technical note:
SR5

WHY GEOGRID APERTURE RIGIDITY IS NOT RELEVANT TO THE PERFORMANCE

Currently, there are no solid technical evidences in the literature that can demonstrate the relationship between geogrid torsional rigidity and the performance of the geogrid-reinforced road sections.

1. The results of numerical modeling show that the section performance is mainly related to geogrid-aggregate interface shear stiffness and geogrid tensile stiffness, for both flexible pavement sections (Perkins, 2001) and unpaved road sections (Leng and Gabr, 2005).

2. Geogrid torsional rigidity is adopted as a design parameter in Giroud and Han design method (2004), which was empirically correlated to the stress distribution angle of the reinforced base course over subgrade from a laboratory cyclic load testing program on unpaved sections conducted at North Carolina State University (Gabr, 2001). The unpaved test results were also later presented by Leng and Gabr (2002). An empirical correlation between geogrid tensile strength @ 2% strain and section performance was proposed by Leng and Gabr (2006) through back-analysis of the same test results.

3. TRI/Environmental conducted a study on the correlation between geosynthetic properties and the confinement factor in base reinforcement application. As shown in Table 1, TRI's results indicate that no correlation exits between the confinement factor and the torsional rigidity. In fact, the geotextile tested was reported to have the lowest confinement factor while the geotextile actually has a higher torsional rigidity value than most of the geogrids tested.

Table 1. Test Results from a Range of Geosynthetics (TRI/Environmental, 2001)

Example Test Results from a Range of Geosynthetics

Product	**In-Plane Rotational Stiffness**												Confine-ment Factor (Coarse Aggr.)	Confine-ment Factor (Well Graded Aggr.)
	In-Plane Deformation (degrees)						Secant Modulus (N-m/deg)					Initial Tangent Modulus (N-m/deg)		
	Torque (in-lb) *(N-m)*						Torque (in-lb) *(N-m)*							
	0.00 *0.00*	4.42 *0.50*	8.84 *1.00*	13.26 *1.50*	17.68 *2.00*	22.1 *2.50*	4.42 *0.50*	8.84 *1.00*	13.26 *1.50*	17.68 *2.00*	22.1 *2.50*			
Grid #1	0	0.70	2.20	3.65	5.15	6.95	0.72	0.46	0.42	0.39	0.36	0.84	1.58	1.15
Grid #2	0	3.35	12.00	14.90	17.25	18.00	0.16	0.09	0.11	0.12	0.14	0.18	1.37	1.10
Grid #3	0	6.65	10.40	13.90	17.35	19.93	0.08	0.10	0.11	0.12	0.13	0.07	1.21	-
Grid #4	0	6.80	10.35	13.55	16.25	18.70	0.07	0.10	0.11	0.12	0.13	0.07	1.21	-
Grid #5	0	6.15	10.70	14.50	17.40	20.10	0.08	0.09	0.10	0.11	0.12	0.08	1.36	1.09
Grid #6	0	0.60	2.25	4.50	9.00	14.70	0.83	0.44	0.33	0.22	0.17	0.90	-	1.24
Grid #7	0	0.60	1.50	2.55	6.45	14.85	0.83	0.67	0.56	0.31	0.17	0.90	-	1.22
Textile	0	1.85	4.90	6.30	7.80	9.30	0.27	0.22	0.25	0.27	0.27	0.30	0.97	-

↑ Torsional Rigidity

↑ GRI Proposed Initial Tangent Modulus

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A better way to determine that maximum interlocking of soil has taken place is to conduct a Pullout Test. This is a direct measurement of the capacity of a geogrid to effectively interlock the soils. Tenax MS geogrid exhibits an excellent coefficient of interaction against pullout, which is supported by test results obtained during large scale Pullout Testing. As shown in Table 2, Tenax MS geogrids have coefficient of interaction from 0.9 to 1.1, which indicates an excellent geogrid-soil interlocking.

Tabel 2. Summary table of the pullout test results and test conditions

PRODUCT NAME		TENAX MS220	TENAX MS220	TENAX MS220	TENAX MS220	TENAX MS220	TENSAR BX 1100	TENSAR BX 1100	TENSAR BX 1100	TENSAR BX 1100
Test Direction		TD	TD	TD	TD	TD	TD	TD	TD	TD
Normal stress	kPa	40	30	20	20	10	40	30	20	10
test n.		6	14	5	8	7	11	27	10	12
Max. Pullout Strength	kN/m	25.72	23.72	18.27	18.91	9.58	19.50	17.10	13.76	6.70
Max. Pullout Stress	kPa	43.96	40.55	31.24	32.33	16.38	33.30	29.20	23.52	11.40
Failure type		Tension	Tension	Pullout	Pullout	Pullout	Tension	Tension	Pullout	Pullout
ϕ soil	deg	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00
Specimen Length, L	m	0.585	0.585	0.585	0.585	0.585	0.585	0.585	0.585	0.585
Pullout Interaction Factor	fpo	0.70	0.87	1.00	1.03	1.05	0.53	0.62	0.75	0.73

PRODUCT NAME		TENAX MS330	TENAX MS330	TENAX MS330	TENAX MS500	TENAX MS500	TENAX MS500	TENSAR BX 1200	TENSAR BX 1200	TENSAR BX 1200
Test direction		TD	TD	TD	TD	TD	TD	TD	TD	TD
Normal stress	kPa	30	20	10	30	20	10	30	20	10
test n.		17	15	16	23	21	22	20	18	19
Max. Pullout Strength	kN/m	24.93	18.71	10.53	26.14	17.70	10.18	22.00	14.90	7.60
Max. Pullout Stress	kPa	42.62	31.99	17.99	44.69	30.26	17.40	28.30	25.50	13.00
Failure type		Pullout	Pullout	Pullout	Pullout	Pullout	Pullout	Pullout	Pullout	Pullout
ϕ soil	deg	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00	38.00
Specimen Length, L	m	0.585	0.585	0.585	0.585	0.585	0.585	0.585	0.585	0.585
Pullout Interaction Factor	fpo	0.91	1.02	1.15	0.95	0.97	1.11	0.80	0.82	0.83

Reference:

TRI/Environmental (2001), IN-PLANE ROTATIONAL STIFFNESS (A.K.A. TORSIONAL RIGIDITY): Is this a relevant property for base reinforcement geosynthetics?

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11/08/2006