Concrete in Practice

What, why & how?

NRMCA

CIP 38 - Pervious Concrete

WHAT is Pervious Concrete

Pervious concrete is a special type of concrete with a high porosity used for concrete flatwork applications that allows water from precipitation and other sources to pass through it, thereby reducing the runoff from a site and recharging ground water. The high porosity is attained by an interconnected void system in the concrete. Pervious concrete mixtures incorporate an aggregate blend that establish the voids with an optimized volume of cementitious paste to coat the aggregate particles while preserving the interconnectivity of the voids. A pervious concrete pavement system includes the pervious concrete pavement above an aggregate base layer that stores storm water to permit percolation into the ground. Thickness of the layers are designed based on design storm, soil subgrade conditions, and traffic loading.

Pervious concrete is traditionally used in parking areas, pavements with light traffic, pedestrian walkways, and other innovative applications. It is an important application for sustainable construction.

WHY Use Pervious Concrete

The US Environmental Protection Agency (EPA) recognizes the use of pervious concrete pavement system as a Best Management Practice for providing first-flush pollution control and storm water management. As regulations further limit storm water runoff, it increases the expense for property owners to develop real estate, due to the size of the drainage systems. Pervious concrete reduces runoff from paved areas, which reduces the size, and in some cases, the need for separate storm water retention ponds and allows the use of smaller capacity storm sewers. This allows property owners to develop a larger area of available property at a lower cost. Pervious concrete pavements reduce pollutants entering streams, ponds, and rivers and naturally filters and purifies storm water percolating in the ground. Pervious concrete functions like a storm water retention basin and allows the storm water to infiltrate the soil over a large area, thus facilitating recharge of groundwater. All of these benefits lead to more effective land use.

Pervious Concrete Infiltrates Water

Pervious concrete can also reduce the impact of development on vegetation. A pervious concrete pavement transfers water and air to root systems allowing trees to flourish in developed areas.

HOW to Install Pervious Concrete Pavement

A project specification should be developed specifically for pervious concrete as the requirements and installation differs significantly from conventional concrete flatwork. Refer to ACI 522.1. An experienced installer is vital to the successful installation of pervious concrete pavements. NRMCA administers a certification program for pervious concrete contractors.

The subgrade should be properly compacted to provide a uniform and stable surface. Excessive compaction will reduce the permeability to water. Swelling soils should not be over-compacted. Contract documents should specify level of compaction needed. Subgrade permeability can be determined in accordance with ASTM D3385. An open-graded stone base with a minimum thickness of 6-in. is typically installed to increase storage capacity of the system. Check dams are used on slopes to control rate of water flow in the stone base. Filter fabric or a choker course may be used between the subgrade and stone base to prevent fine soil from clogging the stone layer. Moisten the stone base and subgrade prior to concrete placement, and wheel ruts from the construction

traffic should be raked and re-compacted.

Pervious concrete mixtures are proportioned based on the aggregate blend used and the type of installation. Pervious concrete has a water to cementitious materials ratio (w/cm) of 0.30 to 0.35 with a void content between 15 to 25%. The correct quantity of water in the concrete is critical. Too much water results in segregation and paste bleed, and too little water results in balling in the mixer and very slow discharge. This material is sensitive to changes in water content, so field adjustment of the load is usually necessary. Less water content also hinders adequate curing of the concrete and leads to premature raveling. The freshly mixed concrete should have wet-metallic sheen with smooth paste coating on aggregates.

A pervious concrete pavement may be placed in fixed forms or by a slip-form paver. Strike off may be by roller, vibratory, or manual screeds. After strike off the concrete is compacted by a manually operated roller. Rolling consolidates the fresh concrete to provide strong bond between the paste and aggregate, and creates a smoother riding surface. Excessive pressure or passes when rolling should be avoided as it may reduce void content or seal the surface. Rolling should be performed immediately after strike off. A lighter pan float develop for pervious concrete can be used for a durable surface finish.

Jointing pervious concrete pavement follows the same rules as for concrete slabs on grade (See CIP 6). Joints in pervious concrete are tooled with a rolling jointing tool or sawcut after finishing. Tooling allows joints to be cut in a short time, and allows curing to continue uninterrupted.

Proper curing is essential for durable and long lasting pervious concrete pavements. Curing ensures that cement paste continues to gain strength to prevent raveling. Curing should begin soon after placement is completed and continue through 7 days. Plastic sheeting is typically used to cure pervious concrete pavements and should be maintained on the pavement for the duration. Soy-based or other curing compounds may be sprayed before securing plastic sheeting.

HOW to Evaluate Pervious Concrete

Pervious concrete mixtures can be proportioned to attain a compressive strength in the range of 800 to 2500 psi (5.5 to 17 MPa). Strength is not specified for acceptance of pervious concrete. Most important to the success of a pervious concrete pavement is the void content. For a specific mixture, the fresh density that is consistent with the specified void content is documented and used as the basis of acceptance. Density of fresh concrete is measured in accordance with ASTM C1688. An acceptable tolerance at delivery is ±5 lb/yd^3 (80 kg/m^3). The raveling potential of a proposed mixture can be evaluated in accordance with ASTM C1747. Slump and air content are not applicable tests for pervious concrete. Density of hardened concrete cores from the installed pavement can be determined in accordance with ASTM C1754. This provides an estimate of the in-place voids. This void content of hardened concrete will differ from that determined on fresh concrete. Void content in the pavement should not be used as a basis of rejection. If pervious concrete pavement is an element of a storm water management plan, the infiltration rate of the installed pavement after construction can be determined in accordance with ASTM C1701. This establishes a benchmark for the change in infiltration of the pavement under service conditions. This periodic measurement will establish maintenance schedules to restore pavement permeability to clean the pavement of debris that clogs the voids. The owner should plan for and schedule cleaning and maintenance. This can be done by a combination of vacuum sweeping and pressure washing.

Pervious concrete has been successfully used in cold climate regions. Saturation of the pervious concrete pavement layer should be prevented by installing the pavement on 8 to 24 in. (100 to 600 mm) layer of open-graded stone base. Entrained air may improve freeze-thaw resistance of pervious concrete, but air content cannot be verified. Some deicing chemicals may cause damage to pervious concrete.

References

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5. *ASTM Standards C1688, C1701, C1754, C1757, D3385,* ASTM International, W. Conshohocken, PA. *www.astm.org*.
6. *Storm Water Technology Fact Sheet Porous Pavement. US* EPA, EPA 832-F-99-023, 1999, *www.epa.gov/npdes*.

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