SECTION 32 14 13.19
PERMEABLE CONCRETE PAVER SLAB PAVEMENT
(1995 MasterFormat Section 02795)

Note: This guide specification for U.S. applications describes construction of concrete paver slabs on a permeable, open-graded crushed stone bedding layer (typically ASTM No. 8 stone) for pedestrian applications only. This 2 in. layer is placed over an open-graded base (typically No. 57 stone no greater than 4 in.) and a sub-base (typically No. 2 stone or similar sized material). The slabs and bedding layer are placed over an open-graded crushed stone base with or without full exfiltration to the soil subgrade. In low infiltration soils or installations with impermeable liners, some or all drainage is directed to an outlet via perforated drain pipes in the subbase. While this guide specification does not cover excavation, liners and drain pipes, notes are provided on these aspects.

The text must be edited to suit specific project requirements. It should be reviewed by a qualified civil or geotechnical engineer, or landscape architect familiar with the site conditions. Edit this specification term as necessary to identify the design professional in the General Conditions of the Contract.

PART 1 GENERAL

1.01 SUMMARY

A) Section includes:
   1) Pedestrian application of concrete paver slabs in a permeable pavement system.
   2) Crushed stone bedding material.
   3) Open-graded subbase aggregate.
   4) Open-graded base aggregate.
   5) Bedding and joint/opening filler materials.
   6) Edge restraints.
   7) [Geotextiles].

B) Related sections:
   1) Section [_____]: Curbs.
   2) Section [_____]: [Stabilized] aggregate base.
   3) Section [_____]: [PVC] Drainage pipes
   4) Section [_____]: Impermeable liner.
   5) Section [_____]: Edge restraints.
   6) Section [_____]: Drainage pipes and appurtenances.
   7) Section [_____]: Earthworks/excavation/soil compaction.
   8) Section [_____]: Earthwork
   9) Section [_____]: Grading
   10) Section [_____]: Concrete [Walks] [Curbs] [and] [Gutters]

1.02 REFERENCES

A) American Society for Testing and Materials (ASTM):
   1) C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   2) C 136, Method for Sieve Analysis for Fine and Coarse Aggregate.
   3) C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   4) D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
   5) C 936, Standard Specification for Solid Interlocking Concrete Pavers.
   6) C 979, Specification for Pigments for Integrally Colored Concrete.
   7) D 698, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb. Rammer and 12 in. drop.

8) D 1557, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb. Rammer and 18 in. drop.
9) D 1883, Test Method for California Bearing Ratio of Laboratory-Compacted Soils.
10) D 2922, Standard Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).
11) D 4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

B) Canadian Standards Association (CSA):
1) A231.1, Precast Concrete Paving Slabs

C) Interlocking Concrete Pavement Institute (ICPI):
1) Permeable Interlocking Concrete Pavement manual.

1.03 SUBMITTALS

A) In accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
B) Indicate perimeter conditions, junction with other materials, expansion and control joints, slab layout, patterns, color arrangement, installation and setting details. Indicate layout, pattern and relationship of paving joints to fixtures, and project formed details.
C) Minimum 3 lb. samples of subbase, base and bedding aggregate materials.
D) Sieve analysis of aggregates for subbase, base and bedding materials per ASTM C 136.
E) Project specific or producer/manufacturer source test results for void ratio and bulk density of the base and subbase aggregates.
F) Soils report indicating density test reports, classification, and infiltration rate measured on-site under compacted conditions, and suitability for the intended project.
G) Erosion and sediment control plan.
H) [Stormwater management (quality and quantity) calculations] using ICPI Permeable Interlocking Concrete Pavements manual, Permeable Design Pro or [specify] design methods and models.
I) Concrete paver slabs:
1) Slab manufacturer’s catalog sheets with product specifications.
2) [Four] representative full-size samples of each slab type, thickness, color, and finish. Submit samples indicating the range of color expected in the finished installation.
3) Accepted samples become the standard of acceptance for the work of this Section.
4) Manufacturers’ material safety data sheets for the safe handling of the specified paving materials and other products specified herein.
5) Paver manufacturer’s written quality control procedures including representative samples of production record keeping that ensure conformance of paving products to the product specifications.

