GUIDE SPECIFICATION FOR THE CONSTRUCTION OF INTERLOCKING CONCRETE PAVEMENT

SECTION 32 14 13.13
INTERLOCKING CONCRETE PAVERS

Note: This guide specification for manually installed concrete paver applications in the U.S. and Canada. Contact CMHA for current information and guide specifications for mechanical installation. This document should be edited to fit project conditions and location. Brackets [ ] indicate text for editing. Notes are provided on the use of a compacted aggregate base under the bedding sand and pavers. Other bases can be used such as cement or asphalt-treated aggregate, concrete or asphalt, as well as other setting materials. The user should refer to Concrete Masonry & Hardscapes Association (CMHA) Details & Specifications for Interlocking Concrete Pavement at www.MasonryAndHardscapes.org for various guide specifications and detail drawings. This Section includes the term “Architect.” Edit this term as necessary to identify the design professional in the General Conditions of the Contract. Coordinate all Sections with the General Conditions as well.

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Interlocking Concrete Paver Units (manually installed).
   2. Bedding and Joint Sand.
   3. Edge Restraints.

B. Related Sections:
   1. Section: [ ]-Curbs and Drains.
   2. Section: [ ]-Aggregate Base.
   3. Section: [ ]-Cement Treated Base.
   4. Section: [ ]-Asphalt Treated Base.
   5. Section: [ ]-Pavements, Asphalt and Concrete.
   6. Section: [ ]-Roofing Materials.
   7. Section: [ ]-Geotextiles.

Note: Pavements subject to vehicles should be designed in consultation with a qualified civil engineer, in accordance with ASCE 58-10 *Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways*, CMHA Interlocking Concrete Pavement Structural Design Program software, and in accordance with the CMHA Tech Notes technical bulletins. Use the current year reference. Edit ASTM and CSA references below and throughout this Section according to project location.

Revised September 2013

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM C 33, Standard Specification for Concrete Aggregates.
   2. ASTM C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   3. ASTM C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   4. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
   5. ASTM C 936, Standard Specification for Solid Concrete Interlocking Paving Units.
   6. ASTM C 979, Pigments for Integrally Colored Concrete.
   7. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft^3 (600 kN-m/m ^{3})).
   8. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   9. ASTM D 2940, Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.

B. Canadian Standards Association (CSA):
   1. A231.2, Precast Concrete Pavers.
   2. A23.2A, Sieve Analysis of Fine and Coarse Aggregates.
   3. A23.1-FA1, Concrete Materials and Methods of Concrete Construction.
   4. A179, Mortar and Grout for Unit Masonry.

C. Concretre Masonry & Hardscapes Association (CMHA):
   1. CMHA *Tech Notes* technical bulletins.

D. American Society of Civil Engineers (ASCE)
   1. 58-10 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways

1.03 SUBMITTALS

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

B. Manufacturer's drawings and details: Indicate perimeter conditions, relationship to adjoining materials and assemblies, [expansion and control joints,] concrete paver [layout,] [patterns,] [color arrangement,] installation [and setting] details.

C. Sieve analysis per [ASTM C 136][CSA A23.2A] for grading of bedding and joint sand.

D. Concrete pavers:
   1. [Four] representative full-size samples of each paver type, thickness, color, finish that indicate the range of color variation and texture expected in the finished installation. Color(s) selected by [Architect] [Engineer] [Landscape Architect] [Owner] from manufacturer's available colors.
   2. Accepted samples become the standard of acceptance for the work.
   3. Test results from an independent testing laboratory for compliance of paving unit requirements to [ASTM C 936] [CSA A231.2].
   4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

E. Paver Installation Subcontractor:
   1. A copy of Subcontractor's current certificate from the Concrete Masonry & Hardscapoes Association Concrete Paver Installer Certification program.

Note: CMHA certifies that installers have passed an exam on installation knowledge and does not certify or guarantee the quality of installation. Job references should be carefully reviewed and verified to assist in identifying competent contractors.

