

32-14-13

## Unilock Permeable 2015

For any additional information or assistance with this spec please contact your Unilock Representative.

**\*\*\* Delete all text in RED after modifying the text in BLUE. All BLUE text requires modification. \*\*\***

## FOREWORD

*These specifications have been prepared for the general guidance of architects, engineers, contractor and superintendents associated with the construction of permeable interlocking concrete pavements. Consult with a qualified engineer to determine the suitability of the design, confirm site conditions and monitor the installation in critical applications.*

## INTRODUCTION

*Unilock® permeable pavers are manufactured in a variety of shapes and colors for residential, commercial, municipal and industrial applications. They offer design professionals several engineered pavement systems that are efficient, durable, economical and aesthetically attractive.*

*Unilock® permeable pavers are manufactured to tight dimensional tolerances. This, in combination with their permeable and interlocking capabilities, allows the surface to be completely porous with a high resistance to compressive loads and lateral forces.*

## SECTION 32 14 13.19

### PERMEABLE CONCRETE PAVER MATERIALS

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes the following:
  - 1. Permeable Concrete Pavers
  - 2. Permeable Joint Opening Aggregate
  - 3. Permeable Joint Aggregate Type 1
  - 4. Permeable Joint Aggregate Type 2
  - 5. Permeable Setting Bed Aggregate (Open-graded)
  - 6. Permeable Base Aggregate (Open-graded)
  - 7. Permeable Subbase Aggregate (Open-graded)

##### 1.02 REFERENCES

Note: Design street, industrial, port and airport pavement thicknesses in consultation with a qualified civil engineer, in accordance with established flexible pavement design procedures, LOCKPAVE® software, and in accordance with Interlocking Concrete Pavement Institute Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modifications.

- A. ASTM International, latest edition:
  - 1. C 29 Bulk Density and Voids in Aggregate Materials.
  - 2. C 33, Standard Specification for Concrete Aggregates.
  - 3. C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile, Section 8, Freezing and Thawing.
  - 4. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 5. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
  - 6. C 144 Standard Specifications for Aggregate for Masonry Mortar.
  - 7. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
  - 8. C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
  - 9. C 979, Standard Specification for Pigments for Integrally Colored Concrete.

10. D 698 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop.
11. D 1557 Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop.
12. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
13. D 1883, Test Method for California Bearing Ratio of Laboratory-Compacted Soils.
14. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.
15. D 4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
16. D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
17. D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
18. D 4533, Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles
19. D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
20. D 4491, Standard Test Method for Water Permeability of Geotextiles by Permittivity
21. D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
22. D 4354, Standard Practice for Sampling of Geosynthetics for Testing
23. D 4759, Standard Practice for Determining the Specifications Conformance of Geosynthetics

Delete the BLUE text above if no geotextile is being utilized.

Note: In order to determine the latest version of the listed specifications and standards, please consult the ASTM web page ([www.astm.com](http://www.astm.com))

- B. U.S. Green Building Council Leadership in Energy and Environmental Design (LEED)
  1. Building Design + Construction, latest edition

### 1.03 SUBMITTALS

- A. Permeable Concrete Pavers:
  1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
  2. Accepted samples become the standard of acceptance for the product produced.
  3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
  4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.
- B. Permeable Joint Opening Aggregate:
  1. Provide three representative one pound samples in containers of aggregate materials that indicate the range of color variation and texture expected upon project completion.
  2. Accepted samples become the standard of acceptance for the product produced.
  3. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
  4. Test results for void space percentage per ASTM C 29.
- C. Permeable Setting Bed, Base and Subbase Aggregate:
  1. Test results from an independent testing laboratory for compliance with ASTM D 448 No. 8, No. 57 and No. 2.
  2. Test results from an independent testing laboratory for sieve analysis, including washed gradations per ASTM C 136.
  3. Test results for void space percentage per ASTM C 29.
- D. Paving Installation Contractor:

