

Installation Specifications for Interlocking Concrete Pavements

Applicable to Standard, Textured & Heavy Duty Unit Pavers.

FOREWORD

These outline specifications have been prepared for the general guidance of specifiers, engineers, contractor and superintendents associated with the construction of interlocking concrete pavements in any type of traffic applications. A qualified engineer must determine the suitability of the design, confirm site conditions and monitor the installation in more critical applications.

INTRODUCTION

Unilock[®] pavers are manufactured in a variety of shapes, colors and textures for residential, commercial, municipal and industrial applications. They offer Engineers, Architects, Landscape Architects and Planners several engineered placing systems that are durable, economical and aesthetically attractive. The systems also lend themselves to a multitude of design applications.

Unilock[®] pavers are manufactured to tight dimensional tolerances. This, in combination with their interlocking capabilities, allows the surface to act as a total membrane with a high resistance to compressive loads and lateral forces.

Advantages of Unilock[®] pavers:

- The design and performance advantages of Unilock[®] pavers over other surfaces are dramatically reflected in the wide range of colors, individual shapes, texture, and variety of installation patterns.
- Unilock[®] pavers offer an economical alternative to other types of pavements when viewed in the long term where maintenance and replacement costs are considered. In some cases, initial costs can be even lower.
- Ability to tolerate some subgrade and/or aggregate base deflection while still maintaining pavement continuity and structural integrity.
- Ease of access to underground services and utilities and subsequent replacement without visual or structural changes.
- High compressive strength provides excellent surface durability.
- Low water absorption rate helps to resist potential damage caused by fuel and oil leakage, salt scaling, and freeze-thaw cycles.
- Superior skid resistance for both vehicular and pedestrian applications.
- Simplicity of construction methods generally suited to unskilled labor, which can reduce installation costs.
- Very low maintenance requirements.
- Maximum efficiency is obtained when the pavers are installed mechanically.

INSTALLATION SPECIFICATIONS FOR _____

SECTION 0278 INTERLOCKING CONCRETE PAVERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete pavers
- B. Bedding and joint sand.
- 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 Concrete Paver Industry Technical Bulletins. Sample construction detail drawings are available from Unilock®. This specification may require modification for pavements with non-stabilized aggregate bases, asphalt or cement stabilized bases, or asphalt and concrete bases.

- 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.

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 interlocking concrete pavers on projects of similar nature or dollar cost.
- 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 concrete paving units shall be submitted to indicate Color and shape selections. Color will be selected by Architect/Engineer/Landscape Architect/Owner from Unilock's available colors.
- C. Sieve analyses for grading of bedding and joint sand 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.

Note: The pattern in which pavers are installed is very important in vehicular applications. Avoid patterns with long continuous lines; these may be subject to failure under vehicular traffic.

1.6 MOCK-UPS

- A. A 7 ft. x 7 ft. (2m x 2m) paver area shall be installed as described in Article 3.02.
- B. This area will be used to determine the amount that the pavers settle into

bedding sand after compaction, 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. Bedding and joint sand shall be covered with a secure waterproof covering to prevent exposure to rainfall or removal by wind.
- C. 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 sand or pavers during heavy rain or snowfall.
- B. Do not install sand and pavers over frozen base materials.
- C. Do not install frozen sand.

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 paver(s) specified as follows:

Product name: _____

Product shape(s): _____

Product color(s), _____

Note: Concrete pavers may have spacer bars on each unit. These insure a minimum joint between each unit into which sand is placed. Spacer bars help prevent contact of the edges with adjacent pavers and subsequent chipping. They are highly recommended for mechanically installed pavers. Manually installed pavers may be installed with or without spacer bars.

- C. Pavers shall meet the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence shall not be 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 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.

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

2.2 GRANULAR SUBBASE

The granular subbase material shall consist of granular material graded in accordance with ASTM D 2940, as presented in Table 1.

**TABLE 1
SUBBASE MATERIAL
GRADING REQUIREMENTS**

ASTM D 2940	
Sieve Size	Percentages Passing
2 in. (50 mm)	100
1½ in. (37.5 mm)	90 to 100
¾ in. (19 mm)	
3/8 in. (9.5 mm)	
No. 4 (4.75 mm)	30 to 60
No. 30 (600 µm)	
No. 200 (75 µm)	0 to 12 *

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.3 GRANULAR BASE

The granular base material shall be graded in accordance with the requirements of ASTM D 2940, as presented in Table 2

**TABLE 2
BASE MATERIAL
GRADING REQUIREMENTS**

ASTM D 2940	
Sieve Size	Percentages Passing
2 in. (50 mm)	100
1½ 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 (600 µm)	12 to 25
No. 200 (75 µm)	0 to 8 *

* In order to prevent damage by frost heaving, it may be necessary to limit the percentages of material passing the No. 200 sieve to less than shown in the tables.

