

## SECTION 32 12 43 – FLEXI-PAVE, POROUS FLEXIBLE PAVEMENT (Rev. 10/17)

### PART 1 - GENERAL .

#### 1.1 SUMMARY

- A. This specification provides requirements for the construction of Flexi-Pave, porous flexible pavement. Flexi-Pave is highly porous, insulating, flexible paving material that is used as a Tree Preservation and Stormwater Mitigation tool in a variety of applications including sidewalks, trails, tree surrounds, potholes, green roofs, driveways, parking spots, diffusion strip drains, courtyards, wooden bridge overlays, inlet protection, playgrounds, splashparks, pool decks, etc.
- B. In case the requirements of this specification conflict with the contract documents, this document shall govern.

#### 1.2 RELATED SECTIONS

- 1. Subgrade preparation under Section 31 20 00 Earth Moving (02200 – Earthwork).
- 2. Utilities and subsurface drainage under Section 33 40 00 Storm Drainage Utilities (02700 – Subsurface Drainage and Structures), as needed.

#### 1.3 DEFINITIONS

- A. ISA Certified Arborist: An individual certified by the International Society of Arboriculture who has been trained through education and experience to be knowledgeable in tree care, tree preservation and construction around trees.
- B. Exposure Condition, Moderate: Exposure to a climate where the paving will not be in a saturated condition when exposed to freezing and will not be exposed to deicing agents or other aggressive chemicals.
- C. Exposure Condition, Severe: Exposure to deicing chemicals or other aggressive agents or where the paving can become saturated by continual contact with moisture or free water before freezing.
- D. Base Reinforcement: The use of a geosynthetic within the aggregate base course to enhance the performance of a paving
- E. Geogrid: Biaxial or triaxial woven polypropylene material for base course reinforcement and confinement, and subgrade stabilization and increased subgrade load capacity
- F. Panel: An individual paving slab bordered by joints or slab edges.
- G. Porous/Pervious/Permeable Paving: A paving comprising material with sufficient continuous voids to allow water to pass from the surface to the underlying layers.

- H. Porous/Pervious/Permeable: The property of a material which permits movement of water through it under ordinary hydrostatic pressure.
- I. Porous Flexible Paving: Paving system comprised of 3 principle components: recycled passenger car tire rubber granules, aggregate, and urethane binder that provides a strong, pervious, flexible pavement.
- J. Subbase: A layer in a paving system between the subgrade and the base course, or between the subgrade and a porous flexible paving.
- K. Subgrade: The soil prepared and compacted to support a structure or paving system.

#### 1.4 PERFORMANCE BASED TEST STANDARDS

- A. Porous Flexible Paving used on this project must meet the following minimum standard performance results:
  - 1. Freeze/Thaw Testing
    - a. ASTM C 666/C 666M-03, Standard Test Method for Resistance of Concrete to Freezing and Thawing, Procedure A - freezing and Thawing in Water. Samples shall indicate only minimal mass change and no deformation or destruction results after 300 nominal freeze-thaw cycles. Visual examination of the test specimens shall also indicate no cracks or breaks.
    - b. D 3385-03 Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
    - c. D 3665-06 Standard Practice for Random Sampling of Construction Materials
    - d. E 329-06a Specifications for Agencies Engaged in Construction Inspection and/or Testing.
  - 2. Initial Scuff / Power Steering Resistance
    - a. ISSA TB 100, Wet Track Abrasion @ 25° C. Pavement shall maintain 4.6 g/ft<sup>2</sup> @ 1 hour, 8.6 g/ft<sup>2</sup> @ 6 days.
    - b. ISSA TB 139 cohesion measurement @ 25° C. Pavement shall maintain 15 kg-cm (solid spin)<sup>2</sup>.
    - c. Accelerated Weathering @ 500 hours with Xenon Arc Cycle A, ISSA TB 100, Wet Track Abrasion @ 25° C. Pavement shall maintain 16.5 g/ft<sup>2</sup> @ 1 hour and 17.7 g/ft<sup>2</sup> @ 6 days.
  - 3. Permeability
    - a. FL DOT FM 5-565 @ 25° C. Pavement shall maintain 1.8x10<sup>-1</sup> cm/sec.
    - b. FL DOT FM 5-565 @ field sample. Pavement shall maintain 1.1 x 10<sup>1</sup> cm/sec.
  - 4. Flexibility
    - a. PRI TM 025 @ 4" w X 2" t X 36" beams @ 25° C. Pavement shall maintain 2 mm average maximum deflection at center of beams with not cracks after 16 days and with no permanent deformation
  - 5. Hamburg Loaded Wheel Tester
    - a. TX DOT 242-F @ 60° C to 8000 cycles or 0.5" rut depth, whichever occurs first. Pavement shall maintain a 2.3 mm rut depth at 8000 cycles measured at end of test and pavement shall fully recover after 24 hours.
  - 6. Static Creep
    - a. TX DOT 231-F @ 60° C. Pavement shall maintain a total strain of +2.703% and permanent strain of 0.514%
  - 7. Resilient Modulus

