CROSSWALK ENHANCEMENT COMPARISON STUDY

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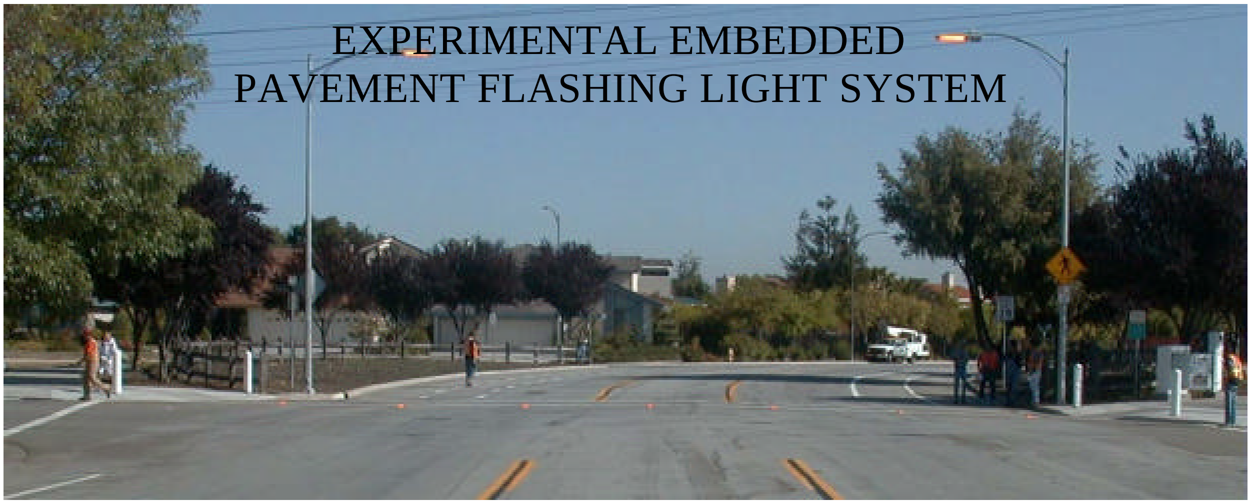

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May 7, 2001

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Prepared by the
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1. BACKGROUND

Many local agencies throughout California have been installing actuated embedded pavement lights adjacent to busy crosswalks. These lights flash only when pedestrians are present to alert approaching motorists of pedestrian activity. The pavement lights are activated either when the pedestrian pushes a button or passes through motion or video detectors.

In October 20, 1994, the California Traffic Control Devices Committee (CTCDC) began to approve these devices on an experimental basis on local roadways. On July 17, 1997, The CTCDC recommended to the California Department of Transportation (Caltrans) to develop specifications and standards for testing of the embedded pavement lights on local roadways. All agencies wishing to use the experimental device had to request authorization from Caltrans. The City of San Jose received Caltrans authorization for the experiment on January 11, 1999. Most agencies, including Caltrans, continued to use the State accepted overhead yellow flashing beacon as the standard warning device.

To date, there has not been an analysis in which compares the effectiveness of the two different warning systems. The purpose of this study is to examine the effectiveness of experimental embedded pavement lights with the standard overhead yellow flashing beacon, both of which are activated automatically by motion detectors that sense the movement of pedestrians into the crosswalk.

The experimental embedded pavement light system utilizes a series of light emitting diodes (LEDs) in a housing embedded in the roadway which flashes to warn approaching motorists that a pedestrian is entering or is in the crosswalk. The lights shine out towards the oncoming traffic to warn drivers and flash for a set period of time before automatically turning off. The system activates when a pedestrian breaks an optical beam by passing through a set of bollards.

The standard overhead yellow flashing beacon system consists of a Caltrans standard mastarm with two 12-inch yellow flashing beacon heads per direction and one W-54 sign placed in between the two heads. This system also activates when a pedestrian passes through a set of bollards that has an optical beam running between them.

The City of San Jose selected two intersections with existing, uncontrolled crosswalks to conduct the study (see Figure 1). The intersection of Samaritan Drive and Kinghurst Way was selected for the standard overhead yellow flashing beacon (see Figure 2). The intersection of McAbee Road and Golden Oak Way was selected for the experimental embedded pavement flashing light system (see Figure 3).

