GUIDE SPEC
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CONCRETE MASONRY &
HARDSCAPES ASSOCIATION

Provided By:

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PERMEABLE PAVERS
SECTION 32 14 13.19

Note: This guide specification for Canadian applications describes construction of permeable interlocking concrete pavers on a permeable, open-graded crushed stone bedding layer (typically ASTM No. 8 stone). This 50 mm layer is placed over an open-graded base (typically No. 57 stone, 100 mm thick) and a subbase (typically No. 2 stone or similar sized material such as No. 3 or 4 stone). The pavers and bedding layer are placed over an open-graded crushed stone base with exfiltration to the soil subgrade. In low infiltration soils or installations with impermeable liners, some or all drainage is directed to an outlet via perforated underdrains in the subbase. While this guide specification does not cover excavation, liners and underdrains, notes are provided on these aspects.

Edit this specification term as necessary to identify the design professional in the General Conditions of the Contract. ***The text must be edited by a qualified, licensed design professional to suit specific project requirements. ICPI makes no representations or warranties of any kind, expressed or implied, and disclaims any liability for damages resulting in the use of this guide construction specification.***

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes

1. Permeable interlocking concrete pavers.
2. Crushed stone bedding material.
3. Open-graded subbase aggregate.
4. Open-graded base aggregate.
5. Bedding and joint/opening filler materials.
6. Edge restraints.
7. [Geotextiles].

B. Related Sections

1. Section [_____]: Curbs.
2. Section [_____]: [Stabilized] aggregate base.
3. Section [_____]: [PVC] Drainage pipes
4. Section [_____]: Impermeable liner.
5. Section [_____]: Edge restraints.

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6. Section [_____]: Drainage pipes and appurtenances.
7. Section [_____]: Earthworks/excavation/soil compaction.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

B. American Society for Testing and Materials (ASTM)

1. C29 Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
2. C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C136 Method for Sieve Analysis for Fine and Coarse Aggregate.
4. C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
5. D448 Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. C936 Standard Specification for Solid Interlocking Concrete Pavers.
7. C979 Specification for Pigments for Integrally Colored Concrete.
8. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units.
9. C1781 Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems.
10. D3385 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
11. E2835 Standard Test Method for Measuring Deflections using a Portable Impulse Plate Load Test Device

D. Interlocking Concrete Pavement Institute (ICPI)

1. Permeable Interlocking Concrete Pavement manual (5th edition).
2. Permeable Design Pro software for hydrologic and structural design.
3. Tech Spec 18 Construction of Permeable Interlocking Concrete Pavements.
4. Tech Spec 23 Maintenance of Permeable Interlocking Concrete Pavements.

1.03 SUBMITTALS

A. In accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Paver manufacturer's/installation subcontractor's drawings and details: Indicate perimeter conditions, junction with other materials, expansion and control joints, paver [layout,] [patterns,] [color arrangement,] installation [and setting] details. Indicate layout, pattern and relationship of paving joints to fixtures, and project formed details.

C. Minimum 2 kg samples each of subbase, base and bedding aggregate materials.

D. Sieve analysis of aggregates for subbase, base and bedding materials per CSA A23.2A.

E. Project specific or producer/manufacturer source test results for void ratio and bulk density of the base and subbase aggregates.

F. Soils report indicating density test reports, classification, and infiltration rate measured on-site under compacted conditions, and suitability for the intended project.

G. Erosion and sediment control plan.

H. [Stormwater management (quality and quantity) calculations; structural analysis for vehicular applications] using ICPI Permeable Interlocking Concrete Pavements manual, Permeable Design Pro, ASCE 68-18, or [specify] design methods and models.

I. Permeable concrete pavers:

1. Paver manufacturer's catalog sheets with product specifications.
2. [Four] representative full-size samples of each paver type, thickness, color, and finish. Submit samples indicating the range of color expected in the finished installation.
3. Accepted samples become the standard of acceptance for the work of this Section.
4. Laboratory test reports certifying compliance of the concrete pavers with CSA A231.2.
5. Manufacturers' material safety data sheets for the safe handling of the specified paving materials and other products specified herein.
6. Paver manufacturer's written quality control procedures including representative samples of production record keeping that ensure conformance of paving products to the product specifications.

J. Paver Installation Subcontractor:

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

1.04 QUALITY ASSURANCE

A. Paver Installation Subcontractor Qualifications:

1. Utilize an installer having successfully completed concrete paver installation similar in design, material and extent indicated on this project.
2. Utilize an installer with job foremen holding a Record of Completion from the Interlocking Concrete Pavement Institute PICP Installer Technician Course.

