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UNILOCK®

INSTALLATION SPECIFICATIONS FOR INTERLOCKING CONCRETE PAVEMENTS - BITUMINOUS SETTING BED METHOD

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

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FOREWORD

This outline specification has been prepared for the general guidance of architects, engineers, contractors and superintendents associated with the construction of Concrete Paving Stone Pavements utilizing the Bituminous Setting Method. A qualified engineer must determine the suitability of the design, confirm site conditions and monitor the installation in critical applications.

**SECTION 321413
SPECIFICATION FOR THE CONSTRUCTION OF INTERLOCKING
CONCRETE PAVING STONES BY THE BITUMINOUS SETTING BED
METHOD**

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 Interlocking Concrete Pavement Institute 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.
 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 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 Owner or Owner's Representative from Unilock's available colors.
- C. Test results shall be submitted from an independent testing laboratory for compliance of paving unit requirements to ASTM C 936 or other applicable requirements.
- D. 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 3.2.

- 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. Joint sand shall be covered with a secure waterproof covering to prevent exposure to rainfall or removal by wind. Insure the covering is secured in place.
- 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 pavers during heavy rain or snowfall.

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 CONCRETE BASE

The concrete base shall be designed by a qualified civil engineer to sustain the traffic loads that the pavement will be subjected to.

2.4 BITUMINOUS SETTING BED

- A. Bituminous setting bed for concrete pavers shall be made from the following materials:
1. Asphalt cement to be used in the bituminous setting bed shall conform to ASTM D 946 with a penetration at 77 degrees F. 100G., 5 sec of minimum 85 millimetres and a maximum of 100 millimetres.
 2. The fine aggregate to be used in the bituminous setting bed shall be clean, hard sand free of organic matter and alkali salts. It shall be uniformly graded from "course" to "fine" and all aggregate shall pass the No. 4 sieve size. Aggregate must meet the gradation requirements when tested in accordance with the standard method of testing for sieve and screen analysis of fine and course aggregates ASTM C 136.
 3. The dried fine aggregate shall be combined with hot asphalt cement, and the mix shall be heated to approximately 300 degrees F. at an asphalt plant. The approximated proportion of materials shall be approximately 7% asphalt cement and 93% fine aggregate. Each ton shall be proportioned by weight in the approximate ratio of 145 lbs asphalt to 1,855 lbs sand.
- B. Setting bed primer/adhesive for adhesion to concrete base material:
Cut Back Asphalt Specification (Rapid Curing Type), per ASTM D 2028 and AASHTO M-81.
- C. Neoprene-Modified Asphalt Adhesive for bonding Concrete Pavers to Bituminous Bedding Material:
Standard neoprene modified asphalt adhesive containing oxidized asphalt combined with 2% neoprene and 10 percent long fibered mineral fibres with a softening point of 155 degrees F.
- D. Preformed Asphalt Joint Filler:
ASTM D 994, ½ inch thick, for expansion joints which are detailed.

2.5 JOINT SAND

- A. The jointing sand shall be clean, non-plastic, and free from deleterious or foreign matter. Natural or manufactured from crushed rock sand is suitable. Do not use limestone screenings or stone dust as they do not conform to the grading requirements in Table 2. When concrete pavers are subjected to vehicular traffic, the sand shall be as hard as practically possible.
- B. The joint sand shall conform to the grading requirements of ASTM C 144 as shown in Table 2.

**TABLE 2
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

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 the gradations 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

2.6 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: 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 subbase 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: 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 concrete base is ready to install the bituminous bedding layer.
- F. Beginning the installing of the bituminous bedding layer and paver installation shall signify acceptance of the concrete 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 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 resulting damage 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 & CONCRETE BASE INSTALLATION

- A. The subbase shall be placed in uniform lifts not exceeding 6 inches (150 mm) loose thickness and compacted to at least 100 percent Standard Proctor Maximum Dry Density as per ASTM C 698-00ae1.
Subbase thickness shall be _____ in (_____ mm).
- B. After proper construction of the concrete curb edge restraints for the interlocking pavement as per Section 3.04, and upon approval by the Consultant, the concrete base shall be installed per specification.
Concrete base thickness shall be _____ in (_____ mm).
- C. The concrete base shall be finished to within 0 to 3/8 in. (0 to 10 mm) of the specified grade. The surface of the prepared concrete base shall not deviate more than 3/8 in. (10 mm) from the bottom edge of a 10 ft. (3 m) straight edge laid in any direction.
- D. Before placing the bituminous bedding course and the placement any Unilock[®] concrete pavers, the concrete base shall be inspected by the Owner or the Consultant.

Note: The concrete base should be installed according to the specifications and requirements of the designing civil engineer. Recommended concrete base surface tolerance should be 0 to 3/8 in. (10mm) over a 10 ft (3 m) straight edge. The surface of the concrete base shall not deviate by more than 3/8 in. (10mm) from the bottom of the 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

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 INSTALLATION

- A. Preparing the bituminous setting bed material prior to the installation of the concrete paving stones:

- 1. Apply setting bed primer/adhesive to concrete base according to manufacturer's direction, to bond the bituminous bedding material to the concrete base.

Note: Utilize Cut Back Asphalt Specification (Rapid Curing Type), per ASTM D 2028-97 (2004) and AASHTO M-81.