Samaritan Drive is a major collector street running in an east-west direction. It is 70 feet wide curb to curb in an 84-foot wide right-of-way and carries approximately 10,000 vehicles per day. The roadway is striped for four lanes and a two way left turn lane with no on-street parking and a continuous sidewalk on both sides of the street. The speed limit on Samaritan Drive is 30 mph and the 85th percentile speed is 34 mph. Kinghurst Way is a residential street teeing into Samaritan Drive from the south with a curb to curb width of 36 feet in a 60-foot wide right-of-way. The posted speed on Kinghurst Way is 25 mph. The intersection of Kighurst Way and Samartan Drive is controlled with a one-way Stop at Kinghurst Way. The standard overhead yellow flashing beacon was installed at the existing crosswalk on the east leg crossing Samaritan

Drive (see Figure 2). Good Samaritan Hospital is located on the north side of Samaritan Drive in the vicinity of the crosswalk. The crosswalk connects the hospital to the residential and medical facilities to the south, and also serves nearby senior living facilities.

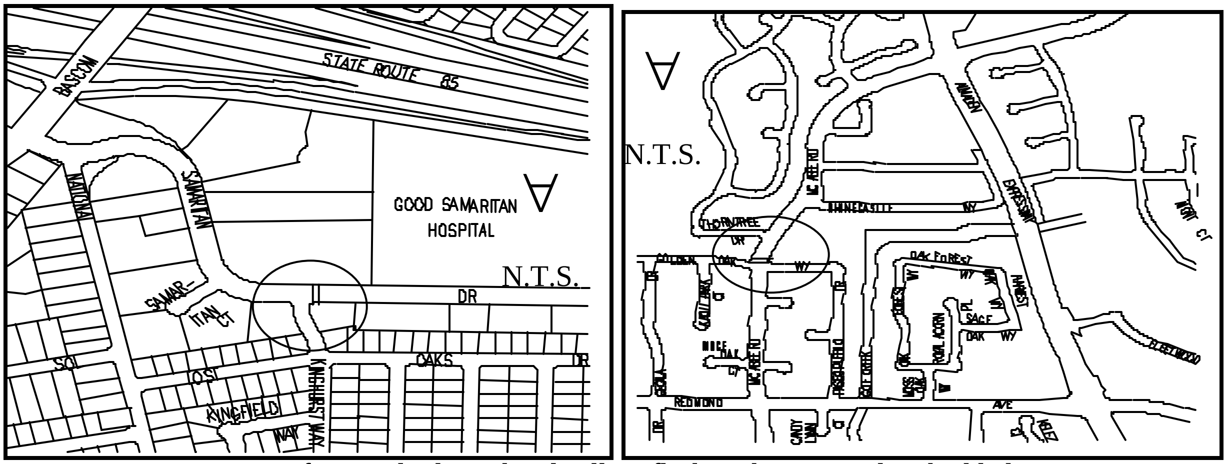


Figure 1: Location maps for standard overhead yellow flashing beacon and embedded pavement flashing light system respectively

Figure 2: Samaritan Drive and Kinghurst Way standard overhead yellow flashing beacon

McAbee Road is a major collector street running in a north-south direction. McAbee Road is 65 feet wide curb-to-curb in a 90-foot wide right-of-way and carries approximately 6,000 vehicles per day. The roadway is striped for two lanes and bike lanes, with a two way left turn lane. Parking is removed in the vicinity of the crosswalk. The speed limit on McAbee Road is 35 mph and the 85th percentile speed is 42 mph. Golden Oak Way is a 36-foot wide curb to curb residential street in a 60-foot wide right-of-way. The posted speed on Golden Oak Way is 25 mph. The intersection of Golden Oak Way and McAbee Road is controlled by a two-way Stop at Golden Oak Way. The embedded pavement flashing light system was installed at the existing crosswalk on the north leg of the intersection. The crosswalk connects a recreational trail through a linear park. A continuous sidewalk exists on both sides of McAbee Road, south of Golden Oak Way. North of Golden Oak Way, on both sides of McAbee Road, there is a meandering pathway through the linear park. Golden Oak Way has continuous sidewalk on the south side and the north side is connected by a meandering pathway along the linear park (see Figure 3).

Figure 3: McAbee Road and Golden Oak Way embedded pavement flashing light system

The City of San Jose requested permission from the California Department of Transportation (Caltrans) to install the experimental device. Caltrans approved the test installation with a list of guidelines on January 11, 1999. Both installations were completed in April of 2000. Caltrans required a one-year after study to evaluate the effectiveness of the device.

