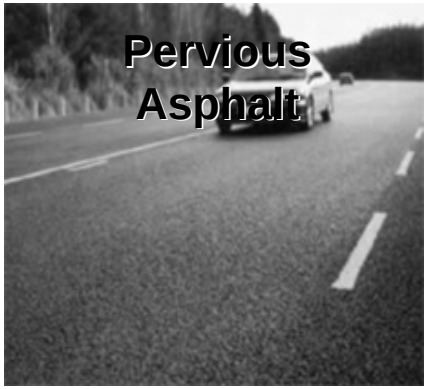
The Performance and Benefits of Porous/Pervious Paving in Cold Climates

Types of Porous/Permeable Paving



Courtesy *Roadstone*

Courtesy *Charger Enterpirses, Inc.*

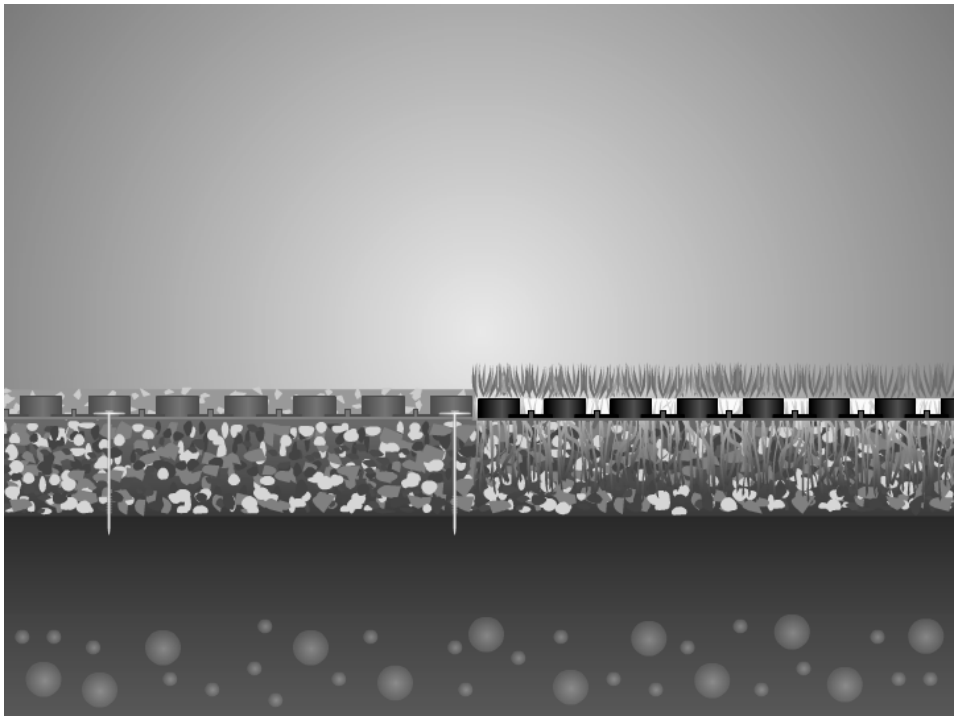
Courtesy *Uni Eco-Stone*

Courtesy *Hastings Pavement, CO*

Grasspave2 by *Invisible Structures, Inc*.

Gravelpave2 by *Invisible Structures, Inc*.

