Comparison of trafficking performance: E'GRID 2020 and Triax TX160 Geogrids

Background

Since the first introduction of biaxial geogrids in 1981 many different types have been developed and introduced to the market. The majority of these provide soil reinforcement but they do not all do it in the same way. Therefore each manufacturer's marketing campaign is based on the particular attributes of their product and it is difficult for users to judge between the differing claims made.

In the 34 years that biaxial geogrids have been available there have been several key trafficking trials in which the performance of different forms of geogrid have been compared for use in low-strain road conditions, e.g. References 1, 2, 3, 4. All show that the leading performance comes from the use of "punched and stretched" biaxial geogrids which primarily provide reinforcement by mechanical stabilisation. This type of geogrid has now progressed through 3 generations from rectangular-aperture products with high transverse (TD) strength, through balanced, square-aperture products with equal TD and MD (machine direction) strength, to balanced products with rib shapes and aperture open areas optimised for interlock with the soil and with either square or triangular apertures.

E'GRID 2020 (square apertures) and Triax TX160 (triangular apertures) are two such 3rd generation products and this technical note describes their testing in full-scale, outdoor trafficking trials carried out in the USA at the TRI Denver Downs test facility. The objective of this work was to explore the question whether, if all else is equal, there is a significant difference in performance between geogrids with square and triangular apertures. This is only the effective way to answer such a question.

Products Tested

When comparing the performance of products in application it is important to know the physical properties of the actual materials under test. This is particularly important for the comparison reported here as there is no commonality between the manufacturers' specifications of the 2 products. Key properties of the actual rolls of E'GRID 2020 and Triax TX160 tested are given in Table 1 below. These are weight per square metre, which governs the total strength that can be generated in a punched and stretched geogrid given equal quality of polymer and manufacture, and Radial Stiffness under radial loading, which governs the action of a geogrid in resisting the radial stress pattern under a wheel load. This Radial Stiffness can be calculated from the low-strain load of the ribs (Ref. 5)

Product	Weight	Rib Load at 2% Strain : ASTM D6637 (modified as needed)			Total Rib Load at 2%	Average Radial Stiffness
	g/m^2	MD (Sq) or MD-A (Tr)	MD-B	CMD		
		kN/m	kN/m	kN/m	kN/m	kN/m
Triax TX160	225	6.69	6.67	7.52	20.88	522
E'GRID 2020	220	10.73		11.27	22.00	550

Table 1: Geogrids tested

The results in Table 1 show that the difference between the weights and Radial Stiffness of the two products tested is 5% or less and therefore their performance under trafficking should be similar.

Trafficking Trials

Trafficking trials were conducted by TRI Environmental, Inc., a world-leading geosynthetic testing organisation, at their outdoor testing facility at Denver Downs, South Carolina, USA. An "oval" track was constructed as shown in Figures 1 and 2 wide enough to give inner and outer tracks for test sections. The sub-base of the track was local soil classified as inorganic sandy fat clay (CH) in accordance with ASTM D2487 with a plastic Index of 26 (ASTM D 4318). This was moisture treated as necessary and compacted to achieve target CBR values between 1 and 3 for unpaved tests. The sub-base was approximately 900mm deep and it was installed in 5 lifts.

Geogrids were then placed in the appropriate sections, tensioned by hand to remove any wrinkles and held in place with plastic pins. Base course aggregate used for test section construction was a crushed stone meeting South Carolina Department of Transportation (SCDOT) standard material specifications (100 percent passing the 50.8 mm sieve, less than 20 percent finer than 75 µm, maximum PI less than 6).

Figure 2: Sub-Base Compaction

were replaced with equal sized, modern "super-single" tires (size 445/50R22.5) inflated to a pressure of 690 kilopascals. Weight distribution and tire pressure was checked and adjusted as necessary throughout the trafficking process. These modifications and the axle spacing (approximately 4.6 m) ensured that each passage of the loading vehicle applied two identical loads to the test sections thereby negating the complicating effects of steering/load/tandem axle combinations often associated with full scale testing. The loading vehicle as used for trafficking is shown in Figure 3. Lines were painted on the road surface prior to trafficking so that the truck wheel paths were centered over each test section. No deliberate attempt was made to introduce wheel path wander to the trafficking procedure and the driver was instructed to maintain the vehicle in a single

Figure 1: Test Track constructed at TRI Denver Downs

After placement of the geogrids, a single loose lift of aggregate was placed from the end using a light weight tracked loader. Installation of the aggregate was carefully monitored to prevent damage to, or movement of, the geogrids during construction. Final grading of the aggregate surface was completed with the loader. This assured that no untoward construction damage would be inflicted on the geogrids and that rutting deformation would not occur before trafficking was initiated. A smooth single-drum vibratory roller was used to compact the aggregate.

