Research Links for Permeable Paving
11.17.05

WEB RESOURCES:

- Low-Impact Development Center, Inc. http://www.lid-stormwater.net/permeable_pavers/permtrans_home.htm
  - Research on watershed benefits of permeable paving surfaces
  - Maintenance and cost information (e.g. http://www.lid-stormwater.net/permeable_pavers/permpavers_maintain.htm)
- The Concrete Network. http://www.concretenetwork.com/concrete/porous_concrete_pavers/ http://www.concretenetwork.com/pervious/index.html
  - Information on specifications, installation, and maintenance
  - Example of a company doing integrated design and installation
- Stormwater Manager's Resource Center. http://www.stormwatercenter.net/
  - Fact Sheets and Articles on a wide range of urban watershed issues
- Biopaver. http://www.biopaver.com/problems.html
  - Good diagrams; appears to be an unfinished product concept
- A soucebook for green and sustainable building. http://www.greenbuilder.com/sourcebook/PerviousMaterials.html
  - Some installation guidelines and resources
- A.J. McCormack & Son. http://www.pavingexpert.com/permabl1.html
  - British company with interesting diagrams
- "Porous Pavements" technical book. http://www.thattechnicalbookstore.com/b0849326702.htm
  - Author: Bruce K. Ferguson. Publisher: Holding Publisher
- Puget Sound Online. http://www.psat.wa.gov/Publications/LID_studies/permeable_pavement.htm
  - Examples of permeable paving projects.
- Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/index.cfm

Overall Comparisons/Descriptions/Reviews

Better Site Design: Alternative Pavers
Porous Pavers - Competitive Analysis
Grass Pavers Compared
BuildingGreen.com - Grasspave Review
Tree-friendly drainage solutions make developers, owners & ADA happy.

TYPES OF PERMEABLE PAVING

1. "There are three general types of permeable paving surfaces. The first is loose stone, which tends to become less pervious over time, especially when used as a mixed grade with stone fines." *(from http://en.wikipedia.org/wiki/Permeable_paving):*

Examples:

- Traditional techniques, such as cobblestones and bricks
  - However, any cobblestone and brick roadways are not particularly permeable surfaces because of the way that they were built. Some newer ones are actually laid over concrete, while some older ones are either mortared or laid over a dense-grade aggregate that prevents absorption of most water.
- http://www.uni-groupusa.org/uni-eco-.htm. UNI Eco-Stone® pavers
  - UNI Eco-Stone® is a *true interlocking concrete paver* that can support heavier vehicular loads, unlike some other types of permeable pavement systems. UNI Eco-Stone® can be installed in running bond, basketweave, and herringbone patterns for residential, municipal and commercial applications such as patios, courtyards, driveways, and parking or storage areas.

o  

2. "The second involves the use of hard paving materials, either concrete, asphalt or paving blocks, that are constructed to be porous and to allow water to pass through the material." (*from wikipedia, see above*)

Examples:

- GraniteRock green products. http://www.graniterock.com/greenproducts.html
  - Pervious Concrete. http://www.graniterock.com/documents/Perv_Painted.pdf
  - Perco-Crete absorbant concrete. http://www.graniterock.com/documents/Percocrete.pdf
- Central Concrete. http://www.centralconcrete.com/pervious_concrete.html
  - Bay Area concrete company with pervious concrete
  - o 
  - Document describing the product: http://www.centralconcrete.com/pdf_files/Pervious_5_18_04.pdf

- http://permapave.com.au/products/pavers.htm. Permapave Permeable Pavers
    - Permapave Permeable Pavers are natural stone pavers which have a flow through rate of up to 30 litres per second.
    - 
- NaturalPAVE resin pavement. http://www.sspco.org/naturalpavexl/naturalpave_OV.html
    - Resin Pavement binder emulsion is mixed with aggregate materials to produce compacted pavement surfaces that retain the natural coloration and texture of the constituent aggregate material. SSPCo's environmentally friendly Resin Pavement mixtures contain no petroleum ingredients and are appropriate for use in sensitive natural environments, including access to beach, estuary and riparian areas.

3. "The third, sometimes called open paving, involves the use of generally impermeable materials, but these are placed to maintain open space between them, as in the "hopsack" method, to allow permeable areas of soils or other fill between the material placed. "Hopsack" is a method of placing oblong blocks so that space is permanently maintained between them. Special spacers are also available on the market. Open-type paving is usually intended for applications where grass will grow in the spaces between the blocks or other materials. This is a highly desirable feature in parking areas and low-impact roadways, being esthetically more pleasing, and has the additional benefit of reducing summer heat buildup due to inert pavement materials absorbing solar radiation and reradiating it as ambient heat." (*from wikipedia, see above*)

Examples:

- Traditional techniques, such as cobblestones and bricks
    - However, any cobblestone and brick roadways are not particularly permeable surfaces because of the way that they were built. Some newer ones are actually laid over concrete, while some older ones are either mortared or laid over a dense-grade aggregate that prevents absorption of most water.
- http://www.uni-groupusa.org/uni-eco-.htm. UNI Eco-Stone® pavers
    - UNI Eco-Stone® is a *true interlocking concrete paver* that can support heavier vehicular loads, unlike some other types of permeable pavement systems. UNI Eco-Stone® can be installed in running bond, basketweave, and herringbone patterns for residential, municipal and commercial applications such as patios, courtyards, driveways, and parking or storage areas.


- http://www.westconpavers.com/turfstone.htm
  - Turfstone provides an intelligent solution to the problem of permanently destroying green space to build occasionally used parking areas or fire and emergency roads. The design with 40% open areas allows ground cover to grow while still providing the necessary structural strength for any traffic. Turfstone also provides excellent erosion control and soil stabilization to slopes, embankments, low flow channels and dikes, ponds or reservoirs where there is no extreme wave action. Strong as concrete, sweet as grass.