1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.
- E. **LEED (required only for LEED projects, delete otherwise)**
1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
    - a. Include statement indicating costs for each product having recycled content.
  2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
    - a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
  3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.
- 1.04 **QUALITY ASSURANCE**
- A. Utilize a Manufacturer having at least ten years of experience manufacturing interlocking concrete pavers on projects of similar nature or project size.
  - B. Source Limitations:
    1. Obtain Permeable Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
    2. Obtain Permeable Joint Opening Aggregate from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
  - C. Paving Contractor Qualifications:
    1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.
  - D. Mockups:
    1. Install a 5 ft x 5 ft paver area.
    2. Use this area to determine joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
    3. Subject to acceptance by owner, mock-up may be retained as part of finished work.
    4. If mock-up is not retained, haul offsite and dispose legally.
- 1.05 **DELIVERY, STORAGE & HANDLING**
- A. **In accordance with Conditions of the Contract and Division 1 Product Requirement Section. (Modify this to match the general conditions of the specific project)**
  - B. Deliver Permeable Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
    1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
    2. Deliver concrete pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
    3. Unload pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.
  - C. Store and protect materials free from mud, dirt and other foreign materials.
- 1.06 **PROJECT/SITE CONDITIONS**
- A. Environmental Requirements:
    1. Install permeable pavers only on unfrozen permeable setting bed aggregate materials.
    2. Install permeable setting bed only on unfrozen permeable base and subbase aggregates.
    3. Install permeable base or subbase aggregates only over unfrozen subgrade.

- 1.07 PERMEABLE CONCRETE PAVER OVERAGE AND ATTIC STOCK
- A. Provide a minimum of 5% additional material for overage to be used during construction.
  - B. Furnish 100 square feet of each product and size used to owner for maintenance and repair. Furnish Permeable Concrete Pavers from the same production run as installed materials.
  - C. Manufacture to supply maintenance and reinstatement manuals for Permeable Concrete Paver units.
- 1.08 LEED REQUIREMENTS (required only for LEED projects, delete otherwise)
- A. Add any specific requirements necessary for achieving desired credits.

## PART 2 PRODUCTS

- 2.01 PERMEABLE CONCRETE PAVERS
- A. Basis-of-Design Product: The permeable concrete paver shapes are based on:
    - 1. Unilock: (Select product or products being used)
      - a. Eco-Optiloc
      - b. Eco-Priora
      - c. Ecoloc
      - d. Eco-Stone
      - e. Town Hall
    - 2. As manufactured by:
      - Unilock (Add location)
      - Address
      - City, State and Zip
      - Contact: (insert Unilock representative name and phone number) or your local Territory Manager
    - 3. The specified products establish minimum requirements that substitutions must meet to be considered acceptable.
      - a. To obtain acceptance of unspecified products, submit written requests at least 7 days before the Bid Date.

Note: Unless required by the owner, an "or equal" line is not necessary when using a basis-of-design specification with the above information is listed and outline in Division 1, Product Substitution Procedures.

Or choose number 3 below and delete above number 3.

    - 3. Substitutions: No substitutions permitted.
  - B. Product requirements:
    - 1. Permeable Paver Type 1: Unilock Eco-Optiloc (or other Unilock product name)
      - a. Color: Insert product color
      - b. Finish: (Select finish type from below and insert here. Finish type will affect product pricing).
        - 1. Standard – this is not a face mix finish.
        - 2. Smooth (Premier) – this is a face mix finish.
        - 3. Brushed (IL Campo) – this is a face mix finish.
        - 4. Exposed Granite (Series 3000) – this is a face mix finish.
        - 5. Granite appearance (Umbriano) – this is a face mix finish.
        - 6. Tile appearance (Belpasso) – this is a face mix finish.
        - 7. TX Active photocatalytic cement – this is a face mix finish.
      - c. Edge: Chamfer - 3 mm bevel
      - d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 in all directions.
        - 1. L-shape

Note: Imperial dimensions are nominal equivalents to the metric dimensions.
    - 2. Permeable Paver Type 2: Unilock Eco-Priora (or other Unilock product name)

- a. Color: Insert product color
- b. Finish: (Select finish type from below and insert here. Finish type will affect product pricing).
  - 1. Standard – this is not a face mix finish.
  - 2. Smooth (Premier) – this is a face mix finish.
  - 3. Brushed (IL Campo) – this is a face mix finish.
  - 4. Exposed Granite (Series 3000) – this is a face mix finish.
  - 5. Granite appearance (Umbriano) – this is a face mix finish.
  - 6. Tile appearance (Belpasso) – this is a face mix finish.
  - 7. TX Active photocatalytic cement – this is a face mix finish either Premier or Brushed.
- c. Edge: Chamfer - 3 mm rolled
- d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 in all directions.
  - 1. 120 mm (5 in) x 120 mm (5 in) x 80 mm (3-1/8 in) thick
  - 2. 120 mm (5 in) x 240 mm (10 in) x 80 mm (3-1/8 in) thick
  - 3. 240 mm (10 in) x 240 mm (10 in) x 80 mm (3-1/8 in) thick

