PCA Portland Cement Association

CONCRETE TECHNOLOGY Today

Pervious Concrete Pavement: A Win-Win System

by Dan Brown, P.E., Product Specialist, Holcim (US) Inc.

Fig. 1. Pervious concrete allows water to flow through it, allowing recharge of groundwater and reducing the need for storm water retention areas. (IMG13626)

CT032 — August 2003
Vol. 24, No. 2

Contents

Concrete Technology Today is now available on the Internet at www.cement.org/cct

Use of pervious pavements helps owners and environment

Although pervious concrete has been in use for more than 50 years in a variety of applications, recent EPA regulations are causing many owners, specifiers and architects to reexamine applications of this unique material. Also referred to as "no-fines concrete" or "porous concrete," this material is comprised of narrowly graded coarse aggregate, cementitious materials, water, admixtures, and, in some cases, fibers. Little or no fine aggregate is included in the mixture. Carefully controlled amounts of water and cementitious materials are used to create a paste that forms a thick coating around aggregate particles without flowing off during mixing and placing. Using just enough paste to coat the particles maintains a system of interconnected voids on the order of 15% to 35% depending on materials and intended application. The result is a very high permeability concrete that drains quickly: Percolation rates of 100 to 750 liters per minute per square meter (2 to 18 gallons per minute per square foot) are common. Due to the high void content, pervious concrete is also lightweight, 1600 to 1900 kg/m^3 (100 to 120 lb/ft^3).

Construction Practices

After placement, pervious concrete resembles popcorn. Its low paste content and low fine aggregate content make the mixture harsh, with a very low slump. The compressive strength of pervious concrete is limited since the void content is so high. However, compressive strengths of 3.5 to 27.5 MPa (500 psi to 4000 psi) are typical and sufficient for many applications.

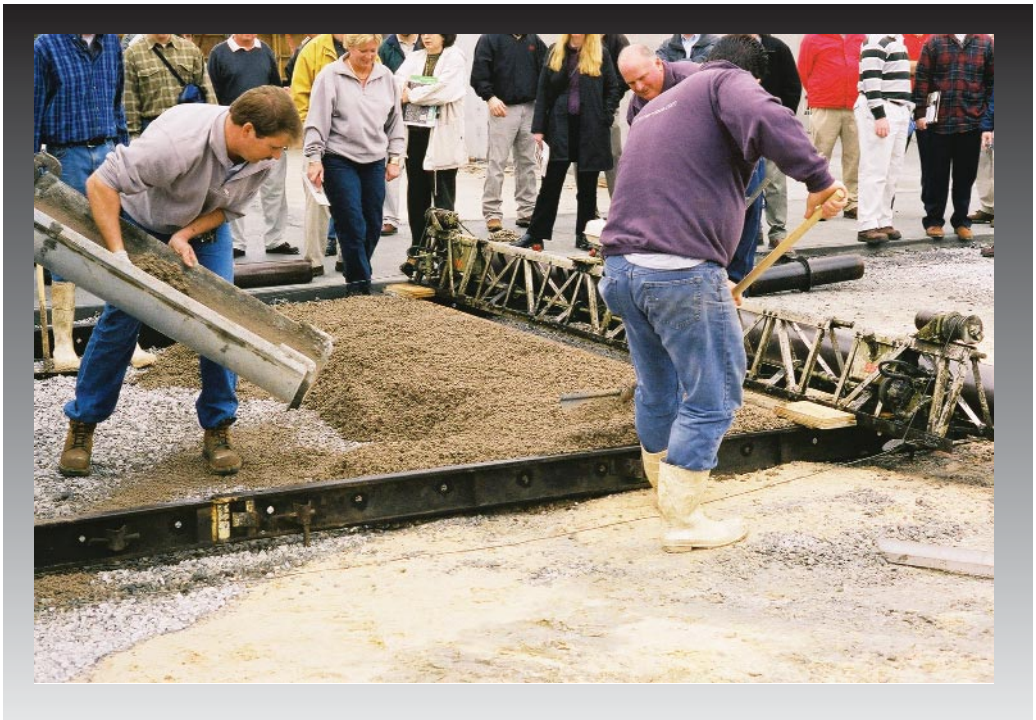

Fig. 2. Pervious concrete is usually placed by hand and then struck off with a vibratory screed, followed by compaction with a hand roller. Prompt curing with plastic sheeting is required. (IMG13627)

Pervious concrete is not difficult to place, but is a bit different from conventional concrete placement. It is a very low workability material, so considerable hand work may be necessary for placement. The use of a vibrating screed is important for optimum density and strength. After screeding, this material is usually compacted with a hand roller. There are no bull floats, trowels etc. used in placing pervious concrete. Conventional jointing methods and spacing are recommended. Curing with plastic sheeting must start immediately and continue for at least 7 days. Careful engineering is required to assure structural adequacy, hydraulic performance, and minimum clogging potential.

Paving the Way for Better Water Management

The principal uses for pervious concrete have been for parking lots, low traffic pavements, and pedestrian walkways. For these applications, the smallest sized aggregate feasible is used for aesthetic reasons. Coarse aggregate size 89 (9.5-mm or $^{3}/_{8}$-inch top size) has been extensively used for parking lot and pedestrian applications, dating back 20 years or more in Florida.

Pervious concrete's main advantage is its ability to pass large amounts of water quickly and this has dictated traditional applications: drainage media for hydraulic structures, porous base layers under heavy duty pavements, parking lots, tennis courts, and greenhouses. Its high porosity also gives it other useful characteristics: it is thermally insulating (in buildings) and has good acoustical properties (for sound barrier walls).

