**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 for pavers and aggregate 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.4).**

**If the pavement will be exposed to roadway heavy traffic with frequent truck exposure with greater than 1.5 million 18-Kip (80 kN) equivalent single axle loads (ESALs), bedding sand should also be tested for durability and Article 2.2 should be modified. 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, bedding sand course, and base course consisting of dense graded aggregate with a geotextile separating the aggregate and subgrade. An edge restraint consisting of cast-in-place concrete is also included.**

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

SECTION 32 14 13.13 – INTERLOCKING CONCRETE UNIT PAVING ON AGGREGATE BASE

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 subgrade elevations and slopes generally conform to the lines, grades and site conditions depicted in the construction documents; and

Furnishing and installing geotextile (where required), base course, bedding course, edge restraint, concrete pavers and joint filling sand as shown on the construction drawings.

* + - * 1. Related Requirements:

Section 31 20 00 Earth Moving

Section 31 05 19.13 Geotextiles for Earthwork

Section 32 11 23 Aggregate Base Courses

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 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 Coarse 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 C936 Standard Specification for 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 D2488 Description and Identification of Soils (Visual-Manual Procedure)

ASTM D2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports

ASTM D4873 Identification, Storage, and Handling of Geosynthetic Rolls and Samples

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

1. AASHTO M288 Geotextile Specification for Highway Applications

* + - 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. 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 subbase, base, 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).

Geotextile

One 18-inch x 18-inch panel of each type of geotextile to be used for inspection and testing. The sample panels shall be uniformly rolled and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Samples shall be externally tagged for easy identification. External identification shall include the name of the manufacturer; product type; product grade; lot number; and physical dimensions.

Current National Transportation Product Evaluation Program (NTPEP) evaluation report.

Safety Data Sheets (SDS).

* + - 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 Concrete Masonry and Hardscapes Association (CMHA). 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 7 ft x 7 ft paver area following the installation practices described in Article 3.2 to 3.4. This area shall be used to verify joint sizes; 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. Geotextile shall be delivered, stored and handled in accordance with ASTM D4873.
			2. ENVIRONMENTAL CONDITIONS
				1. Pavers shall not be installed during heavy rain, freezing conditions or snowfall.
				2. Base course shall not be installed on frozen soil subgrade.
				3. Pavers, bedding sand, and joint filling sand shall not be installed on frozen aggregates.
			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: [Product Name] [Dimensions]

Thickness: [3-1/8 inches] [ 2-3/8 inches]

Shape: [6x6 inches] [12x12 inches]

Color: As determined by the Owner

Finish: Standard (Smooth)

Supplier: APG an Oldcastle Company

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. BEDDING SAND
				1. Bedding sand 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.
				3. Verify gradation conforms to ASTM C33 requirements for concrete sand (listed in Table 1) as tested in accordance with ASTM C136.

Table 1

Gradation Requirements for Bedding Sand

 Sieve Size Percent Passing

3/8 inch (9.5 mm) 100

 No. 4 (4.75 mm) 95 to 100

 No. 8 (2.36 mm) 85 to 100

 No. 16 (1.18 mm) 50 to 85

 No. 30 (0.600 mm) 25 to 60

 No. 50 (0.300 mm) 5 to 30

 No. 100 (0.150 mm) 0 to 10

 No. 200 (0.075 mm) 0 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.
				3. 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. BASE AGGREGATE
				1. Base aggregate shall be clean, non-plastic, free from deleterious or foreign matter, recycled concrete, and manufactured from crushed rock.
				2. Verify gradation conforms to ASTM D2940 as presented in Table 3.

Table 3

Gradation Requirements for Base Course Material

 Sieve Size Percent Passing

 2 in (50 mm) 100

 1 ½ in (37.5 mm) 95 to 100

 ¾ in (19 mm) 70 to 92

 3/8 in (9.5 mm) 50 to 70

 No. 4 (4.75 mm) 35 to 55

No. 30 (0.600 mm) 12 to 25

No. 200 (0.075 mm) 0 to 8

* + - 1. EDGE RESTRAINTS
				1. Edge restraints shall be cast in place concrete curbs constructed at a minimum to the dimensions of the municipal standards.
			2. GEOTEXTILES
				1. Geotextile materials shall be selected by the Design Engineer based on the intended use in accordance with AASHTO M288.
				2. Only geotextiles with a current NTPEP evaluation will be accepted.
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 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. Proof-roll prepared subgrade according to requirements in Section 31 20 00 Earth Moving to identify soft pockets and areas of excess yielding. Proceed with subbase installation only after deficient subgrades have been corrected.
				2. Contractor shall verify compaction of the subgrade is in general conformance with the construction documents prior to placing subbase materials.
				3. Once the Contractor has confirmed the subgrade conditions are in general conformance with the requirements in the construction documents, the Contractor shall begin installing the base course material. By initiating installation of the base course, the Contractor acknowledges acceptance of the subgrade.
			1. INSTALLATION OF BASE COURSE