- a. ASTM D 4123 @ 25° C. Pavement shall maintain a value of 68,495.
- 8. Slip Resistance
  - a. ASTM D 2047 @ 25° C, dry. Pavement shall maintain a value of 0.65.

## 1.5 QUALITY ASSURANCE

### A. Installer Qualifications:

- 1. The technical requirements and short working time of moisture-cured polyurethane based porous flexible pavements dictate higher than normal investment from installers to master the material handling and installation techniques necessary to successfully use and install this material. Therefore, installers must be certified, experienced and show proven competency through the following criteria. Installers must:
  - a. Possess Porous Flexible Paving manufacturer's certification.
  - b. Employ at least one (1) full time employee who is an ISA Certified Arborist with at least 10 years experience to oversee construction around trees.
  - c. Possess a minimum of 5 years continual experience installing Porous Flexible Pavement.
  - d. Offer a minimum 5-year warranty.
  - e. Offer a minimum of 70 colors of Porous Flexible Pavement.
  - f. Exhibit proof that porous flexible pavement is the installer's primary business, and not ancillary to other services.
  - g. Maintain no less than two (2) local full-time dedicated Porous Flexible Paving crews with minimum four (4) workers per crew who directly perform each installation of Porous Flexible Paving and it's associated stone base preparation. General contractors, other subcontractors, landscaping crews, concrete & asphalt crews, first-time installers and out-of-town or traveling installation crews are not acceptable. The requirement for dedicated porous flexible paving crews demonstrates a commitment to the special time constraints, material handling techniques, and installation proficiencies needed for this specialty paving material.
  - h. Have installed a minimum documented 40,000 square feet of Porous Flexible Paving in the greater Washington DC area within the preceding 12 consecutive months.
  - i. Demonstrate quality workmanship and properly installed jobs based on the following criteria. Finished porous flexible pavement must:
    - 1) Have a smooth, monolithic and consistently uniform paving surface
    - 2) Be composed of three (3) ingredients with the following weight distribution: 46% ¼" crumb rubber, 46% 3/8" clean crushed aggregate and 8% single component moisture cured elastomeric polyurethane binder.
    - 3) Be ADA compliant to not exceed 2% side slopes & 5% running slopes
    - 4) Have consistently formed 45 degree beveled edges
    - 5) Have properly level, blended and finished cold seams between pours
    - 6) Be free from visible bull-float and hand trowel finishing marks
    - 7) Exhibit consistently parallel edges
    - 8) Interface with adjacent materials in a seamless manner
    - 9) Not possess significant visible surface variations, rough patches or sloughing

### B. Installer Submittals:

- a. Provide manufacturers certification of training.

- b. Provide resume and copy of certificate for at least one (1) ISA Certified Arborist on staff
- c. Provide proof of having minimum of 5 years of continual experience installing Porous Flexible pavement
- d. Provide a copy of minimum 5-year warranty certificate.
- e. Provide this project's proposed Mix Design.
- f. Provide PDF showing installer's 70 readily available pavement color choices.
- g. Provide physical sample board containing at least 70 physical color samples.
- h. Provide proof that Porous Flexible Pavement is installer's primary business.
- i. Provide names and titles of eight (8) full time dedicated porous flexible paving crew members
- j. Provide documentation of having installed at least 40,000 square feet of porous flexible paving in the Greater Washington DC area within the preceding 12 consecutive months.
- k. Provide a list of 10 successfully installed Porous Flexible Paving projects of equal or greater size to this project, within the Greater Washington DC area so that quality workmanship can be verified. Include in the list the following information for each project:
  - 1) Jobsite Name
  - 2) Jobsite Address
  - 3) Installation Date
  - 4) Product used & mix design
  - 5) Square footage
  - 6) Color
  - 7) Owner name, email & phone number
  - 8) Project Photographs
  - 9) Project cost
- l. Provide a pour stop plan showing planned construction joints and specify expansion joint materials.