Porous Base Filters Surface and Airborne Pollutants from Rain Water



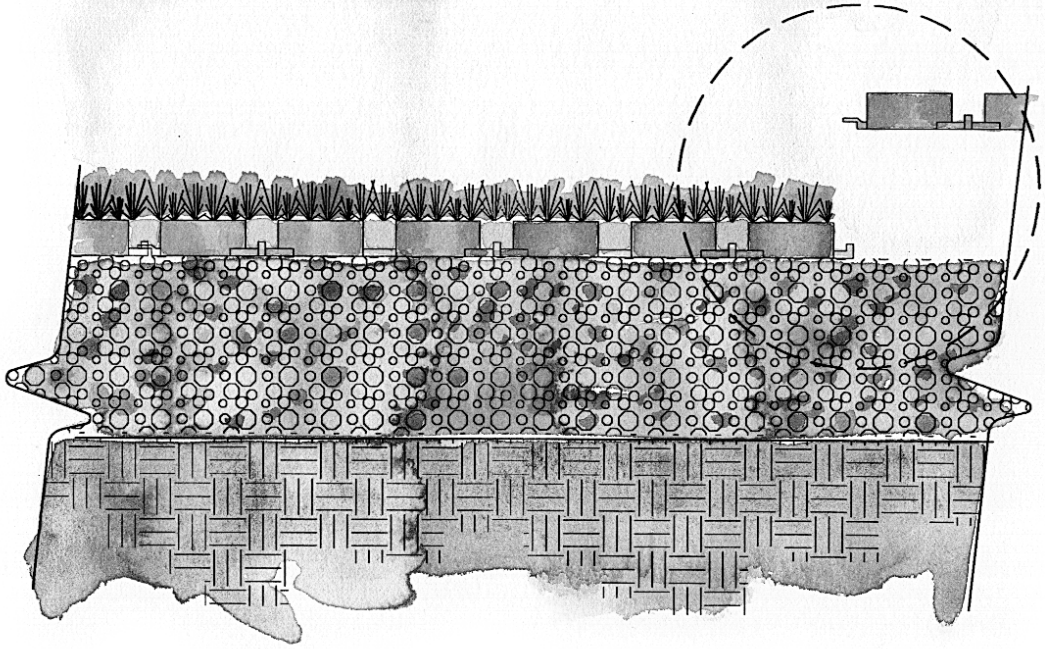
BMP for Cold Climates

- Porous pavements are well suited to cold regions as a method for managing stormwater.

- Studies conducted in Lulea, North Sweden showed porous pavement to out perform less suitable systems, such as dry basin or stormwater reuse.

Backstrom and Viklander 2000

Compacted sandy gravel road base placed above compacted subgrade, 95% modified proctor density.



1. Base

2. Hydrogrow

3. Unroll GP2

4. Sand

5. Sod/Hydroseed

6. Use

Misconceptions about Porous and Pervious Paving

- Freezes Faster
- Higher Maintenance
- Clogs
- Slippery
- Cannot Plow, Salt, or De-Ice
- Heaving and Shifting
- Lower Lifespan

Porous Paving Resists Freezing

- [Resistance to freezing was caused by the damp underlying soil, which held heat beneath the paved surface.]
- [Porous pavement exhibit increased speed in thawing compared to conventional pavement, due to the ability of melted water to flow directly through the pavement.]

Backstrom, 2000 and http://nemo.uconn.edu/reducing_runoff/questions.htm

Lower Maintenance

- Quicker Thaw Times For Porous Paving
  - Less De-icing and Sand
  - Less Plowing
- Lower Year-Round Maintenance and Resurfacing (All Seasons Compared)
- Not All System Perform Equally
  - Grid paver, Unit Blocks, Grass and Gravel Pavers require very little maintenance, especially in winter
  - Permeable Asphalt and Concrete Require Vacuuming and Regular monitoring

Clogging Myth

- Grass Pavers, Gravel Pavers, Unit Pavers, and Concrete Grid Pavers DO NOT CLOG
  - Prevention of compaction to remains porous
  - Sand/Gravel/Soil fill can become water saturated, but not obstructed
- Pervious Concrete and Asphalt clogging can be monitored and treated

Clogging Addressed

Water flowing through pervious concrete

Photo Courtesy California Cement Promotion Council

[Concerns about clogging of pervious pavements (Asphalt and Concrete) can be "designed out", by reducing erosion and sediment runoff through strategic design and water retaining ground cover. Studies indicate that pressure washing a "clogged" pervious concrete pavement can restore 80-90% of the permeability.]

