

**INSTALLATION
SPECIFICATIONS FOR
PERMEABLE INTERLOCKING
CONCRETE PAVEMENTS**

**Applicable to all Unilock® Permeable
Unit Paver Systems**

FOREWORD

These outline specifications have been prepared for the general guidance of architects, engineers, contractor and superintendents associated with the construction of permeable interlocking concrete pavements. A qualified engineer must 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 Engineers, Architects, Landscape Architects and Planners several engineered permeable 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 act as a total membrane with a high resistance to compressive loads and lateral forces maintaining its permeability.

Advantages of Unilock[®] permeable pavers:

- Reduction of runoff as much as 100% from frequent, low-intensity and short duration storms.
- Reduction of retention requirements in other parts of the drainage system.
- Filtration through the base and soil for improvement of water quality.
- Reduction of runoff temperature.
- Slows the release of runoff.
- Increase recharge of groundwater.
- Reduction of downstream flows and bank erosion due to decreased peak flows and volumes.
- Might reduce overall project development costs due to a reduction in storm sewers and drainage appurtenances.
- Very low maintenance requirements.
- Maximum efficiency is obtained when the pavers are installed mechanically.
- Might be beneficial when applying for LEED certification.

SECTION 321413 PERMEABLE INTERLOCKING CONCRETE PAVERS

PART 1 GENERAL

1.1. SECTION INCLUDES

- A. Concrete pavers
- B. Bedding and void opening aggregates
- C. Aggregate Base
- D. Edge Restraints

1.2. RELATED SECTIONS

Note: These related sections refer to standard specifications available from the local municipality or highway agency or from major specification writing agencies such as the Federal Highway Administration (FHWA), the National Stone Association (NSA), the American Concrete Pavement Association (ACPA), the National Asphalt Producers Association (NAPA), the National Institute of Building Sciences (NIBS), National Master Specifications (NMS), the American Society for Testing and Materials (ASTM), the Canadian Government Standards Board (CGSB), the Ontario Provincial Standard Specifications (OPSS), etc.

- A. Section: [-] - Curbs and Drains.
- B. Section: [-] - Aggregate Base.
- C. Section: [-] - Cement Treated Base.
- D. Section: [-] - Asphalt Treated Base.
- E. Section: [-] - Overlays of Asphalt and Concrete Pavements.
- F. Section: [-] - Roofing Materials.
- G. Section: [-] - Bitumen and Neoprene Setting Bed, Acrylic Fortified Mortar Setting Bed.
- H. Section: [-] - Geotextiles.
- I. Section: [-] - Unshrinkable Fill

1.3. REFERENCES

Note: Street, industrial, port and airport pavement thicknesses should be designed 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. American Society of Testing and Materials (ASTM) (latest edition):
 - 1. C 33 Specification for Concrete Aggregates.

2. C 136 Method for Sieve Analysis for Fine and Coarse Aggregate.
3. C 140 Sampling and Testing Concrete Masonry Units.
4. C 144 Standard Specifications for Aggregate for Masonry Mortar.
5. C 936 Specifications for Solid Interlocking Concrete Paving Units.
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 (24.4 N) Rammer and 12 in. (305 mm) drop.
8. 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.
9. D 2940 Graded Aggregate Material for Bases or Subbases for Highways or Airports.
10. C 29 Bulk Density and Voids in Aggregate Materials.

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

1.4. QUALITY ASSURANCE

- A. Installation shall be by a contractor and crew with at least one year of experience in placing permeable concrete pavers on projects of similar size.
- B. The Contractor shall conform to all local, state/provincial licensing and bonding requirements.

1.5. SUBMITTALS

- A. Shop or product drawings and product data shall be submitted.
- B. Full size samples of permeable concrete paving units shall be submitted to indicate color and shape selections. Color will be selected by Owner or Owner's Representative from Unilock's available colors.
- C. Sieve analysis for grading of bedding and joint opening aggregates shall be submitted.
- D. Test results shall be submitted from an independent testing laboratory for compliance of paving unit requirements to ASTM C 936 or other applicable requirements.
- E. The layout, pattern, and relationship of paving joints to fixtures and project formed details shall be indicated.

1.6. MOCK-UPS

- A. A 9 ft. x 9 ft. (2.5m x 2.5m) paver area shall be installed as described in Article 3.02.
- B. This area will be used to determine joint sizes, lines, laying pattern(s), color(s), and texture of the project.

C. This area shall be the standard from which the work will be judged.

1.7. DELIVERY, STORAGE, AND HANDLING

- A. Concrete pavers shall be delivered to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by fork lift or clamp lift. The pavers shall be unloaded at the job site in such a manner that no damage occurs to the product.
- B. Delivery and paving schedules shall be coordinated in order to minimize interference with normal use of buildings adjacent to paving.

1.8. ENVIRONMENTAL CONDITIONS

- A. Do not install bedding aggregates or pavers during heavy rain or snowfall.
- B. Do not install bedding aggregates and pavers over frozen base materials.
- C. Do not install frozen bedding aggregates.

