Standard Specification for
Durable Green Bike Lane Surface Treatments for
Asphalt and Concrete Pavements with Exposure to
Vehicular Traffic.

AASHTO Designation: PP XX-16
1. SCOPE

1.1 This specification describes furnishing and applying a Durable Green Bicycle Lane Surface Treatment (GBLST) for asphalt and concrete pavements that is designed to be exposed to vehicle traffic. The GBLST is comprised of a minimum, single layer using a Resin Binder System with Aggregate, Preformed or Hot Applied Thermoplastic or Resin Binder System with Colored Aggregate. Binder Resin Systems include 100% solids Polymeric or Methyl Methacrylate (MMA).

1.2 This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- AASHTO M-235 Standard Specification Epoxy Resin Adhesives
- AASHTO T-96 Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- AASHTO T-255 Standard Method of Test for Total Evaporable Moisture Content of Aggregate by Drying

2.2 ASTM Standards

- ASTM D 36 Standard Test Method for Softening Point of Bitumen (Ring-and Ball Apparatus)
- ASTM D 522 Standard Test Method for Mandrel Bend Test of Attached Organic coating
- ASTM D 2240 Standard Test Method for Rubber Property—Durometer Hardness
- ASTM D 4060 Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- ASTM D 5895 Standard Test Method for Evaluation Drying or Curing During Film Formation of Organic Coatings Using Mechanical Recorders
- ASTM D 7735 Standard Test Method for Type A Durometer Hardness Testing of Road Marking thermoplastic at Elevated Temperatures
- ASTM E 1347 Standard Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
- ASTM G 154 Standard Test Method for Operating Fluorescent Light Apparatus for UV Exposure of Non Metallic Materials
3. TERMINOLOGY

3.1 Green Bike Lane Surface Treatment (GBLST) – a colored surface application designed to provide demarcation on pavements where vehicles and bicycle riders are in close proximity or utilize the same pavement.

3.2 Binder Resin System - a polymeric or MMA material used with incorporated aggregate or to bond a surface applied aggregate to an asphalt or concrete pavement.

3.3 Prime Coat - a polymeric or MMA material that is used to fill cracks and voids in existing pavement surface and increase bond strength to prepared pavement surfaces and is compatible with the binder resin system.

3.4 Aggregate – natural or manufactured material that is designed to enhance friction and wear resistance.

3.5 Colored Aggregate – aggregate with color throughout or manufactured with a color surface.

3.6 Surface Friction – the ability of a surface to resist slipping by pedestrians or loss of traction by bicycles or vehicles.

3.7 Chromaticity Coordinates – a measure of daytime chromaticity values to establish a unique identification of a materials color.

3.8 Color Fastness – the ability of a material to maintain color when exposed to the effects of the environment and UV rays.

3.9 Retroreflective – the ability of a surface to reflect light back towards the origin of the light source.

3.10 Polymeric Resin – a 100 % solids polymer based material such as epoxy, modified epoxy and polyester.

3.11 MMA Resin – a 100% solids material comprised of methyl methacrylate based resin.

3.12 Thermoplastic – hot applied or preformed 100% solids material that softens or melts when heated.

4. SUMMARY OF SPECIFICATION

4.1 This specification describes furnishing and applying a GBLST for use on asphalt or concrete pavements with exposure to vehicular traffic. The GBLST is comprised of one of the following, a single or multi-layer binder resin system which contains aggregate, a binder resin system with surface applied colored aggregate or hot applied or preformed thermoplastic with aggregate. These systems may or may not be retroreflective.

5. SIGNIFICANCE AND USE

5.1 The GBLST is used primarily for providing enhanced conspicuity and demarcation of designated and marked bicycle lanes and to extend bicycle lanes through intersections and other conflict areas with vehicular traffic. Typical locations for GBLST installations include any travel way designated as a bicycle lane and in extensions of bicycle lanes through intersections and other traffic conflict areas, in accordance with the Manual on Uniform Traffic Control Devices “Interim Approval for Optional Use Green Colored Pavement for Bike Lanes (IA-14)”.

5.2 A GBLST will provide improved demarcation and sufficient friction to ensure that the colored pavement does not result in traction issues for bicyclists, vehicles or pedestrians. GBSLT should be selected to meet the durability requirements for the degree of exposure to vehicular traffic and the safety of bicyclists and pedestrians.

6. MATERIALS

6.1 Binder Resin Systems:
6.1.1 Binder resin systems shall be recommended by the manufacturer as suitable for use on the intended pavement surface, for the environmental conditions and proposed use.

