2019 NTPEP Report Series

NTPEP Report REGEO-2016-01-[Tencate-Miragrid XT]

LABORATORY EVALUATION OF GEOSYNTHETIC REINFORCEMENT

FINAL PRODUCT QUALIFICATION REPORT FOR MIRAGRID XT GEOGRID PRODUCT LINE

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American Association of State Highway and Transportation Officials (AASHTO)

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National Transportation Product Evaluation Program (NTPEP)

NTPEP Report REGEO-2016-01-[Tencate-Miragrid XT]

LABORATORY EVALUATION OF GEOSYNTHETIC REINFORCEMENT

2016 PRODUCT SUBMISSIONS
SAMPLED MARCH 2017

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PROLOGUE

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- ❖ This report contains product data that are intended to be applied to a product line, based on the test results obtained for specific products that are used to represent the product line for the purposes of NTPEP testing. It is expected that the User will estimate the properties of specific products in the line not specifically tested through interpolation or a lower or upper bound approach.
- ❖ It is intended that this data be used by the User to add products to their Qualified Products or Approved Products List, and/or to develop geosynthetic reinforcement strength design parameters in accordance with AASHTO, FHWA, or other widely accepted design specifications/guidelines. It is also intended that the User will conduct further, but limited, evaluation and testing of the products identified in this report for product acceptance purposes to verify product quality.
- ❖ Products included in this report must be resubmitted to NTPEP every three (3) years for a quality verification evaluation and every nine (9) years for a full qualification evaluation in accordance with the work plan. Hence, all product test results included in this Report supersede data provided in previous Editions of this report.
- ❖ The User is guided to read the document entitled "Use and Application of NTPEP Geosynthetic Reinforcement Test Results" (see NTPEP website) for instructions and background on how to apply the results of the data contained in this report.

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Executive Summary

This test report provides data that can be used to characterize the short-term and long-term tensile strength of the Miragrid XT polyester, PVC coated geogrid reinforcement product line using testing conducted on representative products within the product line. The purpose of this report is to provide data for product qualification purposes.

The test results contained herein were obtained in accordance with AASHTO R69-15 and the NTPEP work plan (see www.NTPEP.org) and can be used to determine the long-term strength of the geosynthetic reinforcement, including the long-term strength reduction factors RF_{ID}, RF_{CR}, and RF_D, and also used to determine low strain creep stiffness values.

All testing reported herein was performed on the materials tested in the direction of manufacture, i.e., the machine direction.

Product Line Description: The product line evaluated includes the following specific polyester, PVC coated geogrid reinforcement products:

Miragrid 2XT, 3XT, 5XT, 7XT, 8XT, 10XT, 20XT, 22XT, and 24XT.

This product line was evaluated through detailed testing of three representative products in the Miragrid XT product line, and very limited testing of the other remaining products in the product line. Miragrid 8XT was used as the primary product for product line characterization purposes (i.e., the baseline to which the other products were compared), and Miragrid 2XT and 24XT were used as secondary products to evaluate the properties of the range of products in the Miragrid XT product line. Products are manufactured at the Miragrid manufacturing plant located in Cornelia, GA and samples of these products were taken by an independent sampler on behalf of NTPEP on March 10, 2017, at the Miragrid warehouse located in Pendergrass, GA.

Statistical Validation of Use of SIM and Validation of Product Line: The creep rupture test results obtained were evaluated in accordance with R69-15 to assess the validity of using SIM to extend the creep rupture data and to assess the validity of treating the products submitted as a single product line. The following was verified:

i. The SIM creep test results were characterized by data statistically consistent with conventional creep tests conducted at the reference temperature up to 10,000 hours, including comparison of single rib and multi-rib test data (see Figure F-21 in Appendix F for details).

ii. Based on the available creep data for all the products tested, the product line submitted by the manufacturer statistically qualifies to be a product line and can therefore be represented using test results from representative products in the product line (see Figure F-22 in Appendix F for details). Recommendations on application of the representative product data to the rest of the product line for installation damage, durability and creep stiffness are provided in their respective report sections and summarized below in this executive summary.

Test Results for T_{ult}: All wide width test results (ASTM D6637) obtained for this product line through the NTPEP testing were greater than the minimum average roll values (MARV's) provided by the manufacturer (see Table 3-1).

Test Results for RF_{ID}: Installation damage testing on this product line resulted in values of RF_{ID} that ranged as follows:

$$RF_{ID} = 1.01 \text{ to } 2.01$$

The RF_{ID} factor of 1.01corresponds to the 3XT product in sandy gravel and 2.01 to the lightest product in coarse gravel.

In general, as the test material gradation becomes more coarse, the value of RF_{ID} increased. Therefore, interpolation of this data to intermediate gradations appears to be feasible. The values of RF_{ID} for all of the products tested did demonstrate a trend of decreasing RF_{ID} as product unit weight/tensile strength increases, at least for the 57 stone gradation, that would allow interpolation of RF_{ID} to products not tested. Therefore, interpolation of these test results to products in the line not tested is feasible. This trend was not as clear for the other gradations. See Table 4-3 and Figures 4-5 through 4-9 for details. Laboratory installation damage test data in accordance with ISO/EN 10722 are also provided for future use in comparison to quality verification testing (see Table 4-6).

It should be noted that the installation damage testing conducted represents an increase in compaction and spreading equipment size (i.e., a 15,000 lb wheeled front end loader – Caterpillar 416E, and a 25,000 lb single drum vibratory roller) and a reduced aggregate lift thickness over the geogrid of 6 inches relative to the installation damage testing reported in previous NTPEP test reports. Therefore, the decrease in strength retained values relative to previous NTPEP test reports for this product line does not represent a change in the products, but instead is the result of the more severe installation damage conditions which represent a likely upper bound installation condition for geosynthetic reinforced soil structures. Actual RF_{ID} values could be lower if installation conditions are less severe (e.g., greater initial lift thickness over the geogrid, use of lighter weight equipment, etc.). Actual RF_{ID} values could be higher if the spreading or compacting equipment tires or tracks are allowed to be in direct contact with the geosynthetic before or during fill placement and compaction, if the thickness of the fill material between the equipment tires or tracks is inadequate (especially for high tire pressure equipment such as dump trucks), or if excessive rutting of the first lift of soil over the geosynthetic (e.g., due to soft subgrade soil) is allowed to occur.

Test Results for RF_{CR}: The creep rupture testing conducted indicates that the following value of RF_{CR} may be used:

$$RF_{CR} = 1.44$$

This value of RF_{CR} is applicable to a 75 year life at 68º F (20º C), and may be used to characterize the full product line as defined herein. See Figure 5-1 for detailed creep rupture envelope or to obtain values for other design lives.

Test Results for RF_D: The chemical durability index testing results meet the requirements in AASHTO R69-15 to allow use of a default reduction factor for RF_D. See Table 6-2 for specific test results, and see AASHTO R69-15 or the document entitled "Use and Application of NTPEP Geosynthetic Reinforcement Test Results" (www.NTPEP.org) for recommended default reduction factors for RF_D. The UV test results (ASTM D4355) for this product line, as represented by the lightest weight product from each manufacturing plant, indicate strength retained at 500 hours in the weatherometer of 94%. These values of UV strength retained should be considered to be a lower bound value for the product line.

Test Results for Creep Stiffness: The 1000 hr, 2% strain secant stiffness ($J_{2\%,1000hr}$) test results ranged from 19,801 lb/ft for the lowest strength style to 190,759 lb/ft for the highest strength style. There exists a strong linear relationship between creep stiffness and the short-term tensile strength (T_{lot}), therefore the 1000 hr, 2% strain secant stiffness can be reasonably expressed for any product in the product line as:

$$J_{2\%,1000\,hr} = 6.6609(T_{lot}) + 942.87$$

Where, T_{lot} is the roll/lot specific single rib tensile strength per ASTM D6637. See Table 7-2 and Figure 7-1 for details. Note that once the stiffness is determined from this equation, an equivalent MARV for this property can be determined by multiplying the stiffness by the ratio of T_{MARV}/T_{lot}.

1.0 Product Line Description and Testing Strategy

1.1 Product Description

The **Miragrid XT Series** family of geogrids are high-strength woven, PVC coated geogrids. The product line evaluated consists of the products as manufactured by TenCate Geosynthetics listed in Table 1-1.

Table 1-1. Product designations included in product line.

Miragrid Reinforcement Product Designations (i.e., Styles)		
Miragrid® 2XT	Miragrid® 7XT	Miragrid® 20XT
Miragrid® 3XT	Miragrid® 8XT	Miragrid® 22XT
Miragrid® 5XT	Miragrid® 10XT	Miragrid® 24XT

The scope of the evaluation is limited to the strength in the machine direction (MD). The cross-machine direction (XD) was not specifically evaluated.

1.2 Product Line Testing Approach

This product line was evaluated through detailed testing of three representative products in the Miragrid XT product line, and very limited testing of the other remaining products in the product line. Miragrid 8XT was used as the primary product for product line characterization purposes (i.e., the baseline to which the other products were compared), and Miragrid 2XT and 24XT were used as secondary products to evaluate the properties of the range of products in the Miragrid XT product line. Products are manufactured at the Miragrid manufacturing plant located in Cornelia, GA and samples of these products were taken by an independent sampler on behalf of NTPEP on March 10, 2017, at the Miragrid warehouse located in Pendergrass, GA.

Photographs of all the products tested are provided in figures 1-1 through 1-9

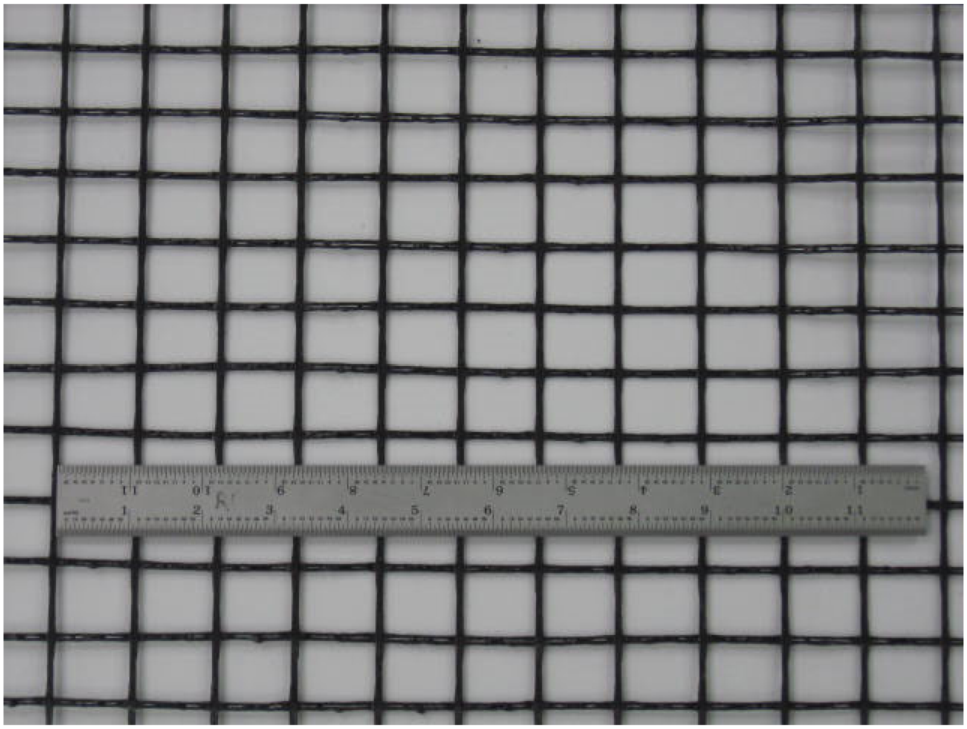


Figure 1-1. Photo of Miragrid 2XT (machine direction is perpendicular to ruler shown).

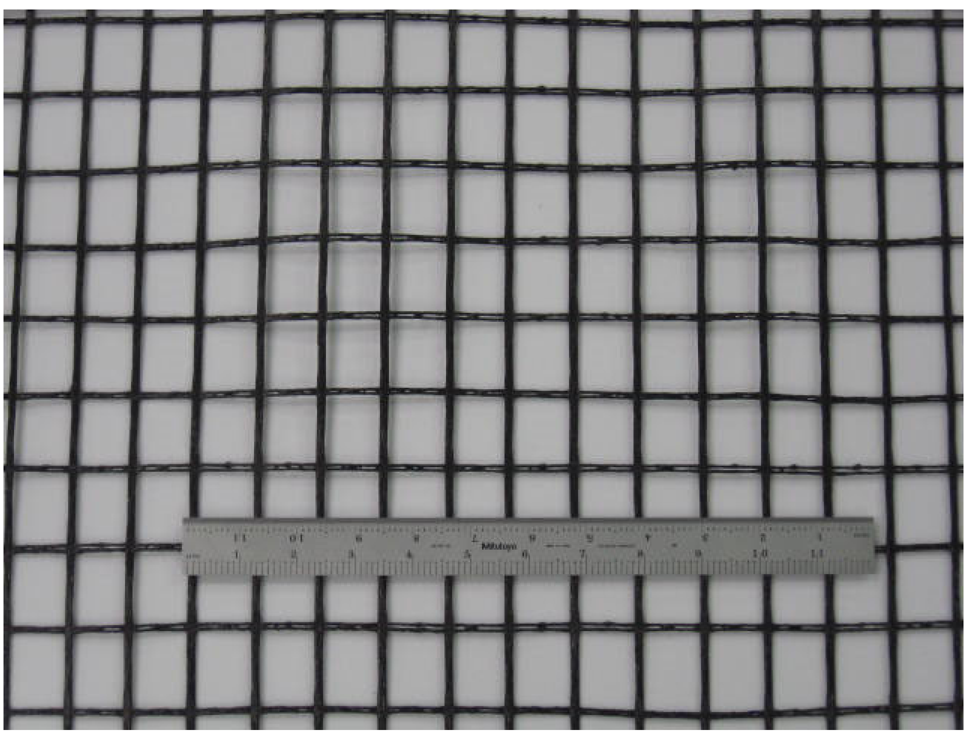


Figure 1-2. Photo of Miragrid 3XT (machine direction is perpendicular to ruler shown).

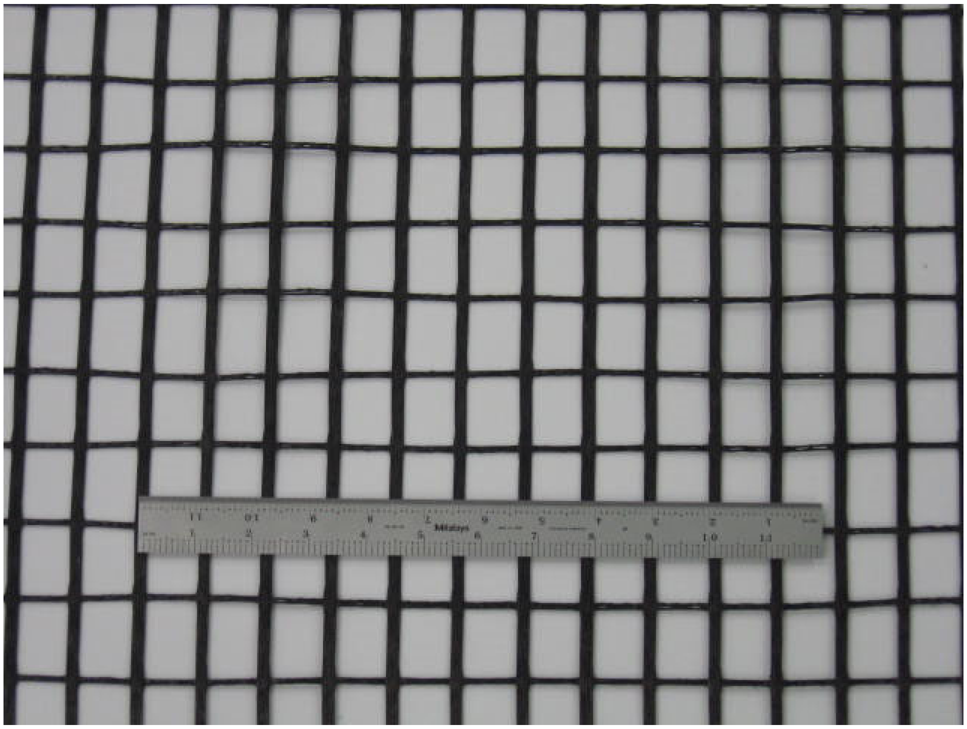


Figure 1-3. Photo of Miragrid 5XT (machine direction is perpendicular to ruler shown).

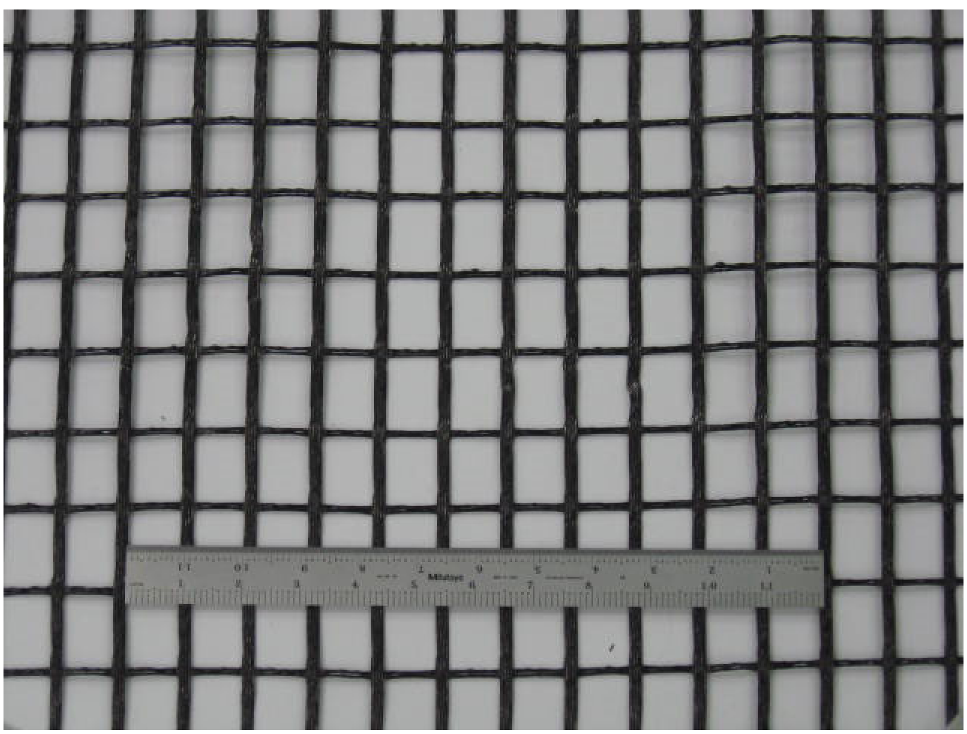


Figure 1-4. Photo of Miragrid 7XT (machine direction is perpendicular to ruler shown).

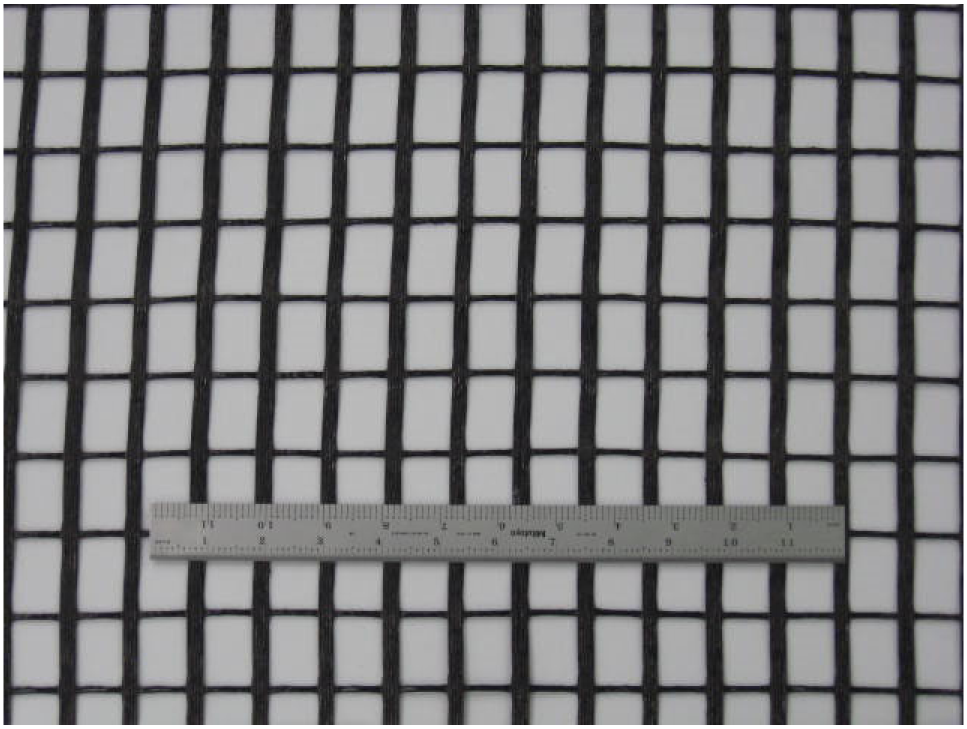


Figure 1-5. Photo of Miragrid 8XT (machine direction is perpendicular to ruler shown).

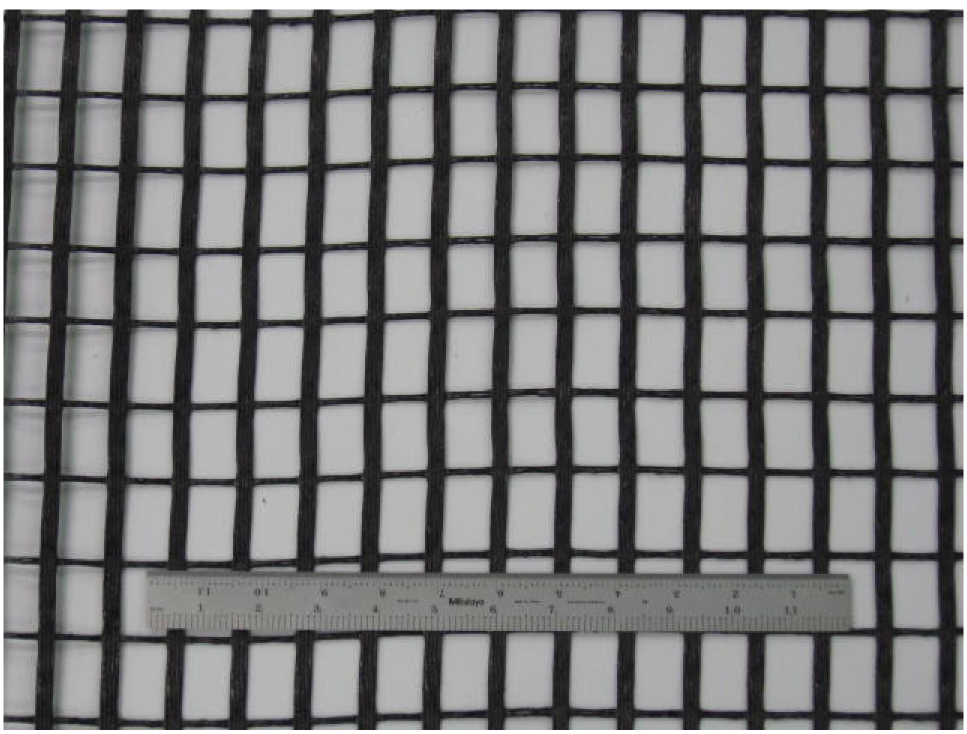


Figure 1-6. Photo of Miragrid 10XT (machine direction is perpendicular to ruler shown).

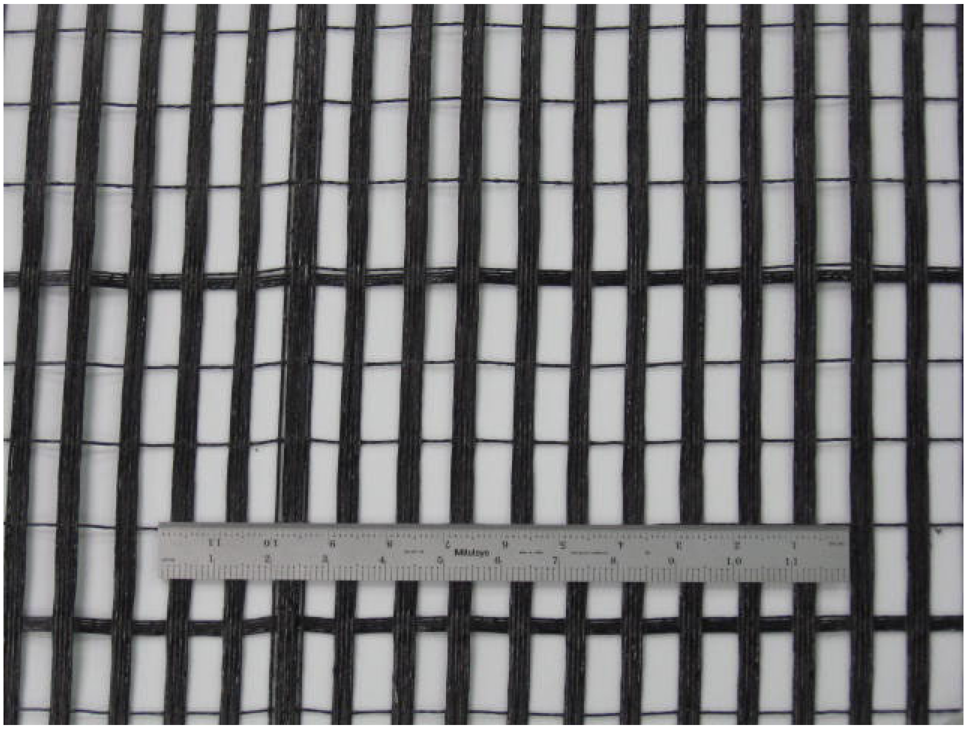


Figure 1-7. Photo of Miragrid 20XT (machine direction is perpendicular to ruler shown).

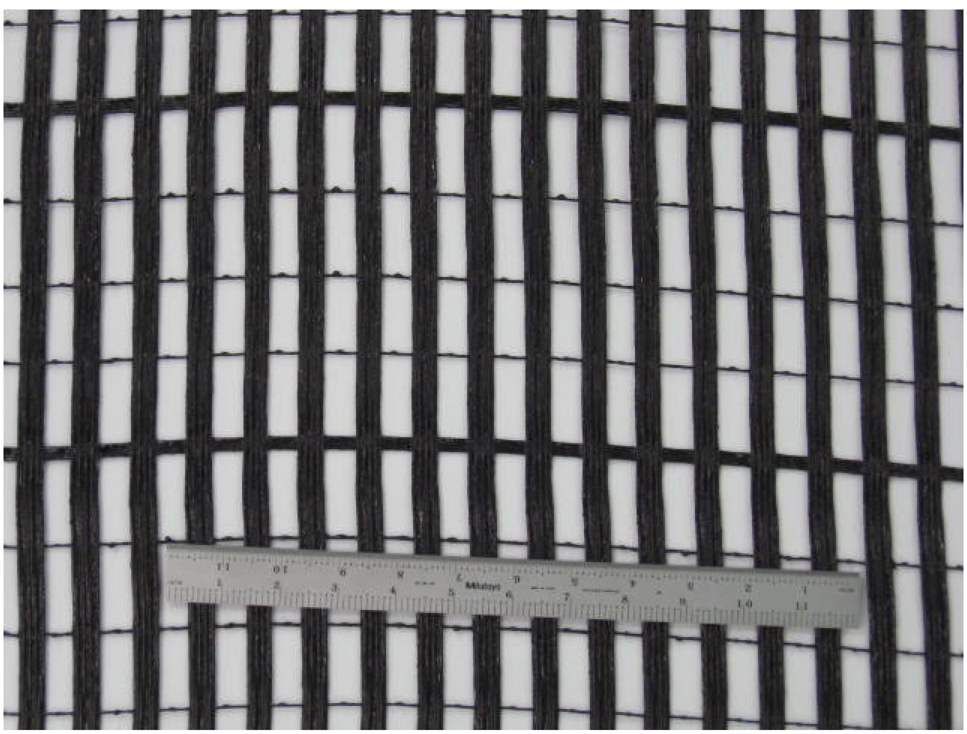


Figure 1-8. Photo of Miragrid 22XT (machine direction is perpendicular to ruler shown).

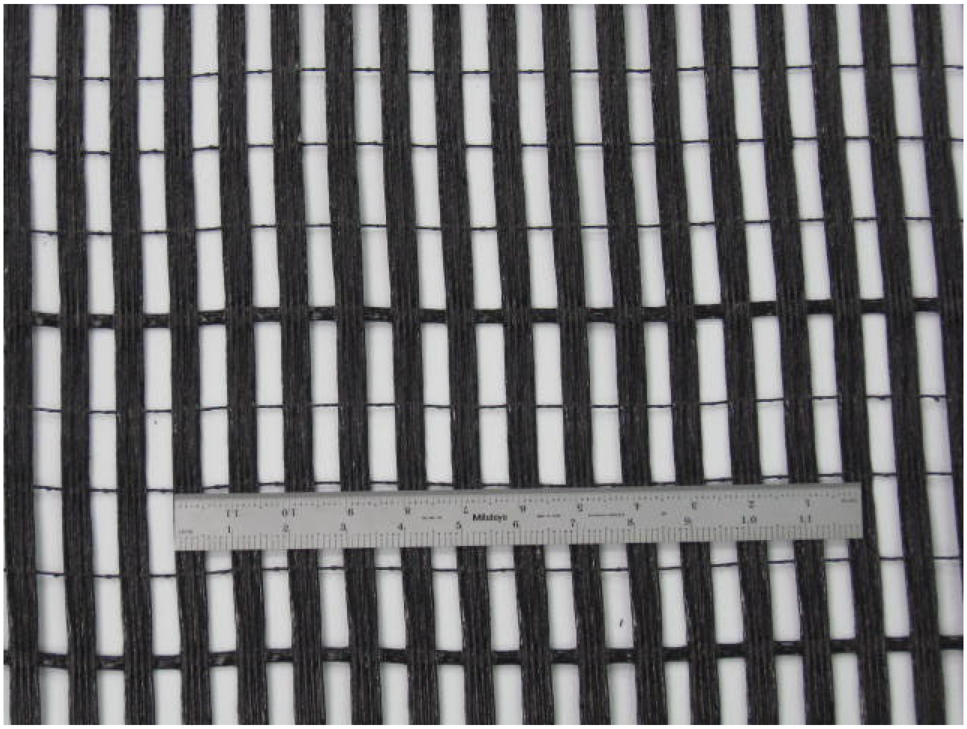


Figure 1-9. Photo of Miragrid 24XT (machine direction is perpendicular to ruler shown).

2.0 Product Polymer, Geometry, and Manufacturing Information

2.1 Product/Polymer Descriptors

Yarn used in all **Miragrid XT Series** geogrids is a high molecular weight, low CEG, high tenacity polyester (PET) with UV inhibitors. The source of the yarns is proprietary. Coating used in all **Miragrid XT Series** geogrids is a PVC-based coating with no post-consumer recycled materials. The source of coating is confidential.

For the PET yarns, key descriptors include minimum production number average molecular weight (GRI-GG7 and ASTM D 4603) and maximum carboxyl end group content (GRI-GG8):

- Minimum Molecular Weight > 25,000 (Measured value is 32,783)
- Maximum CEG < 30 (Measured value is 15.9)
- % of regrind used in product: 0%.
- % of post-consumer recycled material by weight: 0%

2.2 Geometric Properties of Geogrids

Rib width, spacing, thickness, and product weight/unit area vary depending on geogrid style. While such data are generally not used for design, it can be useful for identification purposes, and to be able to detect any changes in the product. Measurements of geogrid rib spacing are also used to convert tensile test results (i.e., load at peak strength, T_{ult}, and load at a specified strain to obtain stiffness, J) to a load per unit width value (i.e., lbs/ft or kN/m). Detailed measurement results, as well as the typical values supplied by the manufacturer for each product, are provided in Appendix B, Section B.1.

2.3 Product Production Data and Manufacturing Quality Control

Geogrid roll sizes and weights, lot sizes, and a summary of the manufacturer's quality control program are provided in Appendix B, Sections B.2 and B.3. Such information can be useful in working with the manufacturer if product quality issues occur.

3.0 Wide Width Tensile Strength Data

Minimum average roll values supplied by the manufacturer and test results obtained on all the products in the product line for this NTPEP testing program are provided in Table 3-1. Wide width tensile tests were conducted in accordance with ASTM D6637. The measured geogrid dimensions discussed in Section 2 and provided in Appendix B, Section B.1, were used to convert test loads to load per unit width values. Note that the independently measured T_{ult} values only indicate that the sampled products have a tensile strength that exceeds the Manufacturer's minimum average roll values (MARV's). As such, these independently measured T_{ult} values should not be used directly for design purposes. However, these independently measured T_{ult} test results have been used as roll specific tensile strengths used for developing installation damage and creep reduction factors. Detailed test results are provided in Appendix C.

Table 3-1. Wide width tensile strength, T_{ult}, for the Miragrid Geogrid XT product line.

Product Style/Type	Test Method	MARV for T_{ult}, in MD (lb/ft)	T_{ult}, Independently Measured in MD (lb/ft)*
2XT	ASTM D 6637	2,300	2,710
3XT	ASTM D 6637	3,650	
5XT	ASTM D 6637	4,700	
7XT	ASTM D 6637	6,300	
8XT	ASTM D 6637	7,600	8,484
10XT	ASTM D 6637	10,200	
20XT	ASTM D 6637	16,000	
22XT	ASTM D 6637	21,000	
24XT	ASTM D 6637	28,000	31,443

(Conversion: 1 lb/ft = 0.0146 kN/m)
MD = machine direction
*Average of 5 specimens obtained during NTPEP testing.

4.0 Installation Damage Data (RF_{ID})

4.1 Installation Damage Test Program

Installation damage testing and interpretation was conducted in accordance with AASHTO R69-15, except as noted herein. Samples were exposed to four "standard" soils: a coarse gravel, a medium gravel, a sandy gravel, and a sand. Additional laboratory installation damage testing in accordance with ISO/EN 10722 was also conducted. The specific installation damage test program is summarized in Table 4-1.

Table 4-1. Independent installation damage testing required for NTPEP qualification.

Manufacturer: TenCate Geosynthetics **PRODUCT Line:** 2XT to 24XT			
Tests Conducted	**Qualification (every 9 yrs) / Verification (every 3 yrs)**		
	Products Tested		**# of Tests (see Note 1)**
	Qualification	**Verification**	
Index tensile tests on undamaged material (ASTM D 6637)	2XT, 3XT, 7XT, 8XT, 24XT	NA	5
Three field exposures, including soil characterization and compaction measurements (ASTM D5818)	2XT, 3XT, 7XT, 8XT, 24XT in 57 stone, Types 1, 2, and 3 soils	NA	20
Tensile tests on damaged specimens (ASTM D 6637)	2XT, 3XT, 7XT, 8XT, 24XT in 57 stone, Types 1, 2, and 3 soils	NA	20
Laboratory installation damage testing –as basis for future QA and to help interpolate full scale field results to products ont full scale field tested (ISO/EN 10722)	2XT, 3XT, 5XT, 7XT, 8XT, 10XT, 20XT, 22XT, 24XT	NA	9
Note 1 Each test is performed using the number of specimens required by the test standard. For example, for index tensile testing, a test is defined 5 to 6 specimens. See the specific test procedures for details on this.			

4.2 Installation Damage Full Scale Field Exposure Procedures and Materials Used

Four "standard" soils were used for the field exposure of the geogrid samples to installation damage. Soil gradation curves for each soil are provided in Figure 4-1. Photographs of each soil illustrating particle angularity are provided in figures 4-2 through 4-5. LA Abrasion tests conducted to characterize the backfill materials indicted a maximum loss of 20%, which is well within the requirements stated in R69-15.

The approach specifically used for applying installation damage to the geosynthetic samples that allows for exhumation of the test samples while avoiding unintended damage was initially developed by Watts and Brady[1] of the Transport Research Laboratory (TRL) in the United Kingdom. The procedure generally conforms to R69-15 and ASTM D 5818 requirements.

Since compaction typically occurs parallel to the face of retaining walls and the contour lines of slopes, the machine direction was placed perpendicular to the running direction of the compaction equipment. To initiate the exposure procedure, four steel plates each measuring 42-inches x 52-inches (1.07 m x 1.32 m), equipped with lifting chains, were placed on a flat clean surface of hardened limestone rock. The longer side of the plates is parallel to the running direction of the compaction equipment. A layer of soil/aggregate was then placed over the adjacent plates to an approximate compacted thickness of 6 inches (0.15 m) except for 57 stone which used a compacted thickness of 8 inches (0.20 m). Next, each of four coupons of the tested geosynthetic sample was placed on the compacted soil over an area corresponding to an underlying steel plate. To complete the installation, the second layer of soil was placed over the coupons using spreading equipment and compacted to a thickness of 6 inches (0.15 m) using a vibratory compactor. The spreading equipment used included a wheeled front end loader and a 23,000 -26,000 lb single drum vibratory roller with pneumatic rear wheels. The front end loader was allowed to spread the aggregate by driving over the geosynthetic with a 6 inch aggregate lift between the wheels and the geosynthetic.

The following construction quality control measures were followed during exposure:

- Proctor and sieve analyses were performed on each soil/aggregate, when possible. (Proctors could not be performed on 57 stone, Gradations 1 and 2.)
- Lift thickness measurements were made after soil/aggregate compaction.
- When possible, moisture and density measurements were made on each lift using a nuclear density gage to confirm that densities >90% of modified Proctor (per ASTM D 1557) were being achieved.

To exhume the geosynthetic, railroad ties were removed and one end of each plate was raised with lifting chains. After raising the plate to about 45°, soil located near the bottom of the leaning plate was removed and, if necessary, the plate was struck with a sledgehammer to loosen the fill. The covering soil/aggregate was then carefully removed from the surface while "rolling" the geosynthetic away from the underlying soil/aggregate. This procedure assured a minimum of exhumation stress. Photographs of the installation damage field exposures are provided in Appendix D. A detailed tabulation of each soil gradation is provided in Appendix D, Table D-21.

[1] G.R.A. Watts and K.C. Brady (1990), *Site Damage trials on geogrids*, Geogrids, Geomembranes and Related Produts, Balkema Rotterdam.