Source: Georgia Concrete & Products Association

Non-Slippery Surfaces

- Less fines = rougher surface
- Higher static coefficient of friction
  - OSHA recommends 0.5
  - Gravel/Aggregate Paver: 0.71 to 0.90
  - Grass Paver: 0.5 to .75 (Grass only*)
  - Concrete Grid Paver: 0.91 and higher
  - Unit/Brick Paver: 0.62 to 0.96
  - Pervious Asphalt: 0.78 to 0.94
  - Pervious Concrete: 0.98 and over

Sources: *Presto Products, Traffic Accident Investigation Textbook, University of Oregon*
**Grass pavers will have more friction due to addition of plastic surface perpendicular to drag*
Grasspave2 is being tested as of November 2003

Porous Asphalt
“Slippery” Statements

- Porous asphalts have “rather moderate behavior” in wintry conditions, the roadways still may be slippery (Berbee et al. 1999).
- Impermeable surface “may” and will become slippery in winter conditions

- Black ice is still a problem when using permeable asphalt (Pagotto et al. 2000)
- Black ice is a problem when using any asphalt - impermeable or permeable.

Plowing, De-Icing, Salting

- All porous/pervious pavers can be plowed
  - Skids or raised blades
- De-Icing (required to be environmentally friendly)
  - Moderate use for pervious concrete/asphalt and concrete grid pavers/concrete bricks
  - No restriction for grass pavers, gravel pavers, or clay unit/bricks -
- Salt is filtered out by porous pavers -
  - Grass, gravel, grid, and unit pavers - no restrictions
  - Moderate use on pervious concrete/asphalt

West Farms Mall, West Hartford, CT

[Joe Leiberis, Westfarms' facilities director, says that he doesn't worry much any more. “We're really happy with it,” he says emphatically, after witnessing the durable, natural parking lot (Grasspave2) handle winters, summers, hurricanes, heavy traffic and more.]

http://nemo.uconn.edu/case_studies/west_farms_cs.htm

Concrete Grid and

Unit/Brick Pavers Plowing

- [Structure of the blocks' top edges minimizes chipping and allows for normal snow plowing procedures.]

Low Impact Development Center, "Permeable Pavement Maintenance"

Morris Arboretum in Philadelphia's Germantown - Porous Asphalt, Plowing

["It's held up pretty well," said Tony Aiello of Morris Arboretum. explained. "Sometimes chunks scraped off."]

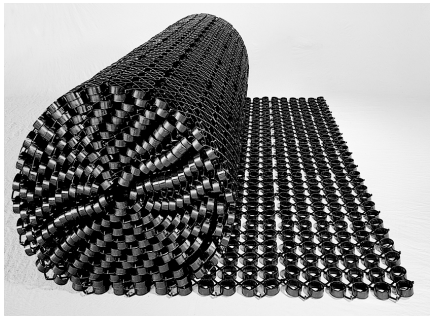
Preventable with skid attachments on snow plow

Source *www.greenworks.tv*

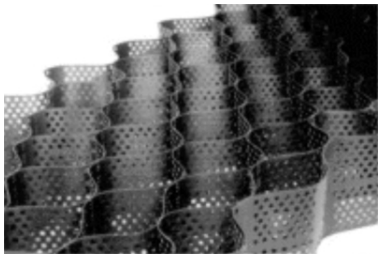
Heaving and Shifting Addressed

- Flexible systems not subject to damage
- Pervious asphalt/concrete not subject to movement
- Unit/Brick, concrete grid, rigid grass/aggregate systems
  - Proper porous base will minimize freeze-thaw
  - Proper compaction (95% proctor) of base
  - Edging minimizes heaving
- Impervious Surfaces are much more prone to freeze-thaw
  - Impervious base can shift
  - Impervious base traps water in surface cracks

Flexibility Reduces Stress



Grasspave^2 by Invisible Structures, Inc.

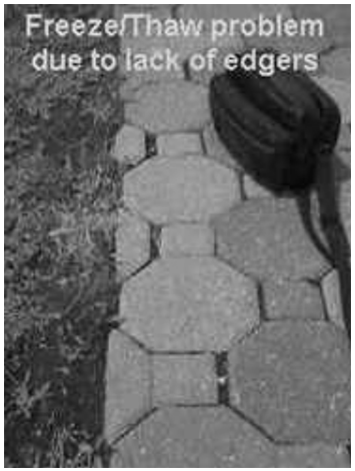


Geoweb by Presto Products
**Not recommended for heavy traffic*

Gravelpave^2 by Invisible Structures, Inc.

