BRAUN INTERTEC

Braun Intertec Corporation
1826 Buerkle Road
Saint Paul, MN 55110

Phone: 651.487.3245
Fax: 651.487.1812
Web: braunintertec.com

August 29, 2011 Project SP-11-00761

Mr. David Barlow
Innovative Base Technologies LLC
5030 Seminole Blvd.
St. Petersburg, Florida 33708

Re: Subgrade Preparation Requirements
UltraBaseSystems™

Dear Mr. Barlow:

As you requested, we have prepared this report for the purpose of evaluating the suitability of your UltraBaseSystems™ underlayment panels for varying soil and climate conditions.

Our Understanding of Project

We understand you have developed a base support system for artificial turf fields. The system consists of interconnected extruded polymer panels that are about 2'4" square and about 1 ¼ "thick. As part of the design, the panels have high permeability, high load handling characteristics, and provide insulation value. You are proposing to market the UltraBaseSystems™ globally and need an independent assessment of the suitability of the system for various soil types and climate conditions.

Background Information and Reference Documents

To assist in this evaluation, you provided us with the following information.

1. Largo High School Test Field installation report, May, 2009.
2. UltraBaseSystems™ "Simply Better from the Ground Up!", Marketing literature, undated
3. Testing Services Incorporated, Water Permeability Test Results, March 4, 2010

Scope of Services

Our scope of services for this project was originally submitted as a Proposal to you on February 28, 2011. You authorized the proposed scope of services on April 11, 2011. Our scope of services consisted of the following:

- Review available technical information regarding product

- Observe installation of product
- Evaluate product engineering characteristics including tolerance to earth pressures, frost heave resistance, and other soil induced forces.
- Provide a report with opinions regarding the suitability of the product for varying soil conditions and provide general recommendations for site remediation to accommodate product.

Our original scope of services was altered to eliminate observation of the installation of the product.

Product Evaluation

We reviewed the characteristics of the panel product based on the design specifications you provided. A summary of the characteristics is provided below.

Permeability

Test results provided by Testing Services, Incorporated indicated that the panels had an average rainfall capacity of approximately 175 inches/hour. Your performance literature also indicated that horizontal flow beneath the panels is up to 96.4 inches/hour and storage capacity of the panels is 3.5 gallons per 5.44 square feet (0.64 gallons per square foot).

Compressive Strength

Provided literature indicates that the panels are able to withstand loads of up to 1000 pounds per square inch before failing.

Thermal Conductivity

You provided a summary of the results indicating that the panel had a thermal conductivity of 0.8146 BTU·inch/square foot·hour·$^{\circ}$F. This equates to an equivalent R-value of approximately 3.4 per inch of thickness.

Analysis

Discussion

The panel will be installed in a wide variety of climate and soil conditions. Soil conditions that would adversely affect the performance of the panels include frost heave, expansive soils, sinkholes, collapsing soils and organic material.

In a typical installation, a geotextile separation fabric is placed beneath the panel in order to avoid soils from infiltrating into the water storage area incorporated into the panel where softer/looser soil conditions are present. Depending on the permeability of the soil, the geotextile can be designed either to promote water infiltration into the soil or to impede it. This is an essential aspect in the performance of the panels.

The interlocking panels are designed to spread laterally if heaving or settlement occurs. Thus, the panels are capable of tolerating some vertical movement due to differential frost heave, differential heaving from expansive soils or differential settlement. The installation of synthetic turf above the panels and a geotextile fabric below will also work to provide some insulation for the underlying soils, reducing frost penetration and the potential for frost heaving.

The intent of this report is to provide general recommendations. Conditions on each site will vary depending on

1. grading requirements (amount of cut and fill required) to provide a level surface,
2. sensitivity of the field, court or other application to movement,
3. soil conditions and variations in the soil conditions beneath the proposed improvement,
4. climate conditions of the project, and
5. special conditions of the site area such as sinkholes, expansive soils, etc

Because of these conditions, a geotechnical evaluation should be completed to address the above issues and to provide specific recommendations relevant to the soils and use of the proposed improvement.

Recommendations

General Site Preparation

General site preparation for play fields would involve grading to prepare a level or near level playing surface. Since the panels allow for rapid vertical and/or horizontal movement of the water, fields can likely be constructed in a level or near-level condition.

Fill required to grade the site should be placed in a controlled and compacted manner in order to reduce the potential for future settlement. Generally, the soil should be compacted to approximately 95 percent of its maximum dry density based on ASTM International Standard Test Method D 698 (standard Proctor) or 90 percent of its maximum dry density based on ASTM International Standard Test Method D 1557 (modified Proctor). Moisture contents of the soil should be near their optimum moisture content except for expansive soils, which should be placed above their optimum moisture content.

The finished surface should be void of any rocks, branches or other deleterious material that could puncture the overlying geotextile fabric. Just prior to placement of the geotextile fabric, the finished subgrade should be surface compacted a vibratory compactor exerting a minimum dynamic force of 3000 pounds. The geotextile fabric should have either a high permeability (greater than 50 gallons per minute per square foot) or be impermeable (less than 1 perms) depending on specific site requirements. The fabric should be adequately overlapped to avoid future separation and to properly convey water entering the fabric surface. In order to avoid puncturing during construction and after construction, the fabric should have a minimum weight of 6-8 ozs. A woven polypropylene fabric is preferred. We do not recommend needle punch fabrics. A spun bond polyester or polypropylene spun bond fabric can also work but not as strong as the woven material. We are looking for low elongation and high tensile strength properties which the woven products deliver. The panels should be carefully installed to avoid puncturing the geotextile fabric.

