Preparing Activity: USACE Superseding
UFGS-32 16 15 (April 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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11/19

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SECTION 32 14 13.13

INTERLOCKING PRECAST CONCRETE UNIT PAVING
11/19

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NOTE: This guide specification covers the requirements for constructing a concrete block pavement.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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PART 1 GENERAL

1.1 PAYMENT PROCEDURES

****
NOTE: Delete this paragraph in fixed price Contracts.
****

1.1.1 Pavements

Pay per square m square ft of satisfactorily installed unit pavement surface including the units, cut units, bedding sand, and jointing sand.

1.1.2 Edge Restraint

Pay per lineal m ft of satisfactorily installed edge restraint.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	(2016) Specifications for Structural Concrete
ACI 301M	(2016) Metric Specifications for Structural Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C140/C140M	(2022c) Standard Test Methods for Sampling and Testing Concrete Masonry Units and

	Related Units
ASTM C144	(2018) Standard Specification for Aggregate for Masonry Mortar
ASTM C535	(2016) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C936/C936M	(2021a) Standard Specification for Solid Concrete Interlocking Paving Units
ASTM C979/C979M	(2016) Standard Specification for Pigments for Integrally Colored Concrete
ASTM C1645/C1645M	(2022a) Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D2488	(2017; E 2018) Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D4318	(2017; E 2018) Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5821	(2013; R 2017) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D7428	(2015) Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion inthe Micro-Deval Apparatus
ASTM E11	(2022) Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the list provided, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Field-Constructed Mock-Up; G[, [_____]]

Concrete Paving Unit; G[, [_____]]

SD-06 Test Reports

Tests, Inspections and Verifications

SD-07 Certificates

Paving Unit Installer Field Supervisor; G[, [_____]]

Provide a copy of an ICPI Concrete Paver Installer School Certification, including a record of completion from a PICP or Permeable Interlocking Concrete Pavement Installer Technician Course.

1.4 DELIVERY, STORAGE AND HANDLING

Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped bundles capable of transfer by forklift or clamp lift. Unload pavers at job site in such a manner that no damage occurs to the product or to existing construction.

Stockpile jointing, bedding, base and subbase aggregates such that they do

not segregate within each pile. Keep piles (1) free from standing water, (2) free of organic material, sediment, or debris, and (3) ready for placement. Store aggregates on paved surfaces. Do not store aggregates on exposed soil or grassed areas unless first covered with geotextile to keep the aggregates clean.

1.5 QUALITY ASSURANCE

1.5.1 Concrete Paver Installer Certification

A paving unit installer field supervisor with a certificate of completion from the Interlocking Concrete Pavement Institute (ICPI) Concrete Paver Installer School Certification is required.

1.5.2 Pre-Construction Meeting

Prior to starting work, hold a pre-construction meeting with the project engineer or other Government representative responsible for the project. Determine the following:

a. Delivery and storage locations for aggregates and concrete paving unit bundles;

b. Anticipated start date;

c. Starting point(s) and direction(s) of paving;

d. Methods for checking slopes and surface tolerances for smoothness and elevations;

e. Estimated daily production for installation of aggregates, edge restraints and paving units; and

f. Recording and reporting actual daily paving production, including identifying the site location and recording the number of bundles installed each day.

For machine assisted installation of paving units, review:

a. Concrete unit manufacturer's written method that explains processes for controlling paver dimensional tolerances, and

b. Diagram(s) of the concrete paver laying pattern and how the paver layers or clusters join together to provide a continuous pattern across the pavement surface.

1.5.3 Weather Requirements

Do not install paver units during rain or snow events or when jointing sand, bedding sand, base or subbase aggregates are frozen. Do not place base or subbase aggregates on frozen soil subgrades.

****

NOTE: Mechanized installations may require a larger field-constructed mock-up area.

****

1.5.4 Field-Constructed Mock-Up

Install paver units on a minimum 3 x 3 m 10 x 10 ft area to determine surcharge of the bedding layer, joint sizes, and lines, laying pattern, color and texture of the job. Use this area as the standard by which the work is judged. Subject to acceptance by Contracting Officer or project engineer, allow the mock-up to be retained as part of finished work. If mock-up is not retained, remove mock-up from the installation boundary and properly dispose of material.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Bedding and Jointing Sand

Use two separate sand gradations for the bedding layer and for the paver unit joints.

Prepare bedding sand and gradation in accordance with:

a. ASTM C33/C33M with a maximum amount passing the 0.075 mm No. 200 sieve of 1 percent.

b. A maximum loss of 8 percent in accordance with ASTM D7428 and a maximum loss of 7 percent in accordance with ASTM C88.

c. A minimum of 60 percent combined sub-angular and sub-rounded particle shapes in accordance with ASTM D2488

Prepare jointing sand gradtion in accordance with:

a. ASTM C144 with a maximum of 100 percent passing the 1.18 mm No. 16 sieve and no more than 5 percent passing the 0.075 mm No. 200 sieve.