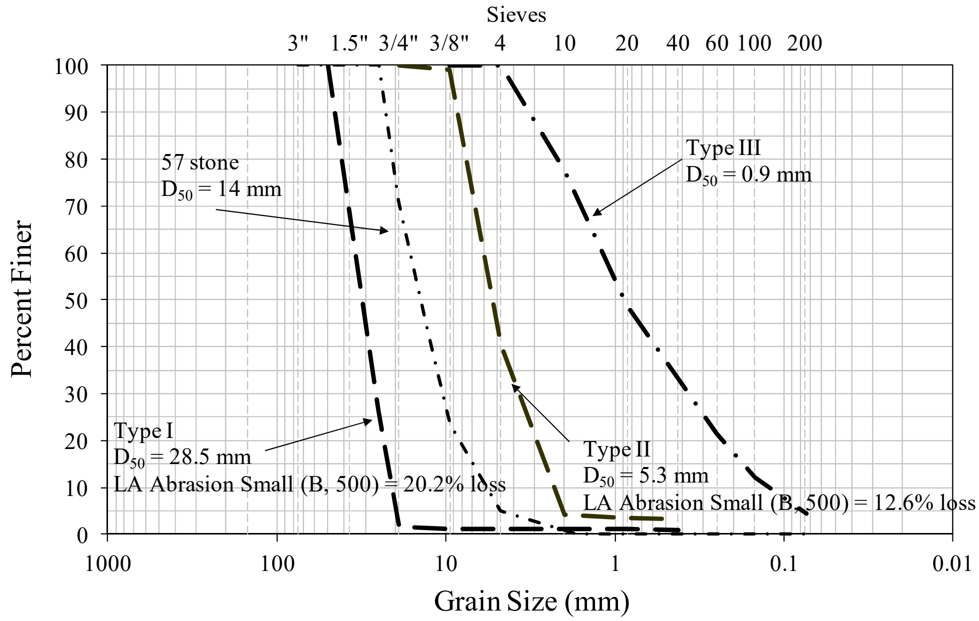


Figure 4-1. Test soil grain size distribution.

Figure 4-2. Installation damage Type 1 test aggregate.

Figure 4-4. Installation damage 57 stone test aggregate.

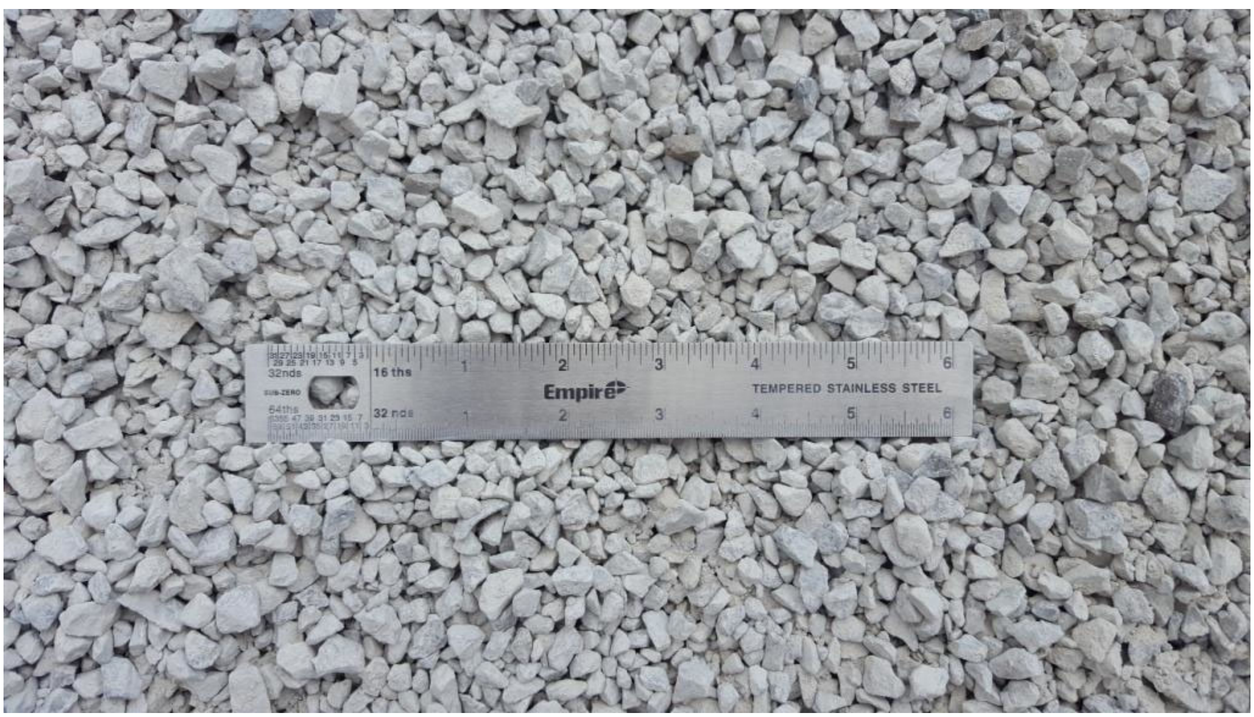


Figure 4-4. Installation damage Type 2 test aggregate.

Figure 4-5. Installation damage Type 3 test aggregate.

4.3 Summary of Installation Damage Full Scale Field Exposure Test Results

The roll specific ultimate tensile strength (ASTM D6637) test results for the baseline, T_{lot} (i.e., undamaged tensile strength tested prior to sample installation in the ground) and the ultimate tensile strength of the installation damaged geogrid samples, T_{dam}, are provided in Table 4-2. RF_{ID}, calculated using the results shown in Table 4-2, are summarized in Table 4-3. Strength retained is calculated as the ratio of the average exhumed strength T_{dam} divided by the average baseline strength T_{lot} for the product sample. RF_{ID} is the inverse of the retained strength (i.e. 1 / 0.779 = 1.28). Detailed test results for each specimen tested are provided in Appendix D, Tables D-1 through D-20.

Table 4-2. Summary of installation damage tensile test results.

Backfill Type	Style	Baseline [1]T_{lot} (lb/ft)	Baseline COV (%)	Exhumed [2]T_{dam} (lb/ft)	Exhumed COV (%)
Type 1 Coarse Gravel (GP)	2XT	2,710	1.39	1,346	14.95
	3XT	3,795	1.35	2,965	8.33
	7XT	6,579	1.47	4,237	7.92
	8XT	8,488	2.37	5,670	8.61
	24XT	31,443	2.97	22,493	6.37
57 stone (GP)	2XT	2,710	1.39	1,861	13.67
	3XT	3,795	1.35	2,844	14.91
	7XT	6,579	1.47	4,655	9.87
	8XT	8,488	2.37	6,180	6.06
	24XT	31,443	2.97	25,598	4.40
Type 2 Sandy Gravel (GP)	2XT	2,710	1.39	2,578	1.20
	3XT	3,795	1.35	3,740	1.92
	7XT	6,579	1.47	5,981	3.50
	8XT	8,488	2.37	7,613	2.78
	24XT	31,443	2.97	29,991	1.42
Type 3 Silty Sand (SM)	2XT	2,710	1.39	2,494	4.35
	3XT	3,795	1.35	3,680	1.52
	7XT	6,579	1.47	6,121	4.06
	8XT	8,488	2.37	7,111	5.48
	24XT	31,443	2.97	28,781	2.84

[1]Average of 5 specimens.
[2]Average of 10 specimens.
(Conversion: 1 lb/ft = 0.0146 kN/m)

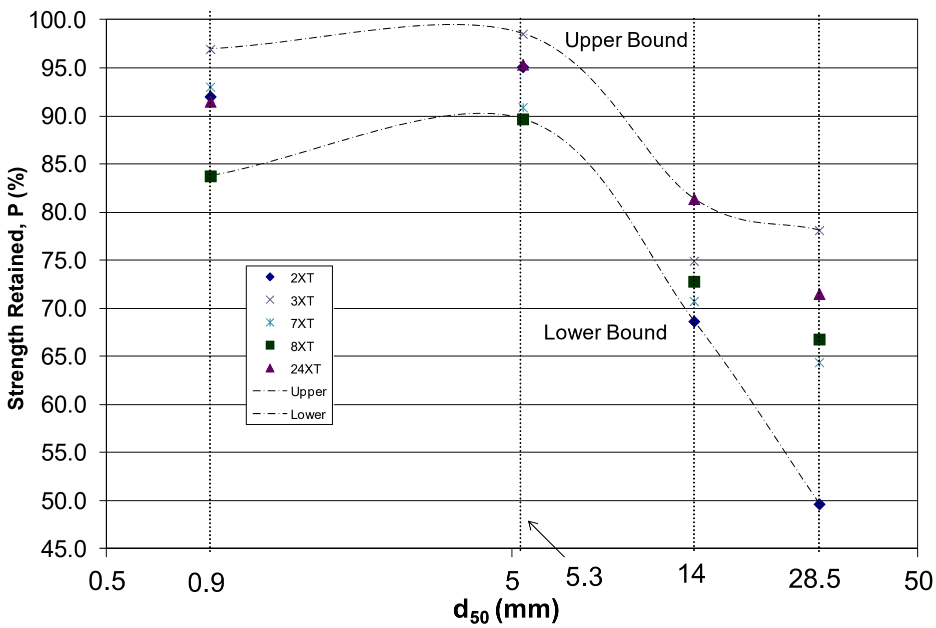
Table 4-3. Measured RF_{ID}.

Style	Mass / Area (oz./yd^2)	Type 1 Coarse Gravel % Retained	Type 1 Coarse Gravel RF_{ID}	57 stone % Retained	57 stone RF_{ID}	Type 2 Sandy Gravel % Retained	Type 2 Sandy Gravel RF_{ID}	Type 3 Silty Sand % Retained	Type 3 Silty Sand RF_{ID}
2XT	6.52	49.7	2.01	68.7	1.46	95.1	1.05	92.0	1.09
3XT	6.51	78.1	1.28	74.9	1.33	98.6	1.01	97.0	1.03
7XT	8.66	64.4	1.55	70.8	1.41	90.9	1.10	93.0	1.07
8XT	10.08	66.8	1.50	72.8	1.37	89.7	1.11	83.8	1.19
24XT	30.74	71.5	1.40	81.4	1.23	95.4	1.05	91.5	1.09

4.4 Estimating RF_{ID} for Specific Soils or for Products not Tested

In general, as the test material gradation becomes more coarse, the value of strength retained decreased (i.e., RF_{ID} increased). Trend lines plotted in Figure 4-5 for the upper bound and lower bound for all the installation damage data obtained for the product line illustrate the general trend of the installation damage data with regard to soil d_{50} size. Interpolation of this data to intermediate gradations appears to be feasible based on these test results, though the scatter in that trend should be recognized when estimating values of RF_{ID} for specific soils.

Only representative products in the product line were installation damage tested for the full range of soil gradations (57 stone and Gradations 1 through 3). However, bench scale installation damage tests (ISO/EN 10722) were conducted for the remaining products in the line to verify whether or not interpolation of the installation damage test results was feasible for the remaining products in the line not fully evaluated for installation damage resistance. The Miragrid XT product line generally exhibited moderately strong relationships between the weight or the tensile strength of the product and the strength retained after installation damage for 57 stone but showed no consistent relationship with product weight or tensile strength for gradations 1, 2 and 3. See figures 4-6 through 4-9 for illustrations of those relationships. Therefore, interpolation of these test results to products in the line not tested based on product weight or strength may be only feasible for 57 stone, though caution should be exercised and appropriate judgment applied to insure a safe estimate of RF_{ID} each product. For products in the product line not tested in the full scale installation damage tests, for gradations 1, 2 and 3, use of a lower bound value of strength retained for the products not tested in the full scale installation damage tests (i.e., (P_{dmin} in Figure 4-6) appears to be appropriate for design.



Note: $RF_{ID} = 1/P$; d_{50} = sieve size at which 50% of soil passes by weight

Figure 4-5. Miragrid XT product line installation damage as a function of soil d_{50} size.

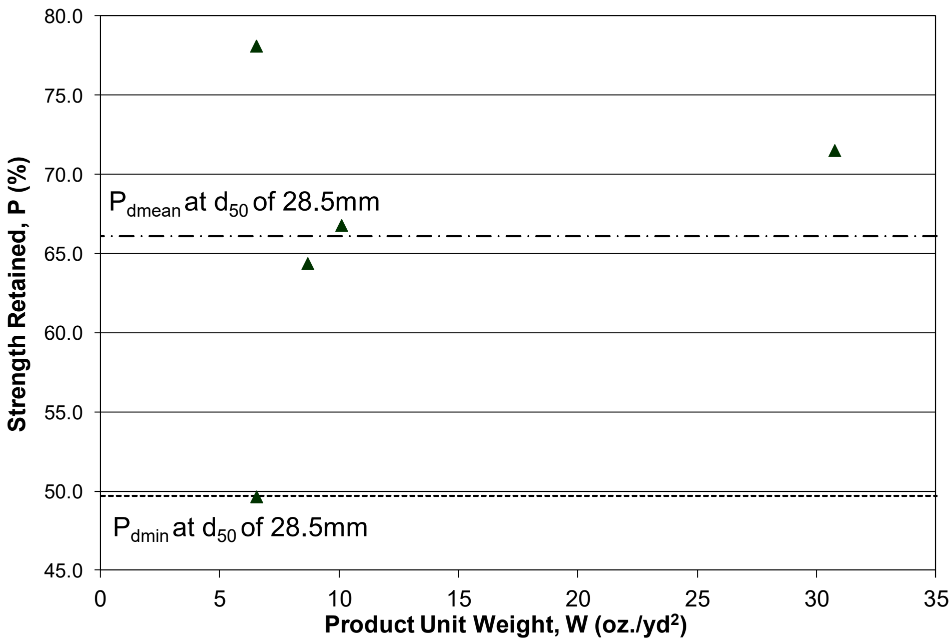


Figure 4-6. Miragrid XT product line installation damage as a function of product unit weight for type 1 soil (coarse gravel - GP).

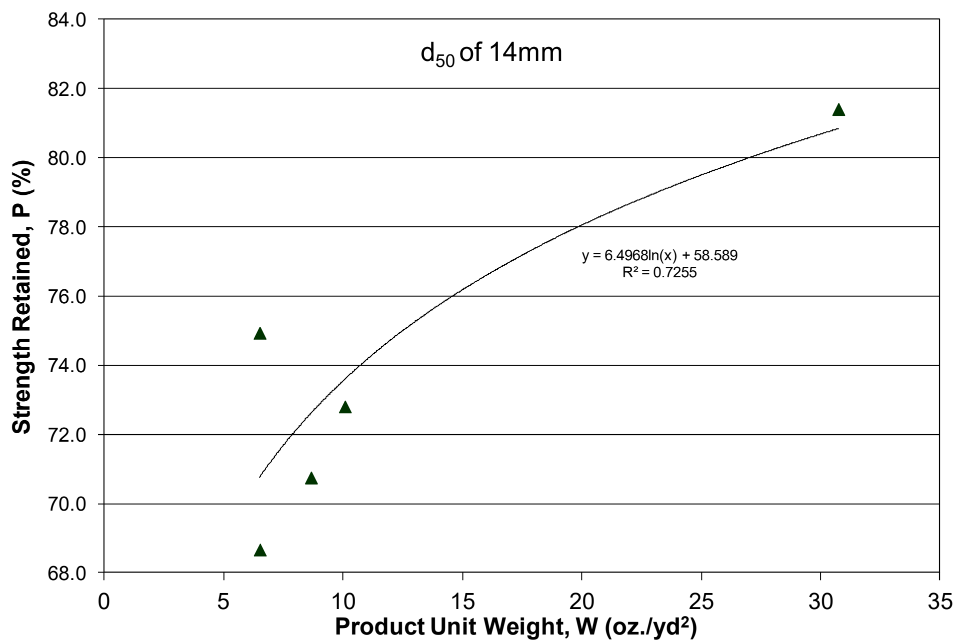


Figure 4-7. Miragrid XT product line installation damage as a function of product unit weight for 57 stone (GP).

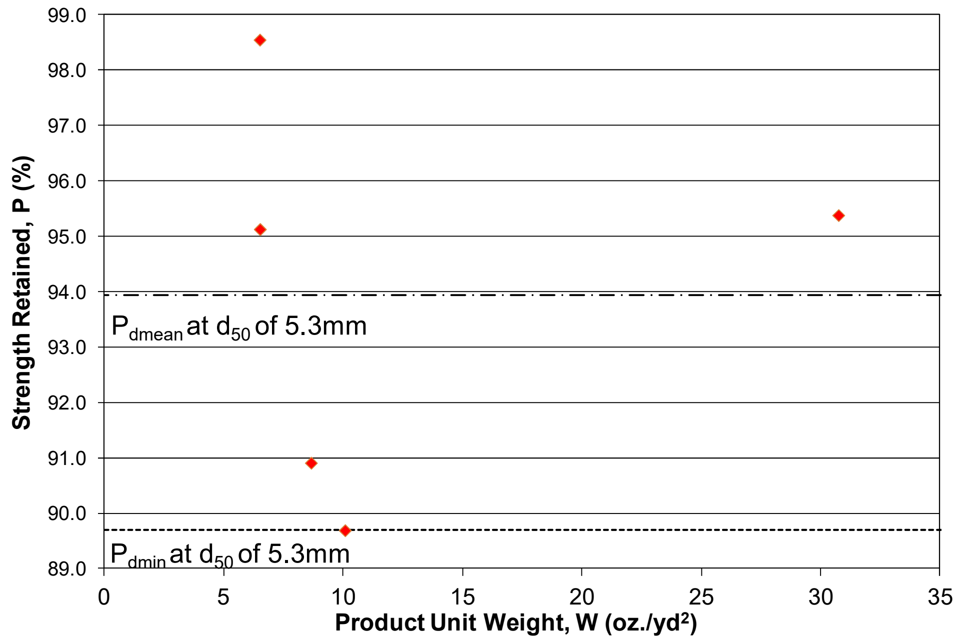


Figure 4-8. Miragrid XT product line installation damage as a function of product unit weight for type 2 soil (sandy gravel - GP).

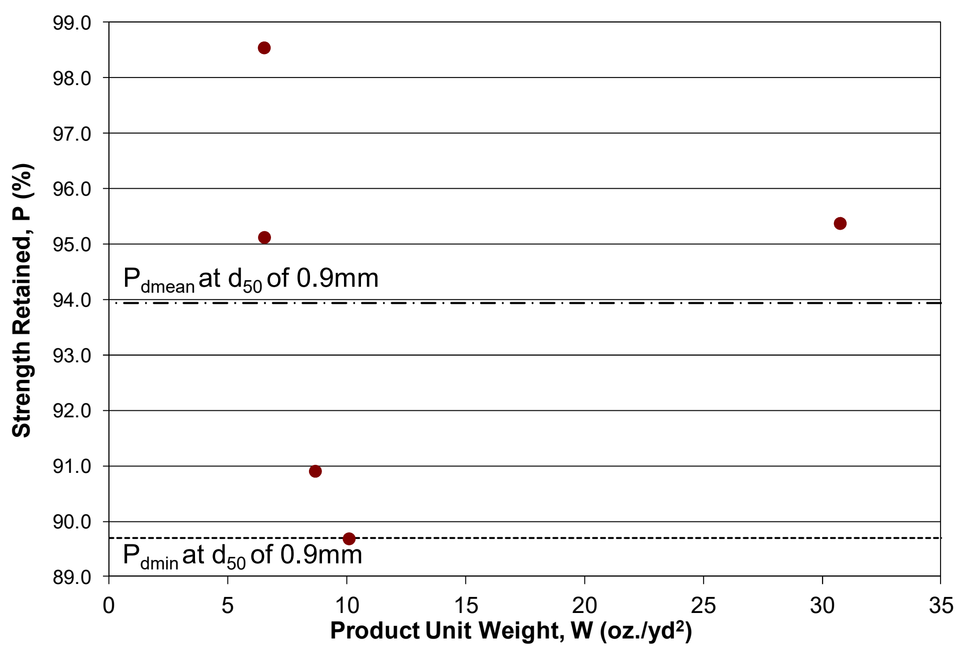


Figure 4-9. Miragrid XT product line installation damage as a function of product unit weight for type 3 soil (silty sand – SM).

It should be noted that the installation damage testing conducted represents an increase in compaction and spreading equipment size (i.e., a 15,000 lb wheeled front end loader – Caterpillar 416E, and a 25,000 lb single drum vibratory roller – a 10,000 lb roller was used in past testing) and a reduced aggregate lift thickness over the geogrid of 6 inches (an 8 inch lift thickness was used in past testing) relative to the installation damage testing reported in previous NTPEP test reports. Therefore, the decrease in strength retained values relative to previous NTPEP test reports for this product line does not represent a change in the products, but instead is the result of the more severe installation damage conditions which represent a likely upper bound installation condition for geosynthetic reinforced soil structures. Actual RF_{ID} values could be lower if installation conditions are less severe (e.g., greater initial lift thickness over the geogrid, use of lighter weight equipment, etc.). Actual RF_{ID} values could be higher if the spreading or compacting equipment tires or tracks are allowed to be in direct contact with the geosynthetic before or during fill placement and compaction, if the thickness of the fill material between the equipment tires or tracks is inadequate (especially for high tire pressure equipment such as dump trucks), or if excessive rutting of the first lift of soil over the geosynthetic (e.g., due to soft subgrade soil) is allowed to occur.

4.5 Laboratory Installation Damage Test Results per ISO/EN 10722

Laboratory Installation damage testing and interpretation was conducted in accordance with ISO/EN 10722. In this procedure, geosynthetic specimens are exposed to simulated installation stresses and abrasion using a standard "backfill" material in a bench scale device. Once exposed, they are tested for tensile strength to determine the retained strength after damage. Five baseline and five exposed specimens from each product were tested. The test results are summarized in Table 4-4. Detailed test results are provided in Appendix E, as well as a photograph of the test set-up and a close up of the standard backfill material used.

This procedure is intended to be a reproducible index test to assess relative susceptibility of the geosynthetic to damage. In this NTPEP testing program, the results from this test are primarily intended to be used for future quality assurance to assess the consistency in the product's susceptibility to installation damage. It is not intended to be used directly in the determination of RF_{ID} for a given soil backfill gradation.

Table 4-4. Summary of laboratory (ISO procedure) installation damage test results.

Miragrid XT Style	Mean Baseline Tensile Strength (lb/ft)	Coefficient of Variation (%)	Mean Exposed Tensile Strength (lb/ft)	Coefficient of Variation (%)	Strength Retained (%)
2XT	2,759	2	2,483	6	90
3XT	4,020	2	3,528	7	88
5XT	5,127	2	4,737	5	92
7XT	6,734	2	5,394	10	80
8XT	8,286	2	7,078	5	85
10XT	11,491	3	9,820	6	85
20XT	17,648	2	15,860	4	90
22XT	24,164	3	22,307	3	92
24XT	32,917	1	29,139	3	89

(Conversion: 1 lb/ft = 0.0146 kN/m)

5.0 Creep Rupture Data (RF_{CR})

5.1 Creep Rupture Test Program

Creep testing and interpretation has been conducted in accordance with AASHTO R69-15. A baseline (i.e., reference) temperature of 68º F (20º C) was used. 8XT was used as the primary product to establish the creep rupture envelope, with limited creep testing of the other Miragrid XT geogrids (i.e., 2XT and 24XT) to verify the ability to interpolate creep rupture behavior to the Miragrid geogrid products not specifically tested (i.e., to treat all the products submitted for evaluation as a product line per R69-15 and the NTPEP work plan).

The creep rupture testing program is summarized in Figure 5-1. Creep testing was conducted using both ASTM D5262 (termed "conventional" creep testing) and ASTM D6992 (i.e., the Stepped Isothermal Method - SIM). A limited number (6) of tests using ASTM D5262, conducted only at the reference temperature of 68º F (20º C) for up to a maximum time of 10,000 hrs were used for comparison purposes to verify the accuracy of the SIM creep tests. Since the SIM creep tests are conducted as single rib tests and conventional creep tests (ASTM D5262) conducted as single-rib and multi-rib tests, both single rib and wide width (multi-rib) short-term tensile tests were conducted for the primary product, 8XT. This was done for comparison purposes to establish the validity of using single rib creep test data as well as to ensure that the correct index tensile strength is used, since the creep load is expressed as a percent of T_{ult}.

Table 5-1. Independent creep rupture testing required for NTPEP qualification.

Manufacturer: TenCate Geosynthetics PRODUCT Line: 2XT to 24XT			
Tests Conducted	Qualification (every 9 yrs) / Verification (every 3 yrs)		
	Products Tested		# of Tests (see Note 1)
	Qualification	Verification	
Index single rib tensile tests on lot specific material (ASTM D6637)	2XT, 8XT, 24XT	NA	3
Index wide width tensile tests on lot specific material (ASTM D6637)	NA	NA	0
PRIMARY PRODUCT 6 Rupture Points – Conventional Creep testing up to 1000 hrs (ASTM D5262)	8XT @ 6 load levels	NA	6
PRIMARY PRODUCT 6 Rupture Points – Accelerated Creep rupture testing (SIM). (ASTM D6992)	8XT @ 6 load levels	NA	6
SECONDARY PRODUCT(S) Conventional Creep Testing (ASTM D5262)	None	NA	0
SECONDARY PRODUCT(S) Accelerated Creep rupture testing (SIM). (ASTM D6992)	2XT and 24XT @ 4 load levels	NA	8
Note 1: Each test is performed using the number of specimens required by the test standard. For example, for index tensile testing, a test is defined 5 to 6 specimens. See the specific test procedures for details on this.			

5.2 Baseline Tensile Strength Test Results

All creep testing using SIM (ASTM D6992) was performed on single rib specimens, whereas single-rib and multi-rib specimens were used for the conventional (ASTM D5262) creep tests. Both types of tests were only conducted for the 8XT geogrid product. To facilitate use of both single rib to wide width specimens for the creep testing, rapid loading tensile and creep tests were conducted, in accordance with R69-15. The multi-rib rupture points fit closely with the single rib rupture curve (see Figure 5-1). The tensile test specimens tested were taken from the same rolls of material that were used for the creep testing. The measured geogrid dimensions discussed in Section 2 and provided in Appendix B, Section B.1, were used to convert tensile test loads to load per unit width values.

Table 5-2. Ultimate tensile strength (UTS) and associated strain.

Product	Single Rib UTS per ASTM D6637, T_{lot} (lb/ft @ % Strain)
2XT	2,753 @ 9.87%
8XT	8,636 @ 13.4%
24XT	28,474 @ 13.0%

(Conversion: 1 lb/ft = 0.0146 kN/m)

5.3 Creep Rupture Test Results

A total of 14 Stepped Isothermal Method (SIM) tests and 6 conventional creep tests were run to fulfill the qualification requirements. Table 5-3 summarize the tests performed and their outcomes. Detailed test results, including creep curves for each specimen tested, are provided in Appendix F, Figures F-1 through F-20.

Table 5-3. Creep rupture test results for all tests conducted.

Style & Test Type	Creep Load (% of T_{lot})	Time to Rupture (log hrs)
2XT - SIM	70.96	5.4100
2XT - SIM	75.00	4.1304
2XT - SIM	79.00	2.4319
2XT - SIM	83.00	1.3981
8XT - SIM	68.00	6.2548
8XT - SIM	71.00	5.0359
8XT - SIM	74.00	4.8030
8XT - SIM	77.00	3.1833
8XT - SIM	80.00	2.2342
8XT - SIM	83.00	1.5275
8XT - Conv.+	81.00	2.0423
8XT - Conv.+	80.00	2.1602
8XT - Conv.+	79.00	2.6325
8XT - Conv.+	77.50	3.8328
8XT - Conv.	76.00	3.3958
8XT - Conv.	74.00	4.0000*
24XT - SIM	70.00	5.4648
24XT - SIM	74.00	4.5842
24XT - SIM	78.00	3.3838
24XT - SIM	82.00	1.5877

+ Multi-rib specimen, * Finished without rupture

5.3.1 Statistical Validation to Allow the Use of SIM Data to Establish Rupture Envelope

Details of the confidence limits evaluation conducted in accordance with R69-15 are contained in Appendix F. Figure F-21 provides a plot of the creep rupture envelope with the confidence limits and the rupture envelopes for the conventional creep and SIM creep data, illustrating this statistical test. Detailed calculation results for this statistical analysis are provided in Table F-2, and summarized in Table F-6. The results indicate that the SIM data meet the statistical validation requirements in R69-15 (i.e., the SIM rupture envelope is within the specified 90% confidence limits of the "conventional" creep rupture data). Thus, the conventional and accelerated (SIM) data may be used together to construct the characteristic creep rupture curve of the primary product, and SIM data may also be used for creep testing of the other two geogrid products to evaluate the potential to construct a composite creep curve for the product line.

5.3.2 Statistical Validation to Allow the Use of Composite Rupture Envelope for Product Line

Details of the confidence limits evaluation for the product line conducted in accordance with R69-15 are contained in Appendix F. Figure F-22 provides a plot of the creep rupture envelope with the confidence limits and the rupture envelopes for the primary product and the other tested products (i.e., 2XT and 24XT), illustrating this statistical test. Detailed calculation results for this statistical analysis are provided in Tables F-3 and F-4, and summarized in Table F-7. The results indicate that the rupture envelopes for the 2XT and 24XT products are within the specified 90% confidence limits of the primary product (i.e., 8XT) creep rupture data, meeting R69-15 requirements. Thus, all the Miragrid XT products tested (i.e., 2XT, 8XT and 24XT) can be used to construct a composite creep rupture envelope representing the entire product line. The calculation results for the statistical analysis and regression to create the full composite creep curve are provided in Table F-5.

5.4 Creep Rupture Envelope Development and Determination of RF_{CR}

In consideration of the statistical validation described in Section 5.3 of this report, a composite creep rupture envelope, using log-linear regression, was constructed as shown in Figure 5-1. The mix of conventional and accelerated (SIM) creep rupture test data points meets R69-15 requirements. Based on this plot of all data, the regression of the data shows that the r^2 value is 0.97 (see Table F-5 in Appendix F for details). Per R69-15, this degree of scatter in the data is acceptable for a composite rupture envelope.

The creep rupture envelope in Figure 5-1 should be considered valid for the entire Miragrid XT geogrid product line evaluated in this report. Since the temperature accelerated creep results produced through the SIM testing allowed time shifting of the creep rupture data points to over 1,000,000 hours (i.e., 114 years), no extrapolation uncertainty factor in accordance with R69-15 need be applied. Table 5-4 provides the estimated value of RF_{CR} for the Miragrid XT geogrid product line based on the reported testing for a period of long-term loading of up to 100 years. This rupture envelope can be used to determine RF_{CR} for times other than 3, 75 and 100 years, if desired.

Table 5-4. RF_{CR} value for Miragrid XT series geogrids for 3, 75 and 100 yr periods of loading/use.

Period of Use (in years)	RF_{CR} for Rupture – All XT Styles
3	1.36
75	1.44
100	1.45

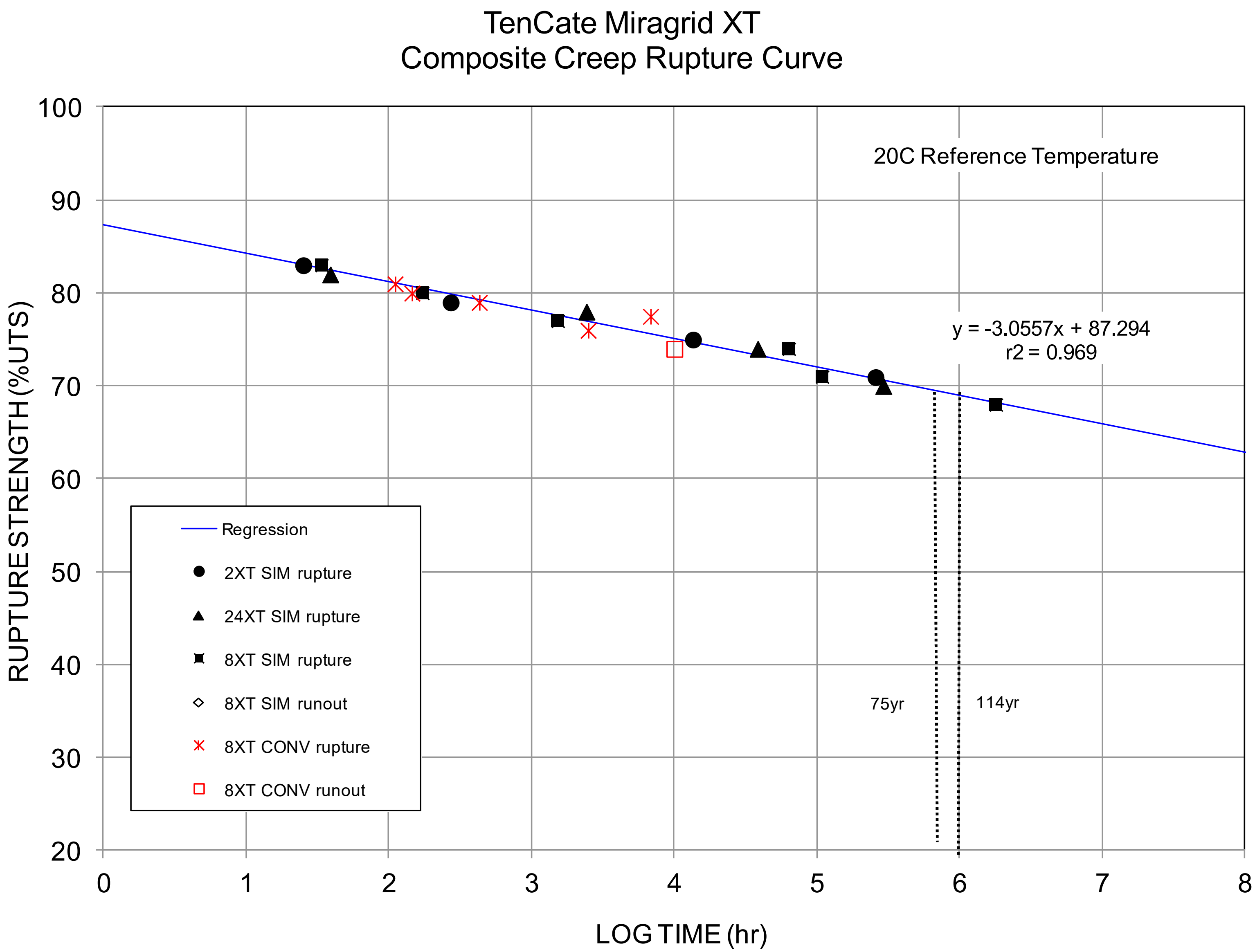


Figure 5-1. Composite creep rupture data/envelope for the Miragrid XT geogrid product line.

6.0 Long-Term Durability Data (RF_D)

6.1 Durability Test Program

Basic molecular properties relating to durability were evaluated, allowing a "default" RF_D to be used in accordance with AASHTO R69-15, provided that the long-term environment in which the geosynthetic is to be used is considered to be non-aggressive in accordance with the AASHTO LRFD Bridge Design Specifications and R69-15. A non-aggressive long-term environment is described in these documents as follows:

- A soil ph of 4.5 to 9.0,
- A maximum particle size of 0.75 inches or less unless installation damage effects are specifically evaluated using full scale installation damage testing in accordance with ASTM D 5818,
- A soil organic content of 1% or less, and
- An effective design temperature at the site of 86ºF (30ºC) or less.

Other specific soil/environmental conditions that could be of concern to consider the site environment to be aggressive are discussed in Elias[2].

The index properties/test results obtained can be related to long-term performance of the polymer through correlation to longer-term laboratory durability performance tests and long-term experience. Note that long-term durability performance testing in accordance with R69-15 and the NTPEP work plan to allow direct calculation of RF_D was not available from the manufacturer, nor evaluated as part of the testing program for this product line.

For polyester (PET) geosynthetics, key durability issues to address include hydrolysis and ultraviolet (UV) oxidative degradation. To assess the potential for these types of degradation, index property tests to assess molecular weight, carboxyl end group content, and ultraviolet (UV) oxidative degradation are conducted. Criteria for test results obtained from each of these tests are provided in R69-15 as well as the AASHTO LRFD Bridge Design Specifications.

The UV degradation tests were conducted on the lightest weight product in the product line (2XT) as recommended in R69-15. Since UV degradation attacks from the surface of the geosynthetic, the heavier the product, the more resistant it will be to UV degradation. Therefore, UV testing the lightest weight product should produce the most conservative result.

The molecular weight and carboxyl end group content tests are conducted on the base yarn for the product series. Since for a product line the base yarn used must be the same for all products in the line, these tests on the base yarn will be applicable to all products in the product line.

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[2] Elias, V., 2000, *Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes,* FHWA-NHI-09-087, Federal Highway Administration, Washington, D.C.

Table 6-1. Independent durability testing required for NTPEP qualification.

<table>
<tr><th colspan="4">Manufacturer: TenCate Geosynthetics PRODUCT Line: 2XT to 24XT</th></tr>
<tr><th rowspan="3">Tests Conducted</th><th colspan="3">Qualification (every 9 yrs) / Verification (every 3 yrs)</th></tr>
<tr><th colspan="2">Products Tested</th><th rowspan="2"># of Tests (see Note 1)</th></tr>
<tr><th>Qualification</th><th>Verification</th></tr>
<tr><td>All polymers, resistance to weathering @ 500 hrs (ASTM D4355), including before/after tensile strength</td><td>2XT</td><td>NA</td><td>1</td></tr>
<tr><td>For polyesters, molecular weight determination (ASTM D4603 and GRI-GG7) – on yarn/strip</td><td>Miragrid XT yarn</td><td>NA</td><td>1</td></tr>
<tr><td>For polyesters, carboxyl end group content determination (GRI-GG8) – on yarn/strip</td><td>Miragrid XT yarn</td><td>NA</td><td>1</td></tr>
<tr><td>CEG-MW Testing Coating Removal, if necessary</td><td>NA</td><td>NA</td><td>0</td></tr>
<tr><td>Brittleness (AASHTO R69-15)</td><td>NA</td><td>NA</td><td>0</td></tr>
<tr><td>For polyolefins, long-term evaluation via Oxidative degradation (ISO/EN 13438:1999)</td><td>NA</td><td>NA</td><td>0</td></tr>
<tr><td>For polyesters, long-term evaluation via Hydrolytic degradation (AASHTO R69-15)</td><td>None</td><td>None</td><td>0</td></tr>
<tr><td>For polyolefins, long-term evaluation via Oxidative degradation (AASHTO R69-15)</td><td>NA</td><td>NA</td><td>0</td></tr>
<tr><td colspan="4">Note 1: Each test is performed using the number of specimens required by the test standard. For example, for index tensile testing, a test is defined 5 to 6 specimens. See the specific test procedures for details on this.</td></tr>
</table>

6.2 Durability Test Results

A summary of the test results is provided in Table 6-2. This table also includes the criteria to allow the use of a default reduction factor for RF_D provided in R69-15 and the AASHTO LRFD Bridge Design Specifications. Detailed durability test results are provided in Appendix G.