**Local aggregate base materials typical of those used for highway flexible pavements are recommended, or those conforming to ASTM D2940.**

**Geotextile is typically placed on the prepared soil subgrade as a separation material. Overlap is a function of CBR: 12 to 18 inches for CBR of 3 and above; 24 to 36 inches for CBR of 1.0 to 3.0; or, sewn for CBR less than 1.0. Please consult manufacturers’ specifications and the Geotechnical Engineer.**

* + - * 1. Install Geotextiles as required in accordance with the construction documents. The Geotextile is applied to the bottom and sides of the excavation with overlapping joints a minimum of [**12 inches**] [**24 inches**]. Overlaps to follow downslope.
				2. Install the base course at the thickness, compaction, surface tolerances, and elevations outlined in the construction documents.

The aggregate should be spread and compacted in uniform layers not exceeding 6-inch loose thickness.

Compact base course to 98% Standard Proctor Density in accordance with ASTM D698.

Density testing shall be conducted to verify conformance.

Surface tolerance should be plus or minus 3/8 inch (10 mm) over a 10-foot. (3 m) straight edge laid in any direction.

Base course compaction must be achieved near curbs, grade beams, concrete collars around utility structures, lights standards, tree wells, building edges and other protrusions as applicable to the project. In areas not accessible to large compaction equipment, compact to specified density with mechanical tampers (jumping jacks).

The upper surface of the base shall be sufficiently well graded and compacted to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Segregated areas of the granular base shall be blended by the application of crushed fines that have been watered and compacted into the surface.

* + - * 1. Before commencing the placing of the bedding course, the base shall be inspected by the Owner or the Consultant.
			1. INSTALLATION OF EDGE RESTRAINTS
				1. Adequate edge restraint shall be provided along the perimeter of all paving as specified. The face of the edge restraint, where it abuts pavers, shall be vertical.
				2. All concrete edge restraints shall be constructed to dimensions and grades in general conformance with the construction documents and shall be supported on a compacted base not less than 6 inches thick. Concrete curbs shall meet local requirements or the requirements of Section 32 16 13 - Curbs and Gutters whichever is more restrictive. All concrete shall be in accordance with ASTM C94 requirements.
			2. INSTALLATION OF BEDDING COURSE, PAVERS, AND JOINT FILLING MATERIAL
				1. Spread the bedding course evenly over the base course and screed to a nominal 1-inch (25 mm) thickness. The Contractor shall screed the bedding course using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards. The screeded sand should not be disturbed. Place sufficient sand to stay ahead of the laid pavers. Do not use the bedding sand to fill depressions in the base course surface.
				2. 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.
				3. Lay the concrete pavers in the pattern(s) as shown on the drawings. Maintain straight pattern lines.
				4. Paving units shall be installed from a minimum of 3 bundles by hand, and 6 bundles during mechanical installation, simultaneously to ensure color blending.
				5. Joints between the individual concrete pavers, and between concrete pavers and the edge restraints, buildings, collars, or other protrusions/edging, on average shall be between 1 /16 inch and 3 /16 inch (2 mm to 5 mm) wide.
				6. Joint (bond) lines shall not deviate more than ±1/2 in. (±15 mm) over 50 ft. (15 m) from string lines.
				7. 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 along edges subject to vehicular traffic – trim two pavers to fit.
				8. Cut all pavers using a 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.
				9. Using a low amplitude plate compactor capable of at least 5,000 lbs. (22 kN) compaction at a frequency of 75 Hz –100 Hz, compact the concrete pavers into the bedding course.
				10. The pavers shall be compacted to achieve consolidation of the bedding sand and brought to level and profile by not less than three passes. Initial compaction should proceed as closely as possible following the installation of the paving units and prior to the acceptance of any traffic or application of joint filling sand.
				11. Any units that are structurally damaged during compaction shall be immediately removed and replaced.
				12. Sweep dry joint filling sand into the joints and vibrate until they are full. This will require two or three passes with the compactor. Do not compact within 3 feet (1 m) of the unrestrained edges of the paving units.
				13. All work to within 3 feet (1 m) of the laying face must be left fully compacted with sand-filled joints at the end of each day.
				14. Sweep off excess sand when the job is complete.
				15. The final surface elevations shall not deviate more than 3/8 inch (10 mm) under a 10-foot (3 m) long straightedge.
				16. The surface elevation of pavers shall be 1/8 to 1/4 inch (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.
			3. 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 inch (10 mm) under a 10-foot long straight edge.
				3. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

END OF SECTION 32 14 13.13