RAMP CROSSWALK TREATMENT FOR SAN DIEGO AIRPORT, TERMINAL ONE

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ABSTRACT

San Diego Airport (SAN) has updated and expanded its transit stations, loading zones, and crosswalks as part of the airport's mobility and safety initiative. The Airport Terminal Road entrance roadway intersects a crosswalk partway along its length. The roadway's posted speed is 45 mph at entry and is reduced to 25 mph 150 feet before the crosswalk. As a modification to the existing crosswalk, an in-road warming light (IRWL) system were installed 300 feet from the crosswalk in a longitudinal layout with a chase pattern. The intention of the layout is to reduce operating speeds of approaching vehicles, given that the IRWL installation is installed in advance of the crosswalk. Speed and compliance measurements were taken before and after the installation of the updated IRWL systems at this location for both activated and non-activated conditions.

The crosswalk has five additional IRWLs installed in the transverse layout (stop bar). The crosswalk is preceded by LED-enhanced Pedestrian Crossing (W11-2) warning signs and passive pedestrian detection sensors. Staged crossings were used to determine driver compliance and yield rate. Additionally, vehicle speeds were measured to quantify change in speed. The experiment found a 47.6% average increase in driver yielding behaviour and a 7 mph reduction in approach speeds when the system is activated. This indicates that implementing the smart IRWL crosswalk delineation system with chase line is an initially-effective means of reducing the hazard presented by approaching vehicles for multi-lane approaches to isolated marked pedestrian crosswalks.

INTRODUCTION

Contemporary research has demonstrated that In-Road Warning Light (IRWL) systems are effective crosswalk warning devices. [1] [2] [3] [4] Researchers continue to assess the visibility and effectiveness of crosswalks in an effort to provide effective tools to meet Vision Zero campaigns. [5] Smart crosswalks with warning devices such as IRWL systems have been implemented in various locations across Canada and the United States. [4] [6] These systems have the primary benefit of providing a road-level (sightline) alert to motorists, particularly those who are distracted.

Distracted driving is one of the leading causes of pedestrian fatalities. [7] According to the United States Center of Disease Control and Prevention (CDC), the main types of distraction include:

1. Visual: the driver's eyes are off the road
2. Manual: the driver's hands are not touching vehicle controls
3. Cognitive: the driver's mind is not focused on the task of driving

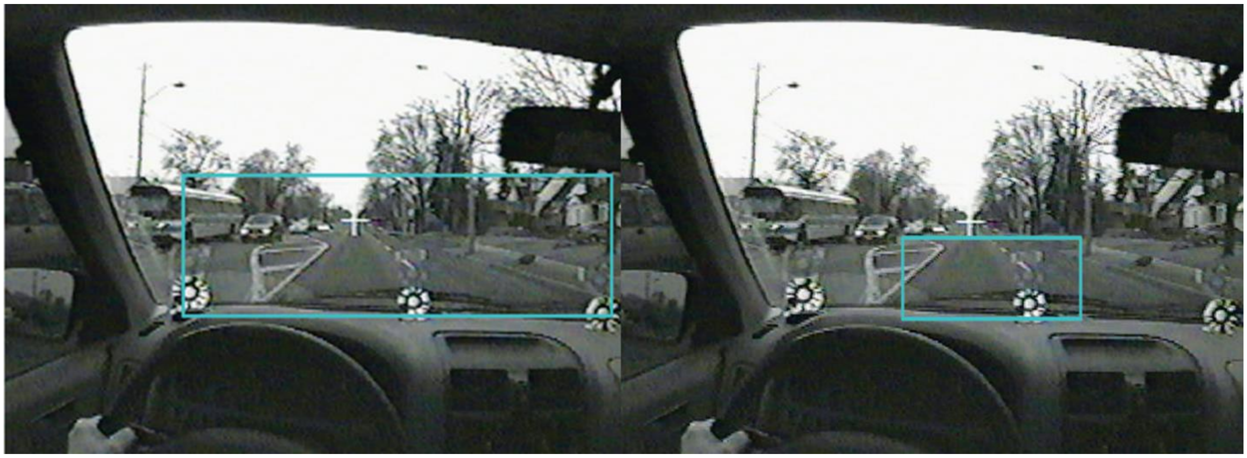

Figure 1 Average attention zone for control group (LEFT) and average attention zone for drivers using hands-free phone (RIGHT) [1]

