Highway Shoulder Use of Grasspave2

Highway shoulders can be an excellent application for Grasspave2 porous pavement. Grasspave2 is a turf reinforcement structure, designed for heavy truck loads, with the ability to maximize root zone mass, storm water infiltration and natural filtration capabilities for highway runoff. There are a few guidelines to ensure maximum success, and this paper will present them below.

Design Objectives

If grass, or porous, paving is desired, then specific design objectives should be outlined and prioritized. This will enable a proper evaluation of features and benefits offered against various costs and tradeoffs that might be necessary.

Features and benefits might include:

- Runoff infiltration (reduced hard surface)
- Bio-filtration
- Less visual hardscape (Scenic Highway objectives)
- Reduced ambient heat generation (Cool Community objectives)

Frequency of Use

Grass as a wearing surface will not offer the same traffic resistance as hard surfaces, but shoulders are not expected to have constant traffic. If we look at shoulder function as primarily an emergency pull-off and breakdown surface, where vehicles will pass over the surface only very occasionally (days or weeks apart), then grass is a viable surface alternative.

If traffic use (over the same square foot) can be expected multiple times per day – every day, then grass use should be reconsidered. This statement is made with the understanding that most applications will not have access to high levels of maintenance - irrigation and/or fertilization.

Cross-section Materials

Assuming that a porous pavement surface is desired in the first place, then the entire cross-section should be designed with porosity in mind. Start with the base course - a mix of crushed stone (or recycled concrete) 1” maximum diameter, and concrete sand in a 2:1 ratio. This mix provides excellent structural stability and porosity, along with near perfect horticultural demands for root development.

Grasspave2 is placed directly upon the base course, with grass roots providing the mechanical anchorage and surface stability (measure the shear strength of sod after 4 weeks of rooting in). Sand (concrete or mason’s) is then used to then fill the Grasspave2, with grass and mulch hydroseeded into place, or sand based grass sod is rammed into the bare rings for faster root zone development.

Organic soil amendments (such as peat, “topsoil”, manure, etc.) are specifically excluded from our cross-section. Organic materials occupy fairly large volumes, and can expose the plastic structure to UV and direct tire contact over the very short time it takes to decompose. Unless the surface is topdressed to replace the volume lost, UV light can damage the structure and crown/root loss can reduce shear strength. Sand is incompressible, and is locked in place with the combination of rings and roots.

The only values offered by organics are water retention and minor food source – both readily replaced with inorganic amendments and fertilizers.

Drainage – Surface and Sub-surface

Grasspave2 cross-sections can percolate water at rates that exceed 35 inches per hour. Thus, runoff leaving the hard surface pavement onto Grasspave2 will enter the soil immediately and move vertically until reaching the subsoil strata. While doing so, Grasspave2 acts as a temporary storage medium, with approximately 25% of the section as available void space (allowing for 10% void used as "holding capacity" in irrigated situations). With a 12" deep section, surface runoff (over clay subsoils) would not begin for the first 2.5" of rainfall.

This initial flow and storage will definitely qualify as able to handle the "first flush" of more heavily polluted hard surface runoff. The high void and massive root system creates a perfect environment for bio-filtration. The high void space provides for increased oxygen levels which support more bio activity at deeper levels than normal soil lawns, and increase the potential for oxidation of various metal contaminants. The deep root system adds to the available surface area for pollutants to be captured and retained – providing increased time of exposure for decay and cleansing.

Porous subsoils will receive the "cleansed" water and allow further vertical movement and effective runoff storage volume – before surface runoff on the Grasspave2 occurs. As soils become less porous (toward clay and silts), then a decision should be made as to the removal of excess water from this porous section adjacent to an impervious (most common?) base course below the hard surface pavement.

Water will move laterally through the porous base medium, but even with a bottom gradient of 1% or more, it will take a long time to evacuate the excess water volume being stored. The best solution would be use of a strip of Draincore2 placed horizontally adjacent to the hard/grass pavement interface, then periodically collected and directed away to inlet or stream. In this manner, the Grasspave2 and Draincore2 combination work similarly to a lateral trench drain, or edge drain, without the installation and maintenance issues.

While not likely affordable on a large scale, small areas may justify use of capture and long-term storage of runoff for use as an irrigation source. Overpasses, scenic overlooks, rest areas, median crossings, etc., could use captured surface runoff stored in subsurface Rainstore3 chambers, with solar powered pumps extracting water for drip and/or spray irrigation applications.

Grass Selection

Grass selection will not be greatly different than selections presently made for various regions in the country. Factors such as ease of establishment, cover density, salt resistance, fertilization demands, drought resistance, wearability are the same when using Grasspave2. For most parking and driveway applications we suggest grass mixes used locally for athletic turf applications, but these environments generally have higher levels of maintenance available. Highway applications would place greater emphasis upon establishment and low maintenance.

