**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.**

**This specification covers the general installation of unit concrete paving slabs for pedestrian applications with joint filling sand, bedding sand course, and base course consisting of dense graded aggregate. Edge restraint consisting of cast-in-place concrete, precast concrete, or aluminum/steel edging, and an optional geotextile for subgrade or aggregate separation is included.**

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

***Oldcastle APG makes no representations or warranties of any kind, expressed or implied, and disclaims any liability for damages resulting in the use of this guide construction specification.***

SECTION 32 14 13.16 – PRECAST CONCRETE UNIT PAVING SLABS ON AGGREGATE BASE

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

Work consists of furnishing and installing a Concrete Paving Slab 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;

Furnishing and installing geotextile (where required), base course, bedding course, edge restraint, concrete slabs 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 31 05 19.16 Geomembranes 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)**]

Section 33 46 14.19 Pipe Underdrains

* + - 1. REFERENCES
				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 C979 Pigments for Integrally Colored Concrete

ASTM C1782 Standard Specification for Segmental Concrete Paving Slabs

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 one full-size sample of each concrete paving slab for type, size, and thickness. Color and finish shall be approved using the mockup described in Section 1.4. 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 Paving Slabs:

Test results from an independent testing laboratory for compliance with ASTM C1782.

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 slab area following the installation practices described in Section3.4. This area shall be used to verify joint sizes; lines; laying pattern(s); 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 paving slabs 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 slabs 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. Slabs shall not be installed during heavy rain, freezing conditions or snowfall.
				2. Base course shall not be installed on frozen soil subgrade.
				3. Slabs, bedding sand, and joint filling sand shall not be installed on frozen aggregates.
			3. MAINTENANCE MATERIALS
				1. Provide [**specify quantity**] square feet additional slab material for use by Owner for maintenance and repair.
				2. Store extra slab materials in Owner-designated location.
1. PRODUCTS
	* + 1. CONCRETE PAVING SLAB

**Confirm paver thickness, shape, color and finish.**

* + - * 1. Concrete Paving Slabs Basis-of-Design:

Slab Name: [**Dimensions] [Specify Product Name]**

Shape: **[24 x 24”] [Specify Product Dimensions]**

Thickness: 60 mm

Color: [**Specify Product Color**]

Finish: [**Standard (Smooth**)]

Supplier: APG, an Oldcastle Company

Substitutions: No substitutions permitted.

* + - * 1. Slabs shall meet the following material and physical properties set forth in ASTM C 1782:

Measured length or width of test specimens shall not differ by more than - 0.04 in and +0.06 for unit up to 24 in and -.06 and +0.12 for units over 24 in. Measured thickness shall not differ by more than +/- 0.12 in.

Average Modulus of Rupture (flexural strength) of not less than 725 psi (5.0 MPa) with no individual unit under 650 psi (4.5 MPa) when tested in accordance with ASTM C1782.

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.

Pigment in Concrete Slabs shall conform to ASTM C979.

* + - * 1. Efflorescence shall not be a cause for rejection.
				2. 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 filling 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. Cast-in-place edge restraints in general conformance with the specifications and dimensions in the construction documents.
				2. Precast concrete or cut stone in general conformance with the specifications and dimensions in the construction documents.
				3. Aluminum or steel edging in general conformance with the specifications and dimensions in the construction documents (pedestrian-only applications).
			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 Concrete Paving Slab 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 industry best practices.**

**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% 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 meet the requirements of 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. 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 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 (e.g. 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 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 sand, the base course shall be inspected by the Owner or the Consultant, confirming the base course is in compliance with the construction documents.
			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 slabs, 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 SAND, SLABS, AND JOINT FILLING MATERIAL
				1. Spread the bedding sand evenly over the base course and screed to a nominal 1-inch (25 mm) thickness. The Contractor shall screed the bedding sand using an approved mechanical spreader or by screed rails and boards. The screeded sand should not be disturbed. Place sufficient sand to stay ahead of the laid slabs. Do not use the bedding sand to fill depressions in the base course surface.
				2. Ensure that concrete paving slabs are free of foreign material before installation. Concrete slabs shall be inspected for color distribution and all chipped, damaged, or discolored concrete slabs shall be replaced. Initiation of concrete slabs placement shall be deemed to represent acceptance of the slabs.
				3. Lay the concrete paving slabs in the pattern(s) shown on the drawings. Maintain straight pattern lines.
				4. Paving slab units shall be installed from a minimum of 3 bundles simultaneously to ensure color blending.
				5. Joints between the individual concrete paving slabs, and between slabs and the edge restraints, buildings, collars, or other protrusions/edging, 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. When a section of a paving slab must be cut and the cut area is less than 25% of the total slab area, there is no need to include additional cuts to reduce the risk of a cracked unit. If more than 25% of a paving slab must be cut and removed, consideration must be given to installing additional cuts to reduce the risk of cracking under loads. Cut all slabs 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 slabs are not damaged during compaction.
				8. The slabs shall be hand tamped or compacted with equipment designed for use on slabs to achieve a leveled surface.
				9. Any units that are structurally damaged during installation shall be immediately removed and replaced.
				10. Sweep dry joint filling sand into the joints and vibrate with a roller compactor with a minimum of two passes until they are full. Do not compact within 3 feet (1 m) of the unrestrained edges of the paving slab units.
				11. 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.
				12. Sweep off excess sand when the job is complete.
				13. The final surface elevations shall not deviate more than 3/8 inch (10 mm) under a 10-foot (3 m) long straightedge.
				14. Surface elevation of slabs shall be 1/8-inch to 1/4-inch (3 mm to 6 mm) above adjacent rigid surfaces, including drainage inlets, concrete collars or gutters, sidewalks, etc.
			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 slabs.
				4. Bond lines for pavers shall be +/- 0.5 inches over a 50 foot string line.
				5. The surface elevation of pavers shall be 1/8 in. to ¼ in. above adjacent drainage inlets, concrete collars or channels.

END OF SECTION 32 14 13.13