REFERENCE

GEONET PROPERTIES

GSE®

Product Data Sheet

GSE STANDARD PRODUCTS

GSE PermaNet UL Geocomposite (Double-Sided)

GSE PermaNet UL (Ultra Load) Geocomposites are patent pending drainage products manufactured with a geonet heat-bonded to a nonwoven, needlepunched geotextile on both sides. The creep resistant structure ensures continuous flow performance over a broad range of conditions and long durations. These products work as an efficient drainage medium and are ideal for extremely high compressive stress applications.

Depending on filtration and interface strength requirements of a specific project, GSE can bond any type of nonwoven, needlepunched geotextiles to the geonet. GSE PermaNet UL Geocomposites are available in a 6, 8, and 10 oz/yd² geotextile as described in the product specification chart below. For more information on the performance transmissivity under site-specific conditions, please contact a GSE representative.

GSE Advantage Products

GSE GundSeal • GSE Conductive • GSE White • GSE PermaNet • GSE Nailrain System

Product Specifications

TESTED PROPERTY	TEST METHOD	FREQUENCY	AVERAGE VALUE		
Geocomposite			6 oz/yd²	[redacted]	10 oz/yd²
Product Code			FR82060060T	FR82080080T	FR82100100T
Transmissivity[a], gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²	4.8 (1 x 10⁻³)	[redacted]	4.8 (1 x 10⁻³)
Ply Adhesion, lb/in (g/cm)	ASTM D 7005	1/50,000 ft²	1.0 (178)	1.0 (178)	1.0 (178)
Roll Width[b], ft (m)			15 (4.5)	15 (4.5)	15 (4.5)
Roll Length[b], ft (m)			150 (45)	140 (42)	130 (39)
Roll Area, ft² (m²)			2,250 (202)	2,100 (189)	1,950 (175)
Geonet Properties			AVERAGE VALUE		
Transmissivity[c], gal/min/ft (m²/sec)	ASTM D 4716		24 (5 x 10⁻³)		
Compression Strength, lb/ft² (kPa)	ASTM D 1621	1/540,000 ft²	50,000 (2,390)		
Creep Reduction Factor		once per formulation	1.3 @ 25,000 psf		
Mass, lb/ft² (g/m²)	ASTM D 5261	1/50,000 ft²	0.43 (2,100)		
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94		
Tensile Strength (MD), lb/in (N/mm)	ASTM D 5035	1/50,000 ft²	100 (17)		
Carbon Black Content, %	ASTM D 1603, modified	1/50,000 ft²	2.0		
Geotextile Properties[d]			MINIMUM AVERAGE ROLL VALUE		
Mass, oz/yd² (g/m²)	ASTM D 5261	1/90,000 ft²	6 (200)	8 (270)	10 (335)
Grab Tensile, lb (N)	ASTM D 4632	1/90,000 ft²	170 (755)	220 (975)	260 (1,155)
Puncture Strength, lb (N)	ASTM D 4833	1/90,000 ft²	90 (395)	120 (525)	165 (725)
AOS, US sieve (mm)	ASTM D 4751	1/540,000 ft²	70 (0.21)	80 (0.180)	100 (0.150)
Permittivity, (sec⁻¹)	ASTM D 4491	1/540,000 ft²	1.5	1.5	1.2
Flow Rate, gpm/ft² (lpm/m²)	ASTM D 4491	1/540,000 ft²	110 (4,480)	110 (4,480)	85 (3,460)
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	once per formulation	70	70	70

NOTES:

- [a]This is an index transmissivity value measured at stress = 25,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geocomposite/plate. Contact GSE for performance transmissivity value for use in design.
- [b]Roll widths and lengths have a tolerance of ±1%.
- [c]This is an index transmissivity value measured at stress = 25,000 psf; gradient = 0.1; time = 15 minutes; boundary conditions = plate/geonet/plate
- [d]All geotextile properties are minimum average roll values except AOS (in mm) which is a maximum average roll value (MaxARV); and UV resistance which is a typical value.