A two axle commercial truck was modified for use as a loading vehicle for trafficking of the test sections. Modifications included adding carefully distributed weight to the vehicle such that each axle applied an equal load of 80 kN. In addition, all tires (steering and rear dual)

Figure 3: Trafficking

wheel path as closely as possible. However, some deviation was inevitable resulting in about 150mm wander. The truck traversed the test sections for a predetermined number of passes before stopping for surface rut depth measurements.

The 6 test sections relevant to this note are summarized in Table 3. Here the actual fill thickness and sub-base CBR values are given for each section, together with the conversion factor applicable to Log(N), the base 10 logarithm of the number of axle passes. This conversion is based on the equation linking N to fill thickness and sub-base CBR value developed by Giroud & Noiray (Ref. 6). It is based on normalising the fill thickness to 300mm and the CBR Value to 1.9%.

4No.	Geogrid	Sub-Grade CBR (%)	Actual Fill Thickness (mm)	Correction Factor of Log(N) to 300mm, 1.9%CBR
1	E'GRID 2020	2.6	197	1.250
2	E'GRID 2020	1.6	298	1.122
3	E'GRID 2020	2.6	292	0.843
4	E'GRID 2020	1.6	457	0.732
5	Triax TX160	1.9	305	0.984
6	Triax TX160	1.6	457	0.732

Table 2: Test Sections

Trial Results

Results of the trafficking are shown in Figure 4 where the normalised number of ESAL passes for each test is plotted against the rut deformation from original level. A normal analysis point for such testing is a rut depression of 26mm which is equivalent to a total rut depth of about 40mm. Where the normalised data did not reach that point it has been extrapolated for each test on the basis of a constant rate of deformation.

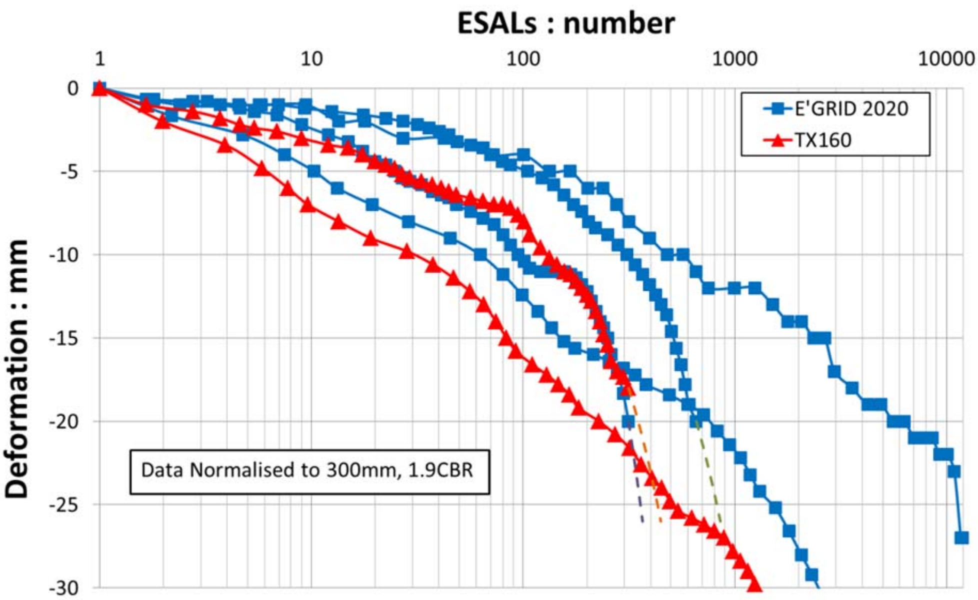

Figure 4: Raw data from the test sections

As is to be expected from any trafficking tests using natural materials there is significant scatter in these results. But these raw data plots show clearly that claims made by the manufacturer of Triax TX160 of superior performance to E'GRID 2020 are not valid. In fact the opposite appears to be the case. To examine this more closely mean plots of the TX160 results and the E'GRID 2020 results are shown in Figure 5. This shows that at 26mm deformation the E'GRID 2020 sections carried on average 3x the traffic of the Triax TX160 sections. This result is significantly affected by Test 1 which included E'GRID 2020 in the thinnest structure tested. Therefore, in case that is a statistical anomaly, Figure 4 also includes a mean plot of the results of the other 3 sections with E'GRID 2020. It can be seen that even this plot shows a traffic carrying capacity for the E'GRID 2020 that is more than 50% greater than for the TX160.