Note: Imperial dimensions are nominal equivalents to the metric dimensions.
- 3. Permeable Paver Type 3: Town Hall (or other Unilock product name)
  - a. Color: Insert product color(s): Burgundy Red, Burnt Clay, Old Oak
  - b. Finish: Streetpaver appearance
  - d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 in all directions.
    - 1. 10 cm (4 in) x 25 cm (9-3/4 in) x 7 cm (2-3/4 in) thick
- 4. (Insert additional Permeable Paver Types here as necessary or delete this line)
- C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.
  - 1. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).
  - 2. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.
  - 3. Resistance to 50 freeze-thaw cycles, when tested according to ASTM C1645, with no breakage greater than 1.0% loss in dry weight of any individual unit. Conduct this test method not more than 12 months prior to delivery of units.

Note: Efflorescence is a whitish powder-like deposit that sometimes appears on concrete products. Calcium hydroxide and other water-soluble materials form or are present during the hydration of Portland cement. Pore water becomes saturated with these materials, and diffuses to the surface of the concrete. When this water evaporates, the soluble materials remain as a whitish deposit on the concrete surface. The calcium hydroxide is converted to calcium carbonate during a reaction with carbon dioxide from the atmosphere. The calcium carbonate is difficult to remove with water. However, the efflorescence will wear off with time, and it is advisable to wait a few months before attempting to remove any efflorescence. Commercially available cleaners can be used, provided directions are carefully followed. Some cleaners contain acids that may alter the color of the pavers.
- D. Accept only pigments in concrete pavers conforming to ASTM C 979.  
Note: ACI Report No. 212.3R provides guidance on the use of pigments.
- E. Maximum allowable breakage of product is 5%.
- F. TX Active is a Portland Cement (white) Type I, II, and III complying with ASTM C 150 with the addition of proprietary particles of titanium dioxide (TiO<sub>2</sub>) specifically engineered for use in the manufacture of concrete and concrete products.
  - 1. TX Active - Self-cleaning and pollution reduction
    - Concrete will resist most organic and inorganic pollutants that gather on the surface causing discoloration.

- Concrete will remove significant amounts of environmental pollutants deemed harmful to human health.
- 2. As manufactured by ESSROC Italcementi Group.
  - a. Unilock Chicago is an authorized producer of TX Active products.

**NOTE: CONTACT YOUR LOCAL UNILOCK COMMERCIAL PRODUCT REPRESENTATIVE PRIOR TO SPECIFYING TX ACTIVE CEMENT.**

2.02 PERMEABLE JOINT OPENING AGGREGATE

- A. Provide Permeable Joint Opening Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as shown in Table 1. **Unilock recommends using granite chips listed in table 2 below for vehicular areas with heavy traffic loads such as roadways or drive-through areas.**

**TABLE 1 - ECO-OPTILOC  
PERMEABLE JOINT OPENING AGGREGATE  
GRADATION REQUIREMENTS  
(CRUSHED LIMESTONE)**

ASTM No. 8	
Sieve Size	Percent Passing
1/2 in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

- B. Provide Permeable Joint Opening Aggregate materials conforming to ASTM C 33 and gradation requirements as presented in Table 2.
  - 1. Supplier:
    - a. [Kafka Granite LLC, 101 S. Weber Ave, Stratford, WI 54484 – Toll Free: 800-852-7415](#)
    - b. [Alliance Aqua-Roc](#)
    - c. [SEK Perm Chip](#)
  - 2. Color: [\(Specify granite chip color if other than crushed limestone\)](#)

**TABLE 2 - ECO-PRIORA & TOWN HALL  
PERMEABLE JOINT OPENING AGGREGATE  
GRADATION REQUIREMENTS  
(GRANITE CHIPS)**

1/8 to 3/16 inch granite chips	
Sieve Size	Percent Passing
1/4 in (6 mm)	97 to 100
No. 4 (4.75 mm)	70 to 83
No. 8 (2.36 mm)	37 to 50
No. 16 (1.18 mm)	0 to 12
pan	

2.03 PERMEABLE SETTING BED AGGREGATE

- A. Provide Permeable Setting Bed Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as presented in Table 3.

