

INTRODUCTION

The Town of Greenwich has requested a study to investigate crosswalk materials and layouts based on published literature. The study will include the development of standardized crosswalk details to be used for all future Town projects.

Methodology

BETA reviewed the requirements set forth in the Manual on Uniform Traffic Control Devices (MUTCD) as well as the following supplemental guidelines:

- Connecticut Department of Transportation Highway Design Manual and Standard Drawings
- Design and Safety of Pedestrian Facilities (ITE)
- Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide (FHWA)

BETA also conducted a search on the internet for additional information regarding crosswalk materials and layouts. The photos below depict some crosswalk layouts and aesthetic treatments.



Continental Crosswalk Layout



Standard Crosswalk Layout



*Standard Brick Paver Crosswalk
At a School in Greenwich, CT*



Standard Imprinted Crosswalk Layout

CROSSWALK MATERIALS

This section describes materials that are commonly used for marking crosswalks. These materials include:

- Paint
- Epoxy Resin
- Thermoplastics
- Inlay Tape

Three criteria are used to evaluate the effectiveness of these materials: durability, retroreflectivity, and cost. Durability measures the product's ability to withstand damage, i.e., its service life. Retroreflectivity allows the markings to be visible at night or in low light conditions. It is provided by glass or ceramic beads that are embedded in the material's surface. Cost takes into account the material and installation cost as well as maintenance.

Paint

Paint is the most common material to be used for marking crosswalks. It is generally hot-applied and water-based. The paint is sprayed onto the road using a pressurized machine, followed by an application of glass beads that provide retroreflectivity.

Paint is the least expensive type of material to install. It can be applied quickly and will dry quickly under favorable conditions, usually under seven minutes. Water-borne paint does not require use of a solvent for cleaning. Paint is particularly sensitive to temperature and humidity. Also, it is the least durable type of material. Painted crosswalks should be repainted once or twice a year in order to maintain adequate visibility and retroreflectivity on high-volume roads.

Epoxy Resin

Epoxy resin is similar in appearance to paint. It is a durable material consisting of two parts: a pigmented resin base and a hardener. Each component is heated separately, then mixed and immediately applied, followed by the addition of glass beads for retroreflectivity.

The low profile on the roadway resists damage from snowplows. Epoxy resin is slower to cure than paint but maintains its retroreflectivity longer. However, three times the number of glass beads are required as compared to paint. Epoxy resin is initially two to three times as expensive as paint though it is more durable and therefore requires less maintenance.

Thermoplastics

Thermoplastic material is a solid that becomes liquid when heated and bonds thermally with the pavement. The material is composed of pigment, reflective beads, filler, binder, and additives. Both material and air temperatures must be closely monitored to ensure effective adhesion to the pavement. Air temperatures must be above 50°F for the material to adhere. The pavement surface must also be clean and dry for proper application. In addition, the application of

thermoplastics is more difficult than paint or epoxy and requires special equipment and trained operators.

Thermoplastic is highly visible due to the integration of the reflective beads. It is also very durable due to its thickness (6-10 times thicker than paint) and thermal adhesion to porous surfaces. Thermoplastics are also less slippery when wet than paint or epoxy resin. It has a much longer life than paint, but is susceptible to damage from snowplows due to its thickness.

Inlay Tape

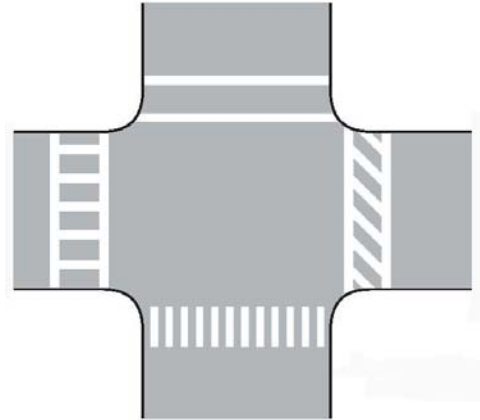
Inlay tape is a retroreflective skid-resistant paint polymer pavement marking material. It is highly reflective, long-lasting, and slip-resistant, and does not require a high level of maintenance. Inlay tape can only be applied on new or repaved roadways. The tape should be pressed into the surface while the pavement is still warm.

Although inlay tape has the highest initial expense, it is the most durable of available materials and therefore the longest-lasting. It also has the highest initial retroreflectivity. When inlaid into the pavement, the tape is sufficiently resistant to snowplow damage.

CROSSWALK LAYOUTS

The MUTCD requires that crosswalks be composed of solid white lines, 6 to 24 inches wide. The width of the crosswalk should be a minimum of 6 feet. The following layouts are most commonly used for crosswalks:

- Standard (top)
- Ladder (left)
- Diagonal Ladder (right)
- Continental (bottom)



Standard

The standard, or transverse, layout is considered the most basic option. The markings are perpendicular to the roadway, spaced at least 6 feet apart (including the width of the lines), and are commonly 12 inches wide. The standard layout is favorable because it requires the least amount of pavement markings. It is also, however, the least visible for motorists. Therefore, it is best used at signalized intersections.