Table 6-2. NTPEP durability test results for the Miragrid XT geogrid product line and criteria to allow use of a default value for RF_D.

Polymer Type	Property	Test Method	Criteria to Allow Use of Default RF*	Test Result Obtained as Part of NTPEP Program
PP and HDPE	UV Oxidation Resistance	ASTM D4355	Min. 70% strength retained after 500 hrs in weatherometer	NA
PET	UV Oxidation Resistance	ASTM D4355	Min. 50% strength retained after 500 hrs in weatherometer if geosynthetic will be buried within one week, 70% if left exposed for more than one week.	94% strength retained
PP and HDPE	Thermo-Oxidation Resistance	ENV ISO 13438:1999, Method A (PP) or B (HDPE)	Min. 50% strength retained after 28 days (PP) or 56 days (HDPE)	NA
PET	Hydrolysis Resistance	Inherent Viscosity Method (ASTM D4603 and GRI Test Method GG8)	Min. Number Average Molecular Weight of 25,000	32,783
PET	Hydrolysis Resistance	GRI Test Method GG7	Max. Carboxyl End Group Content of 30	15.9

Note: PP = polypropylene, HDPE = high density polyethylene, PET = polyester

Based on these test results, all products in the product line meet the minimum UV requirement shown in Table 6-2. Regarding hydrolysis resistance, these test results shown in Table 6-2 indicate that this product line has adequate long-term resistance to hydrolysis to justify the use of a default value for RF_D, meeting the requirements in AASHTO R69-15.

Note that while no specific tests, other than installation damage, were conducted to evaluate the durability of the coating, because the hydrolysis resistance characterization was determined based on the base polymer, any potential coating degradation should have very little effect on the long-term durability of the geogrid product and the default value of RF_D selected. Typically, a default value of 1.3 for RF_D is selected. See AASHTO R69-15, or the document entitled "Use and Application of NTPEP Geosynthetic Reinforcement Test Results" (www.NTPEP.org), for guidance on the selection of a default value for RF_D.

7.0 Low Strain Creep Stiffness Data

7.1 Low Strain Creep Stiffness Test Program

Creep stiffness testing was conducted in accordance with AASHTO R69-15 and the NTPEP work plan. The creep stiffness determination was targeted to 2% strain at 1,000 hours.

Products selected to represent the XT product line (i.e., 2XT, 8XT, and 24XT) were tested for creep stiffness. Roll specific single rib short-term rapid loading tensile strength tests (T_{lot}) were conducted for each product for correlation purposes and to calculate load levels. A total of nine Ramp and Hold (R&H), 1,000 second creep tests, were conducted on each product. Three specimens were R&H tested at each of the following stresses: 5, 10 and 20% of the ultimate tensile strength (UTS). A linear regression based on %UTS and % strain at 0.1 hour was used to normalize strain curves to reduce the variability of the elastic portion of the strain curve. The % UTS required to obtain 2% strain at 1,000 hours was then determined. Three R&H tests and two 1,000 hour conventional creep tests (ASTM D5262, but as modified for low strain in R69-15 and using a single rib specimen) were conducted at this load. All tests were conducted at 68º F (20º C).

7.2 Ultimate Tensile Test Results for Creep Stiffness Test Program

The values provided in Table 7-1 represent the baseline, roll specific, ultimate tensile strength used to normalize the load level for the creep stiffness testing. Sample specific geogrid dimensions were used to convert tensile test loads to load per unit width values.

Table 7-1. Ultimate tensile strength (UTS) & associated strain.

Product	T_{lot} for Single Rib (lb/ft @ % Strain)
2XT	2,753 @ 9.87%
8XT	8,636 @ 13.4%
24XT	28,474 @ 13.0%

(Conversion: 1 lb/ft = 0.0146 kN/m)

7.3 Creep Stiffness Test Results

Detailed test results are provided in Appendix H. Table 7-2 provides a summary of the creep stiffness values obtained. Note that the creep stiffness values at 1,000 hours and 5%UTS, 10%UTS and 20%UTS represent stiffness values at strains other than 2% strain. See Appendix H for details. Figure 7-1 shows the relationship between the measured tensile strength and the creep stiffness. Considering the strong linear relationship between the creep stiffness and the product tensile strength, interpolation to other products in the product line not tested to determine creep stiffness values for those products is acceptable.

Table 7-2. Summary of creep stiffness test results.

Miragrid XT Series Style	Average Creep Stiffness @ 1000 hours for 5% UTS Ramp & Hold (lb/ft)	Average Creep Stiffness @ 1000 hours for 10% UTS Ramp & Hold (lb/ft)	Average Creep Stiffness @ 1000 hours for 20% UTS Ramp & Hold (lb/ft)	Average Creep Stiffness for 2% strain @ 1000 hrs (lb/ft)
2XT	64,509	19,130	19,073	**19,801**
8XT	126,611	68,936	43,470	**57,791**
24XT	772,557	247,151	120,789	**190,759**

(Conversion: 1 lb/ft = 0.0146 kN/m)

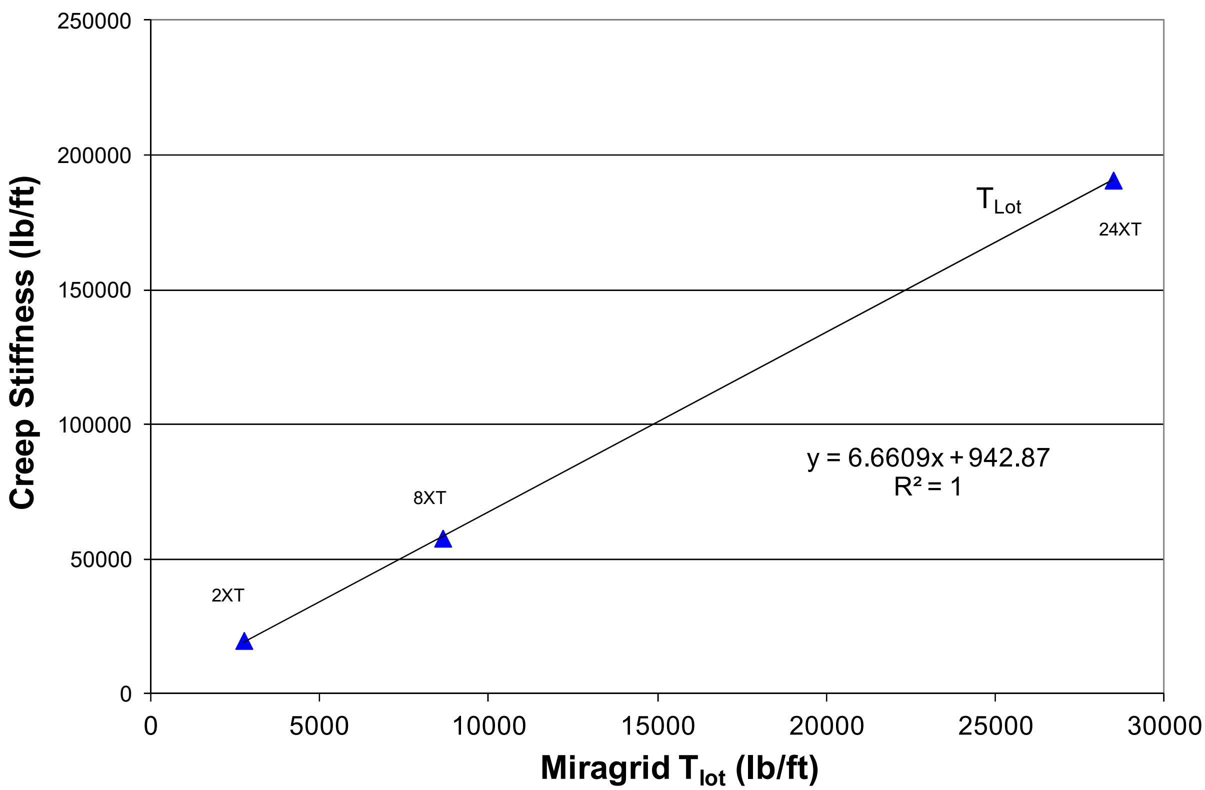

Figure 7-1. Miragrid XT creep stiffness for 2 % strain @ 1000 hours.

To obtain the minimum likely stiffness value for each product in consideration of the MARV tensile strength, multiply the stiffness value from the plot by the ratio of T_{MARV}/T_{lot}. T_{MARV} is the minimum tensile strength, as provided by the manufacturer, for each product in the product line. T_{lot} is the actual roll specific tensile strength for the sample used in the creep stiffness testing.

APPENDICES

Appendix A: NTPEP Oversight Committee

Name	Email Address	Agency Name	Designation	Member Type
Hidden, Scott	shidden@ncdot.gov	North Carolina Department of Transportation	Chair	Voting
Golden, Shannon G.	goldens@dot.state.al.us	Alabama Department of Transportation	Member	Voting
Herrera, Rodrigo A	rodrigo.herrera@dot.state.fl.us	Florida Department of Transportation	Member	Voting
Hughes, Scott Eric	Scott.Hughes@illinois.gov	Illinois Department of Transportation	Member	Voting
Sommers, Scott Michael	scott.sommers@iowadot.us	Iowa Department of Transportation	Member	Voting
Davis, Jason	jason.davis@la.gov	Louisiana Department of Transportation and Development	Member	Voting
Sajedi, Dan	dsajedi@sha.state.md.us	Maryland Department of Transportation	Member	Voting
Lee, Derek	derek.lee@state.ma.us	Massachusetts Department of Transportation	Member	Voting
La Cour, Ian	ilacour@mdot.ms.gov	Mississippi Department of Transportation	Member	Voting
Mclain, Kevin Wade	kevin.mclain@modot.mo.gov	Missouri Department of Transportation	Member	Voting
Lindemann, Mark	mark.lindemann@nebraska.gov	Nebraska Department of Transportation	Member	Voting
Burnett, Thomas W	Tom.Burnett@dot.ny.gov	New York State Department of Transportation	Member	Voting
Merklin, Christopher	chris.merklin@dot.ohio.gov	Ohio Department of Transportation	Member	Voting
Brown, Sophie	sophie.brown@odot.state.or.us	Oregon Department of Transportation	Member	Voting
Berg, Ryan	RyanBerg@att.net	Ryan R. Berg & Associates, Inc.	Member	Non-Voting
Lostumbo, John	j.lostumbo@tencategeo.com	TenCate Geosynthetics	Member	Non-Voting
Kern, Claudia	claudia.kern@txdot.gov	Texas Department of Transportation	Member	Voting
Collin, James G	jim@thecollingroup.com	The Collin Group, Ltd	Member	Non-Voting
Shi, Bin	bshi@utah.gov	Utah Department of Transportation	Member	Voting
Kim, Wan Soo	wansoo.kim@vdot.virginia.gov	Virginia Department of Transportation	Member	Voting
Allen, Tony M	allent@wsdot.wa.gov	Washington State Department of Transportation	Member	Voting

Appendix B: Product Geometric and Production Details

B.1 Product Geometric Information

Table B-1. Typical and measured MD geogrid geometry for the Miragrid XT product line.

Machine Direction (MD) Ribs								
Style	Width (in)		Spacing (in)		Aperture Size (in)		Rib Thickness (in)	
	Typical Values	As Measured*	Typical Values	As Measured*	Typical Values	As Measured *	Typical Values	As Measured*
2XT	N/A	0.098	N/A	1.126	0.875	0.840	N/A	0.054
3XT	N/A	0.153	N/A	1.104	1.0	1.520	N/A	0.054
5XT	N/A	0.193	N/A	1.107	1.2	1.573	N/A	0.057
7XT	N/A	0.246	N/A	1.116	1.3	1.459	N/A	0.053
8XT	N/A	0.271	N/A	1.080	1.3	1.573	N/A	0.050
10XT	N/A	0.325	N/A	1.110	1.3	1.498	N/A	0.058
20XT	N/A	0.418	N/A	1.012	1.5	1.395	N/A	0.081
22XT	N/A	0.460	N/A	0.969	1.4	1.404	N/A	0.092
24XT	N/A	0.569	N/A	1.009	1.4	1.403	N/A	0.086

(Conversions: 1 in = 25.4 mm)

*Average of 5 readings obtained during NTPEP testing. Full test results in tables B-5 through B-13.

Table B-2. Typical and measured XD geogrid geometry for the Miragrid XT product line.

Cross-Machine Direction (XD) Ribs								
Style	Width (in)		Spacing (in)		Aperture Size (in)		Rib Thickness (in)	
	Typical Values	As Measured*	Typical Values	As Measured*	Typical Values	As Measured*	Typical Values	As Measured*
2XT	N/A	0.099	N/A	0.939	1.0	1.028	N/A	0.053
3XT	N/A	0.110	N/A	1.630	1.0	0.950	N/A	0.055
5XT	N/A	0.115	N/A	1.687	1.0	0.914	N/A	0.044
7XT	N/A	0.108	N/A	1.566	0.9	0.870	N/A	0.047
8XT	N/A	0.101	N/A	1.674	0.9	0.809	N/A	0.053
10XT	N/A	0.253	N/A	1.751	0.8	0.785	N/A	0.064
20XT	N/A	0.263	N/A	1.658	0.6	0.594	N/A	0.053
22XT	N/A	0.232	N/A	1.636	0.6	0.509	N/A	0.069
24XT	N/A	0.229	N/A	1.632	0.5	0.439	N/A	0.062

(Conversions: 1 in = 25.4 mm)

*Average of 5 readings obtained during NTPEP testing. Full test results in tables B-5 through B-13.

Table B-3. Typical and measured geogrid junction thickness for the Miragrid XT product line.

Style	Junction Thickness (in)	
	Typical Values	As Measured*
2XT	Not tested	0.056
3XT	Not tested	0.056
5XT	Not tested	0.059
7XT	Not tested	0.061
8XT	Not tested	0.061
10XT	Not tested	0.073
20XT	Not tested	0.095
22XT	Not tested	0.106
24XT	Not tested	0.106

(Conversions: 1 in = 25.4 mm)

*Average of 5 readings obtained during NTPEP testing. Full test results in tables B-5 through B-13.

Table B-4. Typical and measured geogrid unit weight for the Miragrid XT product line.

Geogrid Style/Type	Typical Weight (oz/yd^2)	Measured Weight*, per ASTM D5261 (oz/yd^2)
2XT	7.50	6.52
3XT	8.17	6.51
5XT	9.00	8.69
7XT	10.21	8.66
8XT	11.42	10.08
10XT	14.31	12.82
20XT	22.12	19.03
22XT	30.50	25.29
24XT	38.02	30.74

(Conversion: 1 oz/yd^2 = 33.9 g/m^2)

*Average of 5 readings obtained during NTPEP testing. Full test results in tables B-5 through B-13.

Table B-5. Geogrid geometric measurements for 2XT

PARAMETER		TEST REPLICATE NUMBER					MEAN	STD. DEV.
		1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	7.77							
Specimen Length (in)	7.4							
Mass(g)		8.02	8.28	8.31	8.23	8.23		
Mass/unit area (oz/sq.yd)		6.37	6.58	6.60	6.54	6.54	**6.52**	0.09
Mass/unit area (g/sq.meter)		216	223	224	222	222	**221**	3
Aperature Size (Calipers)								
MD - Aperature Size (in)		0.863	0.790	0.836	0.868	0.845	**0.840**	0.031
MD - Aperature Size (mm)		21.9	20.1	21.2	22.0	21.5	**21.3**	0.8
TD - Aperature Size (in)		1.017	1.035	1.035	1.019	1.036	**1.028**	0.010
TD - Aperature Size (mm)		25.8	26.3	26.3	25.9	26.3	**26.1**	0.2
Rib Width (Calipers)								
MD - Width (in)		0.110	0.094	0.095	0.097	0.095	**0.098**	0.007
MD - Width (mm)		2.78	2.37	2.40	2.46	2.41	**2.49**	0.17
TD - Width (in)		0.102	0.106	0.100	0.094	0.095	**0.099**	0.005
TD - Width (mm)		2.58	2.68	2.54	2.37	2.41	**2.52**	0.12
Rib Thickness (Calipers)								
MD - Thickness (in)		0.051	0.053	0.056	0.054	0.055	**0.054**	0.002
MD - Thickness (mm)		1.30	1.35	1.41	1.36	1.38	**1.36**	0.04
TD - Thickness (in)		0.053	0.049	0.054	0.060	0.049	**0.053**	0.005
TD - Thickness (mm)		1.33	1.23	1.36	1.52	1.23	**1.34**	0.12
Node/Junction Thickness (Calipers)								
Thickness (in)		0.054	0.056	0.056	0.061	0.053	**0.056**	0.003
Thickness (mm)		1.37	1.41	1.42	1.55	1.35	**1.42**	0.08

MD - Machine Direction   TD - Transverse/Cross Machine Direction   NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-6. Geogrid geometric measurements for 3XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.
	1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)							
Specimen Width (in) 7.81							
Specimen Length (in) 8.21							
Mass(g)	8.88	9.26	9.27	9.03	9.23		
Mass/unit area (oz/sq.yd)	6.33	6.60	6.60	6.43	6.57	**6.51**	0.12
Mass/unit area (g/sq.meter)	214	224	224	218	223	**221**	4
Aperature Size (Calipers)							
MD - Aperature Size (in)	1.476	1.507	1.499	1.596	1.522	**1.520**	0.045
MD - Aperature Size (mm)	37.5	38.3	38.1	40.5	38.6	**38.6**	1.2
TD - Aperature Size (in)	0.937	0.945	0.970	0.955	0.946	**0.950**	0.013
TD - Aperature Size (mm)	23.8	24.0	24.6	24.2	24.0	**24.1**	0.3
Rib Width (Calipers)							
MD - Width (in)	0.151	0.151	0.157	0.150	0.158	**0.153**	0.004
MD - Width (mm)	3.82	3.84	3.99	3.81	4.00	**3.89**	0.09
TD - Width (in)	0.108	0.105	0.107	0.115	0.116	**0.110**	0.005
TD - Width (mm)	2.74	2.67	2.71	2.92	2.93	**2.79**	0.12
Rib Thickness (Calipers)							
MD - Thickness (in)	0.053	0.056	0.053	0.055	0.055	**0.054**	0.001
MD - Thickness (mm)	1.35	1.42	1.35	1.38	1.38	**1.38**	0.03
TD - Thickness (in)	0.047	0.048	0.067	0.057	0.059	**0.055**	0.008
TD - Thickness (mm)	1.18	1.22	1.69	1.45	1.50	**1.41**	0.21
Node/Junction Thickness (Calipers)							
Thickness (in)	0.057	0.057	0.054	0.058	0.053	**0.056**	0.002
Thickness (mm)	1.45	1.45	1.37	1.47	1.35	**1.42**	0.06

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-7. Geogrid geometric measurements for 5XT

PARAMETER		TEST REPLICATE NUMBER 1	2	3	4	5	MEAN	STD. DEV.
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	7.85							
Specimen Length (in)	7.97							
Mass(g)		11.53	11.71	12.16	12.03	12.06		
Mass/unit area (oz/sq.yd)		8.42	8.55	8.88	8.78	8.80	**8.69**	0.19
Mass/unit area (g/sq.meter)		285	290	301	298	298	**294**	7
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.601	1.601	1.533	1.576	1.554	**1.573**	0.030
MD - Aperature Size (mm)		40.7	40.7	38.9	40.0	39.5	**39.9**	0.8
TD - Aperature Size (in)		0.927	0.917	0.929	0.898	0.902	**0.914**	0.014
TD - Aperature Size (mm)		23.5	23.3	23.6	22.8	22.9	**23.2**	0.4
Rib Width (Calipers)								
MD - Width (in)		0.196	0.186	0.200	0.199	0.185	**0.193**	0.007
MD - Width (mm)		4.97	4.72	5.08	5.05	4.70	**4.90**	0.18
TD - Width (in)		0.126	0.107	0.099	0.125	0.118	**0.115**	0.012
TD - Width (mm)		3.20	2.71	2.51	3.16	2.98	**2.91**	0.30
Rib Thickness (Calipers)								
MD - Thickness (in)		0.058	0.055	0.054	0.056	0.062	**0.057**	0.003
MD - Thickness (mm)		1.46	1.38	1.36	1.41	1.56	**1.44**	0.08
TD - Thickness (in)		0.047	0.043	0.054	0.040	0.036	**0.044**	0.007
TD - Thickness (mm)		1.18	1.08	1.36	1.02	0.90	**1.11**	0.17
Node/Junction Thickness (Calipers)								
Thickness (in)		0.059	0.060	0.059	0.057	0.062	**0.059**	0.002
Thickness (mm)		1.49	1.51	1.49	1.45	1.57	**1.50**	0.05

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-8. Geogrid geometric measurements for 7XT

PARAMETER		TEST REPLICATE NUMBER					MEAN	STD. DEV.
		1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	7.86							
Specimen Length (in)	7.98							
Mass(g)		11.76	12.12	11.69	11.89	11.99		
Mass/unit area (oz/sq.yd)		8.56	8.83	8.51	8.66	8.73	**8.66**	0.13
Mass/unit area (g/sq.meter)		290	299	289	294	296	**294**	4
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.480	1.482	1.401	1.465	1.465	**1.459**	0.033
MD - Aperature Size (mm)		37.6	37.6	35.6	37.2	37.2	**37.0**	0.8
TD - Aperature Size (in)		0.866	0.885	0.851	0.878	0.870	**0.870**	0.013
TD - Aperature Size (mm)		22.0	22.5	21.6	22.3	22.1	**22.1**	0.3
Rib Width (Calipers)								
MD - Width (in)		0.245	0.245	0.249	0.248	0.244	**0.246**	0.002
MD - Width (mm)		6.21	6.21	6.31	6.30	6.18	**6.24**	0.06
TD - Width (in)		0.110	0.091	0.095	0.147	0.097	**0.108**	0.023
TD - Width (mm)		2.78	2.30	2.40	3.72	2.45	**2.73**	0.58
Rib Thickness (Calipers)								
MD - Thickness (in)		0.051	0.050	0.051	0.057	0.057	**0.053**	0.003
MD - Thickness (mm)		1.30	1.27	1.28	1.44	1.44	**1.34**	0.08
TD - Thickness (in)		0.056	0.044	0.038	0.048	0.050	**0.047**	0.007
TD - Thickness (mm)		1.42	1.10	0.97	1.22	1.27	**1.20**	0.17
Node/Junction Thickness (Calipers)								
Thickness (in)		0.061	0.057	0.061	0.065	0.064	**0.061**	0.003
Thickness (mm)		1.55	1.44	1.54	1.65	1.61	**1.56**	0.08

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-9. Geogrid geometric measurements for 8XT

PARAMETER		TEST REPLICATE NUMBER 1	2	3	4	5	MEAN	STD. DEV.
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	7.7							
Specimen Length (in)	7.98							
Mass(g)		13.54	13.39	13.76	13.46	13.64		
Mass/unit area (oz/sq.yd)		10.06	9.95	10.23	10.01	10.14	**10.08**	0.11
Mass/unit area (g/sq.meter)		341	337	347	339	344	**342**	4
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.406	1.663	1.642	1.532	1.625	**1.573**	0.106
MD - Aperature Size (mm)		35.7	42.2	41.7	38.9	41.3	**40.0**	2.7
TD - Aperature Size (in)		0.874	0.817	0.751	0.730	0.875	**0.809**	0.068
TD - Aperature Size (mm)		22.2	20.7	19.1	18.5	22.2	**20.6**	1.7
Rib Width (Calipers)								
MD - Width (in)		0.266	0.272	0.276	0.271	0.269	**0.271**	0.004
MD - Width (mm)		6.74	6.90	7.00	6.88	6.83	**6.87**	0.09
TD - Width (in)		0.096	0.096	0.120	0.096	0.096	**0.101**	0.011
TD - Width (mm)		2.43	2.44	3.05	2.44	2.44	**2.56**	0.27
Rib Thickness (Calipers)								
MD - Thickness (in)		0.051	0.053	0.048	0.048	0.050	**0.050**	0.002
MD - Thickness (mm)		1.30	1.33	1.22	1.22	1.27	**1.27**	0.05
TD - Thickness (in)		0.062	0.057	0.045	0.054	0.047	**0.053**	0.007
TD - Thickness (mm)		1.56	1.44	1.14	1.36	1.18	**1.34**	0.18
Node/Junction Thickness (Calipers)								
Thickness (in)		0.061	0.061	0.061	0.062	0.063	**0.061**	0.001
Thickness (mm)		1.54	1.55	1.54	1.57	1.60	**1.56**	0.03

MD - Machine Direction   TD - Transverse/Cross Machine Direction   NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-10. Geogrid geometric measurements for 10XT

PARAMETER		TEST REPLICATE NUMBER					MEAN	STD. DEV.
		1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	7.79							
Specimen Length (in)	8.01							
Mass(g)		17.63	17.58	17.45	17.55	17.34		
Mass/unit area (oz/sq.yd)		12.90	12.87	12.77	12.85	12.69	**12.82**	0.08
Mass/unit area (g/sq.meter)		437	436	433	435	430	**434**	3
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.511	1.507	1.457	1.443	1.572	**1.498**	0.051
MD - Aperature Size (mm)		38.4	38.3	37.0	36.7	39.9	**38.0**	1.3
TD - Aperature Size (in)		0.813	0.774	0.772	0.812	0.752	**0.785**	0.027
TD - Aperature Size (mm)		20.7	19.6	19.6	20.6	19.1	**19.9**	0.7
Rib Width (Calipers)								
MD - Width (in)		0.328	0.329	0.321	0.323	0.327	**0.325**	0.004
MD - Width (mm)		8.32	8.36	8.14	8.20	8.31	**8.27**	0.09
TD - Width (in)		0.094	0.875	0.098	0.093	0.104	**0.253**	0.348
TD - Width (mm)		2.39	22.23	2.49	2.36	2.64	**6.42**	8.84
Rib Thickness (Calipers)								
MD - Thickness (in)		0.058	0.061	0.057	0.054	0.060	**0.058**	0.003
MD - Thickness (mm)		1.46	1.54	1.44	1.37	1.52	**1.47**	0.07
TD - Thickness (in)		0.061	0.068	0.059	0.065	0.067	**0.064**	0.004
TD - Thickness (mm)		1.55	1.73	1.50	1.64	1.69	**1.62**	0.10
Node/Junction Thickness (Calipers)								
Thickness (in)		0.075	0.074	0.073	0.070	0.075	**0.073**	0.002
Thickness (mm)		1.89	1.88	1.84	1.78	1.89	**1.86**	0.05

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-11. Geogrid geometric measurements for 20XT

PARAMETER		TEST REPLICATE NUMBER 1	2	3	4	5	MEAN	STD. DEV.
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	8.93							
Specimen Length (in)	9.22							
Mass(g)		35.27	35.35	33.12	35.24	32.51		
Mass/unit area (oz/sq.yd)		19.57	19.61	18.37	19.55	18.03	**19.03**	0.76
Mass/unit area (g/sq.meter)		663	665	623	663	611	**645**	26
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.451	1.372	1.350	1.384	1.420	**1.395**	0.040
MD - Aperature Size (mm)		36.9	34.8	34.3	35.1	36.1	**35.4**	1.0
TD - Aperature Size (in)		0.591	0.586	0.597	0.610	0.588	**0.594**	0.010
TD - Aperature Size (mm)		15.0	14.9	15.2	15.5	14.9	**15.1**	0.2
Rib Width (Calipers)								
MD - Width (in)		0.430	0.396	0.416	0.388	0.460	**0.418**	0.029
MD - Width (mm)		10.91	10.05	10.55	9.86	11.67	**10.61**	0.73
TD - Width (in)		0.245	0.253	0.242	0.330	0.247	**0.263**	0.038
TD - Width (mm)		6.22	6.43	6.13	8.38	6.26	**6.69**	0.95
Rib Thickness (Calipers)								
MD - Thickness (in)		0.084	0.080	0.079	0.072	0.091	**0.081**	0.007
MD - Thickness (mm)		2.12	2.03	2.01	1.83	2.31	**2.06**	0.18
TD - Thickness (in)		0.048	0.063	0.068	0.041	0.047	**0.053**	0.011
TD - Thickness (mm)		1.22	1.59	1.71	1.04	1.18	**1.35**	0.29
Node/Junction Thickness (Calipers)								
Thickness (in)		0.096	0.100	0.093	0.091	0.095	**0.095**	0.003
Thickness (mm)		2.43	2.54	2.35	2.31	2.40	**2.41**	0.09

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-12. Geogrid geometric measurements for 22XT

PARAMETER		TEST REPLICATE NUMBER					MEAN	STD. DEV.
		1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	8.93							
Specimen Length (in)	9.21							
Mass(g)		44.77	46.08	45.08	45.12	46.65		
Mass/unit area (oz/sq.yd)		24.86	25.59	25.03	25.06	25.91	**25.29**	0.44
Mass/unit area (g/sq.meter)		843	868	849	849	878	**857**	15
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.431	1.341	1.492	1.320	1.436	**1.404**	0.071
MD - Aperature Size (mm)		36.3	34.1	37.9	33.5	36.5	**35.7**	1.8
TD - Aperature Size (in)		0.506	0.503	0.510	0.502	0.526	**0.509**	0.010
TD - Aperature Size (mm)		12.8	12.8	13.0	12.7	13.3	**12.9**	0.2
Rib Width (Calipers)								
MD - Width (in)		0.438	0.457	0.456	0.485	0.466	**0.460**	0.017
MD - Width (mm)		11.13	11.60	11.57	12.32	11.82	**11.69**	0.43
TD - Width (in)		0.228	0.232	0.235	0.231	0.235	**0.232**	0.003
TD - Width (mm)		5.78	5.88	5.97	5.85	5.96	**5.89**	0.08
Rib Thickness (Calipers)								
MD - Thickness (in)		0.100	0.100	0.082	0.084	0.094	**0.092**	0.009
MD - Thickness (mm)		2.54	2.54	2.08	2.12	2.37	**2.33**	0.22
TD - Thickness (in)		0.080	0.075	0.069	0.064	0.060	**0.069**	0.008
TD - Thickness (mm)		2.02	1.91	1.74	1.61	1.51	**1.76**	0.21
Node/Junction Thickness (Calipers)								
Thickness (in)		0.110	0.099	0.109	0.108	0.103	**0.106**	0.005
Thickness (mm)		2.78	2.51	2.77	2.73	2.60	**2.68**	0.12

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table B-13. Geogrid geometric measurements for 24XT

PARAMETER		TEST REPLICATE NUMBER					MEAN	STD. DEV.
		1	2	3	4	5		
Mass/Unit Area (ASTM D 5261)								
Specimen Width (in)	8.92							
Specimen Length (in)	9.1							
Mass(g)		55.96	53.70	54.08	56.48	52.93		
Mass/unit area (oz/sq.yd)		31.49	30.22	30.43	31.78	29.78	**30.74**	0.86
Mass/unit area (g/sq.meter)		1067	1024	1032	1077	1010	**1042**	29
Aperature Size (Calipers)								
MD - Aperature Size (in)		1.420	1.342	1.485	1.327	1.441	**1.403**	0.067
MD - Aperature Size (mm)		36.1	34.1	37.7	33.7	36.6	**35.6**	1.7
TD - Aperature Size (in)		0.388	0.443	0.438	0.502	0.427	**0.439**	0.041
TD - Aperature Size (mm)		9.9	11.2	11.1	12.8	10.8	**11.2**	1.0
Rib Width (Calipers)								
MD - Width (in)		0.576	0.557	0.571	0.558	0.586	**0.569**	0.012
MD - Width (mm)		14.62	14.14	14.49	14.17	14.88	**14.46**	0.31
TD - Width (in)		0.241	0.233	0.229	0.238	0.206	**0.229**	0.014
TD - Width (mm)		6.11	5.91	5.80	6.05	5.22	**5.82**	0.35
Rib Thickness (Calipers)								
MD - Thickness (in)		0.083	0.087	0.081	0.091	0.089	**0.086**	0.004
MD - Thickness (mm)		2.10	2.21	2.06	2.30	2.26	**2.18**	0.10
TD - Thickness (in)		0.058	0.063	0.061	0.068	0.059	**0.062**	0.004
TD - Thickness (mm)		1.47	1.60	1.55	1.71	1.50	**1.57**	0.10
Node/Junction Thickness (Calipers)								
Thickness (in)		0.110	0.107	0.097	0.103	0.116	**0.106**	0.007
Thickness (mm)		2.79	2.71	2.46	2.62	2.93	**2.70**	0.18

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

B.2 Product Production Information

Table B-14. Typical geogrid roll dimensions for the Miragrid XT product line.

Style/Type	Width (ft)	Length (ft)	Area (yd²)	Roll Diameter (ft)	Gross weight (lbs)
2XT	12	150	200	12.0	121
3XT	6 / 12	150	100 / 200	12.3 / 11.7	152 / 295
5XT	6 / 12	150	100 / 200	11.8	168 / 333
7XT	12	200	266	13.2	437
8XT	6 / 12	150 / 200	100 / 266	13.6 / 13.2	196 / 494
10XT	12	200	266	14.1	589
20XT	12	200	266	14.7	675
22XT	12	200	266	15.5	913
24XT	12	200	266	16.5	966

(Conversions: 1 ft = 0.3048 m; 1 yd^2 = 0.836 m^2)

B.3 Product Manufacturing Quality Control Program

Testing/sampling is done per the Miragrid Quality Control Plan Document. A summary of the program is provided in Table B-15.

Table B-15. Typical summary of quality control testing conducted by the manufacturer for the Miragrid XT product line.

Test Method	Property	Testing Frequency
ASTM D 5261	Mass / Unit Area	Per LOT (every 10,000 SY to 15,000 SY)
ASTM D6637	Single Rib Tensile	Per LOT (every 10,000 SY to 15,000 SY)
ASTM D6637	Multi-Rib Tensile	Per LOT (every 10,000 SY to 15,000 SY)
Hand measure	Aperture Size	Bi-Annually
Hand measure	Width	Per LOT
GRI-GG2	Junction Strength	Bi-Annually or change in product knit construction
GRI-GG7	CEG	Bi-Annually or change in PET fiber LOT/Merge
GRI-GG8	MW	Bi-Annually or change in PET fiber LOT/Merge

Table B-16. Typical production lot size for the Miragrid XT product line.

