Preview of the FHWA Crosswalk Marking Selection Guide

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Crosswalk Marking Webinar Series

Two sessions on crosswalk marking guidance:

Part 1 – Tuesday, February 15

Preview of the FHWA Crosswalk Marking Selection Guide

Part 2 – Thursday, February 17

Detailed Field Research Findings from the FHWA Crosswalk Marking Selection Guide

Visit www.pedbikeinfo.org/webinars for information about our upcoming sessions
Today’s Panel

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Webinar Part 1


Tuesday, February 15, 2022
1:00 PM EST
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Research Team

- Pierce Schwalb
  - Project Coordinator
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- Bastian Schroeder, PhD, PE
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- Taha Saleem, PhD
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Outline

- Guide Purpose and Organization
- State of Practice
- Original Research
- Guide Recommendations
Guide Purpose and Organization
Purpose of crosswalks and their documented benefits
Factors to consider when selecting marking designs
Question of whether to mark a crosswalk is not the intent of the guide
Guide Purpose

- Provides support for agencies selecting crosswalk marking designs
- Considers various aspects including Safety, Visibility, Effectiveness, Materials, Maintenance, and Cost
- Builds on existing research and guidance on these factors, highlights gaps in knowledge, and documents original research conducted
State of Practice
Why Do We Have Crosswalks?

• **What are crosswalks?**
  • Areas where pedestrians are granted the right of way when crossing a roadway
  • May be marked or unmarked

• **Why do we mark them?**
  • Alert drivers to pedestrians’ potential presence and right of way
  • Establish pedestrian right of way at midblock locations
  • Establish pedestrian right of way at crossings lacking sidewalk connections on both sides (in some states)
  • Provide wayfinding cues to pedestrians with low vision
Crosswalk Markings and Pedestrians With Low Vision

- Markings contrast with pavement can assist pedestrians with low vision
- Markings NOT detectable for blind pedestrians
What are the Types of Crosswalks Markings?

Crosswalk Marking Design Locations

Intersection

Midblock
What are the Safety Effects of Crosswalk Markings?

- **Context matters!**
  - Marked crosswalks alone on multilane, higher-volume, and/or higher-speed facilities not known to reduce crash risk
  - Marked crosswalks are associated with increased driver yielding compared to unmarked crosswalks
  - Yielding rates inversely correlated with speed and are influenced by several factors
    - Roadway characteristics
    - Roadway and site context
    - Sociodemographic characteristics of the driver and pedestrian

Yielding rate is **negligible** at sites with high speeds over 30-35 mph

No conclusive findings on crash risk
Safety Effects -- Crosswalk Marking Visibility

HVCs shown to be more visible from twice the distance of basic.

Basic Crosswalk Marking on Driver Approach (approximately 150 feet upstream).

HVC Marking on Driver Approach (approximately 150 feet upstream).
Original Research
Key Research Questions

1. Does the increased visibility of HVCs lead to increased **effectiveness**?
   - If so, where are they recommended? (i.e., why not use them for all marked crosswalks?)

2. What are agency criteria for selecting marking types, and which criteria should be included in federal guidance?
Field Study
Approach

- **Compare yielding behavior**
- **Approach:**
  - Conducted staged pedestrian crossings at HVC and basic sites
  - Established internal protocol for crossing consistency (pedestrian, body language, influence area, etc.)
  - Collected volumes and speeds for all vehicles while in field for post-hoc evaluation
Example Site Pair

Basic crosswalk

HVC crosswalk
Results

Join us Thursday (2/17) for Part 2 of our webinar series and detailed results!

Modeled yielding behavior as a result of speed and crosswalk markings

- At 15 mph, ~4% difference
- At 25 mph, ~14% difference
- At 40 mph, ~3% difference
Original Research Results

85th percentile speed

HVCs have strong positive effect on driver yielding with 85th percentile speed ≤ 30 mph; above that, HVCs alone no more impactful on driver yielding than basic markings.

Presence of warning signs (MUTCD W11-1 and S1-1)

HVCs have strong positive effect on driver yielding with or without warning signage at the crossing.

