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68-18

Permeable Interlocking Concrete Pavement

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PREFACE

Permeable pavements typically consist of pervious concrete, porous asphalt, or interlocking concrete paver units over an open-graded base or subbase layer(s). Permeable pavements are designed to infiltrate stormwater, reduce peak flows, improve stormwater quality, and promote groundwater recharge. They have become an integral part of low-impact development, sustainable design, green infrastructure, and best management practices for stormwater management. In order to be effective within municipal road networks, permeable pavements must be designed to provide sufficient structural capacity to accommodate the anticipated vehicle loadings while managing stormwater flows into and out of the permeable pavement.

Although there have been many well designed and constructed permeable pavements, this is a relatively new technology compared to conventional pavements, and there have been some performance concerns. These concerns include pavement surface rutting caused by loads exceeding the pavement structural design, settlement caused by improper base and/or subbase gradations, and insufficient compaction of the base or subbase. A common concern is clogging of the pavement surface from sediments tracked onto the pavement or transported by water run-on from adjacent surfaces.

This standard was written to address these concerns and more. It provides design, construction, and maintenance guidance for permeable interlocking concrete pavement to achieve stormwater management goals while providing a structurally adequate pavement section to accommodate the anticipated vehicular loading in a cost-efficient manner.

Introduction

Permeable interlocking concrete pavement (PICP) can provide a durable and effective pavement and stormwater management system. As with any pavement and stormwater management practice, proper design, construction, and maintenance procedures are required. To better address these needs, this standard was prepared by the ASCE Permeable Interlocking Concrete Pavement Committee. This publication establishes guidelines for developing appropriate pavement structures for various stormwater drainage, traffic, and subgrade conditions as well as providing guidance on construction and maintenance.

This standard is written with the intent of being adopted in whole or in part for use by national, provincial, state, and local stormwater and road agencies for the consistent and effective design, construction, and maintenance of permeable interlocking concrete pavement systems. The overall goal is assisting design professionals, civil engineers, the industry, public stormwater and transportation agencies, and the wider public by establishing design standards for permeable interlocking concrete pavements. The document provides

- Definitions of terms common to permeable pavements;
- Methods for structural design to accommodate incidental and frequent vehicular use;
- Methods for hydrologic design to accommodate water infiltration and flow into, within, and out of the pavement system;
- Construction and inspection procedures;
- Guide construction specifications; and
- Maintenance procedures for the permeable pavement system.

PICP may help achieve compliance with many national, provincial, state, and local regulations, as well as transportation agency design requirements for the control of stormwater runoff. Requirements may include the following:

- Compliance with federal, provincial, state, and local transportation design standards;
- Compliance with pavement structural design and construction requirements;
- Compliance with vehicular and pedestrian safety and access requirements;
- Transportation asset management compliance, including lifecycle cost analysis and lifecycle assessment of environmental impacts;
- Stormwater runoff controls and regulatory compliance;
- Compliance with groundwater protection requirements;
- Postconstruction runoff volume and pollutant control for new development and redevelopment;
- Reductions in impervious cover (i.e., roofs and pavements) and resulting runoff;
- Runoff volume storage and/or infiltration to reduce overflows, especially combined sewer overflows, as well as reduction of flooding for a more resilient infrastructure;
- Compliance with total maximum daily load (TMDL) requirements for receiving waters;
- Management of water quality and/or quantity storm events; and
- Compliance with local building code requirements.

Permeable interlocking concrete pavements may assist in achieving regulatory program and policy compliance. Examples include the Great Lakes Protection Act, Species at Risk Act, National Pollutant Discharge Elimination System (NPDES), Canadian Federal Fisheries Act, U.S. Clean Water Act, U.S. Environmental Protection Agency (US EPA) Stormwater Assessment Program, Source Water Protection Plans, CALGreen in California, the International Green Construction Code, ASHRAE Standard 189.1, and stormwater utility fee credits or other codes that require compliance with Leadership in Energy and Environmental Design (LEED) or similar sustainable design and construction rating systems.

