Introduction

History of Porous Paving

Pebbles, cobblestones, and wood decking structures have been used since the dawn of civilization to reinforce where we walk and the roads we use. Little did we realize that these methods had benefits over the modern trends of sealing up the ground with asphalt and concrete. Porous, permeable or pervious paving—whatever you prefer—became a method for addressing stormwater issues in the early 20th century. Concrete turfblock for grass paving began in the mid-1940s and plastic versions were invented in the late ’70s and early ’80s. Great advancements have occurred in pervious concrete, pervious asphalt, and other permeable surfaces. We introduced Grasspave2 in 1982, improving upon these earlier concepts. In 1993, Gravelpave2 was unveiled, the only product specifically developed for gravel porous paving. Past forward to this millennium, and Grasspave2 and Gravelpave2 are considered by most, the finest porous pavers developed.

Infiltration

Porous paving allows rainwater to percolate through the pavement’s surface and back into the ground (infiltrating), where the water is cleaned and returned to ground water supplies. Porous paving improves upon impermeable surfaces, such as concrete or asphalt, which do not allow for this natural filtration. Rain collects airborne and surface pollutants such as sediment, brake dust, chemicals, vehicle exhaust, oil, salts, fertilizers, bacteria, and animal waste. On impermeable surfaces the polluted rainwater runoff (non-point source pollution) is collected, concentrated, and discharged to downstream waters such as streams, reservoirs, and lakes—our drinking water. This runoff also harms vegetation and wildlife with increased water volumes, velocities, and higher temperatures. The Grasspave2 and Gravelpave2 systems protect against this dangerous runoff by processing and cleaning the water, thus safeguarding the natural water cycle.

State of the Earth

Invisible Structures, Inc. has developed an entire line of products to address stormwater and environmental concerns. Rainstore3, Slopetame2, Draincore2, and Beachrings2 can work in addition to, or in conjunction with, Grasspave2 and Gravelpave2 to provide your site, home, or office with stormwater and environmental enhancements. Our products can store and collect rain, provide erosion and sediment control, efficiently convey and deliver water, and protect natural areas.

Advanced Technology

The Grasspave2 and Gravelpave2 systems are based on a simple, but impressive technology—a series of rings (cylinders) connected on a flexible grid system. The cylinders are engineered to withstand significant structural loads and the grid provides stability, flexibility, and continuity for large areas. The grid system also has the unique ability to be rolled up for easy shipping, handling and installation.

This engineered design allows for any street-legal vehicle (and sometimes larger) to park or drive on our Grasspave2 or Gravelpave2 surfaces. The point load pressure is transferred from the top of the ring, through the fill material and cylinders, to the engineered base course.

Wallace Residence, Savannah, GA—Gravelpave2 creates a wheelchair-accessible surface by stabilizing gravel and supporting tire pressure. 7% dry cement was mixed with gravel before filling rings.

Cover photo: Westin Kierland Resort and Spa, Scottsdale, Arizona—Grasspave2 fire lane and Gravelpave2 fire lane (concrete widening).

Grasspave2 large rolls and Gravelpave2 large rolls (not shown) install quickly and conform to the contours of the ground.

Beachrings 2

Pentagon Remote Delivery Facility, Arlington, VA—Grasspave2 was selected for the helicopter landing pads (the four grass squares in center) on the largest “green roof” east of the Mississippi.
The ring and grid structure is 92 percent void space allowing for the healthiest root zone for grass (in Grasspave2) and more decorative gravel (in Gravelpave2) for some of the most attractive paved surfaces around. Less plastic means more natural looking surfaces. This technology also makes for better runoff coefficients and better percolation rates.

**Exceptional Compressive Strength**

When installed to specifications, Grasspave2 and Gravelpave2 will support 15,940 psi – well over the 120 psi highest truck tire pressure allowed on public highways. This is a safety factor of 132 times.

15,940 psi Conversions

2.29 million pounds per sq ft

109,806 kPa

11.2 million kg/m²

20.6 million pounds per sq yard

**Vehicle Loading Examples:**

- Auto tires: 40 psi
- Truck tires: 110 psi
- DC-10 tires: 250 psi
- F-16 tires: 350 psi
- Fire truck with outriggers: 78 psi

(An 85,000 lb. truck distributed to four outrigger pads is equal to 21,250 lbs. for each outrigger pad with 12” × 18” surface contact with Grasspave2.)

All these vehicles are well within our 15,940 psi capability. With a sturdy base course design, our rings will easily perform under all conditions. It’s also a good design practice to strengthen concrete sidewalks and curbing that will be mounted by fire trucks.

