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S-pavers on CTB.doc

SECTION 32 14 13
INTERLOCKING CONCRETE PAVEMENT ON A CEMENT TREATED BASE
(1995 MasterFormat Section 02780)

Note: This guide specification for the U.S. is for concrete pavers on a sand bed with geotextile over a cement treated base (CTB). This assembly is for vehicular applications. CTB is highly recommended for gas station, port and airport pavements. Some guidelines are provided on CTB. However, its specification, as well as excavation and preparation of soil subgrade and subgrade drainage, are generally covered in another Section.. The text must be edited to suit specific project requirements for projects. 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. Concrete paver units.
 - 2. Bedding and joint sand.
 - 3. Geotextiles.
 - 4. Edge restraints.
 - 5. [Cleaners, 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.

Note: Pavements subject to vehicles should be designed in consultation with a qualified civil engineer, in accordance with established pavement design procedures, ICPI Lockpave software, and in accordance with the ICPI Tech Spec technical bulletins. Use the current year reference.

1.02 REFERENCES

- A. American Society of Testing and Materials (ASTM):
 - 1. C 33, Specification for Concrete Aggregates.
 - 2. C 67, Method of Sampling and Testing Brick and Structural Clay Tile
 - 3. C 140, Method of Sampling and Testing Concrete Masonry Units.
 - 4. C 144, Standard Specification for Aggregate for Masonry Mortar.
 - 5. C 150, Standard Specification for Portland Cement.
 - 6. C 936, Specification for Solid Interlocking Concrete Paving Units.
 - 7. C 979, Specification for Pigments for Integrally Colored Concrete.
 - 8. D 698, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb (2.49 kg) Rammer and 12 in. (305 mm) drop.
 - 9. D 558, Standard Test Methods of Moisture-Density Relations of Soil-Cement Mixtures.
 - 10. D 1557, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (4.54 kg) Rammer and 18 in. (457 mm) drop.
 - 11. D 1633, Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
 - 12. D 2940, Graded Aggregate Material for Bases or Sub-bases for Highways or Airports.
- B. Interlocking Concrete Pavement Institute (ICPI)
 - 1. Tech Spec Technical Bulletins

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 for grading of bedding and joint sand.
- D. [Test results for sand durability.]
- 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.
 - 4. Manufacturer's certification of concrete pavers by ICPI as having met applicable ASTM standards.
 - 5. 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 Interlocking Concrete Pavement Institute Concrete 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 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:
 - 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.
 - 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. 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 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. 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 CTB.
 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 CONCRETE PAVERS

Note: Concrete pavers may have spacer bars on each unit. They are highly recommended for mechanically installed pavers. Manually installed pavers may be installed with or without spacer bars.

- 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 C 936.
 - b. Color [and finish]: [Specify color.] [Specify finish].
 - c. Color Pigment Material Standard: Comply with ASTM C 979.
 - d. Size: [Specify.] inches [({Specify.}mm)] x [Specify.] inches [({Specify.}mm)] x [Specify.] inches [({Specify.} mm)] thick.

Note: If 3 1/8 in. (80 mm) thick pavers are specified, their compressive strength test results per ASTM C 140 should be adjusted by multiplying by 1.18 to equate the results to that from 2 3/8 in. (60 mm) thick pavers.

- e. Average Compressive Strength (C 140): 8000 psi (55 MPa) with no individual unit under 7200 psi (50 MPa).
- f. Average Water Absorption (ASTM C 140): 5% with no unit greater than 7%.
- g. Freeze/Thaw Resistance (ASTM C 67): Resistant to 50 freeze/thaw cycles with no greater than 1% loss of material. Freeze-thaw testing requirements shall be waived for applications not exposed to freezing conditions.

2.02 PRODUCT SUBSTITUTIONS

- A. Substitutions: No substitutions permitted.

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 do not conform to the grading requirements of ASTM C 33.
3. Do not use mason sand or sand conforming to ASTM C 144 for the bedding sand.

