RESPONSE 41

APPENDIX III-3G-4

LEACHATE COLLECTION SYSTEM OVERLINER DRAINAGE LAYOUT

LEACHATE COLLECTION SYSTEM OVERLINER DRAINAGE LAYOUT

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INTENDED FOR PERMITTING PURPOSES ONLY

1.0 OBJECTIVE

I) Determine the required transmissivity of the overliner drainage layer (double-sided geocomposite) based on critical case conditions.

II) Based on published data, determine the geocomposite drainage layer type that will meet the required transmissivity.

2.0 GIVEN

The critical case overliner slope is a composite slope consisting of the following : (i) a 15% slope of length (L_{up} - upstream) = 270 ft.

and (ii) a 33% slope of length (L_{down} - downstream) = 85 ft.

The permeability of the protective cover, K_{prot} = 1.0E-05 cm/s (same as HELP model)

3.0 METHOD

Determine the required transmissivity of the overliner drainage layer after applying reduction factors and a factor of safety.

$$\theta_{\text{measured -req, downstream}} = FS\Pi(RF)q_h(L_{up} + L_{down})/(\sin\beta_{down}) \text{ (Ref. 2)}$$

$$\theta_{\text{measured -req, upstream}} = FS\Pi(RF)q_h(L_{up})/(\sin\beta_{up}) \text{ (Ref. 2)}$$

$\theta_{\text{measured -req}}$ = required transmissivity of geocomposite drainage layer measured in laboratory

Test Conditions:	i =	0.33
Normal Stress	=	10,000 psf
Boundary Cond'ns	=	steel plates
Test Time	=	15 minutes

FS = factor of safety (see Table 1)
RF = reduction factors (see Table 1)
Π(RF) = product of all reduction factors
q_h = rate of liquid supply expressed per unit surface area measured horizontally.

L = length of geocomposite in direction of flow
β = slope angle

Based on the above equations and the given slopes of the upstream and downstream sections, the required transmissivity on the upstream slope will be higher. Hence, the upstream section represents the critical case.

The required transmissivity is calculated for the following conditions:

(i) exposed condition - consists of saturated protective cover overlying the drainage layer. Under this condition the gradient = 1.0 and q_h is equal to the hydraulic conductivity of the protective cover soil $q_h = 1.0 \times 10^{-5}$ cm/dec = 0.340 in/day.

(ii) open condition
(iii) intermediate condition
(iv) final condition prior to final cover placement
(v) final condition with final cover

(Refer Appendix III-3E-1 for explanation of conditions ii-v)

4.0 CALCULATION

Table 1 Required Transmissivity for Overliner Upstream Slope Section (Critical Case)

Condition	q_h (in/day)(1)	θ_{design} (m²/sec)	RF_{cr}(	RF_{cc}(2)	RF_{bc}(2)	RF_{in}(2)	FS	$\theta_{required}$ (m²/sec)
Exposed	0.340	5.5E-05	1	1	1.1	1.1	1.5	1.19E-04
Open	0.278	4.5E-05	1	1.2	1.1	1.1	2	1.82E-04
Intermediate	0.152	2.4E-05	2	1.7	1.3	1.1	3	2.67E-04
Final - no cover	0.053	8.5E-06	2	2	2	1.2	4	3.27E-04
Final	1.1E-04	1.8E-08	2	2	2	1.2	4	6.79E-07

(1) All values except the exposed condition (explained in Section 3.0) are obtained from Appendix III-3E-1
(2) Reduction factors are based on Ref. 1

I) The required transmissivity ($\theta_{required}$) (i.e. the transmissivity required during QC and conformance testing) was determined to be **3.7x10^{-4} m^2/sec.**

II) Typical transmissivity values for double-sided 200-mil geonet geocomposites are in the 10^{-4} m^2/sec range and are expected to meet the required transmissivity for the overliver system.

5.0 CONCLUSION

A standard 200-mil, double-sided geocomposite drainage layer will have flow capacity adequate to prevent the development of hydrostatic pressure below the protective cover on the overliner slopes. As per the Liner Quality Control Plan (Appendix III-3F), construction performance testing will be performed to verify that the geocomposite selected for construction has adequate transmissivity to meet the design requirement.

6.0 REFERENCES

1. Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.
2 Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.

APPENDIX III-3F-3C

UNDERDRAIN GEOCOMPOSITE CALCULATION

UNDERDRAIN GEOCOMPOSITE CALCULATION

Made By: JBF
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1.0 OBJECTIVE

Determine the required transmissivity of the sideslope underdrain geocomposite.

2.0 GIVEN

Maximum groundwater flow along entire sideslope = 6.11E-08 ft^3/sec per unit width (maximum total flow along slope - See Appendix III-3F-3a)

3.0 METHOD

Determine the required transmissivity of the sideslope underdrain geocomposite layer after applying reduction factors and a factor of safety.

$\theta_{measured\text{-}req} = \mathbf{FS\Pi(RF)q_hL/(\sin\beta)}$ (Ref. 1)

$\theta_{measured\text{-}req}$ = required transmissivity of geosynthetic drainage layer measured in laboratory

Test Conditions: i = 0.33
Normal Stress = 10,000 psf
Boundary Cond'ns = steel plates
Test Time = 15 minutes

FS = factor of safety = 1.5 (short-term cond'ns)

RF = reduction factors (see below) -- (short-term cond'ns)

Π(RF) = product of all reduction factors

q_h = rate of liquid supply per unit area ($m^3/s/m^2$ or m/s)

L = length of geocomposite in direction of flow (m)

q_hL = 6.11E-08 ft^3/sec (this value represents the total flow along the entire sideslop, which is computed in SEEP/W, IN App. III-3F-3a)

β = slope angle

Reduction Factor	Description	Value (Ref. 1)
RF_{in} =	Reduction Factor for intrusion of geotextile into geonet	1.2
RF_{cr} =	Reduction Factor for creep	1.0
RF_{cc} =	Reduction Factor for chemical clogging of geotextile and/or geonet	1.1
RF_{bc} =	Reduction Factor for biological clogging of geotextile and/or geonet	1.1
	$\Pi(RF)$ =	1.5

4.0 CALCULATION

I) Transmissivity for maximum flow

$$\theta_{measured\text{-}req} = \mathbf{3.9E\text{-}07\ ft^3/s\text{-}ft} = \mathbf{3.6E\text{-}08\ m^3/s\text{-}m}$$

II) Typical transmissivity values for double-sided 200-mil geonet geocomposites under low normal loads are in the 10^{-4} m^3/s-m range; roughly 3 orders of magnitude greater than required.

5.0 CONCLUSION

A standard 200-mil, double-sided geocomposite underdrain layer will have flow capacity adequate to prevent the development of hydrostatic pressure below the clay liner on the sideslopes.

6.0 REFERENCES

1. Giroud, J.P, Zornberg, J.G., and Zhao, A., "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, 2000.