   2. Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names and phone numbers.

1.04 QUALITY ASSURANCE

A. Paving 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 holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

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

C. Mock-Ups:

Note: A site visit and approval by the owner's representative during the first day of paving may substitute for a mock-up.

1. Install a 7 ft x 7 ft (2 x 2 m) paver area.
2. Use this area to determine surcharge of the bedding sand layer, joint sizes, lines, laying pattern(s), color(s) and texture of the job.
3. Evaluate the need for protective pads when compacting paving units with architectural finishes.
4. This area will be used as the standard by which the work will be judged.
5. Subject to acceptance by owner, mock-up may be retained as part of finished work.
6. If mock-up is not retained, remove and properly dispose of mock-up.

1.05 DELIVERY, STORAGE & HANDLING

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

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

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers packaging with identification labels intact.
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 packaging capable of transfer by fork lift or clamp lift.
3. Unload pavers at job site in such a manner that no damage occurs to the product.

D. Storage and Protection: Store materials protected such that they are kept free from mud, dirt, and other foreign materials. [Store concrete paver cleaners and sealers per manufacturer's instructions.]

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
1. Do not install sand or pavers during heavy rain or snowfall.
2. Do not install sand and pavers over frozen base materials.
3. Do not install frozen sand or saturated sand.
4. Do not install concrete pavers on frozen or saturated sand.

1.07 MAINTENANCE

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

PART 2 PRODUCTS

2.01 INTERLOCKING CONCRETE PAVERS

Note: In addition to ASTM or CSA conformance, ASCE 58-10 recommends a maximum 3:1 aspect ratio (length ÷ thickness) and a minimum $3^{1}/_{8}$ in. (80 mm) thickness for vehicular applications. Residential driveways should use a minimum $2^{3}/_{8}$ in. (60 mm) thick units with a maximum 4:1 aspect ratio.

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

B. Interlocking Concrete Paver Units, including the following:
1. Paver Type: [Specify name of product group, family, series, etc.].
a. Material Standard: Comply with material standards set forth in [ASTM C 936][CSA A231.2].
b. Color [and finish]: [Specify color.] [Specify finish].
c. Color Pigment Material Standard: Comply with ASTM C 979.

Note: Concrete pavers may have spacer bars on each unit. Spacer bars are recommended for mechanically installed pavers and for those in heavy vehicular traffic. Manually installed pavers may be installed with or without spacer bars. Verify with manufacturers that overall dimensions do not include spacer bars.

d. Size: [Specify.] inches [({Specify.}mm)] x [Specify.] inches [({Specify}mm)] x [Specify.] inches [({Specify.} mm)] thick.

Note: For ASTM C 936 use the following material characteristics:

e. Average Compressive Strength: 8,000 psi (55 MPa) with no individual unit under 7,200 psi (50 MPa).
f. Average Water Absorption (ASTM C 140): 5% with no unit greater than 7%.
g. Freeze/Thaw Resistance (ASTM C 1645): Resistant to 50 freeze-thaw cycles while immersed in water or a 3% saline solution (depending on conditions during service life) with no greater mass lost than 225 g/m^2 of surface area after 28 cycles, or 500 g/m2 after 49 cycles. Freeze-thaw testing requirements shall be waived for applications not exposed to freezing conditions.

Note: For CSA A231.2 use the following material characteristics:

h. Minimum average cube compressive strength of 7,250 psi (50 MPa) for laboratory cured specimens or 5,800 psi (40 MPa) for unconditioned field samples.
i. Resistance to 28 freeze-thaw cycles while immersed in a 3% saline solution with no greater mass lost than 225 g/m^2 of surface area after 28 years, or 500 g/m^2 after 49 cycles.