- Expansion and contraction in HPDE is enough to withstand any climate
- Roll systems conform to undulations

Alumni Park, East Hartford, CT installed 1997



[In areas where plastic or concrete edging had not been installed, freezing and thawing had caused some of the precast concrete pavers to separate. Also, in areas were the sub-base had not be laid down uniformly, freezing and thawing had caused some precast concrete pavers to sink and then settle lower than the rest of the pavers]

Two preventable issues

http://nemo.uconn.edu/case_studies/alumni_park_ct_cs.htm

Lifespans in Cold Climates

- Impermeable Asphalt - 8 years
- Impermeable Concrete - 20 years (with proper care)

- Grass paver - 25 to 30 years
- Gravel/Aggregate paver - 25 years
- Concrete Grid Paver - 20 to 25 years
- Unit/Brick Pavers - 30 years
- Porous Asphalt - 15 to 20 years
- Porous Concrete - 25 Years

ISI, Pavestone, Hastings Pavement, Cahill and Assoc

Pervious Asphalt/ Concrete Lifespans

The longevity of the systems can be increased

- Regular vacuum sweeping
- High-pressure washing
- Restricting the area’s use by heavy vehicles
- Limiting the use of de-icing chemicals and sand
- Implementing a stringent sediment control plan

Success: Gravel Paver,

Grand Canyon Trust, Flagstaff, AZ

["We're heading into our third winter (2001) with this lot, and we've been really happy with it so far," notes Rick Moore, program officer.]

- **100 in. of snow a year**
- **Trained the snow-plow person**
- **Plow restricted until 3 or 4 inches of snow**

[“The lot doesn't get standing puddles. We drive on the snow that's left and pack it down; it melts and drains in. There's just no runoff from this lot at all,” Moore said.]

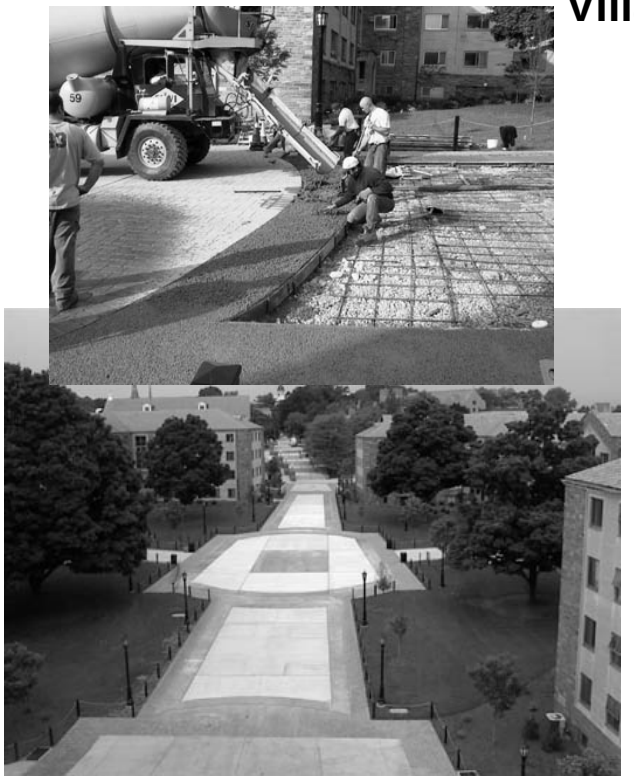
“Porous Pavement,” Janis Keating, *Stormwater Magazine*, 2001

Success Story: Pervious Asphalt, Ford Motor Co., Detroit, MI

[Referred to as the "Mustang Lot" (because new Ford Mustangs are parked there after assembly), the lot has worked well, and current Ford plans include the construction of 62 ac. of porous pavement areas that will drain to constructed stormwater wetlands.]

"Porous Asphalt Pavements," Michele Adams, *Stormwater Magazine*, June 2003

Success Story : Pervious Concrete, Villanova University, PA



[Designed for the smaller storms (0 – 2.0 inches), the captured runoff infiltrates, thereby reducing downstream stormwater volumes, stream bank erosion, and non-point source pollution to the headwaters of Mill Creek.]

