**Instructions are in red text and should be deleted when the specification is complete.**

[**Bracketed text indicates where project specific decisions are required and should be reviewed and edited to meet the project requirements, and all brackets should be removed from the finished document.**]

**This guide specification must be edited for project-specific requirements. It should be reviewed by a qualified civil or geotechnical engineer, architect, or landscape architect familiar with the site conditions. Supplemental quality control testing for large projects and quality assurance requirements for mechanical installation is not addressed in this guide. However, additional ongoing testing requirements for pavers and aggregates is recommended for large commercial roadway projects. The need for freeze-thaw durability testing is not required in warm-weather climates and should be edited or removed based on project location (Article 2.1.B). In addition, the need for aggregate durability testing in heavy traffic load applications should be modified (Articles 2.2 and 2.3). Also, consider modifying Article 3.2.B.2 from Standard Proctor density to Modified Proctor density per ASTM D1557 for heavy traffic locations. Consult a Belgard Commercial Sales Representative for project-specific specification recommendations.**

**This specification covers the general installation of an Interlocking Concrete Pavement System comprised of concrete pavers with joint filling sand, modified asphalt adhesive (not required for pedestrian applications where bedding is not pre-compacted), bituminous setting bed, and tack coat (optional for pedestrian applications) all of which will be installed over an existing asphalt or concrete base. Edge Restraint consisting of cast-in-place concrete, and an optional geotextile for subgrade or aggregate separation is included.**

**This specification does not apply to roof pavers, sand set pavers, concrete overlays, concrete unit paving slabs, or permeable interlocking concrete pavements.**

SECTION 32 14 13.15 – INTERLOCKING CONCRETE UNIT PAVING ON BITUMINOUS SETTING BED

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes

Work consists of furnishing and installing an Interlocking Concrete Pavement System in accordance with these specifications and in general conformance with the lines, grades, design, and dimensions shown on the plans.

Installation work includes:

Verifying the [**concrete**][**asphalt**] base and edge restraints are installed in general conformance with the lines, grades and site conditions depicted in the construction documents;

Furnishing and installing tack coat (optional for pedestrian applications), bituminous setting bed, modified asphalt adhesive (not required for pedestrian applications that do not pre-compact the bedding), concrete pavers, and joint filling sand to the lines and grades shown on the construction drawings

* + - * 1. Related Requirements:

Section 31 32 19.23 Geotextile Layer Separation

Section 32 01 26.74 Concrete Overlays

Section 32 11 26 Asphaltic Base Courses

Section 32 11 36 Concrete Base Courses

Section 32 12 13.13 Tack Coats

Section 32 16 13 Curbs and Gutters

[**Section 32 17 00 Paving Specialties (parking bumpers, pavement markings**, **snow melt systems, tactile warnings)**]

* + - 1. REFERENCES
				1. American Association of State Highway and Transportation Officials (AASHTO)

GDPS-4-M Guide for Design of Pavement Structures

AASHTO M81 Standard Specification for Cutback Asphalt (Rapid-Curing Type)

* + - * 1. American Society of Civil Engineers (ASCE)

ASCE 58-16 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways

* + - * 1. American Society for Testing and Materials (ASTM)

ASTM C33 Standard Specification for Concrete Aggregates

ASTM C94 Standard Specification for Ready-Mixed Concrete

ASTM C131 Resistance to Degradation of Small-Sized Course Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 Sieve Analysis of Fine and Coarse-Grained Aggregates

ASTM C140 Sampling and Testing Concrete Masonry Units and Related Units

ASTM C144 Aggregate for Masonry Mortar

ASTM C920 Standard Specification for Elastomeric Joint Sealants

ASTM C936 Solid Concrete Interlocking Paving Units

ASTM C979 Pigments for Integrally Colored Concrete

ASTM C1645 Freeze-thaw and De-icing Salt Durability of Solid Interlocking Paving Units

ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Effort

ASTM D946 Penetration Graded Asphalt Cement for Use in Pavement Construction

ASTM D977 Emulsified Asphalt

ASTM D994 Preformed Expansion Joint Filler for Concrete (Bituminous Type)

ASTM D2028 Cutback Asphalt (Rapid Curing Type)

ASTM D2488 Description and Identification of Soils (Visual-Manual Procedure)

ASTM D3381 Viscosity Graded Asphalt Cement for Use in Pavement Construction

ASTM D6373 Performance Graded Asphalt Binder

* + - * 1. American Association of State Highway and Transportation Officials (AASHTO):

AASHTO M288 Geotextile Specification for Highway Applications

* + - * 1. Interlocking Concrete Pavement Institute (ICPI)

Tech Specs and Technical Bulletins.

