be a point of start for our topic of discussion. There are two definitions for driveway spacing, near edge definition and center line definition. Figure 1 illustrates both definitions of driveway spacing.

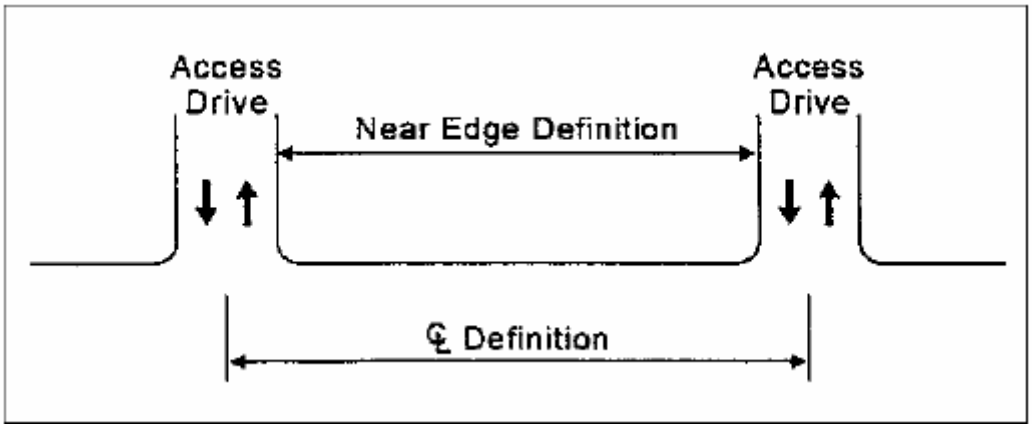

Figure 1: Driveway Spacing definition

Source: http://www.iowasudas.org/documents/5I-3.pdf

The near edge definition established spacing as, "The distance between connections, measured from the closest edge of pavement of the first connection to the closest edge of pavement of the second connection along the edge of the traveled way". (http://www.waco-texas.com)

The center line definition measures spacing distance between the centerlines of two driveways.

Why is Driveway Spacing Important?

Driveway spacing values for a roadway have direct impact on two aspects, namely safety and operation.

SAFETY

Vehicles entering and leaving a driveway travel at lower speeds than the vehicles traveling on the roadway. This speed difference between the vehicles results in a phenomenon called the “speed differential”. Speed differential is one of the main reasons for rear-end collisions in a roadway; when the speed differential is high, not only is the accident occurrence rate higher, but also the magnitude of severity is also high, resulting in greater property damage with higher chances of injuries and fatality. Table 1 illustrates the increase in accident occurrence rates with respect to increase in speed differential.

Table 1: Speed differential and accident occurrence

Speed differential between turning and through traffic	Likelihood of accidents
10 mph	Low
20 mph	3 times greater than at 10 mph
30 mph	23 times greater than at 10 mph
35 mph	90 times greater than at 10 mph

Source: http://www.ctre.iastate.edu/Research/access/toolkit/7.pdf

OPERATION

Driveway density (which is the inverse of driveway spacing) has an important influence on the free flow speed of the roadway. Driveways tend to reduce the travel speed on a roadway, drivers adjust their travel speed based on the activity in these entrances and exits, this is not the only reason, but the mere existence of driveways causes them to slow down. According to NCHRP Report 420 for every addition of 10 access points that would affect the flow of traffic in a given roadway, travel speed would

be reduced by 2.5 mph (Gluck et al 1999). Reduction in travel speed due to the addition of access points for five access density values is given in Table 2.

Table 2: Reduction in speed due to access points

Access points per mile	Reduction in free flow speed (mph)
0	0.0
10	2.5
20	5.0
30	7.5
40 or more	10.0

Source: NCHRP report 420 Table 34

FACTORS INFLUENCING DRIVEWAY SPACING

Factors influencing driveway spacing can be divided broadly into two types:

1. Actual land development factors
2. Theoretical factors from a traffic safety and flow perspective

Actual Land Development Factors

Some of the actual land development factors are:

* Type of Generator

* Locations of Median Openings

TYPE OF GENERATOR

Three types of generators were discussed in NCHRP Report 348 (Koepke and Levinson 1992) namely, *minimum use generators* (50 vehicle trips per day), *minor generator* (51 to 5000 vehicle trips per day) and *major generator* (more than 5000

vehicle trips per day). NCHRP Report 348 recommends driveway spacing values that increase as the size of the generator and roadway operating speed increase. Driveways of big commercial generators like shopping malls are spaced well apart from other driveways whereas driveways of smaller generators are comparatively spaced closer, one of the reasons for this could be due to the longer frontage of bigger generators compared to the shorter frontage of smaller generators.