PART 2 MATERIALS

2.1. CONCRETE PAVERS

- A. Supplied by:
Unilock® Location (Address, Phone, Fax)
- B. Product name(s)/shape(s), color(s), overall dimensions, and thickness of the permeable paver(s) specified as follows:

Product name: _____

Product shape(s): _____

Product color(s), _____

Note: All Unilock® Permeable Concrete pavers have spacer bars on each unit. These spacer bars insure a precise joint spacing between all paving stones. The spacer bars permit the use of mechanical installation equipment for a mechanized installation process.

- C. Pavers shall meet the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units.
 - 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 C 67, with no breakage greater than 1.0% loss in dry weight of any individual unit. This test method shall be conducted not more than 12 months prior to delivery of units.

D. Efflorescence shall not be a cause for rejection.

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.

E. Pigment in concrete pavers shall conform to ASTM C 979. ACI Report No. 212.3R provides guidance on the use of pigments.

F. Maximum allows breakage of product is 5%.

2.2. GRANULAR SUBBASE

The granular subbase material shall consist of granular material graded in accordance with ASTM D 2940. The subbase thickness and specific aggregate gradation shall be determined by the Designing Engineer.

2.3. GRANULAR BASE

The granular base material shall be crushed stone conforming to ASTM C 33 No 57, as presented in Table 1. The granular base thickness and specific aggregate gradation shall be determined by the Designing Engineer.

**TABLE 1
GRANULAR BASE
GRADING REQUIREMENTS**

ASTM C 33 No 57	
Sieve Size	Percent Passing
1 ½ in (37.5 mm)	100
1 in (25 mm)	95 to 100
½ in (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

2.4. BEDDING AND VOID OPENING AGGREGATES

A. The granular bedding material shall be graded in accordance with the requirements of ASTM D 33 No 8. The typical bedding thickness is between 1 ½ & 2 inches and the specific aggregate gradation shall be determined by the Designing Engineer.

Note: Aggregate materials used in the construction of permeable pavements shall be clean, have zero plasticity and contain no No. 200 sieve size materials. The aggregate materials must 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.

- B. The bedding and void opening aggregate shall conform to the grading requirements of ASTM C 33 No 8 as shown in Table 2.

**TABLE 2
BEDDING AND VOID OPENING AGREGATE
GRADING REQUIREMENTS**

ASTM C 33 No 8	
Sieve Size	Percent Passing
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

2.5. EDGE RESTRAINTS

The provision of suitable edge restraints is critical to the satisfactory performance of interlocking concrete block pavement. The pavers must abut tightly against the restraints to prevent rotation under load and any consequent spreading of joints. The restraints must be sufficiently stable that, in addition to providing suitable edge support for the paver units, they are 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, the flexural strength of the edge restraint should be carefully reviewed, particularly if a section that is flush with the surface is used and may be subjected to high point loading.

Edge restraints shall be used along all unrestrained paver edges and supported on a minimum of 6 in. (150mm) of aggregate base.

PART 3 EXECUTIONS

3.1. EXAMINATION

- A. Verify that subgrade preparation, compacted density and elevations conform to the specifications.

Note: For installation on a compacted aggregate base and soil subgrade, the designer

should be aware that the top surface of the pavers may be 1/8 to 1/4 in. (3 to 6 mm) above the final elevation after compaction. This difference in initial and final elevation is to compensate for possible minor settling.

Note: Compaction of the soil subgrade should be based on the recommendations of the Designing Engineer. The Architect/Engineer should inspect subgrade preparations, elevations and conduct density tests for conformance to specifications.

- B. Verify that geotextiles, if applicable, have been placed according to specifications and drawings.
- C. Verify that aggregate base materials, thickness, compaction, surface tolerances and elevations conform to the specifications.

Note: The aggregate base should be spread and compacted in uniform layers not exceeding 6 in. (150 mm) thickness. Recommended base surface tolerance should be plus or minus 3/8 in. (10 mm) over a 10 ft. (3 m) straight edge. The Architect/Engineer should inspect geotextile materials and placement (if applicable), base preparation, surface tolerances and elevations 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. Areas not accessible to roller compaction equipment should be compacted to the specified density with mechanical tampers. **CAUTION** - Care shall be taken around the perimeters of excavations, buildings, curbs, etc. These areas are especially prone to consolidation and settlement. Wedges of backfill should not be placed in these areas. If possible, backfilling and compacting in these areas particularly should proceed in shallow lifts, parallel to the finished surface.

- D. Verify the proper installation of the concrete curbing, in terms of location, elevation, and adherence to the specifications.
- E. Verify that the base is dry, uniform, even and ready to support bedding course aggregates, pavers and imposed loads.
- F. Beginning of bedding course aggregates and paver installation shall signify acceptance of the base and concrete curb edge restraints.

3.2. SITE PREPARATION

- A. The site must be stripped of all topsoil and other objectionable materials to the grades specified.
- B. All subdrainage of underground services within the pavement area must be completed in conjunction with subgrade preparation and before the commencement of subbase construction.
- C. After trimming to the grades specified, the pavement is to be proof rolled to a percentage of Standard Proctor Maximum Dry Density as specified by the Designing Engineering with soft spots or localized pockets of objectionable material excavated and properly replaced with approved granular material.