Cognitive research found a decrease in the attention zone of driver using a hands-free phone when compared to an alert driver, with the attention zones shown in Figure 1, illustrating on the right the decreased area subject to visual scanning by the driver. [1] IRWL smart crosswalks are effective in reducing accidents because they target distracted drivers by placing the warning device directly in the limited field of vision. [1] [2] [3] [4]

CROSSWALK DESIGN

The United States Federal Highway Administration's *Manual for Uniform Traffic Control Devices* (*MUTCD*) provided guidance concerning the use of IRWLs in the 2000 edition. [8] The San Diego County Regional Airport Authority noticed that crosswalk on Airport Access Rd to Terminal 1 exhibited a low vehicle yielding rate to pedestrians in the marked crosswalk, high operating speeds, and multiple pedestrian complaints regarding safety. In 2007, Virginia Tech Transportation Institute (VTTI) evaluated driver response and perception of IRWL various chase patterns on highway ramps. Guided by VTTI's initial findings, the airport authority incorporated a chase line to slow vehicles approaching the crosswalk. Figure 2 shows the original plans for the smart crosswalk with a chase line on the dividing line of the lanes.

Ten (10) years after the initial implementation of the crosswalk, the system was upgraded with new LED enhanced signs, activation bollards, and IRWLs. These upgrades, the "smart crosswalk", were designed with passive pedestrian detection sensors, five (5) IRWLs in stop bar configuration in front of the crosswalk, 11 IRWLs in a line configuration for chasing, and three (3) LED-enhanced W11-2 signs. Figure 3 shows the system's electrical design with each IRWL on the chase line wired to a separate conductor for chase pattern and timing control. A 16-bit sequence was used to chase the IRWL. Two (2) IRWLs are turn on at a time at 100 ms for a total period of 600 ms per cycle. The stop bar IRLWs and LED enhanced signs flash at the same time at an *MUTCD* compliant rate.