**CSI 32 12 43 Flexible Porous Pavers**

In 1997 The Construction Specifiers Institute (CSI) came out with a generalized listing (02795) for all porous paving products. However, since performance and application is varied even in the porous paving industry, the 2004 CSI MasterFormat™ has adopted a new number 32 12 43 Flexible Porous Paving, to recognize that Grasspave2 and Gravelpave2 are in a class by themselves.

**Best Management Practice**

Porous paving is recognized as a Best Management Practice (BMP) by the Environmental Protection Agency, the Center for Watershed Protection, the U.S. Army Corp of Engineers, and countless other federal, state, regional and local authorities. In addition, Grasspave2 and Gravelpave2 are often mentioned by name, as the product of choice for many of these agencies.

**Applications**

**Stormwater Management**

The Grasspave2 and Gravelpave2 systems can easily handle storm water from an intense storm dropping three inches of rain in less than thirty minutes! In one square meter there are 144 rings, two inches in diameter by one inch high. With one inch of fill in the rings and a standard road base of sandy gravel six inches thick, our porous systems will percolate

The University of South Alabama, Mobile used Gravelpave2 in parking areas and Grasspave2 in the spaces.

The Lincoln Hills Club, Lincoln, California—This amphitheater’s grass is reinforced with Grasspave2 to prevent compaction, and provide a stable, attractive surface for visitors.

Bowditch Point Regional Park, Fort Myers Beach, Florida—Gravelpave2 parking bays blend in with the natural surroundings.

The Lincoln Hills Club, Lincoln, California—This amphitheater’s grass is reinforced with Grasspave2 to prevent compaction, and provide a stable, attractive surface for visitors.
Environmental Benefits
Grasspave2 and Gravelpave2 not only protect the environment, they enhance it. All of our products are made from 100 percent recycled plastic—plastic that goes into improving the environment and not into a landfill. Through bioremediation, porous pavers have the ability to clean pollutants (heavy metals, 96–99 percent; suspended solids, 95 percent; phosphorous, 65 percent; nitrogen, 82 percent, hydrocarbons, up to 100 percent) out of stormwater. Our products also reduce erosion and soil migration, reduce site disturbance, and contribute to airborne dust capture and retention.

Cooling the atmosphere and reducing the “urban heat island effect” (cities being up to 10 degrees hotter than undeveloped land) are added benefits of Grasspave2 and Gravelpave2. Both products can mitigate these increased temperatures. In addition, Grasspave2 promotes the conversion of carbon dioxide (greenhouse gas) into oxygen and has an “air-conditioning effect.”

Driveways
Environmental, economic, and aesthetic enhancements are drawing homeowners and designers to use Grasspave2 and Gravelpave2 in driveways. Most residential driveways are good candidates for our porous duo because of the reduced speed and limited frequency of traffic. Our products can add beauty to residential and commercial driveways.

Parking Lots
Parking for churches and synagogues, stadiums, arenas, and overflow at shopping centers, campuses, parks and more are ideal for Grasspave2 and Gravelpave2. These sites generally support large numbers of vehicles but only on periodic basis. Stormwater management and green space can be combined with parking, reducing maintenance, real estate, and development costs. A great design idea is combining durable Gravelpave2 drive aisles with attractive Grasspave2 parking bays.

Pedestrian, Horse Trails and Bicycle Paths
Garden paths, greenhouse aisles, sidewalks, park paths, and wilderness trails paved with Grasspave2/Gravelpave2 provide a stable surface for strollers, bicycles, wheelchairs, and horses. There are no puddles or mud and traction is very good. Tree roots break up hard surface sidewalks, but our mats flex to accommodate such shifts and gradient changes. Plus, with the high proportion of air, roots are discouraged from moving upward. Mountain bikers will not be able to tear up paths reinforced with Grasspave2/Gravelpave2. Our products can resist the destructive forces of mountain bikes, allowing your trails to be reopened to bikes.

Fire Lanes
By far, the most common application for Grasspave2 and Gravelpave2 installations is for fire lanes. Our long and established history of providing safe, well-constructed fire lanes began in 1982 with our first installation in Snowmass, Colorado, near Aspen Ski Resort. Since then, we have firmly established credibility for this application. Tests have been conducted by several fire departments in Aurora, Colorado and Irvine, California. Nearly every major U.S. metropolitan area has accepted and used Grasspave2 in a fire lane. You will most likely find a fire lane installation in your area.
Grasspave2 Installation—Mats can be rolled out in minutes!

~35m² (~400 sf) per man hour! – For all steps shown below.