LOCATIONS OF MEDIAN OPENINGS

Median openings are provided for driveways at unsignalized junction of arterial and collector streets, these openings are provided such that they have minimum impact on roadway flow. The placement of median openings when a road is constructed or modified can affect where business and others locate their driveways. Spacing criteria for median opening based on speed is given in Table 3.

Table 3: Speed and median openings

Speed (mph)	Spacing recommendations (feet) Desirable minimum
30	370
35	460
40	530
45	670
50	780
55	910

Source: NCHRP report 348 Table 7-8

Theoretical Factors from a Traffic Safety and Flow Perspective

Some of the theoretical factors that from a traffic safety and flow perspective should affect access spacing are:

* Stopping Sight Distance,

* Functional Class of Roadway, and

* Posted Speed of Roadway.

STOPPING SIGHT DISTANCE

Ideally for minimizing the chance of vehicular crashes and simplifying the driving task it is required that the driver clears a major intersection before responding to vehicles entering from other access points. AASHTO provides a possible criterion for driveway spacing using deceleration rates of nine feet per second^2 which is not suitable for 50% of the drivers. Some studies have suggested deceleration rates of six feet per second^2 which are suitable for 85% of the drivers (Mn/DOT technical study #4).

FUNCTIONAL CLASS OF ROADWAYS

Driveway spacing must recognize the fact that mobility and access are competing functions, not complimenting functions. This need is illustrated in Figure 2.

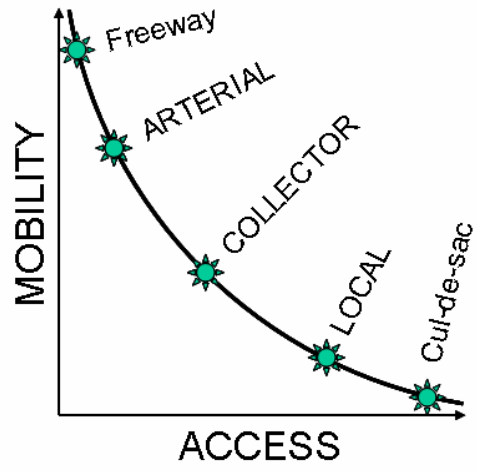

Figure 2 Functional relationships

From Figure 2, it can be seen that the lower a road is in the hierarchy, it provides more access to the abutting land and less mobility to through traffic. The higher the road in the hierarchy, the more the preference tilts towards mobility over access.

Roadways can be functionally classified into three major types, namely: arterials, collectors and locals. The below paragraphs attempt to illustrate the properties of these roadways, which puts them in their respective places in the hierarchy and determines the preference of the roadway for access or mobility. Spacing values based on the roadway type as given by Kansas Department of Transportation is given in Table 4.

Table 4: Kansas DOT Spacing standards

State highway route Type	Minimum spacing between driveways (feet)	Approx no of driveways/mi
Major arterial (national highway system)	2640	2
Other major arterial	1320	4
Minor arterial	660	8
Other (collector, etc)	500	10

Source: http://www.gtcmpo.org/Access%20Management/Driveway%20Spacing.pdf

Arterials: The arterial, as seen in Figure 2, has a higher position in the hierarchy. It has a greater degree of mobility than land access, which is due to its main objective, to maintain a large flow of traffic in a smooth and safe manner. Due to this preference for traffic mobility the roadway would have low driveway density; i.e. spacing values would be higher.

Collector: Collector streets provide a balance between access and mobility. It can be seen from Figure 2 that the collector has to move a somewhat large amount of traffic, but then one of the main functions is to transfer traffic from traffic generation points to arterials, which needs good access points. The above functions of collectors tends to give a driveway density somewhere in the middle, i.e. a balance.

Locals: The primary function of locals is to provide access from the abutting land to the traffic circuits. Mobility is limited but local roads have good accessibility. This function of local streets gives it preference to high driveway density; hence, the spacing values are low.

POSTED SPEED OF THE ROADWAY:

One of the main characteristics of a roadway is its posted speed. Posted speed is the basis of setting the mobility and safety level of a roadway. Posted speed directly influences certain characteristics of a roadway such as stopping sight distance, speed differential etc. Arterial roadways have higher posted speed than collectors and collectors more than locals etc, therefore the greater the posted speed on a roadway the more the preference is for mobility and lower the speed the more the access it has. This fact is shown in a summarization of driveway spacing of 14 different states.

Searching through different state departments of transportation websites, going through their documents, or through other websites which use the information, 14 states were found to have set posted speed as a criterion to illustrate driveway spacing.

