F.8 Porous Pavement

F.8.1 Porous Pavement Plan Standards

1. Verify that the plans include an appropriate sequence of construction that is specific to the construction of the porous pavement. Refer to Section 4.2.5 for guidance. [Section 2.3.1]
2. To avoid soil disturbance and compaction during construction, verify that the infiltration area is proposed to be clearly marked before any site work begins. [Section 4.2.5, 1]
3. Verify that the plans include an appropriate cross-sectional detail for the porous pavement. [Section 2.3.1]

F.8.2 Porous Pavement Design Standards

1. Verify the drainage area directed to any proposed porous pavement. The porous surface cannot receive any runoff in addition to the direct (1:1) rainfall onto it. For porous pavement over a structural SMP, the additional runoff must be conveyed directly to the underlying SMP. The porous surface over the structural SMP footprint must be considered, and modeled as, DCIA. The SMP beneath the porous pavement requires infiltration testing. [Section 4.2.1]
2. For porous pavement over a structural SMP, if infiltration is feasible, verify that the porous pavement design meets all Design Guidance Checklist design standards noted in Appendix F.10, Subsurface Infiltration. [Section 4.2.3, 2]
3. For porous pavement over a structural SMP, if infiltration is infeasible, verify that the porous pavement design meets all Design Guidance Checklist design standards noted in Appendix F.14, Subsurface Detention. [Section 4.2.3, 3]
4. For porous pavement DIC systems:
    a. Verify that the porous pavement DIC is installed on-site such that it does not create any areas of concentrated infiltration or discharge. [Section 4.2.3, 1a]
    b. Verify that the surface slope in any direction across porous pavement does not exceed 5%. [Section 4.2.3, 1b]
    c. Verify that the choker course depth is a minimum of two inches. [Section 4.2.3, 1c]
    d. If an underdrain is proposed, verify that the first 1.5 inches of runoff are stored below the lowest invert of the underdrain. [Section 4.2.3, 1d]
    e. Verify that an appropriate porous pavement curve number value is used when performing Flood Control calculations. [Section 4.2.3, 1e]
    f. Verify that the stone storage bed depth is a minimum of eight inches, except when located beneath walkways or play surfaces, for which a depth of four inches is allowable. [Section 4.2.3, 6a]
    g. Verify that stone is separated from soil media by a separation barrier, such as a geotextile or a pea gravel filter, to prevent sand, silt, and sediment from entering the system. [Section 4.2.3, 6b]

h. Verify that the stone storage system has a level bottom. Terraced systems may be used to maintain a level infiltration interface with native soil while accommodating significant grade changes. [Section 4.2.3, 6c]

5. Verify that pretreatment is provided for all runoff entering the porous pavement, including pretreatment of runoff from all inlets. At a minimum, this can be achieved through the use of sumps and traps for inlets and sump boxes with traps downstream of trench drains. [Section 4.2.3, 4]
6. Verify that, when SMPs are used in series, the storage areas for all SMPs provide cumulative static storage for the WQv. [Section 4.2.3, 9]
7. Verify that any impervious liner, if necessary, lines a minimal portion of the total porous area. If a significant area needs to be lined, porous pavement may not be an appropriate management strategy. [Section 4.2.3, 10]
8. Verify that underdrains, if proposed for porous pavement DIC systems, meet the following requirements:
    a. Underdrains must be surrounded by a sand or stone layer to filter sediment and facilitate drainage. [Section 4.2.3, 11a]
    b. The minimum allowable thickness of a sand or stone filter layer is six inches both above and beneath the underdrain. [Section 4.2.3, 11b]
    c. To prevent clogging, underdrain pipes must be surrounded by a geotextile fabric if a sand layer is used. [Section 4.2.3, 11c]
9. Verify that inlets or area drains are provided for all porous pavement areas in excess of 5,000 square feet, in order to provide positive overflow. [Section 4.2.3, 12]
10. Verify that an adequate number of appropriately placed cleanouts, manholes, access panels and other access features are provided to allow unobstructed and safe access to the structural SMPs beneath porous pavement for routine maintenance and inspection of inflow, outflow, underdrains, and storage systems. [Section 4.2.3, 14]
11. Verify that an observation well is provided for a storage system that includes stone storage and that it meets the following requirements:
    a. The observation well must be placed at the invert of the stone bed. [Section 4.2.3, 15a]
    b. An observation well must be located near the center of the stone bed system to monitor the level and duration of water stored within the SMP (drain down time). [Section 4.2.3, 15b]
    c. Adequate inspection and maintenance access to the observation well must be provided. [Section 4.2.3, 15c]
    d. A manhole may be used in lieu of an observation well if the invert of the manhole is installed at or below the bottom of the SMP and the manhole is configured in such a way that stormwater can flow freely between the SMP and the manhole at the SMP's invert. [Section 4.2.3, 15d]
12. Verify that access features are provided for all underground storage systems that are not stone storage beds. [Section 4.2.3, 16a]
13. Verify that a sufficient number of access points in the system are provided to efficiently inspect and maintain the infiltration area. [Section 4.2.3, 16b]
14. For cast-in-place vault systems, verify that access features consist of manholes or grated access panels or doors. Grated access panels are preferred to maintain airflow. [Section 4.2.3, 16c]