Prepare bedding and jointing sand in accordance with:

a. Material consisting of crushed sand, natural sand, or a combination of crushed and natural sand.

b. A minimum L.A. Abrasion of 40 percent when tested in accordance with ASTM C131/C131M and ASTM C535.

c. A minimum of 90 percent fractured faces in accordance with ASTM D5821.

d. Nonplastic when tested in accordance with ASTM D4318 and free of lumps, clay, vegetation, soft particles, sulphates, and other contaminants.

e. The following gradations, determined in accordance with ASTM C136/C136M and ASTM C117, using ASTM E11 sieve.

Sieve, mm (ASTM E11)	Percent Passing	
	Bedding Sand	Jointing Sand
9.5 3/8 in	100	-
4.75 No. 4	95-100	100
2.36 No. 8	80-100	95-100
1.18 No. 16	50-85	70-100
0.600 No. 30	25-60	40-75
0.300 No. 50	5-30	10-35
0.150 No. 100	0-10	2-15
0.075 No. 200	0-1	0-5

2.1.2 Concrete Paving Unit

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NOTE: Allow color of unit to be specified. Check local availability of specific colors before specifying. Do not permit organic pigments to be used since they are unstable in the alkaline concrete environment and subject to weathering.
****

Submit a sample of five paving units prior to the start of the work. Also, a representative sample of not less than 15 units as directed by the Contracting Officer, from each lot of 20,000 concrete paving units or fraction thereof. Use concrete paving units that are in accordance with ASTM C936/C936M and [_____] thick, [_____] in color, and [_____] in shape. Use units with a pigmentation in accordance with ASTM C979/C979M.

2.1.3 Edge Restraints

2.1.3.1 Precast Concrete

****
NOTE: Minimum compressive strength of precast concrete at 28 days is 21 MPa 3,000 psi unless analysis requires some other value. Entrained air content of the fresh concrete is 6 percent plus or minus 1.5 percent in areas where freezing and thawing coverage is a design consideration. Delete this paragraph when this option is not retained.
****

Use the edge restraints made of precast Portland cement concrete elements with the dimensions shown on the plans. Use precast concrete having a compressive strength of not less than [_____] at 28 days and an entrained air content of not less than [_____].

2.1.3.2 Cast-in-Place Concrete

****

NOTE: Minimum compressive strength of cast-in-place concrete at 28 days is 21 MPa 3,000 psi unless analysis requires some other value. Entrained air content of the fresh concrete is 6 percent plus or minus 1.5 percent in areas where freezing and thawing coverage is a design consideration. Delete this paragraph when this option is not retained.

****

Place edge restraints using Portland cement concrete with the dimensions shown in the plans. Use concrete in conformance with the requirements of ACI 301MACI 301, except that it has a compressive strength of not less than [_____] at 28 days and an entrained air content of not less than [_____].

2.2 TESTS, INSPECTIONS AND VERIFICATIONS

Submit a written report within seven (7) calendar days after completion of the work, covering the following testing which is required for each lot.

2.2.1 Paving Unit

****

NOTE: Require sampling of paving units prior to the start of the work for the purposes of verifying the color and shape of the units only when these considerations are critical to the project aesthetics. For jobs of less than 1000 square m 10,000 square ft or for pavements not to be exposed to vehicular traffic, allow a manufacturer's certificate which certifies that the paving units meet the requirements of ASTM C936/C936M to be accepted in lieu of sampling and testing the units of each lot.

****

Conduct the tests prescribed by ASTM C936/C936M and the following tests on the remaining units of each sample from each lot.

2.2.1.1 Freezing and Thawing

****

NOTE: Allow the freezing and thawing test to be waived for climates not subject to freezing and thawing. For jobs of less than 1000 square m 10,000 square ft, allow a manufacturer's certificate which certifies that the paving units meet the requirements of this paragraph to be accepted in lieu of sampling and testing the units of each lot.

****

Determine the resistance to freezing and thawing in accordance with ASTM C1645/C1645M and check that the results meet the freeze-thaw requirements stated in ASTM C936/C936M.

2.2.1.2 Dimensional Tolerance

Sample and measure three paving units from each lot in accordance with ASTM C140/C140M. Do not permit the length and width of each unit in the sample to vary from other units in this or other lot samples by more than 1.6 mm 1/16 in. Do not permit the thickness of the unit in the sample to vary by more than 3.2 mm 1/8 in from the specified unit thickness.

2.2.1.3 Compressive Strength

Test three paving units in accordance with ASTM C140/C140M. Do not permit the average minimum compressive strength to be less than 55 MPa 8,000 psi with no individual unit less than 50 MPa 7,200 psi.