2.02 PRODUCT SUBSTITUTIONS

A. Interlocking concrete pavers: as specified or approved equal.

2.03 BEDDING AND JOINT SAND

A. Provide bedding and joint sand as follows:
1. Clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
2. Do not use stone dust.
3. Do not use limestone screenings or sand for the bedding that does not conform to the grading requirements of [ASTM C 33][CSA A23.1-FA1].
4. Do not use mason sand, or sand conforming to [ASTM C 144][CSA A179] for the bedding sand.

Note: If the pavement will be exposed to heavy traffic with trucks, i.e., a major thoroughfare with greater than 1.5 million 18-Kip (80 kN) equivalent single axle loads, see *CMHA Tech Note PAV-TEC-017–Bedding Sand Selection for Interlocking Concrete Pavements in Vehicular Applications* for test methods and criteria for assessing bedding sand durability. Limestone screenings will typically not meet the durability requirements outlined in *Tech Note PAV-TEC-017*. However, there are some granite materials that can meet these requirements. *Tech Note PAV-TEC-017* recommends using concrete sand as a first preference.

4. Where concrete pavers are subject to vehicular traffic, utilize sands that are as hard as practically available.

Table 1. Grading Requirements for Bedding Sand

Gradation for Bedding Sand			
ASTM C33		**CSA A23.1 FA1**	
Sieve Size	Percent Passing	Sieve Size	Percent Passing
3/8 in.(9.5 mm)	100	10.0 mm	100
No. 4 (4.75 mm)	95 to 100	5.0 mm	95 to 100
No. 8 (2.36 mm)	80 to 100	2.5 mm	80 to 100
No. 16 (1.18 mm)	50 to 85	1.25 mm	50 to 90
No. 30 (0.6 mm)	25 to 60	630 µm	25 to 65
No. 50 (0.3 mm)	5 to 30	315 µm	10 to 35
No. 100 (0.15 mm)	0 to 10	160 µm	2 to 10
No. 200 (0.075 mm)	0 to 1	80 µm	0 to 1

Note: Bedding sands should conform to ASTM C33 or CSA A23.1 FA1 gradations for concrete sand. For ASTM C33, CMHA recommends the additional limitations on the No. 200 (0.075 mm) sieve as shown. For CSA A23.1 FA1, CMHA recommends reducing the maximum passing the 80 µm sieve from 3% to 1%.

Table 2. Grading Requirements for Joint Sand

Gradation for Joint Sand			
ASTM C144		**CSA A179**	
Sieve Size	Percent Passing	Sieve Size	Percent Passing
No. 4 (4.75 mm)	100	5.0 mm	100
No. 8 (2.36 mm)	95 to 100	2.5 mm	90 to 100
No. 16 (1.18 mm)	70 to 100	1.25 mm	85 to 100
No. 30 (0.6 mm)	40 to 75	630 µm	65 to 95
No. 50 (0.3 mm)	10 to 35	315 µm	15 to 80
No. 100 (0.15 mm)	2 to 15	160 µm	0 to 35
No. 200 (0.075 mm)	0 to 5	80 µm	0 to 10

5. Sieve according to [ASTM C 136][CSA A23.2A].
6. Bedding Sand Material Requirements: Conform to the grading requirements of [ASTM C 33][CSA A23.1-FA1] with modifications as shown in Table 1.

Note: Coarser sand than that specified in Table 2 above may be used for joint sand including C 33 or A23.1 material as shown in Table 1. Use material where the largest sieve size easily enters the smallest joints. For example, if the smallest paver joints are 2 mm wide, use sand 2 mm and smaller in particle size. If C 33 or A23.1 sand is used for joint sand, extra effort may be required in sweeping material and compacting the pavers in order to completely fill the joints.

7. Joint Sand Material Requirements: Conform to the grading requirements of [ASTM C 144][CSA-A179] as shown with modifications in Table 2 or meet the requirements for bedding sand in Table 1.

Note: Specify specific components of a system, manufactured unit or type of equipment. See *CMHA Tech Note PAV-TEC-003–Edge Restraints for Interlocking Concrete Pavements* for guidance on selection and design of edge restraints.

