Low Impact Case Studies at Hobcaw Barony:

Pervious Paving Installation at University of South Carolina’s Baruch Institute

Outline for this Session

- What is Pervious, Porous or Permeable Pavement?
- Permeable Pavement Types
- Permeable Pavement: Why, How, Where
- Permeable Paving Design Basics
- LEED and Permeable Pavement
- Permeable Pavement and Stormwater Quantity / Quality
- Design Specifics – Fire Apparatus Access Lanes
- NDS EZ Roll Gravel Installation at Hobcaw Barony
What is Permeable Pavement?

Permeable pavement, also known as pervious or porous pavement is a paving surface designed to allow stormwater to infiltrate or seep through the pavement surface into the underlying structure and/or soils.

Infiltration allows stormwater to be naturally filtered by vegetation and soils to reduce or remove pollutants while restoring groundwater supplies.

Types of Permeable Pavement

- Porous Asphalt
- Porous Pavers / Block / Brick
- Porous Concrete
Types of Permeable Pavement

Reinforced Turf Paver

Reinforced Gravel Paver

Why Specify Permeable Pavement?

Permeable Pavement is an engineered component that is well suited for most LID design approaches.

Permeable Pavement may contribute to:

- % Impervious Reduction
- Stormwater Quality Improvement
- Stormwater Quantity Reduction
- LEED Points Contribution
- Point Source Treatment
- Softer, Aesthetically Pleasing Surfaces
How Do I Specify Permeable Pavement?

The end-use designation and intended use must always be considered when deciding between permeable pavement types.

The key considerations:

- Traffic Type
- Traffic Volume & Frequency
- Pedestrian and Accessibility Requirements
- Maintenance and Upkeep
- Owner Expectations
- Design Code and Jurisdictional Requirements

Where Do I Specify Permeable Pavement?

Permeable Pavement can be designed to handle almost every traffic and pedestrian application encountered.

The most prevalent uses are in:

- Reinforced Turf Fire Lanes
- Full Duty Occasional and Overflow Parking
- Nature and Interpretive Paths
- Rails – To – Trails Projects
- Residential Driveways
- Sports and Entertainment Venues
Permeable Pavement – Reinforced Turf

Reinforced Turf systems provide the soft, aesthetic appearance of managed grass with the load carrying capability of traditional paving materials. They work well given:

- Adequate Bearing Capacity of underlying soils
- Properly designed base material and thickness
- Proper turf selection and maintenance
- Inherent material strength for proper root zone protection

Permeable Pavement – Reinforced Gravel

Reinforced Gravel systems provide the appearance of a traditional gravel drive or path. A properly designed and constructed gravel paver system provides:

- Inherent material strength to support intended loads
- A mechanically attached geotextile fabric to prevent:
  - Gravel loss into underlying soils
  - Panel heave from gravel undermining
- Cellular confinement to enhance load carrying capability
- Inherent expansion / contraction design
- Secure, mechanical attachment of adjacent panels
Permeable Pavement Design Basics

Permeable Pavement design requires adherence to basic pavement design principles.

- Geotechnical Engineer Consultation (as required)
- Expected Vehicle Type and Weight
- Underlying Soil Support Values
- Groundwater Concerns
- Permittivity of Existing Soils (>1 cm/sec)
- Base Material Selection
  - Graded Aggregate Base – High Compaction & Loading (1.5 cm/sec)
  - Clean Stone – High Void Ratio for Stormwater Storage (8.5 cm/sec)

Permeable Pavement - ADA Accessibility

Accessibility Testing

The grass and gravel paver industry has recently began certifying products to ASTM F 1951-08 "Determination of Accessibility of Surface Systems Under and Around Playground Equipment"
Permeable Pavement & LEED

