

# **GRI's Generic Specifications for Various Geosynthetics**

- 1. The Process**
- 2. Current Specifications**
- 3. Draft Specifications**
- 4. Endorsement via User Feedback**
- 5. Revisions and Maintenance**
- 6. Benefits to the Industry**

# 1. The 10-Step Process

- (i) Need expressed by “the industry”**
- (ii) Initial discussion in focus group**
- (iii) Presentation of draft table(s)**
- (iv) Intense discussion in focus group**
- (v) Eventually text is added**

- (vi) More discussion in focus group**
- (vii) When close, draft sent to all members**
- (viii) Back to focus group for modification**
- (ix) One more iteration, then daylight the original on GSI Web Site**
- (x) Revise/maintain on a regular basis**

## 2. Current Specifications

- **GRI GM13 for HDPE Geomembranes**
- **GRI GM17 for LLDPE Geomembranes**
- **GRI GM18 for fPP Geomembranes**
- **GRI GM21 for EPDM Geomembranes**
- **GRI GM19 for Geomembrane Seams**
- **GRI GT10 for Geotextile Tubes**
- **GRI GT12 for Geotextile Cushions**

# GRI GM13 – High Density Polyethylene Geomembranes

- **thickness – smooth (lowest value – 10%)**
  - textured (nom.-5%, lowest-15% and asperity height)
- **density – greater than 0.940 g/cc**
- **tensile – yield and break (strength & elongation) (break elongation of textured is 100%)**
- **stress crack – SP-NCTL  $\geq$  200 hours**
- **C. B. dispersion – 9 in Cat. 1 & 2; 1 in Cat. 3**
- **OIT – standard or high pressure**
- **oven aged - % OIT remaining**
- **UV (fluorescent tube) - % HP-OIT remaining**

# GRI GM17 – Linear Low Density Polyethylene Geomembranes

- **thickness – same as HDPE**
- **density – less than 0.939 g/cc**
- **tensile – lower than HDPE**
- **2% modulus – maximum value of 420 N/mm<sup>2</sup>**
- **axi-symmetric break – greater than 30%**
- **stress crack – not addressed**
- **C. B. – same as HDPE**
- **OIT – same as HDPE**
- **oven/UV – lower than HDPE**

# GRI GM18 – Flexible Polypropylene Geomembranes

- **type – nonreinforced and scrim reinforced**
- **thickness – (lowest value – 10%)**
- **tensile – NR (dumbbell); R (grab)**
- **axisym break – NR > 120%**
- **tear – N/R (50 N/mm); R (245 N/mm)**
- **ply adhesion – R (65 N)**
- **low temp. flexibility – (-40°C)**
- **oven aging – OIT remaining (black > others)**
- **UV fluorescent – OIT remaining (black > others)**
- **oven and UV – no surface cracking**

# Strength Comparisons

Mechanical Properties	HDPE		LLDPE		fPP	
	smooth	textured	smooth	textured	non-rein	rein
yield strength (N/mm <sup>2</sup> )	15	15	n/a	n/a	n/a	n/a
break strength (N/mm <sup>2</sup> )	27	13	27	11	13	39±
yield strain (%)	12	12	n/a	n/a	n/a	n/a
break strain (%)	700	100	800	250	700	22
mod.-max. (N/mm <sup>2</sup> )	n/a	n/a	420	420	n/a	n/a
Tear (N/mm)	125	125	100	100	50	245
Puncture (N/mm)	320	267	250	200	130	360
axi-sym strain (%)	n/a	n/a	30	30	120	n/a

# Endurance Comparisons

Endurance Properties (via OIT in min.)	HDPE black	LLDPE black	fPP	
			black	other
<b>OIT (initial)</b>				
● standard	100	100	n/a	n/a
● high pressure	400	400	n/a	n/a
<b>OIT (after oven aging)</b>				
● standard	55	35	n/r	n/r
● high pressure	80	60	60	50
<b>OIT (after UV aging)</b>				
● standard	n/r	n/r	n/r	n/r
● high pressure	50	35	80	60

# GRI-GM21 - EPDM Geomembranes

- **type - nonreinforced and scrim reinforced**
- **two thicknesses in each type**
- **tensile - NR (narrow strip); R (grab)**
- **axisym break - NR > 100%**
- **tear - R >> NR**
- **puncture - R >> NR**
- **low temp flex - (-45°C)**
- **oven aging - % str. & elong. ret.; no cracks**
- **UV resist. - % str. ret.; no cracks**

# GRI GM19 – HDPE, LLDPE, fPP Seams

- specimen width is 25 mm
- except fPP-R, a grab test
- hot wedge values same as extrusion
- shear strengths > peel strengths
- shear elongation > 50% all cases
- peel separation < 25% all cases

# GRI-GT10 High Strength Geotextile Tubes

- typically woven PET or PP fabrics
- main tube separate from scour aprons
- aggressive and typical conditions
- circumference and fill port standardized
- wide width strength and elongation, tear, puncture and seam
- AOS and flux
- Xenon Arc UV resistance  $\geq 65\%$  after 150 hr.

# GRI-GT12 Nonwoven GTs for Protection

- up to 2000 g/m<sup>2</sup>
- grab strength and elongation
- trapezoidal tear
- puncture (pin, pyramid or CBR)
- Xenon Arc UV resistance  $\geq 70\%$  at 500 hrs
- all MARV except UV resistance

## **3. Draft Specifications**

- **GRI GGXX for Bidirectional Geogrids**
- **GRI GGXX for Unidirectional Geogrids**
- **GRI GNXX for Biplanar Geonet Composites**
- **GRI GCXX for Drainage Geocomposites**
- **GRI GCLXX for Geosynthetic Clay Liners**

# GRI GGXX-Bidirectional Geogrids (Pavements)

- tensile strength @ 2%, 5%, ultimate
- XMD > MD
- pullout interaction coefficient > 0.8
- direct shear > 30 deg
- aperture size 15 to 75 mm
- torsional rigidity; draft GRI Test
- Xenon Arc UV resistance  $\geq 70\%$  at 500 hrs.