Use of porous media in the base course and paver fill can create initial establishment concerns – primarily related to water holding capacity. Depending upon the site location and environmental conditions, inorganic amendments to hold water (such as ZeoPro, volcanic sand, expanded shale, etc.) should be provided to get the root system established. Deep roots will usually take at least one growing season.

If the grass is seeded, then a heavier-than-normal application of hydroseed mulch material (sometimes with binder) can be used to keep seed moist through germination and initial root development, while minimizing soil erosion during this period. If irrigation is not available and a period of drought occurs after placement of grass, then periodic use of water trucks to irrigate is appropriate.

Grass sod should be used when installation must take place during non-prime seeding periods, or when soil erosion potential is greatest. Sod provides a huge head start in root system development, and filtration can begin almost immediately.

Speed and Friction

Grass surfaces are more slippery than hard surfaces (clean of sand and mud), especially during wet conditions. Little difference can be seen when under ice or snow. Grass shoulders will most often be subjected to slow speeds where traction is available and slowing/stopping can occur safely.

In situations where speeds remain high – accident, emergency, or dozing recovery, traction is perhaps less of a concern than maintaining a surface that remains constant and does not generate a more dangerous situation – such as deep ruts that could cause a vehicle to rotate and flip. Grasspave2 will maintain a consistent surface, avoid rutting, and in some situations perhaps allow a vehicle to recover safely and return to hard pavement.

Transition, Width and Cross Slope

Grasspave2 should be installed with the surface flush with the hard surface pavement edge. The cross-slope should be matched with that of the hard pavement or shoulder. Avoid a raised edge of Grasspave2, which can cause a barrier to surface runoff, and attract damage from errant snow plow blades, in addition to safety issues related to unexpected vehicle redirection.

Widths of Grasspave2 shoulders can vary to meet any number of design criteria. If considering bio-filtration as a key issue, then one can calculate the surface runoff volume of hard surface directed to the porous shoulder and determine the infiltration capacity available per foot of width of shoulder. Refer to “FilterInlet-Surface.xls” at the end of this paper. Remember that Grasspave2 comes in widths of 1 and 2 meters (3.3 and 6.6 feet), with rolls that can be interlocked on site for wider shoulders.

While most shoulders will have cross-slopes less than 5%, other applications (drainage swales, median emergency access paths, etc.) may be steeper than 5%. In those cases, consider use of our Slopetame2 product, which is similar to Grasspave2 with the addition of a thin geotextile bonded to the bottom and full depth cross-bars between rows of rings to reduce water/soil migration down the slope.

Maintenance

We recommend use of slow release fertilizers to avoid excess leaching of nutrients into subsurface and suface waters. In addition, once-yearly applications of micro-nutrient fertilizers will pay large dividends in maintaining the health of micro-organisms in the root zone, maintaining filtration capabilities and turf density at the surface.

Snow can be plowed from Grasspave2 surfaces, but not with the blade in direct contact. We recommend use of skids or rollers on the bottom of blades, leaving a space of 0.5” to 1”. End-of-winter sand/gravel deposits can be easily power-broomed back onto the hard paved shoulder and reclaimed.

Vehicle breakdown spills can be treated in-situ, depending upon the type of material lost. There are even commercially available bio cultures for most vehicle fluids that can be added for large spill areas. In situations where spill materials do not lend themselves to bio-treatment, then localized excavation, removal and replacement of the cross-section is available.

Grass surface damage from sliding or rapidly spinning tires can usually be repaired with surface roughing, reseeding, and topdressing with sand. If the paver is also lost from unusual vehicular action, then simple reconstruction per original installation is readily available, with use of grass sod as the final cover to provide rapid integration with undamaged areas.

Mowing frequency, thatch removal and other turf maintenance issues are similar to existing procedures related to grass species.

Life Cycle Costing

Grasspave2 porous pavements are slightly higher in cost than asphalt pavements to install. Maintenance and replacement costs are much lower than asphalt (over 15 year life), especially considering the reduced levels of maintenance of roadway applications compared to firelanes, parking and driveways. Grasspave2 pavements can

last decades without major maintenance and reconstruction. When the costs of drainage systems for hard surfaces are factored, Grasspave2 can minimize, or even eliminate these costs.

Thus, life cycle costing will favor Grasspave2 pavements over both asphalt and concrete surfaces, especially taking surface drainage systems into account.

Porous Filter Inlet Area to Runoff Area

Assume Filter Section Percolation Rate of 36 inches per hour (.05 cf/min)

Rainfall Rate-in / hr	Rate-cf / min	Runoff Surface to 1 Filter Surface
1.0	0.0014	36.00
1.5	0.0021	24.00
2.0	0.0028	18.00
2.5	0.0035	14.40
3.0	0.0042	12.00
3.5	0.0049	10.29
4.0	0.0056	9.00
4.5	0.0063	8.00
5.0	0.0069	7.20
5.5	0.0076	6.55
6.0	0.0083	6.00

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