* + - 1. SUBMITTALS
				1. Contractor shall submit to the owner for approval a minimum of four full-size samples of each concrete paver type/size/thickness/color/finish specified. The samples shall represent the range of shape, texture, and color permitted for the respective type. Color(s) will be selected by Architect/Engineer/Landscape Architect/Owner from Manufacturer’s standard colors.
				2. Contractor shall submit to the owner for approval a representative sample of the pre-formed asphalt joint filler.
				3. Prior to delivery of the associated material to the site, the Contractor shall submit the following product-specific documentation for approval:

Aggregates

Sieve analysis per ASTM C136 for bedding and joint aggregate materials

Minimum 3 lb. sample of each material for independent testing.

Concrete Pavers:

Test results from an independent testing laboratory for compliance with ASTM C936.

Manufacturer’s catalog product data.

Safety Data Sheets (SDS).

Modified asphalt adhesive product catalog sheet with specifications.

Bituminous setting bed mix design in conformance with ASTM D3381.

Pre-formed asphalt joint filler in conformance with ASTM D944.

* + - 1. QUALITY ASSURANCE
				1. Contractor Qualifications:

Contractor shall submit a list of five (5) previously constructed projects of similar size and magnitude prior to the bid date to be qualified. Contact names, telephone numbers, and date of completion shall be listed for each project.

The Contractor’s site foreman shall hold a Certified Concrete Paver Installer Designation from the Interlocking Concrete Pavement Institute (ICPI). The site foreman shall be onsite for the entire installation.

Contractor shall conform to all local, state/provincial licensing and bonding requirements.

* + - * 1. Mockups: Build mockups to verify selections made under submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

Install a 10 ft x 10 ft paver area following the installation practices described in Article 3.2 to 3.4. This area shall be used to verify surcharge of the bituminous setting bed and adhesives, joint sizes; expansion joints; lines; laying pattern(s); stitching details (for mechanical installation); color(s); and, texture of the job.

To provide a proper representation of color blend, blending during installation of sample mock-up will be pulled from a minimum of 3 cubes.

This area shall be the standard by which the work will be judged.

Subject to approval by the Owner, the mock-up may be retained as part of the finished work. If mock-up is not retained, remove and dispose of mock-up at the completion of the project.

* + - 1. DELIVERY, STORAGE, AND HANDLING
				1. Contractor shall coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
				2. Contractor shall check all materials upon delivery to assure that the proper materials have been received and are in good condition before signing off on the manufacturer’s packing slip.
				3. Contractor shall protect all materials from damage or contamination due to job site conditions and in accordance with manufacturer's recommendations. Damaged or contaminated materials shall not be incorporated into the work.
				4. Concrete pavers shall be delivered to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift. Unload and store concrete pavers at the job site in such a manner that no damage occurs to the product.
				5. Contractor shall handle and transport aggregates to avoid segregation, contamination, and degradation and keep different materials sufficiently separated as to prevent mixing. The material shall not be dumped or stored one material on top of another unless it is part of the installation process. Materials shall be covered to prevent removal by wind.
				6. Tack Coat product(s) and Modifies Asphalt Adhesive shall be stored and handled per the Manufacturer’s recommendations.
				7. Geotextiles shall be delivered, stored and handled in accordance with ASTM D-4873.
			2. ENVIRONMENTAL CONDITIONS
				1. Pavers shall not be installed during heavy rain, freezing conditions or snowfall. Do not install bituminous setting bed when temperature is 40 degrees F and falling.
				2. Base course shall not be installed on frozen soil subgrade.
			3. MAINTENANCE MATERIALS
				1. Provide [**specify quantity**] square feet additional paver material for use by Owner for maintenance and repair.
				2. Store extra paver materials in Owner-designated location.
1. PRODUCTS
	* + 1. INTERLOCKING CONCRETE PAVERS
				1. Interlocking Concrete Pavers Basis-of-Design:

Paver Name: [**Moduline**][**Holland Stone**][**Insert Product**]

Thickness: [**2-3/8 inches (60mm)**] [**3-1/8 inches (80 mm)**] [**4 inches ([101.6 mm)**]

Color: [**Graphite**] [**Foundry**] [**Linen**] [**Insert Local Color**]

Finish: [**Standard (Smooth)**] [**Shot Blast**] [**Antiqued**]

Supplier:

[**Local Oldcastle Supplier**] an Oldcastle Company

[**City, State**] [**Zip**]

Contact Person: [**Local Belgard Sales Rep**] [**Phone Number**]

Substitutions: No substitutions permitted.