B. Regulatory Requirements and Approvals: [Specify applicable licensing, bonding or other requirements of regulatory agencies.].

C. Review the manufacturers' quality control plan, paver installation subcontractor's Method Statement and Quality Control Plan with a pre-construction meeting of representatives from the manufacturer, paver installation subcontractor, general contractor, engineer and/or owner's representative.

D. Mock-Ups:

1. Install a 3 x 3 m paver area.

Note: Mechanized installations may require a larger mock-up area. Consult with the paver installation contractor on the size of the mock-up.

2. Use this area to determine surcharge of the bedding layer, joint sizes, and lines, laying pattern, color and texture of the job.
3. This area will be used as the standard by which the work will be judged.
4. Subject to acceptance by owner, mock-up may be retained as part of finished work.
5. If mock-up is not retained, remove and properly dispose of mock-up.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle.

1. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
2. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes 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 existing construction

D. Storage and Protection: Store materials in protected area such that they are kept free from mud, dirt, and other foreign materials.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not install in rain or snow.

B. Do not install frozen bedding materials.

1.07 MAINTENANCE

A. Extra materials: Provide [Specify area] [Specify percentage] additional material for use by owner for maintenance and repair.

B. Pavers shall be from the same production run as installed materials.

PART 2 PRODUCTS

Note: Some projects may include permeable and solid interlocking concrete pavements. Specify each product as required.

2.01 PAVING UNITS

A. Manufacturer: [Specify ICPI member manufacturer name.].
1. Contact: [Specify ICPI member manufacturer contact information.].

B. Permeable Interlocking Concrete Paver Units:
1. Paver Type: [Specify name of product group, family, series, etc.].
   a. Material Standard: Comply with CSA A231.2.
   b. Color [and finish]: [Specify color.] [Specify finish].
   c. Color Pigment Material Standard: Comply with ASTM C979.

Note: Concrete pavers may have spacer bars on each unit. Spacer bars are recommended for mechanically installed pavers. Manually installed pavers may be installed with or without spacer bars. Overall dimensions should not include spacer bars.

   d. Size: [Specify mm] [Specify mm)] x [Specify mm] thick.

2.02 PRODUCT SUBSTITUTIONS

A. Substitutions: Other gradations than those specified for crushed stone jointing material, base and subbase materials shall be approved in writing by the project engineer.

2.03 CRUSHED STONE FILLER, BEDDING, BASE AND SUBBASE

A. Crushed stone with 90% fractured faces, LA Abrasion < 40 per ASTM C131.

B. Do not use rounded river gravel.

C. All stone materials shall be washed with less than 2% passing the No. 200 sieve.

D. Base and subbase materials shall have a minimum 0.32 porosity per ASTM C29.

E. Joint/opening filler, bedding, base and subbase: conforming to ASTM D448 gradation as shown in Tables 1, 2 and 3 below:

Note: No. 89 or No. 9 stone may be used to fill pavers with narrow joints.

Table 1

ASTM No. 8 Grading Requirements
Bedding and Joint/Opening Filler

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

Table 2

ASTM No. 57 Base
Grading Requirements

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

Note: ASTM No. 3 or No. 4 stone may be used as subbase material if ASTM No. 2 stone is unavailable.

Table 3

ASTM No. 57
Grading Requirement for ASTM No. 2 Subbase

Sieve Size	Percent Passing
75 mm (3 in.)	100
63 mm (2 1/2 in.)	90 to 100
50 mm (2 in.)	35 to 70
37.5 mm (1 1/2 in.)	0 to 15
19 mm (3/4 in.)	0 to 5

2.04 ACCESSORIES

A. Provide accessory materials as follows:

Note: Curbs will typically be cast-in-place concrete or precast set in concrete haunches. Concrete curbs may be specified in another Section. Do not use edging with steel spikes to restrain the paving units for vehicular applications.

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

Note: See ICPI publication, Permeable Interlocking Concrete Pavements for guidance on geotextile selection per AASHTO M-288 Geotextile Specification for Highway Applications. Geotextile use is a designer option.

2. Geotextile:
   a. Material Type and Description: [Specify material type and description.].
   b. Material Standard: [Specify material standard.].
   c. Manufacturer: [Acceptable to interlocking concrete paver manufacturer]]

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. [Specify acceptable paver installation subcontractors.].