2. INSTALLATION OF DEVICES

Both systems were installed and activated in mid-April 2000. The details of each system installation are listed below.

2.1. Standard Overhead Yellow flashing beacon

The installation included a 25-foot luminaire signal mastarm with two 12-inch yellow flashing beacon heads per direction. W-54 (pedestrian crossing symbol with crosswalk lines) signs were installed on the mast arm between the two flashing beacon heads. There were also W-54A (advance pedestrian crossing symbol) signs in advance of the crosswalk for both approaches.

2.2. Experimental Embedded Pavement Flashing Light System

The installation included a total of seven LED embedded fixtures on each side of the crosswalk. A pair of activation bollards and a controller cabinet were installed per the plan. There were W-54A signs installed in advance of the crosswalk for both approaches and W-54 signs were installed at the crosswalk.

2.3 Activation Devices

A pair of activation bollards were installed on each side of the crosswalk at both locations (see Figure 4). Each bollard contains sensor circuitry and were placed so pedestrians entering a crosswalk must pass between them, automatically activating the built in system. The build-in sensors detect pedestrians using the crosswalk and detect their direction of travel. The build-in sensor module projects infrared beams of modulated light to the respective receiver module. Each module incorporates a high gain detector, allowing the system to activate for crosswalk entry and not for exit.

2.4 Controller Cabinet

A NEMA standard type "M" signal controller cabinet (City of San Jose standard) was used at both Samaritan Drive and McAbee Road (see Figure 5).

