



Landscaping of highway medians and roadway safety at unsignalized intersections



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ABSTRACT

Well-planted and maintained landscaping can help reduce driving stress, provide better visual quality, and decrease over speeding, thus improving roadway safety. Florida Department of Transportation (FDOT) Standard Index (SI-546) is one of the more demanding standards in the U.S. for landscaping design criteria at highway medians near intersections. The purposes of this study were to (1) empirically evaluate the safety results of SI-546 at unsignalized intersections and (2) quantify the impacts of geometrics, traffic, and landscaping design features on total crashes and injury plus fatal crashes. The studied unsignalized intersections were divided into (1) those without median trees near intersections, (2) those with median trees near intersections that were compliant with SI-546, and (3) those with median trees near intersections that were non-compliant with SI-546. A total of 72 intersections were selected, for which five-year crash data from 2006–2010 were collected.

The sites that were compliant with SI-546 showed the best safety performance in terms of the lowest crash counts and crash rates. Four crash predictive models—two for total crashes and two for injury crashes—were developed. The results indicated that improperly planted and maintained median trees near highway intersections can increase the total number of crashes and injury plus fatal crashes at a 90% confidence level; no significant difference could be found in crash rates between sites that were compliant with SI-546 and sites without trees. All other conditions remaining the same, an intersection with trees that was not compliant with SI-546 had 63% more crashes and almost doubled injury plus fatal crashes than those at intersections without trees. The study indicates that appropriate landscaping in highway medians near intersections can be an engineering technology that not only improves roadway environmental quality but also maintains intersection safety.

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1. Introduction

1.1. Roadway safety and landscaping

Well-planted and maintained landscaping could help reduce driving stress and provide better visual quality, thus improving roadway safety (Parson et al., 1998). A recent study conducted in Toronto found that improvements to landscaping placement, including trees and plants, decreased the total number of crashes by 5–20% on all five studied arterial roadways (Naderi, 2003). A study in Texas demonstrated that landscape improvements

positively impacted road safety, indicating a 71% reduction in total crashes after improvements were made (Mok et al., 2006).

However, improper implementation of landscaping may increase the risk of crash occurrences. One of the most common causes of poor overall safety at unsignalized intersections—and on urban roadways in particular—involves restricted intersection sight distances related to view obstruction (FHWA, 2007). Trees in medians near intersections may reduce driver or pedestrian visibilities, obscure signs, change patterns of lights, or increase debris on the roadway. Improperly planted trees at highway medians near intersections also can increase potential conflicts due to visibility problems. If a driver's view is obstructed on a major approach, there is a high probability that the driver will be involved in a crash if a vehicle on a minor approach is making a turn onto or crossing the major roadway.

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Bratton and Wolf (2005) found that crashes with trees are likely to be more harmful than other types of crashes in general and suggested that a comprehensive engineering solution regarding trees should be incorporated into safe road design. A study in California examined the impacts of large trees in curbed medians on 58 miles of state highways in median or median-shoulder areas and found that large trees in medians are highly associated with more crashes and higher injury severity (Sullivan and Daly, 2005). However, the study did not consider if the sites with trees were compliant with any specific design standards or guidance; it is uncertain whether these sites had improper landscaping designs that could impact intersection safety.

1.2. FDOT SI-546

Context Sensitive Solutions (CSS) is a practical approach to improve the environmental quality of transportation decisions (FHWA, 2012). Florida Department of Transportation (FDOT) policy is to use a CSS approach on transportation projects for all modes appropriate to scale, cost, location, and schedule. In the past, landscaping in median areas adjacent to left-turn lanes was limited to ground cover, regardless of whether or not the area was within the limit of clear sight and regardless of the length of the turn lanes. To incorporate the CSS approach into landscaping in highway medians, SI-546 was revised in 2011 to allow some flexibility regarding the installation of trees in medians adjacent to left-turn lanes; however, these revisions did not change the requirements to provide intersection sight distance or to maintain a clear sight window.

FDOT and other transportation agencies strive for more context-sensitive designs; but they must maintain intersection safety by providing clear sight views for drivers at both major and minor approaches. To balance aesthetics and safety, an empirical study is needed to understand the policy and safety aspects of highway median trees near intersections. SI-546 is the FDOT design standard for median landscaping at both rural and urban intersections under stop-sign or flashing-beacon control. This six-page document includes criteria for median landscaping near intersections and clear sight distances for 2-, 4-, and 6-lane roadways. Details of the requirements for bottom of canopy, sight line window, tree size, tree offset, and tree spacing distance near unsignalized intersections are shown in Fig. 1.

