AASHTO
American Association of State Highway and Transportation Officials

AASHTO Guide for Interlocking Pavements

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Foreword

The concept of unit pavement has existed since the start of recorded history and remains in every culture. Around 5,000 BC, the Minoans wrote about their stone streets. Later, inexpensive slave labor enabled the Romans to build an interstate highway system equivalent in length to that of the United States. This pavement network across Europe secured their conquered territories and promoted trade.

The principles of pavement construction developed by the Romans remain. The Appian Way, shown in Figure F-i, is an early example of compacted aggregate layers with increasingly smaller particles rising to support a surface of tightly fitted stones. The joints between the stones had to be sufficiently narrow to not accept the head of a Roman spear. If they did, legend says that the crew supervisor was speared by the Roman job superintendent. Adherence to such exacting standards might help explain why Roman roads have lasted for over two millennia.

Figure F-i. Ancient Interlocking Pavement: The Appian Way near Rome ca. 312 BC (Source: Interlocking Concrete Pavement Institute)

Fast forward to the 20th century where the invention of the automobile created the need for smooth asphalt and concrete pavements to accommodate fast moving vehicles. Smoother roads replaced many clay brick streets in urban America and resulted in segmental paving fading into history. The clay and stone streets that remained in some historic districts reminded users of the durability and character these pavements add to such neighborhoods.

However, a more modern and smoother expression of segmental paving, interlocking concrete pavement, emerged in the fourth quarter of the 20th century, first in Europe, then in North America, then around the world. Concrete unit materials and pavements made from them were researched and evaluated. Additional research came about from the 1990s on the permeable version for reducing stormwater runoff called permeable interlocking concrete pavements (PICP). Much research on both pavement systems is found in the proceedings of a series of international conferences on concrete block pavements. The papers from these conferences are available on www.sept.org.

This Guide represents a synthesis of that research and decades of experience on materials, design, construction, and maintenance. It is provided as a resource to state departments of transportation (DOTs) and to municipal public works departments. The timing and contents of this publication can help address needed environmental sustainability and flood resilience of urban pavements (see Chapter 6).

The Interlocking Concrete Pavement Institute (ICPI) greatly appreciates the AASHTO Committee on Materials and Pavements for the opportunity to present this book as a tool in the toolbox for use by transportation agencies and the wider civil engineering community.

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Chapter 1

Introduction to Segmental Concrete Pavement Systems

The types of segmental concrete pavement systems include interlocking, permeable interlocking, paving slabs, planks, and grid units. These are illustrated in Figure 1-1. This Guide provides technical information and references on the first two pavement systems as they are specifically intended for streets, making them of interest to state departments of transportation (DOTs) and municipal public works officials. Moreover, millions of square feet of permeable interlocking pavements have been placed in the United States and Canada.

Figure 1-1. The Family of Segmental Concrete Paving systems (L to R): Interlocking, Permeable Interlocking, Paving Slabs, Planks, and Grids (Source: Concrete Masonry and Hardscapes Association)

1.1 Interlocking Pavements

Interlocking pavements consists of solid, individual, high-strength concrete paving units capable of being grasped and installed with one hand. When installed, the interlock from sand between the units has them resting on a thin layer of sand. Vehicular applications are designed with aggregate bases and subbases, cement- and asphalt-treated bases, asphalt, or concrete bases. Pavements with these bases are considered flexible pavements, except for those with concrete bases, which are considered rigid pavements. Interlocking pavements are also used in pedestrian areas because of their visual appeal and the design flexibility made possible by the various shapes, colors, and patterns available.

Originally developed in Germany and The Netherlands for roads in the 1950s and 60s, manufacturing and installation technology transferred from these countries in the mid-1970s which initiated interlocking pavement manufacturing and installation in Canada and the United States. The advent of mechanized installation in the 1980s increased parking lot, street, port, and airport applications. Since then, advances in materials, manufacturing technologies, product and design standards, mechanized construction methods, and pavement management have been supported by research and experience in the United States and Canada, as well as from overseas.