* + - * 1. Pavers shall meet the minimum material and physical properties set forth in ASTM C 936:

Measured length or width of test specimens shall not differ by more than +/- 0.063 in, while measured thickness shall not differ by more than +/- 0.125 in.

Average compressive strength of not less than 8,000 psi (55 MPa) with no individual unit under 7,200 psi (50 MPa) when tested in accordance with ASTM C140.

Average absorption of 5% or less with no unit greater than 7% when tested in accordance with ASTM C140.

[**Freeze-thaw durable as tested in accordance with ASTM C1645.** **The average mass loss of all specimens tested shall not be greater than (A) 225 g/m2 when subject to 28 freeze-thaw cycles, or (b) 500 g/m2 when subject to 49 freeze-thaw cycles. Testing shall be conducted using a 3% saline solution.**]

Efflorescence shall not be a cause for rejection.

Pigment in Concrete Pavers shall conform to ASTM C979.

* + - 1. BITUMINOUS SETTING BED
				1. Asphalt cement shall conform to one of the following”

ASTM D946 with a penetration at 77 degrees F of minimum 3.35 inches (85 mm) and a maximum of 3.94 inches (100 mm).

ASTM D3381 – sample materials are AC 20 or AR-8000.

ASTM D6373 – sample material is PG 64-22.

* + - * 1. Sands may be quarried or manufactured, if a sand mix is not available, a fine aggregate may be used as long as the maximum particle size does not exceed 1/4 inch (6 mm).

**When concrete pavers are expected to be subjected to 1.5 million lifetime ESALs or greater include the following:**

* + - * 1. [**Micro Deval Degradation shall be less than 8% as per ASTM D7428.**
				2. **Percent combined of sub-angular and sub-rounded shall be greater than 60% as per ASTM D2488.**
				3. **LA Abrasion <40 as per ASTM C131**]
				4. Verify gradation conforms to requirements listed in Table 1 as tested in accordance with ASTM C136.

Table 1

Gradation Requirements for Setting Bed

 Sieve Size Percent Passing

3/8 inch (9.5 mm) 100

 No. 4 (4.75 mm) 80 to 100

 No. 8 (2.36 mm) 65 to 100

 No. 16 (1.18 mm) 40 to 85

 No. 30 (0.600 mm) 25 to 60

 No. 50 (0.300 mm) 7 to 30

 No. 100 (0.150 mm) 3 to 10

 No. 200 (0.075 mm) 2 to 1

* + - 1. JOINT FILLING SAND
				1. Joint sand aggregate shall be clean, non-plastic sand, free from deleterious or foreign matter, and manufactured from crushed rock.
				2. Screenings or stone dust shall not be utilized.

**When concrete pavers are expected to be subjected to 1.5 million lifetime ESALs or greater include the following:**

* + - * 1. [**Micro Deval Degradation shall be less than 8% as per ASTM D7428.**
				2. **Percent combined of sub-angular and sub-rounded shall be greater than 60% as per ASTM D2488.**
				3. **LA Abrasion <40 as per ASTM C131**]
				4. Verify gradation conforms to ASTM C144 requirements for concrete sand (listed in Table 2) as tested in accordance with ASTM C136.

Table 2

Gradation Requirements for Joint Filling Sand

 Sieve Size Percent Passing

 No. 4 (4.75 mm) 100

 No. 8 (2.36 mm) 95 to 100

 No. 16 (1.18 mm) 70 to 100

 No. 30 (0.600 mm) 40 to 100

 No. 50 (0.300 mm) 10 to 35

 No. 100 (0.150 mm) 2 to 15

 No. 200 (0.075 mm) 0 to 5

* + - 1. MODIFIED ASPHALT ADHESIVE
				1. Use neoprene modified asphalt adhesive containing oxidizing asphalt combined with 2 percent neoprene, 10 percent long fibered mineral fibers, 88 percent asphalt that has a softening point of 155 degrees F.
			2. TACK COAT
				1. The following options are acceptable:

Cut back asphalt (rapid curing type) per ASTM D2028 and AASHTO M-81.

Anionic asphalt emulsion SS-1 or SS-1h per ASTM D977.