1. Place and compact sand and gravel base course.
2. Apply Hydrogrow mixture.
3. Roll out Grasspave2.
4. Fill rings with clean sharp concrete sand.
5. Hydroseed or lay sod.
6. Use a regular lawn mower for maintenance. Do not aerate!
7. Ready for use after two mowing cycles.
8. Roll sod with heavy roller.

**Grasspave2 Installation Procedures**

This installation section is only intended as an overview. Please review our Grasspave2 Technical Specifications (available at www.invisiblestructures.com or call 800-233-1510) for comprehensive installation instructions.

Excavate a space for the base course as determined by site soils and loading requirements. Place and compact sandy gravel which should be a mixture of clean sharp sand and gravel varying in size but not exceeding 3/4 of an inch. To check porosity, use a hose to see that water flows into the base and drains away. Add subsurface drainage as necessary to low spots or locations with poor draining soils. Install irrigation lines and sprinkler heads if necessary.

Apply the Hydrogrow mixture that is included free with your order. Hydrogrow is a specialized soil amendment and fertilizer mixture designed exclusively for our Grasspave2 system.

Roll out Grasspave2, aligning the side hole fasteners over the side pegs. The warmth of the sun will relax the plastic so it lays flat. Cut the grid between rings using pruning shears. Incorporate the cut pieces in other areas, as needed, keeping the distance between the rings uniform.

Fill rings with clean sharp concrete sand (AASHTO M6 or ASTM C-33) using large rakes and brooms so that the tops of the rings show when done. USGA Greens mix is also acceptable.

Lay turf over the rings. On warm days, wet the sand first to lower sand temperature and provide moisture for grass roots. Seeding and hydromulching is also an accepted vegetating method at this stage. Repeated hydromulching/seeding may be necessary.

Roll sod with heavy roller to eliminate air pockets and make sure roots are in contact with the sand fill. Water lawn as usual according to climatic requirements.

Whether the area has been seeded or sodded, wait to drive on grass until two mowings have been completed, by which time the root system will be established and the sod pieces locked into place. In an emergency such as the need for fire truck access, grass may be driven on immediately after installation.

Use a regular lawn mower for maintenance. There should be no paver parts protruding through the surface that would damage mowers. Do not aerate!
Gravelpave2 Installation—
Gravelpave2 Size/Shape Fill Requirements
You will need 1/2” of gravel fill, compacted. Be careful to order enough for the compaction process and choose a gravel size that will nest well into the rings. We have found that 1/4” uniformly sized crushed stone and sometimes 1/4” with limited small sharp screenings #40 to #100 screen works well. We DO NOT recommend pea gravel, even though it is often very attractive. Pea gravel will migrate out of the rings. A visit to your local quarry is suggested. We have found that some geological areas of the United States have limited types of sharp gravel available. It has been necessary to import gravel from a neighboring state, but remember the amounts are relatively small—the top one-and-a-quarter inches of the cross section. Gravel should be as free of fines as possible. To maintain porosity, avoid soft stone materials with low durability that will break easily.

Other Fill Materials for Gravelpave2
Please ask our staff for assistance with this category since it is use-specific and often experimental. Ground rubber, crushed glass, crushed brick, and many other materials can be useful as attractive fill materials for various applications. Thermoset (epoxy, polyurethane, etc.) binders may be cost prohibitive for most projects, but offer unique design possibilities, including clarity, color enhancement (wet look), flexibility, and durability.

Our technical support staff will assist with selection of gravel sources. The photographic samples shown on this page will help you narrow your gravel choices. Should you have questions concerning the selection, please submit a small sample for approval prior to specifying or securing the materials.

Mats can be rolled out in minutes!
Gravelpave2 Installation Procedure
This installation section is only intended as an overview. Please review our Gravelpave2 Technical Specifications (available at www.invisiblestructures.com or call 800-235-1510) for comprehensive installation instructions.

Prepare sandy gravel base course to a depth as determined by a soils engineer. Compact with a vibrating plate compactor or use a heavy motorized roller for large jobs. To test porosity, water with a hose and check to see that water drains readily through the base course before installing the Gravelpave2 mats.

Roll out mats with the grain (in the same direction) so that the snap fit fasteners can be used with neighboring mats. To fit around boxes and curbs, cut the grid between the rings with pruning shears and scissors or a small portable electric hand saw.

Fasten the mats together using the snap fit fasteners that are molded into the product inserting the prongs into the rectangular openings. Tuck the fabric underneath the fasteners to keep joints closed. A quarter-inch nut driver head (6 mm) fits nicely over the fastener to compress the pieces together. A piece of lumber placed under the Gravelpave2 mat will provide stability to aid in fastening.

