SECTION 32 14 13
INTERLOCKING CONCRETE PAVERS
(1995 MasterFormat Section 02780)

Note: This guide specification for concrete paver applications in the U.S. for concrete pavers and bedding sand over a compacted aggregate base for pedestrian and vehicular applications. The text must be edited to suit specific project requirements. This Section includes the term "Architect." Edit this term as necessary to identify the design professional in the General Conditions of the Contract.

PART 1 GENERAL

1.01 SUMMARY
- A. Section Includes:
  1. Interlocking Concrete Paver Units (manually installed).
  2. Bedding and Joint Sand.
  3. Edge Restraints.
  4. {Cleaner, Sealers, and Joint sand stabilizers].
- 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 58-16 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways*, ICPI Structural Design software, and in accordance with ICPI Tech Spec technical bulletins. See ICPI Tech Specs 11 and 15 for guidance on specifying machine installed bedding materials and concrete pavers.*

Note: Use the current year reference.

1.02 REFERENCES
- A. American Society for Testing and Materials (ASTM):
  1. C33, Standard Specification for Concrete Aggregates.
  2. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  3. C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
  4. C144, Standard Specification for Aggregate for Masonry Mortar.
  5. C936, Standard Specification for Solid Concrete Interlocking Paving Units.
  6. C979, Standard Specification for Pigments for Integrally Colored Concrete.
  7. C1645, Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units.
  8. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft^3 (600 kN-m/m^3)).
  9. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
  10. D2940, Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
- B. Interlocking Concrete Pavement Institute (ICPI):
  1. ICPI Tech Spec Technical Bulletins
- C. American Society of Civil Engineers (ASCE)
  1. ASCE 58-16 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways
- [D. US Green Building Council (USGBC)

1. Leadership in Energy and Environmental Design (LEED) version 4.]

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 C136 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 concrete pavers with ASTM C936.
4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

[5. LEED v4 submittals according to the following credits:

a. Sustainable Sites: Solar reflectance per ASTM C1549 for non-roof surfaces.
b. Sustainable Sites: Solar reflective index per ASTM E1980 for roof surfaces.
c.. Materials and Resources: Manufacturer's Environmental Product Declaration.
d. Materials and Resources: Sourcing of Raw Materials – Raw Material Source and Extraction Reporting or Leadership Extraction Practices.
e. Materials and Resources: Material Ingredients – Material Ingredient Reporting or Optimization, or Product Manufacturer Supply Chain Optimization.]

E. Paver Installation Subcontractor:

1. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute Certified Concrete Paver Installer program.

Note: ICPI certifies that installers have passed an exam on installation knowledge, and requires verification of minimum installation experience as well as continuing education. ICPI does not certify or guarantee the quality of installation. Job references and past projects 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, postal address, phone, fax, and email address.

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 Certified Concrete Paver Installer program.

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

C. Mock-Ups:

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. 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 & 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 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 forklift 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. Cover bedding sand and joint sand with waterproof covering if needed to prevent exposure to rainfall or removal by wind. Secure the covering in place.

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

PART 2 PRODUCTS

2.01 INTERLOCKING CONCRETE PAVERS

Note: In addition to ASTM conformance, ASCE 58-16 and ICPI recommend a maximum 3:1 aspect ratio (length ÷ thickness) and a minimum 3 1/8 in. (80 mm) thickness for vehicular applications. Residential driveways hould use a minimum 2 3/8 in. (60 mm) thick units with a maximum 4:1 aspect ratio.

A. Manufacturer: [Specify ICPI member manufacturer name.].
   1. Contact: [Specify ICPI member manufacturer contact information.].
B. Interlocking Concrete Pavers:
   1. Paver Type: [Specify name of product group, family, series, etc.].
      a. Material Standard: Comply with material standards in ASTM C936.
      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 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.
e. Average Compressive Strength (C140): 8000 psi (55 MPa) with no individual unit under 7200 psi (50 MPa) per ASTM C140.
f. Average Water Absorption (ASTM C140): 5% with no unit greater than 7%.
g. Freeze/Thaw Resistance (ASTM C1645): 28 freeze-thaw cycles with no greater loss than 225 g/m^2 of paver surface area or no greater loss than 500 g/m^2 of paver surface area after 49 freeze-thaw cycles. Use the lowest freezing temperature in C1645 per the Appendix and zone map in C936. Freeze-thaw testing requirements shall be waived for applications not exposed to freezing conditions.

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. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
2. Do not use limestone screenings, stone dust, or sand for the bedding sand material that does not conform to conform to the grading requirements of ASTM C33.
3. Do not use mason sand or sand conforming to ASTM C144 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 ICPI Tech Spec 17 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 Spec 17. However, there are some granite materials that meet these requirements. Tech Spec 17 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.
5. Sieve according to ASTM C136.
6. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 1.

Table 1
Grading Requirements for Bedding Sand
ASTM C33

Sieve Size	Percent Passing
3/8 in.(9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	80 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	5 to 30
No. 100 (0.150 mm)	0 to 10
No. 200 (0.075 mm)	0 to 1

Note: Bedding sands should conform to ASTM C33 gradations for concrete sand. ICPI recommends the additional limitations on the No. 200 (0.075 mm) sieve as shown.

7. Joint Sand Material Requirements: Conform to the grading requirements of ASTM C 144 as shown with modifications in Table 2 below:

Table 2
Grading Requirements for Joint Sand

Sieve Size	ASTM C144 Natural Sand Percent Passing	ASTM C144 Manufactured Sand Percent Passing
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 to 100	95 to 100
No. 16 (1.18 mm)	70 to 100	70 to 100
No. 30 (0.600 mm)	40 to 75	40 to 100
No. 50 (0.300 mm)	10 to 35	20 to 40
No. 100 (0.150 mm)	2 to 15	10 to 25
No. 200 (0.075 mm)	0 to 1	0 to 5

Note: Coarser sand than that specified in Table 2 may be used for joint sand including C33 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 C33 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.

2.04 EDGE RESTRAINTS

Note: Specify specific components of a system, manufactured unit or type of equipment. See ICPI Tech Spec 3, Edge Restraints for Interlocking Concrete Pavements *for guidance on selection and design of edge restraints.*

A. 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:
   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

Note: Compaction of the soil subgrade is recommended to at least 98% standard Proctor density per ASTM D698 for pedestrian areas and residential driveways. Compaction to at least 98% modified Proctor density per ASTM D1557 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.

Note: Local aggregate base materials typical to those used for highway flexible pavements are recommended, or those conforming to ASTM D2940. Compaction of aggregate is recommended to not less than 98% Proctor density in accordance with ASTM D698 is recommended for pedestrian areas and residential driveways. 98% modified Proctor density according to ASTM D1557 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 ICPI Tech Spec 2, 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.

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.
      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.
      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, not exceeding 1½ in. (40 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 rubber hammers and pry bars as paving proceeds.

B. Lay pavers in pattern(s) shown on drawings. Place units hand tight without using hammers. Make horizontal adjustments to placement of laid pavers with rubber hammers and pry bars 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 Hz 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 requires 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 shall 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) under a 10 ft (3 m) straightedge.
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 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

Note: For pedestrian access routes maximum elevation should not exceed ¼ 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 ICPI Tech Spec 5, 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 between] 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