* + - 1. PREFORMED ASPHALT JOINT FILLER
				1. Use 1/4-inch thick asphalt joint filler per ASTM D-994.
				2. Use an elastomeric joint sealant per ASTM C-920.
			2. EDGE RESTRAINTS
				1. For vehicular applications, edge restraints shall be cast in place concrete curbs constructed at a minimum to the dimensions of the municipal standards.
				2. For pedestrian or non-vehicular areas, aluminum or galvanized angles mechanically fastened to the concrete base may be used.
1. EXECUTION

**Construction drawings and design calculations for the Interlocking Concrete Pavement System are typically prepared and stamped by a Professional Engineer registered in the state of the project. The engineering designs, techniques, and material evaluations should be completed in accordance with ASCE Standard 58-16 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways, or the AASHTO Guide for Design of Pavement Structures (whichever is applicable to the designer).**

**Compaction of the soil subgrade is recommended to at least 98% Standard Proctor Density per ASTM D698 for pedestrian areas, walkways, plazas and residential driveways. Compaction to at least 98% Modified Proctor Density per ASTM D1557 is recommended for areas subject to heavy vehicular traffic. Stabilization of the subgrade and/or base material, or addition of an impermeable layer, may be necessary with weak, saturated or expansive subgrade soils.**

* + - 1. PREPARATION
				1. Prior to commencement of any work, the Contractor shall conduct a pre-construction meeting with the Owner, Designer, and affected sub-trades. The pre-construction meeting should establish contractor responsibilities and at a minimum verify:

The location of the mock-up, and whether it will be part of the final construction or need to be removed.

The site layout is in general conformance with the construction documents.

The [**concrete**][**asphalt**] base and edge restraints are in general conformance with the lines, grades, and locations shown in the construction documents. The surface of the base shall have a minimum slope of 1/4 inch per foot (2 percent grade) and be within a tolerance of 0 to 3/16 inch over a 10-foot straight edge. Surface to be free of dust, oil, grease, paint, wax, curing compounds, primer, sealer, form release agents, cracks over 3/16 inch, or any deleterious substances and debris that may prevent or reduce bonding.

[**Asphalt**][**Concrete**] shall be fully cured and free of hydrostatic pressure, control joints are located at the specified interval, and the moisture content is less than 5 percent.

The location and spacing of weep holes and that weep holes are filled with pea gravel.

The subgrade lines and elevations are in general conformance with the construction documents. The subgrade elevations shall be within +/- 0.1 ft of the specified grades.

Subgrade soil conditions and grades meet the requirements in the construction documents.

The details of the site’s erosion and sediment control plan

* + - * 1. Contractor shall verify compaction of the subgrade and base is in general conformance with the construction documents prior to commencing work.
				2. Once the Contractor has confirmed the base conditions are in general conformance with the requirements in the construction documents, the Contractor shall begin installing the bituminous bedding sand material. By initiating installation of the bedding sand, the Contractor acknowledges acceptance of the base.
			1. BASE PREPARATION AND INSTALLATION OF TACK COAT

**Installation of the tack coat is optional in pedestrian applications. Where tack coat is not used, delete steps A and E and remove TACK COAT from the section heading.**

**Emulsified asphalt primer tack coats are typically applied at a rate of 0.6 to 1.0 gal per 100 ft² (2.5 to 4.1 liters per 10.0 m²) to asphalt base, and 0.9 to 1.3 gal per 100 ft² (3.6 to 5.3 liters per 10.0 m²) to concrete base. Cutback asphalt tack coats are typically applied at a rate of 1.0 to 1.3 gal per 100 ft² (4.1 to 5.3 liters per 10.0 m²) to asphalt base, and 1.2 to 1.5 gal per 100 ft² (4.8 to 6.1 liters per 10.0 m²) to a concrete base.**