2.4 BEDDING AND JOINT SAND

- A. The bedding and joint sand shall be clean, non-plastic, and free from deleterious or foreign matter. It can be natural or manufactured from crushed rock. Do not use limestone screenings or stone dust that do not conform to the grading requirements in Table 3. When concrete pavers are subject to vehicular traffic, the sands shall be as hard as practically available.

Note: The type of sand used for bedding is often called concrete sand. Sands vary regionally. Screenings and stone dust can be unevenly graded and have material passing the No. 200 (75µm) sieve. Bedding sands with these characteristics should not be used. Contact local paver contractors or manufacturers to the project and confirm sand(s) successfully used in previous similar applications.

Note: If the hardness of the bedding sand is not sufficient or questionable for the application (usually a heavily trafficked thoroughfare), contact Unilock® (1-800-UNILOCK) for information and specifications on assessing bedding sand durability under heavy traffic loads.

- B. The bedding sand shall conform to the grading requirements of ASTM C 33 as shown in Table 3.

**TABLE 3
BEDDING SAND
GRADING REQUIREMENTS**

ASTM C 33	
Sieve Size	Percent Passing
3/8 in. (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 (600 µm)	25 to 60
No. 50 (300 µm)	10 to 30
No. 100 (150 µm)	2 to 10

Note: Bedding sand may be used for joint sand. However, extra effort in sweeping and compacting the pavers may be required in order to fill the joints completely. It is recommendable to use sand specially gradated for joints. The gradations shown in Table 4 are recommended. Joint sand should never be used for bedding sand.

- C. The joint sand shall conform to the grading requirements of ASTM C 144 as shown in Table 4 below:

**TABLE 4
JOINT SAND
GRADING REQUIREMENTS**

ASTM C 144		
	Natural Sand	Manufactured Sand
Sieve Size	Percent Passing	Percent Passing
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 - 100	95 to 100
No. 16 (1.18 mm)	70 - 100	70 to 100
No. 30 (600 µm)	40 - 75	40 to 75
No. 50 (300 µm)	10 - 35	20 to 40
No. 100 (150 µm)	2 - 15	10 to 25
No. 200 (75 µm)	0	0 to 10

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 specifier 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 to at least 95% Standard Proctor Density per ASTM D 698 is recommended. Higher density or compaction to ASTM D 1557 (Modified Proctor Density) may be necessary for areas subject to vehicular traffic. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils. The Architect/Engineer should inspect subgrade preparation, 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: Local aggregate base materials typical to those used for flexible pavements are recommended, or those conforming to ASTM D 2940. Compaction to not less than 95% Proctor Density in accordance with ASTM D 698 is recommended for pedestrian areas. Compaction to not less than 98% Modified Proctor Density according to ASTM D 1557 is recommended for vehicular areas.

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, 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. 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 sand, pavers and imposed loads.
- F. Beginning of bedding sand and paver installation shall signify acceptance of base and 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.

Note: All service trenches within the pavement area must be back filled to the subgrade level with approved material placed in uniform lifts not exceeding 4 in. (200 mm) loose thickness. Each lift must be compacted to at least 100 percent Standard Proctor Density as specified in ASTM D 698.

- C. After trimming to the grades specified, the pavement is to be proof rolled to 100 percent Standard Proctor Density in the presence of the Consultant, 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 ½ in. (0 to 10mm) of the specified grades. The surface of the prepared subgrade shall not deviate by more than 3/8 in. (10mm) from the bottom edge of a 39 in. (1m) straight edge laid in any direction.
- E. The Contractor shall ensure 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. The subbase shall be placed in uniform lifts not exceeding 6 in., (150 mm) loose thickness and compacted to at least 100 percent Standard Proctor Density as per ASTM D 698.

Subbase thickness shall be ____ in. (____ mm).

- B. After proper construction of the edge restraints for the interlocking concrete pavement as per Section 3.4, and upon approval by the Consultant, aggregate base shall be placed in uniform lifts not exceeding 6 in. (150 mm) loose thickness. Each lift shall be compacted to at least 100 percent Standard Proctor Maximum Dry Density.

Base thickness shall be ____ in. (____ mm).