6.1.2 Prime Coat: When recommended by a manufacturer a primer shall be used before application of the binder resin system.

6.1.3 The properly proportioned and mixed binder shall conform to the requirements of Table 1.

<table>
<thead>
<tr>
<th>Table 1 Physical Requirements of the 100% Solids Binder Resin Systems</th>
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</thead>
<tbody>
<tr>
<td>Property</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Gel Time*</td>
</tr>
<tr>
<td>Elongation at break point*</td>
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<tr>
<td>Durometer Hardness (Type D)*</td>
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<tr>
<td>Abrasion Resistance*</td>
</tr>
<tr>
<td>Surface Friction (wet)</td>
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<tr>
<td>Color*</td>
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<tr>
<td>UV Resistance*</td>
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<tr>
<td>Bond Strength @ 24 hours† asphalt substrate</td>
</tr>
<tr>
<td>Bond Strength @ 24 hours† concrete substrate</td>
</tr>
</tbody>
</table>

*refer to section 8 of this document for variations of testing requirements other than Test Method listed in table

†Bond strength should be considered a test to assure that a pavement is sufficiently aged, properly prepared and has the structural capacity to receive a GBLST. This test should be performed in the field using the specified material and application methods proposed for the project.

6.1.4 Independent laboratory reports shall be provided, documenting that the resin binder meets the requirements of Table 1

6.1.5 A sample of the binder resin or the components shall be supplied upon request.

6.2 Thermoplastic Hot Applied and Preform:

6.2.1 Thermoplastic material systems shall be recommended by the manufacturer as suitable for use on the intended pavement surface, for the environmental conditions and proposed use.

6.2.2 Thermoplastic materials shall conform to the requirements in Table 2.

<table>
<thead>
<tr>
<th>Table 2 Physical Requirements of Thermoplastic System</th>
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</thead>
<tbody>
<tr>
<td>Property</td>
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<td></td>
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<tr>
<td>TS-4c</td>
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<tr>
<td>Property</td>
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<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>Thickness</td>
</tr>
<tr>
<td>Softening Point</td>
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<td></td>
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<tr>
<td>Durometer Hardness (Type A)</td>
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<td></td>
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<tr>
<td>Surface Friction (wet)*</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Color</td>
</tr>
<tr>
<td>UV Resistance*</td>
</tr>
<tr>
<td>Bond Strength @ 24 hours‡</td>
</tr>
</tbody>
</table>

*refer to section 8 of this document for variations of testing requirements other than Test Method listed in table
‡Bond strength should be considered a test to assure that a pavement is sufficiently aged, prepared and has the structural capacity to receive a pavement marking system. This test should be performed in the field using the specified material and application methods.

6.2.3 Independent laboratory reports shall be provided, documenting that the thermoplastic materials meet the requirements of Table 2.

6.2.4 A sample of the thermoplastic traffic marking materials shall be supplied upon request.

6.3 Aggregates:

6.3.1 Aggregate can be mixed with binder resin systems, surface applied or an integral part of a thermoplastic. Aggregate can be silica, granite, flint, corundum, synthetic colored material, colored glass, color coated glass, bauxite or other materials that exhibit resistance to fracture and wear. The aggregate type and size can vary based on the friction and wear resistance requirements of the installation.

6.3.2 The aggregate shall be clean, dry, and free from foreign matter.

6.3.3 The aggregate shall conform to the physical requirements of Table 3.

### Table 3 Physical Requirements of the Aggregate

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>Mohs</td>
<td>5.5 minimum</td>
</tr>
<tr>
<td>Resistance to Degradation*</td>
<td>AASHTO T-96</td>
<td>20% max</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>AASHTO T-255</td>
<td>0.2% max</td>
</tr>
<tr>
<td>Color†</td>
<td>ASTM E 1347</td>
<td>fall within color box in Table 4</td>
</tr>
<tr>
<td>UV Resistance†</td>
<td>ASTM G 154</td>
<td>fall within color box in Table 4</td>
</tr>
</tbody>
</table>

*refer to section 8 of this document for variations of testing requirements other than Test Method listed in table
†Only for colored surface aggregates that are installed as the finished color surface.

6.4.4 Independent laboratory reports shall be provided, documenting that the aggregate meets the Requirements of Table 3.
A sample of the aggregate shall be supplied upon request.

