Present Day Application of Interlocking Concrete Pavers
Overview

- This presentation will focus on current trends in the world of interlocking concrete pavements (ICPs).
Outline

■ What are concrete pavers
  – Concrete: Basic Properties
  – Concrete Pavers: Interesting Facts
  – Concrete Pavers: Manufacturing

■ What are interlocking concrete pavers (ICPs)
  – Types of ICPs
    • Permeable vs. Non-Permeable ICPs
  – Benefits of using ICPs
    • Environmental
      – PICPs
      – The Greening of Concrete Pavements
    • Aesthetic Benefits
    • Cost

■ Project Examples
Concrete

- “Concrete is a mixture of aggregate, Portland cement, water and sometimes special admixtures. Its most outstanding qualities are strength durability, stability, availability, adaptability, and in most cases, its relatively low cost in terms of construction and life-time maintenance.”

Concrete Pavers

- Known as concrete block in some countries.
- In North America paver use has grown 900% between 1980 and 2005.
- Globally, there is now at least one square foot of concrete paving for every person living on planet earth.
- During every second of the working day, 1,000 pavers are made throughout the world!

Concrete Pavers

- Concrete pavers are factory made.
- This property assures quality and strength.
- Because there are a wide range of manufacturers throughout the country, pavers are diverse.
- They come in numerous styles and can be custom manufactured.
Concrete Pavers  Manufacturing Steps

1. Concrete is mixed
2. Pigment is added
3. Pavers are cast individually in multiunit molds
4. They are then vibrated and compressed under extreme pressure
5. Pavers receive finishing effects, like tumbling for distressed appearance
Manufacturing Photos

Images courtesy of Everett Ward
What are Interlocking Concrete Pavers (ICPs)?

- Pavers that apply force to each other in a way that holds them in place are referred to as interlocking concrete pavers.
- Sand or other joint fillers (often very fine aggregate) is added to the joints to reinforce the interlocking action.

Different paving patterns (patterns in which the concrete pavers are arranged) provide different levels of interlocking strength.

- For example, herringbone creates the strongest interlocking force because it provides contact with the greatest number of other pavers.
ICPs

- Some units are manufactured to interlock on the underside of the pavers for additional system strength.
ICPs

Non-Permeable vs. Permeable

- **Non-Permeable**
  - Traditional interlocking pavers are placed against each other so tightly that the resulting surface is not pervious. The sand in the joints has no filtration properties.

- **Permeable**
  - Gaps are designed into the block shape and are filled with aggregate. This allows for infiltration while also providing the necessary interlock.

Non-permeable: pavers flush
Permeable: gaps between
ICPs

Benefits

- Designers and homeowners choose to use ICPs in projects for a variety of reasons:
  - **Cost**
    - Although the initial installation cost may be greater for ICPs than other materials, they can be less expensive than products such as stone and have a lower long term maintenance cost than surfaces such as asphalt.
  - **Longevity**
    - Monolithic paved surfaces such as concrete can settle and crack. ICPs can withstand freeze-thaw cycles in climates with great temperature fluctuation. Since pavers are modular, they create a more flexible system that does not have settling problems.
  - **Strength**
    - Since ICPs are factory manufactured, quality and density is more consistent than poured concrete applications.
  - **Ease of Repair and Maintenance**
    - Since the system is modular, one damaged paver can be replaced at a time rather than the entire system needing replacement.
  - **Extensive Design Possibilities**
    - A large range of colors, sizes and types of ICPs provide designers with many choices. Custom colors are available from many manufacturers. Different patterns can offer a wide range of “looks” for a project.
  - **Safety**
    - ICP systems provide a safe, non-slippery surface for pedestrians.
ICPs

- Using ICPs instead of other paving materials can have environmental benefits.
- Local materials can be incorporated into the pavers during manufacturing.
- This reduces shipping mileage and emissions from trucking.
- ICP systems can be pervious which reduces runoff from sites.
- Permeable systems allow groundwater to recharge and filter off pollutants from entering groundwater.
- Many ICPs are light in color (low albedo) and this can help lessen the heat emitted from a site (heat island effect).
ICP’s

While there are environmental benefits to choosing a permeable ICP system, there may be reasons designers choose a non-permeable system.

Soils, loading, upfront costs, or type of use may drive the designer to choose a non-permeable ICP installation.

- For example, if changing car oil or doing maintenance on airplanes, a non-permeable surface would prevent pollutants from leaching into the groundwater.
- Certain sealants and polymers are only used with non-permeable surfaces like stain protection.
Types of ICP Installation

Non-Permeable

Figure 2: Edge Restraints. Note: Troweled concrete and submerged concrete curbs are recommended in non-freeze-thaw areas only.