3.02 EXAMINATION

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

A. Acceptance of Site Verification of Conditions:

1. General Contractor shall inspect, accept and certify in writing to the paver installation subcontractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.

Note: Compaction of the soil subgrade is optional and should be determined by the project engineer. If the soil subgrade requires compaction, compact to a minimum of 95% standard Proctor density per ASTM C698. Compacted soil density and moisture should be checked in the field with a nuclear density gauge or other test methods for compliance to specifications. Stabilization of the soil and/or base material may be necessary with weak or continually saturated soils, or when subject to high wheel loads. Compaction will reduce the permeability of soils. If soil compaction is necessary, estimate the infiltration rate per ASTM D3385 for hydrologic design after compacting the test area(s) and measuring density. Reduced infiltration may require perforated underdrains within/ below the open-graded subbase to conform to local storm drainage requirements.

   a. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

   b. Provide written density test results for soil subgrade to the Owner, General Contractor and paver installation subcontractor.

   c. Verify location, type, and elevations of edge restraints, [concrete collars around] utility structures, and drainage pipes and inlets.

2. Do not proceed with installation of bedding and interlocking concrete pavers until subgrade soil conditions are corrected by the General Contractor or designated subcontractor.

3.03 PREPARATION

A. Verify that the soil subgrade is free from standing water.

B. Stockpile joint/opening filler, base and subbase materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

C. Edge Restraint Preparation:

1. Install edge restraints per the drawings [at the indicated elevations].

3.04 INSTALLATION

Note: The minimum slope of the soil subgrade is typically 0.5%. Actual slope of soil subgrade will depend on the drainage design and infiltration type. All underdrains, observation wells, overflow pipes, and (if applicable) geotextiles, berms, baffles and impermeable liners should be in place per the drawings prior to or during placement of the subbase and base, depending on their location. Care must be taken not to damage drainpipes during compaction and paving. Base/subbase thicknesses and drainage should be determined using ASCE 68-18, ICPI's Permeable Interlocking Concrete Pavements manual and Permeable Design Pro software.

A. General

1. Any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities shall be removed before application of the [geotextile] and subbase materials.

2. Keep area where pavement is to be constructed free from sediment during entire job. [Geotextiles] Base and bedding materials contaminated with sediment shall be removed and replaced with clean materials.

3. Do not damage drainpipes, overflow pipes, observation wells, or any inlets and otherdrainage appurtenances during installation. Report any damage immediately to the project engineer.

B. Geotextiles

1. Place on [top and] sides of soil subgrade. Secure in place to prevent wrinkling from vehicle tires and tracks.
2. Overlap a minimum of [0.3 m] in the direction of drainage.

C. Open-graded subbase and base

Note: Compaction of areas or sites that cannot accommodate a roller vibratory compactor may use a minimum 60 kN vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the subbase and base aggregates.

1. Moisten, spread and compact the No. 2 subbase in maximum 200 mm lifts [without wrinkling or folding the geotextile. Place subbase to protect geotextile from wrinkling under equipment tires and tracks.] Do not place subbase aggregate on a subgrade [or geotextile] with water ponded on it. Do not damage underdrain pipes.
2. For each lift, make at least two passes in the vibratory mode then at least two in the static mode with a minimum 8 T vibratory roller until there is no visible movement of the No. 2 stone. Do not crush aggregate with the roller
3. Use a minimum 60 kN plate compactor with a compaction indicator to compact areas that cannot be reached by the vibratory roller. Do not crush the aggregate with the plate compactor.
4. The surface tolerance of the compacted No. 2 subbase shall be ±65 mm over a 3 m straightedge.
5. Moisten, spread and compact the No. 57 base layer in one 100 mm thick lift.
   On this layer, make at least two passes in the vibratory mode then at least two in the static mode with a minimum 8 T vibratory roller until there is no visible movement of the No. 57 stone. Do not crush aggregate with the roller.
6. The surface tolerance the compacted No. 57 base should not deviate more than. ± 25 mm over a 3 m straightedge.

Note: At the option of the designer, this supplemental test method bracketed in item C6 describing the use of a lightweight deflectometer (LWD) can be used for in-situ deflection testing of the compacted base layer (typically ASTM No. 57 stone). This test method can assist contractors in reaching adequate job site compaction and offer an additional level of confidence for the project owner and designer. This test method is appropriate for pavement subject to consistent vehicular traffic such as parking lots and roads. This test protocol is not needed for pedestrian areas and residential driveways. The LWD test method should comply with ASTM E2835.