SI-546 specifies the requirements as follows:

- Tree offset:
 - No trees can be planted within 100 ft from the beginning of the median nose for sites with a speed limit under 50 mph if there is a left-turn lane present;
 - No trees can be planted within 200 ft from the beginning of the median nose for sites with a speed limit equal to or higher than 50 mph if there is a left-turn lane present;
 - No trees can be planted within 100 ft from the beginning of the median nose if there is no left-turn lane.
- Tree spacing:
 - Mature trees are defined as those having a trunk size between 4–18-in.;
 - Minimum tree spacing are determined by tree size and speed limit which should meet the criteria detailed in Fig. 1.
- Bottom of canopy Should be kept to a minimum of 5 ft, measured to the sight line datum (generally 3.5 ft above pavement).

These recent efforts to incorporate CSS needed to be evaluated to understand whether the criteria in the current FDOT SI-546 remain

valid regarding intersection safety. An extensive literature review was conducted on intersection median landscaping policies, practices, research, criteria, and guidelines related to median tree size, spacing, setbacks, design speed, median width, and roadway safety.

1.3. National and state policy review

1.3.1. National guidance

The American Association of State Highway and Transportation Officials (AASHTO) provides national guidelines to determine intersection sight distances (ISD) under different intersection types (signalized/unsignalized), roadway types, and geometrics in *A Policy on Geometric Design of Highways and Streets* (AASHTO, 2011). For visibility criteria, AASHTO recommends that no object should be placed within the sight triangles that may obstruct a driver's view. However, AASHTO does not quantify or specify trees offsets and spacing criteria. The Federal Highway Administration (FHWA) recommends that all plants in medians within sight triangle areas should not be higher than 2 ft and should be at least 50 ft away from the intersection (FHWA, 2009a). Again, spacing criteria are not specified.

1.3.2. State policy review

A total of 29 state policies related to median trees were reviewed and are detailed in Appendix A. Because of climate and geometric restrictions, eight states do not plant trees in medians, and median landscaping is limited to low vegetation and shrubs. Five states do not have standards for median planting but they do have practices regarding median planting (based on discussions with state agencies); for example, the Kansas Department of Transportation has no specified guidelines for trees in medians but usually allows trees to be planted 6 ft or more from street gutters.

The remaining 16 states have design requirements for median landscaping. For the offset requirement, 9 of 16 states do not allow trees to be planted within sight triangle areas, which are determined by AASHTO speed and intersection types (AASHTO, 2011). The other six states, in addition to Florida, regulate setback restrictions from intersections, ranging from 35–300 ft (FHWA, 2009a; Brown, 2010; Caltrans, 2012, GDOT, 2012). Many states adopt the AASHTO standard for vehicle visibility criteria, which is no obstruction within clear sight triangle areas. Only 3 of the 29 states—Florida, Tennessee, and Ohio—specify quantitative visibility requirements. Tennessee and Ohio have cited Florida SI-546 and the *Florida Median Handbook* (FDOT, 2008) for intersection sight distance requirements. These three states have the same vehicle visibility criteria—at least 50% of the visual area of a vehicle and two seconds' full view of an entering vehicle—and Tennessee (TDOT, 2010) has the same landscaping design criteria as FDOT SI-546.

FDOT SI-546 is one of the more demanding policies in the U.S. regarding median tree criteria based on a review of the 29 state policies for quantifying tree offsets and spacing requirements at median highways near intersections. SI-546 interprets the AASHTO policy on intersection sight distance, complies with the regulations of the *Manual on Uniform Traffic Control Device* (MUTCD) (FHWA, 2009b), and incorporates the CSS approach. Validation of SI-546 is desirable in an effort to apply it at a national level with policies related to median tree design near unsignalized intersections.

1.4. Objectives

The purpose of this study was to (1) empirically evaluate the safety performance of SI-546 as a national/state landscaping standard at unsignalized intersections and (2) quantify the impacts of geometrics, traffic, and landscaping design features on total and injury plus fatal crashes.

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