Figure 4: Bollard activation system

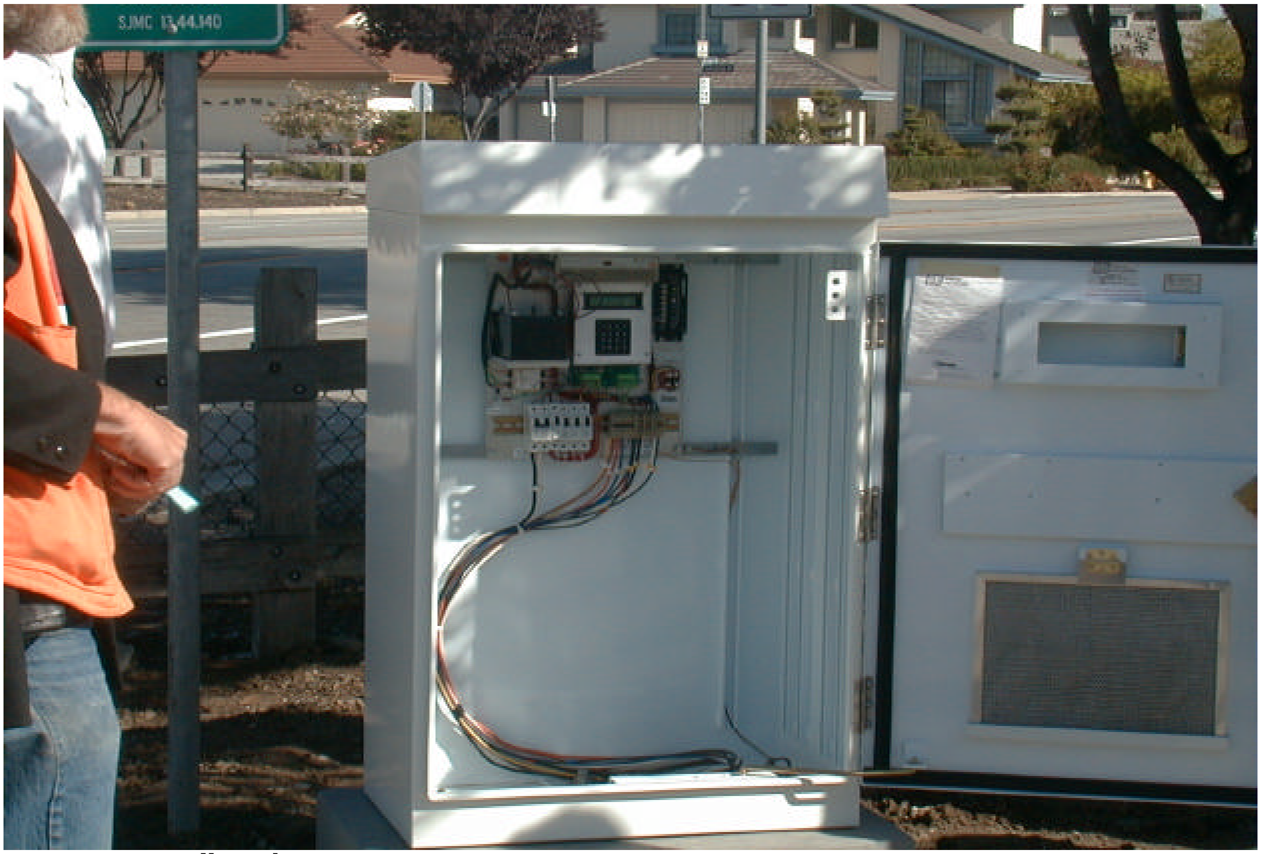


Figure 5: Controller cabinet

3. MAINTENANCE OF DEVICES

As of the writing of this report, both systems have been in operation for seven months. During this period, the following maintenance issues have occurred:

- Prior to final inspection, one of the 14 embedded fixtures developed condensation inside the lens and had a burned-out bulb. The manufacturer replaced the bulb and gasket for the housing fixture (see Figure 6). Two of the fixtures closest to the curb have distinct indentations in the top of the housing, which may have been caused by street sweeping. These two fixtures are still fully functional.
- One of the bollard detection systems at Samaritan Drive and Kinghurst Way malfunctioned due to an act of vandalism. A bollard was hit and moved off its foundation base. The manufacturer straightened and secured the bollard to its base and the infrared beam was adjusted. The system defaulted to continuous flashing mode when the malfunction occurred.
- The embedded pavement light LED-housing devices will need to be raised or protected to accommodate pavement maintenance activities, scheduled to occur in the summer of 2001.


Figure 6: Embedded pavement flashing light system housing fixture

4. STUDY METHODOLOGY

A before and after study was performed at both installations. The study focused on the reaction of drivers to a pedestrian waiting to cross the street as well as driver and pedestrian perceptions of the system. The study is described in detail below.

4.1. Driver Reaction

At both locations, driver reaction was measured with a pedestrian waiting to cross the street. Using a staged pedestrian, the following driver reaction parameters were evaluated at each location for conditions both before and after installation:

- Approach speed of vehicles (from 500 to 300 feet in advance of the crosswalk)
- Travel time of the vehicles (from 500 to 100 feet in advance of the crosswalk)
- Distance prior to the crosswalk at which brakes were applied (if any)
- Reaction of driver to the pedestrian waiting to cross (did the driver brake or yield?)

Data was collected manually during the daylight and nighttime conditions using visual observations, stop watches, and two-way radios. The weather was clear and the pavement was dry during the testing periods. The staged pedestrian stood on the curb, preparing to cross, for half of the data samples, and stepped out into the roadway for the other half of the data samples. The staged pedestrian never directly challenged the vehicles during the study. Data was collected on randomly chosen vehicles, typically the first in a platoon to ensure good potential for eye contact between driver and pedestrian. During the after-study, the pedestrian activated the flashing lights (or flashing beacon) by walking through the bollards as the vehicles approached.

Both systems were activated in mid-April 2000. There were a total of two after-studies conducted for both daylight and nighttime conditions. The first after-study occurred one month after installation and results were compared with six-month after-study data. Results of the study are discussed in Section 5 of this report.

4.2. Driver Survey

Six months after the installation of the devices, randomly selected drivers were interviewed after passing through the activated crosswalk warning systems. Drivers were flagged to the side of the road by City of San Jose police officers (see Figure 7), and the following questions were asked of the drivers:

- Did you notice the crosswalk in which you passed in the last block?
- Did you notice any pedestrians in or near that crosswalk?
- Did you notice the flashing lights at the crosswalk?
- Are the warning devices effective?

Figure 7: Driver survey

4.3. Pedestrian Survey

Pedestrian interviews were randomly taken and data was collected before, as well as one month and six months after, the installation of the crosswalk warning devices. Eleven pedestrians were surveyed at the McAbee Road and Golden Oak Way site in the evening and 10 pedestrians were surveyed at Samaritan Drive and Kinghurst Way during the day. Pedestrians were asked the following questions:

- Did you feel safe crossing at this location?
- Are you aware of the flashing lights?
- Do you rely upon the lights to stop drivers to give you the right-of-way?

Results of the study are discussed in Section 5 of this report.