## 1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for pedestrian traffic around the work area and prevent pedestrian & vehicular access into the paving area for 24 hours after paving completion.
- B. Schedule pavement placements to minimize exposure to wind and heat before curing materials are applied.
- C. Avoid placing porous paving if rain, snow, or frost is forecast within 24 hours unless measures are taken as described later. Always protect fresh paving from moisture and freezing.
- D. Maintain polyurethane binder temperatures above 45 degrees Fahrenheit at all times up to point of installation.
- E. Protect under roof all rubber and stone components to ensure that they remain free from all forms of moisture prior to mixing with urethane.
- F. Certain equipment is forbidden from operating on Flexi-Pave and will void the warranty. This includes forklifts, backhoes, excavators, bucket trucks, material handlers, skid steers, tracked steers, wheeled loaders, scissor lifts, man lifts, booms, truck outriggers, cranes, dumpsters, roll

or containers, tracked vehicles, zero turn radius equipment, any solid tire machine and any off road tire machine or vehicle.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURER

Capitol Flexi-Pave, LLC  
39024 E Colonial Hwy  
Hamilton, VA 20158  
Ph: 202.760.1099  
Fx: 571.312.9208  
Email: sales@capitolflexipave.com  
Website: www.capitolflexipave.com

### 2.2 SITE PREP

- A. Existing hard surfaces such as concrete, brick or asphalt in the area to receive Porous Flexible Paving shall be demolished and hauled away to an approved recycling or disposal facility. Demolition shall be done carefully to not damage existing tree trunks or roots. Exposed roots shall be protected and not cut or pruned without authorization of an ISA Certified Arborist or Urban Forestry Administration forestry inspector.
- B. Common soil excavation shall be performed as needed to achieve desired pavement elevations and ADA compatibility. Common excavation shall be done carefully so as to not impact, damage or destroy existing tree trunks or roots.

### 2.3 GEOTEXTILES & GEOGRIDS

- A. A non-woven, needle punched geotextile fabric such as Mirafi 140 or equal shall be installed as a soil separator whenever stone base course will be installed over existing exposed soil.
- B. A geo-grid such as Tensar TriAx or equal shall be installed on top of the geotextile fabric whenever porous flexible pavement is expected to receive vehicular traffic.

### 2.4 BASE COURSE

- A. Coarse aggregates shall meet the durability requirements of ASTM C 33. #57 stone, recycled concrete RC-57, or ¾" stalite shall be laid under pavement to a minimum depth of 4" for pedestrian use and a minimum of 6" for vehicular use. There is no maximum depth of stone. It shall be as specified per project. Stone shall be tamped with a vibratory plate compactor or vibratory roller compactor to align the stone facets and achieve relative compaction.

### 2.5 POROUS FLEXIBLE PAVING

- A. Bonding: Have the capacity to bind with: wood; steel; concrete; aluminum; compacted aggregate; enamel tile, fiberglass.

- B. Resistance to degradation: Resistant to: chlorine; ozone; bromine; muriatic acid; salt water; oil; transmission oil, hydraulic oil.
- C. Aggregate:
  - 1. Stone: Triple-washed & kiln dried 1/8” to 3/8” crushed granite per ASTM C 33, bagged, labeled, kept dry and under cover until installation.
  - 2. Rubber: Recycled passenger tires ground to 1/4” nominal crumbs with 99.9% of the wire remnants removed and 90% of the chord removed.
- D. Binding agent:
  - 1. Firm, Pedestrian and Light Vehicular Pavement Binder: Single component elastomeric moisture cured aromatic polyurethane liquid prepolymer based upon Diphenylmethane-Diisocyanate designed for permanently binding stone and rubber with a firm and flexible bond. The natural properties of aromatic binders is to produce an ‘amber’ tint on some lighter colored pavements, however this effect wears off with foot traffic and weathering.
  - 2. Soft, Pedestrian Only Playground Binder: Single component elastomeric moisture cured aromatic or aliphatic polyurethane liquid prepolymer based upon Diphenylmethane-Diisocyanate designed for permanently binding EPDM, TPV & SBR rubber granules while maintaining a minimum 6 foot critical fall height capacity in compliance with ASTM F1292. Aliphatic binders are clear and do not produce an ‘amber’ effect on the pavement surface, however aliphatic binders are more costly.
- E. Air Entraining Agents: Prohibited.
- F. Mix Design: Design a tentative mix of materials and colors to prove the consistency intended for use on the specified work, including the following parameters.
  - 1. Flexi-Pave Rubber/Stone Pavement - HD1000, HD1500, HD2000, HDX1000, HDX1500, HDX2000 (Flagship product for sidewalks, trails, tree surrounds, potholes, courtyards, green roofs, diffusion strip drains, etc.)
    - a. The volume by weight of aggregate per cu. yd. shall be 46% of the total mix.
    - b. The volume by weight of the rubber product per cu. yd. shall be 46% of the total mix.
    - c. The volume by weight of the urethane component per cu. yd. shall be 8% of the total mix.
    - d. The percentage of each rubber or stone component to match the selected final color.
    - e. Permeability: Pervious infiltration rate of minimum 2,500 gallons/square foot/hour.
  - 2. Flexi-Pave All-Stone Pavement - AS1000, AS1500, AS2000, ASX1000, ASX1500, ASX2000 (All stone product for vehicular surfaces, patios, parking spots, driveways, etc.)
    - a. The volume by weight of aggregate per cu. yd. shall be 92% of the total mix.
    - b. The volume by weight of the urethane component per cu. yd. shall be 8% of the total mix.
    - c. The percentage of each stone component to match the selected final color.
    - d. Permeability: Pervious infiltration rate of minimum 2,500 gallons/square foot/hour.
  - 3. Flexi-Pave All-Rubber Play Surface - P1000, P1500, P2000, P2500, PX1000, PX1500, PX2000 (All rubber product for safety surfaces, playgrounds, splashparks, pool decks, etc)