2.04 EDGE RESTRAINTS

A. Where not otherwise retained, provide edge restraints installed around the perimeter of all interlocking concrete paving unit areas as follows:
   1. Manufacturer: [Specify manufacturer.].
   2. Material: [Plastic] [Concrete] [Aluminum] [Steel] [Pre-cast concrete] [Cut stone] [Concrete].
   3. Material Standard: [Specify material standard.].

2.05 ACCESSORIES

A. Provide accessory materials as follows:

Note: Delete article below if geotextile is not used.

1. 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] [Specify manufacturer.].

Note: Delete article below if cleaners, sealers, and/or joint sand stabilizers are not specified.

2. [Cleaners] [Sealers] [Joint sand stabilizers]
   a. Material Type and Description: [Specify material type and description.].
   b. Material Standard: [Specify material standard.].
   c. Manufacturer: [Specify manufacturer.].

PART 3 EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. [Specify acceptable paving subcontractors.].

3.02 EXAMINATION

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 recommended to at least 98% standard Proctor density per ASTM D 698 for pedestrian areas and residential driveways. Compaction to at least 98% modified Proctor density per ASTM D 1557 is recommended for areas subject to heavy vehicular traffic. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.

   a. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
   b. Verify that geotextiles, if applicable, have been placed according to drawings and specifications.

Note: Local aggregate base materials typical to those used for highway flexible pavements are recommended, or those conforming to ASTM D 2940. Compaction of aggregate is recommended to not less than 98% Proctor density in accordance with ASTM D 698 is recommended for pedestrian areas and residential driveways. Minimum 98% modified Proctor density according to ASTM D 1557 is recommended for vehicular areas. Mechanical tampers are recommended for compaction of soil subgrade and aggregate base in areas not accessible to large compaction equipment. Such areas can include that around lamp standards, utility structures, building edges, curbs, tree wells and other protrusions.

Note: Prior to screeding the bedding sand, the recommended base surface tolerance should be ± $^{3}/_{8}$ in. (10 mm) over a 10 ft. (3 m) straight edge. See *CMHA Tech Note PAV-TEC-002–Construction of Interlocking Concrete Pavements* for further guidance on construction practices.

Note: The elevations and surface tolerance of the base determine the final surface elevations of concrete pavers. The paver installation contractor cannot correct deficiencies in the base surface with additional bedding sand or by other means. Therefore, the surface elevations of the base should be checked and accepted by the General Contractor or designated party, with written certification to the paving subcontractor, prior to placing bedding sand and concrete pavers.

   c. Verify that [Aggregate] [Cement-treated] [Asphalt-treated] [Concrete] [Asphalt] base materials, thickness, [compacted density], surface tolerances and elevations conform to specified requirements.
   d. Provide written density test results for soil subgrade, [aggregate] [cement-treated][asphalt-treated][asphalt] base materials to the Owner, General Contractor and paver installation subcontractor.
   e. Verify location, type, and elevations of edge restraints, [concrete collars around] utility structures, and drainage inlets.
   2. Do not proceed with installation of bedding sand and interlocking concrete pavers until [subgrade soil and] base conditions are corrected by the General Contractor or designated subcontractor.

3.03 PREPARATION

A. Verify base is dry, certified by General Contractor as meeting material, installation and grade specifications.

B. Verify that base [and geotextile] is ready to support sand, [edge restraints,] and, pavers and imposed loads.

C. Edge Restraint Preparation:
   1. Install edge restraints per the drawings [and manufacturer's recommendations] [at the indicated elevations].

Note: Retain the following two subparagraphs if specifying edge restraints that are staked into the base with spikes.

2. Mount directly to finished base. Do not install on bedding sand.
3. The minimum distance from the outside edge of the base to the spikes shall be equal to the thickness of the base.

