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CENTER FOR RESEARCH & EDUCATION IN ADVANCED TRANSPORTATION ENGINEERING SYSTEMS

Emerging Countermeasures for Pedestrian Safety: A Review of State of Art and Recent Advances

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RUTGERS
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Research Team

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Project Objectives

Conducting a comprehensive literature review on:

1. The Effectiveness of Intelligent Transportation System (ITS)- Based Countermeasures on Pedestrian Safety
2. The impacts of ITS-based safety countermeasures on road user behavior

Evaluating the Effectiveness of ITS-Based Countermeasures on Pedestrian Safety

Literature review

ITS-based pedestrian safety countermeasures

1. Signal-Based Countermeasures:
    - Pedestrian Hybrid Beacon (PHB)
    - Leading Pedestrian Interval (LPI)
    - Responsive Push Buttons
    - Pedestrian Countdown Signal
    - Puffin Crossing
2. Sign-Based Countermeasures:
    - Rectangular Rapid Flashing Beacon (RRFB)
    - Flashing LED Signs
    - Speed-Monitoring Trailer
3. In-Pavement Countermeasures:
    - In-Pavement Flashing Light System
4. Automatic Pedestrian Detection:
    - Automatic Pedestrian Detection Device and Smart Lighting
5. Other Countermeasures:
    - Crosswalk Illuminator
    - Overhead Lighting
    - Flashing LED “State Law Stop for Pedestrian Crosswalk” Sign

Literature review

Limitations:

- Lack of data on the effectiveness of countermeasures
- Lack of implementation criteria
- Lack of cost information
- Lack of education on the application of the countermeasures
- Lack of inventory

Signal-Based Countermeasures

Pedestrian Hybrid Beacon (PHB)

Description:

- Consists of two horizontally-arranged red lenses above a single yellow lens
- Dark until activated, flashing and steady yellow upon activation, steady red during pedestrian crossing, alternating flashing red, dark again

Results:

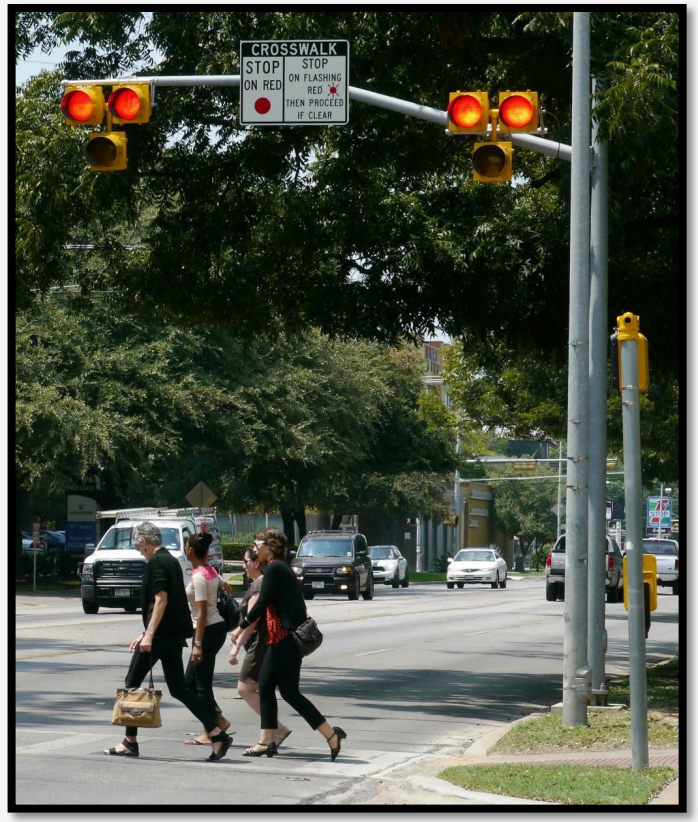
- Up to 69% reduction in pedestrian crashes
- Up to 96% driver yielding rate
- Reduction in pedestrian-vehicle conflicts

Cost of installation:

- $21,000 to $128,000

Typical Locations:

- Crossings where vehicle speeds or volumes are high, but traffic signal warrants are not met
- Average vehicle volume: 39,771 per day
- Average pedestrian volume: 405 per day
- Number of lanes: 4-6
- Speed limit: 30-50 mph
- Successfully installed at school crossings, parks, and senior centers