- a. The volume by weight of the rubber product per cu. yd. shall be 92% of the total mix.
  - b. The volume by weight of the urethane component per cu. yd. shall be 8% of the total mix.
  - c. The percentage of each rubber component to match the selected final color.
  - d. Permeability: Pervious infiltration rate of minimum 2,500 gallons/square foot/hour.
4. The "X" in any pavement mix design denotes a final surface overspray of the urethane binder. This overcoat provides additional strength, durability and longevity to the pavement without compromising the porosity. It is required for all vehicular applications on an annual basis, and it can be applied to any pedestrian surface as needed throughout its lifespan to bring it back to like-new condition.

## 2.6 FORMS

- A. Make forms with steel, wood, or other material that is sufficiently rigid to maintain specified tolerances, and capable of supporting concrete and mechanical concrete placing equipment.
- B. Forms shall be clean and free of debris of any kind, rust, and hardened concrete.
- C. Form release: Diesel, Bio-diesel or vegetable oil coating.
- D. Forms should not have pins, stakes or spikes protruding above the form top, which would preclude smooth screeding.

## PART 3 - EXECUTION

### 3.1 SUBGRADE PREPARATION

- A. Prepare subgrade as specified in the contract documents.
- B. Construct subgrade to ensure that the required paving thickness is obtained in all locations.
- C. Keep all traffic off of the subgrade during construction to the maximum extent practical. Regrade subgrade disturbed by delivery vehicles or other construction traffic, as needed.
- D. Compact the material added to obtain final subgrade elevation.
- E. If requested, determine subgrade permeability in accordance with ASTM D3385 before porous paving placement. Confirm that subgrade permeability meets requirements of Contract Documents.

### 3.2 SUBBASE

- A. Prepare subbase in accordance with contract documents.

### 3.3 SETTING FORMWORK

- A. Set, align, and brace forms so that the hardened paving meets the tolerances specified herein.
- B. Apply form release agent to the form face which will be in contact with porous paving, immediately before placing paving.
- C. The vertical face of previously placed concrete may be used as a form.
  - 1. Protect previously placed paving from damage using masking.
  - 2. Do not apply form release agent to previously placed concrete.
  - 3. Apply liquid urethane bonding agent to face of surfaces when adhesion is desired
- D. Placement width shall be as specified in Contract Documents.

### 3.4 BATCHING, MIXING, AND DELIVERY

- A. Batch and mix materials in a volumetric mixer on site in compliance with mix design. Discharge shall be completed within 1-2 minutes of the introduction of urethane to the dry products. Do not leave material in mixer more than 4 minutes or batch integrity will be compromised. Discard any material that has mixed for more than 5 minutes.