- D. The subgrade shall be trimmed to within 0 to 3/8 in. (0 to 10 mm) of the specified grades. The surface of the prepared subgrade shall not deviate by more than 3/8 in. (10 mm) from the bottom edge 39 in. (1 m) straight edge laid in any direction.
- E. The Contractor shall insure that the prepared subgrade is protected from damage from inundation by surface water. No traffic shall be allowed to cross the prepared subgrade. Repair of any damage resulting shall be the responsibility of the Contractor and shall be repaired.
- F. Under no circumstances shall further pavement construction proceed until the subgrade has been inspected by the Owner or the Consultant.

3.3. GRANULAR SUBBASE AND BASE INSTALLATION

- A. After proper construction of the concrete curb edge restraints for the interlocking pavement as per Section 3.4, and upon approval by the Consultant, aggregate subbase (as specified in design) and base shall be placed in uniform lifts not exceeding 6 in (150 mm) loose thickness and roller compacted according to the AASHTO guidelines for installing open graded aggregates. Because the subbase and base are open graded aggregated materials, a method specification is appropriate for guidance in all aggregate compactive force.

Subbase thickness shall be: _____ in. (_____ mm).

Base thickness shall be: _____ in. (_____ mm).

- B. The granular base shall be trimmed to within to within 0 to 3/8 in. (0 to 10 mm) of the specified grade. The surface of the prepared base shall not deviate more than: (an example: 3/8 in. (10 mm) from the bottom edge of a 10 ft. (3 m) straight edge laid in any direction).

Note: The acceptable final base tolerances shall be determined by the Designing Engineer.

- C. Before commencing the placing of bedding aggregate course and the placement of the Unilock[®] permeable concrete pavers, the base shall be inspected by the Owner or the Consultant.

3.4. EDGE RESTRAINTS

- A. Adequate concrete edge restraint shall be provided along the perimeter of all paving as specified. The face of the concrete edge restraint, where it abuts pavers, shall be vertical down to the subbase.
- B. All concrete edge restraints shall be constructed to dimensions and level specified and shall be supported on a compacted subbase not less than 6 in (150 mm) thick.
- C. Concrete used for the construction of the edge restraints shall be air-entrained and have a minimum compressive strength as specified. All concrete shall be in accordance with ASTM C 94 requirements.

3.5. PAVER INSTALLATION

- A. Spread the bedding aggregate evenly over the base course and screed to a nominal 1 ½ in. to 2 in.(28 mm to 51 mm) thickness. The bedding aggregate should not be disturbed. Place sufficient bedding aggregate to stay ahead of the laid pavers. Do not use the bedding aggregate to fill depressions in the base surface.
- B. Initiation of paver placement shall be deemed to represent acceptance of the pavers.
- C. Pavers shall be free of foreign material before installation.
- D. Pavers shall be inspected for color distribution and all chipped, damaged or discolored pavers shall be replaced. Maximum allow breakage as per 2.1, section F.
- E. The pavers shall be laid in pattern(s) as shown on the drawings.
- F. Joints between the pavers shall be maintained according to the spacer bars.
- G. Gaps at the edges of the paved area shall be filled with cut pavers.
Note: Units cut no smaller than one-third of a whole paver are recommended along edges subject to vehicular traffic.
- H. Pavers to be placed along the edge shall be cut with a masonry saw.
Note: The use of infill concrete or discontinuities in patterns will not be permitted except along the outer pavement boundaries, adjacent to drains and manholes.
- I. Upon completion of cutting, the area must be swept clean of all debris to facilitate inspection and to ensure pavers are not damaged during compaction.
- J. Low amplitude, high frequency plate compactor shall be used to compact the pavers. Use Table 3 below to select size of compaction equipment:

**TABLE 3
PAVER THICKNESS AND REQUIRED MINIMUM
COMPACTION FORCE**

Paver Thickness	Compaction Force
3 1/8 in. (80 mm)	5000 lbs [22 kN]

- Note:** Use of a urethane plate compactor pad is recommended to minimize any scuffing of the paving stone surface.
- K. The pavers shall be compacted and the bedding aggregates shall be swept into all joints and void openings until they are full. This will require at least two or three passes with the compactor. Do not compact within 3 ft. (1 m) of the unrestrained edges of the paving units.
- L. All work to within 3 ft. (1 m) of the laying face must be left fully compacted at the completion of each day.
- M. Excess surface bedding and void opening aggregates shall be swept off when

the job is complete.

- N. The final surface elevations shall not deviate, as an example, more than 3/8 in. (10 mm) under a 10 ft. (3 m) long straight edge. Acceptable surface elevation deviations shall be specified by the Designing Engineer.
- O. The surface elevation of pavers shall be 1/8 to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

3.6. FIELD QUALITY CONTROL

- A. Final elevations shall be checked for conformance to the drawings after removal of excess jointing aggregate.

END OF SECTION