Source:
https://www.mercurynews.com/2016/06/21/atherton-work-underway-for-almendral-avenue-traffic-light/

Leading Pedestrian Interval (LPI)

Description:

- Allows pedestrians to enter a crosswalk in an intersection 3-7 seconds before the vehicle's green signal
- Helps pedestrians establish their presence in the crosswalk before vehicles turn right or left

Results:

- Up to 58.7% reduction in pedestrian crashes
- Up to 18% increase in left-turning drivers yielding at the WALK phase
- Up to 31% increase in the percentage of pedestrians crossing at the beginning of the WALK phase

Cost of installation:

- The cost of altering the timing is up to $3,500.

Typical Locations:

- Intersections without high pedestrian traffic
- Average vehicle volume: 13,404 per day
- High crash locations (31 crashes per year)
- Number of lanes: 2-4
- Speed limit: 25-35 mph

Source:
http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=12

Responsive Push Buttons

Description:

- Gives audible and visible response when pressed

Results:

- Reduction in the number of trapped pedestrians
- Reduction in the percentage of pedestrians violating signal

Cost of installation:

- $800 to $1,200

Typical Locations:

- Intersections that operate with actuated motor vehicle detection
- Speed limit: 25 mph

Source:
https://www.newrochelleny.com/DocumentCenter/View/14888/PSAP-Summary/

Pedestrian Countdown Signal

Description:

- Designed to begin counting down at the beginning of the clearance (flashing DON'T WALK) interval; can be on fixed-time or pushbutton operation

Results:

- Up to 70% reduction in pedestrian crashes
- Increase in the percentage of pedestrians who looked for vehicles before beginning to cross

Cost of installation:

- $190 to $1,930

Typical Locations:

- When vehicle signals are not visible to pedestrians
- When signal phasing is complex (e.g., there is a dedicated left-turn signal for motorists)
- At established school zone crossings
- Speed limit: 35-45 mph
- Ideally, at every signalized intersection

Source:
https://www.spokesman.com/stories/2010/may/31/crosswalk-countdowns/

Puffin Crossing

Description:

- Enables pedestrians to call a WALK phase
- Uses pedestrian detection system to extend the pedestrian phase when necessary

Results:

- 24% reduction in pedestrian crashes

Cost of installation:

- $80,000 to $150,000

Typical Locations:

- Signalized crossings with a relatively high frequency of pedestrians aged 65 and above and/or pedestrians with disabilities
- Traditional traffic signals with pedestrian signals; may be used with Pedestrian Hybrid Beacons

Source: https://thenantwichnews.co.uk/tag/shavington-high-school/

Sign-Based Countermeasures

Rectangular Rapid Flashing Beacon (RRFB)

Description:

- Enhances pedestrian crossings at mid-block locations and unsignalized intersections by drawing attention to crossing signs

Results:

- Up to 92% driver yielding rate
- Reduction in pedestrian-vehicle conflicts

Cost of installation:

- $4,500 to $52,000

Typical Locations:

- Uncontrolled, marked crosswalks with a pedestrian, school, or trail crossing warning sign
- Locations with limited visibility such as S-curves and hills
- Average vehicle volume: 7,500 per day
- Number of lanes: 2-4
- Speed limit: 35-40 mph

Source:
http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=54/

Flashing LED signs

Description:

- A traffic control device used at pedestrian crossings

Results:

- Up to 80% driver yielding rate
- 20% increase in the number of motorists who reduced their speed as they approached the crosswalk

Cost of installation:

- $1,000 to $1,825

Typical Locations:

- Crosswalks on roadways with low operating speeds, low traffic volumes, narrow lanes, and typical sidewalks (3-5 ft)
- Number of lanes: maximum 4
- Speed limit: 35 mph

Source: https://www.tapconet.com/product/24-7-blinkersign-flashing-led-pedestrian-crosswalk-symbol-sign-w11-2

Speed-Monitoring Trailer

Description:

- Displays the speed of an approaching vehicle to enhance enforcement efforts directed at speed compliance

Results:

- Increase in driver yielding rate
- Decrease in pedestrian delay

Cost of installation:

- $7,000 to $18,000

Typical Locations:

- Residential areas
- Areas where speeding is a problem
- Speed limit: 25-45 mph

Source: https://www.tsandl.us/collections/trailer-mounted-radar-speed-signs/products/tc-mini-display-trailer

Radar Speed Signs

Description:

- Displays the speed of an approaching vehicle to enhance enforcement efforts directed at speed compliance

Results:

- Slowed down up to 80% of speeding motorists
- Up to 20% reduction in vehicle speeds
- Up to 60% increase in overall compliance with the posted speed limit

Cost of installation:

- $2,000 to $3,900

Typical Locations:

- Areas where speeding is a problem
- Successfully installed at school zones

Source: https://panow.com/2021/07/26/speed-monitoring-data-used-for-future-traffic-enforcement/

In-Pavement Countermeasures

In-Pavement Flashing Light System

Description:

- Consists of lights embedded in the pavement at both sides of the crosswalk

Results:

- Increase in driver yielding rate
- Decrease in the mean speed of vehicles approaching the crosswalk

Cost of installation:

- $12,000 to $20,000
- Cost of maintenance: $1,000 per 3 years

Typical Locations:

- Uncontrolled crosswalks
- School crossings
- Number of lanes: 2-4
- Speed limit: 35 mph

Source: https://www.facebook.com/lightguardsystems/

Pedestrian Warning Systems

Automatic Pedestrian Detection Device and Smart Lighting

Description:

- Uses ultrasonic or microwave radar to detect the presence of pedestrians
- Increases the illumination of crosswalks with the help of smart lighting

Results:

- Up to 17% increase in the percentage of diverted pedestrians
- Up to 15% reduction in the percentage of trapped pedestrians
- Up to 13% increase in driver yielding rate

Cost of installation:

- $10,000 to $70,000

Typical Locations:

- Intersections and mid-blocks crossings
- Average vehicle traffic: 37,500 per day
- Number of lanes: 4
- Speed limit: 35 mph
- 11 pedestrian-involved crashes in five years

Source: https://www.icomsdetections.com/project/tma-011-en/

Other Countermeasures

* There are no studies evaluating the effectiveness of these countermeasures.

Crosswalk Illuminator

Description:

- Consists of a flood light that illuminates the crosswalk approaches and a beam of light that illuminates the middle of the crosswalk

Results:

- Increases pedestrian visibility at poorly lit locations

Cost of installation:

- Not available

Typical Locations:

- Uncontrolled crossings
- Where trails intersect with residential areas
- Average vehicle volume: 1,000 per day
- Number of lanes: 4

Source: https://www.tapconet.com/case-study/danville-california

Overhead Lighting

Description:

- Increases visibility at mid-block crossings with a directional, compliant, and efficient LED light

Results:

- Helps pedestrians cross visibly and safely

Cost of installation:

- Not available

Typical Locations:

- Uncontrolled crossings/mid-block crossings
- 25 pedestrian-involved crashes in 10 years

Source: https://carmanah.com/resources/hanover-boosts-safety-rrbs-overhead-lighting-crosswalk-case-study/

Flashing LED "State Law Stop for Pedestrian Crosswalk" Sign

Description:

- Employs a set of synchronized, flashing high-intensity LEDs that extend the range of visibility of the sign during the day or night and in all weather conditions.

Results:

- Increases driver awareness of the sign

Cost of installation:

- $1,500 to $2,500

Typical Locations:

- Uncontrolled crossings/mid-block crossings

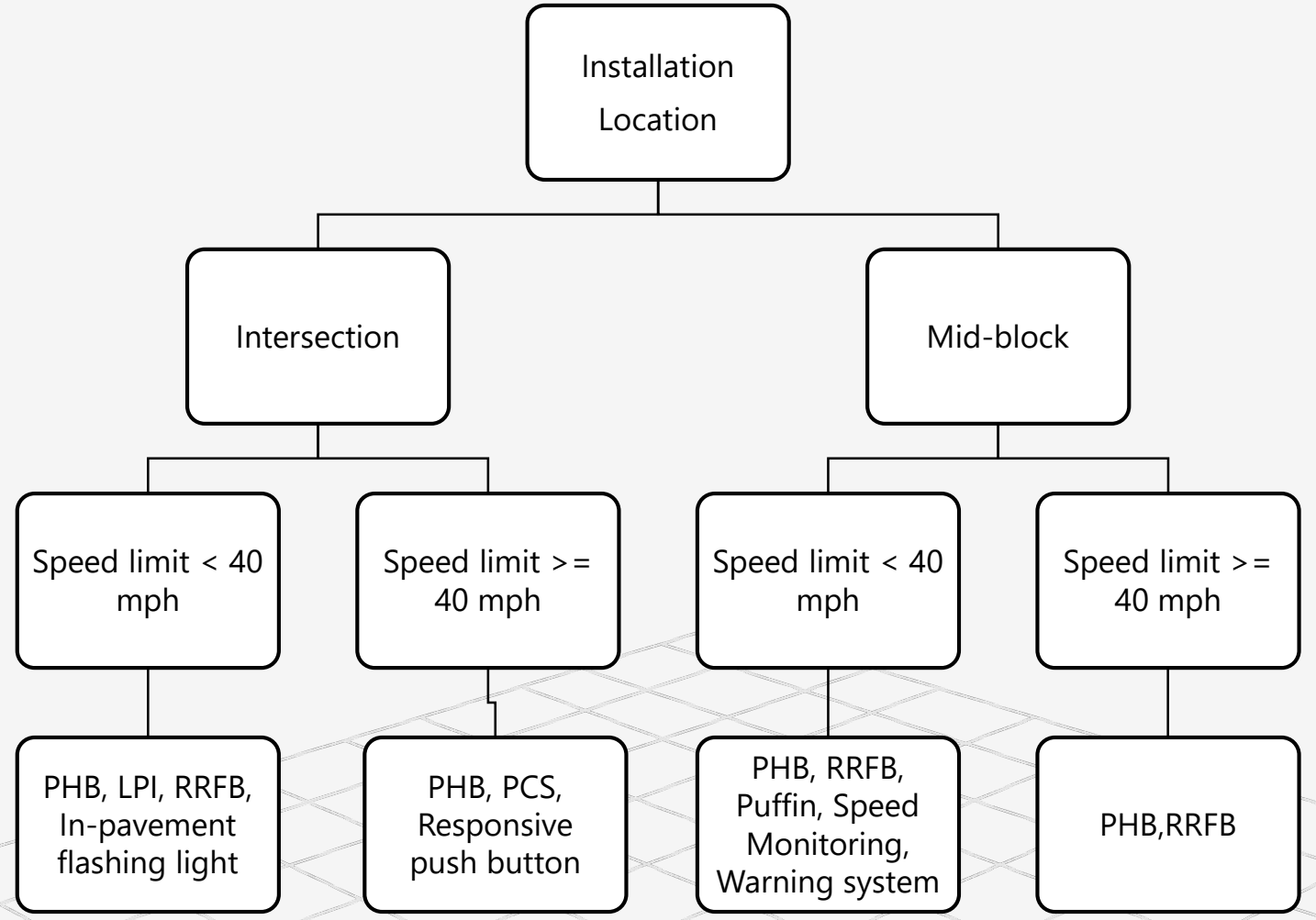
Source: https://www.trafficsafetywarehouse.com/Solar-Powered-Flashing-LED-State-Law-Yield-for-Pedestrian-Crosswalk-Sign/productinfo/1236R1-6SGM/

Summary of the ITS-based Countermeasures

ITS countermeasure	Crash Reduction Factor[1]	Proven?[2]
Pedestrian Countdown Signals	0.70	No
Pedestrian Hybrid Beacon	0.69	Yes
Leading Pedestrian Interval	0.59	Yes
Rectangular Rapid Flashing Beacon	0.47	Yes
Puffin Crossing	0.24	No
Responsive Push Buttons	NA	No
Speed-Monitoring Trailer	NA	No
Flashing LED signs	NA	No
In-Pavement Flashing Light System	NA	No
Automatic Pedestrian Detection	NA	No

1. Source: cmfclearinghouse.org
2. Source: Proven Safety Countermeasures-FHWA

Recommended Countermeasures



Thank you!

Any Questions?