Geosyntec consultants

COMPUTATION COVER SHEET

Client: BRC	Project: CAMU	Project/ Proposal No.:	SC0313
		Task No.	04

Title of Computations: **DRAINAGE COMPOSITE EQUIVALENCY DEMONSTRATION**

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DRAINAGE COMPOSITE EQUIVALENCY DEMONSTRATION
BRC CAMU
HENDERSON, NEVADA

OBJECTIVE

The objective of this analysis is to evaluate the hydraulic performance of a drainage composite, and compare it to the prescriptive leachate collection layer, consisting of drainage aggregate, within the BRC CAMU. A drainage composite, consisting of two 8 oz/sy nonwoven geotextiles bonded to either side of a geonet, is proposed. This analysis will demonstrate equivalence or performance exceedance of the drainage composite to the prescriptive 1-foot thick (0.3m) aggregate drainage layer. The method of analysis will compare the current transmissivity of the aggregate drainage layer and the equivalent transmissivity of the drainage composite.

SUMMARY OF ANALYSIS

The calculations suggest that a drainage composite having a transmissivity of $6.1*10^{-5}$ m^2/sec, at a maximum stress of 12,000 psf (574 kN/m^2) and a hydraulic gradient of 0.10, will provide equivalence to the aggregate drainage layer.

METHOD OF ANALYSIS

The analysis was performed using procedures recommended by Koerner (1994). The procedure first evaluates the flow rate (transmissivity) through the aggregate drainage layer, using the basic flow equation described by Darcy, and then calculates the equivalent flow rate (transmissivity) of the drainage composite, and includes appropriate partial factors of safety for geosynthetic materials.

ANALYSIS

This calculation evaluates the flow rate within the drainage composite.

- **FLOW RATE (TRANSMISSIVITY) OF THE AGGREGATE DRAINAGE LAYER**

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The maximum flow rate within the leachate collection zone is determined from Darcy's Law by the equation:

$$q = K\ i\ A$$

where:

- q = flow rate within the leachate collection layer (m^3/sec)
- K = hydraulic conductivity (m/sec)
- i = hydraulic gradient (dimensionless)
- A = area of flux (m^2)

The following properties will be used for the aggregate drainage layer material.

- $K = 1*10^{-2}$ cm/sec = $1*10^{-4}$ m/sec.
- i = 0.10 (minimum slope of base liner system)
- A= (1 ft * 1 ft) = 1 ft^2 = 0.093 m^2

The hydraulic conductivity is the prescriptive minimum value for the aggregate drainage layer, and the hydraulic gradient is a function of the minimum base slope of the cell. The area of flux is based on the unit thickness of the aggregate drainage layer (1 foot minimum).

Therefore,

$$q_{req} = (1*10^{-4} \text{ m/sec.})(0.10)(0.093 \text{ m}^2)$$
$$= 9.3*10^{-7} \text{ m}^3\text{/sec}$$

This maximum flow rate through the aggregate drainage layer, is the required flow through the drainage composite (q_{req}).

The allowable flow rate is obtained from laboratory testing for design purposes. This value is determined using appropriate safety factors against the required flow rate. The factor of safety is expressed as the ratio of the allowable flow rate (q_{all}) to the required flow rate (q_{req}).

$$FS = q_{all} / q_{req}$$

Similarly, the factor of safety equation can be expressed as the ratio of allowable to required in plane flow, transmissivity (θ), where the factor of safety equals:

$$FS = \theta_{all} / \theta_{req}$$

Where the transmissivity is calculated by:

$$\theta_{req} = q_{req} / (i*W)$$ (Attachment A)

W = unit width of the drainage layer = 1 ft = 0.3408 m

Therefore,

$$\theta_{req} = \frac{(9.3*10^{-7}\ m^3/sec)}{(0.3048m)(0.10)}$$

$$= 3.05*10^{-5}\ m^2/sec.$$

The transmissivity of the aggregate drainage layer then becomes the minimum required transmissivity (θ_{req}) of the drainage composite.

TRANSMISSIVITY OF THE DRAINAGE COMPOSITE

To ensure that the transmissivity of the proposed drainage composite meets or exceeds the required values over the life of the landfill, the required transmissivity must be increased through the use of appropriate partial factors of safety. These partial factors of safety make the adequate adjustment between the laboratory transmissivity values for drainage composite and actual field conditions.

As seen in Attachment A, Koerner suggests four factors of safety which should be accounted for: the intrusion of the adjacent geotextile into the core of the geonet (FS_{IN}), creep deformation of the geonet (FS_{CR}), factor of safety against chemical clogging of the geonet (FS_{CC}), and factor of safety against biological clogging of the geonet (FS_{BC}). Partial factor of safety values were applied to the geotextile in the filtration geotextile calculation to account for flow through the geotextile component of the drainage composite.

Attachment A shows the ranges for the partial factors of safety. For the purposes of the calculations made, the factors of safety were assumed to be:

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FS_{IN} = 1.0 (Accounted for during the testing of the drainage composite)
FS_{CR} = 2.0
FS_{CC} = 1.0 (Accounted for in the Filter Calculation)
FS_{BC} = 1.0 (waste does not contain biological materials or food source)

The ultimate transmissivity of the drainage composite then becomes:

$$\theta_{ultimate} = \theta_{req} * (\Sigma\ FS)$$

Σ FS = product of all the partial factors of safety for the site specific conditions

The ultimate transmissivity of the drainage composite is then calculated as:

$$\theta_{geonet} = \theta_{req} * (\Sigma\ FS) = 3.05*10^{-5}\ m^2/sec\ [\ 1.0*2.0*1.0*1.0]$$

$$= 6.1*10^{-5}\ m^2/sec$$

MAXIMUM STRESS

The maximum height of the waste fill is 90 ft. Assuming a unit weight of 136 pcf, this translates to an overburden stress of approximately 12,000 psf.

CONCLUSIONS

The required transmissivity of the geocomposite shall be $6.1*10^{-5}$ m^2/sec at a maximum stress of 12,000 psf and a gradient of 0.10.

REFERENCES

Koerner, R.M. (1994) “Designing with Geosynthetics”, 3rd Edition, Prentice Hall, New Jersey *(Attachment A)*