Site Context

HVCs associated with increased driver yielding at sites on roadways not located within a dense grid street network.
- HVCs are associated with **increased** driver yielding compared to basic
- Yielding rates showed **robust negative relationship** with driver speeds
  - HVC effectiveness strongest with **lower driver speeds** (sites with 85th percentile speeds ≤ 30 mph)
- HVCs show **positive yielding effect** with and without supplemental warning signs present (a stronger effect in the absence of warning signs).
Implications for Marking Decisions

- HVCs are associated with increased yielding
- Driver speed has stronger relationship with yielding
- Context still matters! Test sites are limited in scope (2-lane, low-volume roads)
- HVC markings are not a panacea!
Guide
Recommendations
When Should HVCs be used?

- Existing and original research have indicated potential crash reduction and yielding benefits from HVC markings in certain contexts.
- If a crosswalk is worth marking, it is worth marking as HVC for improved visibility. HVCs are recommended over basic patterns for all marked crosswalks.
HVC Marking Recommendation

Recommended HVC Marking Styles for All Crosswalks.

When is Marking Alone Not Enough?

- Two sets of criteria that agencies may consider:
  1. Roadway configuration, speed, and volume
  2. Pedestrian demand and delay
### Table 1. Application of pedestrian crash countermeasures by roadway feature.

<table>
<thead>
<tr>
<th>Roadway Configuration</th>
<th>Posted Speed Limit and AADT</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicle AADT &lt;9,000</td>
<td>Vehicle AADT 9,000–15,000</td>
<td>Vehicle AADT &gt;15,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤30 mph</td>
<td>35 mph</td>
<td>≥40 mph</td>
<td>≤30 mph</td>
</tr>
<tr>
<td>2 lanes (1 lane in each direction)</td>
<td>1 2 3 4 5 6</td>
<td>5 6 7</td>
<td>9</td>
<td>5 6</td>
</tr>
<tr>
<td>3 lanes with raised median (1 lane in each direction)</td>
<td>2 3 4 5 6 7</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)</td>
<td>3 4 5 6 7 8</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>4+ lanes with raised median (2 or more lanes in each direction)</td>
<td>4 5 6 7 8</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>4+ lanes w/o raised median (2 or more lanes in each direction)</td>
<td>5 6 7 8 9</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

Given the set of conditions in a cell:
- * Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ** Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- # Signifies that high-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
- 1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Rectangular Rapid-Flash Beacon (RRFB)**
- 8 Road Diet
- 9 Pedestrian Hybrid Beacon (PHB)**

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.
More Existing Guidance for HVC Use

- 2009 MUTCD
- National Committee of Uniform Traffic Control Devices (NCUTCD)
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- National Association of City Transportation Officials (NACTO)
  - Urban Street Design Guide
Agencies should consider social equity when prioritizing investment and selecting supplemental treatments:

- Quality and presence of existing transportation infrastructure in Black, Indigenous, People of Color (BIPOC) and low-income communities
- Disparate sociodemographic safety effects on yielding
- Avoid only responding to public comment and request
Typical schedules for refreshing markings include:
- Ad hoc as needs are identified
- On same schedule as inspection program—but only if the crosswalk needs refreshing
- On a fixed schedule

Some agencies prefer to replace rather than refresh due to:
- Unit costs often the same to refresh as to replace
- Mobilization more efficient for larger projects
- Traffic control needed regardless of refresh or replace
<table>
<thead>
<tr>
<th>Material</th>
<th>Findings from State of Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint</td>
<td>Generally agreed paint lasts no longer than 1 year (or one winter season in cold-weather climates)</td>
</tr>
<tr>
<td>Thermoplastic</td>
<td>As low as 2–3 years in high-volume locations, but most agencies reported 5 or more years before needing refreshing. A few agencies reported 10–15 years</td>
</tr>
<tr>
<td>Methyl Methacrylate (MMA)</td>
<td>Generally lasted 3–5 years before needing refreshing</td>
</tr>
<tr>
<td>Epoxy</td>
<td>One agency reported durability for epoxy reported that it lasted 3–5 years before needing refreshing</td>
</tr>
<tr>
<td>Preformed polymer tape</td>
<td>Lasting more than 5 years before needing refreshing and more than 7 years when the markings are recessed</td>
</tr>
</tbody>
</table>
Factors Considered When Selecting Materials

- Equipment availability
- Desired material properties
- Material cost
- Job size
- Pavement type
- Lighting conditions
- Climate
- Traffic volume
- Time to the next planned pavement preservation project
- Environmental concerns
- Experience
Example Selection: materials, not markings!