[7. Light Weight Deflectometer (LWD) for Compacted Subbase and Base Aggregate Deflection Testing

   a. After three preloading drops, the maximum average deflection from three additional drops shall be no greater than 0.5 mm.

Note: Adjust tonnage quantity based on anticipated daily tons installed and compacted.

   b. Conduct LWD tests on every [725 T] of remaining area of compacted subbase and base aggregates.

8. Test Report

   a. The test report shall include the following:

      1) Project description.
      2) Sketch of test area and numbered test locations.
      3) Aggregate type and layer thicknesses.
      4) Aggregate characteristic properties: gradation, porosity, bulk density.
      5) Compaction equipment type and weight.
      6) Static and/or vibratory compaction.

7) Number of passes of the compaction equipment.

8) Average of three deflections for each location.]

Note: If No. 8 stone is not available, No. 89 can be used as a bedding course if choke criteria in the ICPI Permeable Interlocking Concrete Pavement manual (5th edition) are met.

D. Bedding layer

1. Moisten, spread and screed the No. 8 stone bedding material. Maintain a consistent 50 mm thickness prior to compaction with the pavers.
2. Fill voids left by removed screed rails with No. 8 stone.
3. The surface tolerance of the screeded No. 8 bedding layer shall be ±10 mm over a 3 m straightedge.
4. Do not subject screeded bedding material to any pedestrian or vehicular traffic before paving unit installation begins.

E. Permeable interlocking concrete pavers and joint/opening fill material

1. Lay the paving units in the pattern(s) and joint widths shown on the drawings. Maintain straight pattern lines.
2. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to tire traffic shall be no smaller than 1/3 of a whole unit.
3. Cut pavers and place along the edges with a [double-bladed splitter or] masonry saw.
4. Fill the openings and joints with [No. 8] stone.

Note: Some paver joint widths may be narrow and not accept most of the No. 8 stone. Use joint material that will fill joints such as washed ASTM No. 89 or No. 9 stone.

5. Remove excess aggregate on the surface by sweeping pavers clean.
6. Compact and seat the pavers into the bedding material using a low-amplitude, 75-90 Hz plate compactor capable of at least 22 kN. This will require at least two passes with the plate compactor.
7. Do not compact from 2 m to the unrestrained edges of the paving units.
8. Apply additional aggregate to the openings and joints if needed, filling them completely. Remove excess aggregate by sweeping then compact the pavers. This will require at least two passes with the plate compactor.
9. All pavers more than 2 m from the laying face must be left fully compacted at the completion of each day.
10. The final surface tolerance of compacted pavers shall not deviate more than ± 10 mm under a 3 m long straightedge.
11. The surface elevation of pavers shall be 3 to 6 mm above adjacent drainage inlets, concrete collars or channels.

3.05 FIELD QUALITY CONTROL

A. After sweeping the surface clean, check final elevations for conformance to the drawings.

B. Lippage: No greater than 3 mm difference in height between adjacent pavers.

Note: The surface of the pavers may be 3 to 6 mm above the final elevations after compaction. This helps compensate for possible minor settling normal to pavements.

C. The surface elevation of pavers shall be 3 to 6 mm above adjacent drainage inlets, concrete collars or channels.

D. Bond lines for paver courses: ±15 mm over a 15 m taut string line.

E. Verify the surface infiltration of at least 2,500 mm/hour using test method C1781.

3.06 PROTECTION

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

B. PICP installation contractor shall return to site after 6 months from the completion of the work and provide the following as required: fill paver joints with stones, replace broken or cracked pavers, and re-level settled pavers to initial elevations. Any additional work shall be considered part of original bid price and with no additional compensation.

END OF SECTION

ABOUT CMHA

The Concrete Masonry & Hardscapes Association (CMHA) represents a unification of the Interlocking Concrete Pavement Institute (ICPI) and National Concrete Masonry Association (NCMA). CMHA is a trade association representing US and Canadian producers and suppliers in the concrete masonry and hardscape industry, as well as contractors of interlocking concrete pavement and segmental retaining walls. CMHA is the authority for segmental concrete products and systems, which are the best value and preferred choice for resilient pavement, structures, and living spaces. CMHA is dedicated to the advancement of these building systems through research, promotion, education, and the development of manufacturing guides, design codes and resources, testing standards, and construction practices.

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