### 3.5 PLACING AND FINISHING PAVING

- A. Do not place porous flexible paving on frozen or wet subgrade or subbase.
- B. Deposit porous flexible paving directly onto the stone base by either mixer chute, wheelbarrow or by material handler, unless otherwise specified.
- C. Paving shall be a continuous operation with fresh batches being screeded into previously paid sections.
- D. Deposit porous flexible paving between the forms to the specified depth, whether 1", 1.5", 2" or 2.5" nominal depth. (Example: AS1000 = 1" nominal depth, HD2000 = 2" nominal depth, P2500 = 2.5" nominal depth).
- E. Spread the porous flexible paving using a come-along, square-ended shovel or asphalt rake.
- F. Utilize a screed to level to strike off material to a uniform finish.
- G. Fill imperfections and divots with material from the same batch and smooth with magnesium hand trowels.
- H. Use aluminum bull floats to compact and smoothly finish the pavement to elevations and thickness specified in mix design.
- I. Finish all troweling and bull floating within 10 minutes of screeding material.
- J. Finish edging with 45° chamfered edge using magnesium trowels.
- K. Do not touch or tool pavement after it has been out of mixer for 15 minutes.



- L. Pour stops or construction joints should be consistent with the approved joint plan.

### 3.6 FINAL SURFACE TEXTURE

- A. Final surface of porous flexible paving shall be smoothed with aluminum bull float and magnesium trowels to a uniform smooth finish.

### 3.7 EDGING

- A. When permanent forms are not used, bevel the edge of the side surface to a 45° chamfer.

### 3.8 CURING

- A. Begin curing within 20 minutes of paving discharge. Do not handle, smooth, or otherwise touch pavement after 15 minutes or pavement integrity will be compromised and potholing will result.
- B. Completely cover the paving surface with a minimum 4 mil thick polyethylene sheet only if rain or sprinklers are imminent within 20 minutes. Cut sheeting to a minimum of a full placement width.
  - 1. Cover all exposed edges of paving with polyethylene sheet.
  - 2. Secure curing cover material without using dirt or placing heavy items over sheet.
- C. Cure paving for a minimum of 24 uninterrupted hours until it is fully cured, which can be observed if it is hard to the touch and dry. If surface is still tacky after 24 hours, leave protected for another 24 hours before opening for use. Maintain a protective fence around the pavement until fully cured.

### 3.9 SURFACE OVERSPRAY

- A. After curing for 24 hours, a urethane overspray can be applied if specified by the “X” in the mix design.
- B. Protective fencing shall be maintained until overspray dries.
- C. Overspray shall not be performed if precipitation has occurred in the previous 48 hours before application or if precipitation is expected within 48 hours after application.
- D. Sprinklers around overspray area shall be turned off for 48 hours prior and 48 hours after application.
- E. Care should be taken to protect adjacent surfaces, buildings, vehicles and windows from overspray drift.

### 3.10 HOT- AND COLD-WEATHER CONSTRUCTION

- A. When hot weather is anticipated up to 95 degrees Fahrenheit, no special procedures are necessary. When temperatures are over 95 degrees, pavement cure rate increases by approximately 50% and material can become unworkable.
- B. In cold weather it is imperative that the polyurethane binder be kept above 45 degrees Fahrenheit until mixed with dry ingredients and placed. This requires the binder to be kept in enclosed heated containers protected from the elements. Binder that falls below 45 degrees becomes compromised and shall be discarded.
- C. When precipitation is imminent and temperatures will fall below freezing after installation, cover with polyethylene sheet and utilize a fan or torpedo heater to maintain airflow over the paving during the curing process.

### 3.11 OPENING TO TRAFFIC

- A. Do not open the paving to pedestrian or light vehicular traffic until the porous flexible paving has cured for at least 24 hours during warm weather, and 48-72 hours during cold temperatures and not until the porous flexible paving is accepted by the Owner for opening to traffic. Paving should be checked and verified to be sufficiently hardened after the curing period as relative humidity can alter the curing time in some regions.

### 3.12 FINAL CLEANUP

- A. Once pavement is cured and the protective fence is removed, the adjacent areas shall be dressed with soil, seed and straw or soil and sod as the contract requirements dictate.
- B. Mulch shall be installed around tree pits to cover exposed aggregate base that extends beyond the pavement.
- C. Up to 4 subsequent waterings shall be applied as needed to aid establishment of new sod.

### 3.13 COMPENSATION

- A. The amount of Flexi-Pave to be compensated shall be measured in square yards of pavement. This quantity shall be measured by the Flexi-Pave foreman and verified by the inspector. Daily reports containing the square yards of pavement shall be submitted for payment. The Flexi-Pave pay item shall be understood to incorporate all the necessary conditions in the aforementioned specifications that are required to install the Flexi-Pave. These items include and are limited to mobilization, no-parking signs, maintenance of traffic, demolition of hard surfaces, common excavation, masking and forming, geotextile, geogrid, stone base, Flexi-Pave, protective fencing, soil, seed/sod, straw and mulch.

END OF SECTION 32 12 43