GRI-GC8 Guide

Determination of Allowable Flow Rate of Drainage Geocomposites

- this is a "guide" for determining allowable flow rate (or transmissivity) of geosynthetic drainage products
- focuses on geonets, geonet composites (one or two attached geotextiles), and drainage geocomposites (one or two attached geotextiles)
- see following photos……

Biplanar Geonet

Triplanar Geonet

Geonet Composite

Drainage Composite

General Comments

- utilizes ASTM D4716 "Transmissivity Test"
- parallel flow, constant pressure, given gradients for 100 hours load duration
- baseline then modified for creep, chemical clogging, and biological clogging
- results in allowable flow rate for design
- used in factor-of-safety equation, i.e.,

$$FS = q_{allow}/q_{reqd}$$

ASTM D4716 Test Device

Target can also be Transmissivity (θ)

Darcy's Formula

$Q = kiA$
$= ki\ (Wt)$
$Q/W = (kt)\ i$
$q = \theta i$

where
- q = flow rate/unit width (m^2/sec)
- θ = transmissivity (m^2/sec)
- i = hydraulic gradient (= H/L)
- H = head loss (m)
- L = specimen length (m)

Determination of Baseline Flow Rate

- test the as-manufactured product
- average of three replicate tests
- 300 × 300 mm (12 × 12 in.) test specimens
- specimen orientation as agreed upon
- options for substratum and superstratum are; rigid, closed cell foam; sand; or soil
- applied stress and gradient as agreed upon
- duration of normal load is 100 hours
- tap water (unless agreed upon)
- results in "q_{100}" or "θ_{100}"-value

Reduction Factor for Creep (RF_{CR})

- long-term creep test on drainage core (not the composite)
- 150 × 150 mm (6 × 6 in.) test specimen
- within rigid box; steel plate above
- stationary water (or other liquid)
- same normal stress as for baseline test
- deformation monitored for 10,000 hours (for conformance test can be 1,000 hours)
- calculation method follows……

$$RF_{CR} = \left[\frac{\left(t_{CO}/t_{original}\right) - \left(1 - n_{original}\right)}{\left(t_{CR}/t_{original}\right) - \left(1 - n_{original}\right)} \right]^3$$

where

RF_{CR} = reduction factor for creep
$t_{original}$ = original thickness (m)
t_{CO} = thickness at 100-hours (m)
t_{CR} = thickness at >>100-hours, e.g., at 10,000 hours (m)
$n_{original}$ = original porosity

$$n_{original} = 1 - \frac{\mu}{\rho t_{original}}$$

where
μ = mass per unit area (kg/m^2)
ρ = density of the formulation (kg/m^3)

Reduction Factors for Clogging

- chemical clogging due to precipitates of calcium or magnesium; also turbidity
- biological clogging due to microorganisms (fungi and bacteria) or roots of vegetative matter
- can be laboratory simulated (but with great difficulty and expense)
- following table is a recommended guide

Range of Clogging Reduction Factors (modified from Koerner, 2012)

Application	Chemical Clogging (RF_{CC})	Biological Clogging (RF_{BC})
Sport fields	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.0 to 1.2	1.1 to 1.3
Roof and plaza decks	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.1 to 1.5	1.0 to 1.2
Drainage blankets	1.0 to 1.2	1.0 to 1.2
Landfill caps	1.0 to 1.2	1.2 to 3.5
Landfill leak detection	1.1 to 1.5	1.1 to 1.3
Landfill leachate collection	1.5 to 2.0	1.1 to 1.3

Issue of Polymer Degradation

- use ASTM D5322 immersion procedure
- test incubated drainage core per D6388
- test incubated geotextile per D6389
- data is plotted for 120 days
- results in a "go-no go" decision depending upon magnitude of property changes over incubation time
- see following for HDPE geomembrane

Property	O'Toole		Little		Koerner	
	Resistant	Not Resistant	Resistant	Not Resistant	Resistant	Not Resistant
Permeation range (g/m^2-hr.)	-	-	<0.9	≥0.9	<0.9	≥0.9
Change in weight (%)	<0.5	>1.0	<3	≥3	<2	≥2
Change in volume (%)	<0.2	>0.5	<1	≥1	<1	≥1
Change in yield strength (%)	<10	>20	<20	≥20	<20	≥20
Change in yield elongation (%)	-	-	<20	≥20	<30	≥30
Change in modulus (%)	-	-	-	-	<30	≥30
Change in tear strength (%)	-	-	-	-	<20	≥20
Change in puncture strength (%)	-	-	-	-	<30	≥30

Summary

- baseline flow rate is 100-hour transmissivity test for "q_{100}" or "θ_{100}"
- modified by ($RF_{CR} \times RF_{CC} \times RF_{BC}$)
- degradation is also considered
- results in "q_{allow}" or "θ_{allow}" values
- does not address "q_{reqd}" or "θ_{reqd}" values
- required values are a design issue