15. For grid storage or other manufactured systems, verify that the manufacturer's recommendations are followed. [Section 4.2.3, 16d]
16. Verify that ladder access is proposed for vaults greater than four feet in height. [Section 4.2.3, 16e]
17. Verify that header pipes, at minimum 36-inch diameter, connected to manholes at each corner of the subsurface system are provided. Alternatively, smaller header pipes may be used if cleanouts are provided on the manifold/header pipe junction for each distribution pipe. The cleanouts must be on alternating sides of the SMP. [Section 4.2.3, 16f]

F.8.3 Porous Pavement Material Standards

Porous Asphalt Binder Course Aggregate Gradation	
U.S. Standard Sieve Size	**Percent Passing by Weight**
1"	100%
3/4"	90-100%
1/2"	80-100%
3/8"	50-80%
#4	10-20%
#8	5-10%
#40	3-8%
#200	0-3 %

Porous Asphalt Wearing Course Aggregate Gradation	
U.S. Standard Sieve Size	**Percent Passing by Weight**
5/8"	100%
1/2"	95-100%
3/8"	70-95%
#4	20-40%
#8	10-20%
#40	0-8%
#200	0-3%

1. Verify that porous bituminous asphalt, if proposed, is specified on the plans as meeting the following specifications: [Section 4.2.4, 2]
    a. Bituminous surface must be laid with a bituminous mix of 5.75% to 6% by weight dry aggregate.
    b. In accordance with American Society of Testing and Materials (ASTM) D6390, drain down of the binder must be no greater than 0.3%.
    c. Aggregate material in the asphalt must be clean, open-graded, and a minimum of 75% fractured with at least one fractured face by mechanical means of each individual particle larger than ¼-inch, and it must have the following gradations:
    d. Neat asphalt binder modified with an elastomeric polymer to produce a binder meeting the requirements of PG 76-22 as specified in American Association of State Highway and Transportation Officials (AASHTO) MP-1. The elastomer polymer must be styrene-butadiene-styrene, or approved equal, applied at a rate of 3% by weight of the total binder.
    e. Hydrated lime should be added at a dosage rate of 1% by weight of the total dry aggregate to mixes containing granite.
        i. The additive must be able to prevent the separation of the asphalt binder from the aggregate and achieve a required tensile strength ratio of at least 80% on the asphalt mix when tested in accordance with AASHTO T 283.
        ii. The asphaltic mix must be tested for its resistance to stripping by water in accordance with ASTM D-1664.
        iii. If the estimated coating area is not above 95%, anti-stripping agents must be added to the asphalt.
    f. The asphaltic mix must be tested for its resistance to stripping by water in accordance with ASTM D 3625. If the estimated coating area is not above 95%, anti-stripping agents must be added to the asphalt.
2. Verify that porous concrete, if proposed, is specified on the plans as meeting the following specifications: [Section 4.2.4, 3]
    a. Porous concrete must use Portland Cement Type I or II conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595.
    b. Aggregate must be No. 8 coarse aggregate (3/8-inch to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8-inch to No. 50) per ASTM D 448.
    c. An aggregate/cement ratio range of 4:1 to 4.5:1 and a water/cement ratio range of 0.34 to 0.40 should produce porous pavement of satisfactory properties in regard to permeability, load carrying capacity, and durability characteristics.
3. Verify that permeable paver and grid systems, if proposed, are specified on the plans as meeting the following specifications: [Section 4.2.4, 4]
    a. Permeable paver and grid systems must conform to manufacturer specifications.
    b. The systems must have a minimum flow through rate of five inches per hour and a void percentage of no less than 10%.
    c. Gravel used in interlocking concrete pavers or plastic grid systems must be well-graded and washed to ensure permeability.