Installation Overview  Non-permeable

- Compact subgrade
- Layer of compacted aggregate, 8”
- Lay setting bed, 1”
- Add Edge Restraints
- Place blocks so they click into place next to each other
- Sweep sand into cracks
- Vibrate to settle sand and lock in place

Installation Photos
What is PICP?

- Permeable interlocking concrete pavements (PICPs) filter and drain stormwater back into the soil rather than create runoff.
- “PICP comprises a layer of solid concrete pavers separated by joints filled with small stones. Water enters the joints between the pavers and through an ‘open-graded’ base—crushed stone layers with no small or fine particles. The void spaces among the crushed stone store water and infiltrate it back into the soil subgrade. The stones in the joints provide permeability, and the base filters stormwater and helps reduce pollutants.”(1)
ICP’s

- As stated previously, pervious and permeable paving allows water to infiltrate back into the subgrade.
- Less run-off is generated in pervious systems than with impervious systems.
- Permeable ICP installations are often used where detention basins would otherwise be needed.
- Systems can be designed to handle stormwater quality and quantity issues.
ICP’s

With impermeable pavers the water runs off the impervious surfaces without filtering as there are no gaps in surfaces.

With permeable pavers the water runs off the impervious surfaces while it filters through gaps in permeable surfaces.

Permeable Pavement

- ICP manufacturers have stated that permeable pavement systems are one of the fastest growing segments of the industry.
- Many municipalities have revised stormwater regulations requiring less site runoff.
- Permeable paving products have become more readily available with increased demand, and the industry is developing new permeable ICP paving products all the time.
- New research and development means that the efficiency of these systems and installation practices have improved greatly in the past few years.
ICPs

The “Green” Industry

- Due to new federal and local mandates and increased environmental awareness by the building industry, the “green” building industry is one of the fastest growing segments of our economy. (1)

- The following is a brief overview of industry standards and how they influence the use of ICPs.
"LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts.” (1)

- The LEED (Leadership in Energy and Environmental Design) system is one of the most widely used green industry standards. The LEED point system rates multiple levels of construction including homes, existing buildings and new construction.
- Permeable paving systems can earn a variety of points within the LEED rating system.
SITES™ Sustainable Sites Initiative

-The Sustainable Sites Initiative™ (SITES™) is an interdisciplinary effort by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices.” (1)

- The SSI (Sustainable Sites Initiative) rating system is the first national rating system for site work and landscapes.

- The SSI rating system gives points for using sustainable materials and managing stormwater in an environmentally beneficial way.

- The SSI system may soon be incorporated in the LEED rating system. SSI is in a pilot stage until 2012.
LID

“Low Impact Development is a non-profit organization dedicated to the advancement of Low Impact Development technology.

Low Impact Development is a new, comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds.”(1)

LID recommends managing stormwater close to the source by looking at a site’s pre-development hydrology.

LID advocates using micro-scale management practices and low cost, site specific strategies including pervious pavement systems.
The Green Industry & PICPs

- According to the Interlocking Concrete Pavers Institute:
  - “permeable interlocking concrete pavements (PICPs) are highly effective in providing infiltration, detention and treatment of storm water pollution. The base can be designed to filter, treat and slowly release water into a storm sewer or water course while providing a walking and driving surface. PICPs answer the call from municipal regulations to limit impervious cover and runoff into storm drains working at capacity, or when sites have limited space for detention ponds.”

- The U.S. Environmental Protection Agency and several state agencies consider PICPs an infiltration BMP.

- An increasing number of cities, counties and states are incorporating them into land development and runoff standards, low-impact development guidelines and design manuals on stormwater control.

- With proper design, material selection, construction and routine maintenance, PICP is a sustainable low-impact BMP used by landscape architects, architects, engineers, developers and public agency staff.” (2)
How PICPs Achieve Environmental Goals

- Reduce runoff
- Increase infiltration
- Reduce pollutants and suspended solids
- Reduce impact to aquatic habitat
- Improve water quality
- Can completely negate the need for detention ponds
PICP

Diagram
USGBC LEED Points for ICPs

ADD image: Summary of USGBC LEED Points
PICP

- Since the 1970s, EPA (Environmental Protection Agency) has conducted tests on permeable pavements.
- Currently, the EPA is testing PICPs, permeable concrete, and porous asphalt in a new parking lot at the EPA laboratory in New Jersey.
- The agency is testing for long term processing of stressors in the soil and groundwater.
PICP