DRIVEWAY SPACING SUMMARIZATION

Effort would be made in this research work to establish a relation between driveway spacing and posted speed of a roadway. Driveway spacing values taken from different access spacing guidelines provided by the 14 states would be used to calculate average spacing values for eight posted speed values. Then these averages would be plotted against posted speed values and the results would be discussed. To achieve the above the below work plan was devised:

Task 1: Collect data

Task 2: Tabulate and sort data

Task 3: Take averages of the summarized data

Task 4: Plot graphs

Data Collection

Data for the research was obtained from access management manuals or materials which would enumerate access management policies of the concerned state. Access management materials were found mostly in the internet and for three states namely Montana, Vermont and West Virginia access management materials were obtained by requesting the concerned DOTs for the material.

The needed data is posted speed as a criterion for driveway spacing, for this materials were searched, and were found the data was taken. Fourteen states were found to have the needed data; the 14 states are Florida, Georgia, Iowa, Kansas, Maine, Minnesota, Nevada, New Jersey, Ohio, Oregon, Utah, Vermont and West Virginia

Data Tabulation

In the column of the spread sheet containing the data for this research work there are eight speed categories ranging from values lesser than 30 mph to over 60 mph, in 5 mph increments. In the row of the spread sheet the 14 states are represented.

Each state had their own access categories and each category having its own spacing values with spacing as one of its determining criteria or the only criteria. States like Georgia, Maine, Ohio, Oregon, Vermont and West Virginia have associated posted speed with driveway spacing directly without the influence of access categories; hence it was possible to tabularize them without sorting them into access categories.

There were situations in which a posted speed had two spacing values due to subcategories or special conditions, for example in Nevada, every access category has two sub-categories, namely private access and public access, and for each access category private access and public access have different spacing values with regard to posted speed limit. A screen shot of the spread sheet is given in Figure 3.

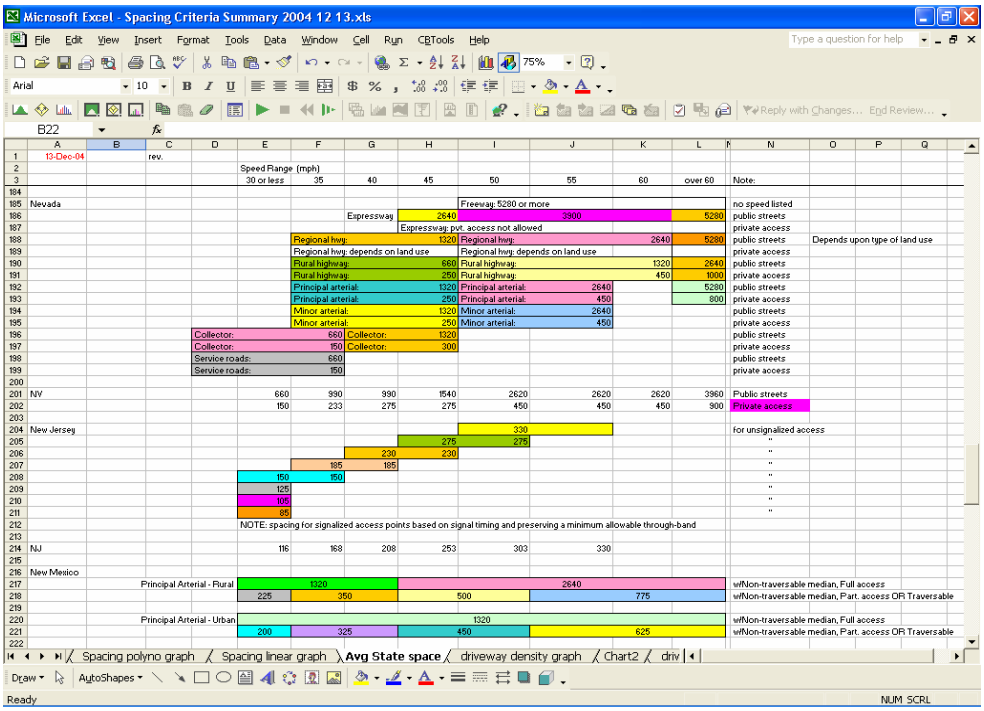

Figure 3: Screen shot of the data sheet

Data Summary

The average of all the access categories for every speed category was taken. If a state has 2 spacing values (because of subcategories or special conditions) two separate averages were taken, one which is the average of all lower values and the other of all higher values. For example, in Nevada separate averages for public access and private access were taken the higher of the averages (Public streets) was considered as higher average and the lower of the averages (Private access) was considered as lower average.

Finally, after the averages for each speed category for each of the 14 states have been calculated, then the individual averages of all the 14 states were averaged together to get the grand average for every one of the eight posted speed categories. Even here, the lower value averages and higher value averages were averaged separately. The average values are given in Table 5.