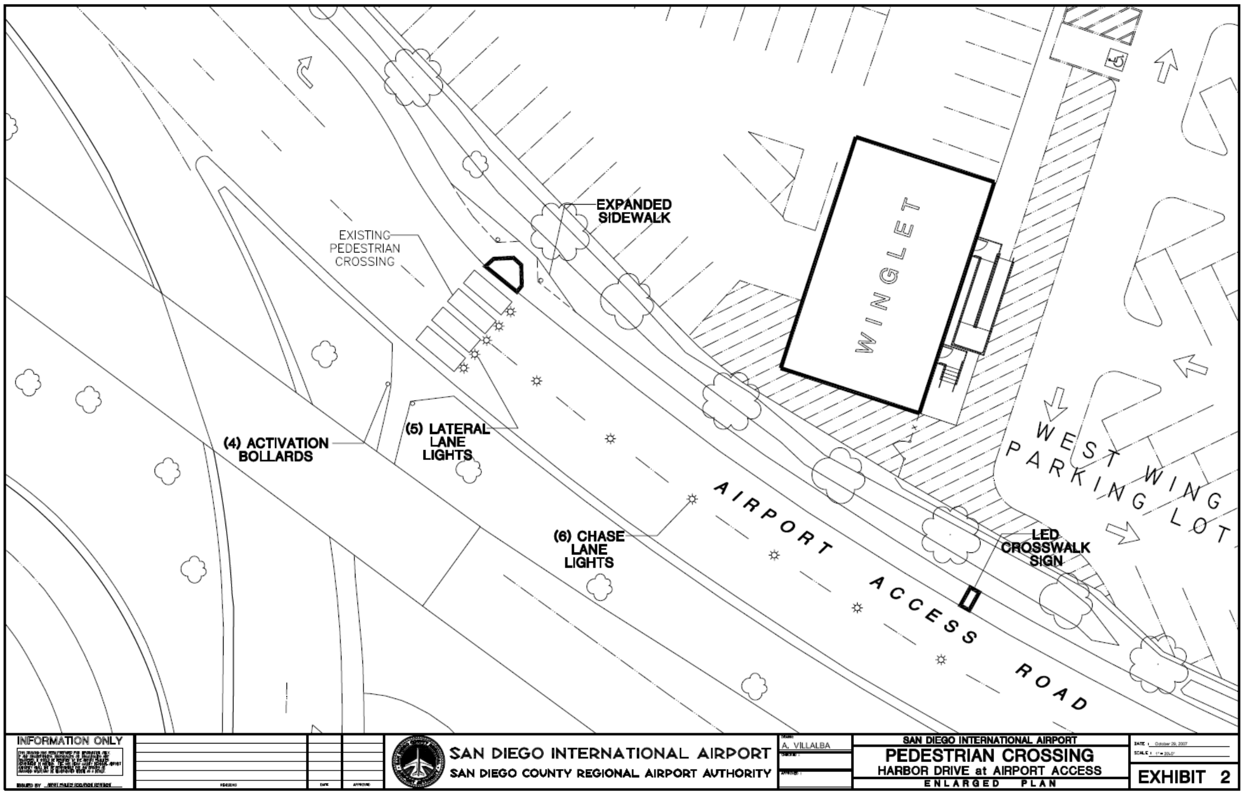

Figure 2 Crosswalk Plans, 2007

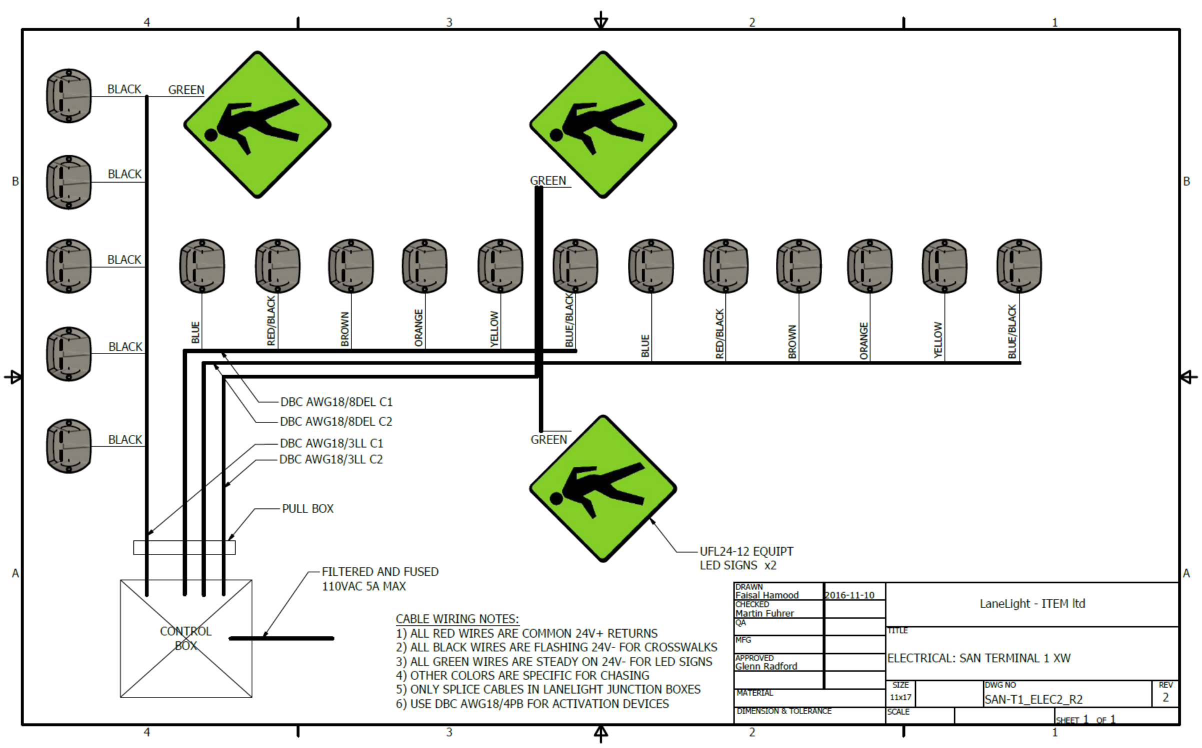

Figure 3 IRWL “Smart Crosswalk” System Electrical Diagram

The chase pattern is a result of VTTI's research on ramp chase patterns in 2006. The chase pattern was studied and first implemented in Florida in 2004, at I-95 and State Route 84. The chase line or delineation system, IRWL crosswalk (stop bar lights), and LED enhanced signs are all triggered at the same time when a pedestrian is detected at the crosswalk. The purpose of the chase line is for advanced warning, and to reduce vehicle speeds as they approach the crosswalk. The chase pattern gives the driver the perception that they are moving fast, thus prompting the driver to slow down as they approach the crosswalk.

EXPERIMENT DESIGN

The objective of this study is to compare vehicle yielding behavior and change in approach speed when a pedestrian is crossing, against the variable of system activation and system non-activation. Figure 4 illustrates the study area beginning and ending at the W11-2 signs. Vehicles arrive in to the study area from a 45 mph speed zone subsequent to leaving a major arterial street.

The experiment was conducted by assessing the outcome of several independent variables on driver yielding behavior and vehicle speed. The factors studied included:

1. Number of Pedestrians (1 person, 2 persons)
2. Side of the street (Visible to car, hidden from car)
3. System Activation (Triggered, Not Triggered)

A total of 32 runs were conducted on each day, including those with varying environmental conditions, such as sunny and cloudy days, one night, and one rainy day, for a total of 118 experimental runs. Ten runs could not be conducted due to a malfunctioning system activation on one side.

Figure 4 Site View

RESULTS

The smart crosswalk aims to encourage vehicles to yield to pedestrians and ultimately reduce the speed of vehicles. The results from 117 experimental observations are shown in Table 1, a comparison of vehicles' yielding rate when a pedestrian is crossing during system activation against the yielding rate when the system is not activated.

Table 1 Data for Yielding Vehicles

	Yield Rate (% slowing)	Yield Speed (mi/hr)