Note: Bedding sand durability is important for crosswalks and other vehicular pavements exposed to high traffic. The engineer/architect is advised to evaluate the hardness of bedding sand with the following test method when the pavers and sand will be placed over concrete, or asphalt, and subject to major thoroughfare traffic (over 1.5 million ESALs): One (1) 1.4 kg (3 lbs.) sample of bedding sand can be randomly sampled from the sand source. The sample is dried for 24 hours at 115° to 121° C. (240° to 250° F.). Obtain three (3) sub-samples each weighing 0.2 kg (0.5 lbs.) by passing the main sample several times through a riffle box. Carry out a sieve analysis test on each sub-sample according to ASTM C 136. Re-mix each sub-sample and place in a nominal quart/liter capacity porcelain jar with two (2) 25 mm (1 inch) diameter steel ball bearings weighing 75 ±5 grams each. Rotate each jar at 50 rpm for six (6) hours. Repeat the sieve analysis. Record the individual and average sieve analysis. For each sample tested, the maximum increase in the percentages passing each sieve and the maximum individual percent passing should be as follows:

Sieve Size	Max. Increase	Maximum Passing
No. 200 (0.075 mm)	2%	2%
No. 100 (0.150 mm)	5%	15%
No. 50 (0.300 mm)	5%	35%

4. Where concrete pavers are subject to vehicular traffic, utilize sands that are as hard as practically available.
5. Sieve according to ASTM C 136.
7. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 1.

Table 1
ASTM C 33 Grading Requirements for Bedding Sand

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: Coarser sand than that specified in Table 2 below 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 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.

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

Table 2

Sieve Size	ASTM C 144 Grading for Joint Sand	
	Natural Sand Percent Passing	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 10

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.

2.04 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 Fabric:
 - 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: Sealer for the purposes of joint stabilization are recommended for gas station and airfield applications. 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.].

Note: CTB is typically a mixture of portland cement Type I, ASTM C 150 and crushed coarse and fine aggregate conforming to ASTM D 2940. The material should achieve a minimum compressive strength of 4.5 MPa (650 psi) at seven days per ASTM D 1633. Consult a qualified professional civil engineer for material, testing, and installation specifications for CTB.

PART 3 EXECUTION

Note: Subgrade preparation, drainage, and installation and/or rehabilitation of subbase and CTB materials may be specified under other Sections. Some minimum requirements follow and a qualified civil engineer should be consulted for guidance in developing specifications for those Sections. Soil under CTB or subbases should be free from deleterious material and compacted to a minimum of 98% Proctor density according to ASTM D 698 or modified Proctor density per ASTM D1557 for heavily loaded industrial, port and airport pavements. Stabilization of the subgrade and/or base material may be necessary with weak or

saturated subgrade soils. A minimum 4 to 6 in. (100 to 150 mm) thick compacted aggregate sub-base under CTB is sometimes used as a working platform and is recommended. Compact aggregate subbase to a minimum of 98% modified Proctor density per ASTM 1557. CTB is typically applied in 4 in. (100 mm) lifts and compacted to a minimum of 96% density per ASTM D 558. Field measurements of density of soil subgrade, subbases, and CTB should be reported in writing to the Engineer/Architect.

Note: Mechanical tampers are recommended for compaction of soil subgrade, sub-base and base around lamp standards, utility structures, building edges, curbs, tree wells and other protrusions. In areas not accessible to roller compaction equipment, compact to specified density with mechanical tampers.

3.01 ACCEPTABLE INSTALLERS

- A. [Specify acceptable paving subcontractors].

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.

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.
 - 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] 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] 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 holes and 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 clean and 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 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 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 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 $\pm 1/2$ 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

Note: Surface tolerances on flat slopes should be measured with a rigid straightedge. Tolerances on complex contoured slopes should be measured with a flexible straightedge capable of conforming to the complex curves on the pavement surface.

- A. The final surface tolerance from grade elevations shall not deviate more than $\pm 3/8$ 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.
- 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