Supplied anchors must be used to secure the mats to the base. Hammer anchors with washers at a rate of one anchor per six rings in both directions. Use extra anchors around the perimeter of the Gravelpave2 install and in high traffic areas. Reciprocating hammers can be used to speed up the anchoring process. Anchors should be placed inside the rings as close to the center as possible. Begin anchoring from one corner in a radial pattern.

Gradually place gravel fill (see suggested fill material on facing page) into rings by using a front-end loader and shaking out the fill as the machine drives forward. Carefully lower the bucket when empty and back up while dragging it above the rings to smooth out the gravel, finishing with a stiff broom. Wheel barrow and shovel works well for small jobs. Contractor tip—you can store excess material for future maintenance, top dressing as may be necessary. Use rakes and/or push brooms to distribute the gravel fill to a level slightly above rings so that compacting the fill will not uncover the rings.

Use a vibrating plate compactor or large driving roller again to compact the gravel fill. Additional gravel may be necessary to finish filling the rings. Compact again until the material appears solid in the rings. Wetting the gravel may help it to interlock.

Drive on the installation when finished. If car tires make a pattern, there may be too much gravel or it may need additional compaction. It is expected that tops of the rings may be visible. If sides of the rings show, then add more fill material and repeat the compaction process.
Without interrupting your land-canal incorporate a structural road as asphalt access roads are necessary to get to window washing towers, tanks, or electrical boxes. No obtrusive concrete or areas, pump stations, microwave sary to get to window washing and display areas, outdoor amphithe- ter such as the “soft” attractive look grass and decorative gravel provide.

Utility and Maintenance Vehicle Access
Providing your site with impor-tant utilitarian functions without compromising beauty is simple. Grasspave2 and Gravelpave2 can incorporate a structural road without interrupting your landscaping. No obtrusive concrete or asphalt access roads are necessary to get to window washing areas, pump stations, microwave towers, tanks, or electrical boxes.

Unique Applications
Our mats are installed in some unique and interesting places: Helicopter landing pads, race car display areas, outdoor amphithe-ater seating, under picnic tables, under concrete pavers (support), airplane display and transport, cemetery marker reinforcement, eave drip lines and more. Installations are not limited to traditional paved areas.

Grasspave2 Characteristics
Ring and Grid Structure
Grasspave2 is by most accounts the best flexible grass paver made today. Its unique ring and grid structure allow for flexibility, sta-bility, and exceptional grass growth. With 92 percent void space for healthy roots and 100 percent grass coverage, Grasspave2 is the industry’s preferred choice. Our installations are hard to find because they are invisible! With so little plastic near the crown of the grass, the blades of grass are not smashed by product. Root development is not interrupted from spreading laterally. The rings are strong and rigid, keeping grass root systems protected from harm. The roots grow directly downward, deep into the sandy gravel base course.

Runoff Comparison Chart
Rolling out Grasspave2 is similar to rolling out carpeting and cover-age is fast and efficient. The mat system can be easily cut to fit around trees, irrigation, curb-ing, or other terrain. The rolls have snap-fit connectors to attach to adjacent rolls, making one unified, contiguous system. This unified mat system adds stability and continuity in design. Grasspave2 can just as easily be snapped to Gravelpave2 to add stability and product vari-ation.

Hydrogrow
Another reason Grasspave2 is the industry leader is the addition of Hydrogrow soil amend-ment, which is supplied with your order. Hydrogrow is engineered to help grass grow in our sand based root zone. The results are amazing and our Grasspave2 areas often look healthier than surrounding turf. By using this special mixture in the sand, porosity will be maintained, turf will be attractive, and aeration will not be necessary.

Sand Fill
Grasspave2 is the only grass paver on the market specifying sand as part of its cross section. Sand is the best medium to pro-vide water and air to the roots and still provide high compres-sive strength. The United States Golf Association uses sand for every USGA golf course and nearly every professional and collegiate turf athletic field uses a sand cross section as well. Topsoil (or other organics fill material) in the rings will eventually compact and damage the root zone. Sand negates the need for mechanical aeration, which can dam-age Grasspave2 and other grass pavers.

Strength When Installed
When installed over a thick base course and compacted to 95 percent modified Proctor, sand-filled rings can support 5,700 pounds per square inch (psi) without deflection or compromise to safety. The cylinder is the strongest shape to support compressive loads because it has no corners. Supporting heavy loads with the rings allows us to use less plastic in the product creating a 92 percent void area for root development, combined with strength! Less plastic means a lower cost for you.
Traffic Frequency
Grass as a surface material can withstand from two to six (varies with grass species and environmental conditions) trips daily over the same spot. This suggests that most parking applications we pave with asphalt today could be paved with Grasspave2 instead. Vehicles can remain parked on grass for extended periods of time, provided some relief can be given for a few days for the grass to recover.