With system activation	77.1%	18.48
Without system activation	22.9%	9.00

The results indicate a positive 54% change in vehicle yielding when the system is activated. The reduction in speed when measured from the first W11-2 sign (entry) to the speed limit sign, 133 feet, indicates a 9.5 mph reduction in speed when the system is activated.

The results also showed that the vehicles did not yield for pedestrians 72.5% of the time when the system was not activated.

CONCLUSIONS

Using an existing crosswalk with an existing IRWL system, the researchers examined the effect of the system activation on yielding behavior and approach speeds. The results of the study indicated that yielding compliance tripled and approach speeds were cut in half, falling well below the 20 km/hr threshold for serious bodily injury to pedestrians that is held by most international road safety organizations.

Although modern IRWL systems exhibit low failure rates, it appears that a failure does not result in excessive approach speeds, although yielding behavior suffers considerably under the non-activation scenario.

While the study indicates that the chase system in conjunction with the other devices is effective in reducing vehicle speeds from a high-speed approach for an isolated, marked crosswalk, the researchers expect that further analysis is warranted to examine the following issues:

- Does the chase system alone contribute to the effectiveness of the chase/transverse/signing system for yielding behavior?
- Do flashing signs and the flashing transverse markings alone have an equal impact on approach speeds?
- Given that system deactivation/non-activation led to higher speeds, a comparison of crosswalks with no system to crosswalks with the system is warranted to determine if there are residual effects on approach speeds owing to system implementation, even if the system is not always activated.

The researchers recommend that IRWL "smart" crosswalk systems be considered for implementation where high approach speeds are evident in advance of isolated crosswalks, particularly those located adjacent to institutional environments and along access roads to the same, such as hospitals and airports.

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