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Report on Pervious Concrete

Reported by ACI Committee 522

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Report on Pervious Concrete

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
U.S.A.
Phone: 248-848-3700
Fax: 248-848-3701

www.concrete.org

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This report provides technical information on pervious concrete's application, design methods, materials, properties, mixture proportioning, construction methods, testing, and inspection.

The term "pervious concrete" typically describes a near-zero-slump, open-graded material consisting of portland cement, coarse aggregate, little or no fine aggregate, admixtures, and water. The combination of these ingredients will produce a hardened material with connected pores, ranging in size from 0.08 to 0.32 in. (2 to 8 mm), that allow water to pass through easily. The void content can range from 15 to 35%, with typical compressive strengths of 400 to 4000 psi (2.8 to 28 MPa). The drainage rate of pervious concrete pavement will vary with aggregate size and density of the mixture, but will generally fall into the range of 2 to 18 gal./min/ft^2 (81 to 730 L/min/m^2). Pervious concrete is widely recognized as a sustainable building material, as it reduces stormwater runoff, improves stormwater quality, may recharge groundwater supplies, and can reduce the impact of the urban heat island effect.

Keywords: construction; design; drainage; green building; LEED® credit; permeability; pervious concrete pavement; stormwater; sustainability; testing.

CONTENTS

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CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

This report provides technical information on pervious concrete's application, design methods, materials, properties, mixture proportioning, construction methods, testing, and inspection.

The term "pervious concrete" typically describes a near-zero-slump, open-graded material consisting of portland cement, coarse aggregate, little or no fine aggregate, admixtures, and water. The combination of these ingredients will produce a hardened material with connected pores (Fig. 1.1), ranging in size from 0.08 to 0.32 in. (2 to 8 mm), that allow water to pass through easily. The void content can range from 15 to 35%, with typical compressive strengths of 400 to 4000 psi (2.8 to 28 MPa). The drainage rate of pervious concrete pavement will vary with aggregate size and density of the mixture, but will generally fall into the range of 2 to 18 gal./min/ft^2 (81 to 730 L/min/m^2) or 192 to 1724 in./h (0.14 to 1.22 cm/s).

1.2—Scope

Concern has been growing in recent years toward reducing the pollutants in water supplies and the environment. In the

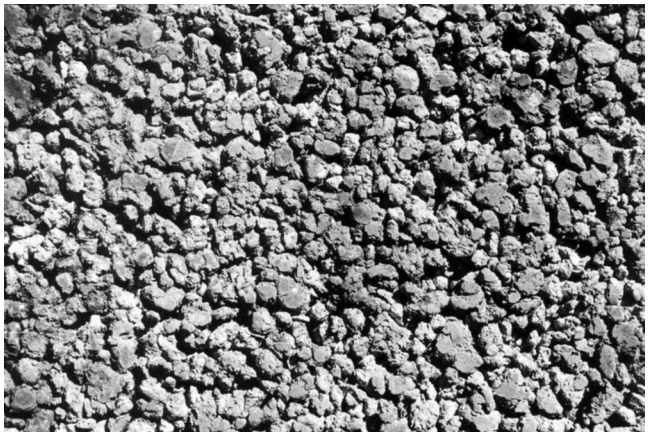

Fig. 1.1—Pervious concrete pavement texture on parking lot.

1960s, engineers realized that runoff from developed real estate had the potential to pollute surface and groundwater supplies. Further, as land is developed, runoff leaves the site in higher rates and volumes, leading to downstream flooding and bank erosion. Pervious concrete pavement reduces the impact of development by reducing or eliminating storm-water runoff rates and protecting water supplies.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

A	=	area of the pavement, acre (m^2)
b	=	solid volume of coarse aggregate in a unit volume of concrete, ft^3 (m^3)
b_o	=	solid volume of coarse aggregate in a unit volume of coarse aggregate, ft^3 (m^3)
b/b_o	=	dry-rodded volume of coarse aggregate in a unit volume of concrete
C	=	runoff coefficient
c	=	cement content, lb (kg)
d_1	=	thickness of the pavement, ft (m)
d_2	=	thickness of the subgrade, ft (m)
f'_c	=	specified compressive strength of concrete, psi (MPa)
f_r	=	modulus of rupture of concrete, psi (MPa)
t	=	time, seconds
h_1	=	initial head, in. (mm)
h_2	=	final head, in. (mm)
k	=	permeability, in./s (mm/s)
p_1	=	percentage of void space in the pavement
p_2	=	percentage of void space in the subgrade
R	=	pressure reflection coefficient
V_a	=	aggregate volume, ft^3 (m^3)
V_c	=	cement volume, ft^3 (m^3)
V_P	=	paste volume; total of cement and water volume, ft^3 (m^3)
V_p	=	available storage in pavement, ft^3 (m^3)
V_r	=	required storage volume, ft^3 (m^3)
V_s	=	available storage in subgrade, ft^3 (m^3)
V_s	=	total solid volume of aggregate, cement, and water, ft^3 (m^3)
V_{tot}	=	total volume, ft^3 (m^3)
V_w	=	water volume, ft^3 (m^3)
W_a	=	dry aggregate weight, lb (kg)
W_{ssd}	=	saturated surface-dry weight, lb (kg)
w	=	water content, lb (kg)
α	=	absorption coefficient

2.2—Definitions

ACI provides a comprehensive list of acceptable definitions through an online resource, "ACI Concrete Terminology," http://terminology.concrete.org. Definitions provided here complement that resource.

concrete, pervious—hydraulic cement concrete proportioned with sufficient interconnected voids that result in a highly permeable material, allowing water to readily pass.

impervious area—an area covered by a material that prevents precipitation from infiltrating soils and recharging groundwater supplies.

pavement, pervious—a pavement comprising material with sufficient continuous voids to allow water to pass from the surface to the underlying layers.

percolation rate—the rate, usually expressed as inches per hour or inches per day, at which water moves through pervious concrete.

porosity—the volume of open and connected interstitial void space in pervious concrete.

raveling—the wearing away of the concrete surface caused by the dislodging of aggregate particles.

runoff—water from rain or snow that is not absorbed into the ground but instead flows over less pervious surfaces into streams and rivers.

surface course—the top layer of a concrete pavement structure.

void content—the ratio of the volume of voids, including both entrapped and entrained air, to the total volume expressed as a percentage.

CHAPTER 3—APPLICATIONS

3.1—General

Pervious concrete has been used in a wide range of applications, including:

- Pervious pavement for parking lots (Fig. 3.1);
- Rigid drainage layers under exterior mall areas;
- Greenhouse floors to keep the floor free of standing water;
- Structural wall applications where lightweight or better thermal insulation characteristics, or both, are required;
- Pavements, walls, and floors where better acoustic absorption characteristics are desired;
- Base course for streets, roads, driveways, and airports;
- Surface course for parks and tennis courts;
- Floors for zoo areas and animal barns and stalls;
- Bridge embankments;
- Swimming pool decks;

Fig. 3.1—Parking lot built with pervious concrete pavement.