LEED provides building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

Potential LEED Credits with Permeable Pavement

- Credit 5.1 Reduced Site Disturbance, Protect or Restore Open Space
- Credit 5.2 Reduced Site Disturbance, Development Footprint
- Credit 6.1 Stormwater Management, Rate or Quantity
- Credit 6.2 Stormwater Management, Treatment
- Credit 7.1 Landscape and Exterior Design to Reduce Heat Island, Non-Roof
- Credit 7.2 Landscape and Exterior Design to Reduce Heat Island, Roof
- Credit 3.1-2 Resource Reuse, 5% - 10%
- Credit 4.1-2 Recycled Content, 25% - 50%
- Credit 1.1 Innovation in Design

Permeable Pavement & Stormwater Quantity

Stormwater quantity reductions are achievable by specifying materials with accepted or known permittivity and void space ratios.

Objectives:
- Reduce runoff volumes with reduced % impervious
- Create storage by specifying open graded materials
- Promote infiltration and natural stormwater treatment
- Reduce channel volumes and downstream impact
- Reduce attenuation with lower combined “C” coefficient

Challenges:
- Lack of an established design procedure
- Regional differences (real and perceived) in soils
- Contractors (experience, exposure, acceptance)
Permeable Pavement & Stormwater Quality

Stormwater quality contributions with permeable pavement, while intuitively apparent, have proven difficult to measure.

Obvious Contributions:
- Reduction in impervious = reduced stormwater runoff
- Reduction in runoff volume = reduced associated pollutants
- Infiltrative Surface = natural treatment & groundwater recharge

Challenges:
- Quantifying reductions in TSS, Nutrients and Metals
- Concerns with clogging of porous media
- Product inconsistencies (inherent strength, base requirements)

Fire Apparatus Access Lane Design Specifics

Fire Apparatus Access Lanes (Fire Lanes) require a solid, informed design approach that considers load, hydraulics and code requirements.
Fire Apparatus Access Lane Design Specifics

In the case of fire apparatus access lanes consideration must be given to the conditions under which the design will see use. These conditions will involve heavy vehicles (approx. 75,000 pounds GVW) with equipment, personnel and up to 1,200 gallons of water in a saturated environment.

In other words, a structure fire where response time is the difference between life and death.

Under these conditions, review of the subsoil, pavement section and their behavior under saturation is advised by the designer or Geotechnical Engineer.

International Fire Code (IFC)

In 2003 the International Fire Code Institute formally consolidated into the International Code Council (ICC) along with ICBO, BOCA and SBCCI.

Many jurisdictions are adopting or phasing into the most recent code set known as the 2009 I-Code, in which the IFC is adopted. Others may use different code sets such as the National Fire Prevention Association (NFPA). Check with local officials.
Fire Apparatus Access Lane Design Specifics

International Fire Code (IFC) Appendix D

D102 Required Access
D102.1 Support fire apparatus weighing at least 75,000 lbs.

D103 Minimum Specifications
D103.1 Width at least 26’ if hydrant is present on access road
D103.2 Grade no more than 10%
D103.3 Turning Radius to be determined by Fire Official
D103.4 Dead End Provisions

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 150’</td>
<td>20’</td>
<td>No Turnaround Required</td>
</tr>
<tr>
<td>151’ – 500’</td>
<td>20’</td>
<td>120’ Hammerhead / 60’ “Y” / 90’ D Cul-de-Sac</td>
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<tr>
<td>501’ – 750’</td>
<td>26’</td>
<td>120’ Hammerhead / 60’ “Y” / 90’ D Cul-de-Sac</td>
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<tr>
<td>&gt;750’</td>
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<td>See Fire Official for Special provisions</td>
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</tbody>
</table>

D103.5 Gates 20’ width minimum, swinging/sliding, 1 person operable
D103.6 Signage – Confer with local Fire Official

D104 Commercial and Industrial Developments

D105 Aerial Fire Apparatus Access Roads
D105.1 Required for buildings >30’ height, No O/H power or utility lines
D105.2 Width at least 26’
D105.3 Proximity within 15’, maximum of 30’ from building parallel to one entire side
Fire Apparatus Access Lane Design Specifics

International Fire Code (IFC) Appendix D

Additional Notes:
Methods of delineation will be determined by local Fire Officials
Curb cuts should be provided for all Fire Apparatus Access Lanes and the final width will be determined by local Fire Officials

Fire Apparatus Access Lane Design Specifics

Fire Apparatus Contact Patch Weights
The typical tire found on fire apparatus have a contact patch of approximately 10" x 12" or 120 square inches.