# GRI GGXX-Unidirectional Geogrids (Wall & Slopes)

- three different categories
- monolithic PE; coated PET yarns; PET straps
- coating adhesion test for PET yarns (GRI draft)
- six ultimate strength classes
- junction efficiency (GRI-GG2)
- pullout interaction coefficient  $> 0.8$
- direct shear  $> 30$  deg
- default RFs for CR, ID, CBD and seams
- PE durability; OIT, CB, UV
- PET durability; UV,  $M_w$ , CEG

# GRI GNXX-Biplanar Geonets & Geocomposites

- focuses on waste containment
- GN & GT before lamination
- then the composite
- GN;  $\rho$ ,  $t$ , CB,  $\theta = f(t)$
- GT; Class 1 & 2 of AASHTO M288
- composite; single and double sided
- transmissivity for different thicknesses
- ply adhesion

# GRI GCXX – Drainage Geocomposites

- focuses on transp./geotech./private
- requires compressive strength
- core (t, comp, flow rate)
- GT: Class 1 and 2 of AASHTO M288
- composite: single and double sided
- uses flow rate (not  $\theta$ ) after lamination
- ply adhesion

# GRI GCLXX-Geosynthetic Clay Liners

- **reinforced and nonreinforced**
- **GT and GM related**
- **Clay; swell index and fluid loss**
- **GCL (as manufactured)**
  - mass (of GCL and clay)
  - moisture content
  - thickness
  - grab (MD/XMD) and puncture
  - peel strength
  - flux and permeability
- **GCL (long-term)**
  - bentonite (draft GRI)
  - geotextile/yarns (draft GRI)
  - geomembranes (draft GRI)

# Additional Aspects of Specs

- (a) minimum testing frequencies are generally included**
- (b) some have a suggested warranty**
- (c) the test methods are tightened-up whenever necessary**
- (d) all are regularly reviewed and updated**
- (e) all are available free on the internet at [<geosynthetic-institute.org>](http://geosynthetic-institute.org)**

# Some Additional Specifications

- **GTs in transportation applications**
  - see AASHTO M288
- **PVDs and Edge Drains**
  - see Dutch and ASTM
- **PVC Geomembranes**
  - different institute
- **Various types of plastic pipe**
  - solid wall, see ASTM F17
  - profiled, see AASHTO

# Some Potential Difficulties

- **GRI specs are based on ASTM tests**
- **ISO is a worldwide standards-setting group**
- **most countries in Europe, Asia, Africa will go with ISO (an opinion)**
- **we will need dual ASTM/ISO tables**
- **CEN (Vienna Agreement) controls ISO**

ITEM	ORGANIZATION		
	ASTM	ISO	CEN
Process	4 steps*	6 steps	6 steps
Voting	Each member**	1 country/1 vote	By country, but, weighted and based on gross national product, and population
Time Limit	No time limit	To Enquiry Stage within 3 years	To Enquiry Stage within 2 years
Voting Requirement	60% ballot return - 90% affirmative	2/3 affirmative for approval, no more than 1/4 negative	76% of weighted vote for approval
Membership	Voting producer membership may not exceed voting user/general interest membership. Individual membership from 19 nations.	No membership balance required. 37 nations represented from Europe, Asia, Australia, Africa, N & S Amer.	No membership balance required. 15 EU member nations; 4 non-EU European nations that have signed the Vienna Agreement: 4 nations as observers
Support	Individual's employer	Other than USA, delegates may receive support from gov't., or national standards body.	Similar to ISO
Negatives	Stops progress until negative vote is resolved.	Enquiry negatives – revision prior to Stage 5 – Stage 5 is a Yes/No vote	Same as ISO
Review	Every 5 years after approval.	Every 5 years after approval.	Every 5 years after approval.

## 4. Endorsement via User Feedback

- our highest endorsement  
“use latest modification of GRI GXXX”
- an intermediate endorsement  
“use latest modification of GRI-GXXX,  
except \_\_\_\_\_, \_\_\_\_\_, and  
\_\_\_\_\_”
- the lowest, i.e., negative endorsement  
“use NSF54 for XXXX”  
“use Consultant XYZ Specification for XXXX”  
“use Manufacturer ABC Spec for XXXX”

# Alternative User Feedback

- **direct contact to manufacturers**
- **direct contact to us**
- **indirect contact through literature**
- **use of alternative material!**

# 5. Revisions and Maintenance

- adoption and revision dates are on last page of each specification
- revision schedule describes the specific action that was taken
- GM13 (4 rev.); GM17 (2 rev.); others (1 or 0 rev.)
- meetings held 1, 2 or 3 times per year
- possible transition to ASTM or ISO
- GRI Standards meant to be provisional

## 6. Benefits to the Industry

- signifies a healthy maturing of the industry
- provides a comfort level to regulators
- designers can focus on the recommended values
- uninformed specifiers can use it directly
- informed specifiers can modify it directly
- test labs know exactly what to expect
- manufacturers can inventory material
- manufacturers can charge for atypical requirements
- resin and additive suppliers are not “blind sided” with unusual demands

**Thanks for Listening!**

**Please Let Us  
Hear from You!**