* + - * 1. Tack coat should only be installed when the ambient temperature is above 50 degrees F.
				2. Fill any cracks under 3/16 inch wide in the concrete base with mortar, and in the asphalt base with the bituminous bedding course material.
				3. Sweep the surface clean making sure not to sweep debris into the weep holes.
				4. The surface of the base should be thoroughly clean and dry before application. Do not apply if rain is likely before placing the bituminous setting bed.
				5. Thoroughly mix the tack coat in accordance with manufacturer’s recommendations based on the type of base material. Install tack coat by spraying, brushing, or squeegeeing to the top of the base and to all surfaces that will be in contact with the bituminous setting bed. Once applied, the tack coat should not be disturbed and allowed to cure or break before covering with the bituminous setting bed.
			1. INSTALLATION OF THE BITUMINOUS SETTING BED
				1. Blend approximately 7% hot asphalt cement with 93% sand and heat to a minimum of 325 degrees F. Ensure final product is a uniform mixture with all the aggregate particles being evenly coated with asphalt cement.
				2. Place the bituminous setting bed ensuring that the bituminous material will remain at least 250 degrees F during compaction.
				3. The screed rails should be carefully set to ensure proper bituminous setting bed depth and finished paver grade. Use 1/2-inch high x 1-1/2 inch wide steel screed rails, and adjust to proper grade using thin wooden or plastic shims under the screed rails.
				4. Place bituminous material between the parallel screed bars. Pull the material with the striking board over the screed bars several times. After each pass of the screed bar, any voids must be filled with fresh bituminous material to provide a smooth, firm, and even setting bed.
				5. As soon as one area is complete, advance screed rails to the next position. Remove any shims used, fill depressions left from removed screed rails, and smooth to consistent height.
				6. For vehicular applications (optional for pedestrian applications), roll the setting bed with a roller compactor to an even, nominal thickness of ¾ inch after compaction. The depth of this layer must be consistent.
				7. Re-heat, fill, and roll low areas with bituminous setting bed material to conform to slope and elevation shown on the drawings. Re-heat, remove, level, and roll bituminous setting bed in high areas to conform to slope and elevation shown on the drawings.
				8. Irregularities or evenness in the grade of the concrete base surface may be corrected with bituminous setting bed materials only with approval by the Engineer.
				9. Extend expansion joints through full depth of bituminous setting bed by installing pre-molded asphalt joint filler per ASTM D-994.
			2. INSTALLATION OF MODIFIED ASPHALT ADHESIVE
				1. Modified asphalt adhesive is only used when the bituminous setting bed has been rolled. If the setting bed has not been rolled, proceed to installation of concrete pavers and joint filling sand.
				2. After the Bituminous Setting Bed has cooled, thoroughly mix the asphalt adhesive and apply a 1/32 inch (maximum) coating over the entire Bituminous Setting Bed by either:

Using a notched trowel with serrations not exceeding 1/32 inch.

Squeegeeing

* + - * 1. Do not apply Concrete Pavers to adhesive until dry skin forms on surface of adhesive – this typically takes 2 to 3 hours.
				2. Only apply as much adhesive as can be covered before the end of the day.
			1. INSTALLATION OF CONCRETE PAVERS AND JOING FILLING SAND
				1. Ensure that concrete pavers are free of foreign material before installation. Concrete pavers shall be inspected for color distribution and all chipped, damaged, or discolored concrete pavers shall be replaced. Initiation of concrete paver placement shall be deemed to represent acceptance of the pavers.
				2. Lay the concrete pavers firmly onto the adhesive following the pattern(s) shown on the drawings. Maintain straight pattern lines.
				3. Paving units shall be installed from a minimum of 3 bundles simultaneously to ensure color blending.
				4. Joints between the individual concrete pavers, and between concrete pavers and the edge restraints, buildings, collars, or other protrusions/edging, shall be between 3/16 inch and 1/8 inch (2 mm to 5mm) wide (±1/16 in).
				5. Joint (bond) lines shall not deviate more than ±1/2 in. (±15 mm) over 50 ft. (15 m) from string lines.
				6. Fill gaps at the edges of the paved area with cut pavers or edge units. Do not install cut pavers smaller than one-third of a whole paver in areas subject to vehicular traffic – trim two pavers to fit.
				7. Cut all pavers using a double-bladed splitter or masonry saw. Upon completion of cutting, the area must be swept clean of all debris to facilitate inspection and to ensure the concrete pavers are not damaged during compaction.
				8. Extend structural joints through full depth of paving units and bituminous setting bed by installing pre-molded joint filler as units are set in the bituminous bed. Maintain top of filler 3/8 inch below the exposed face of the paving units for insertion of sealant.
				9. Use a roller compactor to fully compact the pavers into place.
				10. Install joint sealant at the structural joints.
				11. Once all pavers, joint filler and sealant are installed, spread the joint filling sand and fill joints between the pavers. Use a light tired rubber roller or plate compactor with neoprene pads to vibrate the joint filling sand into the joints. Top up the joints as required. Sweep off excess sand when the job is complete.
				12. Note: For large slabs, it may not be possible to run a compactor over the slabs without either damage the units or causing the Jointing Sand to migrate under the slabs. In this case it may be necessary to use a small plate tamper with neoprene pad.
			2. AS-BUILT CONSTRUCTION TOLERANCES
				1. Final inspection shall be conducted to verify conformance to the drawings after removal of excess joint sand. All pavements shall be finished to lines and levels to ensure positive drainage at all drainage outlets and channels.
				2. The final surface elevations shall not deviate more than 3/8 (10 mm) inch under a 10-foot long (3 M) straightedge.
				3. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

END OF SECTION 32 14 13.15