**TABLE 3  
PERMEABLE SETTING BED AGGREGATE  
GRADATION REQUIREMENTS**

<b>ASTM No. 8</b>	
<b>Sieve Size</b>	<b>Percent Passing</b>
½ in (12.5 mm)	100
3/8 in (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5

2.04 PERMEABLE BASE AGGREGATE

- A. Provide Permeable Base Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 57 as presented in Table 4.

**TABLE 4  
PERMEABLE BASE AGGREGATE  
GRADATION REQUIREMENTS**

<b>ASTM No. 57</b>	
<b>Sieve Size</b>	<b>Percent Passing</b>
1-1/2 in (37.5 mm)	100
1 in (25 mm)	95 to 100
1/2 in (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

2.05 PERMEABLE SUBBASE AGGREGATE

- A. Provide Permeable Subbase Aggregate materials conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 2 as presented in Table 5.

**TABLE 5  
PERMEABLE SUBBASE AGGREGATE  
GRADATION REQUIREMENTS**

<b>ASTM No. 2</b>	
<b>Sieve Size</b>	<b>Percent Passing</b>
3 in (75 mm)	100
2-1/2 in (63 mm)	90 to 100
2 in (50 mm)	35 to 70
1-1/2 in (37.5 mm)	0 to 15
3/4 (19 mm)	0 to 5

Note: For all aggregates, provide washed, clean, have zero plasticity, free from deleterious or foreign matter, crushed, angular rock and contain no No. 200 sieve size aggregate materials used in the construction of permeable pavement. Aggregate materials serve as the structural load bearing platform of the pavement as well as a temporary receptor for the infiltrated water that is collected through the openings in the pavement's surface.



**2.06 GEOTEXTILE (Optional depending on soil conditions)**

- A. Provide Geotextile material conforming to the following performance characteristics, measured per the test methods referenced:
1. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
  2. Grab Tensile Strength: ASTM D 4632: 115 lbs.
  3. Grab Tensile Elongation: ASTM D 4632: 50%
  4. Trapezoidal Tear: ASTM D4533: 50 lbs.
  5. Puncture: ASTM D4833: 65 lbs.
  6. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
  7. Permittivity: ASTM D 4491: 2.0 sec<sup>-1</sup>
  8. Flow Rate: ASTM D 4491: 140 gal/min/s.f.
- B. As supplied by Unilock (add location, address, City, State and Zip)  
Contact: (Insert Unilock representative name and phone number) or your local Territory Manager
1. Carthage Mills – FX-40HS
  2. U.S. Fabrics – US 115NW
  3. Mirafi – 140N

**2.07 EDGE RESTRAINTS**

- A. Concrete Edge Restraint as indicated.
- B. Plastic and Metal Edge Restraints:
1. Permaloc, [www.permaloc.com](http://www.permaloc.com)
    - a. Material Type: Aluminum
    - b. Model No.: 3 inch GeoEdge capture plate and geogrid
  2. SEK Surebond
    - a. Model No.: 8 feet PermEdge with attached geogrid

**Note:** The provision of suitable edge restraints is critical to the satisfactory performance of interlocking concrete block pavement. Abut pavers tightly against the restraints to prevent rotation under load and any consequent spreading of joints. Install sufficiently stable edge restraints that are, in addition to providing suitable edge support for the paver units, able to withstand the impact of temperature changes, vehicular traffic and/or snow removal equipment.

Curbs, gutters or curbed gutter, constructed to the dimensions of municipal standards (noting that these standards generally refer to cast-in-place concrete sections), are considered to be acceptable edge restraints for heavy duty installations. Where extremely heavy industrial equipment is involved such as container handling equipment, review the flexural strength of the edge restraint carefully particularly if a section that is flush with the surface is used and may be subjected to high point loading.

**2.08 ACCESSORIES (Optional depending on project needs)**

- A. [Cleaners] [Sealers]
1. Supplier: Unilock (add location, address, City, State and Zip)  
Contact: (Insert Unilock representative name and phone number) or your local Territory Manager
  2. Material Type and Description: (Specify material type and description)
  3. Material Standard: (Specify material standard)

**Note:** Generally sealing permeable pavers for utilitarian uses such as parking lots is not necessary. Consult with your product representative prior to specifying or remove section 2.08 Accessories.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Permeable Concrete Pavers.
  - 1. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
  - 2. Verify that Geotextiles, if applicable, have been placed according to drawings and specifications.
  - 3. Verify that Permeable Base and Subbase Aggregate materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
  - 4. Provide written density test results for soil subgrade, Permeable Base and Subbase Aggregate materials to the Owner, General Contractor and paver installation subcontractor.
  - 5. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Beginning of bedding sand and paver installation signifies acceptance of base and edge restraints.

