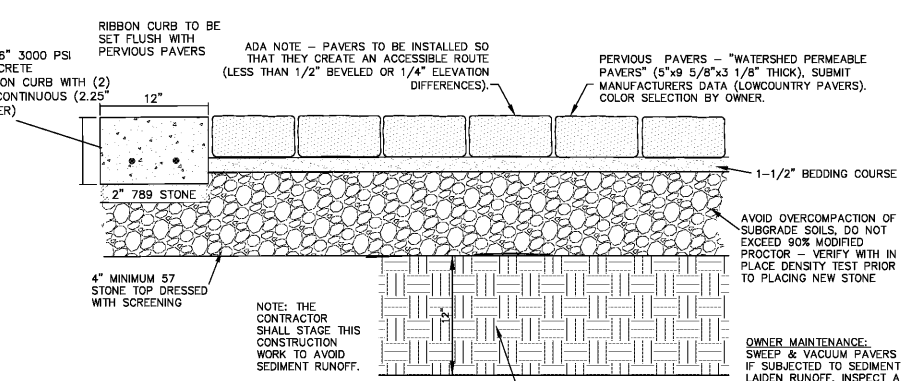
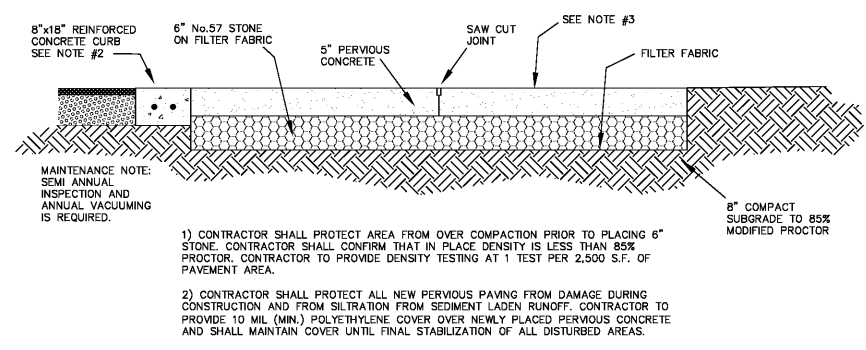


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Permeable Pavement Construction Sequence

Experience has shown that proper installation is absolutely critical to the effective operation of a permeable pavement system.

Erosion and Sediment Controls. The following erosion and sediment control guidelines must be followed during construction:

- All permeable pavement areas should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- Intended permeable pavement areas must remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment (unless the area has been determined to have a low CBR and will require compaction during the permeable pavement construction phase). Where this is unavoidable, the impacted area should not be excavated below 2 feet above the final design elevation of the bottom of the aggregate reservoir course until further compaction by heavy equipment can be avoided. Once the area is excavated to grade, the impacted area should be filled to a depth of 12 inches below the bottom of the reservoir layer. Permeable pavement areas must be clearly marked on all construction documents and grading plans.
- During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid clogging.
- Any area of the site intended ultimately to be a permeable pavement area should generally not be used as the site of a temporary sediment basin. Where locating a sediment basin on an area intended for permeable pavement is unavoidable, the invert of the sediment basin must be a minimum of 2 feet above the final design elevation of the bottom of the aggregate reservoir course. All sediment deposits in the excavated area should be carefully removed prior to installing the sub-base, base, and surface materials.

Permeable Pavement Installation. The following is a typical construction sequence to properly install permeable pavement, which may need to be modified depending on the specific variant of permeable pavement that is being installed.

Step 1: Construction of the permeable pavement should only begin after the entire contributing drainage area has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain or snow and do not install frozen bedding materials.

Step 2: As noted above, temporary erosion and sediment controls are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures, such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials contaminated by sediments must be removed and replaced with clean materials.

Step 3: Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For small pavement applications, excavating equipment should have arms with adequate extension so that it does not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is excavated into 500-to 1000-square-foot temporary cells with a 10- to 18-foot earth berm between cells. Cells can be excavated from the side. Excavated material should be placed away from the excavation so as to not jeopardize the stability of the side walls.

Installation of Permeable Pavers. The basic installation process is described in greater detail by Smith (2016):

- Place edge restraints for open-jointed pavement blocks before the bedding layer and pavement blocks are installed. Permeable pavement systems may require edge restraints to prevent vehicle loads from moving the paver blocks. Edge restraints may be standard curbs or gutter pans, or precast or cast-in-place reinforced concrete borders a minimum of 6 inches wide and 18 inches deep, constructed with Class A3 concrete. Edge restraints along the traffic side of a permeable pavement block system are recommended.
- Place the No. 57 stone in a single lift. Level the filter course and compact it into the reservoir course beneath with at least four passes of a 10-ton steel drum static roller until there is no visible movement. The first two passes are in vibratory mode, with the final two passes in static mode. The filter aggregate should be moist to facilitate movement into the reservoir course.
- Place and screed the bedding course material (typically No. 8 stone).
- Fill gaps at the edge of the paved areas with cut pavers or edge units. When cut pavers are needed, cut the pavers with a paver splitter or masonry saw. Cut pavers no smaller than 1/3 of the full unit size.
- Pavers may be placed by hand or with mechanical installers. Fill the joints and openings with stone. Joint openings must be filled with ASTM D 448 No. 8 stone, although, No. 8P or No. 9 stone may be used where needed to fill narrow joints. Remove excess stones from the paver surface.
- Compact and seat the pavers into the bedding course with a minimum low-amplitude 5,100-lb, 75- to 95-Hz plate compactor.
- Do not compact within 6 feet of the unrestrained edges of the pavers.
- The system must be thoroughly swept by a mechanical sweeper or vacuumed immediately after construction to remove any sediment or excess aggregate.
- Inspect the area for settlement. Any blocks that settle must be reset and re-inspected.
- Inspect the facility 18 to 30 hours after a significant rainfall (1/2 inch or greater) or artificial flooding to determine whether the facility is draining properly.