The interconnected void structure of this material allows water to pass through and percolate into the ground. This unique ability of pervious concrete captures rainwater and recharges ground water, reducing storm water runoff and helping owners comply with EPA regulations. In the last few years, a high level of interest in pervious concrete has developed due to federal clean water legislation.

Control of "First Flush" Storm Water

Pervious concrete pavement systems provide a viable solution to the new requirements under the EPA Storm Water Phase II Final Rule (see Reference 1). Phase II regulations require programs and practices to help control the amount of hazardous contaminants in our waterways. Impervious pavements, particularly in parking lots, collect oil, anti-freeze and other automobile fluids, which may be washed into streams and lakes when it rains.

The EPA Storm Water regulations set limits on the levels of pollution in our streams and lakes. To meet these regulations, local officials have considered two basic approaches: reduce the overall runoff from an area and reduce the level of pollution contained in runoff. Efforts to reduce runoff include zoning ordinances and regulations that reduce the amount of impervious surfaces in new developments; green

space requirements; and implementation of "storm water utility districts" that levy an impact fee on a property owner, based on the amount of impervious area. Efforts to reduce the level of pollution from storm water include requirements for developers to provide systems that collect the "first flush" of rainfall (usually about 25 mm or 1 in.) and "treat" the pollution prior to release.

Pervious concrete pavement reduces runoff. It can also be used as part of a system to reduce the level of pollution contained in storm water that is captured, the so-called "first flush" that contains most of the pollution that comes from an impervious surface. By capturing the first flush of rainfall and allowing it to percolate into the ground, soil chemistry and biology are allowed to naturally "treat" the polluted water. Thus, storm water retention areas may be reduced, allowing increased land use.

Trees planted in parking lots capture some storm water and offer a cooling effect in the area, further reducing pollution. Pervious concrete pavement is ideal for protecting trees in a paved environment. For lack of water, trees planted in small "islands" in parking lots often have difficulty growing. Pervious concrete placed in parking spaces and pavements adjacent to tree islands greatly increases the amount of rain available to the trees without reducing usable area. Pervious concrete sidewalks allow urban trees to receive more water and still permit full pedestrian usage.

The use of pervious pavements has been growing in recent years as owners, architects, specifiers, and other concrete professionals become familiar with its benefits.

For more information please contact:

Dan R. Brown, P.E.
Product Specialist
Holcim (US) Inc.
1-800-292-4355 (office)
Chairman of ACI Committee 522, Pervious Concrete
Email: *danr.brown@holcim.com*

Reference 1: Storm Water Phase II Final Rule: An Overview, EPA 833-F-00-001, Fact Sheet 1.0, US Environmental Protection Agency, Office of Water, January 2000, 4 pages. Available at: http://www.epa.gov/npdes/pubs/fact1-0.pdf .

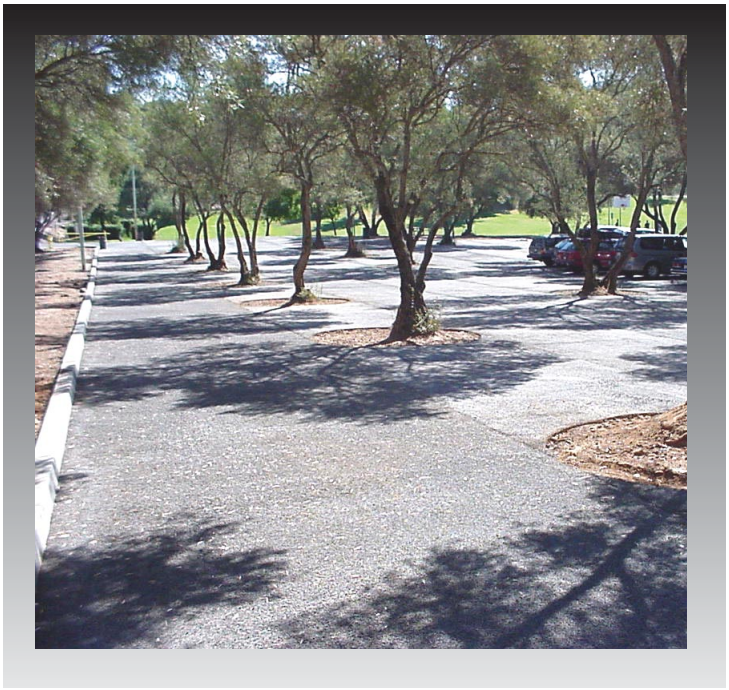

Fig. 3. Trees in this parking lot in California are adequately watered by percolation through the pervious concrete pavement. (IMG13628)

New Documents Available from ACI

The American Concrete Institute has recently issued the following committee reports and specifications:

- *Guide for the Design and Construction of Concrete Reinforced with FRP Bars*, ACI 440.1R-03
- *Slag Cement in Concrete and Mortar*, ACI 233R-03
- *Design and Construction Practices to Mitigate Corrosion of Reinforcement in Concrete Structures*, ACI 222.3R-03
- *Specification for Unreinforced Concrete Parking Lots*, ACI 330.1-03

These publications are available from ACI International, P.O. Box 9094, Farmington Hills, Michigan, 48333. You may order by telephone at 248.848.3800, or on-line at http://www.concrete.org/BOOKSTORE/BKSTR.HTM .