VALUE ENGINEERING PROPOSAL FOR PERMEABLE DRAINAGE LAYER AT MINOT STATE UNIVERSITY

Submitted by

Engineered Sportfield Solutions, LLC

4223 Rock Run Road

Havre de Grace, Maryland 21078

Phone: 410-878-6341

1. GEOSYNTHETIC GEOCOMPOSITE DESIGN

The proposed design provided by Engineered Sportfield Solutions (ESS), is to determine the transmissivity that can be met by using a geocomposite in place of 1.0 feet of drainage rock. Determining the equivalency factor of the gravel drainage layer to geocomposite is found by using the following equation,

$$E = 1\left[\;1 + \frac{t_{soildrain}}{0.88\ L}\ \frac{\cos\beta}{\tan\beta}\;\right] \qquad (1)$$

$t_{soilddrain}$ = thickness of soil drain
L = slope length
β = slope
E = equivalency factor

using information provided it was determined that the thickness of soil drain = 1.0 feet, slope length = 105 feet with a slope of 0.03 percent, the determined equivalency factor = 5.24.

To be equivalent under the confined flow condition, the geocomposite layer should have a greater hydraulic transmissivity than the granular liquid collection layer. The following equation is used to determine the equivalency,

$$\Theta_{GST} = E \times \Theta_{SD} \qquad (2)$$

Θ_{GST} = geocomposite drainage transmissivity
Θ_{SD} = soil drainage transmissivity
E = equivalency factor

3. GEOSYNTHETIC GEOCOMPOSITE DESIGN

Geosynthetic drainage materials are widely being used as cover drainage layers; gas vent layers; leachate collection and removal layers; and leak detection and removal layers. There are many advantages for geosynthetic drainage materials used in sport field applications. For instance, ease of installation and consistency in material properties inherent with manufacture quality control (MQC) plans. However, since geosynthetic geocomposite is made of polypropylene, there are some unique factors are different from natural soils and must be considered. Different design safety factors shall be used. A commonly used design method for geosynthetic drainage product is **Design by Function** proposed by Koerner (1994).
A drainage geocomposite system must meet the following equations. The allowable transmissivity can be derived from laboratory index transmissivty value through the equation below,

$$\Theta_{allow} = \frac{\Theta_{ultimate}}{RF_{cr} \times RF_{cc} \times RF_{bc}} = \frac{\Theta_{ultimate}}{\Pi\ RF} \qquad (3)$$

where $\Theta_{ultimate}$ is the ultimate flow rate (index value) measured in accordance with ASTM D4716. The following reduction factors have been proposed by Koerner (1994)

- RF_{cr} = reduction factor for creep deformation of the drainage core and/or adjacent geotextile into the drainage channel, 1.1 for Tenflow 770-2.
- RF_{cc} = reduction factor for chemical clogging and/or precipitation of chemicals in the drainage core space, 1.0-1.2 for sport fields.
- RF_{bc} = reduction factor for biological clogging in the drainage core space, 1.1-1.3 for sport field.
- RF = product of all relevant reduction factors for the site specific conditions.

Transmissivity test conducted under in-soil conditions resulted in $1.61x10^{-2}$ m^2/s. This transmissivity value was met by the proposed geosynthetic product under normal pressure 1,000 psf [1] and hydraulic gradient =1%,

$$\Theta_{allow} = 1.61x10^{-2}\ m^2/sec.\ /\ (1.1\ x\ 1.0\ x\ 1.1) = 1.2x10^{-2}\ m^2/sec \quad (4)$$

Since the soil drainage transmissivity is to be found, given that the geocomposite transmissivity =$1.2x10^{-2}$ m^2/sec and the determined equivalency factor = 5.24. The following equation was used to determine Θ_{SD},

$$\frac{1.2x10^{-2}}{5.24}\ x\ (1.5\ x1.5) = 5.2x10^{-3}\ m^2/sec \quad (5)$$

- RF_{cc} = reduction factor for chemical clogging and/or precipitation of chemicals in the gravel drainage layer, 1.5.
- RF_{bc} = reduction factor for biological clogging in the gravel drainage layer, 1.5.

Using equation (6) the hydraulic conductivity of the gravel drainage layer (k) can by using the calculated transmissivity of the soil drainage = $5.2x10^{-3}$ m^2/s, and drainage layer height = 30cm,

$$k = \frac{\Theta_{SD}}{h} \quad (6)$$

k = hydraulic conductivity
h = thickness of drainage layer
Θ_{SD} = transmissivity of the rock drainage layer

$$\frac{5.2x10^{-3}\ m^2/sec}{0.30m} = 1.7x10^{-2}\ m/sec \rightarrow 4821ft/day$$

3. PROPOSED ESS GEOCOMPOSITES

ESS SportFlow HF can meet a transmissivity value of $1.61x10^{-2}$ $m^2/sec.$ under normal pressure 1,000 psf and gradient 1%. ESS' SportFlow HF can replace a layer of drainage rock with the permeability of 4821 ft/day.

ESS SportFlow HF is recommended for this project. SportFlow HF product consists of a tri-planar geonet with a 6oz/sy geoetxtile heat-bonded to one side of the geonet. Extensive laboratory testing conducted both internally and independently concludes that ESS' tri-planar products have the following advantages over the conventional drainage geocomposites:

- High flow capacity under in-situ conditions.
- Low long term compressive creep.
- Great tensile strength.

REFERENCES

Koerner, R. M. (1994), Designing with Geosynthetics, Third Edition, Prentice Hall.

Zhao, A., Banks, J. (1997), Tri-planar geonet replaces double geonet systems at Sarasota landfill project, Sixth Int. Landfill Sym. Cagliari, Italy.