Table 5: Averaged spacing values with respect to posted speed

Posted speed(mph)	30 or less	35	40	45	50	55	60 over60
Avg of lower values(feet)	204	320	430	548	759	833	808	881
Avg of Higher Values(feet)	314	442	579	869	1175	1243	1562	1732

The values seem to be increasing from lower posted speed to higher posted speed, except for the dip at 60 mph for lower averages. This is due to some states having spacing values up to 55 mph only, as those states were also included for averaging values at 60 mph the value is lower. This fact was considered while drawing the graph, and only values up to 55 mph were graphed.

Graphical Representation and its Interpretation

A graph between the speed limit (x axis, up to 55 mph only) and average spacing values (y axis) was drawn. Both higher value average and lower value average were

taken into consideration and the graph was plotted for both. After the graph was plotted a linear line was fitted to see the trend of driveway spacing values with respect to posted speed.

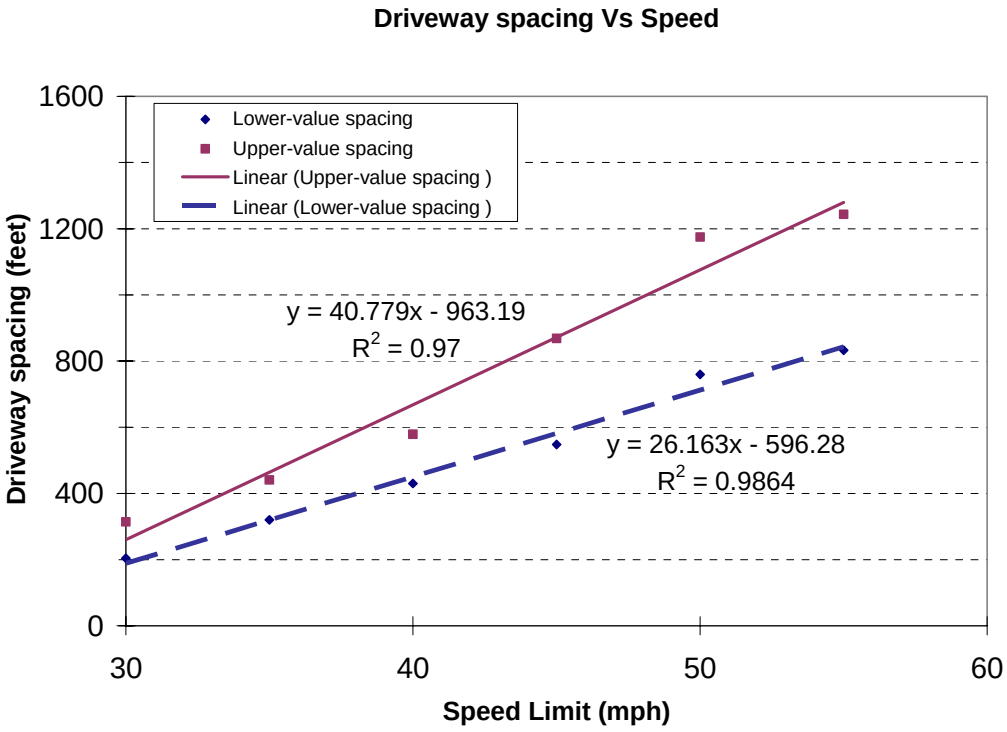

Figure 4; Graphical representation of the relation between Driveway spacing and posted speed

Figure 4 is the graphical representation of the relation between driveway spacing and posted speed. It can be seen from Figure 4 that the fitted line representing the relation between spacing values and posted speed has a positive slope, which means that the spacing values increases as the posted speed of the roadway to which it connects increases.

Figure 4 can be explained as follows: States tend to have lower spacing values in roadways with lower posted speed limit and higher spacing values in roadways with higher speed limits.

CONCLUSION

Driveway spacing values for a particular roadway depend on several factors which were broadly classified as actual land development factors and theoretical factors from safety and flow perspective. Each one of the two factors has several sub categories, each of which influences driveway spacing value for the given roadway.

In this research effort a relation between one of the sub categories of safety and flow factor namely posted speed of the roadway and driveway spacing was established.

It was seen in this research effort that as the posted speed of a roadway increases the spacing between the driveways to which it provides access also increases. There could be several reasons associated with this, for example speed differential and safe stopping sight distance. We know that both safe stopping sight distance and speed differential are dependent on speed, lower speed values tend to have lower sight distance requirements and result in lower speed differential, which in turn would encourage lower spacing values.

The above could be one of the reasons for states to choose lower spacing values for roadways with lower posted speed limit and higher spacing values for roadways with higher posted speed limits, there could be several other important influences which may have not been discussed.

It could be concluded that posted speed limit is an important factor to be considered while choosing spacing values, as nearly 14 states have chosen to do so.

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