- 2. Install the setting bed over the base surface (typically prepared by others), place 1" deep control bars directly over the concrete base. If grade must be adjusted, set thin wooden shims under the depth control bars to adjust the proper grade. Set two bars parallel to each other approximately eleven (11) feet apart to serve as guides for the striking boards (12 ft long x 2 in x 6 in board). The depth control bars must be set carefully to bring the bedding material to proper grade, to insure proper paving stone finished height.
 - 3. Place bituminous bedding material between the parallel control bars. Pull this bedding material with the striking board over the depth control bars several times. After each passage, any void must be filled with fresh bituminous material to produce a smooth, firm and even setting bed. As soon as this initial panel is completed, advance the first depth control bar to the next position, in readiness for striking the next panel. Carefully fill any voids that remain, after removing the depth control bars and any wooden adjustment shims.
 - 4. The setting bed shall be rolled with a power roller. The roller (check with the manufacturer for proper machinery specifications) should be equipped with a water tank and have the capacity to fully consolidate the bituminous bedding mixture to a nominal depth of $\frac{3}{4}$ inch, while still hot. The setting bed thickness shall be adjusted so that the concrete pavers will be at the required finished grade. (Adjustments in the setting bed should be performed to keep the setting bed thickness at $\frac{3}{4}$ inches or as close as possible.) Proper

attention to elevations during the construction of the concrete base material will insure maintaining the required nominal $\frac{3}{4}$ inch thick bituminous setting bed.

5. After the setting bed material has cooled, a coating of two (2) percent Neoprene-Modified Asphalt Adhesive is applied by mopping, squeegeeing or troweling over the top surface of the bituminous setting bed to provide a bond between the pavers and the bituminous setting bed. If utilizing the troweling method, the trowel shall have a serrated edge that does not exceed one – sixteenth ($\frac{1}{16}$) of an inch.

B. Installing paving stones:

After the application of the 2% Neoprene-Modified Asphalt Adhesive, you must allow 2-3 hours open air time or until the adhesive material becomes tacky and just skins over prior to laying the paving stones. Once the 2% Neoprene-Modified Asphalt Adhesive is ready for use, carefully place the paving stones by hand in straight courses with hand tight joints and uniform top surface. Good alignment must be kept, and the pattern shall be that shown on the plans.

C. Joint Treatment:

Hand tight joints will be placing paving stones in contact with their spacer bars or if the paving stones have no spacer bars shall read from $\frac{1}{16}$ " to $\frac{1}{8}$ ". Sweep dry properly graded sand into concrete paver joints.

3.6. OTHER CONDITIONS

A. Expansion joints on roof deck (for hand tight joints only).

Place a pre-molded, non-extruded, and resilient expansion joint against all vertical walls with flashing to within one (1) inch of finished grade.

B. Base (typically constructed by others):

The preferred base (minimum of 4 inches thick) is constructed of concrete and designed by a qualified engineer to sustain the required traffic loads. An alternative base material which also must be designed by a qualified engineer, is an asphalt binder mix (minimum of 4 inches thick), which can be obtained from a local asphalt plant. The base materials must be designed and constructed in accordance with state and local road specifications. Drainage should be incorporated into the pavement design by the engineer to facilitate the removal of any water that might migrate into the base area of the pavement. French drains and weep holes are examples of drainage design possibilities.

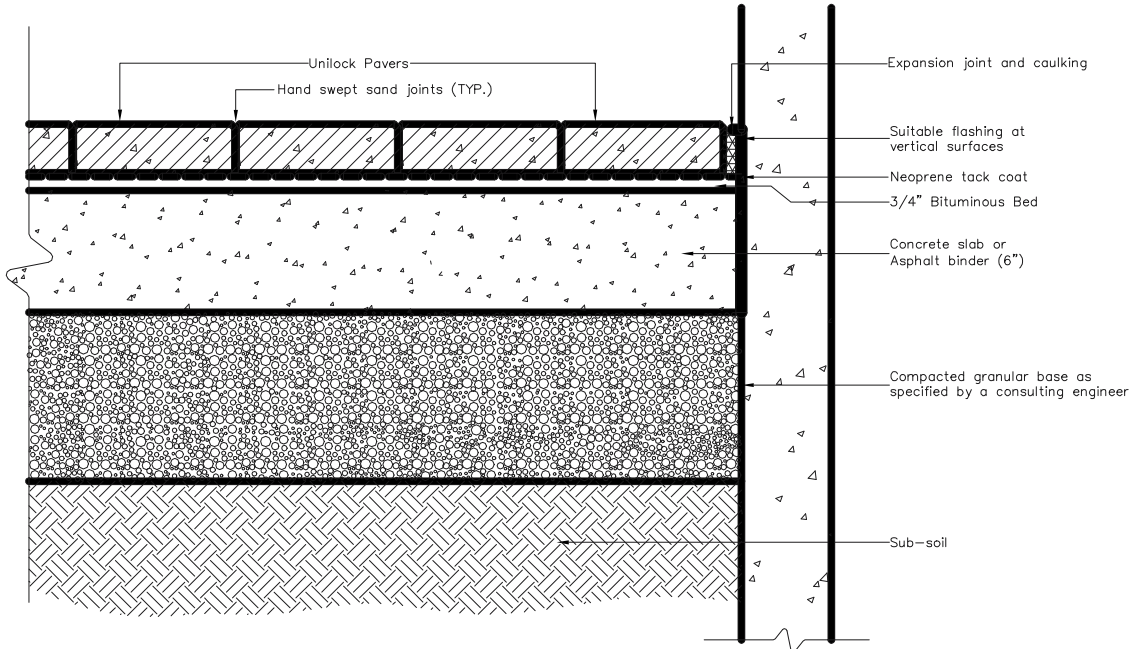
C. Vehicular traffic:

If there is to be vehicular traffic over the concrete pavers, apply a primer/adhesive to the concrete base and between the bituminous bedding course. Use a Cut Back Asphalt Specification (Rapid Curing Type), per ASTM D 2028 and AASHTO M-81.

D. Curbs (constructed by others):

Concrete curbs are required to contain the paving stones under vehicular applications.

Cross section of bituminous setting bed on grade for vehicular



END OF SECTION

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