

SECTION 32 14 13 19
PERMEABLE INTERLOCKING CONCRETE UNIT PAVEMENT

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PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Permeable Articulating Concrete Block (P-ACB)
 - 2. Open-Graded Aggregate Sub-Base
 - 3. Transition and Edge Restraints
 - 4. Geosynthetics
- B. Related Sections:
 - 1. Section 31 22 00 – Grading
 - 2. Section 31 23 00 – Excavation and Fill
 - 3. Section 31 32 00 – Soil Stabilization
 - 4. Section 31 34 00 – Soil Reinforcement

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 – Standard Specification for Concrete Aggregates
 - 2. ASTM D75 – Standard Practice for Sampling Aggregates
 - 3. ASTM C136 – Standard Test Method for Sieve Analysis for Fine and Coarse Aggregate
 - 4. ASTM C140 – Methods of Sampling and Testing Concrete Masonry and Related Units
 - 5. ASTM C150 – Standard Specification for Portland Cement
 - 6. ASTM D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction
 - 7. ASTM C618 – Standard Specification for Coal Fly Ash for Use in Concrete
 - 8. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
 - 9. ASTM C1781 – Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement System
 - 10. ASTM D6684 – Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB)
- B. American Association of State Highway and Transportation Office (AASHTO)
 - H-20, HS-20, HS-25 – Highway Truck Load Rating
- C. P-ACB Manufacturers' Installation Manual
- D. P-ACB Manufacturers' Maintenance Manual

1.3 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, equipment, and incidentals required per Manufacturers' Installation Manual.
- B. The Contractor shall perform all operations in connection with the installation of the P-ACB's in accordance with the aggregates, grades, design and dimensions shown on the Contract Documents, manufacturers' installation manual and specified herein.

1.4 SUBMITTALS

- A. Refer to Section 01 33 00 – Submittal Procedures
- B. Shop Drawings: Submit design details, unit details, cross-sections and layouts as per Contract Documents to Engineer of Record (EOR).
- C. Samples:
 - 1. Natural Gray: Submit one (1) full-sized P-ACB sample.
 - 2. Color: Submit 4" x 4" samples representative of color(s) selected within this specification or noted on Contract Documents
 - 3. Minimum 3 lb. samples of proposed subbase &/or base aggregate materials.
- D. Geosynthetic: Submit product data sheet(s) and test reports for geosynthetic(s) proposed for use by EOR within this specification or on Contract Documents.
- E. Submit to the EOR manufacturers' printed installation manual, literature, layout drawings, and product specifications.
- F. Certification of Compliance
 - 1. Test Reports – Indicate compliance with requirements of Contract Documents including:
 - a. P-ACB unit compressive strength, moisture content and density on like units, tested in accordance to ASTM C140 by independent laboratory per unit requirements of ASTM D6684, Table 1.
 - b. Sieve analysis of all aggregate grades indicated in Contract Documents, sampled according to ASTM D75 and tested in accordance to ASTM C136.
 - c. Specified standard sizes of coarse aggregates shall comply with sizes given in accordance to ASTM D448, Table 1.
 - 2. Performance Compliance – Indicate compliance with requirements of Contract Documents including:
 - a. **Infiltration Performance** – Submit independent laboratory test report indicating in-place infiltration performance of: Average of three (3) tests of one thousand (1,000) inches per hour (in/hr.). Test shall be performed in accordance to ASTM C1781 or C1701 and based on an outdoor working surface with typical base material and installation.
 - b. **Structural Performance** - Design of the P-ACB shall be capable of supporting AASHTO H-20, HS-20 and HS-25 truck loading with proper subgrade and base installation. The P-ACB's shall be analyzed as unreinforced concrete arches supporting a uniform truck tire load with impact per AASHTO standards as tested by an independent laboratory.

- c. **Maintainability** – Provide maintenance study based on at least 24 months by an independent or third party representative which includes pre and post infiltration testing documentation in multiple locations in accordance with ASTM C1781 or C1701. The study shall show that after manufacturers' recommended maintenance that the original infiltration performance of the permeable system can effectively be restored to 80% +/- 10% of initial infiltration rates.

G. Substitutions

- 1. No material shall be considered as an equivalent to the P-ACB specified herein unless it meets all areas of this specification without exception.
- 2. Manufacturer's requesting to submit materials as equivalent must provide records, data, independent laboratory test results, samples, certifications, and documentation meeting all areas of this specification without exception. Any requests must be submitted to EOR 15 days prior to bid date.