Soil Types

We are providing our recommendations for site preparation based on varying soil types. For the purpose of our discussion, we are using the visual soil classification in accordance with ASTM International Standard Practice D 2488.

Relatively Clean Sands (less than 7 percent fines)

For the purpose of this discussion, relatively clean sands are sands with less than 7 percent of the particles by weight passing a number 200 sieve. This type of soil is highly suitable for support of the panels. A highly permeable geotextile should be placed beneath the sand to prevent the panel from indenting into the sand, since the indenting would reduce the available storage area for drainage. This is especially important for sand containing increasing amounts of fines that would be less permeable and require more storage area.

Sands (greater than 7 percent fines)

Sands with increasing amounts of silt have a corresponding increase in frost heave potential. This could cause frost heaving of the soil in northern climates where temperatures are below freezing for extended periods (frost zones). The potential heave could be as much as 6 inches if silt soils and severe freezing are present. If the soils are relatively uniform, the frost heave may not adversely affect the performance of the panels. If the frost heave is relatively large and isolated due to significantly changing soil conditions over a small area, it would be necessary to provide an impermeable vapor barrier beneath the panels. Otherwise, a permeable vapor barrier could be used. Since the soil was relatively impermeable, a significant amount of water will need to be conveyed horizontally to the edge of the panels.

Preparation of the site for placement of the panels should consist of surface compaction of the subgrade surface after fine grading has been completed. Purpose of the compaction is to densify soils disturbed by the grading process and to provide a more uniform subgrade on which to place the panels.

In areas with limited below freezing weather, the preparation could be similar to that for relatively clean sands as provided above.

Lean Clay Soils

For the purpose of this discussion, lean clay soils consist of fine-grained soils with an expansive index of less than 50. Lean clay should typically be suitable for support of the panels. These soils will be poorly draining, however. Consequently, horizontal drainage should be provided to provide drainage during storm events. The geotextile separation fabric should be used to prevent the panels from indenting into the underlying clayey soils, especially if the soils are in a soft condition.

Since the soils are poorly draining, vertical drainage will be very limited. Consequently, drainage should be provided around the perimeter of the walls to convey storm water away from the site.

Expansive Clay Soils

More expansive clayey soils may require additional site preparation. Similar to frost susceptible soils, if the soils are relatively uniform, the potential expansive heave may not adversely affect the performance of the panels. If the expansive heave potential is relatively large and isolated due to significantly changing soil conditions over a small area, it would be necessary to provide an impermeable vapor barrier beneath the panels. An impermeable moisture vapor should be provided beneath the expansive soils. This will reduce the potential for seasonal variations in moisture content and thus reduce the movement of the panels. Similar to nonexpansive clays, the soils are poorly draining and vertical drainage will be very limited. Consequently, drainage should be provided around the perimeter of the walls to convey storm water away from the site.

Organic Soils

Soils with increased organic content tend to be somewhat more compressible, and tend to be more frost susceptible. Typically, with topsoil, the organic content decreases with depth. In frost zones, soils with greater than 6 percent organic content should be removed from beneath the panel areas. In other areas, removal can be limited to soils with more than 15 percent organic content by weight. Surface vegetation should also be removed in all cases.

Construction should be avoided in areas with highly organic soils such as peats and organic clays. Since differential settlement would be significant with these soil conditions, differential settlement would likely exceed the capability of the panels to compensate for it. If the extent and depth of the material is limited, however it may be possible to leave some or all of the organic soils in place. This would need to be evaluated on a case-by-case basis.

Collapsing Soils

Soil collapse occurs due to an increase in water content and an applied load. Assuming a significant increase in grade is not completed beneath the panels, soil collapse should not be an issue. If the geotechnical engineer indicates that collapse would be a significant concern for the project, however, an impermeable membrane should be provided beneath the panels to prevent water infiltration. In this case it would be necessary to convey the water horizontally while away from panels in order to avoid water infiltration beneath the panels and the possibility of collapse.

Sinkholes

Sinkholes occur in parts of the country where karst rock is present. Vertical conveyance of water into the ground serves as the catalyst for sinkhole development. If the panels will be constructed in a known karst area, an impermeable membrane should be provided beneath the panels to prevent infiltration. Water should then be conveyed to the perimeter of the panels and be outleted well away from the perimeter of the field. Grading immediately adjacent to the field should also be completed such that water is not allowed to pond in the vicinity of the panels. Following these procedures should dramatically reduce the potential for sinkhole development.

Settlement-Sensitive Facilities

Running tracks and tennis courts are more sensitive to movement than playing fields. Consequently, additional site preparation and/or increased use of impermeable vapor barriers would likely be required to reduce the potential movement on the more movement-sensitive playing surfaces. Even more site preparation would be required without the use of the panels, however.

For example, if the soils have a high frost potential and are saturated at the time the panels are installed, a limited soil subcut (removal and replacement of soil) would be necessary to remove the more frost susceptible soils for movement-sensitive structures. Generally a subcut would be 2 feet or less. Using conventional construction (without panels), however, up to 6 feet of removal would be required.

General Remarks

We appreciate the opportunity to be of service to you on this project. If you have any questions regarding this report please contact Loren Braun at 651.487.7011 or by e-mail at lbraun@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Loren W. Braun
Senior Engineer

Gregg R Jandro
Vice President