The area between the standard crosswalk lines may be enhanced with pavers or another aesthetic treatment, most common in commercial or school areas. Aesthetic treatments involve stamping the asphalt with a pattern and often coloring it. Stamped concrete is another type of aesthetic treatment. It requires a long curing time, which is often not practical for crosswalk construction, and it is fairly expensive.



Brick Paver Crosswalk

Brick is the most suitable paver material, as granite and cobblestones become slippery when wet and are difficult to cross by the disabled. When installed properly, brick pavers provide the longest service life. The photo to the left shows brick pavers that were installed on a project approximately ten years ago. When pavers are not installed properly, however, they will settle and/or shift and become subject to damage. Granite strips are often installed between the pavers and the striping to help prevent shifting. Brick pavers are the most expensive type of crosswalk enhancement.

An imprint is a resin-based synthetic bituminous compound that is applied to the roadway while hot, about half an inch to an inch thick. It is imprinted with a mold and comes in a variety of colors. The most common mold simulates brick pavers, shown in the photo to the left, though there are several available patterns. Imprint is well-suited for high-traffic and intersection areas. Other techniques applied to asphalt surfaces, such as Streetprint or Stamped Asphalt, are less expensive than Imprint, but do not provide the same level of durability.

Ladder

The ladder layout consists of the standard layout with additional longitudinal lines that are parallel to traffic flow. The longitudinal lines should be 12 to 24 inches wide and spaced 12 to 60 inches apart. It is desirable to set the spacing of the longitudinal lines to avoid wheel paths in order to prolong the life of the crosswalk.

According to the Design & Safety of Pedestrian Facilities (Report No. FHWA/RD-88/038), the optimal crosswalk pattern is the ladder design with a 12-inch strip and a 24-inch space.

Diagonal Ladder

The diagonal ladder layout is similar to the ladder layout, only with lines that are angled 45 degrees to the line of the crosswalk. According to the MUTCD, the diagonal lines should be 12 to 24 inches wide, spaced 12 to 60 inches apart. Spacing should be less than 2.5 times the line width.

While more visible than the standard layout, the diagonal lines are more prone to wear from vehicle tires.

Continental

The continental layout consists of the ladder layout with the transverse lines removed. As with the ladder layout, the longitudinal lines should be spaced to avoid wheel paths. The longitudinal lines, often referred to as bars, should be 12 to 24 inches wide, spaced 12 to 60 inches apart.

This layout is most visible to motorists and to those with low vision and cognitive impairments. ConnDOT uses this layout in its Standard Drawings. The continental layout is recommended by FHWA in “Designing Sidewalks and Trails for Access” because research indicates it is the most visible to drivers. The continental crosswalk layout is shown on page 1.



Zebra Layout

A variation of the continental layout is the zebra layout, shown in the photo to the left. The pattern typically consists of groupings of two 8-inch lines with an 8-inch space between of them, in lieu of a single 24-inch line, with a 24-inch space between each grouping. The zebra layout has the same visual effect as the continental layout with less markings and therefore less maintenance.

CONCLUSION AND RECOMMENDATIONS

This section includes a summary of crosswalk materials and layouts, followed by specific recommendations.

Conclusion

Materials commonly used for crosswalks include paint, epoxy resin, thermoplastics, and inlay tape. The primary criteria used to evaluate each material's effectiveness include durability, retroreflectivity, and cost.

Paint is the least expensive to install but also the least durable and retroreflective. Epoxy resin is more durable than paint but also more expensive. Thermoplastics are not a viable option for this climate, due to their susceptibility to damage from snowplows. Inlay tape is the most durable and retroreflective, but also the most expensive to install, and can only be applied to new or resurfaced roadways.

Several crosswalk layouts are available. The most common are the standard, ladder, diagonal ladder, and continental layouts.

Recommendations

As a result of our research and experience, BETA recommends the following standards to be applied at all crosswalks:

- Epoxy resin should be used for all crosswalk striping.
- All crosswalks should be 9 feet wide, measured from the outside of the lines.
- Either the continental layout or IMPRINT should be used at all mid-block intersections.
- The standard layout with 12-inch crosswalk lines should be used at signalized and unsignalized intersections.
- In commercial and school areas, the area between the crosswalk lines should be enhanced using a high visibility material, as determined by the Town Traffic Engineer.
-

Details for each layout are included in Figure 1 on the following page. The ConnDOT Standard Specification, Section 12.10 "Epoxy Resin Pavement Markings, Symbols, and Legends". A specification for a common imprint supplier, Imprint, is included in the Appendix.