DS023 PermaNetUL R04/25/06

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Middle East	GSE Lining Technology-Egypt	The 6th of October City, Egypt		202 2 828 8888	Fax: 202 2 828 8889

www.gseworld.com

REFERENCE

KOERNER, DESIGNING w/ GEOSYNTHETICS

Fourth Edition

Designing with Geosynthetics

Robert M. Koerner, Ph.D., P.E.

H. L. Bowman Professor of Civil Engineering,
Drexel University and Director, Geosynthetic
Research Institute

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4.1.6 Allowable Flow Rate

As described previously, the very essence of the design-by-function concept is the establishment of an adequate factor of safety. For geonets, where flow rate is the primary function, this takes the following form.

$$\text{FS} = \frac{q_{\text{allow}}}{q_{\text{reqd}}} \tag{4.3}$$

where

FS = factor of safety (to handle unknown loading conditions or uncertainties in the design method, etc.),
q_{allow} = allowable flow rate as obtained from laboratory testing, and
q_{reqd} = required flow rate as obtained from design of the actual system.

Alternatively, we could work from transmissivity to obtain the equivalent relationship.

$$\text{FS} = \frac{\theta_{\text{allow}}}{\theta_{\text{reqd}}} \tag{4.4}$$

where θ is the transmissivity, under definitions as above. As discussed previously, however, it is preferable to design with flow rate rather than with transmissivity because of nonlaminar flow conditions in geonets.

Concerning the allowable flow rate or transmissivity value, which comes from hydraulic testing of the type described in Section 4.1.3, we must assess the realism of the test setup in contrast to the actual field system. If the test setup does not model site-specific conditions adequately, then adjustments to the laboratory value must be made. This is usually the case. Thus the laboratory-generated value is an ultimate value that must be reduced before use in design; that is,

$$q_{\text{allow}} < q_{\text{ult}}$$

One way of doing this is to ascribe reduction factors on each of the items not adequately assessed in the laboratory test. For example,

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\text{RF}_{IN} \times \text{RF}_{CR} \times \text{RF}_{CC} \times \text{RF}_{BC}}\right] \tag{4.5}$$

or if all of the reduction factors are considered together.

$$q_{\text{allow}} = q_{\text{ult}}\left[\frac{1}{\Pi\text{RF}}\right] \tag{4.6}$$

where

q_{ult} = flow rate determined using ASTM D4716 or ISO/DIS 12958 for short-term tests between solid platens using water as the transported liquid under laboratory test temperatures,

q_{allow} = allowable flow rate to be used in Eq. (4.3) for final design purposes,
RF_{IN} = reduction factor for elastic deformation, or intrusion, of the adjacent geosynthetics into the geonet's core space,
RF_{CR} = reduction factor for creep deformation of the geonet and/or adjacent geosynthetics into the geonet's core space,
RF_{CC} = reduction factor for chemical clogging and/or precipitation of chemicals in the geonet's core space,
RF_{BC} = reduction factor for biological clogging in the geonet's core space, and
ΠRF = product of all reduction factors for the site-specific conditions.

Some guidelines for the various reduction factors to be used in different situations are given in Table 4.2. Please note that some of these values are based on relatively sparse information. Other reduction factors, such as installation damage, temperature effects, and liquid turbidity, could also be included. If needed, they can be included on a site-specific basis. On the other hand, if the actual laboratory test procedure has included the particular item, it would appear in the above formulation as a value of unity. Examples 4.2 and 4.3 illustrate the use of geonets and serve to point out that high reduction factors are warranted in critical situations.

Example 4.2

What is the allowable geonet flow rate to be used in the design of a capillary break beneath a roadway to prevent frost heave? Assume that laboratory testing was done at the proper design load and hydraulic gradient and that this testing yielded a short-term between-rigid-plates value of 2.5×10^{-4} m²/s.

Solution: Since better information is not known, average values from Table 4.2 are used in Eq. (4.5).