Lifespan
Grasspave2 has a projected lifespan of 60 years. Compared to asphalt with a lifespan of 15 years; and concrete with a lifespan of 25 years, Grasspave2 will save you money on replacement costs.

Irrigation
Grass needs water and you may need to have irrigation installed. Grasspave2 has a sand based root zone which usually requires slightly more water than a normal topsoil or organic root zone. If golf courses in your area use irrigation systems, you probably should in your vicinity or for installations requiring “binders.”

Gravelpave2 Characteristics

Fabric, Ring and Grid
When we developed Gravelpave2 in 1993, our goal was to provide designers a second option for a porous pavement that can tolerate high frequency and low-speed traffic. By molding our ring and grid structure onto a permeable pavement, we can turn a traditional gravel road into a more attractive, functional, and low-maintenance pavemen:

- **Gravelpave2** is designed to do the opposite—welcoming water shed water and keep it away from the pavement’s cross-section. Traditional pavements, including gravel roads, are designed to shed water and keep it away from the pavement’s cross-section. Gravelpave2 has no limits on frequency or duration of traffic on the system. Park or drive as often as you like on Gravelpave2. However, speeds should be kept at or below about 20 mph (30 km/h).

- **Durability**
  - Gravelpave2 and Gravelpave2 are made from flexible High Density Polyethylene (HDPE) plastic with UV inhibitors, which withstands repeated freeze-thaw cycles and continuous subzero temperatures without cracking. HDPE resists aggressive chemicals such as road salts, motor oils and fuels. HDPE is highly abrasion-resistant and is unaffected by extremes in pH. A well-maintained Gravelpave2 installation will last 25 years in most climates.

- **Aesthetics**
  - Part of what draws many designers to use Gravelpave2 is the ability to have an area maintain a natural look. Many times native soils or gravel can be used as fill material, complementing surrounding areas.

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Snap-Fit Fasteners
Designed into Gravelpave2 is a snap-fit fastener, a two-pronged arrow that fits into a rectangular slot. Simply push the slot over the prongs to easily snap together panels of Grasspave2. To take them apart, just squeeze the prongs together and lift off the slot.

Gravelpave2 is the only system specifically designed for aggregate containment porous paving. The cylinders displace the load onto an engineered base course and hold the decorative gravel in place. The fabric keeps the top-dress gravel from compacting into the road base, acts as a weed and vegetation barrier, and suppresses dust.

Traditional pavements, including gravel roads, are designed to shed water and keep it away from the pavement’s cross-section. Gravelpave2 is designed to do the opposite—welcoming water down through the system. Plus, Gravelpave2 will not rut, washboard, or puddle like traditional gravel roads.

Invisible Structures—Standard Product Roll Sizes

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Rolls can be installed manually (2 people advised). Rolls apply to Grasspave 2, Gravelpave2, Draincore2, and Slopetame2.

Table 1: Gravelpave2 Model m ft m ft m ft m2 ft 2 kg lbs

Grasspave2 has a lifespan of 25 years, and concrete with a lifespan of 15 years; and asphalt with a lifespan of 60 years.

Compared to asphalt including gravel roads, are designed to shed water and keep it away from the pavement’s cross-section. Gravelpave2 has no limits on frequency or duration of traffic on the system. Park or drive as often as you like on Gravelpave2. However, speeds should be kept at or below about 20 mph (30 km/h).

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Dust Suppression
Dirt and gravel roads have the potential to kick up dust and dirt when traversed. Many communities have regulations limiting or eliminating gravel surfaces from new construction. Rest assured, if you design a Gravelpave2 surface you will be getting a virtually dust-free surface. The clean and washed fill material required to fill the rings will not have any more dust than an asphalt-paved surface. Gravelpave2’s geotextile fabric will prevent the dust-sized particles contained within the base material (existing gravel surface or dirt), from being displaced by moving tire or wind forces.

Industry Advantages
Economic Advantages
Whether you are an engineer, architect, landscape architect, contractor or homeowner you will be concerned with the cost of your project. Grasspave2 and Gravelpave2 will save you money. Our products will save on design costs, installation costs, component materials, maintenance/operations expenses and lifecycle costs. We can find a way to reduce your site expenses with our porous pavers.

When designing, you may be able to eliminate or reduce stormwater filters, detention basins, conveyance lines, modifying grading requirements, or many other “necessities” associated with asphalt or concrete. A great deal of your stormwater mitigation plan can be built into Grasspave2 and Gravelpave2.