### 3.02 PREPARATION

- A. Verify that the subgrade soil is free from standing water.
- B. Stockpile Permeable Setting Bed, Joint, Base and Subbase Aggregate materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.
- C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Geotextile and Permeable Subbase Aggregate materials.
- D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Geotextile, Permeable Joint, Setting Bed, Base and Subbase Aggregate materials contaminated with sediment with clean materials.
- E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Permeable Subbase Aggregate construction.
- F. Prevent damage to underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.
- G. Compact soil subgrade uniformly to at least 90 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 95 percent Modified Proctor per ASTM D 1557 for vehicular areas.
- H. Proof-roll prepared subgrade according to requirements in Division 31 Section "Earth Moving" to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting and replace with compacted backfill or fill as directed.

**Note:** Base compaction and proof-rolling of the subgrade soil on the recommendations of the Design Engineer. Request the Architect/Engineer to inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

**Note:** Mechanical tampers (jumping jacks) are recommended for compaction of soil subgrade and aggregate base around lamp standards, utility structures, building edges, curbs, tree wells and other protrusions. Compact areas, not accessible to roller compaction equipment, to the specified density with mechanical tampers. **CAUTION** – Proceed with care around the perimeters of excavations, buildings, curbs, etc. These areas are especially prone to consolidation and settlement. Do not place wedges of backfill in these

areas. If possible particularly in these areas, proceed with backfilling and compacting in shallow lifts, parallel to the finished surface.

### 3.03 INSTALLATION

#### A. EDGE RESTRAINTS

1. Provide edge restraints as indicated.
  - a. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete." (Add section number and match specification name)
  - b. Provide concrete edge restraint along the perimeter of all paving as specified. Install the face of the concrete edge restraint, where it abuts pavers vertical down to the subbase.
  - c. Construct concrete edge restraint to dimensions and level specified and support on a compacted subbase not less than 6 in (150 mm) thick.
2. Provide plastic or metal edge restraints as indicated. (Delete if not being used).
  - a. Provide plastic or metal edge restraints along the perimeter of all paving as indicated and supported on a minimum of 6 inches (150 mm) of Base Aggregate.
  - b. Provide 10" spiral galvanized or stainless steel spike to fasten plastic edge restraint at 24 inches on center for straight sections and 12 inches on center for curved sections.

#### B. GEOTEXTILES (Delete if not being used).

1. Provide separation geotextile on bottom and sides of prepared soil subgrade. Secure in place to prevent wrinkling or folding from equipment tires and tracks.
2. Overlap ends and edges a minimum of 18 in. (450 mm) in the direction of drainage.

#### C. PERMEABLE BASE AND SUBBASE AGGREGATE

1. Provide the Permeable Subbase Aggregate in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
2. Compact the Permeable Subbase Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller.
3. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Subbase Aggregate material more than  $\pm 3/4$  in. (20 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
4. Provide the Permeable Base Aggregate material in uniform lifts not exceeding 6 in. (150 mm) over the compacted Permeable Subbase Aggregate material and compact to at least 95 percent as per ASTM D 4254 to depths as indicated.
5. Compact the Permeable Base Aggregate material with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 ton vibratory roller until there is no visible movement. Do not crush aggregate with the compaction device.
6. Tolerance: Do not exceed the specified surface grade of the compacted Permeable Base Aggregate material more than  $\pm 1/2$  in. (13 mm) over a 10 ft. (3 m) long straightedge laid in any direction.
7. Grade and compact the upper surface of the Permeable Base Aggregate material sufficiently to prevent infiltration of the Permeable Setting Bed Aggregate material both during construction and throughout its service life.

Note: In-place density of the Permeable Base and Subbase Aggregate materials may be checked per ASTM D 4254. Establish a Compacted density of 95% of the laboratory index density for the subbase and base stone.

#### D. PERMEABLE SETTING BED AGGREGATE

1. Provide and spread Permeable Setting Bed aggregate evenly over the Permeable Base Aggregate course and screed to a nominal thickness of 1-1/2 in. (40 mm).
  - a. Protect screeded Permeable Setting Bed Aggregate from being disturbed.