4. Reinforcement of vegetated turf, using plastic cells, wire mesh, or some combination of the above.

Examples:

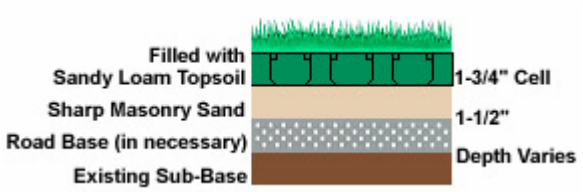
- http://www.prestogeo.com. Geoblock® Porous Pavement System.
  - The porous pavement system, manufactured from up to 100% recycled polyethylene, is a series of interlocking blocks designed to offer turf protection and load support in areas used by heavy vehicles. The units create a flexible structural bridge system within the topsoil layer to support and distribute concentrated loads.

- o  
- o 

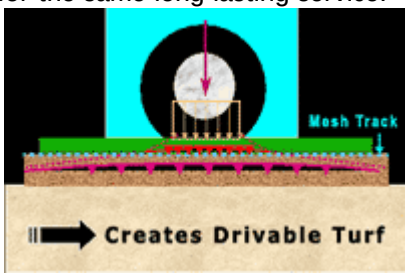
- http://www.invisiblestructures.com/GP2/grasspave.htm. Invisible Structures, Inc. Grasspave^2 Porous Paving System
  - Grasspave^2 is a structure which provides incredible load bearing strength while protecting vegetation root systems from deadly compaction. High void spaces within the entire cross-section enable excellent root development, and storage capacity for rainfall from storm events. Stormwater is slowed in movement through and across Grasspave^2 surfaces, which deposits suspended sediment and increases time to discharge. Suspended pollutants and moderate amounts of engine oils are consumed by active soil bacteria, which are aided by the system's excellent oxygen exchange capacity.
  - o 
  - The Grasspave^2 system is comprised of a sandy gravel base course, Hydrogrow polymer-fertilizer mixture, the Grasspave^2 ring and grid structure, sharp concrete sand, and grass seed or sod.

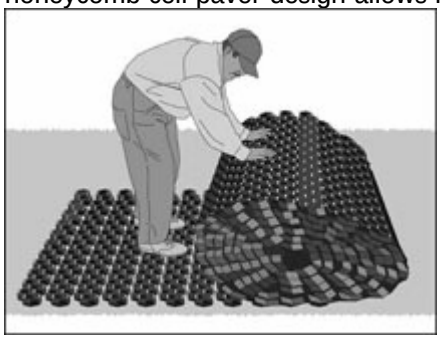
- Grasscrete. http://www.grasscrete.com/
  - Cast on site cellular reinforced concrete system with voids created by plastic void formers.
  - o 

- GRASSYTM PAVERS. http://www.rkmfg.com/grassypavers.asp

- Minimum 97% post-consumer recycled, reinforced high density Polyethylene (HDPE). UV stabilized. 48 hexagon cells each 2-1/8" base opening and 1/2" perimeter openings. 1/8" cell wall and base thickness.
- 

- GrassTrac reinforced grass areas. http://www.grasstrac.com/index.htm
  - GrassTrac is heavy duty wire mesh with torsioned flat wire reinforcement. It is used for load distribution in applications where driving or parking on turf is desirable. GrassTrac comes in large rolls of various widths for quick and easy installation with limited equipment. The GrassTrac system can be installed over existing turf for the same long lasting service.
  - 



- EZ Roll™ Grassroad Paver™
  - EZ Roll™ Grassroad Paver™ is a load transfer paving system, designed to be rolled out over a class II compacted gravel road base, allowing for easy installation and savings on labor costs. The honeycomb cell paver design allows light to heavy vehicular traffic.
  - 

5. Integrated design of paved landscape, incorporating adjacent swales, underground stormwater storage, constructed wetland, etc. (see Web Resources section above for further information)

INSTALLERS:

- ETGeo grasspave installers
- 2020 ENGINEERING grass paving city of bellingham
- ValleyCrest Landscape Development
- Wheeler Zamaroni
- Advanced Pavement Technology. http://www.advancedpavement.com/system.htm

PUBLICATIONS:

Rushton, B.T., 2001: Low-impact parking lot design reduces runoff and pollutant loads. *Journal of Water Resources Planning and Management*, (May/June), 172-179.

James, W., 2002: Green roads: Research into Permeable Pavers. *Stormwater*, (March/April), 48-50.

Booth, D.B., J. Leavitt and K. Peterson, 1996: *The University of Washington Permeable Pavement Demonstration Project.* Background and First-Year Results, available online at http://dept.washington.edu/cuwrm/ under Research.

Pratt, C.J., A.P. Newman and P.C. Bond, 1999: Mineral oil bio-degradation within a permeable pavement: long term observations. *Wat. Sci. Tech.*, 39 (2), 103-109.

Southwest Florida Water Management District, 2001: *Florida Aquarium Parking Lot - A Treatment Train Approach to Stormwater Management.* Final Report for FDEP Contract No. WM 662, Brooksville, Florida, 220 pp.

Booth, D.B. and J. Leavitt, 1999: Field evaluation of permeable paver systems for improved stormwater management. *Journal of the American Planning Association*, 65(3), 314-325.

Stenmark, C. 1995. An Alternative Road Construction for Stormwater Management. *Water Science and Technology*, 32(1): 79-84.

Water storage beneath paved surface (from Invisible Structures, Inc. http://www.invisiblestructures.com/RS3/rainstore.htm):