Style/Type	Lot Size (yd^2)	# of rolls per Lot
2XT	14,040	70
3XT	14,040	70
5XT	14,040	70
7XT	14,040	70
8XT	14,040	70
10XT	14,040	70
20XT	14,040	70
22XT	14,040	70
24XT	14,040	70

Appendix C: Tensile Strength Detailed Test Results

Table C-1. Geogrid single rib tensile test results for 2XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	2	3	4	5			
Single Rib Tensile Properties (ASTM D 6637, Method A)								
MD - Number of Ribs per foot:	10.80							
MD Maximum Strength (lbs)	255.7	253.0	256.5	259.1	250.4	**254.9**	3.3	
MD Maximum Strength (lbs/ft)	2762	2732	2770	2798	2704	**2753**	36	2,300
MD Maximum Strength (kN/m)	40.3	39.9	40.4	40.9	39.5	**40.2**	0.5	
MD Break Elongation (%)	9.83	9.91	9.98	9.95	9.66	**9.87**	0.13	

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table C-2. Geogrid single rib tensile test results for 8XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	2	3	4	5			
Single Rib Tensile Properties (ASTM D 6637, Method A)								
MD - Number of Ribs per foot:	10.91							
MD Maximum Strength (lbs)	787.1	798.7	768.8	808.4	796.6	**791.9**	15.0	
MD Maximum Strength (lbs/ft)	8583	8710	8384	8816	8687	**8636**	163	7,600
MD Maximum Strength (kN/m)	125.3	127.2	122.4	128.7	126.8	**126.1**	2.4	
MD Break Elongation (%)	13.1	13.0	13.0	14.3	13.5	**13.4**	0.6	

MD - Machine Direction   TD - Transverse/Cross Machine Direction   NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table C-3. Geogrid single rib tensile test results for 24XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	2	3	4	5			
Single Rib Tensile Properties (ASTM D 6637, Method A)								
MD - Number of Ribs per foot:	12.10							
MD Maximum Strength (lbs)	2413	2301	2305	2329	2418	**2353**	58	
MD Maximum Strength (lbs/ft)	29200	27842	27889	28177	29261	**28474**	703	28,000
MD Maximum Strength (kN/m)	426.3	406.5	407.2	411.4	427.2	**415.7**	10.3	
MD Break Elongation (%)	12.8	14.5	12.5	12.6	12.6	**13.0**	0.8	

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table C-4. Geogrid wide width tensile test results for 2XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	**2**	**3**	**4**	**5**			
Wide Width Tensile Properties (ASTM D 6637, Method B)								
MD Number of Ribs per Specimen:	7							
MD Number of Ribs per foot:	10.80							
MD Ultimate Strength (lbs)	1771	1743	1721	1764	1782	**1756**	24	
MD Ultimate Strength (lbs/ft)	2733	2689	2655	2722	2749	**2710**	38	2,300
MD Ultimate Strength (kN/m)	39.9	39.3	38.8	39.7	40.1	**39.6**	0.5	
MD Strength @ 2% Strain (lbs)	440	433	436	425	422	**431**	8	
MD Strength @ 2% Strain (lbs/ft)	680	667	672	656	651	**665**	12	
MD Strength @ 2% Strain (kN/m)	9.9	9.7	9.8	9.6	9.5	**9.7**	0.2	
MD Strength @ 5% Strain (lbs)	956	963	963	935	933	**950**	15	
MD Strength @ 5% Strain (lbs/ft)	1474	1486	1486	1443	1440	**1466**	23	
MD Strength @ 5% Strain (kN/m)	21.5	21.7	21.7	21.1	21.0	**21.4**	0.3	
MD Break Elongation (%)	9.17	9.06	8.88	9.28	9.33	**9.14**	0.18	

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table C-5. Geogrid wide width tensile test results for 8XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	**2**	**3**	**4**	**5**			
Wide Width Tensile Properties (ASTM D 6637, Method B)								
MD Number of Ribs per Specimen:	7							
MD Number of Ribs per foot:	10.91							
MD Ultimate Strength (lbs)	5584	5564	5389	5274	5418	**5446**	129	
MD Ultimate Strength (lbs/ft)	8699	8668	8395	8217	8440	**8484**	201	7,600
MD Ultimate Strength (kN/m)	127.0	126.6	122.6	120.0	123.2	**123.9**	2.9	
MD Strength @ 2% Strain (lbs)	1119	1123	1132	1135	1129	**1128**	7	
MD Strength @ 2% Strain (lbs/ft)	1744	1749	1764	1768	1759	**1757**	10	
MD Strength @ 2% Strain (kN/m)	25.5	25.5	25.8	25.8	25.7	**25.6**	0.2	
MD Strength @ 5% Strain (lbs)	1964	1971	1987	1993	1965	**1976**	13	
MD Strength @ 5% Strain (lbs/ft)	3059	3070	3096	3104	3061	**3078**	21	
MD Strength @ 5% Strain (kN/m)	44.7	44.8	45.2	45.3	44.7	**44.9**	0.3	
MD Strength @ 10% Strain (lbs)	4472	4436	4429	4408	4417	**4432**	25	
MD Strength @ 10% Strain (lbs/ft)	6967	6911	6899	6866	6881	**6905**	39	
MD Strength @ 10% Strain (kN/m)	101.7	100.9	100.7	100.2	100.5	**100.8**	0.6	
MD Break Elongation (%)	13.2	13.5	12.7	12.4	13.3	**13.0**	0.4	

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table C-6. Geogrid wide width tensile test results for 24XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	MARV
	1	2	3	4	5			
Wide Width Tensile Properties (ASTM D 6637, Method B)								
MD Number of Ribs per Specimen:	8							
MD Number of Ribs per foot:	12.10							
MD Ultimate Strength (lbs)	21182	20833	21277	20917	19736	**20789**	616	
MD Ultimate Strength (lbs/ft)	32038	31510	32182	31636	29851	**31443**	932	28,000
MD Ultimate Strength (kN/m)	467.8	460.0	469.9	461.9	435.8	**459.1**	13.6	
MD Strength @ 2% Strain (lbs)	3519	3596	3618	3621	3656	**3602**	51	
MD Strength @ 2% Strain (lbs/ft)	5322	5439	5471	5477	5529	**5448**	77	
MD Strength @ 2% Strain (kN/m)	77.7	79.4	79.9	80.0	80.7	**79.5**	1.1	
MD Strength @ 5% Strain (lbs)	5500	5596	5592	5608	5707	**5601**	73	
MD Strength @ 5% Strain (lbs/ft)	8319	8464	8458	8482	8632	**8471**	111	
MD Strength @ 5% Strain (kN/m)	121.5	123.6	123.5	123.8	126.0	**123.7**	1.6	
MD Strength @ 10% Strain (lbs)	11763	12043	12311	12107	12477	**12140**	272	
MD Strength @ 10% Strain (lbs/ft)	17792	18214	18621	18312	18871	**18362**	411	
MD Strength @ 10% Strain (kN/m)	259.8	265.9	271.9	267.4	275.5	**268.1**	6.0	
MD Break Elongation (%)	16.2	15.1	15.5	15.3	15.6	**15.5**	0.4	

MD - Machine Direction TD - Transverse/Cross Machine Direction NP - Not Provided

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

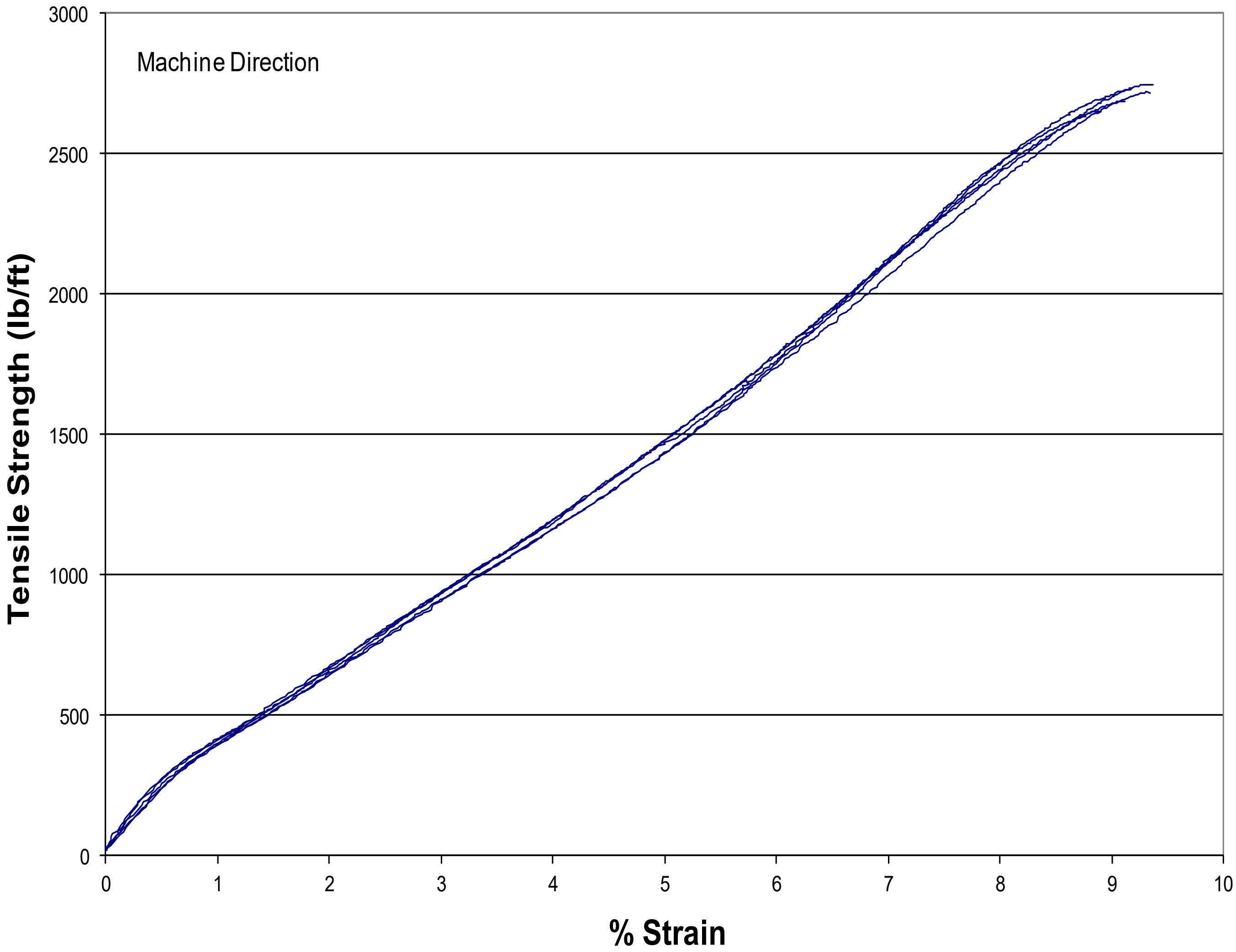

Figure C-1. Geogrid tensile test load-strain curve for 2XT

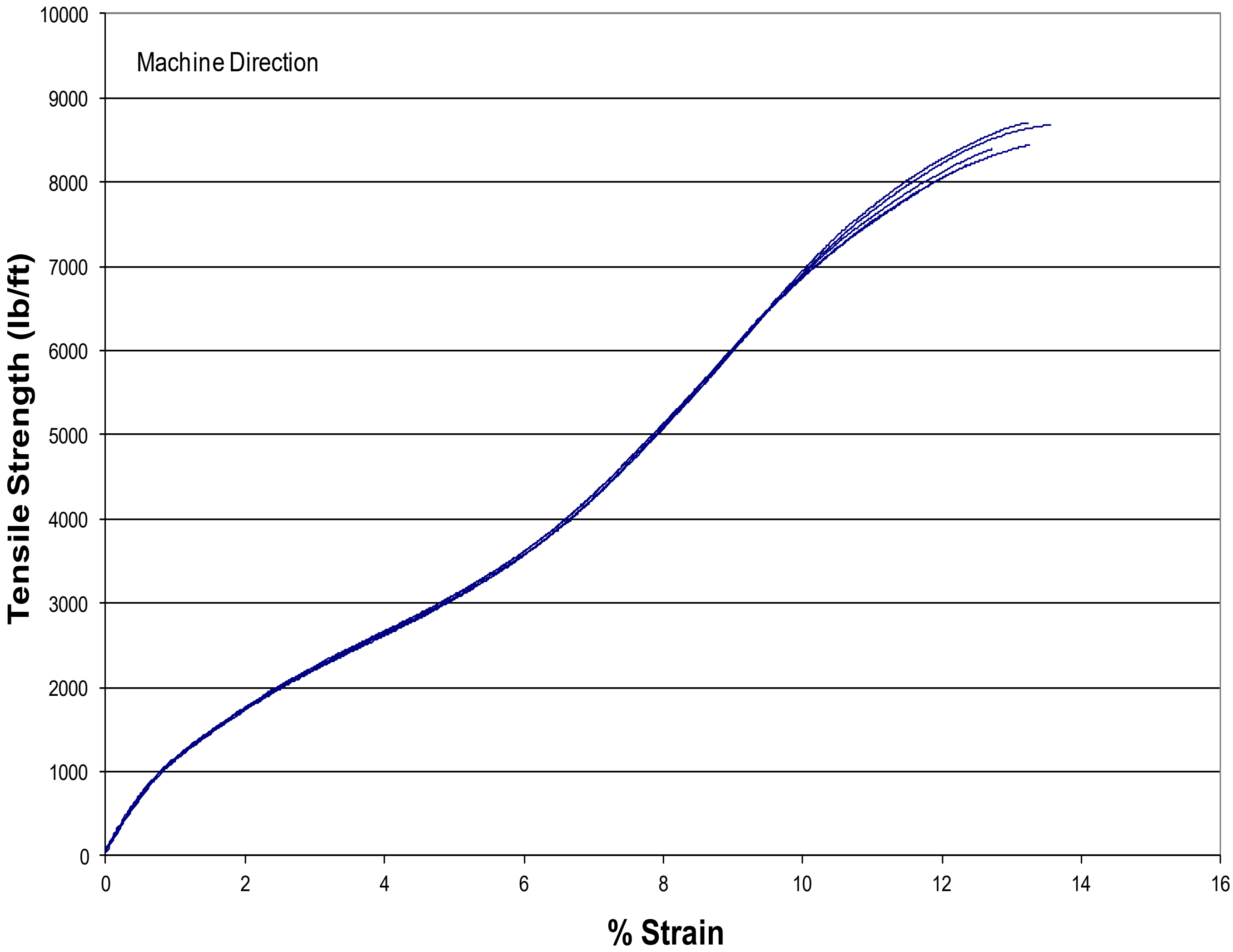

Figure C-2. Geogrid tensile test load-strain curve for 8XT

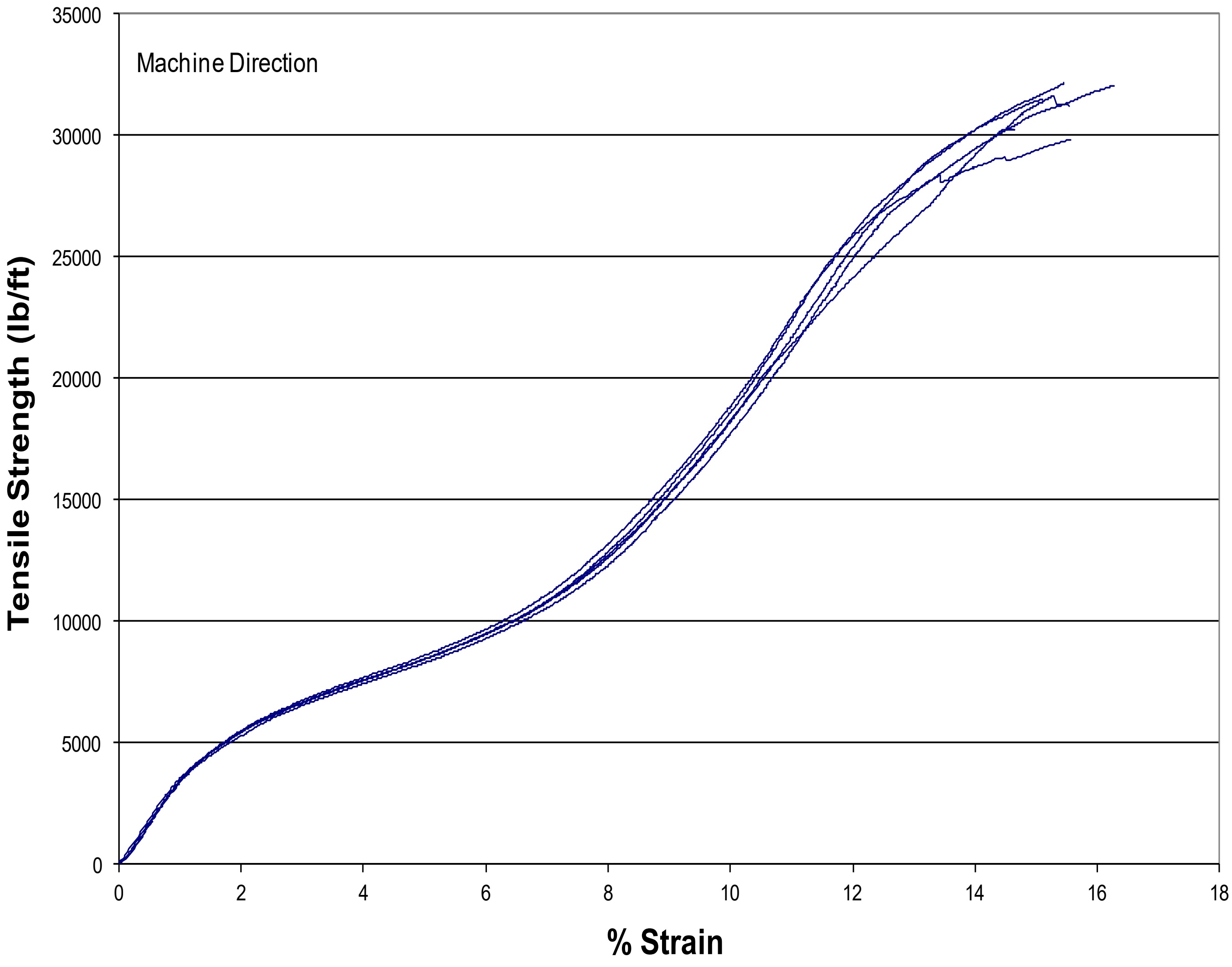

Figure C-3. Geogrid tensile test load-strain curve for 24XT

Appendix D: Installation Damage Detailed Test Results

Table D-1. Installation damage wide width tensile test results for TenCate Miragrid 2XT geogrid, soil gradation 1.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT Baseline	1	10.80	7	1771	2733	39.9	9.17	440	680	9.92	956	1474	21.5			
	2	10.80	7	1743	2689	39.3	9.06	433	667	9.74	963	1486	21.7			
	3	10.80	7	1721	2655	38.8	8.88	436	672	9.82	963	1486	21.7			
	4	10.80	7	1764	2722	39.7	9.28	425	656	9.58	935	1443	21.1			
	5	10.80	7	1782	2749	40.1	9.33	422	651	9.51	933	1440	21.0			
Average				1756	2710	39.6	9.14	431	665	9.71	950	1466	21.4			
Standard Deviation				24.4	37.6	0.55	0.18	7.5	11.6	0.17	14.7	22.7	0.33			
% COV				1.39	1.39	1.39	1.98	1.75	1.75	1.75	1.55	1.55	1.55			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT installed in Gradation 1 (Coarse Gravel)	1	10.80	7	721	1112	16.2	3.99	395	609	8.90						
	2	10.80	7	718	1108	16.2	6.08	321	495	7.23	601	927	13.5			
	3	10.80	7	825	1273	18.6	5.00	363	560	8.18	825	1273	18.6			
	4	10.80	7	717	1106	16.2	5.78	361	557	8.13	628	969	14.1			
	5	10.80	7	800	1234	18.0	6.17	376	580	8.47	699	1078	15.7			
	6	10.80	7	991	1529	22.3	6.43	378	583	8.51	758	1169	17.1			
	7	10.80	7	914	1410	20.6	4.82	424	654	9.55						
	8	10.80	7	993	1532	22.4	5.36	422	651	9.51	917	1415	20.7			
	9	10.80	7	1021	1575	23.0	5.47	399	616	8.99	911	1406	20.5			
	10	10.80	7	1021	1575	23.0	6.61	404	623	9.10	944	1456	21.3			
Average				872	1346	19.6	5.57	384	593	8.66	785	1212	17.7			
Standard Deviation				130.3	201	2.94	0.81	31.32	48.32	0.71	134.6	207.7	3.03			
% COV				14.95	14.95	14.95	14.56	8.15	8.15	8.15	17.14	17.14	17.14			

Percent Retained			49.7	49.7	49.7	60.9	89.1	89.1	89.1	82.7	82.7	82.7			
RFid			**2.01**	**2.01**	**2.01**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-2. Installation damage wide width tensile test results for TenCate Miragrid 2XT geogrid, 57 stone.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT Baseline	1	10.80	7	1771	2733	39.9	9.17	440	680	9.92	956	1474	21.5			
	2	10.80	7	1743	2689	39.3	9.06	433	667	9.74	963	1486	21.7			
	3	10.80	7	1721	2655	38.8	8.88	436	672	9.82	963	1486	21.7			
	4	10.80	7	1764	2722	39.7	9.28	425	656	9.58	935	1443	21.1			
	5	10.80	7	1782	2749	40.1	9.33	422	651	9.51	933	1440	21.0			
Average				1756	2710	39.6	9.14	431	665	9.71	950	1466	21.4			
Standard Deviation				24.4	37.6	0.55	0.18	7.5	11.6	0.17	14.7	22.7	0.33			
% COV				1.39	1.39	1.39	1.98	1.75	1.75	1.75	1.55	1.55	1.55			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT installed in 57 Stone	1	10.80	7	1268	1956	28.6	6.82	400	617	9.01	887	1369	20.0			
	2	10.80	7	1386	2138	31.2	7.80	388	599	8.74	862	1330	19.4			
	3	10.80	7	1391	2146	31.3	8.10	390	602	8.79	851	1313	19.2			
	4	10.80	7	1049	1618	23.6	6.73	394	608	8.88	874	1348	19.7			
	5	10.80	7	1295	1998	29.2	7.50	392	605	8.83	867	1338	19.5			
	6	10.80	7	1384	2135	31.2	7.47	387	597	8.72	882	1361	19.9			
	7	10.80	7	1068	1648	24.1	6.24	377	582	8.49	852	1315	19.2			
	8	10.80	7	1120	1728	25.2	6.68	384	592	8.65	845	1304	19.0			
	9	10.80	7	918	1416	20.7	6.55	360	555	8.11	784	1210	17.7			
	10	10.80	7	1182	1824	26.6	8.08	385	594	8.67	879	1356	19.8			
Average				1206	1861	27.2	7.20	386	595	8.69	858	1324	19.3			
Standard Deviation				164.9	254	3.71	0.67	10.94	16.89	0.25	29.7	45.8	0.67			
% COV				13.67	13.67	13.67	9.36	2.84	2.84	2.84	3.46	3.46	3.46			

Percent Retained			68.7	68.7	68.7	78.7	89.4	89.4	89.4	90.3	90.3	90.3			
RFid			**1.46**	**1.46**	**1.46**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-3. Installation damage wide width tensile test results for TenCate Miragrid 2XT geogrid, soil gradation 2.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT Baseline	1	10.80	7	1771	2733	39.9	9.17	440	680	9.92	956	1474	21.5			
	2	10.80	7	1743	2689	39.3	9.06	433	667	9.74	963	1486	21.7			
	3	10.80	7	1721	2655	38.8	8.88	436	672	9.82	963	1486	21.7			
	4	10.80	7	1764	2722	39.7	9.28	425	656	9.58	935	1443	21.1			
	5	10.80	7	1782	2749	40.1	9.33	422	651	9.51	933	1440	21.0			
Average				1756	2710	39.6	9.14	431	665	9.71	950	1466	21.4			
Standard Deviation				24.4	37.6	0.55	0.18	7.5	11.6	0.17	14.7	22.7	0.33			
% COV				1.39	1.39	1.39	1.98	1.75	1.75	1.75	1.55	1.55	1.55			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT installed in Gradation 2 (Sandy Gravel)	1	10.80	7	1651	2547	37.2	8.57	419	646	9.44	931	1436	21.0			
	2	10.80	7	1692	2611	38.1	9.05	412	636	9.28	917	1415	20.7			
	3	10.80	7	1639	2529	36.9	8.77	391	603	8.81	901	1390	20.3			
	4	10.80	7	1672	2580	37.7	8.76	414	639	9.33	911	1406	20.5			
	5	10.80	7	1674	2583	37.7	8.86	401	619	9.03	919	1418	20.7			
	6	10.80	7	1659	2560	37.4	8.76	374	577	8.42	885	1365	19.9			
	7	10.80	7	1695	2615	38.2	9.04	396	611	8.92	899	1387	20.3			
	8	10.80	7	1654	2552	37.3	8.35	416	642	9.37	908	1401	20.5			
	9	10.80	7	1674	2583	37.7	8.79	407	628	9.17	904	1395	20.4			
	10	10.80	7	1698	2620	38.2	9.33	407	628	9.17	926	1429	20.9			
Average				1671	2578	37.6	8.83	404	623	9.09	910	1404	20.5			
Standard Deviation				20.1	31	0.45	0.27	13.71	21.16	0.31	13.7	21.2	0.31			
% COV				1.20	1.20	1.20	3.06	3.40	3.40	3.40	1.51	1.51	1.51			

Percent Retained			95.1	95.1	95.1	96.5	93.6	93.6	93.6	95.8	95.8	95.8			
RFid			**1.05**	**1.05**	**1.05**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-4. Installation damage wide width tensile test results for TenCate Miragrid 2XT geogrid, soil gradation 3.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT Baseline	1	10.80	7	1771	2733	39.9	9.2	440	680	9.92	956	1474	21.5			
	2	10.80	7	1743	2689	39.3	9.1	433	667	9.74	963	1486	21.7			
	3	10.80	7	1721	2655	38.8	8.9	436	672	9.82	963	1486	21.7			
	4	10.80	7	1764	2722	39.7	9.3	425	656	9.58	935	1443	21.1			
	5	10.80	7	1782	2749	40.1	9.3	422	651	9.51	933	1440	21.0			
Average				1756	2710	39.6	9.1	431	665	9.71	950	1466	21.4			
Standard Deviation				24.4	37.6	0.55	0.18	7.5	11.6	0.17	14.7	22.7	0.33			
% COV				1.39	1.39	1.39	1.98	1.75	1.75	1.75	1.55	1.55	1.55			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
2XT installed in Gradation 3 (Sand)	1	10.80	7	1607	2479	36.2	8.59	384	592	8.65	873	1347	19.7			
	2	10.80	7	1577	2433	35.5	8.49	372	574	8.38	875	1350	19.7			
	3	10.80	7	1601	2470	36.1	8.52	387	597	8.72	890	1373	20.0			
	4	10.80	7	1629	2513	36.7	8.89	362	559	8.15	856	1321	19.3			
	5	10.80	7	1445	2229	32.5	8.04	335	517	7.55	829	1279	18.7			
	6	10.80	7	1681	2594	37.9	8.96	386	596	8.69	884	1364	19.9			
	7	10.80	7	1653	2550	37.2	8.74	396	611	8.92	904	1395	20.4			
	8	10.80	7	1633	2519	36.8	8.60	401	619	9.03	908	1401	20.5			
	9	10.80	7	1698	2620	38.2	9.11	395	609	8.90	899	1387	20.3			
	10	10.80	7	1640	2530	36.9	8.60	409	631	9.21	914	1410	20.6			
Average				1616	2494	36.4	8.65	383	590	8.62	883	1363	19.9			
Standard Deviation				70.3	108	1.58	0.30	21.61	33.35	0.49	26.1	40.3	0.59			
% COV				4.35	4.35	4.35	3.44	5.65	5.65	5.65	2.96	2.96	2.96			

Percent Retained				92.0	92.0	92.0	94.6	88.7	88.7	88.7	93.0	93.0	93.0			
RFid				**1.09**	**1.09**	**1.09**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-5. Installation damage wide width tensile test results for TenCate Miragrid 3XT geogrid, soil gradation 1.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT Baseline	1	10.75	7	2457	3773	55.1	8.91	585	898	13.12	1185	1820	26.6			
	2	10.75	7	2428	3729	54.4	8.91	582	894	13.05	1182	1815	26.5			
	3	10.75	7	2475	3801	55.5	9.07	570	875	12.78	1163	1786	26.1			
	4	10.75	7	2520	3870	56.5	9.29	592	909	13.27	1180	1812	26.5			
	5	10.75	7	2475	3801	55.5	8.98	597	917	13.39	1204	1849	27.0			
Average				2471	3795	55.4	9.03	585	899	13.12	1183	1816	26.5			
Standard Deviation				33.5	51.4	0.75	0.16	10.3	15.9	0.23	14.6	22.4	0.33			
% COV				1.35	1.35	1.35	1.75	1.77	1.77	1.77	1.24	1.24	1.24			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT installed in Gradation 1 (Coarse Gravel)	1	10.75	7	1847	2836	41.4	7.39	558	857	12.51	1154	1772	25.9			
	2	10.75	7	2180	3348	48.9	8.26	533	819	11.95	1140	1751	25.6			
	3	10.75	7	2129	3270	47.7	8.11	559	858	12.53	1158	1778	26.0			
	4	10.75	7	2002	3075	44.9	7.95	557	855	12.49	1153	1771	25.9			
	5	10.75	7	2032	3121	45.6	7.92	560	860	12.56	1176	1806	26.4			
	6	10.75	7	1692	2598	37.9	7.84	559	858	12.53	1144	1757	25.7			
	7	10.75	7	1720	2641	38.6	7.11	547	840	12.26	1148	1763	25.7			
	8	10.75	7	1914	2939	42.9	7.89	573	880	12.85	1177	1808	26.4			
	9	10.75	7	1944	2985	43.6	7.63	569	874	12.76	1172	1800	26.3			
	10	10.75	7	1845	2833	41.4	7.93	542	832	12.15	1125	1728	25.2			
Average				1931	2965	43.3	7.80	556	853	12.46	1155	1773	25.9			
Standard Deviation				160.9	247	3.61	0.34	12.03	18.47	0.27	16.7	25.7	0.38			
% COV				8.33	8.33	8.33	4.37	2.16	2.16	2.16	1.45	1.45	1.45			

Percent Retained				78.1	78.1	78.1	86.4	95.0	95.0	95.0	97.6	97.6	97.6			
RFid				**1.28**	**1.28**	**1.28**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-6. Installation damage wide width tensile test results for TenCate Miragrid 3XT geogrid, 57 stone.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT Baseline	1	10.75	7	2457	3773	55.1	8.91	585	898	13.12	1185	1820	26.6			
	2	10.75	7	2428	3729	54.4	8.91	582	894	13.05	1182	1815	26.5			
	3	10.75	7	2475	3801	55.5	9.07	570	875	12.78	1163	1786	26.1			
	4	10.75	7	2520	3870	56.5	9.29	592	909	13.27	1180	1812	26.5			
	5	10.75	7	2475	3801	55.5	8.98	597	917	13.39	1204	1849	27.0			
Average				2471	3795	55.4	9.03	585	899	13.12	1183	1816	26.5			
Standard Deviation				33.5	51.4	0.75	0.16	10.3	15.9	0.23	14.6	22.4	0.33			
% COV				1.35	1.35	1.35	1.75	1.77	1.77	1.77	1.24	1.24	1.24			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT installed in 57 Stone	1	10.75	7	1580	2426	35.4	7.60	538	826	12.06	1132	1738	25.4			
	2	10.75	7	1592	2445	35.7	6.69	559	858	12.53	1177	1808	26.4			
	3	10.75	7	2050	3148	46.0	8.29	540	829	12.11	1136	1745	25.5			
	4	10.75	7	1574	2417	35.3	7.42	552	848	12.38	1144	1757	25.7			
	5	10.75	7	1593	2446	35.7	6.77	547	840	12.26	1159	1780	26.0			
	6	10.75	7	2088	3207	46.8	8.25	555	852	12.44	1150	1766	25.8			
	7	10.75	7	2298	3529	51.5	9.01	559	858	12.53	1162	1785	26.1			
	8	10.75	7	2150	3302	48.2	8.38	561	862	12.58	1176	1806	26.4			
	9	10.75	7	1869	2870	41.9	8.59	566	869	12.69	1177	1808	26.4			
	10	10.75	7	1722	2645	38.6	7.90	553	849	12.40	1000	1536	22.4			
Average				1852	2844	41.5	7.89	553	849	12.40	1141	1753	25.6			
Standard Deviation				276.0	424	6.19	0.77	9.07	13.93	0.20	52.3	80.4	1.17			
% COV				14.91	14.91	14.91	9.70	1.64	1.64	1.64	4.59	4.59	4.59			

Percent Retained				74.9	74.9	74.9	87.4	94.5	94.5	94.5	96.5	96.5	96.5			
RFid				**1.33**	**1.33**	**1.33**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-7. Installation damage wide width tensile test results for TenCate Miragrid 3XT geogrid, soil gradation 2.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT Baseline	1	10.75	7	2457	3773	55.1	8.91	585	898	13.12	1185	1820	26.6			
	2	10.75	7	2428	3729	54.4	8.91	582	894	13.05	1182	1815	26.5			
	3	10.75	7	2475	3801	55.5	9.07	570	875	12.78	1163	1786	26.1			
	4	10.75	7	2520	3870	56.5	9.29	592	909	13.27	1180	1812	26.5			
	5	10.75	7	2475	3801	55.5	8.98	597	917	13.39	1204	1849	27.0			
Average				2471	3795	55.4	9.03	585	899	13.12	1183	1816	26.5			
Standard Deviation				33.5	51.4	0.75	0.16	10.3	15.9	0.23	14.6	22.4	0.33			
% COV				1.35	1.35	1.35	1.75	1.77	1.77	1.77	1.24	1.24	1.24			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT installed in Gradation 2 (Sandy Gravel)	1	10.75	7	2380	3655	53.4	8.53	584	897	13.09	1207	1854	27.1			
	2	10.75	7	2460	3778	55.2	8.92	584	897	13.09	1195	1835	26.8			
	3	10.75	7	2447	3758	54.9	8.71	593	911	13.30	1225	1881	27.5			
	4	10.75	7	2455	3770	55.0	8.89	575	883	12.89	1191	1829	26.7			
	5	10.75	7	2488	3821	55.8	9.03	584	897	13.09	1187	1823	26.6			
	6	10.75	7	2441	3749	54.7	8.82	576	885	12.91	1207	1854	27.1			
	7	10.75	7	2331	3580	52.3	8.64	571	877	12.80	1176	1806	26.4			
	8	10.75	7	2460	3778	55.2	8.95	575	883	12.89	1201	1844	26.9			
	9	10.75	7	2422	3720	54.3	8.87	563	865	12.62	1180	1812	26.5			
	10	10.75	7	2467	3789	55.3	9.02	578	888	12.96	1192	1831	26.7			
Average				2435	3740	54.6	8.84	578	888	12.97	1196	1837	26.8			
Standard Deviation				46.8	72	1.05	0.16	8.35	12.83	0.19	14.5	22.2	0.32			
% COV				1.92	1.92	1.92	1.86	1.44	1.44	1.44	1.21	1.21	1.21			

Percent Retained				98.5	98.5	98.5	97.9	98.8	98.8	98.8	101.1	101.1	101.1			
RFid				**1.01**	**1.01**	**1.01**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-8. Installation damage wide width tensile test results for TenCate Miragrid 3XT geogrid, soil gradation 3.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT Baseline	1	10.75	7	2457	3773	55.1	8.91	585	898	13.12	1185	1820	26.6			
	2	10.75	7	2428	3729	54.4	8.91	582	894	13.05	1182	1815	26.5			
	3	10.75	7	2475	3801	55.5	9.07	570	875	12.78	1163	1786	26.1			
	4	10.75	7	2520	3870	56.5	9.29	592	909	13.27	1180	1812	26.5			
	5	10.75	7	2475	3801	55.5	8.98	597	917	13.39	1204	1849	27.0			
Average				2471	3795	55.4	9.03	585	899	13.12	1183	1816	26.5			
Standard Deviation				33.5	51.4	0.75	0.16	10.3	15.9	0.23	14.6	22.4	0.33			
% COV				1.35	1.35	1.35	1.75	1.77	1.77	1.77	1.24	1.24	1.24			

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
3XT installed in Gradation 3 (Sand)	1	10.75	7	2417	3712	54.2	8.83	572	878	12.83	1174	1803	26.3			
	2	10.75	7	2360	3624	52.9	8.66	568	872	12.74	1185	1820	26.6			
	3	10.75	7	2393	3675	53.7	8.59	611	938	13.70	1221	1875	27.4			
	4	10.75	7	2394	3677	53.7	8.71	580	891	13.00	1187	1823	26.6			
	5	10.75	7	2398	3683	53.8	8.86	545	837	12.22	1185	1820	26.6			
	6	10.75	7	2327	3574	52.2	8.94	561	862	12.58	1149	1765	25.8			
	7	10.75	7	2419	3715	54.2	8.75	570	875	12.78	1180	1812	26.5			
	8	10.75	7	2461	3779	55.2	9.06	570	875	12.78	1182	1815	26.5			
	9	10.75	7	2380	3655	53.4	8.66	568	872	12.74	1174	1803	26.3			
	10	10.75	7	2416	3710	54.2	9.12	572	878	12.83	1168	1794	26.2			
Average				2397	3680	53.7	8.82	572	878	12.82	1181	1813	26.5			
Standard Deviation				36.4	56	0.82	0.18	16.58	25.46	0.37	18.1	27.8	0.41			
% COV				1.52	1.52	1.52	2.02	2.90	2.90	2.90	1.54	1.54	1.54			

Percent Retained			97.0	97.0	97.0	97.6	97.7	97.7	97.7	99.8	99.8	99.8			
RFid			**1.03**	**1.03**	**1.03**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-9. Installation damage wide width tensile test results for TenCate Miragrid 7XT geogrid, soil gradation 1.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT Baseline	1	10.68	7	4405	6721	98.1	10.2	991	1512	22.07	2006	3061	44.7	4371	6669	97.4
	2	10.68	7	4273	6519	95.2	10.2	970	1480	21.61	1973	3010	43.9	4239	6468	94.4
	3	10.68	7	4286	6539	95.5	10.1	954	1456	21.25	1933	2949	43.1	4271	6516	95.1
	4	10.68	7	4348	6634	96.9	9.96	974	1486	21.70	1969	3004	43.9			
	5	10.68	7	4249	6483	94.6	9.62	969	1478	21.58	1983	3025	44.2			
Average				4312	6579	96.1	10.0	972	1482	21.64	1973	3010	43.9	4294	6551	95.6
Standard Deviation				63.5	96.8	1.41	0.24	13.2	20.2	0.29	26.5	40.4	0.59	68.9	105	1.53
% COV				1.47	1.47	1.47	2.42	1.36	1.36	1.36	1.34	1.34	1.34	1.60	1.60	1.60

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT installed in Gradation 1 (Coarse Gravel)	1	10.68	7	2515	3837	56.0	6.47	909	1387	20.25	1912	2917	42.6			
	2	10.68	7	2882	4397	64.2	7.29	931	1420	20.74	1931	2946	43.0			
	3	10.68	7	2668	4071	59.4	6.76	887	1353	19.76	1898	2896	42.3			
	4	10.68	7	3111	4746	69.3	7.54	972	1483	21.65	1961	2992	43.7			
	5	10.68	7	3024	4614	67.4	8.34	924	1410	20.58	1883	2873	41.9			
	6	10.68	7	2410	3677	53.7	7.29	851	1298	18.96	1809	2760	40.3			
	7	10.68	7	2788	4254	62.1	7.79	936	1428	20.85	1962	2993	43.7			
	8	10.68	7	2879	4393	64.1	7.30	868	1324	19.34	1871	2855	41.7			
	9	10.68	7	2636	4022	58.7	6.66	928	1416	20.67	1907	2910	42.5			
	10	10.68	7	2859	4362	63.7	7.10	944	1440	21.03	1895	2891	42.2			
Average				2777	4237	61.9	7.25	915	1396	20.38	1903	2903	42.4			
Standard Deviation				220.1	336	4.90	0.56	36.76	56.09	0.82	44.8	68.4	1.00			
% COV				7.92	7.92	7.92	7.67	4.02	4.02	4.02	2.36	2.36	2.36			

Percent Retained				64.4	64.4	64.4	72.4	94.2	94.2	94.2	96.5	96.5	96.5			
RFid				**1.55**	**1.55**	**1.55**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-10. Installation damage wide width tensile test results for TenCate Miragrid 7XT geogrid, 57 stone.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT Baseline	1	10.68	7	4405	6721	98.1	10.2	991	1512	22.07	2006	3061	44.7	4371	6669	97.4
	2	10.68	7	4273	6519	95.2	10.2	970	1480	21.61	1973	3010	43.9	4239	6468	94.4
	3	10.68	7	4286	6539	95.5	10.1	954	1456	21.25	1933	2949	43.1	4271	6516	95.1
	4	10.68	7	4348	6634	96.9	10.0	974	1486	21.70	1969	3004	43.9			
	5	10.68	7	4249	6483	94.6	9.6	969	1478	21.58	1983	3025	44.2			
Average				4312	6579	96.1	10.0	972	1482	21.64	1973	3010	43.9	4294	6551	95.6
Standard Deviation				63.5	96.8	1.41	0.24	13.2	20.2	0.29	26.5	40.4	0.59	68.9	105	1.53
% COV				1.47	1.47	1.47	2.42	1.36	1.36	1.36	1.34	1.34	1.34	1.60	1.60	1.60