- C. The granular base shall be trimmed to within 0 to 3/8 in. (0 to 10 mm) of the specified grade. The surface of the prepared base shall not deviate by more than 3/8 in. (10 mm) from the bottom edge of a 10 ft. (3 m) long straight edge laid in any direction.
- D. The upper surface of the base shall be sufficiently well graded and compacted to prevent infiltration of the bedding sand into the base both during construction and throughout its service life. Segregated areas of the granular base shall be blended by the application of crushed fines that have been watered and compacted into the surface.
- E. Before commencing the placing of the sand bedding course and the placement of the interlocking concrete pavers, the base shall be inspected by the Owner or the Consultant.

3.4 EDGE RESTRAINTS

- A. Adequate edge restraint shall be provided along the perimeter of all paving as specified. The face of the edge restraint, where it abuts pavers, shall be vertical 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 edge restraints shall be air-entrained and have a compressive strength as specified. All concrete shall be in accordance with ASTM C 94 requirements.

3.5 PAVER INSTALLATION

- A. Spread the bedding sand evenly over the base course and screed to a nominal 1 in. (25 mm) thickness, not exceeding 1 ½ in. (40 mm) thickness. The screeded sand should not be disturbed. Sufficient sand shall be placed in order to stay ahead of the laid pavers. Do not use the bedding sand to fill depressions in the base surface.

Note: The spread sand shall be carefully maintained in a loose condition, and protected against incidental compaction, both prior to and following screeding. Any incidentally compacted sand or screeded sand left overnight, shall be loosened before further paving units are placed. Sand shall be lightly screeded in a loose condition to the predetermined depth, only slightly ahead of the paving units. Under no circumstances shall the sand be screeded in advance of the laying face to an extent to which paving will not be complete on that day.

Screed sand shall be fully protected against incidental compaction, including compaction by rain. Any screeded sand which is incidentally compacted prior to laying of the paving unit, shall be removed and brought back to profile in a loose condition. Neither pedestrian nor vehicular traffic shall be permitted on the screeded sand.

The Contractor shall screed the bedding sand using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards.

- 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.

Note: Color Blending - Paving units shall be installed from a minimum of 3 bundles simultaneously drawing the paver vertically rather than horizontally. (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 bundles simultaneously, variation in color is dispersed and blended throughout the project.

- E. The pavers shall be laid in the pattern(s) as shown on the drawings. String lines or chalk lines on bedding sand should be used to hold all pattern lines true.
- F. Joints between the pavers on average shall be between 1/16 in. and 1/8 in. (2 mm to 4 mm) wide. In order to maintain the desired pattern, joint spacing must be consistent. This spacing must also be provided for the first row abutting the edge restraint.

Note: Installing pavers too tightly may lead to chipping at the edges.

- 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 double blade paver splitter or 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. (Debris or sand particles left on pavers which are being compacted can cause point loading which may chip, scrape or break the paver.)
- J. After sweeping and prior to compaction, the paved area must be inspected by the owner or consultant to ensure satisfactory color blending. Pavers can be moved easily at this time to achieve good color distribution.

- K. Low amplitude, high frequency plate compactor shall be used to compact the pavers into the sand. The compactor shall transmit an effective force not less than 75 kN per square metre (1600 Lb/ft²) of plate area. The frequency of vibration shall be within the range of 75 to 100 Hz. Use Table 5 below to select size of compaction equipment:

**TABLE 5
PAVER THICKNESS AND REQUIRED MINIMUM
COMPACTION FORCE**

Paver Thickness	Compaction Force
2 3/8 in. (60 mm)	3000 lbs [13 kN]
2 3/4 in. (70 mm) & 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.

- L. The pavers shall be compacted to achieve consolidation of the sand bedding and brought to level and profile by not less than three passes. Initial compaction should proceed as closely as possible following the installation of the paving units and prior to the acceptance of any traffic or application of sweeping sand.
- M. Any units that are structurally damaged during compaction shall be immediately removed and replaced.
- N. Dry joint sand shall be swept into the joints until the joints 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.
- O. All work to within 3 ft. (1 m) of the laying face must be left fully compacted with sand-filled joints at the completion of each day.
- P. Excess joint sand shall be swept off when the job is complete.

3.06 FIELD QUALITY CONTROL

- A. Final elevations shall be checked for conformance to the drawings after removal of excess joint sand.
- B. All surface and pavement structures shall be true to the lines and levels, grades, thickness and cross sections shown on the drawings. All pavements shall be finished to lines and levels to ensure positive drainage at all drainage outlets and channels. In no case shall the cross-fall of any portion of pavement be less than 2 percent. The final surface elevations shall not deviate more than 3/8 in. (10 mm) under a 10 ft. (3 m) long straight edge.
- C. 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.

END OF SECTION