- Impervious concrete drains to pervious concrete
- 2” or less rainfall in a storm accounts for 90% of rainfall, PA

http://faculty.engineering.villanova.edu/public/Civil_Environmental/WREE/VUSP_Web_Folder/PC_web_folder/PC_exec.html

Success Story : Concrete Grid Numerous Rural Roads,

Nierstein, Germany

http://langsdorff.com/

Success Story : Brick/Unit paver

Wil, Switzerland

- 1995 install
- 40,000 sq ft
- Commercial Loading Dock

http://langsdorff.com/

Success Story : Grass Paver

Tech Center, Denver, Colorado

• September to November 1992; September 1999; April 2000
• 30,000 sq ft total
• Firelane and outdoor lounge
• Grass paver replaced concrete paving blocks

www.invisiblestructures.com

Success Story : Grass paver and concrete grid paver
Evergreen Fish Hatchery, Vancouver, WA
Sensitive Water Area

Grass Paver, Parking
2001 install
3100 sq ft

Concrete Grid Paver, Parking
2001 install
900 sq ft

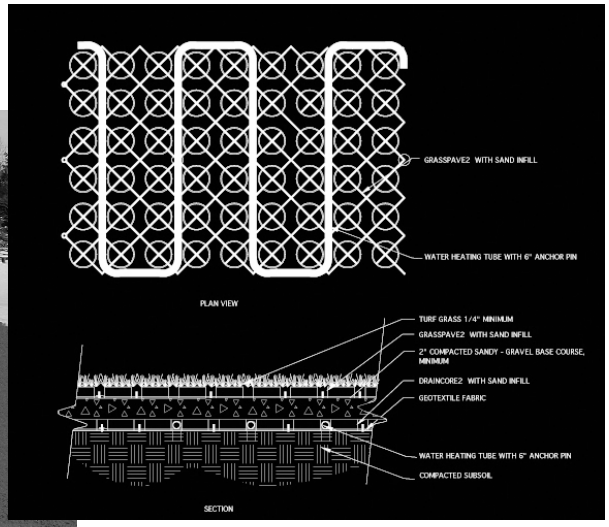

BURGER KING
BURGER-KING

Success Story : Grass paver and gravel paver
Technology Park, Vancouver, British Columbia, Canada

Gravel Paver drive aisle
Grass Paver, parking bays
2001 install - 67,000 sq ft
No Irrigation on parking lot
Irrigation on all surrounding areas

Parking Delineation -
Bumper Stops

- Forced Air
- Heating Coils
- Additional Drainage Layer



Performance Recap

	Plowable	Cold Climate Maintenace	Life Span	Salt and De-Icer Use	Freeze Thaw Problem
Grass Paver Plastic	Yes/Skids	Low	25-30	Yes	No*
Gravel Paver Plastic	Yes/Skids	Low	25	Yes	No*
Unit Blocks/ Brick Paver	Yes	Low	30	Yes	Low
Concrete Grid Turf Blocks	Yes	Low	20-25	Low to moderate	Low
Pervious Asphalt	Yes/Skids	High	15	Low to moderate	No
Pervious Concrete	Yes	High	20-25	Low to moderate	No

*Flexible systems not subject to problems

If you must pave…

Porous Pave!

Thank You!

Additional Sources

Backstrom M. 2000. “Ground Temperature in Porous Pavement during Freezing and Thawing.” *Journal of Transportation Engineering – ASCE* 126(5) (September – October): 375-381.

Backstrom M, and Viklander M. 2000. “Integrated Stormwater Management in Cold Climates.” *Journal of Environmental Science and Health Part A- Toxic/Hazardous Substances & Environmental Engineering* 35(8): 1237-1249.

Berbee R, Rijis G, de Brouwer R, van Velzen L. 1999. “Characterization and Treatment of Runoff from Highways in the Netherlands Paved with Impervious and Pervious Asphalt”. *Water Environment Research* 71(2) (March-April): 183-190.

Pagotto C, Legret M, and Le Cloirec P. 2000. “Comparison of the Hydraulic Behaviour and the Quality of Highway Runoff Water According to the Type of Pavement.”

Water Resources 34(18): 4446-4454. United States Environmental Protection Agency. 1999. *Storm Water Technology Fact Sheet: Porous Pavement.* EPA 832-F-99-023. Washington, DC: Office of Water, United States Environmental Protection Agency.