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT installed in 57 Stone	1	10.68	7	3224	4919	71.8	9.72	868	1324	19.34	1487	2269	33.1			
	2	10.68	7	3372	5145	75.1	9.47	903	1378	20.11	1547	2360	34.5			
	3	10.68	7	3280	5004	73.1	9.49	906	1382	20.18	1534	2340	34.2			
	4	10.68	7	2717	4145	60.5	9.19	865	1320	19.27	1476	2252	32.9			
	5	10.68	7	3092	4718	68.9	9.25	854	1303	19.02	1460	2228	32.5			
	6	10.68	7	3191	4869	71.1	9.49	876	1337	19.51	1483	2263	33.0			
	7	10.68	7	2885	4402	64.3	9.36	861	1314	19.18	1474	2249	32.8			
	8	10.68	7	2470	3769	55.0	7.80	868	1324	19.34	1486	2267	33.1			
	9	10.68	7	2898	4422	64.6	9.14	846	1291	18.85	1478	2255	32.9			
	10	10.68	7	3382	5160	75.3	9.61	857	1308	19.09	1496	2282	33.3			
Average				3051	4655	68.0	9.25	870	1328	19.39	1492	2277	33.2			
Standard Deviation				301.2	460	6.71	0.54	19.82	30.23	0.44	27.4	41.8	0.61			
% COV				9.87	9.87	9.87	5.86	2.28	2.28	2.28	1.83	1.83	1.83			

Percent Retained			70.8	70.8	70.8	92.4	89.6	89.6	89.6	75.6	75.6	75.6			
RFid			**1.41**	**1.41**	**1.41**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-11. Installation damage wide width tensile test results for TenCate Miragrid 7XT geogrid, soil gradation 2.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT Baseline	1	10.68	7	4405	6721	98.1	10.2	991	1512	22.07	2006	3061	44.7	4371	6669	97.4
	2	10.68	7	4273	6519	95.2	10.2	970	1480	21.61	1973	3010	43.9	4239	6468	94.4
	3	10.68	7	4286	6539	95.5	10.1	954	1456	21.25	1933	2949	43.1	4271	6516	95.1
	4	10.68	7	4348	6634	96.9	10.0	974	1486	21.70	1969	3004	43.9			
	5	10.68	7	4249	6483	94.6	9.6	969	1478	21.58	1983	3025	44.2			
Average				4312	6579	96.1	10.0	972	1482	21.64	1973	3010	43.9	4294	6551	95.6
Standard Deviation				63.5	96.8	1.41	0.24	13.2	20.2	0.29	26.5	40.4	0.59	68.9	105	1.53
% COV				1.47	1.47	1.47	2.42	1.36	1.36	1.36	1.34	1.34	1.34	1.60	1.60	1.60

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT installed in Gradation 2 (Sandy Gravel)	1	10.68	7	3966	6051	88.3	8.96	960	1465	21.38	1952	2978	43.5			
	2	10.68	7	3967	6053	88.4	9.17	965	1472	21.50	1939	2958	43.2			
	3	10.68	7	3950	6027	88.0	8.94	981	1497	21.85	1983	3025	44.2			
	4	10.68	7	3895	5943	86.8	8.82	976	1489	21.74	1935	2952	43.1			
	5	10.68	7	3581	5464	79.8	7.96	990	1510	22.05	2003	3056	44.6			
	6	10.68	7	3990	6088	88.9	9.10	974	1486	21.70	1952	2978	43.5			
	7	10.68	7	3861	5891	86.0	8.71	973	1485	21.67	1974	3012	44.0			
	8	10.68	7	4072	6213	90.7	9.33	960	1465	21.38	1937	2955	43.1			
	9	10.68	7	4043	6168	90.1	9.22	947	1445	21.09	1936	2954	43.1			
	10	10.68	7	3877	5915	86.4	9.27	949	1448	21.14	1928	2942	42.9			
Average				3920	5981	87.3	8.95	968	1476	21.55	1954	2981	43.5			
Standard Deviation				137.1	209	3.05	0.40	13.80	21.06	0.31	24.8	37.8	0.55			
% COV				3.50	3.50	3.50	4.48	1.43	1.43	1.43	1.27	1.27	1.27			

Percent Retained			90.9	90.9	90.9	89.3	99.6	99.6	99.6	99.0	99.0	99.0			
RFid			**1.10**	**1.10**	**1.10**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-12. Installation damage wide width tensile test results for TenCate Miragrid 7XT geogrid, soil gradation 3.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT Baseline	1	10.68	7	4405	6721	98.1	10.2	991	1512	22.07	2006	3061	44.7	4371	6669	97.4
	2	10.68	7	4273	6519	95.2	10.2	970	1480	21.61	1973	3010	43.9	4239	6468	94.4
	3	10.68	7	4286	6539	95.5	10.1	954	1456	21.25	1933	2949	43.1	4271	6516	95.1
	4	10.68	7	4348	6634	96.9	10.0	974	1486	21.70	1969	3004	43.9			
	5	10.68	7	4249	6483	94.6	9.6	969	1478	21.58	1983	3025	44.2			
Average				4312	6579	96.1	10.0	972	1482	21.64	1973	3010	43.9	4294	6551	95.6
Standard Deviation				63.5	96.8	1.41	0.24	13.2	20.2	0.29	26.5	40.4	0.59	68.9	105	1.53
% COV				1.47	1.47	1.47	2.42	1.36	1.36	1.36	1.34	1.34	1.34	1.60	1.60	1.60

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
7XT installed in Gradation 3 (Sand)	1	10.68	7	4051	6181	90.2	9.45	955	1457	21.27	1935	2952	43.1			
	2	10.68	7	4217	6434	93.9	9.90	965	1472	21.50	1943	2964	43.3			
	3	10.68	7	4027	6144	89.7	9.00	990	1510	22.05	2001	3053	44.6			
	4	10.68	7	4022	6136	89.6	9.22	987	1506	21.99	1979	3019	44.1			
	5	10.68	7	3779	5766	84.2	8.63	941	1436	20.96	1924	2935	42.9			
	6	10.68	7	3684	5621	82.1	8.45	972	1483	21.65	1957	2986	43.6			
	7	10.68	7	4104	6262	91.4	9.48	954	1456	21.25	1912	2917	42.6			
	8	10.68	7	4033	6153	89.8	9.28	954	1456	21.25	1935	2952	43.1			
	9	10.68	7	4042	6167	90.0	9.36	924	1410	20.58	1897	2894	42.3			
	10	10.68	7	4163	6352	92.7	9.83	960	1465	21.38	1927	2940	42.9			
Average				4012	6121	89.4	9.26	960	1465	21.39	1941	2961	43.2			
Standard Deviation				162.7	248	3.63	0.47	19.87	30.31	0.44	31.0	47.3	0.69			
% COV				4.06	4.06	4.06	5.03	2.07	2.07	2.07	1.60	1.60	1.60			

Percent Retained			93.0	93.0	93.0	92.5	98.8	98.8	98.8	98.4	98.4	98.4			
RFid			**1.07**	**1.07**	**1.07**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-13. Installation damage wide width tensile test results for TenCate Miragrid 8XT geogrid, soil gradation 1.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT Baseline	1	10.91	7	5584	8703	127.1	13.2	1119	1744	25.47	1964	3061	44.7	4472	6970	101.8
	2	10.91	7	5564	8672	126.6	13.5	1123	1750	25.54	1971	3072	44.8	4436	6915	101.0
	3	10.91	7	5389	8399	122.6	12.7	1132	1765	25.76	1987	3097	45.2	4429	6902	100.8
	4	10.91	7	5274	8220	120.0	12.4	1135	1769	25.83	1993	3106	45.3	4408	6869	100.3
	5	10.91	7	5418	8444	123.3	13.3	1129	1760	25.69	1965	3062	44.7	4417	6884	100.5
Average				5446	8488	123.9	13.0	1128	1758	25.66	1976	3079	45.0	4432	6908	100.9
Standard Deviation				129.1	201.1	2.94	0.45	6.6	10.3	0.15	13.3	20.8	0.30	24.8	39	0.56
% COV				2.37	2.37	2.37	3.46	0.59	0.59	0.59	0.68	0.68	0.68	0.56	0.56	0.56

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT installed in Gradation 1 (Coarse Gravel)	1	10.91	7	3136	4888	71.4	7.97	1114	1736	25.35	1957	3050	44.5			
	2	10.91	7	3343	5210	76.1	8.10	1108	1727	25.21	1937	3019	44.1			
	3	10.91	7	3326	5184	75.7	7.89	1138	1774	25.90	1991	3103	45.3			
	4	10.91	7	3431	5347	78.1	8.21	1090	1699	24.80	1934	3014	44.0			
	5	10.91	7	3759	5859	85.5	8.73	1094	1705	24.89	1924	2999	43.8			
	6	10.91	7	3794	5913	86.3	8.58	1110	1730	25.26	1984	3092	45.1			
	7	10.91	7	4113	6410	93.6	9.15	1091	1700	24.83	1945	3031	44.3			
	8	10.91	7	3943	6145	89.7	9.70	1076	1677	24.48	1922	2996	43.7			
	9	10.91	7	3692	5754	84.0	9.75	1067	1663	24.28	1909	2975	43.4			
	10	10.91	7	3844	5991	87.5	8.80	1108	1727	25.21	1940	3024	44.1			
Average				3638	5670	82.8	8.69	1100	1714	25.02	1944	3030	44.2			
Standard Deviation				313.1	488	7.12	0.68	20.41	31.81	0.46	26.4	41.1	0.60			
% COV				8.61	8.61	8.61	7.79	1.86	1.86	1.86	1.36	1.36	1.36			

Percent Retained				66.8	66.8	66.8	66.7	97.5	97.5	97.5	98.4	98.4	98.4			
RFid				**1.50**	**1.50**	**1.50**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-14. Installation damage wide width tensile test results for TenCate Miragrid 8XT geogrid, 57 stone.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT Baseline	1	10.91	7	5584	8703	127.1	13.2	1119	1744	25.47	1964	3061	44.7	4472	6970	101.8
	2	10.91	7	5564	8672	126.6	13.5	1123	1750	25.54	1971	3072	44.8	4436	6915	101.0
	3	10.91	7	5389	8399	122.6	12.7	1132	1765	25.76	1987	3097	45.2	4429	6902	100.8
	4	10.91	7	5274	8220	120.0	12.4	1135	1769	25.83	1993	3106	45.3	4408	6869	100.3
	5	10.91	7	5418	8444	123.3	13.3	1129	1760	25.69	1965	3062	44.7	4417	6884	100.5
Average				5446	8488	123.9	13.0	1128	1758	25.66	1976	3079	45.0	4432	6908	100.9
Standard Deviation				129.1	201.1	2.94	0.45	6.6	10.3	0.15	13.3	20.8	0.30	24.8	39	0.56
% COV				2.37	2.37	2.37	3.46	0.59	0.59	0.59	0.68	0.68	0.68	0.56	0.56	0.56

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT installed in 57 Stone	1	10.91	7	4205	6554	95.7	9.92	969	1510	22.05	1763	2748	40.1			
	2	10.91	7	3759	5859	85.5	9.06	985	1535	22.41	1788	2787	40.7			
	3	10.91	7	4163	6488	94.7	9.65	993	1548	22.60	1812	2824	41.2			
	4	10.91	7	4226	6587	96.2	9.59	1009	1573	22.96	1853	2888	42.2			
	5	10.91	7	3978	6200	90.5	10.53	988	1540	22.48	1772	2762	40.3			
	6	10.91	7	4075	6351	92.7	9.62	981	1529	22.32	1761	2745	40.1			
	7	10.91	7	3786	5901	86.2	9.62	962	1499	21.89	1705	2657	38.8			
	8	10.91	7	3760	5860	85.6	9.30	966	1506	21.98	1711	2667	38.9			
	9	10.91	7	3533	5506	80.4	9.69	973	1516	22.14	1736	2706	39.5			
	10	10.91	7	4165	6491	94.8	9.56	1006	1568	22.89	1804	2812	41.1			
Average				3965	6180	90.2	9.7	983	1532	22.37	1771	2759	40.3			
Standard Deviation				240.4	375	5.47	0.38	16.21	25.26	0.37	46.1	71.8	1.05			
% COV				6.06	6.06	6.06	3.99	1.65	1.65	1.65	2.60	2.60	2.60			

Percent Retained				72.8	72.8	72.8	74.2	87.2	87.2	87.2	89.6	89.6	89.6			
RFid				**1.37**	**1.37**	**1.37**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-15. Installation damage wide width tensile test results for TenCate Miragrid 8XT geogrid, soil gradation 2.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT Baseline	1	10.91	7	5584	8703	127.1	13.2	1119	1744	25.47	1964	3061	44.7	4472	6970	101.8
	2	10.91	7	5564	8672	126.6	13.5	1123	1750	25.54	1971	3072	44.8	4436	6915	101.0
	3	10.91	7	5389	8399	122.6	12.7	1132	1765	25.76	1987	3097	45.2	4429	6902	100.8
	4	10.91	7	5274	8220	120.0	12.4	1135	1769	25.83	1993	3106	45.3	4408	6869	100.3
	5	10.91	7	5418	8444	123.3	13.3	1129	1760	25.69	1965	3062	44.7	4417	6884	100.5
Average				5446	8488	123.9	13.0	1128	1758	25.66	1976	3079	45.0	4432	6908	100.9
Standard Deviation				129.1	201.1	2.94	0.45	6.6	10.3	0.15	13.3	20.8	0.30	24.8	39	0.56
% COV				2.37	2.37	2.37	3.46	0.59	0.59	0.59	0.68	0.68	0.68	0.56	0.56	0.56

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT installed in Gradation 2 (Sandy Gravel)	1	10.91	7	5008	7805	114.0	10.8	1107	1725	25.19	1949	3038	44.3	4621	7202	105.2
	2	10.91	7	4872	7593	110.9	10.5	1114	1736	25.35	1968	3067	44.8	4654	7254	105.9
	3	10.91	7	4800	7481	109.2	11.1	1110	1730	25.26	1963	3059	44.7	4658	7260	106.0
	4	10.91	7	4794	7472	109.1	10.3	1100	1714	25.03	1945	3031	44.3	4662	7266	106.1
	5	10.91	7	4640	7232	105.6	10.1	1091	1700	24.83	1930	3008	43.9	4632	7219	105.4
	6	10.91	7	5005	7801	113.9	10.8	1104	1721	25.12	1945	3031	44.3	4632	7219	105.4
	7	10.91	7	4923	7673	112.0	10.6	1113	1735	25.33	1943	3028	44.2	4632	7219	105.4
	8	10.91	7	4980	7762	113.3	10.6	1112	1733	25.30	1954	3045	44.5	4689	7308	106.7
	9	10.91	7	5070	7902	115.4	10.8	1121	1747	25.51	1974	3077	44.9	4704	7332	107.0
	10	10.91	7	4757	7414	108.2	10.3	1112	1733	25.30	1944	3030	44.2	4657	7258	106.0
Average				4885	7613	111.2	10.6	1108	1728	25.22	1952	3042	44.4	4654	7254	105.9
Standard Deviation				135.9	212	3.09	0.30	8.40	13.09	0.19	13.3	20.8	0.30	26.6	41.4	0.60
% COV				2.78	2.78	2.78	2.83	0.76	0.76	0.76	0.68	0.68	0.68	0.57	0.57	0.57

Percent Retained				89.7	89.7	89.7	81.4	98.3	98.3	98.3	98.8	98.8	98.8	105.0	105.0	105.0
RFid				**1.11**	**1.11**	**1.11**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-16. Installation damage wide width tensile test results for TenCate Miragrid 8XT geogrid, soil gradation 3.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT Baseline	1	10.91	7	5584	8703	127.1	13.2	1119	1744	25.47	1964	3061	44.7	4472	6970	101.8
	2	10.91	7	5564	8672	126.6	13.5	1123	1750	25.54	1971	3072	44.8	4436	6915	101.0
	3	10.91	7	5389	8399	122.6	12.7	1132	1765	25.76	1987	3097	45.2	4429	6902	100.8
	4	10.91	7	5274	8220	120.0	12.4	1135	1769	25.83	1993	3106	45.3	4408	6869	100.3
	5	10.91	7	5418	8444	123.3	13.3	1129	1760	25.69	1965	3062	44.7	4417	6884	100.5
Average				5446	8488	123.9	13.0	1128	1758	25.66	1976	3079	45.0	4432	6908	100.9
Standard Deviation				129.1	201.1	2.94	0.45	6.6	10.3	0.15	13.3	20.8	0.30	24.8	39	0.56
% COV				2.37	2.37	2.37	3.46	0.59	0.59	0.59	0.68	0.68	0.68	0.56	0.56	0.56

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
8XT installed in Gradation 3 (Sand)	1	10.91	7	4770	7434	108.5	10.3	1096	1708	24.94	1894	2952	43.1	4617	7196	105.1
	2	10.91	7	4535	7068	103.2	9.79	1103	1719	25.10	1897	2957	43.2			
	3	10.91	7	4906	7646	111.6	10.4	1102	1718	25.08	1897	2957	43.2	4681	7296	106.5
	4	10.91	7	4390	6842	99.9	9.62	1086	1693	24.71	1876	2924	42.7			
	5	10.91	7	4041	6298	92.0	9.02	1102	1718	25.08	1918	2989	43.6			
	6	10.91	7	4440	6920	101.0	9.97	1091	1700	24.83	1895	2953	43.1			
	7	10.91	7	4428	6901	100.8	9.63	1089	1697	24.78	1880	2930	42.8			
	8	10.91	7	4706	7335	107.1	10.1	1088	1696	24.76	1876	2924	42.7	4657	7258	106.0
	9	10.91	7	4759	7417	108.3	10.3	1089	1697	24.78	1877	2925	42.7	4626	7210	105.3
	10	10.91	7	4650	7247	105.8	9.93	1111	1732	25.28	1925	3000	43.8			
Average				4563	7111	103.8	9.91	1096	1708	24.93	1894	2951	43.1	4645	7240	105.7
Standard Deviation				250.2	390	5.69	0.42	8.38	13.06	0.19	17.3	26.9	0.39	29.4	45.7	0.67
% COV				5.48	5.48	5.48	4.19	0.76	0.76	0.76	0.91	0.91	0.91	0.63	0.63	0.63

Percent Retained				83.8	83.8	83.8	76.1	97.2	97.2	97.2	95.8	95.8	95.8	104.8	104.8	104.8
RFid				**1.19**	**1.19**	**1.19**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-17. Installation damage wide width tensile test results for TenCate Miragrid 24XT geogrid, soil gradation 1.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT Baseline	1	12.10	8	21182	32038	467.8	16.2	3519	5322	77.70	5500	8319	121.5	11763	17792	259.8
	2	12.10	8	20833	31510	460.0	15.1	3596	5439	79.41	5596	8464	123.6	12043	18214	265.9
	3	12.10	8	21277	32182	469.9	15.5	3618	5471	79.88	5592	8458	123.5	12311	18621	271.9
	4	12.10	8	20917	31636	461.9	15.3	3621	5477	79.97	5608	8482	123.8	12107	18312	267.4
	5	12.10	8	19736	29851	435.8	15.6	3656	5529	80.73	5707	8632	126.0	12477	18871	275.5
Average				20789	31443	459.1	15.5	3602	5448	79.54	5601	8471	123.7	12140	18362	268.1
Standard Deviation				616.4	932.3	13.61	0.42	51.1	77.4	1.13	73.5	111.1	1.62	271.7	411	6.00
% COV				2.97	2.97	2.97	2.68	1.42	1.42	1.42	1.31	1.31	1.31	2.24	2.24	2.24

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT installed in Gradation 1 (Coarse Gravel)	1	12.10	8	15062	22781	332.6	11.1	3700	5596	81.71	5638	8527	124.5	12765	19307	281.9
	2	12.10	8	15714	23767	347.0	11.9	3638	5502	80.34	5537	8375	122.3	12705	19216	280.6
	3	12.10	8	15496	23438	342.2	11.2	3526	5333	77.86	5532	8367	122.2	12656	19142	279.5
	4	12.10	8	16062	24294	354.7	11.5	3741	5658	82.61	5740	8682	126.8	13483	20393	297.7
	5	12.10	8	15871	24005	350.5	10.9	3878	5865	85.64	5901	8925	130.3	13971	21131	308.5
	6	12.10	8	14641	22145	323.3	10.8	3744	5663	82.68	5850	8848	129.2	13972	21133	308.5
	7	12.10	8	13824	20909	305.3	10.9	3587	5425	79.21	5647	8541	124.7	12519	18935	276.5
	8	12.10	8	13143	19879	290.2	11.5	3604	5451	79.59	5585	8447	123.3	11904	18005	262.9
	9	12.10	8	14325	21667	316.3	11.6	3527	5335	77.88	5492	8307	121.3	12664	19154	279.7
	10	12.10	8	14573	22042	321.8	10.7	3592	5433	79.32	5603	8475	123.7	13042	19726	288.0
Average				14871	22493	328.4	11.2	3654	5526	80.68	5653	8549	124.8	12968	19614	286.4
Standard Deviation				947.4	1433	20.92	0.40	111.34	168.40	2.46	137.1	207.4	3.03	659.8	998.0	14.57
% COV				6.37	6.37	6.37	3.55	3.05	3.05	3.05	2.43	2.43	2.43	5.09	5.09	5.09

Percent Retained			71.5	71.5	71.5	72.1	101.4	101.4	101.4	100.9	100.9	100.9	106.8	106.8	106.8
RFid			**1.40**	**1.40**	**1.40**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-18. Installation damage wide width tensile test results for TenCate Miragrid 24XT geogrid, 57 stone.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT Baseline	1	12.10	8	21182	32038	467.8	16.2	3519	5322	77.70	5500	8319	121.5	11763	17792	259.8
	2	12.10	8	20833	31510	460.0	15.1	3596	5439	79.41	5596	8464	123.6	12043	18214	265.9
	3	12.10	8	21277	32182	469.9	15.5	3618	5471	79.88	5592	8458	123.5	12311	18621	271.9
	4	12.10	8	20917	31636	461.9	15.3	3621	5477	79.97	5608	8482	123.8	12107	18312	267.4
	5	12.10	8	19736	29851	435.8	15.6	3656	5529	80.73	5707	8632	126.0	12477	18871	275.5
Average				20789	31443	459.1	15.5	3602	5448	79.54	5601	8471	123.7	12140	18362	268.1
Standard Deviation				616.4	932.3	13.61	0.42	51.1	77.4	1.13	73.5	111.1	1.62	271.7	411	6.00
% COV				2.97	2.97	2.97	2.68	1.42	1.42	1.42	1.31	1.31	1.31	2.24	2.24	2.24

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT installed in 57 Stone	1	12.10	8	17439	26376	385.1	11.8	3813	5767	84.20	5764	8718	127.3	13845	20941	305.7
	2	12.10	8	17197	26010	379.8	11.4	3881	5870	85.70	5851	8850	129.2	13949	21098	308.0
	3	12.10	8	17523	26504	387.0	11.4	3965	5997	87.56	5976	9039	132.0	14522	21965	320.7
	4	12.10	8	17459	26407	385.5	11.7	3814	5769	84.22	5739	8680	126.7	13801	20874	304.8
	5	12.10	8	15258	23078	336.9	11.8	3684	5572	81.35	5662	8564	125.0	12754	19290	281.6
	6	12.10	8	16937	25617	374.0	11.6	3876	5862	85.59	5913	8943	130.6	13956	21108	308.2
	7	12.10	8	17761	26864	392.2	11.4	3934	5950	86.87	5953	9004	131.5	14521	21963	320.7
	8	12.10	8	16378	24772	361.7	11.9	3917	5924	86.50	5892	8912	130.1	14222	21511	314.1
	9	12.10	8	16849	25484	372.1	11.4	3835	5800	84.69	5823	8807	128.6	13657	20656	301.6
	10	12.10	8	16441	24867	363.1	11.5	3858	5835	85.19	5783	8747	127.7	13941	21086	307.9
Average				16924	25598	373.7	11.6	3858	5835	85.19	5836	8826	128.9	13917	21049	307.3
Standard Deviation				745.2	1127	16.46	0.20	79.11	119.65	1.75	100.2	151.6	2.21	501.8	758.9	11.08
% COV				4.40	4.40	4.40	1.70	2.05	2.05	2.05	1.72	1.72	1.72	3.61	3.61	3.61

Percent Retained			81.4	81.4	81.4	74.6	107.1	107.1	107.1	104.2	104.2	104.2	114.6	114.6	114.6
RFid			**1.23**	**1.23**	**1.23**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-19. Installation damage wide width tensile test results for TenCate Miragrid 24XT geogrid, soil gradation 2.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT Baseline	1	12.10	8	21182	32038	467.8	16.2	3519	5322	77.70	5500	8319	121.5	11763	17792	259.8
	2	12.10	8	20833	31510	460.0	15.1	3596	5439	79.41	5596	8464	123.6	12043	18214	265.9
	3	12.10	8	21277	32182	469.9	15.5	3618	5471	79.88	5592	8458	123.5	12311	18621	271.9
	4	12.10	8	20917	31636	461.9	15.3	3621	5477	79.97	5608	8482	123.8	12107	18312	267.4
	5	12.10	8	19736	29851	435.8	15.6	3656	5529	80.73	5707	8632	126.0	12477	18871	275.5
Average				20789	31443	459.1	15.5	3602	5448	79.54	5601	8471	123.7	12140	18362	268.1
Standard Deviation				616.4	932.3	13.61	0.42	51.1	77.4	1.13	73.5	111.1	1.62	271.7	411	6.00
% COV				2.97	2.97	2.97	2.68	1.42	1.42	1.42	1.31	1.31	1.31	2.24	2.24	2.24

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT installed in Gradation 2 (Sandy Gravel)	1	12.10	8	19617	29671	433.2	13.2	3753	5676	82.88	5721	8653	126.3	13503	20423	298.2
	2	12.10	8	19462	29436	429.8	13.0	3787	5728	83.63	5777	8738	127.6	13572	20528	299.7
	3	12.10	8	20045	30318	442.6	13.1	3756	5681	82.94	5775	8735	127.5	13495	20411	298.0
	4	12.10	8	19973	30209	441.1	13.3	3663	5540	80.89	5634	8521	124.4	13206	19974	291.6
	5	12.10	8	19681	29768	434.6	12.9	3800	5748	83.91	5752	8700	127.0	13510	20434	298.3
	6	12.10	8	20106	30410	444.0	13.2	3837	5803	84.73	5747	8692	126.9	14145	21394	312.4
	7	12.10	8	20282	30677	447.9	13.4	3861	5840	85.26	5824	8809	128.6	13997	21170	309.1
	8	12.10	8	19620	29675	433.3	12.9	3810	5763	84.13	5818	8800	128.5	13879	20992	306.5
	9	12.10	8	19980	30220	441.2	13.5	3749	5670	82.79	5691	8608	125.7	13814	20894	305.0
	10	12.10	8	19519	29522	431.0	13.0	3758	5684	82.99	5735	8674	126.6	13254	20047	292.7
Average				19829	29991	437.9	13.2	3777	5713	83.41	5747	8693	126.9	13638	20627	301.2
Standard Deviation				281.6	426	6.22	0.21	55.31	83.65	1.22	57.2	86.5	1.26	310.6	469.8	6.86
% COV				1.42	1.42	1.42	1.57	1.46	1.46	1.46	0.99	0.99	0.99	2.28	2.28	2.28

Percent Retained			95.4	95.4	95.4	84.6	104.9	104.9	104.9	102.6	102.6	102.6	112.3	112.3	112.3
RFid			**1.05**	**1.05**	**1.05**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-20. Installation damage wide width tensile test results for TenCate Miragrid 24XT geogrid, soil gradation 3.
Installation damage testing (ASTM D5818, as modified in AASHTO R69-15).
Wide wide tensile testing (ASTM D6637, Method B).

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT Baseline	1	12.10	8	21182	32038	467.8	16.2	3519	5322	77.70	5500	8319	121.5	11763	17792	259.8
	2	12.10	8	20833	31510	460.0	15.1	3596	5439	79.41	5596	8464	123.6	12043	18214	265.9
	3	12.10	8	21277	32182	469.9	15.5	3618	5471	79.88	5592	8458	123.5	12311	18621	271.9
	4	12.10	8	20917	31636	461.9	15.3	3621	5477	79.97	5608	8482	123.8	12107	18312	267.4
	5	12.10	8	19736	29851	435.8	15.6	3656	5529	80.73	5707	8632	126.0	12477	18871	275.5
Average				20789	31443	459.1	15.5	3602	5448	79.54	5601	8471	123.7	12140	18362	268.1
Standard Deviation				616.4	932.3	13.61	0.42	51.1	77.4	1.13	73.5	111.1	1.62	271.7	411	6.00
% COV				2.97	2.97	2.97	2.68	1.42	1.42	1.42	1.31	1.31	1.31	2.24	2.24	2.24

Machine Direction

Sample Identification	Specimen Number	Ribs per Foot Width	Number of Ribs Tested	Maximum Load (lbs)	Maximum Load (lbs/ft)	Maximum Load (kN/m)	Elongation @ Break (%)	Load @ 2% lbs	Load @ 2% (lbs/ft)	Load @ 2% (kN/m)	Load @ 5% lbs	Load @ 5% (lbs/ft)	Load @ 5% (kN/m)	Load @ 10% lbs	Load @ 10% (lbs/ft)	Load @ 10% (kN/m)
24XT installed in Gradation 3 (Sand)	1	12.10	8	19003	28742	419.6	12.6	3799	5746	83.89	5674	8582	125.3	13635	20623	301.1
	2	12.10	8	18989	28721	419.3	12.8	3671	5552	81.06	5534	8370	122.2	13242	20029	292.4
	3	12.10	8	19380	29312	428.0	12.9	3654	5527	80.69	5545	8387	122.4	13415	20290	296.2
	4	12.10	8	19368	29294	427.7	13.1	3673	5555	81.11	5472	8276	120.8	13247	20036	292.5
	5	12.10	8	18261	27620	403.2	12.4	3611	5462	79.74	5473	8278	120.9	12964	19608	286.3
	6	12.10	8	19858	30035	438.5	13.0	3858	5835	85.19	5699	8620	125.8	14212	21496	313.8
	7	12.10	8	19396	29336	428.3	12.8	3763	5692	83.10	5586	8449	123.4	13817	20898	305.1
	8	12.10	8	19205	29048	424.1	12.7	3738	5654	82.54	5595	8462	123.6	13522	20452	298.6
	9	12.10	8	18714	28305	413.3	12.3	3483	5268	76.91	5695	8614	125.8	13807	20883	304.9
	10	12.10	8	18113	27396	400.0	11.7	3967	6000	87.60	5831	8819	128.8	14240	21538	314.5
Average				19029	28781	420.2	12.6	3722	5629	82.18	5610	8486	123.9	13610	20585	300.5
Standard Deviation				539.7	816	11.92	0.41	135.59	205.08	2.99	113.9	172.2	2.51	417.9	632.1	9.23
% COV				2.84	2.84	2.84	3.25	3.64	3.64	3.64	2.03	2.03	2.03	3.07	3.07	3.07

Percent Retained			91.5	91.5	91.5	81.3	103.3	103.3	103.3	100.2	100.2	100.2	112.1	112.1	112.1
RFid			**1.09**	**1.09**	**1.09**										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table D-21. Standard test soil gradations (% passing).

		Standard Installation Damage Soils Used for Field Exposures			
US Sieve No.	Sieve Size (mm)	Percent Passing by Weight			
		Type 1 (Coarse Gravel)	57 stone	Type2 (Sandy Gravel)	Type 3 (Silty Sand)
6 - in	150	100.0	100.0	100.0	100.0
3 - in.	75	100.0	100.0	100.0	100.0
2 - in.	50	100.0	100.0	100.0	100.0
1.5 - in.	38	-	100.0	100.0	100.0
1 - in.	25	26.4	100.0	100.0	100.0
3/4 - in.	19	1.6	71.0	100.0	100.0
1/2 - in.	12.5	-	42.0	-	100.0
3/8 - in.	9.5	1.1	23.5	99.1	100.0
No. 4	4.75	1.1	5	40.5	100.0
No. 10	1.7	1.1	0.0	4.2	77.6
No. 20	0.85	1.1	0.0	3.4	48.8
No. 40	0.425	1.0	0.0	3.3	33.1
No. 60	0.25	-	0.0	-	21.5
No. 100	0.15	-	0.0	-	12.2
No. 200	0.075	-	0.0	-	4.4
D50, mm		22.6	14	5.3	0.9
LA Abrasion Small Drum Method B 500 Cycles		20.2% loss		12.6% loss	
Liquid Limit, %		-		-	-
Plasticity Index, %		-		-	-
Angularity (ASTM D 2488)		Angular to Subangular	Angular to Subangular	Angular	Angular to Subangular
AASHTO Classification		No. 4 Aggregate	No. 57 Aggregate	No. 89 Aggregate	A-1b Soil
Soil Classification		GP	GP	GP	SM
		Poorly Graded Gravel	Poorly Graded Gravel	Poorly Graded Gravel with Sand	Well Graded Silty Sand

Figure D-1. Lifting Plates positioned between ties and covered with first lift of compacted soil/aggregate.

Figure D-2. Grid positioned over compacted base and covered. Cover soil/aggregate is uniformly spread and compacted using field-scale equipment and procedures.

Figure D-3. The density of the compacted soil is measured with a nuclear density gauge.

Figure D-4. The steel plates are tilted to facilitate exhumation.

Appendix E: ISO/EN Laboratory Installation Damage Detailed Test Results

E.1 ISO/EN Laboratory Installation Damage Test Program

Testing is done per the EN/ISO 10722. Five wide width tensile specimens are exposed to 200 cycles producing between 209 lb/ft^2 (10 kPa) minimum and 10,443 lb/ft^2 (500 kPa) maximum stress at a frequency of 1 Hz. The aggregate used is a sintered aluminum oxide with a grain size such that 100% shall pass a 10 mm sieve and 0% shall pass a 5 mm sieve. The exposed specimens and five baseline specimens are tested according to ISO/EN 10319.

Representative photos of test apparatus and aggregate are provided in Figures E-1 and E-2. Detailed test results are provided in Tables E-1 through E-9.

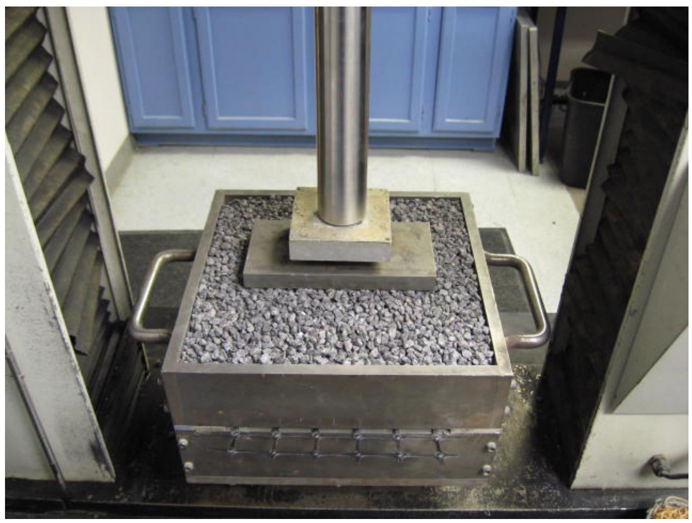

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Figure E-1. ISO/EN 10722, laboratory installation damage test apparatus.

Figure E-2. ISO/EN 10722, laboratory installation damage aggregate.