Installers have been astounded by the speed and efficiency for which large areas can be accommodated by our large rolls. Unrolling our mats, snap fitting, and cutting is easy and requires no special machinery. Please view our technical specifications (from www.invisiblestructures.com, call 800-233-1510, or available through our partner network) for the installation procedure. A brief installation overview is also on pages 8 and 10.

In addition to cost savings in the design phase, you may be able to eliminate other components during installation such as root protection for trees, grates, manholes, curbing, and tree and vegetation removal costs.

Maintenance and operations costs are significantly reduced over asphalt and concrete surfaces. A. Andy E. Lindsey, Director of Grounds Maintenance, University of South Alabama, in his written analysis dated February 18, 1999, compared the cost of our porous systems to asphalt pavement using historical data from university records. The conclusion was a $56,000 savings over 20 years, by using Grasspave2 and Gravelpave2.

Our products can save you the most money by combining your surfaces’ uses into one area. Multiple surface use means savings on real estate, design costs, maintenance, insurance and more. You can have a fire lane that doubles as “green space” for employees or visitors, combine a parking lot with a bio-swale and stormwater mitigation system, and expand your lawn into the driveway.

As mentioned above, Grasspave2 and Gravelpave2 have a longer lifespan than asphalt. Compound the above savings with the longer lifespan, and you can have a lifecycle cost which can save thousand of dollars on even moderately sized installations.

Competitive Advantages
Our porous pavers have advantages over impervious surfaces, but we are proud to compete with any other plastic porous pavers manufactured. Our products are the strongest on the market—15,940 psi installed to specification (2.29 million lbs./ft2; 109,906 kPa; 11.2 million kg/m2; 20.6 million lbs./yd2). Grasspave2 and Gravelpave2 have

In addition to dust suppression, Grasspave2 and Gravelpave2 enhance stormwater performance, provide “green space” for employees and visitors, and improve overall property appearance.
Grasspave2 and Gravelpave2 rolls are considered the favorite to which are cumbersome to install and difficult to cut and shape. Pavements.

Invisible Structures also contends that while these competing technologies have their place, in most instances, our Grasspave2 and Gravelpave2 systems outperform, last longer, require less maintenance, look better, and are easier to install. Check with our technical specialists at 800-233-1510, as some conditions can be overcome with design and component adjustments.

Designing for Grasspave2 and Gravelpave2

Considerations for Design:

- Keep the porous paving area free of sediment and erosion from adjacent areas as they can cause drainage and aesthetic issues. Extra care should be taken for use in swales or berms.
- Slope should be considered. Grasspave2 and Gravelpave2 perform the best for all vehicles when the slope is no greater than 8 percent. Light vehicles (golf carts, bicycles, and pedestrian areas can have up to a 20 percent slope. Grasspave2 in fire lanes should not exceed five percent (consult your local fire departments).
- Check the permeability of existing underlying soils. Percolation rates should be .64 cm to 1.3 cm of water per hour (EPA guidelines).
- The water table should be about three feet (approx. 1 m) below base course in most instances.
- Bedrock should not be closer than two feet (0.6 m) below base course.
- Avoid use of Grasspave2 and Gravelpave2 in areas where high speed acceleration or braking and turning occur. Examples are entrances and exits to parking lots that connect to higher speed roads.

If your site varies from these conditions, please consult ISI directly, 800-233-1510, as some conditions can be overcome with design and component adjustments.

Base Course Design

Calculating the depth and composition of materials for the base course incorporates the same design criteria as for other pavements:

- Load-bearing capacity of native (or fill) subsoil.
- Plasticity or impact of moisture on strength and longevity.
- Frostheave potential, and
- Traffic load, frequency and/or duration.

Sample Base Course Depths

Please consult with a soils engineer for site-specific base requirements. Generally, the depth that is used under asphalt will be the requirement under Grasspave2/Gravelpave2. Golf carts and pedestrian traffic may require nothing over sandy gravel soils, and just two to four inches of base course (5–10 cm) over very weak soils. Cars usually need a six- to eight-inch base course (15–20 cm). Buses, trucks, and fire engines can easily require eight to 12 inches (20–30 cm) or more. The use of geotextiles, below the base is not required, but will prevent integration with subsoils and is strongly advised in areas of clay or silt soils and frost heave. Do not use 100 percent limestone base as limestone will compact and become impermeable. —If limestone must be used, mix with 25–30 percent sand (AASTO M6 or equal).