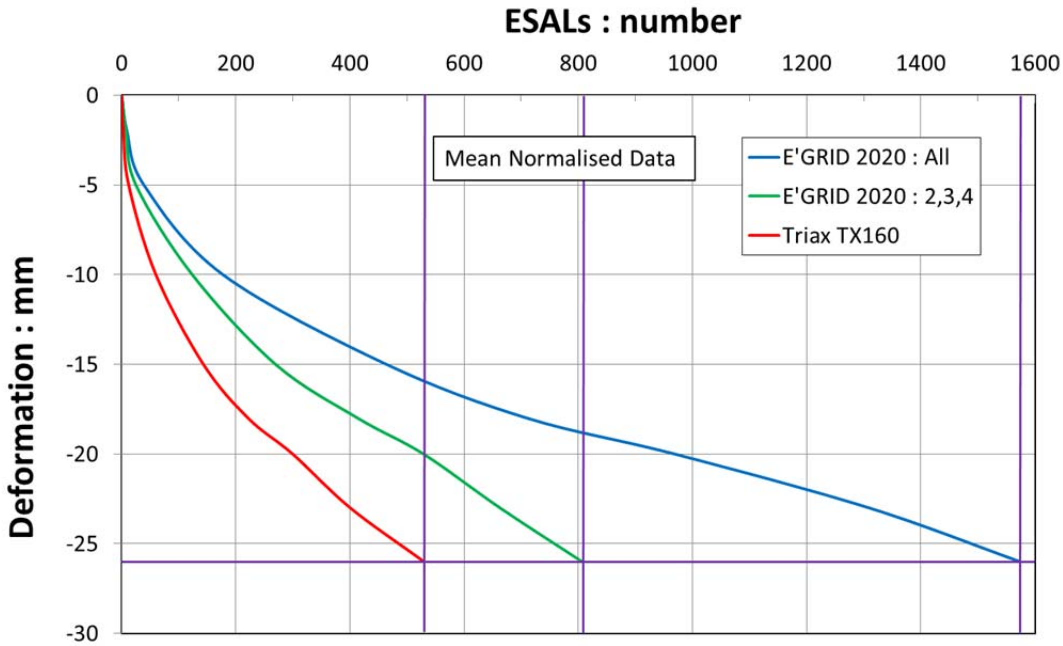

Figure 5: Mean Deformation vs Normalised ESALs indicating 26mm deformation

Conclusions

An engineering study of these results clearly concludes that the two products tested are not safely interchangeable in design. Certainly E'GRID 2020 can be used in place of Triax TX160, but great care needs to be taken before the opposite is considered. These results, based on the calculation method of Giroud and Noiray (ref 6) indicate that fill thickness could need to be increased by up to 17% in order to use TX160 in a project designed to use E'GRID 2020.

References

1. C.G.Jenner et al, 2002: *Trafficking of reinforced, unpaved subbases over a controlled subgrade*, Proceedings, 7th International Conference on Geosynthetics, Nice, Swets & Zeitlinger, Lisse, ISBN 90 5809 523 1
2. G.R.A.Watts et al, 2004: *The performance of reinforced unpaved subbases subjected to trafficking*, Proceedings, EuroGeo3 Geosynthetics Conference, Munich, international Geosynthetics Society.
3. C.A.P.M van Gurp, 2005: *Keuzemodel wegconstructies Achtergrondrapport,* CROW, Postbus 37, 6710 BA EDE, Netherlands
4. E.Cuelho et al, 2014, *Relative operational performance of geosynthetics used as subgrade stabilization*, Western Transportation Institute, Montana State University, Bozeman, Montana, USA.
5. N.E.Wrigley et al, 2015, *The radial tensile properties of biaxial geogrids*, Proceedings, Geosynthetics 2015 Conference, Portland, Industrial Fabrics Association International.
6. J.P.Giroud and L.Noiray, 1981, *Geotextiles-reinforced unpaved road design*, ASCE, Journal of Geotechnical Engineering, 107(9), 1233-1253.