Table E-1. Laboratory installation damage (ISO/EN 10722) tensile test results for 2XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.80								
MD - Tensile Strength (lbs) - B	1781	1770	1802	1821	1735	**1782**	33	2	
MD Tensile Strength (lbs/ft) - B	2748	2731	2780	2810	2677	**2749**	50	2	
MD Tensile Strength (kN/m) - B	40.1	39.9	40.6	41.0	39.1	**40.1**	0.7	1.8	
MD - Tensile Strength (lbs) - E	1529	1505	1727	1662	1595	**1604**	92	6	
MD Tensile Strength (lbs/ft) - E	2359	2322	2665	2564	2461	**2474**	142	6	**90**
MD Tensile Strength (kN/m) - E	34.4	33.9	38.9	37.4	35.9	**36.1**	2.1	5.7	
MD - Elong. @ Max. Load (%) - B	9.14	9.17	9.33	9.50	8.73	**9.17**	0.3	3.1	
MD - Elong. @ Max. Load (%) - E	7.73	7.87	9.05	8.61	8.26	**8.30**	0.5	6.5	**91**
B - Baseline Unexposed									
E - Exposed									

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-2. Laboratory installation damage (ISO/EN 10722) tensile test results for 3XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	**2**	**3**	**4**	**5**				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.75								
MD - Tensile Strength (lbs) - B	2469	2492	2540	2480	2580	**2512**	47	2	
MD Tensile Strength (lbs/ft) - B	3790	3826	3899	3807	3961	**3857**	72	2	
MD Tensile Strength (kN/m) - B	55.3	55.9	56.9	55.6	57.8	**56.3**	1.0	1.9	
MD - Tensile Strength (lbs) - E	2400	1999	2199	2302	2125	**2205**	155	7	
MD Tensile Strength (lbs/ft) - E	3684	3069	3376	3534	3262	**3385**	238	7	**88**
MD Tensile Strength (kN/m) - E	53.8	44.8	49.3	51.6	47.6	**49.4**	3.5	7.0	
MD - Elong. @ Max. Load (%) - B	9.13	9.39	10.4	9.38	9.98	**9.66**	0.5	5.4	
MD - Elong. @ Max. Load (%) - E	9.61	13.0	8.72	8.68	11.0	**10.2**	1.8	17.9	**106**
B - Baseline Unexposed									
E - Exposed									

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-3. Laboratory installation damage (ISO/EN 10722) tensile test results for 5XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.71								
MD - Tensile Strength (lbs) - B	3334	3359	3296	3245	3214	**3290**	60	2	
MD Tensile Strength (lbs/ft) - B	5100	5138	5042	4964	4916	**5032**	92	2	
MD Tensile Strength (kN/m) - B	74.5	75.0	73.6	72.5	71.8	**73.5**	1.3	1.8	
MD - Tensile Strength (lbs) - E	3091	2847	3142	3195	2922	**3039**	148	5	
MD Tensile Strength (lbs/ft) - E	4728	4355	4806	4887	4470	**4649**	227	5	**92**
MD Tensile Strength (kN/m) - E	69.0	63.6	70.2	71.4	65.3	**67.9**	3.3	4.9	
MD - Elong. @ Max. Load (%) - B	10.4	10.1	10.4	10.4	9.98	**10.3**	0.2	2.0	
MD - Elong. @ Max. Load (%) - E	9.94	9.37	10.8	10.3	9.74	**10.0**	0.5	5.4	**98**

B - Baseline Unexposed
E - Exposed

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-4. Laboratory installation damage (ISO/EN 10722) tensile test results for 7XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	**2**	**3**	**4**	**5**				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.68								
MD - Tensile Strength (lbs) - B	4478	4383	4402	4286	4295	**4369**	80	2	
MD Tensile Strength (lbs/ft) - B	6830	6685	6714	6537	6551	**6663**	122	2	
MD Tensile Strength (kN/m) - B	99.7	97.6	98.0	95.4	95.6	**97.3**	1.8	1.8	
MD - Tensile Strength (lbs) - E	3529	3049	3285	3930	3705	**3500**	345	10	
MD Tensile Strength (lbs/ft) - E	5382	4650	5010	5994	5651	**5338**	527	10	**80**
MD Tensile Strength (kN/m) - E	78.6	67.9	73.2	87.5	82.5	**77.9**	7.7	9.9	
MD - Elong. @ Max. Load (%) - B	12.0	11.6	11.7	11.1	11.2	**11.5**	0.4	3.2	
MD - Elong. @ Max. Load (%) - E	9.56	9.24	9.58	10.7	10.1	**9.84**	0.6	5.8	**85**
B - Baseline Unexposed									
E - Exposed									

MD - Machine Direction   TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-5. Laboratory installation damage (ISO/EN 10722) tensile test results for 8XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.91								
MD - Tensile Strength (lbs) - B	5431	5448	5267	5322	5289	**5351**	83	2	
MD Tensile Strength (lbs/ft) - B	8461	8487	8205	8291	8240	**8337**	129	2	
MD Tensile Strength (kN/m) - B	124	124	120	121	120	**122**	2	2	
MD - Tensile Strength (lbs) - E	4310	4507	4892	4661	4486	**4571**	218	5	
MD Tensile Strength (lbs/ft) - E	6714	7021	7621	7261	6989	**7121**	340	5	**85**
MD Tensile Strength (kN/m) - E	98	103	111	106	102	**104**	5	5	
MD - Elong. @ Max. Load (%) - B	11.9	11.9	11.7	11.7	11.7	**11.8**	0.1	0.9	
MD - Elong. @ Max. Load (%) - E	10.2	10.2	10.9	11.7	9.93	**10.6**	0.7	6.8	**90**

B - Baseline Unexposed
E - Exposed

MD - Machine Direction   TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-6. Laboratory installation damage (ISO/EN 10722) tensile test results for 10XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	7								
MD Number of Ribs per foot:	10.78								
MD - Tensile Strength (lbs) - B	7757	7221	7193	7567	7535	**7455**	242	3	
MD Tensile Strength (lbs/ft) - B	11947	11122	11079	11655	11605	**11481**	372	3	
MD Tensile Strength (kN/m) - B	174	162	162	170	169	**168**	5	3	
MD - Tensile Strength (lbs) - E	6700	6577	5787	6176	6612	**6370**	383	6	
MD Tensile Strength (lbs/ft) - E	10319	10130	8913	9512	10184	**9812**	590	6	**85**
MD Tensile Strength (kN/m) - E	151	148	130	139	149	**143**	9	6	
MD - Elong. @ Max. Load (%) - B	14.2	12.8	12.6	13.6	13.5	**13.3**	0.6	4.8	
MD - Elong. @ Max. Load (%) - E	13.0	12.0	11.0	11.3	11.9	**11.8**	0.8	6.5	**89**

B - Baseline Unexposed
E - Exposed

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-7. Laboratory installation damage (ISO/EN 10722) tensile test results for 20XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	**2**	**3**	**4**	**5**				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	8								
MD Number of Ribs per foot:	12.09								
MD - Tensile Strength (lbs) - B	11213	11501	11707	11878	11801	**11620**	268	2	
MD Tensile Strength (lbs/ft) - B	16948	17383	17695	17953	17837	**17563**	405	2	
MD Tensile Strength (kN/m) - B	247	254	258	262	260	**256**	6	2	
MD - Tensile Strength (lbs) - E	9968	10258	10280	10850	10857	**10443**	395	4	
MD Tensile Strength (lbs/ft) - E	15066	15504	15538	16399	16410	**15783**	597	4	**90**
MD Tensile Strength (kN/m) - E	220	226	227	239	240	**230**	9	4	
MD - Elong. @ Max. Load (%) - B	12.3	12.1	12.7	12.7	12.5	**12.5**	0.3	2.1	
MD - Elong. @ Max. Load (%) - E	10.5	11.3	10.9	11.4	11.5	**11.1**	0.4	3.7	**89**
B - Baseline Unexposed									
E - Exposed									

MD - Machine Direction   TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-8. Laboratory installation damage (ISO/EN 10722) tensile test results for 22XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	8								
MD Number of Ribs per foot:	12.09								
MD - Tensile Strength (lbs) - B	15275	14914	15760	15930	16005	**15577**	467	3	
MD Tensile Strength (lbs/ft) - B	23092	22546	23825	24082	24195	**23548**	706	3	
MD Tensile Strength (kN/m) - B	337	329	348	352	353	**344**	10	3	
MD - Tensile Strength (lbs) - E	15043	14130	14088	14065	14575	**14380**	426	3	
MD Tensile Strength (lbs/ft) - E	22741	21361	21297	21262	22033	**21739**	643	3	**92**
MD Tensile Strength (kN/m) - E	332	312	311	310	322	**317**	9	3	
MD - Elong. @ Max. Load (%) - B	13.9	13.6	13.3	13.9	13.9	**13.7**	0.3	2.0	
MD - Elong. @ Max. Load (%) - E	13.4	12.5	12.4	12.1	13.0	**12.7**	0.5	4.1	**92**

B - Baseline Unexposed
E - Exposed

MD - Machine Direction   TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table E-9. Laboratory installation damage (ISO/EN 10722) tensile test results for 24XT

PARAMETER	TEST REPLICATE NUMBER					MEAN	STD. DEV.	COEF. VARI.	PERCENT RETAINED
	1	2	3	4	5				
Laboratory Installation Damage (ISO/EN 10722)									
Strength Retained measured via wide width tensile (ISO/EN 10319)									
MD Number of Ribs per Specimen:	8								
MD Number of Ribs per foot:	12.10								
MD - Tensile Strength (lbs) - B	20750	20911	21124	21087	20925	**20959**	151	1	
MD Tensile Strength (lbs/ft) - B	32189	32439	32769	32712	32461	**32514**	234	1	
MD Tensile Strength (kN/m) - B	470	474	478	478	474	**475**	3	1	
MD - Tensile Strength (lbs) - E	18937	17610	19285	18341	18597	**18554**	636	3	
MD Tensile Strength (lbs/ft) - E	29377	27318	29916	28452	28849	**28782**	987	3	**89**
MD Tensile Strength (kN/m) - E	429	399	437	415	421	**420**	14	3	
MD - Elong. @ Max. Load (%) - B	13.9	13.8	14.1	13.9	14.2	**14.0**	0.2	1.2	
MD - Elong. @ Max. Load (%) - E	12.5	12.3	13.1	13.2	12.4	**12.7**	0.4	3.3	**91**
B - Baseline Unexposed									
E - Exposed									

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Appendix F: Creep Rupture Detailed Test Results

Table F-1: Explanation/Key for Individual Creep Test Data Tables/Figures

Accelerated Creep Rupture via SIM - ASTM D 6992

Spreadsheet Filename

SUMMARY CREEP PARAMETERS: NTPEP - Manufacturer Product

Specimen: Test Filename | Test Date: 01-Jan-07 | Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 65.0 kN/m | %UTS: 66.00

Ultimate Tensile Strength: 100.0 kN/m | Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$\log A_T$	Temp	$\log A_T/T$
1	0	0.5	0.5	-	-	20.00	-
2	9500	10000	500	0.1	1.2600	34.00	0.0900
3	19500	20000	500	0.1	1.2600	48.00	0.0900
4	29500	30000	500	0.1	1.2600	62.00	0.0900
5	39500	40000	500	0.1	1.2600	76.00	0.0900
6	49500	50000	500	0.1	1.2600	90.00	0.0900

Summary	Initial	Final	Units	@20C refT	AVG	0.0900
lab time	90	60000	sec	-		
$\log A_T(t-t')$	1.9542	4.7782	log hours	6.0000		
$A_T(t-t')$	-	17.25	years	114.00		
Strain	9.500	12.500	%	-		
Modulus	800.0	600.0	kN/m	-		

$\log A_{T}/T$ = Horizontal shift factor for each temperature step expressed per degree C

Average temperature for each step

$\log A_T$ = Horizontal shift factor for each temperature step

Vshift(%) = Vertical shift to offset system temperature expansion

Rupture Time expressed in log hours and years

% Strain and Creep Modulus at end of test

% Strain and Creep Modulus at onset of creep

t = The actual start time of each temperature step

t' = The theoritical start time of each temperature step

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 2XT

Specimen: 27463n2m-2XT-sim7 Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 1954 lb/ft %UTS: 70.96
Ultimate Tensile Strength: 2753 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9700	10020	320	0.095	1.4949	34.1	0.1034
3	19750	20010	260	0.1	1.5976	48.5	0.1109
4	29800	30000	200	0.14	1.7091	63.1	0.1174
5	39400	39990	590	0.13	1.2363	79.3	0.0762
6							
						AVG	0.1012

Summary	Initial	Final	Units	@20C refT
lab time	55.9	40320	sec	-
$logA_T(t-t')$	1.7478	9.0015	log hours	5.4100
$A_T(t-t')$	-	31.80	years	29.32
Strain	7.59	12.009	%	-
Modulus	25764.2	3870.0	lb/ft	-

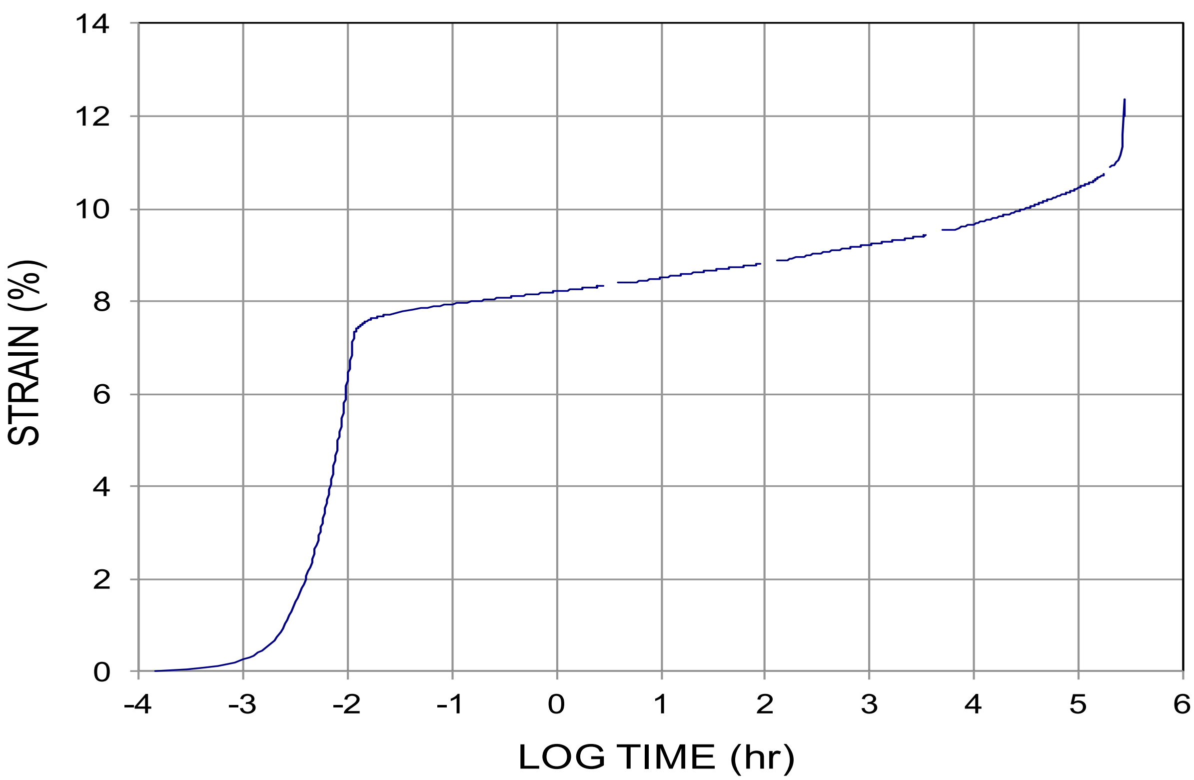

Figure F-1. SIM/Creep data/curve for 2XT at load level of 70.96% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 2XT

Specimen: 27463n2m-2XT-sim75 | Test Date: June 2017 | Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 2065 lb/ft | %UTS: 75.00

Ultimate Tensile Strength: 2753 lb/ft | Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9500	10019	519	0.08	1.2840	34.1	0.0888
3	19750	20009	259	0.1	1.6063	48.5	0.1115
4	29800	29999	199	0.16	1.7096	63.8	0.1123
5							
6							
						AVG	0.1043

Summary	Initial	Final	Units	@20C refT
lab time	43.3	31109	sec	-
$logA_T(t-t')$	1.6360	7.7169	log hours	4.1304
$A_T(t-t')$	-	1.65	years	1.54
Strain	7.60	11.442	%	-
Modulus	27379.6	18044.7	lb/ft	-

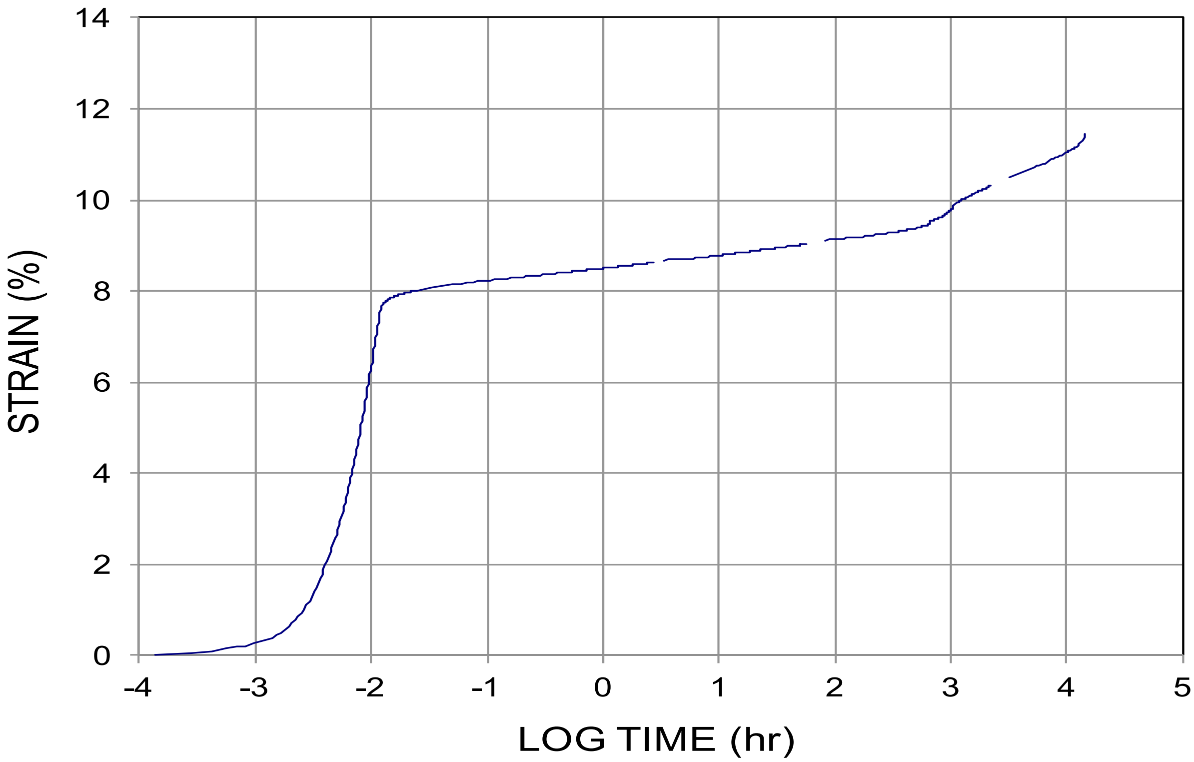

Figure F-2. SIM/Creep data/curve for 2XT at load level of 75.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 2XT

Specimen: 27463n2m-2XT-sim7!   Test Date: June 2017   Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress:	2175	lb/ft	%UTS:	79.00
Ultimate Tensile Strength:	2753	lb/ft	Rupture:	YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$\log A_T$	Temp	$\log A_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9500	10019	519	0.06	1.2841	34.1	0.0888
3	19600	20009	409	0.05	1.4082	49.1	0.0938
4							
5							
6							
						AVG	0.0914

Summary	Initial	Final	Units	@20C refT
lab time	38.0	21719	sec	-
$\log A_T(t-t')$	1.5798	6.0185	log hours	2.4319
$A_T(t-t')$	-	0.03	years	0.03
Strain	6.04	9.664	%	-
Modulus	35936.8	22509.2	lb/ft	-

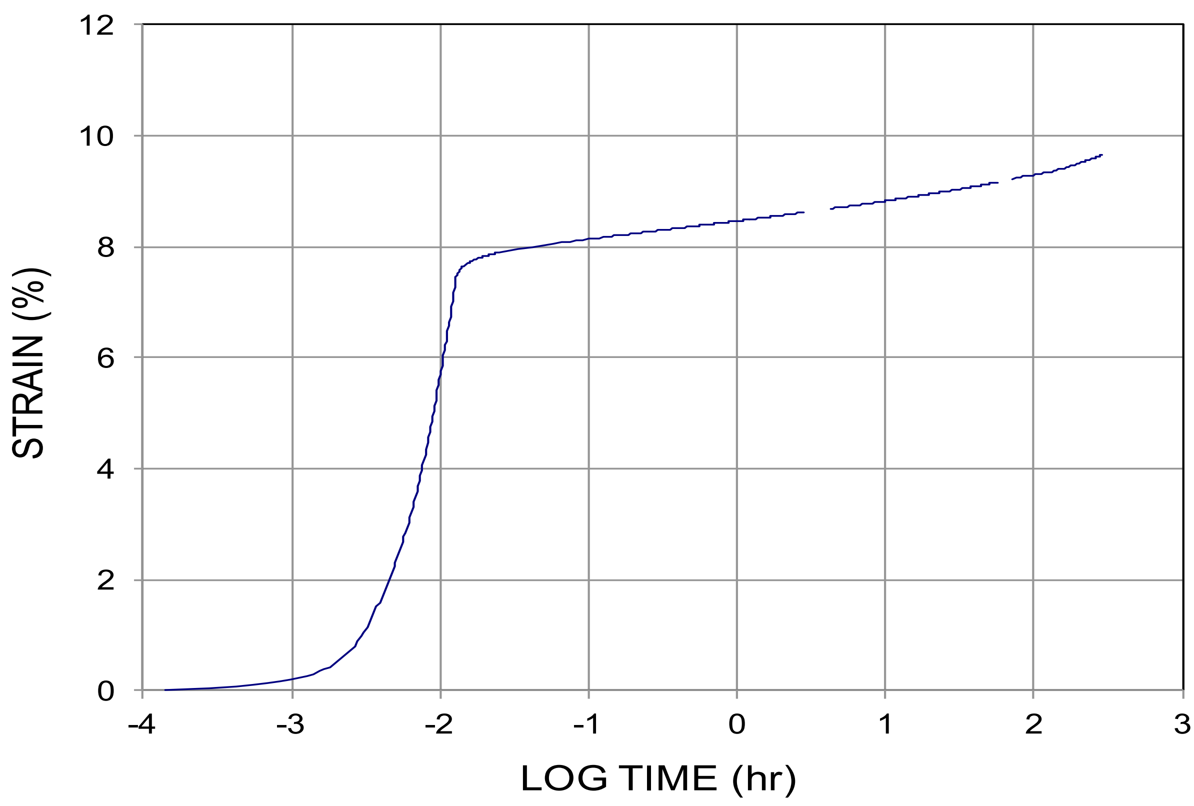

Figure F-3. SIM/Creep data/curve for 2XT at load level of 79.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 2XT

Specimen: 27463n2m-2XT-sim8; Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 2285 lb/ft %UTS: 83.00

Ultimate Tensile Strength: 2753 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$\log A_T$	Temp	$\log A_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9750	10020	270	0.06	1.5688	34.5	0.1055
3							
4							
5							
6							

Summary	Initial	Final	Units	@20C refT
lab time	40.5	12390	sec	-
$\log A_T(t-t')$	1.6075	4.9903	log hours	1.3981
$A_T(t-t')$	-	0.00	years	0.00
Strain	7.43	9.994	%	-
Modulus	29613.5	22865.2	lb/ft	-

AVG 0.1055

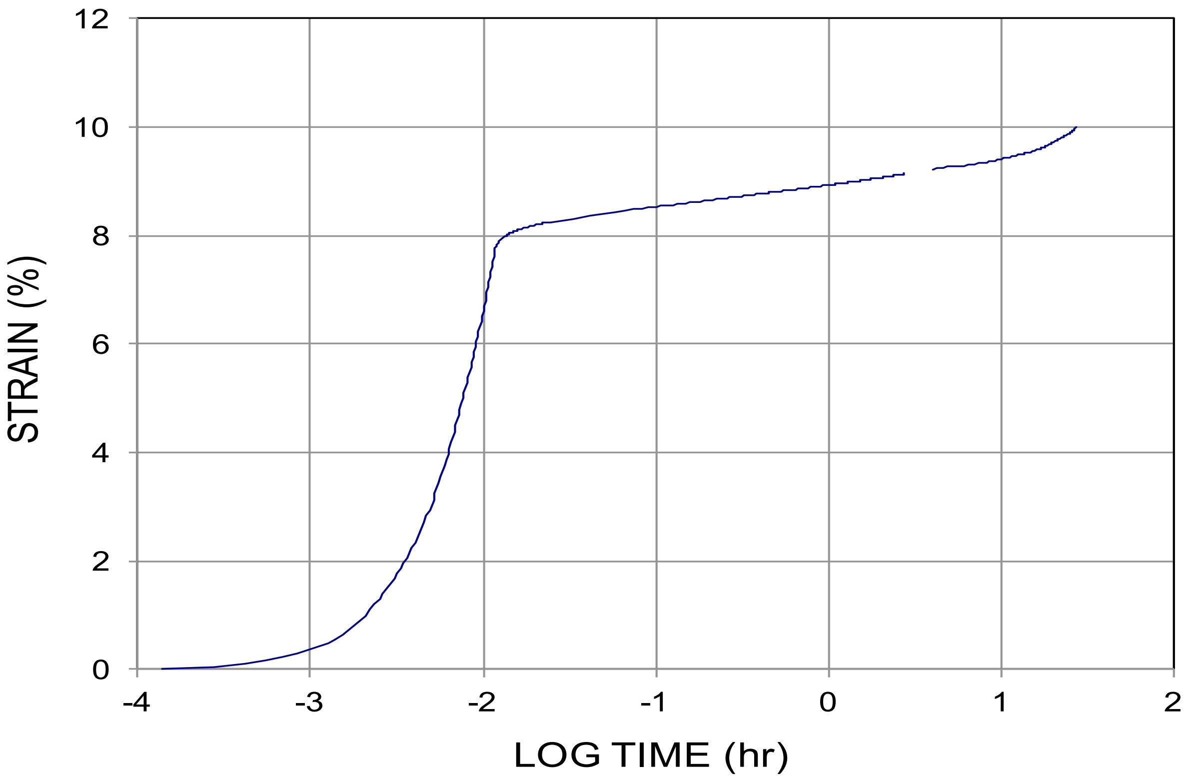

Figure F-4. SIM/Creep data/curve for 2XT at load level of 83.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim6 Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 5872 lb/ft %UTS: 68.00

Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t\text{-}t')_i$	Vshift(%)	$\log A_T$	Temp	$\log A_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9500	10020	520	0.115	1.2839	34.1	0.0888
3	19500	20010	510	0.13	1.3131	48.5	0.0912
4	29500	30000	500	0.09	1.3213	63.1	0.0908
5	39500	39990	490	0.13	1.3297	77.6	0.0913
6	49500	49980	480	0.18	1.3382	92.6	0.0897
						AVG	0.0903

Summary	Initial	Final	Units	@20C refT
lab time	51.3	51300	sec	-
$\log A_T(t\text{-}t')$	1.7104	9.8413	log hours	6.2548
$A_T(t\text{-}t')$	-	219.90	years	205.12
Strain	8.64	12.084	%	-
Modulus	68166.7	48596.3	lb/ft	-

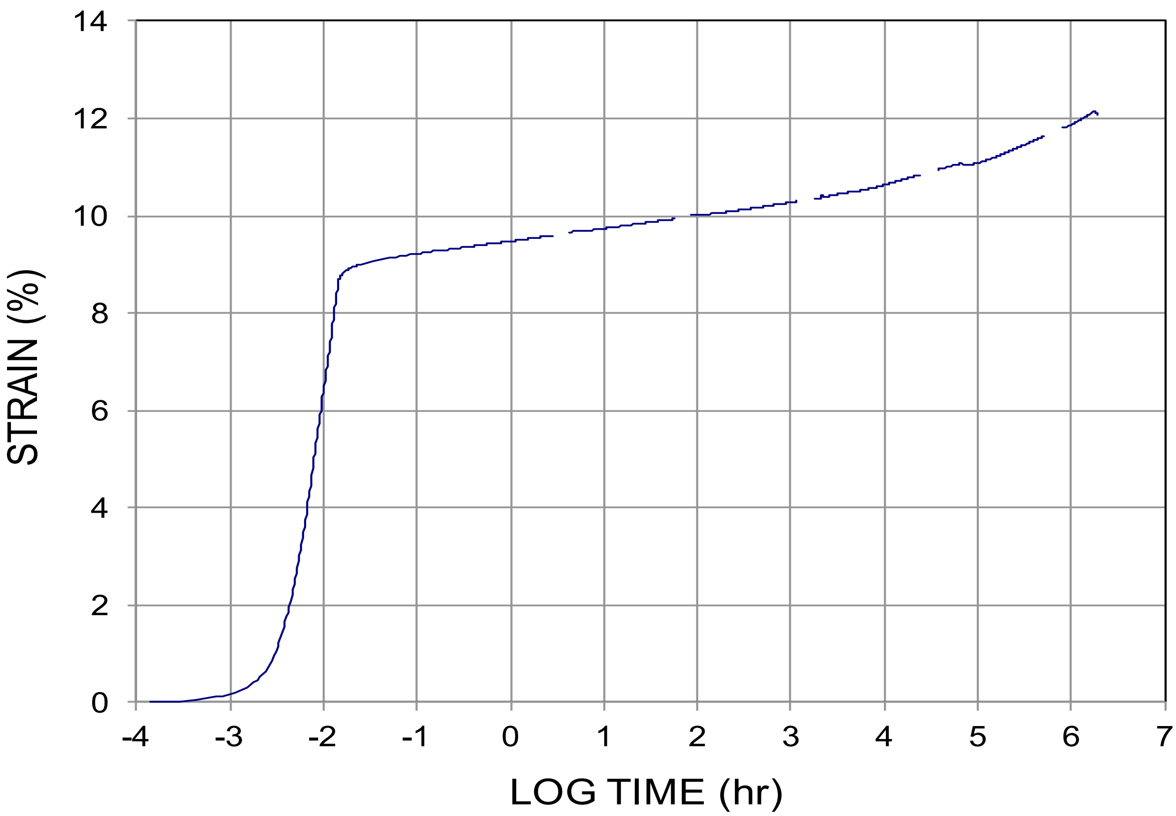

Figure F-5. SIM/Creep data/curve for 8XT at load level of 68.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim7 Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 6132 lb/ft %UTS: 71.00
Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9000	10019	1019	0.1	0.9912	34.1	0.0685
3	19400	20009	609	0.12	1.2556	48.5	0.0872
4	29500	29999	499	0.05	1.3255	63.1	0.0911
5	39500	39989	489	0.05	1.3298	77.8	0.0903
6							
						AVG	0.0843

Summary	Initial	Final	Units	@20C refT
lab time	61.7	44669	sec	-
$logA_T(t-t')$	1.7900	8.6155	log hours	5.0359
$A_T(t-t')$	-	13.07	years	12.39
Strain	8.98	12.154	%	-
Modulus	68253.0	50449.9	lb/ft	-

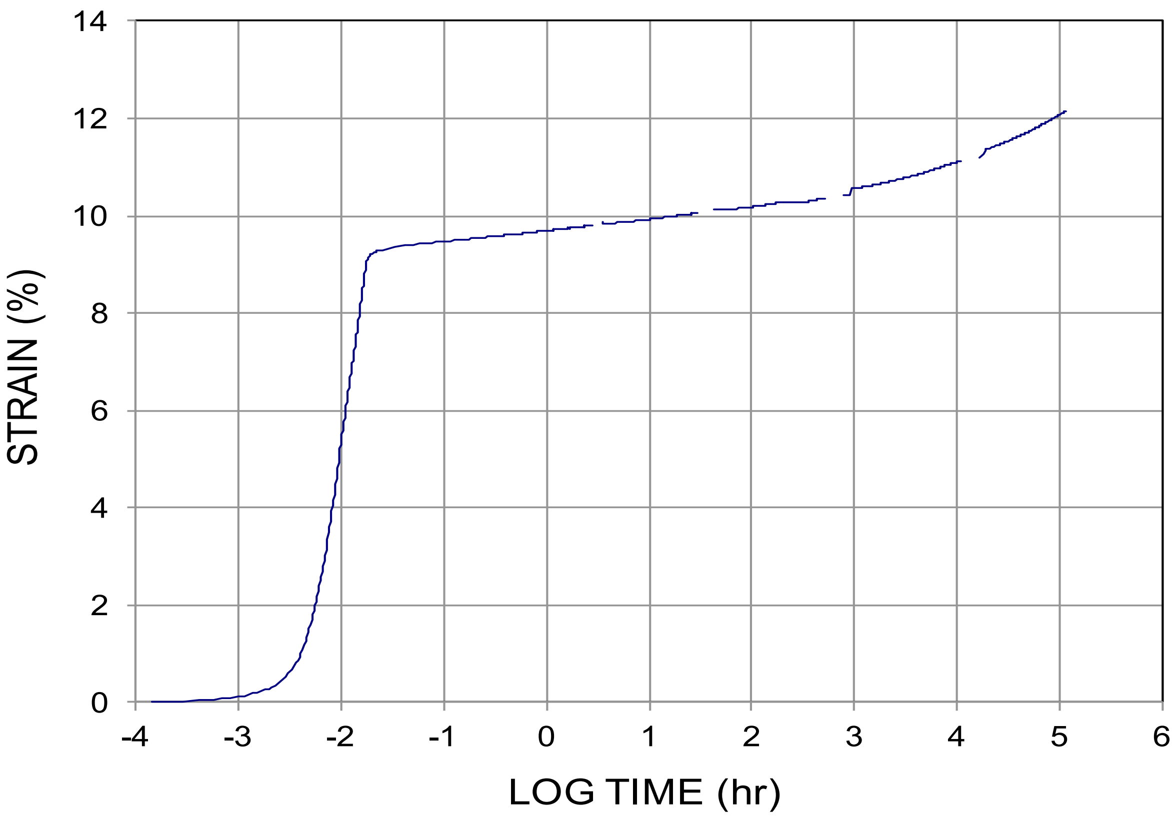

Figure F-6. SIM/Creep data/curve for 8XT at load level of 71.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim7 Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 6391 lb/ft %UTS: 74.00

Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9200	10019	819	0.16	1.0860	34.1	0.0751
3	19200	20009	809	0.18	1.1244	48.5	0.0781
4	29600	29999	399	0.09	1.4307	63.1	0.0983
5	39500	39989	489	0.13	1.3256	77.9	0.0891
6							
						AVG	0.0852

Summary	Initial	Final	Units	@20C refT
lab time	55.7	42119	sec	-
$logA_T(t-t')$	1.7458	8.3849	log hours	4.8030
$A_T(t-t')$	-	7.69	years	7.25
Strain	8.72	11.605	%	-
Modulus	73502.2	55069.9	lb/ft	-

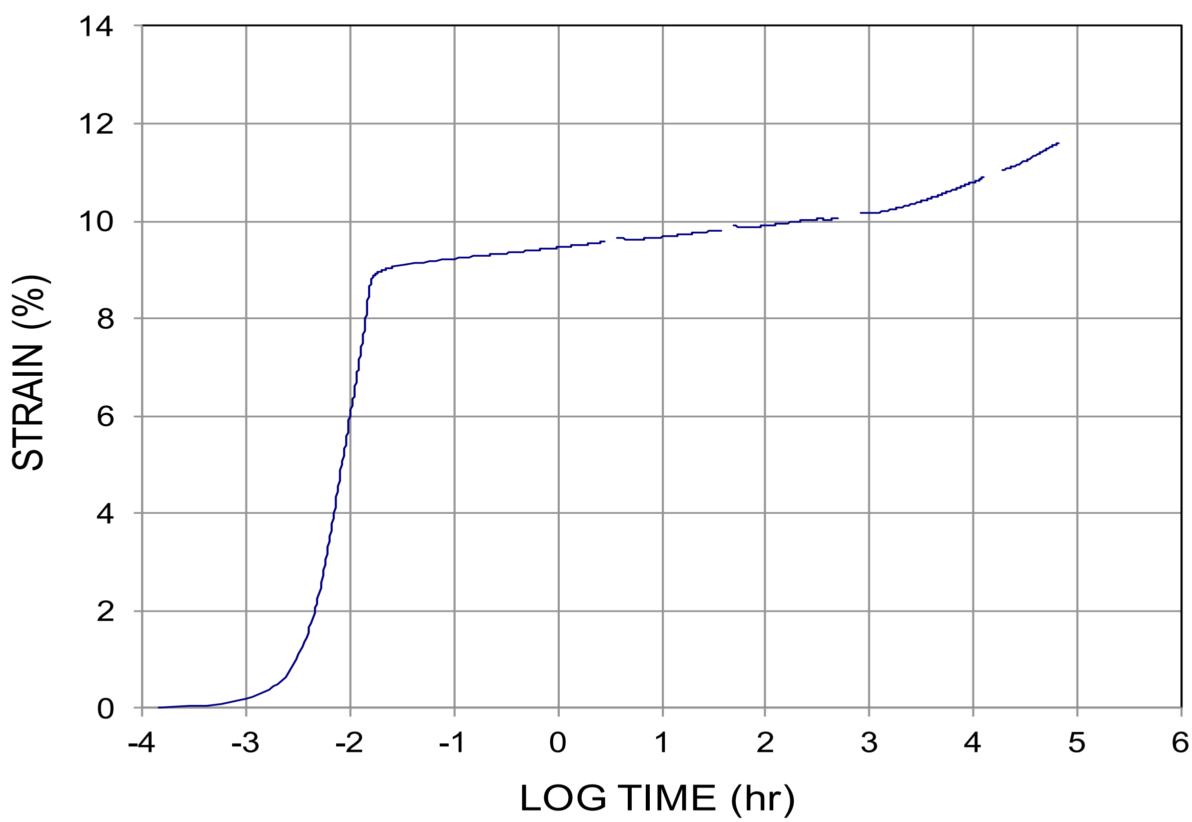

Figure F-7. SIM/Creep data/curve for 8XT at load level of 74.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim7 Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 6650 lb/ft %UTS: 77.00

Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9500	10019	519	0.14	1.2841	34.1	0.0888
3	19500	20009	509	0.13	1.3134	48.5	0.0912
4	29500	29999	499	0.1	1.3216	66.1	0.0751
5							
6							

AVG 0.0843

Summary	Initial	Final	Units	@20C refT
lab time	57.5	30209	sec	-
$logA_T(t-t')$	1.7597	6.7699	log hours	3.1833
$A_T(t-t')$	-	0.19	years	0.17
Strain	9.31	12.111	%	-
Modulus	71558.0	54907.4	lb/ft	-

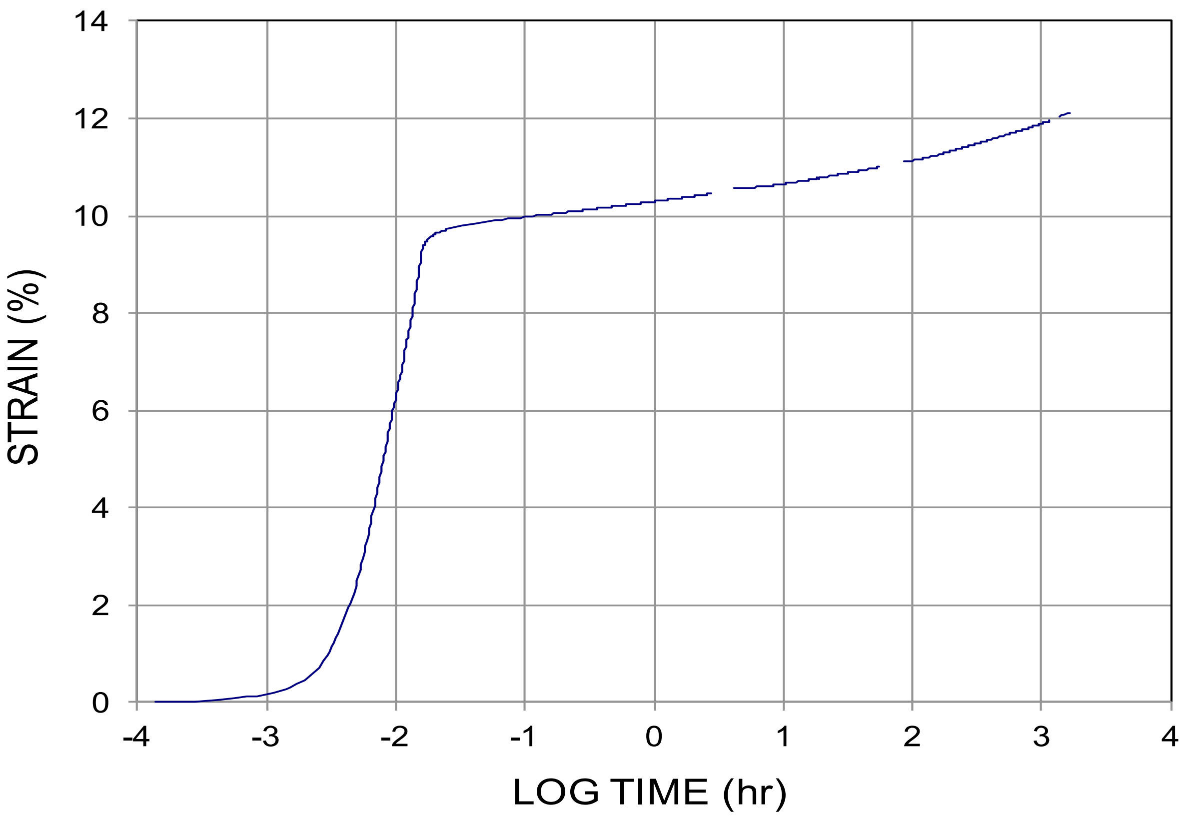

Figure F-8. SIM/Creep data/curve for 8XT at load level of 77.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim8(Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 6909 lb/ft %UTS: 80.00
Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t\text{-}t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9500	10019	519	0.09	1.2840	34.1	0.0888
3	19300	20009	709	0.08	1.1694	49.2	0.0778
4							
5							
6							
						AVG	0.0832