Interlocking pavement is used in urban streets, including major arterials. The pavement is sometimes designed to increase pedestrian and driver safety in traffic calming measures, such as at-grade or raised crosswalks, intersections, speed humps, speed tables, bump outs, and chicanes. Unlike monolithic pavements, interlocking concrete pavement (ICP) facilitates pavement cuts for utility repairs by the reinstatement of the same removed units without surface damage. Additional information on materials, design, construction, and maintenance of interlocking pavement is available from the American Society for Civil Engineers (ASCE) and the Concrete Masonry and Hardscapes Association (CMHA).

1.2 Permeable Interlocking Pavements

Originally developed in Germany in the early 1990s and transferred to the United States in the mid-1990s, permeable interlocking concrete pavements are used in pedestrian areas, parking lots, alleys, road shoulders, and low-volume streets. Such pavements consist of solid, individual concrete paving units, like those used in interlocking pavements. When installed, the pavement consists of slightly larger joints between the units than interlocking pavements. The paving units rest on a thin bedding layer of permeable aggregates, and the joints are filled with small permeable aggregates. Designed as a flexible pavement, the base and subbase reservoir consist of open-graded aggregates which enable water storage and infiltration into the subgrade or exiting via underdrains.

The open-graded aggregate base and subbase reservoir simultaneously manage stormwater and reduce pollutants while functioning as a pavement that supports traffic. This combination can reduce or eliminate the need for stormwater detention facilities and drainage appurtenances, thereby making permeable interlocking concrete pavement (PICP) cost-effective in many applications. DOTs and municipalities have used permeable interlocking pavements to comply with National Pollutant Discharge Elimination System (NPDES) permits and total maximum daily load (TMDL) requirements. Applications have used the water storage capacity of the subbase reservoir to decrease the impacts of flooding. The absence of internal hydrostatic pressures that typically break apart inundated impervious pavements provide increased flood resilience. Additional information on permeable interlocking pavement is available from ASCE and the Concrete Masonry and Hardscapes Association (CMHA).

1.3 Comparison of Interlocking and Permeable Interlocking Pavement Characteristics

Table 1-1 summarizes the similarities and differences between these two pavement systems.

Table 1-1. Comparison of Interlocking and Permeable Interlocking Pavement Characteristics

Characteristic	Interlocking Pavement	Permeable Interlocking Pavement
Primary Function	Urban Pavement	Low-volume pavement & stormwater management
Posted Speed Limit	45 mph	35 mph
Lifetime Design ESALs*	10 million	1 million
Typical Paving Patterns for Roads	45° or 90° herringbone	45° or 90° herringbone
Surface Slope	Typically 1.5% to 20%	Typically ≤ 5%; can be higher 3% or higher may require check dams
Surface Water Infiltration	Minimal	100% infiltration
Surface Area Open to Base	Close to 0%	Typically 5% to 15%
Typical Joint Widths	1/8 to 3/16 in.	1/4 to 1/2 in.
Joint Fill Materials	AASHTO M 45 sand	AASHTO M 43 No. 8, 89, or 9 stone
Bedding Layer Under Pavers	1-in.-thick, washed ASTM C33 concrete sand on flexible & concrete bases or 1-in.-thick typical asphalt surface course on a concrete base	2-in.-thick AASHTO No. 8 stone
Base Materials	Dense-graded aggregates, cement-treated, asphalt-treated, asphalt, or concrete—thickness varies with structural design	4-in.-thick AASHTO No. 57 stone for vehicular traffic over a subbase 6 in. min. thickness for pedestrian uses; subbase not used
Subbase Materials	Dense-graded aggregates—thickness varies with structural design	AASHTO No. 2, 3, or 4 stone—thickness varies with structural & hydrologic designs
Underdrains	On low-infiltration soils	On low-infiltration soils, typically with a raised outlet for detention

**Note*: 18,000 lb equivalent single axle loads