- b. Screed only the area which can be covered by pavers in one day.
    - c. Do not use Permeable Setting Bed Aggregate material to fill depressions in the base surface.
  - 2. Keep moisture content constant and density loose and constant until Concrete Pavers are set and compacted.
  - 3. Inspect the Permeable Setting Bed Aggregate course prior to commencing the placement of the permeable concrete pavers.
  - 4. Inspect the Setting Bed Aggregate course prior to commencing the placement of the Permeable Concrete Pavers. Acceptance of the Setting Bed Aggregate occurs with the initiation of Permeable Concrete Paver placement.
- E. PERMEABLE CONCRETE PAVERS
- 1. Replace unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
  - 2. Mix Concrete Pavers from a minimum of three (3) bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three (3) bundles simultaneously, variation in color is dispersed and blended throughout the project).
  - 3. Exercise care in handling face mix pavers to prevent surfaces from contacting backs or edges of other units.
  - 4. Provide Permeable Concrete Pavers using joint pattern as indicated. Adjust joint pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
  - 5. Use string lines or chalk lines on Permeable Setting Bed aggregate to hold all pattern lines true.
  - 6. Set surface elevation of pavers 1/8 in. (3 mm) above adjacent drainage inlets, concrete collars or channels.
  - 7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
    - a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
  - 8. Provide space between paver units of 1/32 in. (1 mm) wide to achieve straight bond lines.
  - 9. Prevent joint (bond) lines from shifting more than  $\pm 1/2$  in. ( $\pm 15$  mm) over 50 ft. (15 m) from string lines.
  - 10. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
  - 11. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 12. Prevent all traffic on installed pavers until Permeable Joint Aggregate has been vibrated into joints. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and Permeable Joint Aggregate material.
  - 13. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
    - a. After edge pavers are installed and there is a completed surface.
    - b. Compact installed concrete pavers to within 6 feet (1,800 mm) of the laying face before ending each day's work. Cover pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Permeable Setting Bed Aggregate from becoming disturbed.

14. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
15. Remove any cracked or structurally damaged pavers and replace with new units prior to installing Permeable Joint Opening Aggregate material.
16. Provide, spread and sweep Permeable Joint Opening Aggregate into joints immediately after vibrating pavers into Permeable Setting Bed course until full. Vibrate pavers and add Permeable Joint Aggregate material until joints are completely filled, then remove excess material. This will require at least 4 passes with a plate compactor.
17. Remove excess Permeable Joint Aggregate broom clean from surface when installation is complete.

#### 3.04 FIELD QUALITY CONTROL

- A. Verify final elevations for conformance to the drawings after sweeping the surface clean.
  1. Prevent final Concrete Paver finished grade elevations from deviating more than  $\pm 3/8$  in. ( $\pm 10$  mm) under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.
- B. Lippage: No greater than 1/32 in. (0.8 mm) difference in height between Permeable Concrete Pavers and adjacent paved surfaces.

#### 3.05 REPAIRING, CLEANING AND SEALING

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess dirt, debris, stains, grit, etc. from exposed paver surfaces; wash and scrub clean.
  1. Clean Permeable Concrete Pavers in accordance with the manufacturer's written recommendations.
- C. Seal as indicated. (If not indicated elsewhere in the contract documents, sealing is not required and remove this section 3.05, C.)
  1. Apply Sealer for Permeable Concrete Pavers in accordance with the sealer and paver manufacturer's written recommendations.

#### 3.06 PROTECTION

- A. Protect completed work from damage due to subsequent construction activity on the site.

#### 3.07 PERMEABLE JOINT AGGREGATE MATERIAL REFILLING

- A. Remove all debris from joint and provide additional Permeable Joint Aggregate material after 120 days and before 150 days after date of Substantial Completion/Provisional Acceptance.

1. Fill Permeable Joint Aggregate material full to the lip of the paver.

**NOTE: This preventative maintenance requirement is very important to include in your specification to help increase the long term function of the system. This is a good item to mention during the prebid meeting.**

#### 3.08 LIFE CYCLE ACTIVITIES

- A. Paver cleaning: Clean Permeable Concrete Pavers as needed to remove staining, dirt, debris, etc.
  1. Clean per manufacturers recommendations.
- B. Maintenance: Permeable Joint Aggregate Material.
  1. Annually inspect Permeable Joint Aggregate material for areas clogged with debris.
  2. Vacuum or sweep as necessary to restore surface infiltration.
  3. Remove debris by vacuuming or sweeping Permeable Joint Aggregate
    - a. Replenish removed Permeable Joint Aggregate material with clean aggregate material flush to paver lip.

- b. Sweep excess material from paver surface.

END OF SECTION