J) Paver Installation Subcontractor:
1) Demonstrate that job foremen on the project have a current certificate from the Interlocking Concrete Pavement Institute Concrete’s (ICPI) Paver Installer Certification program.
2) Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.
3) Written Method Statement and Quality Control Plan that describes material staging and flow, paving direction and installation procedures, including representative reporting forms that ensure conformance to the project specifications.

1.04 QUALITY ASSURANCE

A) Regulatory Requirements and Approvals: [Specify applicable licensing, bonding or other requirements of regulatory agencies.]
B) Paver Installation Subcontractor Qualifications:
   1) Utilize an installer having successfully completed installations similar in design, material and extent indicated on this project.
   2) Installer shall hold a current membership to the Interlocking Concrete Pavement Institute (ICPI).
   3) Installer shall hold a current certificate to the Interlocking Concrete Pavement Institute's (ICPI) Paver Installer Certification program. Installation crew shall have at least one member having completed at least Level One of this Certified Paver Installer program present at jobsite at all times.
C) Review the manufacturers' quality control plan, paver installation subcontractor's Method Statement and Quality Control Plan with a pre-construction meeting of representatives from the manufacturer, paver installation subcontractor, general contractor, engineer and/or owner's representative.
D) Mock-Ups:
   1) Install a 10 ft x 10 ft (3 x 3 m) paver area.
   2) Use this area to determine surcharge of the bedding layer, joint sizes, and lines, laying pattern, color and texture of the job.
   3) This area will be used as the standard by which the work will be judged.
   4) Subject to acceptance by owner, mock-up may be retained as part of finished work.
   5) If mock-up is not retained, remove and properly dispose of mock-up.

1.05 DELIVERY, STORAGE, AND HANDLING
A) General: Comply with Division 1 Product Requirement Section.
B) Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
C) Delivery: Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each slab bundle.
   1) Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
   2) Deliver concrete slabs to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift.
   3) Unload slabs at job site in such a manner that no damage occurs to the product or existing construction
D) Storage and Protection: Store materials in protected area such that they are kept free from mud, dirt, and other foreign materials.

1.06 ENVIRONMENTAL REQUIREMENTS
A) Do not install in rain or snow.
B) Do not install frozen bedding materials.
C) Do not install in freezing conditions.

1.07 MAINTENANCE
A) Extra materials: Provide [specify area or percentage] additional material for use by owner for maintenance and repair.

PART 2 PRODUCTS

2.01 CONCRETE PAVING SLABS
A) Manufacturer: StoneBilt Concepts, Henderson, Colorado
   1) Contact: Gregory Stavaridis, 303-867-6700
B) Concrete Paving Slabs:
   1) Travertine (Light and/or Dark)

2) Sandstone (Light Buff, Dark Buff and/or Rustic Red)
3) Slate (Bluestone and/or Smoke)
4) Old World (Limestone and/or Raven)
5) Classic (Pewter, Brick Red and/or Buff)

C) Size:
1) 1.75 in. thick.
2) Available sizes as follows:

	12" x 12"	12" x 18"	12" x 24"	18" x 18"	18" x 24"	24" x 24"
Travertine						
Light		x	x			
Dark		x	x			
Sandstone						
Light Buff	x	x	x	x	x	x
Dark Buff	x	x	x	x	x	x
Rustic Red	x	x	x	x	x	x
Slate						
Bluestone	x	x	x	x	x	x
Smoke	x	x	x	x	x	x
Old World						
Limestone	x		x	x		x
Raven	x		x	x		x
Classic						
Pewter						x
Buff						x
Brick Red						x

2.02 PRODUCT SUBSTITUTIONS

A) Concrete Paving Slabs:
1) No substitutions permitted.

B) Aggregates:
1) Permitted for gradations for crushed stone jointing material, base and subbase materials. Base and subbase materials shall have a minimum 0.32 void ratio. All substitutions shall be approved in writing by the project engineer.

2.03 CRUSHED STONE FILLER, BEDDING, BASE AND SUBBASE

A) Crushed stone with 90% fractured faces, LA Abrasion < 40 per ASTM C 131, minimum CBR of 80% per ASTM D 1883.
B) Do not use rounded river gravel.
C) All stone materials shall be washed with less than 1% passing the No. 200 sieve.
D) Joint/opening filler, bedding, base and subbase: conforming to ASTM D 448 gradation as shown in Tables 1, 2 and 3 below:

Note: No. 89 stone or that having similar gradation and infiltration rates may be used to fill pavers with narrow joints.

