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PAVERS ON AGGREGATE BASE WITH LEED SUBMITTALS

SECTION 32 14 13

*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. This version is similar to the CMHA guide spec, US-pavers on agg base. doc and adds submittals that comply with LEED v4.1 for new construction (NC). The list of LEED submittals in Part 1.03, D6 may be used in other CMHA guide specifications. This Section includes the term "Architect." Edit this 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. CMHA 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. 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/T&DI/ICPI 58-16 Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways, CMHA Structural Design software, and in accordance with CMHA Tech Note technical bulletins. See CMHA Tech Note PAV-TEC-011 and 015 for guidance on specifying machine installed bedding materials and concrete pavers.

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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. C1549 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 8. C1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units.
 9. D698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft³ (600 kN-m/m³)).
 10. D1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 11. D2940 Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
 12. E1980 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- B. Concrete Masonry and Hardscapes Association (CMHA) Technical Bulletins:**
1. Tech Note PAV-TEC-003 Edge Restraints for Interlocking Concrete Pavements.
 2. Tech Note PAV-TEC-005 Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement.
 3. Tech Note PAV-TEC-016 Achieving LEED Credits with Segmental Concrete Pavement.
 4. Tech Note PAV-TEC-017 Bedding Sand Selection for Interlocking Concrete Pavements in Vehicular Applications.
- C. U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design for New Construction (LEED®-NC) v4.1.**

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. Current certificates from the Concrete Masonry and Hardscapes Association Concrete Paver Installer Certification program for job foremen on the project.

6. Provide documentation complying with LEED-NC v4.1 Sustainable Sites (SS) and/or Materials & Resources (MR) Credits as follows:
 - a. SS Credit: Heat Island Effect, Nonroof – Test results according to ASTM C1549 indicating a minimum a three-year aged solar reflectance (SR) value of at least 0.28. If three-year aged value information is not available, use materials with a minimum initial SR of at least 0.33 at installation.
 - b. SS Credit: Heat Island Effect, Roof – Test results according to ASTM E1980 indicating a minimum initial solar reflectance index (SRI) according of 82 or and a 3-year aged minimum SRI of 64 for paving units on low-sloped roofs < 2:12 (< 15%). For steep-sloped roofs >2:12 (15%) the initial minimum SRI shall be 39 and the 3-year aged minimum SRI shall be 32.
 - c. MR Building Product Disclosure and Optimization—Environmental Product Declarations Credit: Product-specific Type III EPD internally or externally reviewed.
 - d. MR Building Product Disclosure and Optimization—Sourcing of Raw Materials Credit: Document products extracted, manufactured and purchased within 100 miles (160 km) of the project site; recycled content, i.e., post-consumer recycled content and pre-consumer recycled content based on weight; salvaged, refurbished, or reused materials; and/or whose manufacturers participate in an extended producer responsibility program.
 - e. MR Building Product Disclosure and Optimization—Material Ingredients Credit: Provide documentation for any of the following: material ingredient screening and optimization action plan; health product declaration (HPD); Red List free; Cradle-to-Cradle Certified v3 product with Material Health category score of Bronze, or a certified Material Health Certificate Bronze level; Material Ingredient Optimization using a manufacturer chemical inventory or HPD: a chemical inventory to at least 0.01% by weight (100 ppm) with at least 95% by weight of product assessed using the GreenScreen Benchmark assessment.
- E. Paver Installation Subcontractor:**
1. A copy of Subcontractor’s current certificate from the Concrete Masonry and Hardscapes Association Paver Installer Certification program.
 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 Concrete Masonry and Hardscapes Association 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 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 standards conformance, CMHA recommends a maximum 3:1 aspect ratio (length ÷ thickness) and a minimum 3 1/8 in. (80 mm) thickness for vehicular applications. Residential driveways and pedestrian applications can 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 Pavers:**
 - 1. Paver Type: [Specify name of product group, family, series, etc.].
 - a. Material Standard: Comply with material standards set forth 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. Manually installed pavers may be installed with or without spacer bars. Overall paver dimensions do not include spacer bars.

- d. Size: [Specify] inches [mm] x [Specify] inches [mm] x [Specify] inches [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/m² of paver surface area or no greater loss than 500 g/m² of paver surface area after 49 freeze-thaw cycles. 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 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 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 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.
- 5. Sieve according to ASTM C136.
- 6. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C33 with modifications as shown in Table 1 below.

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)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075 mm)	0 to 1

Note: Bedding sands should conform to ASTM C33 gradations for concrete sand. CMHA 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 C144 as shown with modifications in Table 2 below:

Table 2
Grading Requirements for Joint Sand

Sieve Size	ASTM C144	ASTM C144
	Natural Sand	Manufactured Sand
	Percent Passing	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 5	0 to 5

Note; ASTM C144 allows up to 10% passing the No. 200 (0.075 mm) sieve for manufactured sand. CMHA recommends reducing this to no more than 5% as a means to maintain interlock since material passing the No. 200 sieve can lubricate larger sand particles and thereby reduce interlock among paving units.

Note: Coarser sand than that specified in Table 2 above may be used for joint sand including ASTM 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 ASTM 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. CMHA Tech Note PAV-TEC-003, 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:**

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

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 $\pm 3/8$ 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.

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 consistent joints widths between [1/16 in. and 3/16 in. (2 and 5 mm)]. 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 4,000 lbf (18 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 will require at least 4 to 6 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 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. For pedestrian access routes maximum elevation should not exceed 1/4 in. (6 mm) above final elevations.

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.

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, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement 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

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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