5. STUDY FINDINGS

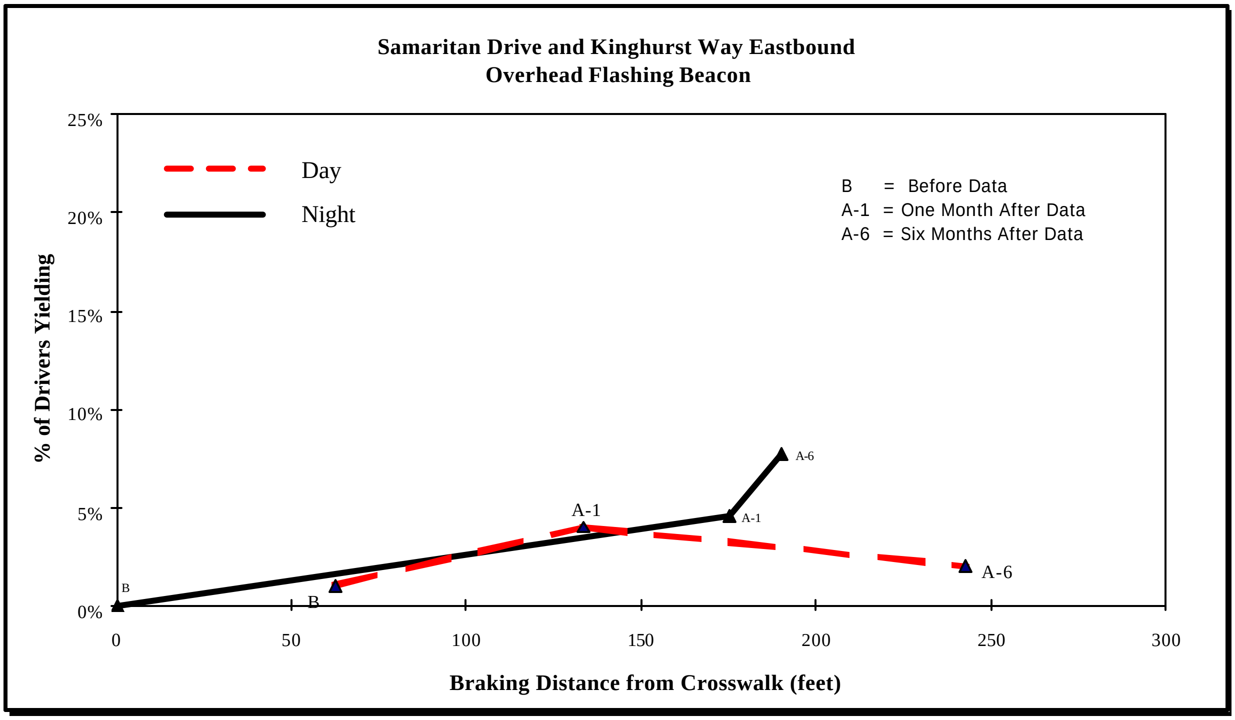
5.1. Driver Reaction – Samaritan Drive and Kinghurst Way (Standard Overhead Yellow flashing beacon)