Table 1
ASTM No. 8
Bedding and Joint

Sieve Size	Percent Passing
1/2 inch	100
3/8 inch	85 to 100

No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

Table 2
ASTM No. 57
Base

Sieve Size	**Percent Passing**
1.5 inch	100
1 inch	95 to 100
1/2 inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5

Table 3
ASTM No. 2
Subbase

Sieve Size	**Percent Passing**
3 inch	100
2.5 inch	90 to 100
2 inch	35 to 70
1.5 inch	0 to 15
3/4 inch	0 to 5

E) Gradation criteria for the bedding and base:

Note: Dx is the particle size at which x percent of the particles are finer. For example, D15 is the particle size of the aggregate for which 15% of the particles are smaller and 85% are larger.

1) D15 base stone /D15 bedding stone < 5.
2) D50 base stone/D50 bedding stone > 2.

2.04 ACCESSORIES

A) Provide accessory materials as follows:

Note: Curbs will typically be cast-in-place concrete or precast set in concrete haunches. Concrete curbs may be specified in another Section. Edge restraint shall be paver/hardscape specific and aluminum or landscape edging shall not be used.

1) Edge Restraints
   a) Manufacturer: [Specify manufacturer.].
   b) Material: [Plastic] [Concrete] [Steel] [Pre-cast concrete] [Cut stone] [Concrete].
   c) Material Standard: [Specify material standard.].

Note: See ICPI publication, Permeable Interlocking Concrete Pavements for guidance on geotextile selection. Geotextile use is optional.

B) Geotextile Fabric:
   a) Material Type and Description: [Specify material type and description.].
   b) Material Standard: [Specify material standard.].

c) Manufacturer: [Acceptable to interlocking concrete paver manufacturer]

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A) As per above 1.04 B. No exceptions shall be made.

3.02 EXAMINATION

Note: The elevations and surface tolerance of the soil subgrade determine the final surface elevations of concrete paver slabs. The paver installation contractor cannot correct deficiencies in excavation and grading of the soil subgrade with additional bedding materials. Therefore, the surface elevations of the soil subgrade should be checked and accepted by the General Contractor or designated party, with written certification presented to the paver installation subcontractor prior to starting work.

A) Acceptance of Site Verification of Conditions:
   1) Contractor shall inspect, accept and certify in writing to the slab installation subcontractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.

Note: Compaction of the soil subgrade is optional and should be determined by the project engineer. If the soil subgrade requires compaction, compact to a minimum of 95% standard Proctor density per ASTM C 698. Compacted soil density and moisture should be checked in the field with a nuclear density gauge or other test methods for compliance to specifications. Stabilization of the soil and/or base material may be necessary with weak or continually saturated soils. Compaction will reduce the permeability of soils. If soil compaction is necessary, reduced infiltration may require drain pipes within the open-graded subbase to conform to local storm drainage requirements.

a) Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
b) Provide written density test results for soil subgrade to the Owner, General Contractor and paver installation subcontractor.
c) Verify location, type, and elevations of edge restraints, [concrete collars around] utility structures, and drainage pipes and inlets.
d) Do not proceed with installation of bedding and paver slabs until subgrade soil conditions are corrected.

3.03 PREPARATION

A) Verify that the soil subgrade is free from standing water.
B) Stockpile joint/opening filler, base and subbase materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.
C) Edge Restraint Preparation:
   1) Install edge restraints per the drawings [at the indicated elevations].

3.03 INSTALLATION

Note: The minimum slope of the soil subgrade is typically 0.5%. Actual slope of soil subgrade will depend on the drainage design and exfiltration type. All drain pipes, observation wells, overflow pipes, and (if applicable) geotextiles, berms, baffles and impermeable liner should be in place per the drawings prior to or during placement of the subbase and base, depending on their location. Care must be taken not to damage drainpipes during compaction and paving. No mud or sediment can be left on the base or bedding aggregates. If they are contaminated, they must be

removed and replaced with clean materials. Base/subbase thicknesses and drainage should be determined by civil or geotechnical engineer. Additionally, joint size (and size of aggregate in joint) depends on surface area of selected pavers and should be determined by civil or geotechnical engineer.