1.5 SCHEDULING

- A. Contractor shall contact P-ACB manufacturer to determine necessary lead time to produce unit material order.
- B. Schedule manufacture and delivery of P-ACB's to coincide with construction schedule to prevent storage for extended periods.
- C. Approximately two (2) weeks prior to the start of the installation, a **preconstruction meeting** shall occur with representative(s) from the design team, general contractor, site contractor, installation contractor and manufacturers' representative.

1.6 DELIVERY, STORAGE AND HANDLING

- A. P-ACB individual blocks must be delivered on wooden pallets and marked accordingly.
- B. All P-ACB's shall be sound and free of defects that would interfere with proper placement or that would impair the strength of longevity of the installation.
- C. Minor cracks incidental to the usual method of manufacture; scuffing or chipping that results from customary methods of handling in shipping, delivery and placement shall not be deemed grounds for rejection.

PART 2 - PRODUCTS

2.1 MANUFACTURED PERMEABLE ARTICULATING CONCRETE BLOCK (P-ACB)

A. P-ACB

- 1. Color(s): [] [] []
- 2. Type: Closed-cell pre-manufactured individual concrete blocks with an arched storage chamber for additional stormwater runoff capacities as per shop drawings &/or Contract Documents. Blocks may be hand-placed or mechanically installed.
- 3. Physical and Performance Requirements: At the time of delivery to the work site, the units shall conform to the requirements prescribed in Table 1 below.

TABLE 1: PHYSICAL & PERFORMANCE CHARACTERISTICS

Item	Description	Values
Dimensional Tolerance	Length x Width x Height ASTM D6684 Section 5.3.2	12" x 12" x 5.65" (+/- 1/8")
Compressive Strength	ASTM D6684 / ASTM C140	Avg. of three units: 4,000 psi min. Individual units: 3,500 psi min.
Block Unit Weight		Arched Block: 45-50 lbs/sf Solid Block: 55-60 lbs/sf
Loading Capabilities	Truck Load Traffic Rating	AASHTO H-20, HS-20, HS-25
Joint Filler Between Blocks	Material Used	NONE Required
Percent Open Space		Surface: 7% Storage: 20%
Water Absorption (Max. %)		Avg. of three units: 9.1% lb/ft ³ Individual units: 11.7% lb/ft ³
Density (Min. lb/ft ³)	ASTM D6684 Table 1/ ASTM C140	Avg. of three units: 130 lb/ft ³ Individual units: 125 lb/ft ³
Storage Capacity	Above Aggregate Within Arch	0.0833 cf/block
Post-Installation, Verified Surface Infiltration Rates	ASTM C1781 Test Method	Avg. of three tests: 1,000 in/hr min.

B. Acceptable manufacturers and distribution partners:

1. **Local** – Contact PaveDrain, LLC.
2. **Manufacturer** – Contact PaveDrain, LLC.

2.2 AGGREGATE MATERIALS

A. Open-Graded Coarse Aggregate: Select coarse aggregate shall be clean material free from organic materials and angular on all sides. Select coarse aggregate shall meet the gradations that are listed in Table 1 of ASTM D448 and based on sieve analysis in accordance to ASTM C136. Recycled aggregate material is NOT allowed within the top 4-6" elevation directly contacting the bottom of the P-ACB units.

1. Base Course Aggregate: ASTM Grade #57 stone shall be used as the finish (top) 4-6" layer of stone directly underneath the P-ACB units.
2. Secondary Sub-base Aggregate: ASTM Grade #2, #3 or #4 as determined by engineer of record, thickness as indicated by cross-sections on the shop drawings &/or Contract Documents.

2.3 TRANSITION AND EDGE RETRAINTS

- A. Transition: Utilize P-ACB end block, solid block and half block shapes to make smooth transitions with curbs and other rigid surfaces as per shop drawings &/or Contract Documents.
- B. Edge Restraint: Type and dimensions shall be indicated by EOR as per shop drawings &/or Contract Documents.

2.4 GEOSYNTHETIC MATERIALS

- A. Geotextile: Mirafi RS380i (or approved equal), a high strength, high water flow, woven monofilament or multifilament geotextile as specified by EOR based on native soil properties.
- B. Geogrid: Tensar BX-1100 (or approved equal) as specified by EOR based on native soil properties.

PART 3 - EXECUTION

3.1 EXAMINATION AND INSPECTION

- A. The contractor shall verify that the subgrade has been excavated, shaped, stabilized and compacted in accordance to Sections 31 22 00, 31 23 00, 31 32 00 & 31 34 00 and conforms to the lines, grades and cross-sections shown on Contract Documents.
- B. Verify that native subgrade has been compacted to a maximum of 95% Modified Proctor in accordance to ASTM D 1557. Do not over over-compact or rut native subgrade.
- C. Immediately prior to placing the P-ACB units, the final prepared sub-base aggregate shall be inspected by the EOR and witness to a proof roll test by a fully loaded dump truck. Unsatisfactory conditions must be corrected prior to installation of the P-ACB units.