Nonregulatory drivers that influence PICP use include the following: economics that often make PICP a lower-cost alternative to conventional drainage and stormwater management system designs, and project owner preference for conformance to sustainable rating systems for roads and transportation infrastructure. Examples include the Green Business Certification, Inc.'s Sustainable SITES Initiative, the Institute for Sustainable Infrastructure's Envision evaluation system, Greenroads, GreenPave, and the Federal Highway Administration's Infrastructure Voluntary Evaluation Sustainability Tool (INVEST).

Finally, other nonregulatory drivers include product, system, or project lifecycle analysis (LCA) of environmental impacts in the manufacture, construction, use, and end-of-life phase. Product Category Rules (PCRs) for segmental concrete paving products used in PICP are available from ASTM. These rules provide a useful framework for conducting a LCA, as well as for providing environmental product declarations for paving products.

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CHAPTER 1
GENERAL

1.1 SCOPE

This standard establishes hydrologic and structural design methods for permeable interlocking concrete pavement (PICP). Permeable pavement design is typically site specific and requires careful consideration of structural and hydrologic conditions, and of the impact on the surrounding environment.

This document provides information for professionals to use in the design of permeable pavement systems. This information includes applicable standards, definitions, best practices, structural and hydrologic design, key design elements, guide specifications, construction guidelines, and long-term maintenance. This standard is recommended for roadways with design speeds no greater than 50 kph (35 mph) receiving less than 1 million equivalent single axle loads (ESALs).

The pavement structural design recommendations in this standard are based on mechanistic-empirical design research. The process described herein is based on data from a full-scale accelerated PICP load testing program. Design considerations herein require a working knowledge of stormwater drainage, soil mechanics, traffic loading, and pavement materials. Pavement design and stormwater specialists should be consulted for the application of this standard.

This book consists of six chapters plus appendixes and references:

- Chapter 1 outlines the general scope of the standard;
- Chapter 2 provides definitions of key terms, as well as a list of consensus standards and other referenced documents used in this standard;
- Chapter 3 provides preliminary information required to design permeable pavements and also provides fundamental information on typical designs for common site conditions;
- Chapter 4 provides detailed procedures and rationale for structural and hydrologic design;
- Chapter 5 covers construction and inspection guidelines; and
- Chapter 6 includes pavement maintenance guidelines.

The appendixes are the following:

- Appendix A: Design Examples,
- Appendix B: Guide Construction Specifications,
- Appendix C: Examples of Orifice and Common Weir Equations,
- Appendix D: PICP Structural Design Using AASHTO 1993, *Guide for Design of Pavement Structures*, and
- Appendix E: Approximate Correlation between Permeability and Unified Soil Classification.

This standard applies to the design of new and retrofit pavement systems surfaced with PICP. It also includes hydrologic and structural design guidelines using open-graded aggregate bases. This standard does not address the specific biological, chemical, and physical processes as related to water quality improvement. Other references should be consulted for the water quality benefits available to project-specific pavement systems.

This standard does not address site-specific constraints and/or local conditions that may require more detailed analysis, specifications, construction, and maintenance practices critical to successful pavement performance.

1.2 REFERENCED STANDARDS

In addition to provincial, state, and local government jurisdiction over stormwater drainage and pavement structural design procedures, the provisions of applicable ASTM, CSA, or AASHTO standards listed herein are provided in full in the list of consensus standards and are part of this standard. Many ASTM standards and test methods have equivalent standards and test methods in AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*. Equivalent standards published by both organizations are used throughout this standard.

1.3 VARIATIONS FROM THIS STANDARD

Use of proprietary, new and/or improved permeable interlocking concrete pavers, aggregate materials, evaluation techniques, and installation methods are not specifically excluded, as long as the design and installation of the pavement are shown to comply with or exceed this standard.

1.4 ENGINEER REQUIRED

Work covered by this standard should be carried out under the guidance of a professional engineer with a background in the design of pavement and stormwater systems. The professional engineer is hereinafter referred to as the engineer. This standard does not dictate the means and methods to be used by the engineer. Means and methods must be appropriate to each project.