Permeable Pavement Maintenance Criteria

Maintenance is a required and crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment. Periodic street sweeping will remove accumulated sediment and help prevent clogging; however, it is also critical to ensure that surrounding land areas remain stabilized.

The following tasks must be avoided on ALL permeable pavements:

- Sanding
- Re-sealing
- Re-surfacing
- Power washing
- Storage of trash or soil materials

Step 4: The native soils along the bottom of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or geotextile fabric. In large scale paving applications with weak soils, the soil subgrade may need to be compacted to 95 percent of the Standard Proctor Density to achieve the desired load-bearing capacity. Note: This may reduce or eliminate the infiltration function of the installation, and it must be addressed during hydrologic design.

Step 5: Geotextile fabric should be installed on the sides of the reservoir layer (and the bottom if the design calls for it). Geotextile fabric strips should overlap down-slope by a minimum of 2 feet and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of geotextile fabric 1 foot below the surface to prevent sediments from falling into the reservoir layer. Excess geotextile fabric should not be trimmed until the site is fully stabilized.

Step 6: Provide a minimum of 2 inches of aggregate above and below the underdrains. The up-gradient end of underdrains in the reservoir layer should be capped. For an underdrain connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure there are no perforations in clean-outs and observation wells within 1 foot of the orifice.

Step 7: Spread 6-inch lifts of the appropriate clean, washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the reservoir layer, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

Step 8: Install the desired depth of the bedding layer depending on the type of pavement as indicated in Table 4.3-3.

Bedding materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

Installation of Pervious Concrete. The basic installation sequence for pervious concrete is outlined by the National Ready Mixed Concrete Association (NRMCA, 2004). It is strongly recommended that contractors install or successfully complete a recognized pervious concrete installer training program, such as the Pervious Concrete Contractor Certification Program offered by the NRMCA. The basic installation procedure is as follows:

- Drive the concrete truck as close to the project site as possible.
- Water the underlying aggregate (reservoir layer) before the concrete is placed, so the aggregate does not draw moisture from the freshly laid pervious concrete.
- After the concrete is placed, approximately 1/2 to 1/4 inch is struck off, using a vibratory screed. This is to allow for compaction of the concrete pavement.
- Compact the pavement with a steel pipe roller. Care should be taken to ensure over-compaction does not occur.
- Cut joints for the concrete to a depth of 1/2 inch.
- The curing process is very important for pervious concrete. Concrete installers should follow manufacturer specifications to the extent allowed by on-site conditions when curing pervious concrete.

Construction staging on unprotected pavement

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. The frequency of maintenance will depend largely on the pavement use, traffic loads, and the surrounding land use.

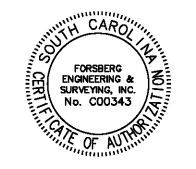
One preventative maintenance task for large-scale applications involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the parking lot. Many consider an annual, dry-weather sweeping in the spring months to be important. The contract for sweeping should specify that a vacuum sweeper be used that does not use water spray, since spraying may lead to subsurface clogging. Typical maintenance tasks are outlined in Table 4.3-3.

Frequency	Maintenance Tasks
After installation	<ul style="list-style-type: none"> For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 1/2 inch of rainfall. Conduct any needed repairs or stabilization.
Once every 1-2 months during the growing season	<ul style="list-style-type: none"> Mow grass in grid paver applications.
As needed	<ul style="list-style-type: none"> Stabilize the contributing drainage area to prevent erosion. Remove any soil or sediment deposited on pavement. Replace or repair any necessary pavement surface areas that are deteriorating or spalling.
2-4 times per year (depending on use)	<ul style="list-style-type: none"> Vacuum pavement with a standard street sweeper to prevent clogging.
Annually	<ul style="list-style-type: none"> Conduct a maintenance inspection. Spot seeding of grass applications.
Once every 2-3 years	<ul style="list-style-type: none"> Remove any accumulated sediment in pretreatment cells and inflow points.
If clogged	<ul style="list-style-type: none"> Conduct maintenance using a regenerative street sweeper. Replace any necessary joint material.

When permeable pavements are installed on private residential lots, homeowners will need to (1) be educated about their routine maintenance needs and (2) understand the long-term maintenance plan. It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at each permeable pavement site, particularly at large-scale applications. An example Maintenance checklist for permeable pavement areas is included in Appendix F.

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coast architects
671 St. Andrews Blvd., Charleston, SC 29407
Phone: 843.763.7064 Fax: 843.763.7061
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