5.1.1. Eastbound

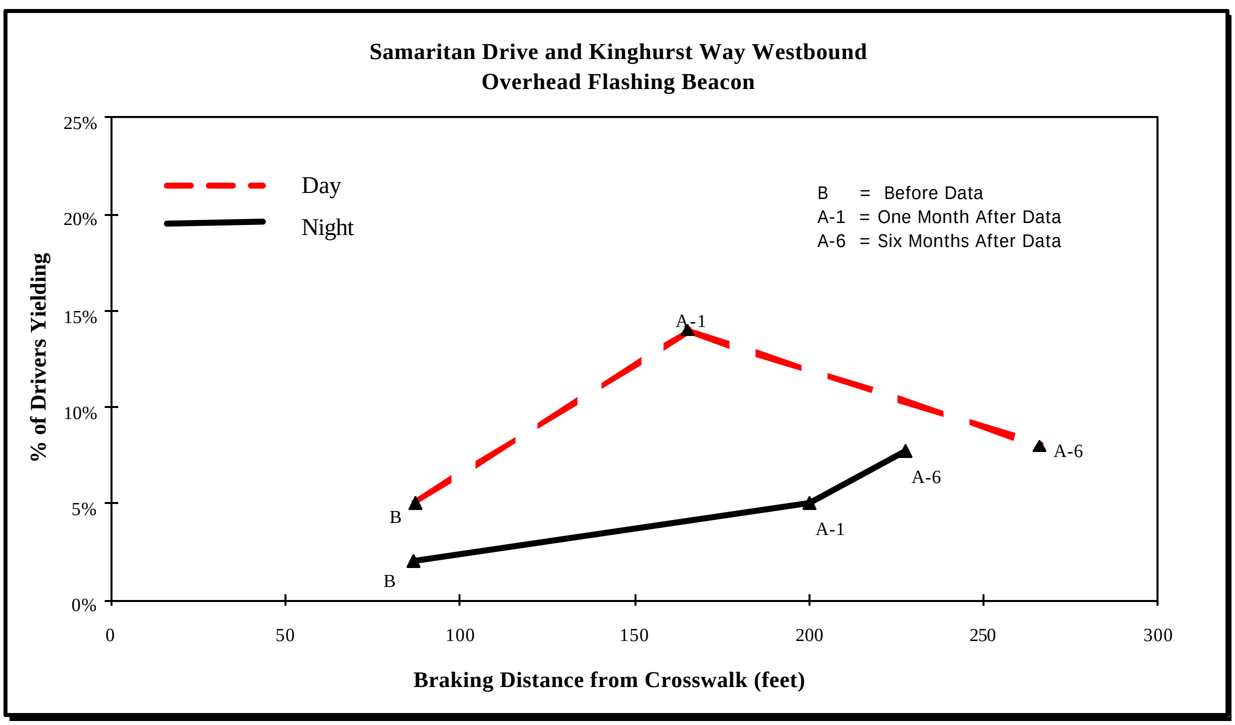
- Drivers yielding for pedestrians during the day increased from 1% in the before condition to 4% and 2% for one month and six months after installation, respectively. Braking distance during the day increased from 63 feet in the before condition to 133 feet and 243 feet for one month and six months after installation, respectively.
- Drivers yielding for pedestrians during the dark hours of the night increased from 0% in the before condition to 5% and 8% for one month and six months after installation, respectively. Braking distance during the night increased from none in the before condition to 175 feet and 190 feet for one month and six months after installation, respectively (see Graph 1).

5.1.2. Westbound

- Drivers yielding for pedestrians during the day increased from 5% in the before condition to 14% and 8% for one month and six months after installation, respectively. Braking distance during the day increased from 87 feet in the before condition to 165 feet and 266 feet for one month and six months after installation, respectively.
- Drivers yielding for pedestrians during the night increased from 2% in the before condition to 5% and 8% for one month and six months after installation, respectively. Braking distance during the day increased from 87 feet in the before condition to 200 feet and 228 feet for one month and six months after installation, respectively (see Graph 2).



Graph 1: Samaritan Drive and Kinghurst Way eastbound



Graph 2: Samaritan Drive and Kinghurst Way westbound

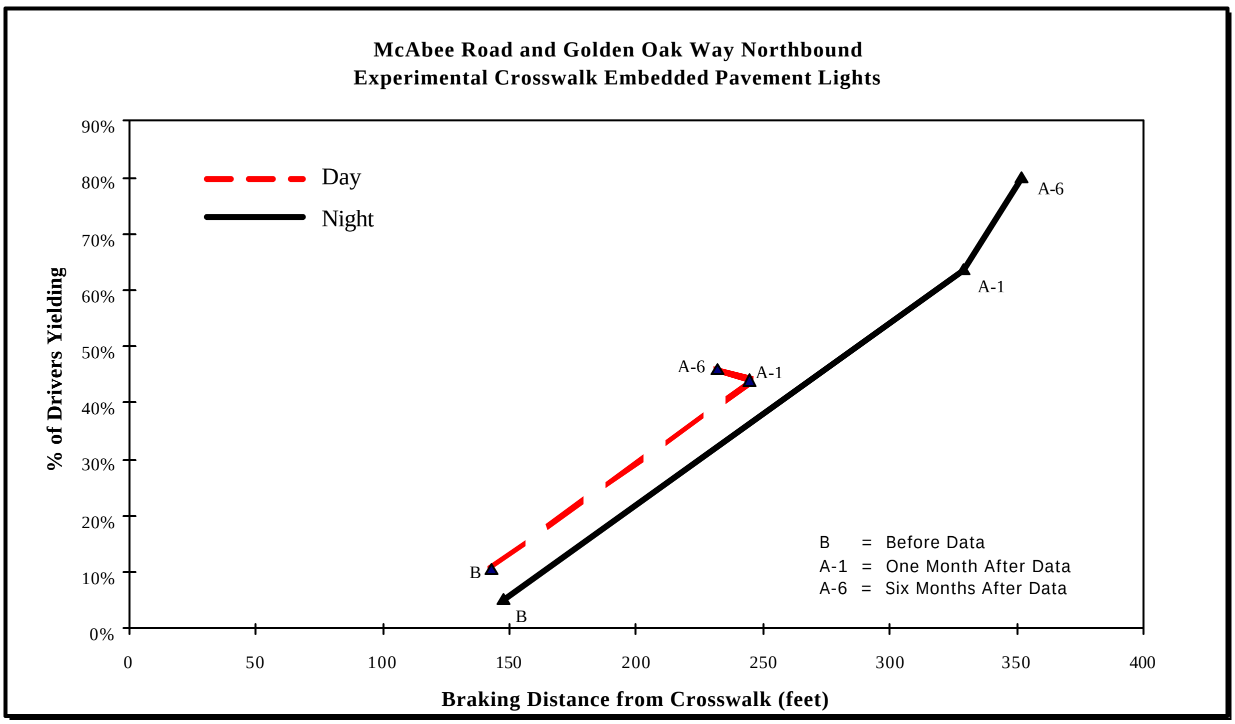
5.2. Driver Reaction - McAbee Road and Golden Oak Way (Experimental Embedded Pavement Light System)