7. COLOR REQUIREMENTS

7.1 The finished surface of the installed GBLST material must meet the day time chromaticity specified in this section. Color resistance to fading due to UV exposure will be tested in accordance with ASTM G 154, Cycle 1 for 144 hours of exposure.

7.2 Color will be measured according to ASTM E 1347 and must fall within the coordinates listed in Table 4. Reference section 8 of this document for variations of testing requirements other than Test Method listed in table.

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<table>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>x</td>
<td>y</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>0.230</td>
<td>0.714</td>
<td>0.266</td>
<td>0.460</td>
</tr>
</tbody>
</table>

8. METHOD OF TESTING

8.1 Test shall be conducted as applicable for different GBLST material systems.

8.1.1 Bond Strength---ASTM D 4541, test at surface temperatures between 60°F - 80°F. Test to be performed in the field on the fully cured GBLST.

8.1.2 Color---ASTM E 1347. Color before and after QUV testing to be performed using D65/2 illuminant and then be graphed to see if within Color box in Table 4.

8.1.3 Dry Time (to recoat) ---ASTM D 5895, prepare sample at 23 ± 1°C; 37 ± 3% RH

8.1.4 Durometer Hardness---ASTM D 2240/ ASTM D 7735, prepare sample as per manufacturer's recommendation. For all materials except thermoplastic use Type 1 Precision—Type D Durometer Method. Cure specimens for 7 days at 73 ± 2°F [23 ± 1°C]. Test specimens at 73 ± 2°F [23 ± 1°C]. For Thermoplastic materials, ASTM 7735 covers testing at 115 ± 2°F and using a Type A Durometer.

8.1.5 Elongation at break point---AASHTO M 235/ ASTM D 638, prepare sample as per manufacturer's recommendation. Prepare Type I specimens in accordance with ASTM D638. Cure specimens for 7 days at 73 ± 2°F [23 ± 1°C]. Test specimens at 73 ± 2°F [23 ± 1°C].

8.1.6 Gel time---AASHTO M 235/ ASTM C 881, prepare a 70 mL sample per manufacturer's recommendation. Perform testing at a temperature of 73 ± 2°F [23 ± 1°C].

8.1.7 Moisture Content---AASHTO T-255.

8.1.8 Resistance to Small Size Coarse Aggregate Degradation---AASHTO T 96/ASTM C 131, use Grading D from Table 1

8.1.9 UV Resistance---ASTM G 154, prepare sample as per manufacturer recommendation. Test according to exposure condition Cycle 1 for 144 hours.

8.1.10 Abrasion Resistance---ASTM D 4060, prepare sample as per manufacturer recommendation. Cure specimens for 7 days at 73 ± 2°F [23 ± 1°C]. Test with CS-17 wheel, 1000-gram load for 1000 cycles.
9. **PACKAGING**

9.1 GBLST packaging will vary based on the material type and application method.

9.1.1 Binder resin components and shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and the ratio of the components to be mixed by volume. Any special instructions regarding mixing and temperature restrictions shall be included.

9.1.2 Thermoplastic systems shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and special instructions regarding application.

9.1.3 All labels shall show product name, manufacturer, lot or batch number, temperature range for storage, expiration date, quantity contained therein and all safety warnings.

9.1.4 Aggregate shall be in appropriate packaging that is clearly labeled and protects the aggregate from contamination and exposure to rain or other moisture.

9.1.5 Aggregate label shall show the name of the manufacturer and location of processing.

10. **MATERIALS CERTIFICATION**

10.1 At the request of the purchaser, the manufacturer of the GBLST shall certify that the system meets the requirements of this specification. Such certification shall consist of either a copy of the manufacturer's test report or a statement by the manufacturer accompanied by a copy of test results. Such certification shall indicate the date of testing and shall be signed by the manufacturer.

10.2 At the request of the purchaser, the producer of the aggregate if different from the GBLST system manufacturer, shall certify that the aggregate meets the requirements of this specification. Such certification shall consist of either a copy of the manufacturer's test report or a statement by the manufacturer accompanied by a copy of the current test results, that the aggregate has been sampled and tested.

11. **QUALIFICATION OF INSTALLER**

11.1 The installer shall submit a minimum of three projects on which GBLST have been placed within the past three years. An installer who does not meet this minimum shall be allowed if they have a manufacturer’s technical representative on site to train them in the proper installation of the manufacturer materials.

11.1.1 Quality Control (QC) Plan: The QC Plan shall be project specific detailing installer's key personnel, equipment, materials and proposed methods of installation.