A) General
   1) Any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities shall be removed before application of the [geotextile] and subbase materials.
   2) Keep area where pavement is to be constructed free from sediment during entire job. [Geotextiles] Base and bedding materials contaminated with sediment shall be removed and replaced with clean materials.
   3) Do not damage drainpipes, overflow pipes, observation wells, or any inlets and other drainage appurtenances during installation. Report any damage immediately to the project engineer.

B) Geotextiles
   1) Place on [bottom and] sides of soil subgrade. Secure in place.
   2) Overlap a minimum of 12 inches in the direction of drainage.

C) Open-graded subbase and base
   1) Moisten, spread and compact the No. 2 subbase in 4 to 6 in. lifts [without wrinkling or folding the geotextile. Place subbase to protect geotextile from wrinkling under equipment tires and tracks.]
   2) For each lift, make at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 t (10 T) vibratory roller until there is no visible movement of the No. 2 stone. Do not crush aggregate with the roller.
   3) The surface tolerance of the compacted No. 2 subbase shall be ±2 1/2 in. over a 10 ft straightedge.
   4) Moisten, spread and compact the No. 57 base layer in one 4 in. thick lift. On this layer, make at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 t (10 T) vibratory roller until there is no visible movement of the No. 57 stone. Do not crush aggregate with the roller.
   5) The surface tolerance of the compacted No. 57 base should not deviate more than. ±1 in. over a 10 ft straightedge.

Note: As a test method, in-place density of the base aggregate may be checked per ASTM D 4254. Compacted density should be 95% of the laboratory index density established for the base layer.

D) Bedding layer
   1) Moisten, spread and screed the No. 8 stone bedding material.
   2) Fill voids left by removed screed rails with No. 8 stone.
   3) The surface tolerance of the screeded No. 8 bedding layer shall be ±3/8 in over a 10 ft straightedge.
   4) Do not subject screeded bedding material to any pedestrian or vehicular traffic before paving unit installation begins.

E) Concrete paver slab and joint/opening fill material
   1) Lay the paving units in the pattern(s) and joint widths shown on the drawings. Maintain straight pattern lines.
   2) Fill gaps at the edges of the paved area with cut units. Cut pavers shall be no smaller than 1/3 of a whole unit.
   3) Cut pavers and place along the edges with a masonry saw. A paver splitter shall not be used.
   4) Fill the openings and joints with No. 8 stone.

Note: Some paver joint widths may be narrow and not accept most of the No. 8 stone. Use joint material that will fill joints such as washed ASTM No. 9 or No. 10 stone.

5) Remove excess aggregate on the surface by sweeping pavers clean.
6) Keep all motorized equipment, such as skid steer and forklift, off slabs at all times.
7) Compact and seat the pavers into the bedding material using a low-amplitude, 75-90 Hz plate compactor capable with rug attachment of at least 5,000 lbf (22 kN) centrifugal compaction force. This will require at least two passes with the plate compactor.
8) Do not compact within 6 ft of the unrestrained edges of the paving units.
9) Apply additional aggregate to the openings and joints if needed, filling them completely. Remove excess aggregate by sweeping then compact the pavers. This will require at least two passes with the plate compactor.
10) All pavers within 6 ft of the laying face must be left fully compacted at the completion of each day.
11) The final surface tolerance of compacted pavers shall not deviate more than ±3/8 under a 10 ft long straightedge.
12) The surface elevation of pavers shall be 1/8 to 1/4 in. above adjacent drainage inlets, concrete collars or channels.

3.05 FIELD QUALITY CONTROL

A) After sweeping the surface clean, check final elevations for conformance to the drawings.
B) Lippage: No greater than 1/4 in. difference in height between adjacent pavers.

Note: The surface of the pavers may be 1/8 to 1/4 in. above the final elevations after compaction. This helps compensate for possible minor settling normal to pavements.

C) Bond lines for paver courses: ±½ in. over a 50 ft string line.

3.06 PROTECTION

A) After work in this section is complete, Contractor shall be responsible for protecting work including sediment deposition and damage due to construction activity on the site.

END OF SECTION