5.2.1. Northbound

- Drivers yielding for pedestrians during the day increased from 10% in the before condition to 44% and 46% for one month and six months after installation, respectively. Braking distance during the day increased from 143 feet in the before condition to 245 feet and 232 feet for one month and six months after installation, respectively.
- Drivers yielding for pedestrians during the night increased from 5% in the before condition to 64% and 80% for one month and six months after installation, respectively. Braking distance during the night increased from 148 feet in the before condition to 329 feet and 352 feet for one month and six months after installation, respectively (see Graph 3).

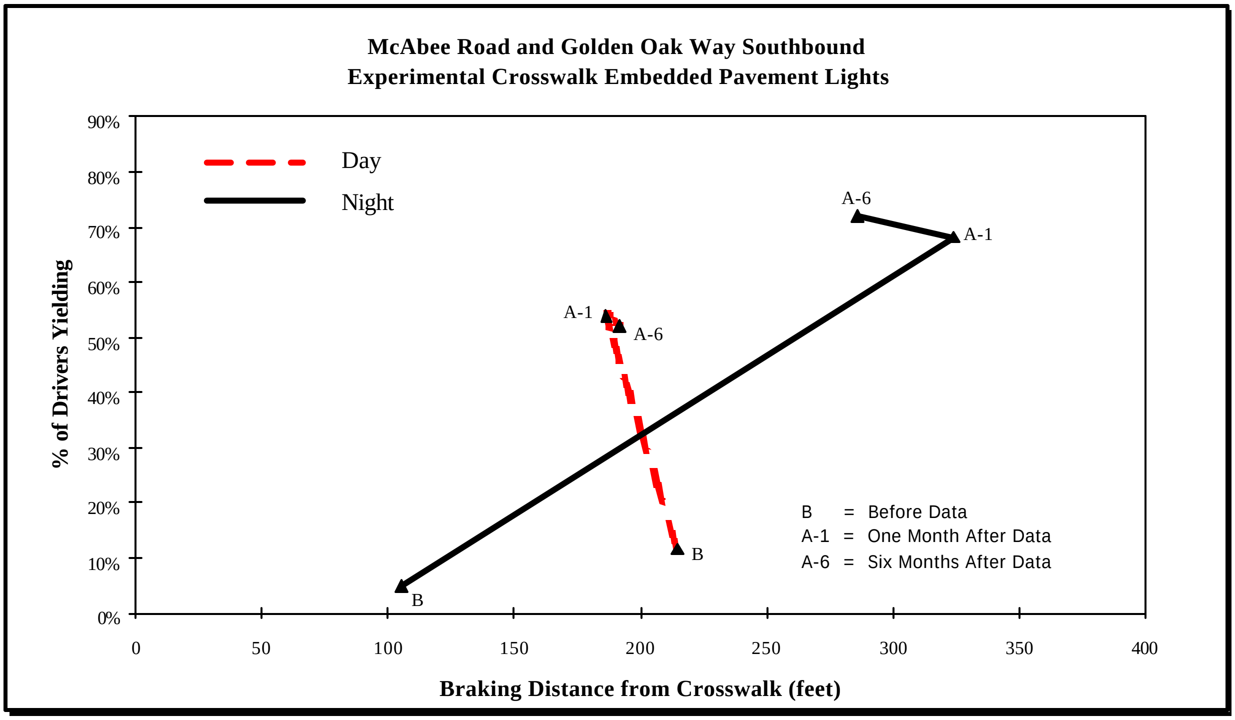
5.2.2. Southbound

- Drivers yielding for pedestrians during the day increased from 12% in the before condition to 54% and 52% for one month and six months after installation, respectively. Braking distance during the day decreased from 214 feet in the before condition to 186 feet and 192 feet for one month and six months after installation, respectively.



Graph 3: McAbee Road and Golden Oak Way northbound

- Drivers yielding for pedestrians during the night increased from 5% in the before condition to 68% and 72% for one month and six months after installation, respectively. Braking distance during the day increased from 105 feet in the before condition to 324 feet and 286 feet for one month and six months after installation, respectively (see Graph 4).



Graph 4: McAbee Road and Golden Oak Way southbound

5.3. Driver Survey

5.3.1. Standard Overhead Yellow flashing beacon

- The six-month after study of the drivers during the day revealed that 50% of the surveyed drivers noticed the crosswalk. Fifty percent of the drivers surveyed noticed a pedestrian, and of those, 17% noticed the flashing lights. Only 4% of the surveyed drivers thought the device was effective.
- The six-month after study of the drivers during the night revealed that 50% of the surveyed drivers noticed the crosswalk. Sixty percent of the drivers surveyed noticed a pedestrian, and of those, 5% noticed the flashing lights. Only 5% of the surveyed drivers thought the device was effective.

5.3.2. Experimental Embedded Pavement Light System

- The six-month after study of the drivers during the day revealed that 71% of the surveyed drivers noticed the crosswalk. Eighty-nine percent of the drivers surveyed noticed a pedestrian, and of those, 42% noticed the flashing lights. Sixty-nine percent of the surveyed drivers thought the device was effective.