11.1.2 Key Personnel, provide contact information for key personnel.

11.1.3 Designate a Project Superintendent: who shall have full authority to institute any action necessary for the successful operation of the QC plan.

11.1.4 Designate a Lead Technician who shall be present at the job site and be responsible for the required field quality control sampling and testing in conformance with the approved QC plan and contract documents.

11.1.5 **Equipment:**

11.1.5.1 Equipment calibration records of metering devices and application monitoring devices.

11.1.5.2 Cleaning and maintenance schedule for application equipment.
11.1.6  Installation of GBLST:

11.1.6.1  Provide procedures for blending of materials and placement of GBLST.

11.1.6.2  Monitoring and recording of ambient conditions (air temperature, surface temperature, relative humidity) and material temperature, should be done at regular intervals during application.

11.1.6.3  Recording of quantities of materials and total area installed.

11.1.6.4  Provide procedures for curing of GBLST.

11.1.6.5  Corrective Action: The manufacturer shall address corrective actions to address unsatisfactory installation.

11.1.6.6  Submit a QC Plan to the Engineer for approval at least 30 days prior to the placement.

11.1.6.7  Any deviation from the approved QC Plan shall be cause for immediate suspension of operations.

12.  RECOMMENDED CONSTRUCTION PRACTICES

12.1  Storage of Materials:

12.1.1  Materials shall be stored in a clean, dry environment and in accordance to the manufacturer’s recommendations.

12.1.2  At no time shall the aggregate be exposed to rain, or moisture.

12.1.3  Safety Data Sheet (SDS), Product Data Sheet, and other information pertaining to the safe practices for the storage, handling, and disposal of the materials, and to their health hazards. A copy of such information shall be provided to the Engineer.

12.1.4  Application Conditions:

12.1.5  Do not apply the GBLST material on a wet surface or when the ambient temperature is below manufacturer's recommendation.

12.1.6  Do not apply when anticipated weather conditions would prevent proper application and curing of the GBLST.

12.1.7  Preparation of surface:

12.1.8  Utilities, drainage structures, curbs and any other structure within or adjacent to treatment location shall be protected from the surface preparation and installation of the GBLST.

12.1.9  Cover and protect all existing pavement markings that are adjacent to the treatment location as directed by the Engineer prior to performing surface preparation. Pavement markings that conflict with the GBLST installation shall be removed by methods acceptable to the Engineer.

12.1.10  Prepare all pavement surfaces immediately prior to the installation of GBLST. Pavement surfaces contaminated with oils, greases, or other deleterious materials not removed by the surface preparation shall be washed with a mild detergent solution, rinsed with clean potable water, and dried using a hot compressed air lance.

12.1.11  Clean asphalt pavement surfaces using mechanical sweepers and high pressure air wash with
sufficient oil traps. Mechanically sweep all surfaces to remove dirt, loose aggregate, debris, and deleterious material. Vacuum sweep or air wash using clean and dry compressed air, all surfaces to remove all dust, debris, and deleterious material. For applications on new asphalt pavements a mandatory minimum 30-day cure period shall take place prior to the installation of the GBLST. Prior to starting the material application an adhesion test per ASTM D 4541 should be performed using the surface preparation, GBLST material and application method proposed to complete the project.

12.1.12 Clean concrete pavement surfaces by shot blasting. Shot blast all surfaces to remove all curing compounds, loosely bonded mortar, surface carbonation, existing marking materials and deleterious material. The prepared surface shall comply with the International Concrete Repair Institute (ICRI) standard for surface roughness CSP 5. After shot blasting, vacuum sweep or air wash with clean and dry compressed air all surfaces to remove all dust, debris, and deleterious material.

13. APPLICATION

13.1 Apply GBLST as recommended by the manufacturer’s installation instructions and approved by the Engineer. Any deviation from the manufacturer’s installation instructions should be approved by the manufacturer in writing and approved by the Engineer.

14. FIELD TESTING

14.1 In-place surface friction testing may be performed on installed GBLST material per ASTM E 274, Skid Resistance of Paved Surfaces using a standard ribbed Full Scale Tire at a speed of 40 mph (FN40R) and have a minimum FN40R value of 35. If field friction testing is not possible the material manufacturer shall submit a cured sample prior to the application that is representative of the expected surface texture of the installed GBLST material to be used as a visual comparison. Replacement or reapplication of the GBLST surface shall be considered when surface friction falls below the surface friction of the surrounding pavement.