3.04 INSTALLATION

A. Spread bedding sand evenly over the base course and screed to a nominal 1 in. (25 mm) thickness. Spread bedding sand evenly over the base course and screed rails, using the rails and/or edge restraints to produce a nominal 1 in. (25 mm) thickness, allowing for specified variation in the base surface.
   1. Do not disturb screeded sand.
   2. Screeded area shall not substantially exceed that which is covered by pavers in one day.
   3. Do not use bedding sand to fill depressions in the base surface.

Note: When initially placed on the bedding sand, manually installed pavers often touch each other, or their spacer bars if present. Joint widths and lines (bond lines) are straightened and aligned to specifications with pry bars as paving proceeds.

B. Lay pavers in pattern(s) shown on drawings. Make horizontal adjustments to laid pavers as required.

Note: Contact manufacturer of interlocking concrete paver units for recommended joint widths.

C. Provide joints between pavers between [1/16 in. and 3/16 in. (2 and 5 mm)] wide. No more than 5% of the joints shall exceed 1/4 in. (6 mm) wide to achieve straight bond lines.

D. Joint (bond) lines shall not deviate more than ± 1/2 in. (15 mm) over 50 ft. (15 m) from string lines.

E. Fill gaps at the edges of the paved area with cut pavers or edge units.

F. Cut pavers to be placed along the edge with a [double blade paver splitter or] masonry saw.

Note. Specify requirements for edge treatment in paragraph below.

G. [Adjust bond pattern at pavement edges such that cutting of edge pavers is minimized. All cut pavers exposed to vehicular tires shall be no smaller than one-third of a whole paver.] [Cut pavers at edges as indicated on the drawings.]

H. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and joint sand.

I. Use a low-amplitude plate compactor capable of at least minimum of 5,000 lbf (22 kN) at a frequency of 75 to 100 Hhz to vibrate the pavers into the sand. Remove any cracked or damaged pavers and replace with new units.

J. Simultaneously spread, sweep and compact dry joint sand into joints continuously until full. This will require at least 4 passes with a plate compactor. Do not compact within 6 ft (2 m) of unrestrained edges of paving units.

K. All work within 6 ft. (2 m) of the laying face must be left fully compacted with sand-filled joints at the end of each day or compacted upon acceptance of the work. Cover the laying face or any incomplete areas with plastic sheets overnight if not closed with cut and compacted pavers with joint sand to prevent exposed bedding sand from becoming saturated from rainfall.

L. Remove excess sand from surface when installation is complete.

Note: Excess joint sand can remain on surface of pavers to aid in protecting their surface especially when additional construction occurs after their installation. If this is the case, delete the article above and use the article below. Designate person responsible for directing timing of removal of excess joint sand.

M. Allow excess joint sand to remain on surface to protect pavers from damage from other trades. Remove excess sand when directed by [Architect].

N. Surface shall be broom clean after removal of excess joint sand.

3.05 FIELD QUALITY CONTROL

A. The final surface tolerance from grade elevations shall not deviate more than ± 3/8 in. (10 mm) over 10 ft (3 m). Use a straightedge, flexible straightedge or transit depending on surface slope and contours.

B. Check final surface elevations for conformance to drawings.

Note: For installations on a compacted aggregate base and soil subgrade, the top surface of the pavers may be 1/8 to 1/4 in. (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 1/8 in. to 3/8 in. (3 to 10 mm) above adjacent drainage inlets, concrete collars or channels.

Note: For pedestrian access routes maximum elevation should not exceed 1/4 in. (6 mm).

D. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

Note: Cleaning and sealing may be required for some applications. See *CMHA Tech Note PAV-TEC-005–Cleaning and Sealing Interlocking Concrete Pavements* for guidance on when to clean and seal the paver surface, and when to stabilize joint sand. Delete article below if cleaners, sealers and or joint sand stabilizers are not applied.

3.06 [CLEANING] [SEALING] [JOINT SAND STABILIZATION]

A. [Clean] [Seal] [Apply joint sand stabilization materials to concrete pavers in accordance with the manufacturer's written recommendations.]

3.07 PROTECTION

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

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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