- In addition to all the monitoring, they are comparing cleaned and not cleaned surfaces to determine appropriate cleaning intervals (vacuuming)
PICP

- PICPs can have environmental benefits beyond stormwater infiltration and runoff reduction.
- PICPs can reduce the amount of disturbed land on sites due to a decreased need for detention basins. The result may be saving forested areas and less emissions from demolition and construction equipment.
- The individual components of a PICP system can be sustainable as well. A PICP system can:
  - Use local materials
  - Be installed with low impact or smaller equipment than traditional paving systems
  - Use recycled materials (ex. Crushed concrete) for
    - Base materials
    - Aggregate in PICP block
PICP

- Many municipalities have increased standards for stormwater infiltration.

- Municipalities themselves often use PICPs as a way to “showcase” new green building methods and improve water quality on a large scale.

- The City of Chicago has implemented a program to demonstrate different scale installations throughout the city.

- Alleys, plazas and small demonstration sites are located all over the city.

- Chicago is also in the process of requiring sustainable design and infrastructure practices.
Chicago’s Green Alley Program

- Replaces impermeable surfaces throughout Chicago to lessen stormwater runoff
- Read more about the program here

Before

After
Chicago moved a street vendor market to a new location and in the process incorporated permeable paving for the large space

Used the Green Alleys program for public plazas
PICP Case Studies

- Case study showcasing eight permeable interlocking concrete pavement projects across North America.
- The profiles demonstrate that permeable pavers work in practically every climate and soil type, addressing local, state and national mandates to reduce runoff and water pollution.
- To view this document click here
The 59,000 square-foot science and cultural center nestled on 233 pristine acres offers a unique mix of recreational, educational, and rental opportunities.

As Gwinnett County's first "green" building, the GEHC is a working exhibit of resource-efficient design, construction and operations.

The Center exceeds the (LEED) Leadership in Energy and Environmental Design Silver Level standards of the U.S. Green Building Council!

As a result of the sustainable design strategy, stormwater runoff will be minimized, indoor air quality will be improved, energy use will be reduced by 35%, and water use will be reduced by 75%.

Features such as the largest sloped vegetative roof in the Southeast, pervious pavement and the use of recycled materials promote environmentally friendly strategies and make the Center unique!
Case Studies  
Institutional  

- Site utilized combined system approach including:
  - Bio-swales
  - Roof gardens
  - Water feature using reused water

Gwinnett Environmental & Heritage Center
Case Studies

Residential

High Point Development
Seattle, Washington

- Seattle’s High Point neighborhood was among five outstanding developments selected worldwide as winners of the Urban Land Institute's (ULI) Global Awards for Excellence. This award has become widely recognized as the land use industry’s most prestigious recognition program.
Case Studies

Residential

- High Point is a 120-acre, ecologically-conscious, planned community with half of its 1,600 houses completed.
- High Point is Seattle's first and only Built Green™ neighborhood.
- An innovative natural drainage system uses natural processes to filter and clean rainwater on its way to Longfellow Creek.
- Landscaping uses native plantings chosen for their hardiness and low water needs.
- The first porous pavement street in Washington, plus porous pavement walkways allow rainwater and runoff to filter into the ground naturally.
- All homes meet a minimum of Built Green 3-Star standards, with many achieving 4-Star level and ENERGY STAR® certification.
Glen Brook Green subdivision in Waterford, Connecticut includes over 15,000 sq. ft (1500 m2) of PCIP riveways and roads. These are mixed with asphalt driveways, and crushed stone driveways joined to single family homes.

Infiltration tests in 2002 and 2003 showed that the PICP built on a dense-graded, crushed stone base provided somewhat higher infiltration rates than the crushed stone driveways in the same subdivision.

A rain garden in the center of a PICP cul-de-sac.  
PICP driveway and road.
Case Studies
Residential Subdivision
Glen Brook Green
Waterford, Connecticut
Case Studies
Commercial

- The Hilton Garden Inn designers chose PICP to satisfy the City of Calabasas stormwater management requirements.
- These mandated at least 30% pervious cover to control the quantity and quality of runoff from the site, specifically by containing the “first flush” or the initial 1/4 in. (6 mm) of rain water within a 24-hour period.
- PICPs accommodate markings for parking spaces and an access route for disabled persons.
Case Studies
Commercial

Shopping Center
Burnaby, British Columbia

- There are 350,000 sq. ft of PICPs in the parking lot of this shopping center in Burnaby, British Columbia.
- The PICPs help infiltrate the stormwater runoff from the roofs of the buildings.