3.2 GEOSYNTHETIC INSTALLATION

- A. Geotextile: The contractor shall place Mirafi RS380i (or approved equal) woven monofilament or multifilament geotextile flat on subgrade and vertical sections of base aggregate free of wrinkles and overlapping a minimum of twelve (12) inches.
- B. Geogrid: Install Tensar BX-1100 (or approved equal) directly on top of properly prepared and leveled final aggregate base.

3.3 AGGREGATE SUB BASE INSTALLATION

- A. The thickness of the sub-base, requirement of multiple gradations of open-graded coarse aggregate and intermediate geosynthetic shall be indicated by the EOR and detailed on the Contract Documents. The minimum thickness of open-graded coarse aggregate is six (6) inches. If more than six (6) inches of base aggregate is required, only the top four to six (4-6) inches shall be ASTM Grade #57.
- B. All base aggregates shall be compacted in six to eight (6-8") inch lifts with a roller compactor and final grade level compacted with a minimum 10,000 lb. vibratory plate compactor in with at least two passes in both the perpendicular and parallel directions. Open-graded base aggregate installation shall not damage or dislodge the geotextile.
 - 1. When using multiple aggregate layers including ASTM #2, #3 or #4, the contractor shall compact a 2" layer of ASTM #57 into the ASTM #2, #3 or #4.
- C. Finished grade shall be a smooth, plane surface with no sign of movement and conform to the lines, grades and cross-sections shown on Contract Documents.

3.4 PERMEABLE ARTICULATING CONCRETE BLOCK INSTALLATION

A. Refer to: P-ACB Manufactures' Installation Manual (latest edition)

B. HAND OR MECHANICAL PLACING P-ACB UNITS

1. The contractor shall determine the best starting point of the P-ACB unit installation to conform to the lines, grades and elevations shown on the Contract Documents.
2. Place P-ACB units tight together in running bond pattern such that one unit is directly in contact with one half of the two adjacent units. Place units in such a manner as to ensure that the pattern remains square to curbs, transitions or adjacent pavements.
3. Verify that each P-ACB unit makes contact with the geogrid or open-graded aggregate sub-base and is tightly engaged with adjacent units.
4. When necessary, make partial units from saw cutting solid, arch-less P-ACB units. Transitions against curbs and other rigid pavements should be made with maximum one-half (1/2) inch gaps utilizing solid, end and half P-ACB units.

C. ADJUSTMENTS

1. Minor adjustments to properly engage P-ACB units shall be made with a dead blow hammer or rubber mallet.
2. Once all P-ACB units have been installed, minor differential heights between units can be corrected with a small non-vibratory single or double barrel roller compactor or vibratory plate compactor. When using plate compactor, protect units with nonwoven geotextile or mat to eliminate scuffing.
3. Inspect completed installation and replace any cracked or damaged units.

3.5 TOLERANCES

- A. No individual P-ACB unit shall protrude more than one-quarter (1/4) inch within the plane of final placed units/mats.
- B. No gap between the individual P-ACB units shall exceed one-half (1/2) inch.

3.6 FINISHING

- A. The joints between the P-ACB units **DO NOT** require backfilling with smaller aggregate joint material or sand in order to function properly. **The joints are designed to be left open; this includes following maintenance of the P-ACB system.**

3.7 POST INSTALLATION CERTIFICATION

- A. Upon completion of the P-ACB installation, the surface infiltration rate of the permeable pavement area shall be verified in accordance with ASTM C1781 or C1701 to confirm the required infiltration rate as per Table 1 in this specification.
- B. If the system fails to perform as required in Table 1 of this specification, it shall be removed and replaced at the supplier's expense.
- C. The expenses associated with this post installation infiltration verification are included in

the cost of the permeable system and provided by the supplier.

3.8 INSPECTION AND MAINTENANCE OF P-ACB SYSTEM

- A. Refer to: P-ACB Maintenance Manual (latest edition)
- B. Maintenance shall be required when either of the following two conditions are met:
 - 1. The surface infiltration rates of more than 75% of the total permeable surface falls below 10% of the rate required in Table 1.
 - 2. Surface ponding remains for 24 hours in an area greater than 10 square feet of the permeable surface.

END OF SECTION 32 14 13 19