Caltrans Axle Weights

<table>
<thead>
<tr>
<th>Apparatus Configuration</th>
<th>Typical Weight (Lbs)</th>
<th>Tires</th>
<th>Square Foot Load</th>
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<tr>
<td>Single Steering Axle</td>
<td>23,000</td>
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<td>13,800</td>
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<td>Single Steering Aerial</td>
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<td>Single Drive Axle</td>
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<td>Tandem Axle</td>
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<td>Tridem Axle</td>
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<td>7,350</td>
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Fire Apparatus Access Lane Design Specifics

Fire Apparatus Outrigger Weights

<table>
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<tr>
<th>Apparatus Configuration</th>
<th>Typical Weight (Lbs)</th>
<th>Tires</th>
<th>Square Foot Load</th>
<th>Ostriggers</th>
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<td>5,290*</td>
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* The load on an Aerial Apparatus outrigger increases 3-4x with ladder extension and use

Belle W. Baruch Institute
for Marine & Coastal Sciences
NDS EZ Roll Gravel Paver – Hobcaw Barony

The Design:
The original design at Hobcaw Barony called for a pavement section consisting of a #57 stone to allow for maximum infiltration and stormwater storage. This would address several LEED design basics and provide on-site stormwater management.

The Challenge:
Once installed, #57 stone is resistant to lock-up and while straight line travel is generally acceptable, turning causes stone to “plow” ahead of the tire.

The Goal:
Maintain original design parameters related to stormwater infiltration and storage, maintain aesthetic approach of a natural gravel drive while maintaining vehicle and pedestrian accessibility.

The Solution:
Install NDS EZ Roll Gravel Paver directly on the in-place #57 stone, requiring minimal site preparation and disturbance. The gray color blends with the granite stone for visual aesthetics. The attached geotextile provides separation and sediment capture and the cellular confinement provides an even, accessible surface for vehicles and pedestrians.
NDS EZ Roll Gravel Paver – Hobcaw Barony

The Product:
- NDS EZ Roll Gravel Paver – Gray
- Roll Size – 4’ x 150’
- Cell Height – 1”
- Load Rating (No Fill) – 66,590 PSF
- Load Rating (Filled) - >500,000 PSF
- Up To 100% Recycled (PCR & IR)
- 100% Recyclable
- Weight – 348 Lbs / Roll

Shipping and Site Preparation
NDS EZ Roll Gravel Paver – Hobcaw Barony

Site Preparation and Installation

NDS EZ Roll Gravel Paver – Hobcaw Barony

Installation – Panel Joints
NDS EZ Roll Gravel Paver – Hobcaw Barony

Installation – Pinning Method & Layout

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Installation – Compound Joints & Adjacent Surfaces
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Installation – Infill Material

NDS EZ Roll Gravel Paver – Hobcaw Barony

Installation – Final Completion April 2009
NDS EZ Roll Gravel Paver – Hobcaw Barony

Installation – Final Completion June 2009

NDS EZ Roll Gravel Paver – Hobcaw Barony

Post Mortem – Lessons Learned

• The finished surface is a reflection of the underlying surface.
• Pinning anything to open graded stone is difficult.
• Initial settlement of the infill material will occur.
NDS EZ Roll Gravel Paver – Hobcaw Barony

Post Mortem – Lessons Learned

- Settlement and compaction of the infill material will occur.
- This photo illustrates why inherent panel strength is important.
- "Matching" color makes this settlement less visually apparent.
- Maintenance requires brushing up existing stone or adding some additional stone.

Thank You!

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