Summary	Initial	Final	Units	@20C refT
lab time	71.5	21629	sec	-
$logA_T(t\text{-}t')$	1.8545	5.8207	log hours	2.2342
$A_T(t\text{-}t')$	-	0.02	years	0.02
Strain	10.55	13.538	%	-
Modulus	65634.4	51022.6	lb/ft	-

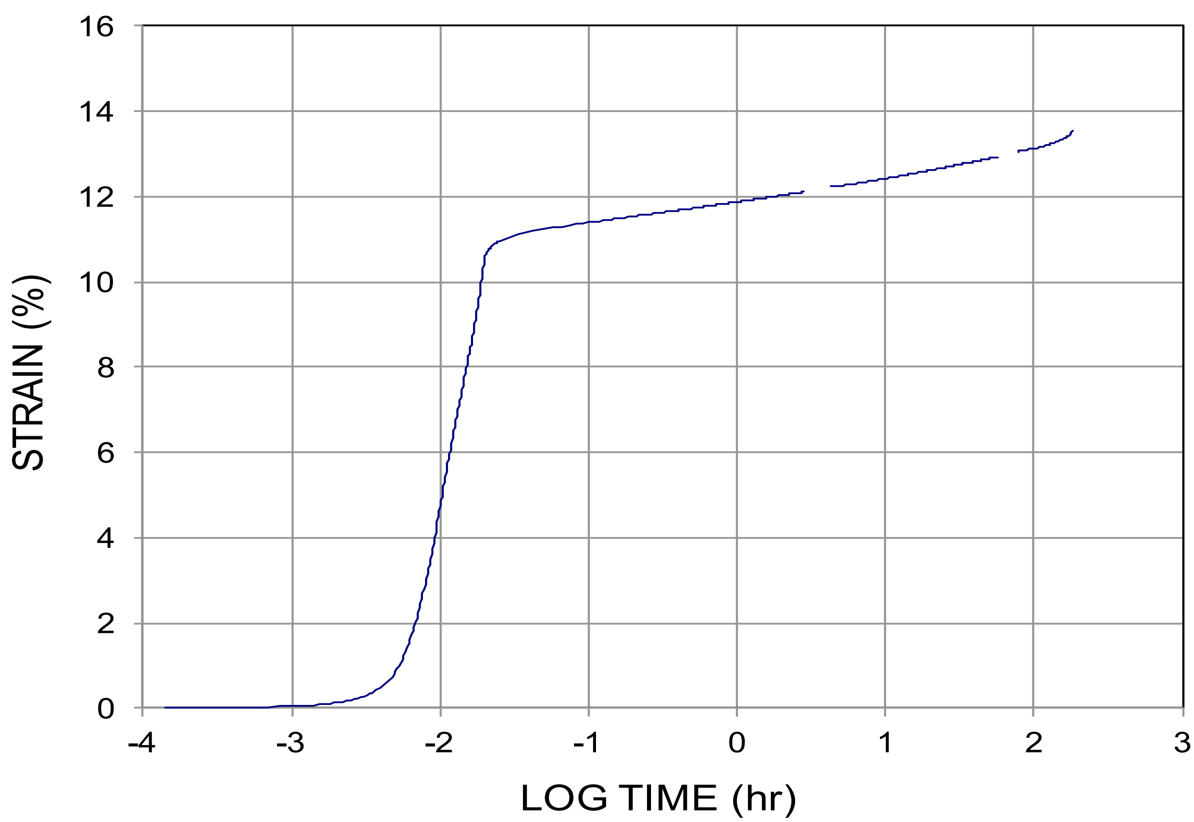

Figure F-9. SIM/Creep data/curve for 8XT at load level of 80.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 8XT

Specimen: 27463n2m-8XT-sim8; Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 7168 lb/ft %UTS: 83.00

Ultimate Tensile Strength: 8636 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9400	10020	620	0.04	1.2074	34.2	0.0831
3							
4							
5							
6							

Summary	Initial	Final	Units	@20C refT
lab time	73.3	17430	sec	-
$logA_T(t-t')$	1.8649	5.1121	log hours	1.5275
$A_T(t-t')$	-	0.00	years	0.00
Strain	10.84	14.023	%	-
Modulus	66106.4	51111.2	lb/ft	-

AVG 0.0831

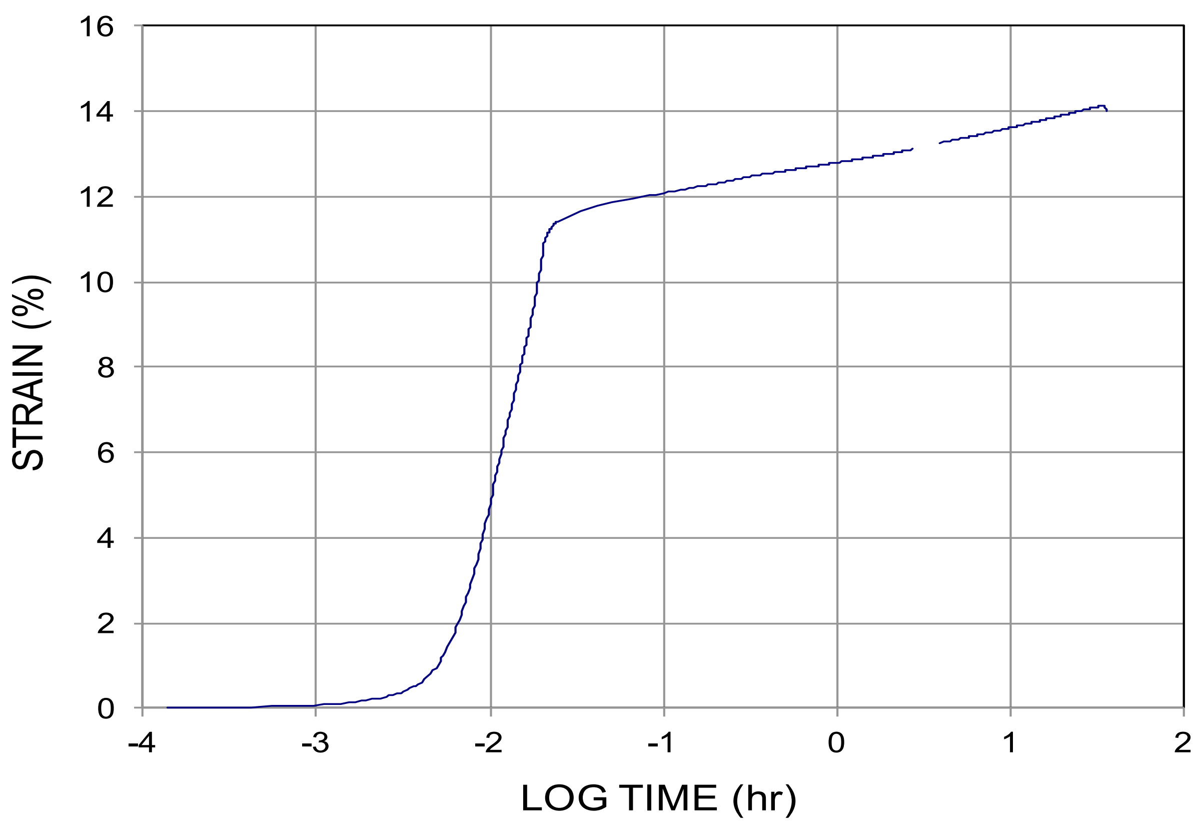

Figure F-10. SIM/Creep data/curve for 8XT at load level of 83.0% UTS.

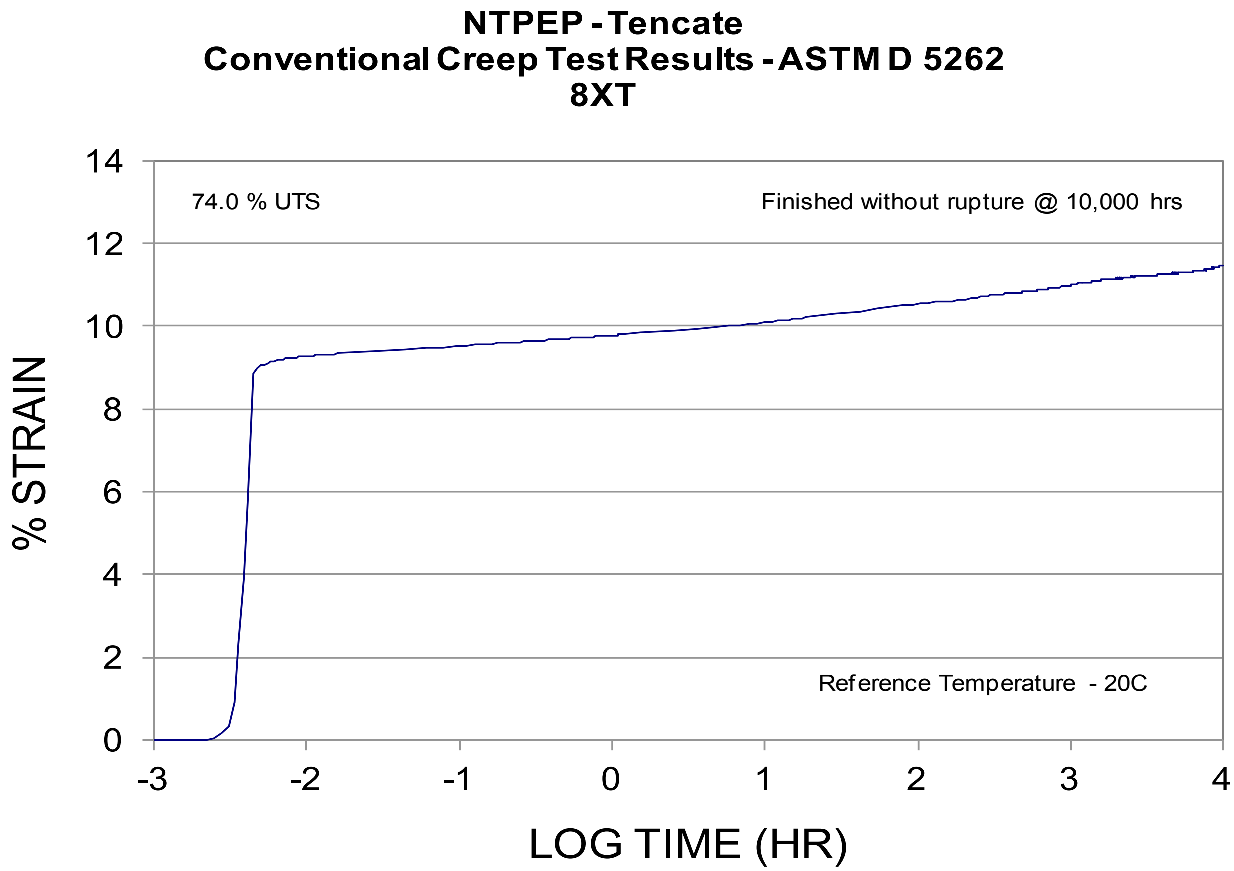

Figure F-11. Creep data/curve per ASTM D5262 for 8XT at a load level of 74.0% UTS and 68°F(20°C)

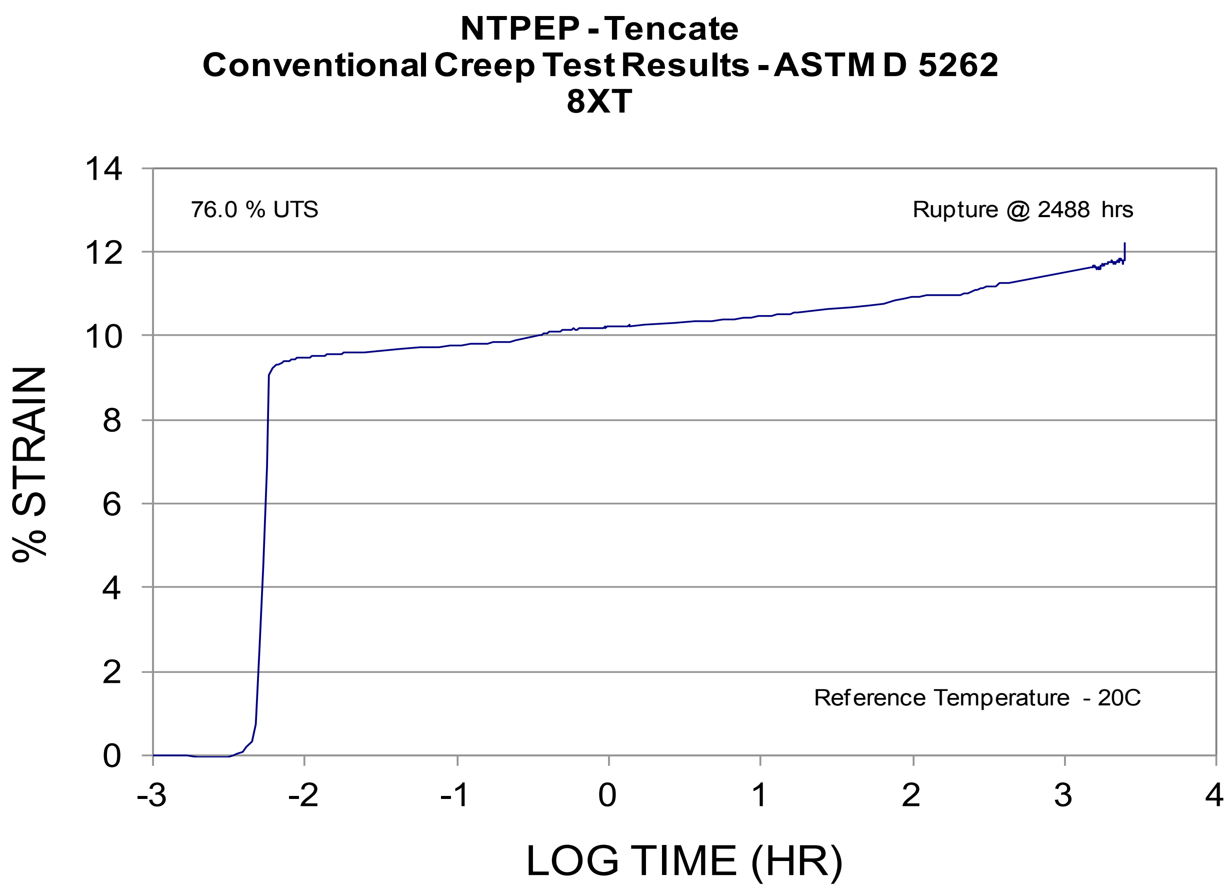

Figure F-12. Creep data/curve per ASTM D5262 for 8XT at a load level of 76.0% UTS and 68°F(20°C)

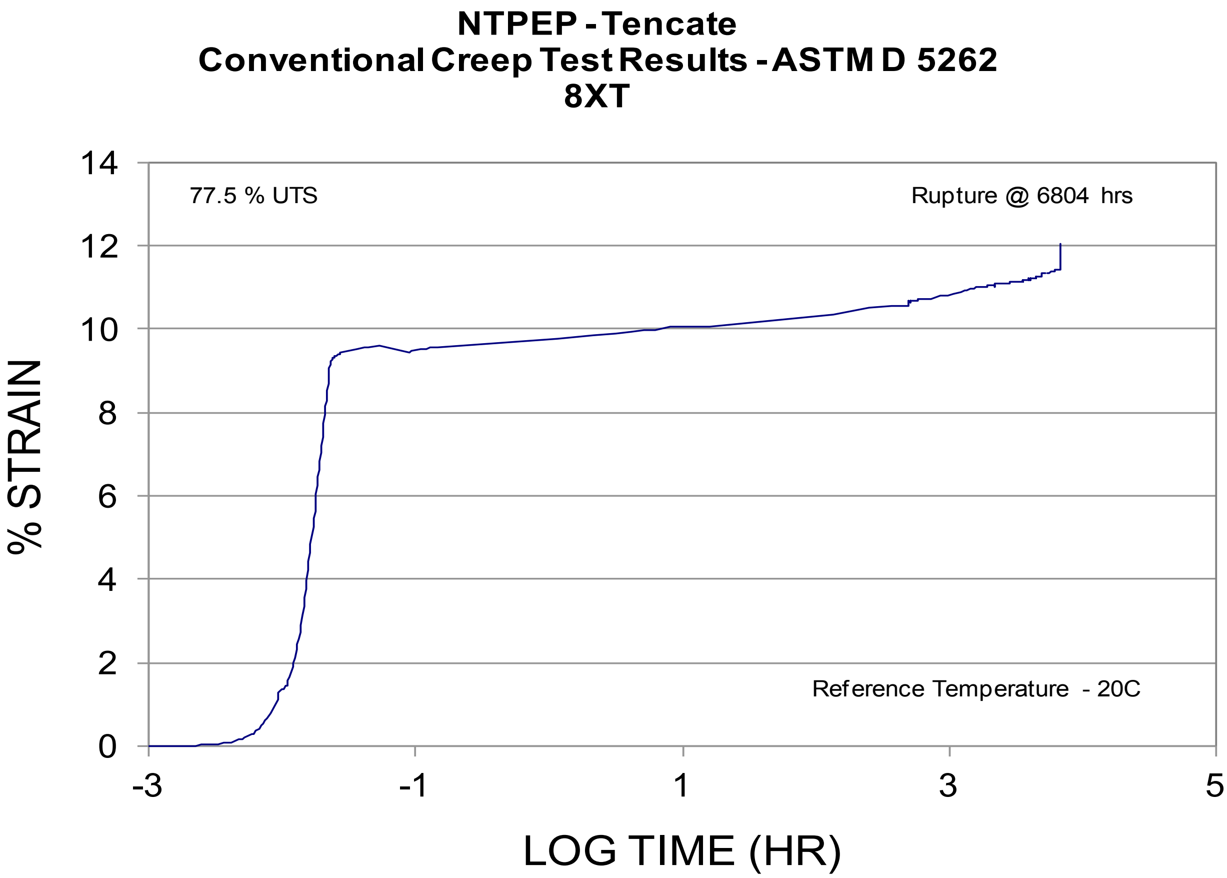

Figure F-13. Creep data/curve per ASTM D5262 for 8XT at a load level of 77.5% UTS and 68°F(20°C)

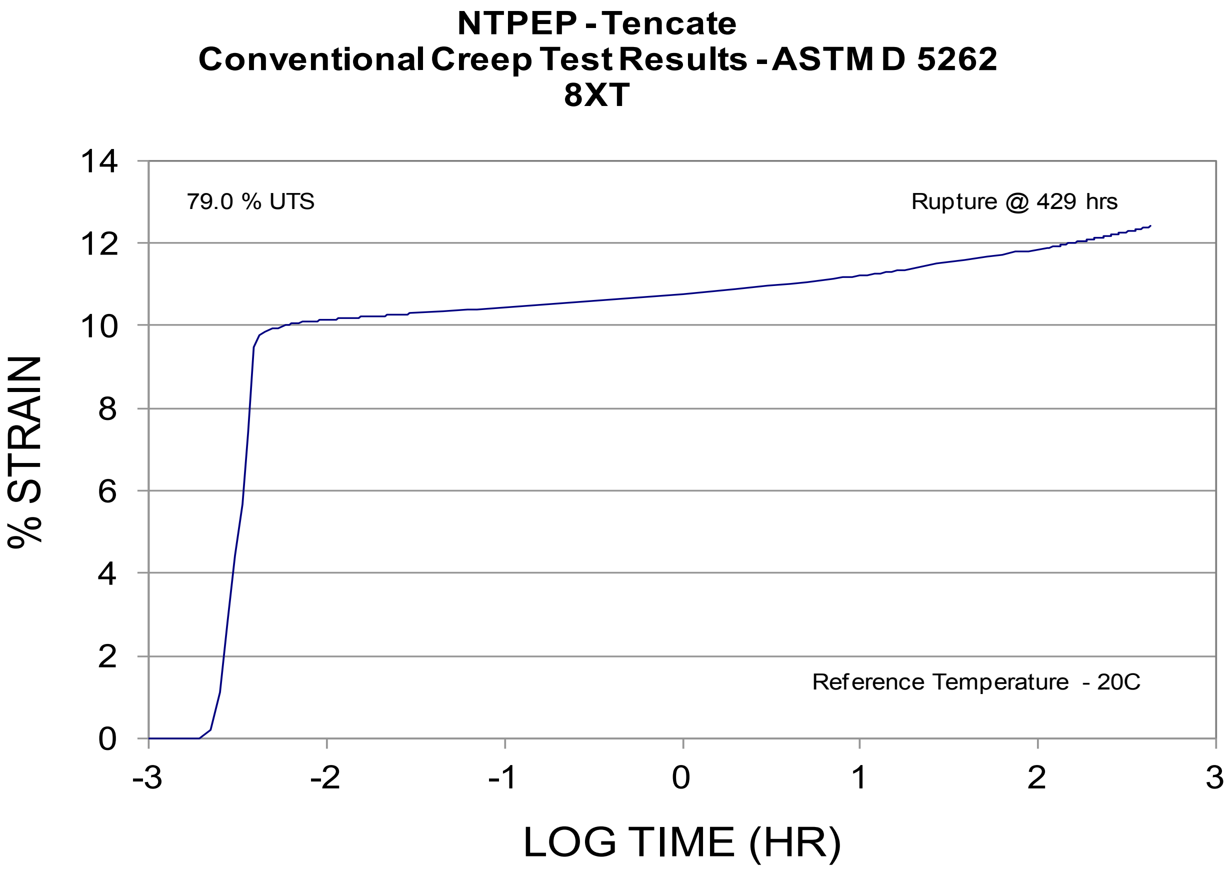

Figure F-14. Creep data/curve per ASTM D5262 for 8XT at a load level of 79.0% UTS and 68°F(20°C)

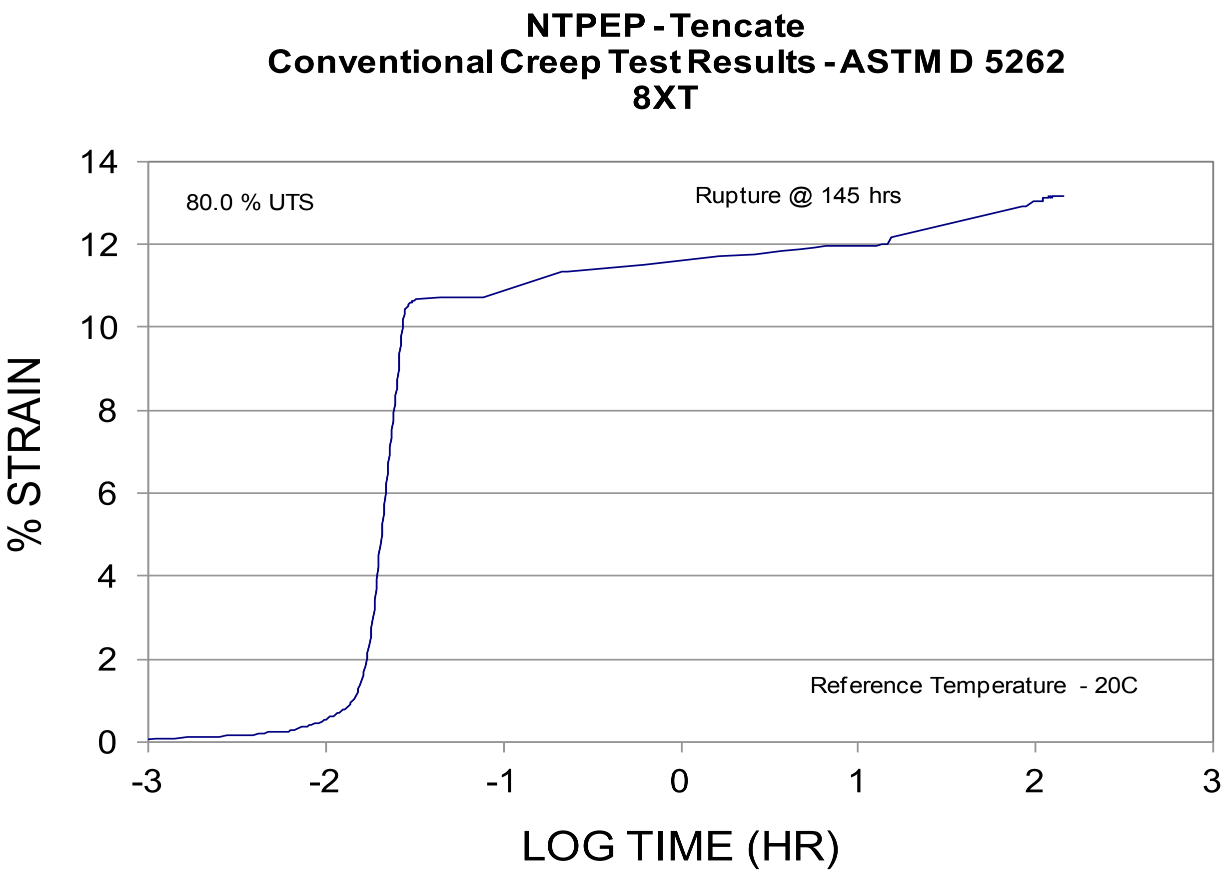

Figure F-15. Creep data/curve per ASTM D5262 for 8XT at a load level of 80.0% UTS and 68°F(20°C)

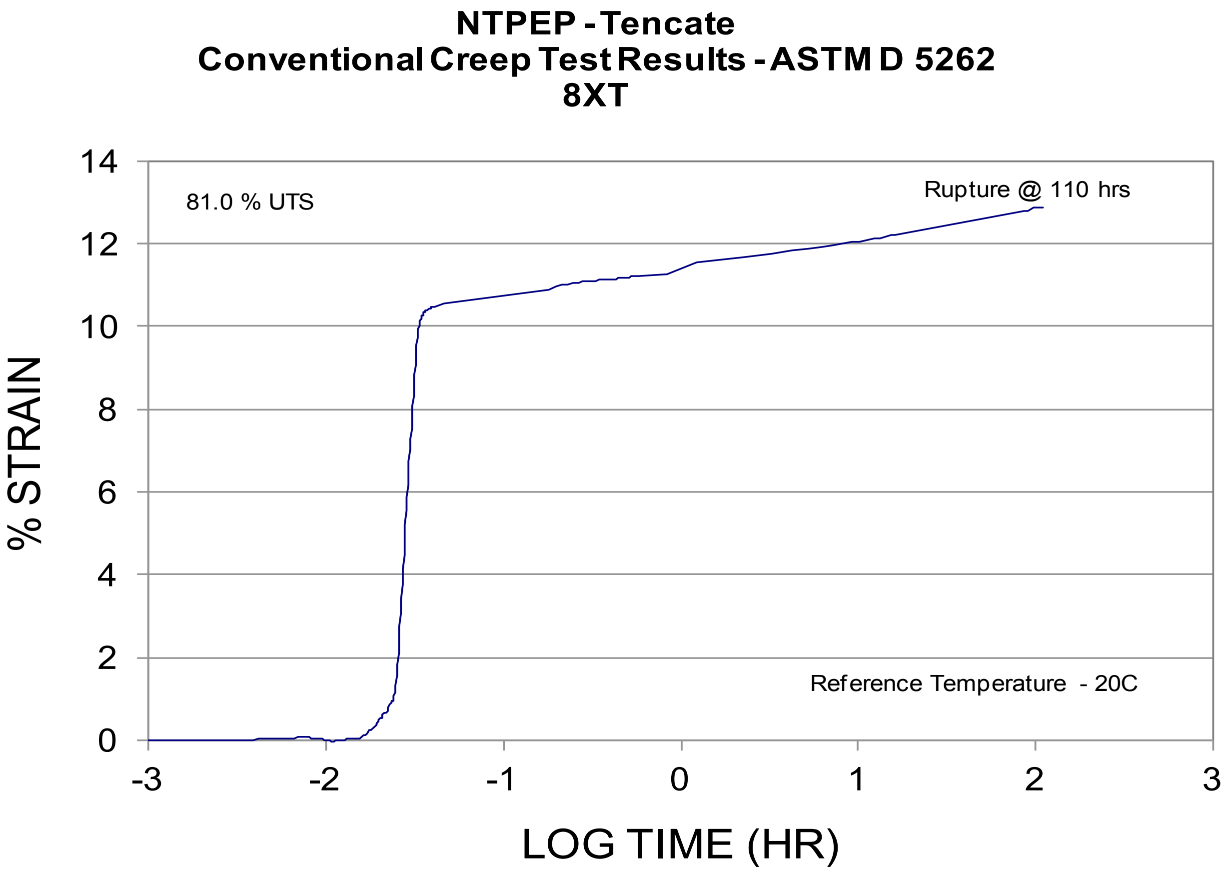

Figure F-16. Creep data/curve per ASTM D5262 for 8XT at a load level of 81.0% UTS and 68°F(20°C)

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 24XT

Specimen: 27463n2m-24XT-sim Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 19932 lb/ft %UTS: 70.00

Ultimate Tensile Strength: 28474 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9300	10020	720	0.12	1.1424	34.1	0.0790
3	19300	20010	710	0.13	1.1775	48.5	0.0817
4	29300	30000	700	0.11	1.1832	63.1	0.0813
5	39400	39990	590	0.15	1.2571	77.6	0.0863
6	49300	49980	680	0.16	1.1909	92.5	0.0801
						AVG	0.0817

Summary	Initial	Final	Units	@20C refT
lab time	76.2	50550	sec	-
$logA_T(t-t')$	1.8820	9.0480	log hours	5.4648
$A_T(t-t')$	-	35.39	years	33.26
Strain	9.75	12.015	%	-
Modulus	205824.8	165892.4	lb/ft	-

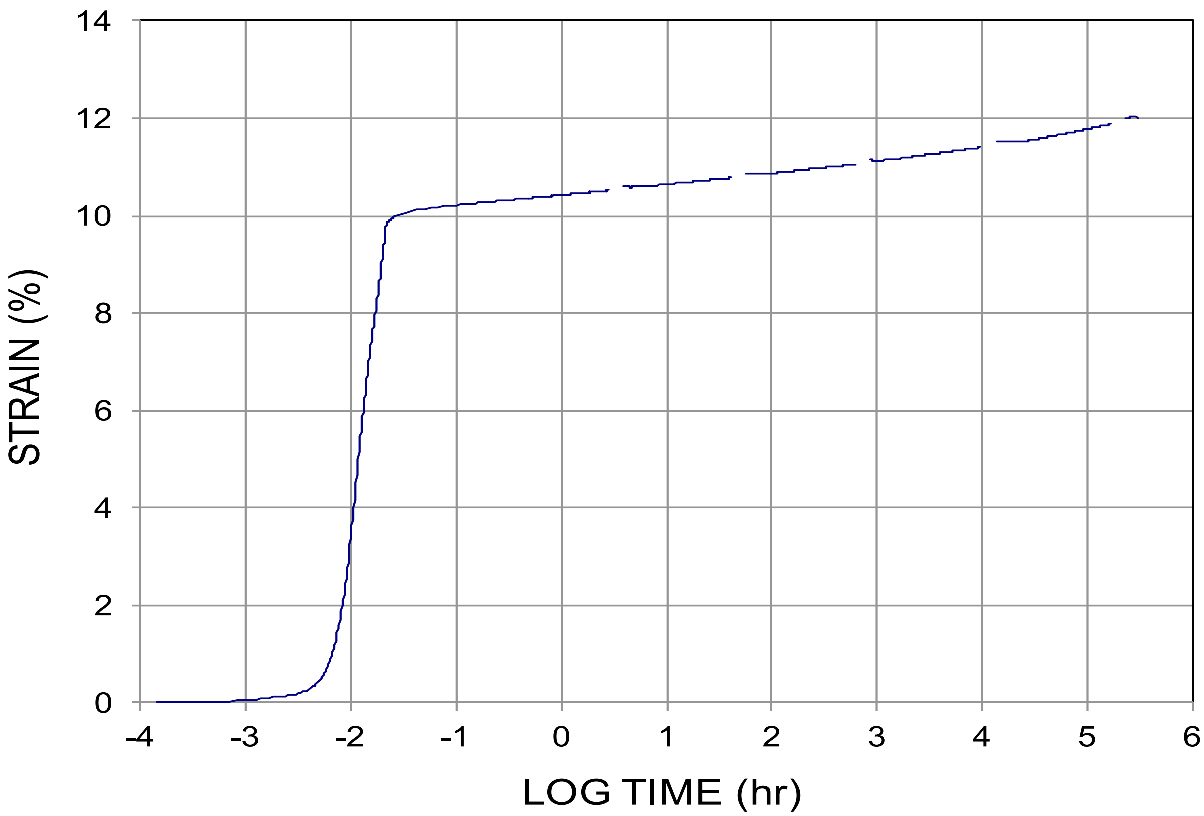

Figure F-17. SIM/Creep data/curve for 24XT at load level of 70.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 24XT

Specimen: 27463n2m-24XT-sim Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 21071 lb/ft %UTS: 74.00
Ultimate Tensile Strength: 28474 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9200	10020	820	0.1	1.0857	34.1	0.0751
3	19200	20010	810	0.12	1.1241	48.5	0.0780
4	29200	30000	800	0.1	1.1291	63.1	0.0776
5	39200	39990	790	0.12	1.1342	77.8	0.0770
6							
						AVG	0.0769

Summary	Initial	Final	Units	@20C refT
lab time	77.0	44130	sec	-
$logA_T(t-t')$	1.8862	8.1660	log hours	4.5842
$A_T(t-t')$	-	4.64	years	4.38
Strain	9.95	12.673	%	-
Modulus	213185.4	166253.1	lb/ft	-

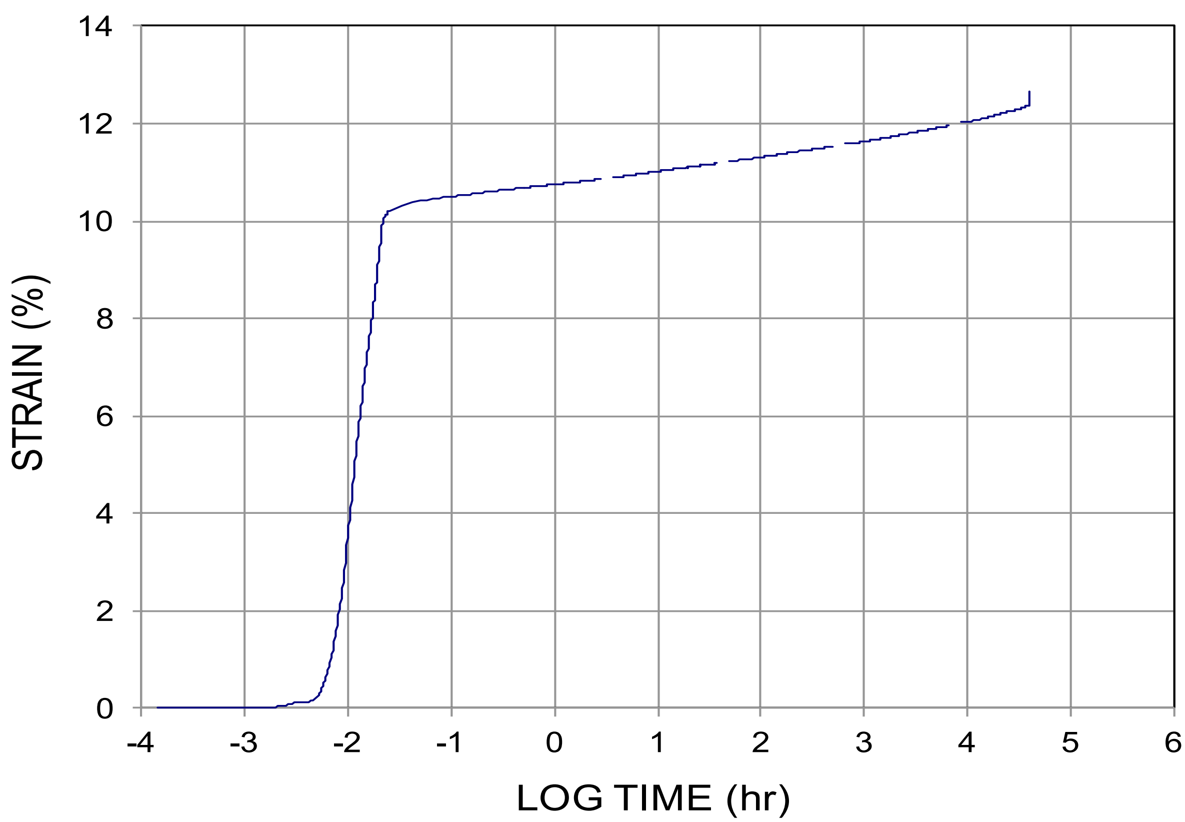

Figure F-18. SIM/Creep data/curve for 24XT at load level of 74.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 24XT

Specimen: 27463n2m-24XT-sim Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 22210 lb/ft %UTS: 78.00
Ultimate Tensile Strength: 28474 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	8900	10020	1120	0.1	0.9503	34.1	0.0657
3	18800	20010	1210	0.1	0.9617	48.5	0.0668
4	28900	30000	1100	0.1	1.0066	63.1	0.0692
5							
6							

Summary	Initial	Final	Units	@20C refT
lab time	84.0	39960	sec	-
$logA_T(t-t')$	1.9242	6.9625	log hours	3.3838
$A_T(t-t')$	-	0.29	years	0.28
Strain	11.05	13.252	%	-
Modulus	202348.6	167584.4	lb/ft	-

AVG 0.0672

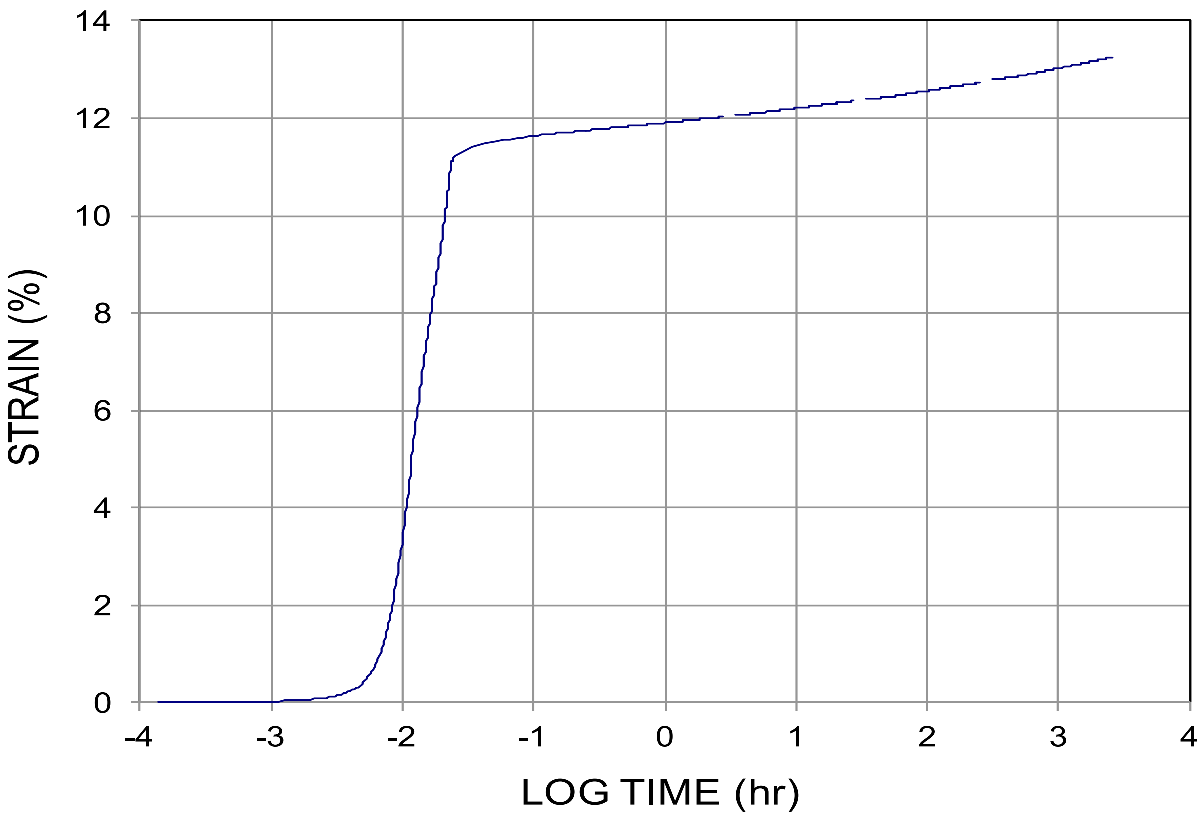

Figure F-19. SIM/Creep data/curve for 24XT at load level of 78.0% UTS.