TABLE 4.2 RECOMMENDED PRELIMINARY REDUCTION FACTOR VALUES FOR EQ. (4.5) FOR DETERMINING ALLOWABLE FLOW RATE OR TRANSMISSIVITY OF GEONETS

Application Area	RF_{IN}	RF_{CR}*	RF_{CC}	RF_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock, and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill covers	1.3 to 1.5	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values are sensitive to the density of the resin used in the geonet's manufacture. The higher the density, the lower the reduction factor. Creep of the covering geotextile(s) is a product-specific issue.

REFERENCE

USEPA TECHNICAL MANUAL

HEAD ON LINER FORMULA REF.

United States Environmental Protection Agency | Solid Waste and Emergency Response (5305) | EPA530-R-93-017 November 1993 www.epa.gov/osw

EPA

Solid Waste Disposal Facility Criteria

Technical Manual

Leachate Collection Pipes

All components of the leachate collection system must have sufficient strength to support the weight of the overlying waste, cover system, and post-closure loadings, as well as the stresses from operating equipment. The component that is most vulnerable to compressive strength failure is the drainage layer piping. Leachate collection system piping can fail by excessive deflection, which may lead to buckling or collapse (USEPA, 1988). Pipe strength calculations should include resistance to wall crushing, pipe deflection, and critical buckling pressure. Design equations and information for most pipe types can be obtained from the major pipe manufacturers. For more information regarding pipe structural strength, refer to U.S. EPA (1988).

Perforated drainage pipes can provide good long-term performance. These pipes have been shown to transmit fluids rapidly and to maintain good service lives. The depth of the drainage layer around the pipe should be deeper than the diameter of the pipe. The pipes can be placed in trenches to provide the extra depth. In addition, the trench serves as a sump (low point) for leachate collection. Pipes can be susceptible to particulate and biological clogging similar to the drainage layer material. Furthermore, pipes also can be susceptible to deflection. Proper maintenance and design of pipe systems can mitigate these effects and provide systems that function properly. Acceptable pipe deflections should be evaluated for the pipe material to be used (USEPA, 1989).

The design of perforated collection pipes should consider the following factors:

- The required flow using known percolation impingement rates and pipe spacing;
- Pipe size using required flow and maximum slope; and
- The structural strength of the pipe.

The pipe spacing may be determined by the Mound Model. In the Mound Model (see Figure 4-8), the maximum height of fluid between two parallel perforated drainage pipes is equal to (U.S. EPA, 1989):

$$h_{max} = \frac{L\sqrt{c}}{2}\left[\frac{\tan^2\alpha}{c} + 1 - \frac{\tan\alpha}{c}\sqrt{\tan^2\alpha + c}\right]$$

where c = q/k
k = permeability
q = inflow rate
α = slope.

The two unknowns in the equation are:

L = distance between the pipes; and
c = amount of leachate.

Using a maximum allowable head, h_{max}, of 30 cm (12 in), the equation is usually solved for "L" (U.S. EPA, 1989).

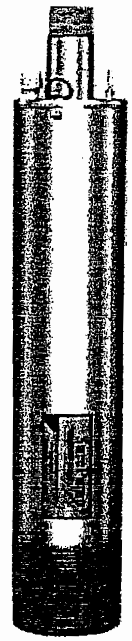
The amount of leachate, "c", can be estimated in a variety of ways including the Water Balance Method (U.S. EPA, 1989) and the computer model Hydrologic Evaluation of Landfill Performance (HELP). The HELP Model is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The model uses climatologic, soil, and landfill design data and incorporates a solution technique that accounts for the effects of surface storage, run-off, infiltration, percolation, soil-moisture

REFERENCE

SURE PUMP DATA SHEET

SurePump™

Vertical Sump Drainer



EPG's SurePump™ Vertical Sump Drainer (VSD) pumps contaminated liquids for recovery, leachate collection, gas condensate removal, and sampling applications. It can be used in aggressive environments. Other designs may fail while EPG Vertical Sump Drainers are still going strong. EPG backs the vertical sump drainers with a one year warranty effective the date of installation. For more information please call the experts at EPG companies Inc.