4. Verify that stone designed for stormwater storage, if proposed, is specified on the plans as being uniformly graded, crushed, clean-washed stone and that it is noted that PWD defines “clean-washed” as having less than 0.5% wash loss, by mass, when tested per the AASHTO T-11 wash loss test. AASHTO No. 3 and No. 57 stone can meet this specification. [Section 4.2.4, 6a]
5. Verify that all aggregates used within a porous pavement system meets the following requirements: [Section 4.2.4, 6b]
    a. Maximum wash loss: 0.5% per AASHTO T-11
    b. Minimum durability index: 35 per ASTM D3744
    c. Maximum abrasion: 10% for 100 revolutions and 50% for 500 revolutions per ASTM C131
6. Verify that all choker course aggregate meets the specifications of AASHTO No. 57 and meets the gradation listed in Table 4.2-3 of the Manual. [Section 4.2.4, 6c]
7. Verify that sand, if proposed, is specified on the plans to be AASHTO M-6 or ASTM C-33 sand and to have a grain size of 0.02 inches to 0.04 inches. [Section 4.2.4, 7]
8. Verify that storage chambers for porous pavement over a structural SMP, if proposed, are specified on the plans as meeting the following specifications: [Section 4.2.4, 8]
    a. Pipe used within a subsurface infiltration SMP must be continuously perforated and have a smooth interior with a minimum inner diameter of four inches.
    b. High-density polyethylene (HDPE) pipe, if proposed, must meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S.
    c. Any pipe materials outside the SMP are to meet City Plumbing Code Standards.
9. Verify that geotextile, if proposed, is specified on the plans to consist of polypropylene fibers and to meet the following specifications (AASHTO Class 1 or Class 2 geotextile is recommended): [Section 4.2.4, 9]
    a. Grab Tensile Strength (ASTM-D4632): ≥ 120 lbs
    b. Mullen Burst Strength (ASTM-D3786): ≥ 225 psi
    c. Flow Rate (ASTM-D4491): ≥ 95 gal/min/ft^2
    d. UV Resistance after 500 hrs (ASTM-D4355): ≥ 70%
    e. Heat-set or heat-calendared fabrics are not permitted
10. Verify that underdrains, if proposed, are made of continuously perforated HDPE plastic piping with a smooth interior and a minimum inner diameter of four inches. HDPE pipe must be specified on the plans to meet the specifications of AASHTO M252, Type S or AASHTO M294, Type S. [Section 4.2.4, 10]
11. Verify that observation wells are specified on the plans as consisting of perforated plastic pipe with a minimum inner diameter of six inches. [Section 4.2.4, 12]
12. Verify that cleanouts are made of material with a smooth interior having an inner diameter that is no less than four inches and matches that of its connecting pipe up to eight inches. If the pipe is larger than eight inches in diameter, verify that the cleanout is eight inches in diameter. [Section 4.2.4, 13]