- The six-month after study of the drivers during the night revealed that 71% of the surveyed vehicles noticed the crosswalk. One hundred percent of the drivers surveyed noticed a pedestrian, and of those, 91% noticed the flashing lights. Sixty-six percent of the surveyed drivers thought the device was effective.

5.4. Pedestrian Survey

Overall, pedestrians were receptive to the new devices, however, several pedestrians thought that both systems were a poor use of funds and felt a standard traffic signal with a pedestrian push button would be more effective.

5.4.1. Standard Overhead Yellow flashing beacon

- The six-month after-study of the pedestrians was conducted only during the day due to lack of pedestrian activities during the night. The data reveled that 50% felt comfortable crossing at the crosswalk, out of which 80% were aware of the flashing lights. No pedestrians said that they rely upon the lights to stop drivers to give them the right of way.

5.4.2. Experimental Embedded Pavement Light System

- The six-month after-study of pedestrians was conducted only during the night due to lack of pedestrian activity during the day. The data revealed that 81% felt comfortable crossing at the crosswalk, out of which 91% were aware of the flashing lights. Eighteen percent of the pedestrians said that they rely upon the lights to stop drivers to give them the right of way.

6. CONCLUSIONS

Based on the before and after study of the two sites, the experimental embedded pavement light system was found to be more effective at alerting motorists of pedestrian presence in the crosswalk than the standard overhead yellow flashing beacon, particularly at night. This was also validated by pedestrian and driver surveys. It appears that drivers more easily observe the experimental embedded pavement lights rather than the standard overhead yellow flashing beacon installation. These devices should be evaluated under adverse weather conditions i.e. rainy days, fog and other wet conditions. In addition, the effectiveness of the experimental device should be evaluated over time, as motorists become accustomed to the system.

There were some maintenance issues with the experimental embedded pavement lights and the bollard activation system during the six-month test period. These issues included moisture penetration in the fixture housing, vandalism and a malfunction of the bollard detection system. The manufacturer was notified and corrective actions were taken. The experimental embedded pavement flashers appear to be prone to more maintenance needs, particularly at the time of pavement resurfacing and other maintenance activities.

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