2.2.1.4 Retest

Notify the Contracting Officer if units fail to meet the specified requirements. In case the shipment fails the specified requirements, take another sample and new specimens selected from the retained lot for retesting, as directed by the Contracting Officer. Concrete paving unit retests are to be performed at the expense of the Contractor. In case the second set of specimens fails to meet the test requirements, reject the entire lot..

2.2.2 Bedding and Jointing Sand

Obtain representative samples of bedding and jointing sand in accordance with ASTM D75/D75M from each 75 cubic m 100 cubic yds of sand to be used in the project. If the sand fails to meet the gradation requirements take another sample and retest it at no cost to the Government. If this retest fails or if no second test is taken, reject the sand and remove from the job site.

PART 3 EXECUTION

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NOTE: Use a base course for the block pavement that is a dense graded or bound material to avoid loss of the sands from the bedding layer. Properly grade and level the base course. A smoothness of no more than 10 mm 3/8 in deviation from a 3 m 10 ft straight edge is needed. Check the project specification for the pavement base course to ensure these requirements are met.

****

3.1 PREPARATION

3.1.1 Edge Restraint Location

Install the edge restraint as shown in the drawings prior to placement of the units.

3.1.2 Bedding Sand Layer

Spread the bedding sand evenly over the area to be paved and screed to an uncompacted average thickness of 25 mm 1 in with a tolerance for grade and surface smoothness of plus or minus 6 mm 1/4 in. Do not use this bedding sand to fill low areas that exceed the specified tolerance for the base.

Lease the sand uncompacted and do not disturb by pedestrian or vehicle construction traffic.

3.2 UNIT PLACEMENT

****

NOTE: Place paving unit subject to vehicular traffic in herringbone pattern, and this pattern can be specified here.

****

Place the paving units by hand or machine in the indicated pattern. Start the placement of paving units from a corner or straight edge and proceed forward over the undisturbed sand bedding layer. Do not permit the joints, excluding chamfer between paving units, to be less than 2 mm 1/16 in or more than 5 mm 3/16 in in width. After seating, check that the unit surface is flush or up to 6 mm 1/4 in above the edge restraint.

3.2.1 Unfilled Gaps

Fill gaps between paving units and the edge restraint, drainage structure, or other member that cannot be filled with a whole unit with a paving unit cut to fit the gap, except do not allow slivers and the minimum size of cut unit is be [_____]. Use a hydraulic splitter, a masonry saw, or other device that accurately leaves a clean, vertical face without spalling for cutting. Do not accept a remaining gap between the unit and adjoining edge restraint, drainage structures, or other member that is greater than 6 mm 1/4 in. Cut or rearrangeadjacent units to prevent this.

3.2.2 Seating Units

Seat the units in the bedding sand by compacting them with a minimum of three passes of a vibratory plate compactor, sized as follows: [_____].

3.2.3 Jointing Sand

Sweep the jointing sand into joints and vibrate with a vibratory plate or vibratory roller compactor. Continue this process until sweeping and vibrating have filled joints with sand and further vibration cannot force additional sand into the joints. Sweep the coarser sand particles that did not enter the joints and remain on the surface and excess sand on the surface off the pavement.

3.2.4 Timing of Operations

Seating of units and placement of jointing sand can be done concurrently with unit placement. However, do not allow seating of units and placement of jointing sand within 1.5 m 5 ft of an unfinished edge of the pavement that is not supported by the edge restraint.

3.2.5 Final Rolling

****

NOTE: This paragraph can be deleted for light load pavements such as driveways or pedestrian walkways.

****

Roll the final finished paving unit surface with four passes of a vibratory or pneumatic roller with a static weight of not less than 4.5

metric tons 10,000 lbs.

3.2.6 Construction Traffic

Do not allow construction traffic on the paving unit surface until the jointing sand has been placed and vibrated into the joints and debris and excess sand have been swept off.

3.3 SMOOTHNESS AND GRADE TOLERANCES

3.3.1 Smoothness

Do not allow a portion of the finished pavement surface to deviate by more than 10 mm 3/8 in from a 3 m 10 ft long metal straightedge placed on the pavement surface.

3.3.2 Unit Height

Check that the finished unit surface is either flush or up to 6 mm 1/4 in higher than edge restraints or drainage structures.

3.3.3 Grade

Check that the finished pavement is within 12 mm 1/2 in of the planned grade shown on the plans.

3.3.4 Remedial Action

Remove paver units and sand in those area not meeting the smoothness, unit height, or grade tolerance , adjust aggregate base grade, and relay the units and sand.

3.4 CLEANUP

Sweep the entire pavement surface and remove excess sand, units and debris from the project area.

3.5 MAINTENANCE

****
NOTE: Include this paragraph only if the project has aesthetic considerations where future maintenance has to exactly match the color of the block.
****

At the completion of work provide [_____] paving units matching those used in the project. Deliver these paving units stacked on pallets to a Base location provided by the Project Engineer.

-- End of Section --