Source: Adapted from Minnesota DOT

Minnesota DOT Transverse Marking Selection Guidance

New Bituminous (mill & overlay or reconstruct)
- Preservation planned within 1 – 2 years
  - <1,500 ADT – Latex
  - ≥1,500 ADT Multi-Compound Liquid
- Preservation planned 3 or more years out
  - <1,500 ADT – Multi-Compound Liquid
  - ≥1,500 ADT

Bituminous Preservation Projects
- (micro-surface, ultra-thin bonded wear course, chip seal², fog seal)
  - <1,500 ADT – Multi-Compound Liquid
  - ≥1,500 ADT
    - Lit
    - Unit

New Concrete (restoration or reconstruction)
- Lit
- Unit

1 - Based on life of material and suggested optimum time to initial preservation project.
2 - Methods for recessing markings on chip seals are still being developed.
3 - Enhanced skid resistant materials are recommended for roundabouts and crosswalk blocks.
## Material Recommendations

<table>
<thead>
<tr>
<th>Site Characteristic</th>
<th>Material or Application Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-visibility crosswalk</td>
<td>Antiskid properties into marking material</td>
</tr>
<tr>
<td>Unlighted crossing</td>
<td>A material with high retroreflectivity (dry or wet retroreflectivity, depending on the climate)</td>
</tr>
<tr>
<td>Frequent winter snowplowing</td>
<td>Recessed markings more resistant to snowplow damage; alternatively, nondurable markings can be used and refreshed annually.</td>
</tr>
<tr>
<td>High-volume location</td>
<td>Use durable markings; consider recessed markings.</td>
</tr>
<tr>
<td>Low-volume location</td>
<td>Moderately durable markings</td>
</tr>
<tr>
<td>Roadway will be resurfaced within the next 1–2 years</td>
<td>Nondurable markings</td>
</tr>
</tbody>
</table>
Marking
Design and Wear
Recommendations

- Designs incorporating longitudinal elements (e.g., longitudinal bar, double-paired) can place markings outside typical vehicle paths to improve longevity.
- Regularly scheduling inspections or an asset management system are good options.
- Staff observations and public input are supplemental means of identifying crosswalk markings.
- Replacing markings can be as cost-effective as refreshing.
The cost to install a crosswalk depends on several factors, including:

- Traffic control
- Removing old markings
- Labor to install the new markings
- Material used for marking
- Crosswalk length and width
- Marking pattern
- Marking height
Difficult to provide exact cost estimates for installing crosswalk markings.

However, there are comparative installation costs of basic and HVC:

**Comparative Crosswalk Installation Costs**

<table>
<thead>
<tr>
<th>Crosswalk Type</th>
<th>Median Cost</th>
<th>Average Cost</th>
<th>Minimum Cost</th>
<th>Maximum Cost</th>
<th>Cost Unit</th>
<th>Number of Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Visibility</td>
<td>$3,692</td>
<td>$3,054</td>
<td>$721</td>
<td>$6,866</td>
<td>Each</td>
<td>4</td>
</tr>
<tr>
<td>Basic</td>
<td>$409</td>
<td>$926</td>
<td>$132</td>
<td>$2,513</td>
<td>Each</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: UNC Highway Safety Research Center. Costs have been adjusted to 2020 U.S. dollars using the National Highway Construction Cost Index.
Maintenance Costs and Life-Cycle Costs

• Agencies generally agreed it cost as much to refresh as it costs to replace or install due to
  • Mobilization
  • Traffic control
  • Other labor costs
• No research available to quantify the effect of longitudinal markings on reducing need for maintenance
• Life-cycle costs
  • Mainly driven by the cost to install initially and refreshing before replacement
  • Other costs to potentially consider include:
    • Initial equipment costs
    • Traffic delay
Thank you!
Questions?

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Discussion

᠄ Send us your questions

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