Design for Use

There is an area in your development, site, or home that will most likely benefit from Grasspave2 and Gravelpave2. We advise that you take a look at proper use patterns, site conditions, and other specifications to get full advantage and long life out of our products. Invisible Structures, 800-233-1510, is available for preliminary design assistance and consultation. Please note that other porous paving systems are NOT interchangeable with Grasspave2 or Gravelpave2, consult our technical specifications for full installation instructions.

Considerations for Design:

- High use, low speed, and unlimited traffic volume is optimal for Gravelpave2
- Low to moderate use, low speed, with recovery time is perfect for Grasspave2 or Gravelpave2

Sample Site Conditions:

- Low to moderate use, low speed, with recovery time is perfect for Grasspave2 or Gravelpave2
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Competing Technologies

Porous paving technology has made great strides not only in flexible plastic pavers but in other areas as well. Permeable asphalt, permeable concrete, interlocking unit blocks, reinforcement mats, and concrete grid pavements, have all improved and advanced to meet the growing demand for environmentally friendly technologies. It is Invisible Structures’ firm belief that you should use porous paving, even if it is not our product line, whenever possible. The more you use these technologies, the better accepted they become. If you have to pave, porous pave!

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Invisible Structures also contends that while these competing technologies have their place, in most instances, our Grasspave2 and Gravelpave2 systems outperform, last longer, require less maintenance, look better, and are easier to install. Check with our technical specialists at 800-233-1510, as some conditions can be overcome with design and component adjustments.

Base Course Design

Calculating the depth and composition of materials for the base course incorporates the same design criteria as for other pavements:

- Load-bearing capacity of native (or fill) subsoil.
- Plasticity or impact of moisture on strength and longevity.
- Frostheave potential, and
- Traffic load, frequency and/or duration.

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Bedding Sand Not Necessary
Do not use a sand setting base with our products. Unlike concrete pavers, bricks, and other rigid pavers—our Grasspave2 and Gravelpave2 are flexible and do not require sand to level.

Edge Protection
For aesthetic and maintenance considerations, you may want to design in a durable edging material to separate our porous pavers from adjacent areas of turf or to simply delineate a fire lane or path. With Gravelpave2, an edging can prevent vegetation from encroaching onto the system and can prevent the gravel fill from migrating at the edge. Steel, aluminum, wood, brick, or concrete are all acceptable edging materials. Keep the edging flush or slightly higher than the porous paver grade.

Maintenance and Operation
Grasspave2 Maintenance
Irrigation is required in dry climates. Any popular pop-up system can be used. Simply cut out rings to reveal the irrigation head. If golf courses in your area use irrigation systems, you probably should in your Grasspave2 installation. Be careful not to overwater as this will encourage shallow root development. Fertilize once a year with an NPK slow-release fertilizer that contains trace elements. There are many brands on the market. Do not aerate! You'll end up with product damage. When installed using sand in the rings, there will not be a compaction problem. Be careful not to use clay-based sods in pedestrian or vehicular traffic areas—use sandy soil sod, or seed and mulch. There seems to be no problem with soil selection for fire lanes. If the Grasspave2 area has just been seeded or sodded, drive on it only in an emergency.

Gravelpave2 Maintenance
Potholes will only appear if the base course has not been compacted properly before laying the rings or if the base material is allowed to mix into clay soils below (use nonwoven fabric to keep separate). Should this occur, remove a section by vacuuming the gravel from the rings, unfasten the snap fit fastener, bring the base course to the proper grade and compaction, put the Gravelpave2 square back in place, anchor, and fill to the top of the rings. Seasonally check the rings in high-traffic areas and entrance lanes for lower levels of fill and replace by sweeping gravel from other areas to bring it level again. Leaves should be raked or vacuumed and not allowed to decay. Organic matter will stimulate weed growth and reduce porosity. To attack any occasional weeds that may locate within the Gravelpave2 installation, simply spray them with a weed killer (such as Roundup™) and remove them when dead.

Cold Climates Concerns
Porous pavement thaws faster than conventional pavements because it allows melted water to flow directly through the pavement, increasing the temperature in the cross-section. Grasspave2 and Gravelpave2 are made from flexible High Density Polyethylene (HDPE) plastic with UV inhibitors, which withstands repeated freeze-thaw cycles and continuous subzero temperatures without cracking.
Fire departments usually require you to plow snow that is over three inches deep. (7.5 cm). Consult with your local fire department for their guidelines. Educate your snow removal crew to take care not to have the plow blade make contact with the Grasspave2 or Gravelpave2 systems. Experienced snowplow drivers can leave a thin layer of snow on the systems or they can attach skids (¼ inch—2 cm) to the bottom of the blades.