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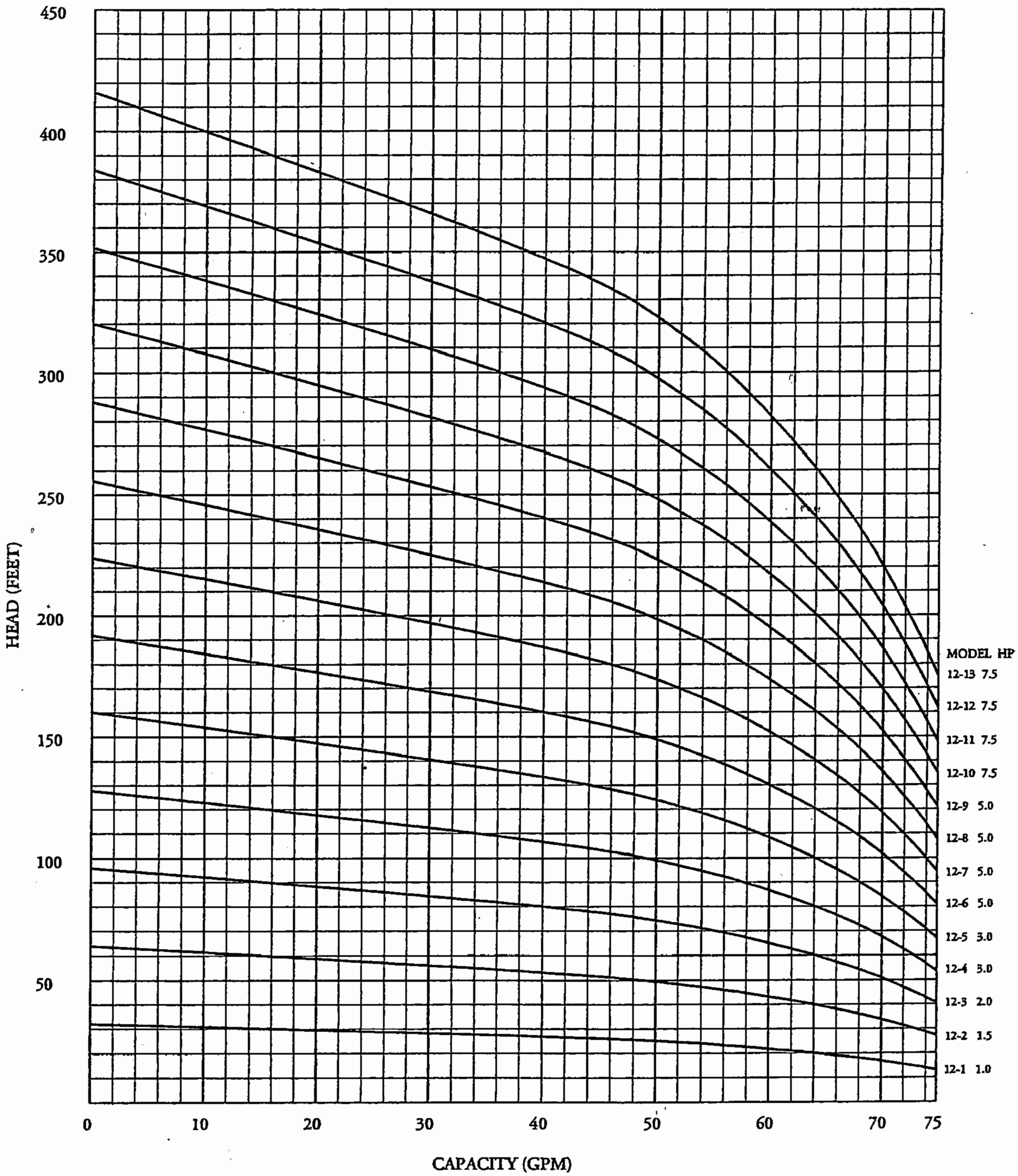

DATA SUBJECT TO CHANGE WITHOUT NOTICE

REFERENCE

ESI 1996 CALCULATION