Sales and Technical Support Partners

Invisible Structures, Inc. welcomes the opportunity to review designs and answer technical questions. Design details, technical specifications, white papers, and other support material may be downloaded from our web site. See a comprehensive list of project profiles and case studies at www.invisiblestructures.com

In addition to the high-quality, professional, experienced staff at our main headquarters in Colorado, we have excellent partners representing their geographical areas. They are prepared to assist you locally, at all levels, with your project needs. Please contact us or check our web site for your partner name and information.

Contact Information

Invisible Structures, Inc.
1600 Jackson St. Suite 310 • Golden, Colorado 80401, USA
800-233-1510 overseas and locally 303-233-8383
Fax 800-233-1522 overseas and locally 303-233-8282
www.invisiblestructures.com
email: sales@invisiblestructures.com


Grasspave2 is used as a stable surface for picnic tables at a community pool.

City of White Rock Operations, White Rock, British Columbia—Gravelpave2 is used in the main drive aisle of the works yard and Grasspave2 is used for the parking bays.

Grasspave2: Available in several roll sizes.
Squares weigh 1.97 kg (4.34 lb) each.
Colors: Cashew Brown, Black, Pewter Grey, Terra Cotta.
Resin: HDPE
Strength: 1120 kg/cm² (16,120 psi)

Gravelpave2: Reusable snap connector requires 5 lbs to connect and resists 70 lbs of pull-apart force.
Beachrings², a portable and re-usable plastic boardwalk system, provides an attractive, comfortable, and slip resistant surface for equal access to beaches. Beachrings² also works well for temporary vehicle access over mud and sand.

Draincore² conveyance layer is used for advanced subsurface and green-roof applications. A replacement for antiquated French drains, Draincore² can maximize drainage (58 gpm per foot with) and minimize costs.

Rainstore³ is the new standard in efficient sub-surface stormwater storage. Rainstore³ is modular and stackable for versatile site design. Rainstore³ is 94% void space and can be designed for detention, retention, or water harvesting for re-use.

Slopetame²—much more than an erosion control blanket or mat—a completely integrated system of rings, grid, fabric, anchors, and vegetation to control erosion on some of the toughest slopes, channels, swales and more.

<table>
<thead>
<tr>
<th>Description</th>
<th>Grasspave²</th>
<th>Gravelpave²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Connectable ring and grid system</td>
<td>Connectable ring, grid, and integrated fabric</td>
</tr>
<tr>
<td>Also Included</td>
<td>Hydrogrow polymer—exclusively for Grasspave²</td>
<td>Geotextile fabric molded to grid (exclusive to Gravelpave²) and anchors</td>
</tr>
<tr>
<td>Available in Large, Flexible Rolls</td>
<td>Yes, various sizes—see roll chart page 14</td>
<td>Yes, various sizes—see roll chart page 14</td>
</tr>
<tr>
<td>Colors</td>
<td>Black</td>
<td>Black, gray, tan, terra cotta, custom colors extra</td>
</tr>
<tr>
<td>Components Needed for System</td>
<td>Base course, sand, labor, sod or seed (irrigation is recommended)</td>
<td>Base course, 1½” (3.8cm) of 1/4” to ½” decorative gravel, and labor</td>
</tr>
<tr>
<td>Traffic</td>
<td>Low speed, light to moderate</td>
<td>Low speed, unlimited use</td>
</tr>
<tr>
<td>Compressive System Strength</td>
<td>Filled: 15,940 psi (2.29 million per sq ft / 109,906 kPa)</td>
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</tr>
<tr>
<td>Life Span</td>
<td>60 years</td>
<td>25 years</td>
</tr>
<tr>
<td>Recommended Maximum Slope</td>
<td>5% fire lanes, 8% car/light truck, 15-20% golf carts, pedestrian use, and trails</td>
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</tr>
<tr>
<td>Stormwater Storage</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Clean Pollutants through Bioremediation</td>
<td>Excellent</td>
<td>Good</td>
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<tr>
<td>Air-Conditioning Effect</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Heat Island Mitigation</td>
<td>Yes—Albedo Number .40</td>
<td>Yes, with light colored gravel fill—Albedo .16</td>
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<tr>
<td>Reduces Runoff and Non-Point Source Pollution</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Recycled Content</td>
<td>100% recycled HDPE plastic</td>
<td>100% recycled HDPE plastic with recycled remnant fabric</td>
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<tr>
<td>Erosion Control</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Airborne Dust Capture and Retention</td>
<td>Excellent</td>
<td>Good</td>
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<tr>
<td>Promotes and Retains Tree Growth</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Recharges Groundwater</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>