Accelerated Creep Rupture via SIM - ASTM D 6992

SUMMARY CREEP PARAMETERS: NTPEP - TenCate
Miragrid 24XT

Specimen: 27463n2m-24XT-sim Test Date: June 2017 Method: SIM (10^4s, 14C),single rib, machine dir.

Average Creep Stress: 23349 lb/ft %UTS: 82.00

Ultimate Tensile Strength: 28474 lb/ft Rupture: YES

Dwell Seq	t'	t	$(t-t')_i$	Vshift(%)	$logA_T$	Temp	$logA_T/T$
1	0	0.5	0.5	-	-	19.7	-
2	9300	10020	720	0.09	1.1424	34.1	0.0790
3							
4							
5							
6							

AVG 0.0790

Summary	Initial	Final	Units	@20C refT
lab time	77.5	19980	sec	-
$logA_T(t-t')$	1.8893	5.1709	log hours	1.5877
$A_T(t-t')$	-	0.00	years	0.00
Strain	11.25	13.143	%	-
Modulus	195516.6	177608.3	lb/ft	-

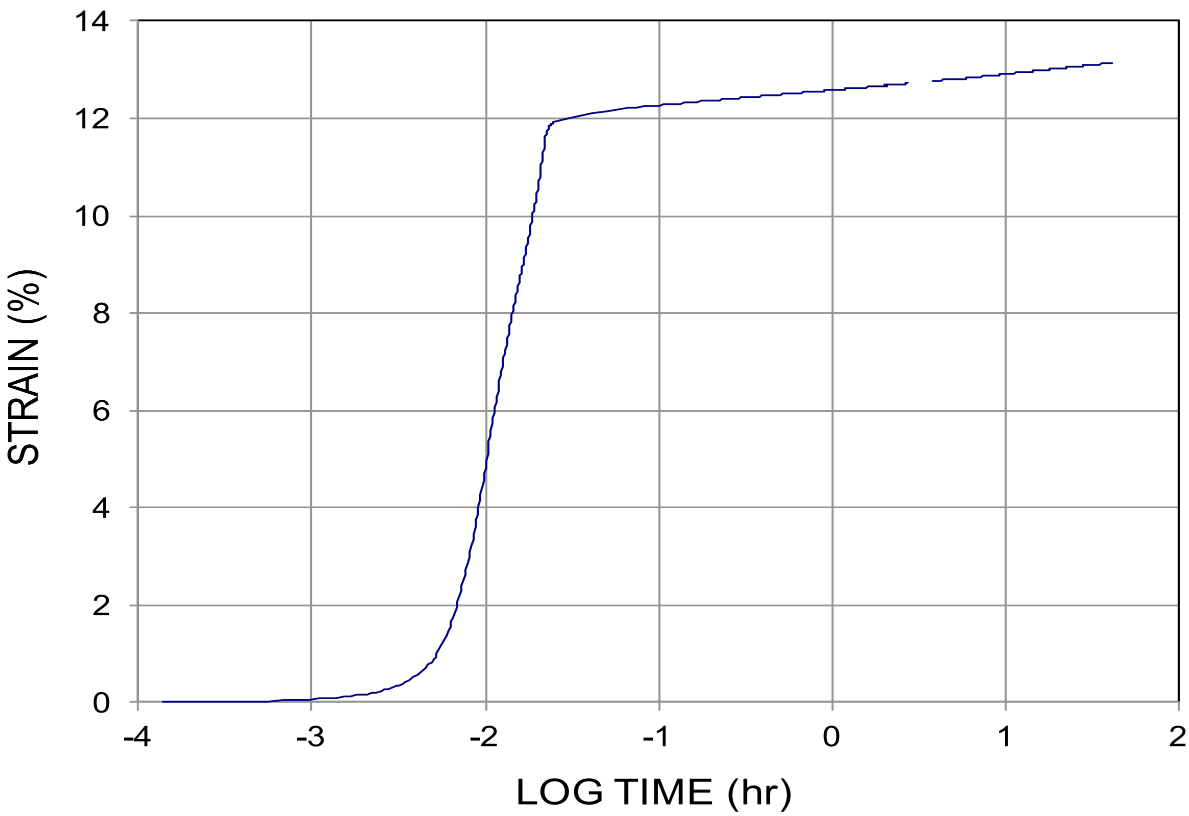

Figure F-20. SIM/Creep data/curve for 24XT at load level of 82.0% UTS.

TenCate Miragrid XT - Creep Rupture

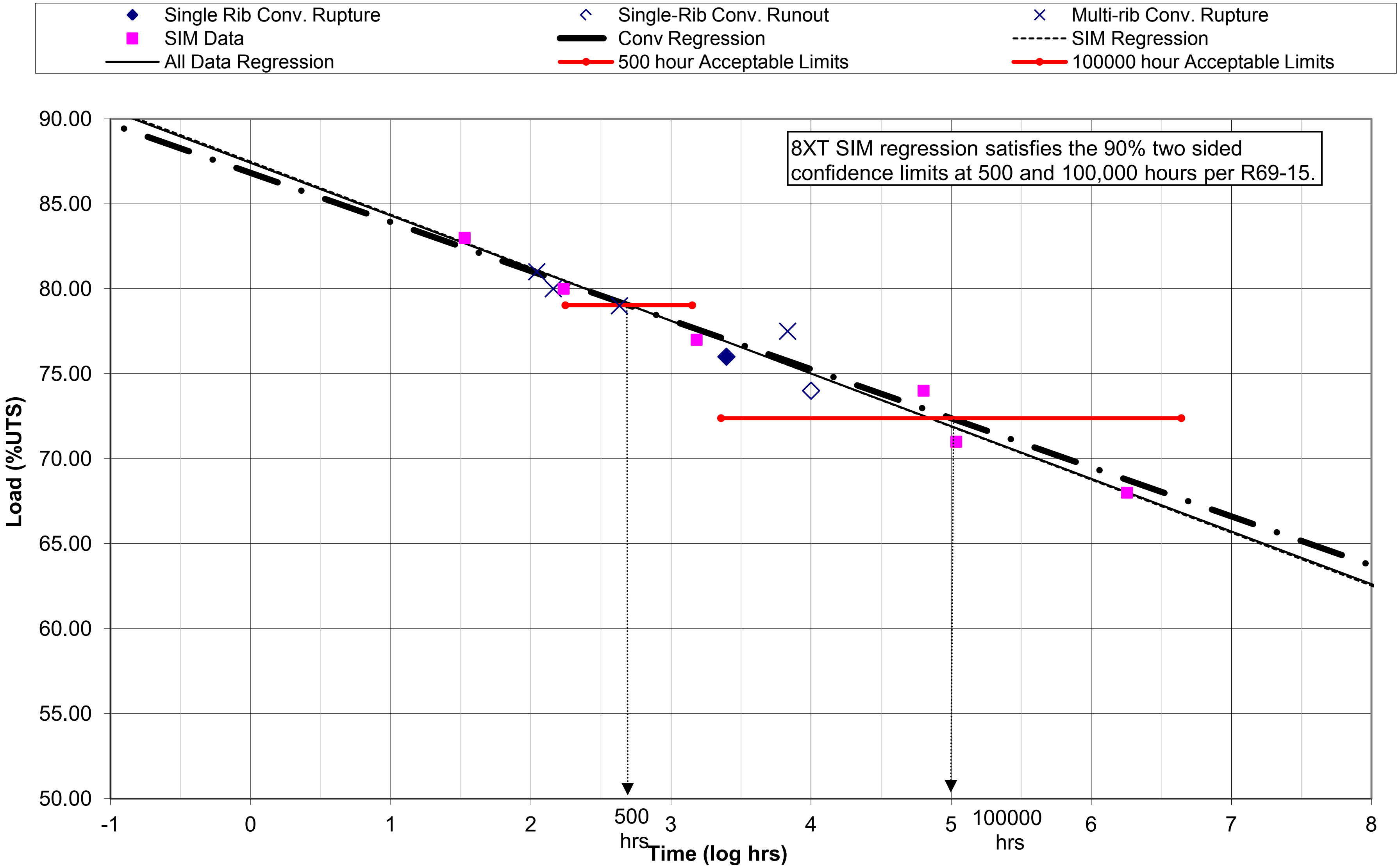

Figure F-21. Statistical evaluation results for determining validity of using SIM to extend TenCate Miragrid XT geogrid conventional creep rupture data, and to compare single-rib to multi-rib data.

Table F-2. Computation table to determine statistical validity of using SIM to extend TenCate Miragrid XT geogrid conventional creep data.

SIM

Test Report	Product	time, log hrs	%UTS	Rupture	Runout
	8XT	6.2548	68.00	68.00	
	8XT	5.0359	71.00	71.00	
	8XT	4.8030	74.00	74.00	
	8XT	3.1833	77.00	77.00	
	8XT	2.2342	80.00	80.00	
	8XT	1.5275	83.00	83.00	

Conventional

Test Report	Product	time, log hrs	%UTS	Rupture	Runout	logti-logtbar	(logti-logtbar)2	Pi - Pbar	(Pi-Pbar)2	K * L
	8XT	2.0423	81.00	81.00		-0.77	0.5935	2.30	5.29	-1.77197
	8XT	2.1602	80.00	80.00		-0.65	0.4258	1.30	1.69	-0.84828
	8XT	2.6325	79.00	79.00		-0.18	0.0325	0.30	0.09	-0.05407
	8XT	3.8328	77.50	77.50		1.02	1.0406	-1.20	1.44	-1.2241
	8XT	3.3958	76.00	76.00		0.58	0.3400	-2.70	7.29	-1.57432
	8XT	4.0000	74.00		74.00					
	Sum	14.0636	393.50		Sum	0.00	2.4324	0.00	15.8	-5.47272
	Mean	2.8127	78.70							

student's t =	2.353	(90% 2-sided prediction limit)	
n-sim =	6		
n-conv =	5	d-o-f	3
treg =	2.699		
treg =	5.000		
P500 =	79.0283		
P100000 =	72.3852		
sigma squared =	0.1789		
sigma =	0.4230		

Conv - 500 hrs (log 2.699)			Conv - 100000 hrs (log 5.000)		
log tL - lower =	2.25	79.0283	log tL - lower =	3.36	72.3852
log tL - upper =	3.15	79.0283	log tL - upper =	6.64	72.3852
SIM - logtL @ Load =	**2.71**	**OK**	SIM - logtL @ Load =	**4.84**	**OK**

90% 2-sided conf. limit	
df	student's t
2	2.92
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.86
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761

SIM - All Points		
time is dependent variable:		
	if time were the y axis	but time is the x axis
slope	-0.32058	-3.11931
intercept	28.04386	87.47747
R squared	0.978279	0.978279
	-2	93.71609
	10	56.28438
2.6990	79.05846	= 500 hr intercept
5.0000	71.88093	= 100000 hr intercept
Conventional - All Points		
time is dependent variable:		
	if time were the y axis	but time is the x axis
slope	-0.34637	-2.88705
intercept	30.07241	86.82045
R squared	0.779332	0.779332
	-2	92.59455
	10	57.94998
2.6990	79.02831	= 500 hr intercept
5.0000	72.38522	= 100000 hr intercept
All Creep Data (conv & SIM)		
time is dependent variable:		
	if time were the y axis	but time is the x axis
slope	-0.32266	-3.09923
intercept	28.20314	87.40805
R squared	0.958555	0.958555
	-2	93.60652
	10	56.41575
2.6990	79.04323	= 500 hr intercept
5.0000	71.9119	= 100000 hr intercept

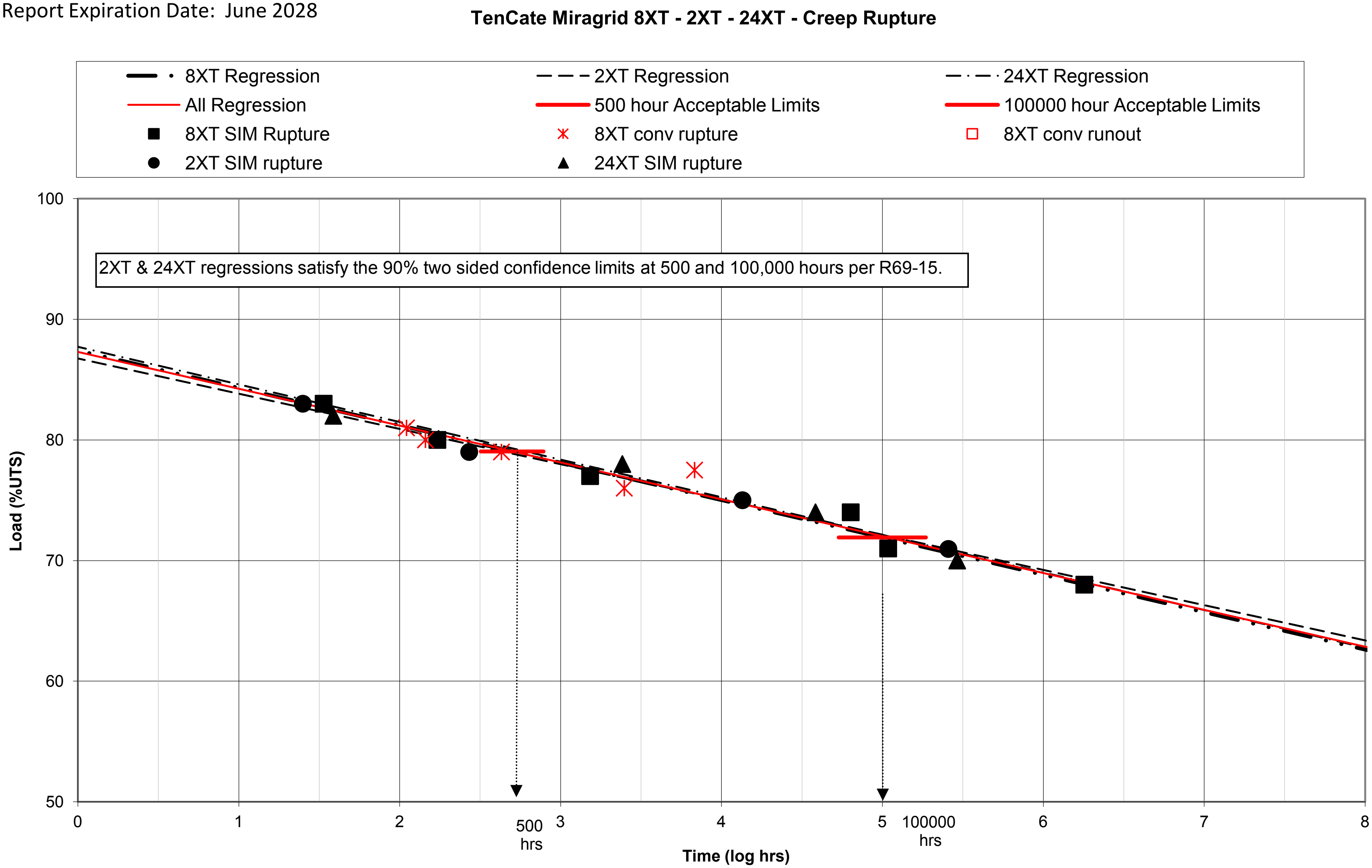

Figure F-22. Statistical evaluation results for determining validity of creating composite creep rupture envelope for the TenCate Miragrid XT geogrid product line.

Table F-3. Computation table to determine statistical validity of creating composite creep rupture envelope for the TenCate Miragrid XT geogrid product line - 2XT and 8XT comparision.

Miragrid 2XT Creep Data Evaluation

SIM Tests on 2XT

Test Report	Product	Expected time, log hrs	%UTS	Rupture
	2XT	5.4100	70.96	70.96
	2XT	4.1304	75.00	75.00
	2XT	2.4319	79.00	79.00
	2XT	1.3981	83.00	83.00

student's t =	1.833	(90% 2-sided prediction limit)	
n-2XT =	4		
n-8XT =	11	d-o-f	9
treg =	2.6990		
treg =	4.6990		
P500 =	79.0432		
P100000 =	71.9119		
sigma squared =	0.1006		
sigma =	0.3172		

SIM & Conventional Tests on 8XT

Test Report	Product	time, log hrs	%UTS	Rupture	Runout	logti-logtbar	(logti-logtbar)2	Pi - Pbar	(Pi-Pbar)2	K * L	
	8XT	6.2548	68.00	68.00		2.88	8.3051	-8.95	80.18388	-25.8058	SIM
	8XT	5.0359	71.00	71.00		1.66	2.7654	-5.95	35.45661	-9.90219	SIM
	8XT	4.8030	74.00	74.00		1.43	2.0451	-2.95	8.729339	-4.22519	SIM
	8XT	3.1833	77.00	77.00		-0.19	0.0360	0.05	0.002066	-0.00862	SIM
	8XT	2.2342	80.00	80.00		-1.14	1.2967	3.05	9.274793	-3.46797	SIM
	8XT	1.5275	83.00	83.00		-1.85	3.4056	6.05	36.54752	-11.1565	SIM
	8XT										SIM
	8XT										SIM
	8XT	2.0423	81.00	81.00		-1.33	1.7706	4.05	16.3657	-5.38303	Conv
	8XT	2.1602	80.00	80.00		-1.21	1.4707	3.05	9.274793	-3.69333	Conv
	8XT	2.6325	79.00	79.00		-0.74	0.5482	2.05	4.183884	-1.51453	Conv
	8XT	3.8328	77.50	77.50		0.46	0.2115	0.55	0.297521	0.250835	Conv
	8XT	3.3958	76.00	76.00		0.02	0.0005	-0.95	0.911157	-0.02182	Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
Sum		37.1023	846.50		Sum	0.00	21.8556	0.00	201.2273	-64.9281	
Mean		3.3729	76.95								

* runout plotting below the regression line is not included in the regression

8XT - 500 hrs (log 2.699)			8XT - 100000 hrs (log 5.000)		
log tL - lower =	2.50	79.0432	log tL - lower =	4.73	71.9119
log tL - upper =	2.89	79.0432	log tL - upper =	5.27	71.9119
2XT - logtL @ Load =	2.64	**OK**	**2XT - logtL @ Load =**	5.08	**OK**

90% 2-sided conf. limit	
df	student's t
2	2.92
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.86
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761

2XT- All Points
time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.34233	-2.92116	
intercept	29.69855	86.75427	
R squared	0.992249	0.992249	
	-2	92.5966	
	10	57.54266	
2.6990	78.87006	= 500 hr intercept	
5.0000	72.14847	= 100000 hr intercept	

8XT - All Points
time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.32266	-3.09923	
intercept	28.20314	87.40805	
R squared	0.958555	0.958555	
	-2	93.60652	
	10	56.41575	
2.6990	79.04323	= 500 hr intercept	
5.0000	71.9119	= 100000 hr intercept	

All Creep Data 8XT & 2XT (conv & SIM)
time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.32934	-3.0364	
intercept	28.73243	87.24317	
R squared	0.970822	0.970822	
	-2	93.31597	
	10	56.87916	
5.8176	69.5786	= 75-yr intercept	
5.9425	69.19936	= 100-yr intercept	

Table F-4. Computation table to determine statistical validity of creating composite creep rupture envelope for the TenCate Miragrid XT geogrid product line - 24XT and 8XT comparision.

Miragrid 24XT Creep Data Evaluation

SIM Tests on 24XT

Test Report	Product	Expected time, log hrs	%UTS	Rupture
	24XT	5.4648	70.00	70.00
	24XT	4.5842	74.00	74.00
	24XT	3.3838	78.00	78.00
	24XT	1.5877	82.00	82.00

student's t =	1.833	(90% 2-sided prediction limit)	
n-24XT =	4		
n-8XT =	11	d-o-f	9
treg =	2.6990		
treg =	4.6990		
P500 =	79.0432		
P100000 =	71.9119		
sigma squared =	0.1006		
sigma =	0.3172		

90% 2-sided conf. limit

df	student's t
2	2.92
3	2.353
4	2.132
5	2.015
6	1.943
7	1.895
8	1.86
9	1.833
10	1.812
11	1.796
12	1.782
13	1.771
14	1.761

SIM & Conventional Tests on 8XT

Test Report	Product	time, log hrs	%UTS	Rupture	Runout	logti-logtbar	(logti-logtbar)2	Pi - Pbar	(Pi-Pbar)2	K * L	
	8XT	6.2548	68.00	68.00		2.88	8.3051	-8.95	80.18388	-25.8058	SIM
	8XT	5.0359	71.00	71.00		1.66	2.7654	-5.95	35.45661	-9.90219	SIM
	8XT	4.8030	74.00	74.00		1.43	2.0451	-2.95	8.729339	-4.22519	SIM
	8XT	3.1833	77.00	77.00		-0.19	0.0360	0.05	0.002066	-0.00862	SIM
	8XT	2.2342	80.00	80.00		-1.14	1.2967	3.05	9.274793	-3.46797	SIM
	8XT	1.5275	83.00	83.00		-1.85	3.4056	6.05	36.54752	-11.1565	SIM
	8XT										SIM
	8XT										SIM
	8XT	2.0423	81.00	81.00		-1.33	1.7706	4.05	16.3657	-5.38303	Conv
	8XT	2.1602	80.00	80.00		-1.21	1.4707	3.05	9.274793	-3.69333	Conv
	8XT	2.6325	79.00	79.00		-0.74	0.5482	2.05	4.183884	-1.51453	Conv
	8XT	3.8328	77.50	77.50		0.46	0.2115	0.55	0.297521	0.250835	Conv
	8XT	3.3958	76.00	76.00		0.02	0.0005	-0.95	0.911157	-0.02182	Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
	8XT										Conv
Sum		37.1023	846.50		Sum	0.00	21.8556	0.00	201.2273	-64.9281	
Mean		3.3729	76.95								

* runout plotting below the regression line is not included in the regression

8XT - 500 hrs (log 2.699)			8XT - 100000 hrs (log 5.000)		
log tL - lower =	2.50	79.0432	log tL - lower =	4.73	71.9119
log tL - upper =	2.89	79.0432	log tL - upper =	5.27	71.9119
24XT - logtL @ Load =	2.78	**OK**	**24XT - logtL @ Load =**	5.07	**OK**

24XT - All Points

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.32079	-3.11728	
intercept	28.13536	87.70578	
R squared	0.97474	0.97474	
	-2	93.94034	
	10	56.53298	
	2.6990	79.29224	= 500 hr intercept
	5.0000	72.11938	= 100000 hr intercept

8XT - All Points

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.32266	-3.09923	
intercept	28.20314	87.40805	
R squared	0.958555	0.958555	
	-2	93.60652	
	10	56.41575	
	2.6990	79.04323	= 500 hr intercept
	5.0000	71.9119	= 100000 hr intercept

All Creep Data 8XT & 24XT (conv & SIM)

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.32027	-3.12234	
intercept	28.05057	87.58337	
R squared	0.976551	0.976551	
	-2	93.82805	
	10	56.35998	
	5.8176	69.41885	= 75-yr intercept
	5.9425	69.02887	= 100-yr intercept

Table F-5. Computation table for composite creep rupture envelope for the TenCate Miragrid XT geogrid product line.

Stress, % of UTS

data for regression calculation

product:		loghrs	all	2XT	24XT	8XT	sim rupture	rlt rupture	conv''l rupture	sim runout*	conv'l runout*
SIM DATA:	2XT	5.4100	70.96	70.96			70.96				
	2XT	4.1304	75.00	75.00			75.00				
	2XT	2.4319	79.00	79.00			79.00				
	2XT	1.3981	83.00	83.00			83.00				
	24XT	5.4648	70.00		70.00		70.00				
	24XT	4.5842	74.00		74.00		74.00				
	24XT	3.3838	78.00		78.00		78.00				
	24XT	1.5877	82.00		82.00		82.00				
	8XT	6.2548	68.00			68.00	68.00				
	8XT	5.0359	71.00			71.00	71.00				
	8XT	4.8030	74.00			74.00	74.00				
	8XT	3.1833	77.00			77.00	77.00				
	8XT	2.2342	80.00			80.00	80.00				
	8XT	1.5275	83.00			83.00	83.00				
CONV DATA:	8XT	2.0423	81.00			81.00			81.00		
	8XT	2.1602	80.00			80.00			80.00		
	8XT	2.6325	79.00			79.00			79.00		
	8XT	3.8328	77.50			77.50			77.50		
	8XT	3.3958	76.00			76.00			76.00		
	8XT	4.0000				74.00					74.00

NOTE: Don't include runouts in the regression calculation unless the points lie above the line

SIM Only - All

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.3263348	-3.064338	
intercept	28.497362	87.325548	
R squared	0.9802268	0.9802268	
	-2	93.454224	
	10	56.682168	
6.000	68.94	= 114 Year intercept	
5.943	69.11	= 100 Year intercept	
5.818	69.50	= 75 Year intercept	
4.420	73.78	= 3 Year intercept	

SIM & Conventional - All

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.3272588	-3.0557	
intercept	28.567742	87.2940	
R squared	0.9692884	0.9693	
	-2	93.405404	
	10	56.737178	
6.000	68.96	= 114 Year intercept	
5.943	69.13	= 100 Year intercept	
5.818	69.52	= 75 Year intercept	
4.420	73.79	= 3 Year intercept	

SIM & Conventional - 2XT

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.34233	-2.9212	
intercept	29.69855	86.7543	
R squared	0.992249	0.99225	
	-2	92.5966	
	10	57.5427	
6	69.22731	= 114 Year intercept	
5.817863	69.75936	= 75 Year intercept	

SIM & Conventional - 24XT

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.320793	-3.1173	
intercept	28.13536	87.7058	
R squared	0.97474	0.97474	
	-2	93.9403	
	10	56.533	
6	69.0021	= 114 Year intercept	
5.817863	69.56987	= 75 Year intercept	

SIM Only - 8XT

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.320584	-3.1193	
intercept	28.04386	87.4775	
R squared	0.978279	0.97828	
	-2	93.7161	
	10	56.2844	
5.999706	68.76253	= 114 Year intercept	
5.817863	69.32976	= 75 Year intercept	

SIM & Conventional - 8XT

time is dependent variable:

	if time were the y axis	but time is the x axis	
slope	-0.318438	-3.1403	
intercept	27.85201	87.4646	
R squared	0.955004	0.955	
	-2	93.7452	
	10	56.0612	
5.999706	68.6235	= 114 Year intercept	
5.817863	69.19455	= 75 Year intercept	

The regression for the conventional creep tests produced at log 2.699 hr (500 hrs) and log 5.000 hr (100,000 hrs) intercepts at 79.03% and 72.39% UTS, respectively. The regression for the accelerated creep tests (SIM) produced log 2.71 and log 4.84, respectively, for the same %UTS. This was within the 90% confidence limits of log 2.25 to log 3.15 and log 3.36 to log 6.64 associated with those %UTS. This evaluation is summarized in Table F-6. Thus, the conventional and accelerated data may be used together to construct the characteristic creep rupture curve of the primary product. Confidence limits satisfied per R69-15.

Table F-6. Summary of statistical comparison between SIM and conventional creep rupture envelopes.

Product	Intercept at log 2.699 & 5.000 hrs, %UTS	Intercept at same % UTS, log hrs	90% Confidence Limits @ Higher %UTS, log hrs	90% Confidence Limits @ Lower %UTS, log hrs
8XT	79.03 & 72.39	2.699 & 5.000	-	-
8XT SIM	-	2.71 & 4.84	2.25 to 3.15	3.36 to 6.64

The regression for the all creep tests on the primary product (8XT) produced log 2.699 hr (500 hrs) and log 5.000 hr (100,000 hrs) intercepts at 79.04% and 71.91% UTS, respectively. The regression for the creep tests on 2XT & 24XT produced log time intercepts for the same %UTS within the 90% confidence limits of log 2.50 to log 2.89 and log 4.73 to log 5.27 associated with those %UTS. This evaluation is summarized in Table F-7. Thus, the primary, 8XT, and secondary products, 2XT & 24XT, data may be used together to construct the characteristic creep rupture curve of the family of products. Confidence limits satisfied per R69-15.

Table F-7. Summary of statistical comparison between rupture envelopes for all tested Miragrid geogrid products, to test validity of composite creep rupture envelope for product line.

Product	Intercept at log 2.699 & 5.000 hrs, %UTS	Intercept at same % UTS, log hrs	90% Confidence Limits @ Higher %UTS, log hrs	90% Confidence Limits @ Lower %UTS, log hrs
8XT	79.04 & 71.91	2.699 & 5.000	-	-
2XT		2.64 & 5.08	2.50 to 2.89	4.73 to 5.27
24XT	-	2.78 & 5.07	2.50 to 2.89	4.73 to 5.27

Appendix G: Durability Detailed Test Results

Table G-1. Yarn test results to evaluate susceptibility to hydrolysis

Material: Polyester Yarn
Product Identification: Yarn used to produce Miragrid XT Geogrids

PARAMETER	TEST REPLICATE NUMBER 1	2	3	MEAN	STD. DEV.
Carboxyl End Group (CEG) Count (Test Method: GRI GG7)					
mmol/Kg	15.7	16.1	15.8	**15.9**	0.2
Molecular Weight (Test Method: GRI GG8)					
Mn (Number average molecular weight)	35,109	29,455	33,786	**32,783**	2,957

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table G-2. UV resistance test results of TenCate Miragrid 2XT geogrid.

PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	MEAN	STD. DEV.	PERCENT RETAINED
UV Resistance (ASTM D 4355)								
Strength Retained measured via single strip tensile (ASTM D 6637, Method A)								
MD - Number of Ribs per foot:	10.80							
MD - Tensile Strength (lbs) - B	246.4	246.6	245.5	243.0	249.4	**246**	2	
MD - Tensile Strength (lb/ft) - B	2661	2663	2651	2624	2694	**2659**	25	
MD - Tensile Strength (kN/m) - B	38.9	38.9	38.7	38.3	39.3	**38.8**	0.4	
MD - Tensile Strength (lbs) - E	233.6	222.8	236.7	233.9	234.1	**232**	5	
MD - Tensile Strength (lb/ft) - E	2523	2406	2556	2526	2528	**2508**	58	**94**
MD - Tensile Strength (kN/m) - E	36.8	35.1	37.3	36.9	36.9	**36.6**	0.9	
MD - Elong. @ Max. Load (%) - B	9.53	9.22	9.06	8.94	9.58	**9.27**	0.28	
MD - Elong. @ Max. Load (%) - E	9.22	8.69	9.53	9.50	9.40	**9.27**	0.35	**100**

B - Baseline Unexposed
E - Exposed for 500 hours of ASTM D 4355 Cycle

MD - Machine Direction TD - Transverse/Cross Machine Direction

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested.

Table G-3. Summary of UV resistance test results for Miragrid 2XT geogrid.

Miragrid XT Series Style	Mean Baseline Tensile Strength (lb/ft)	Standard Deviation (lb/ft)	Mean Exposed Tensile Strength (lb/ft)	Standard Deviation (lb/ft)	% Strength Retained
2XT	2,659	25	2,508	58	94

(Conversion: 1 lb/ft = 0.0146 kN/m)

Appendix H: Creep Stiffness Detailed Test Results

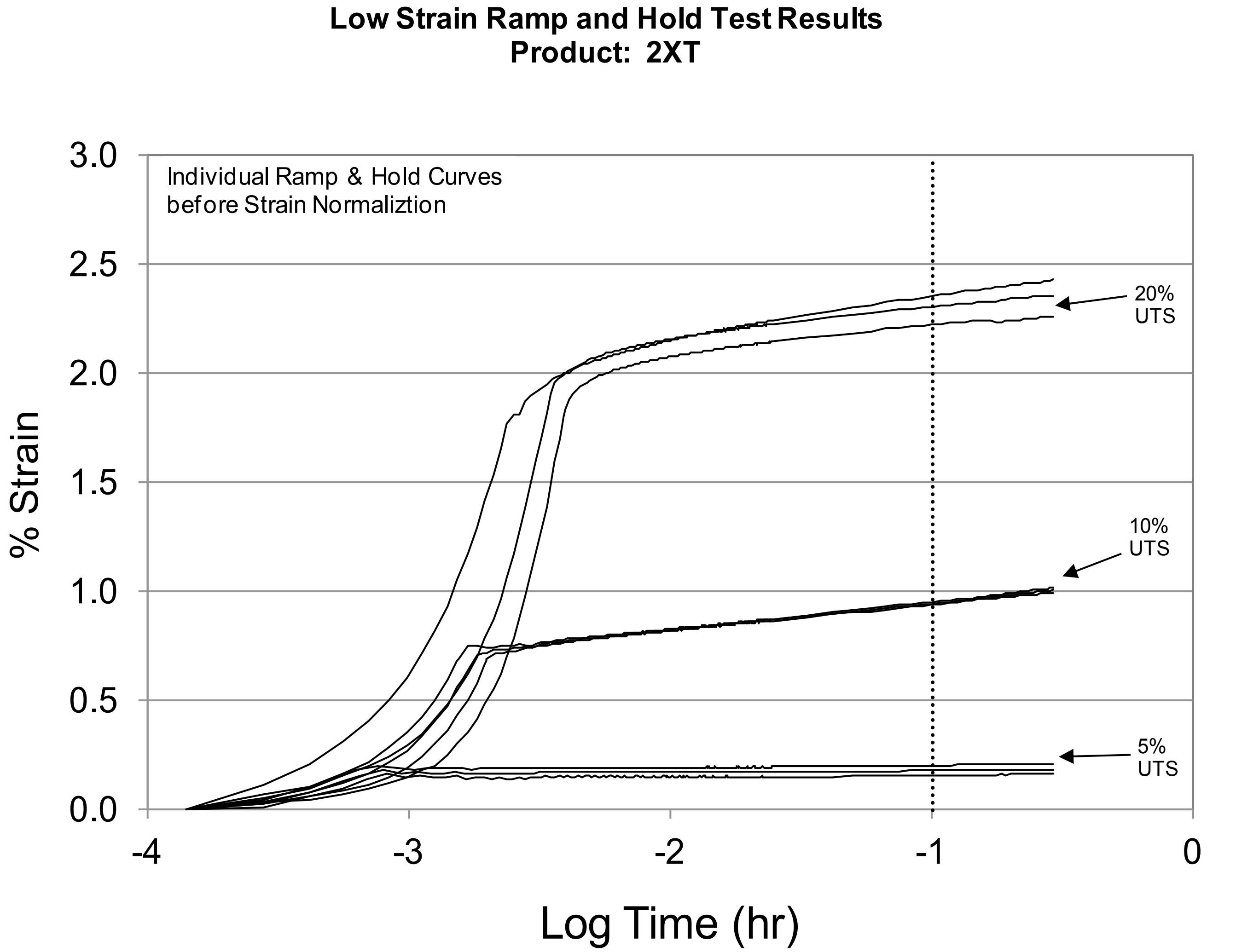

Figure H-1. Low strain ramp and hold tests for 2XT, before strain normalization.

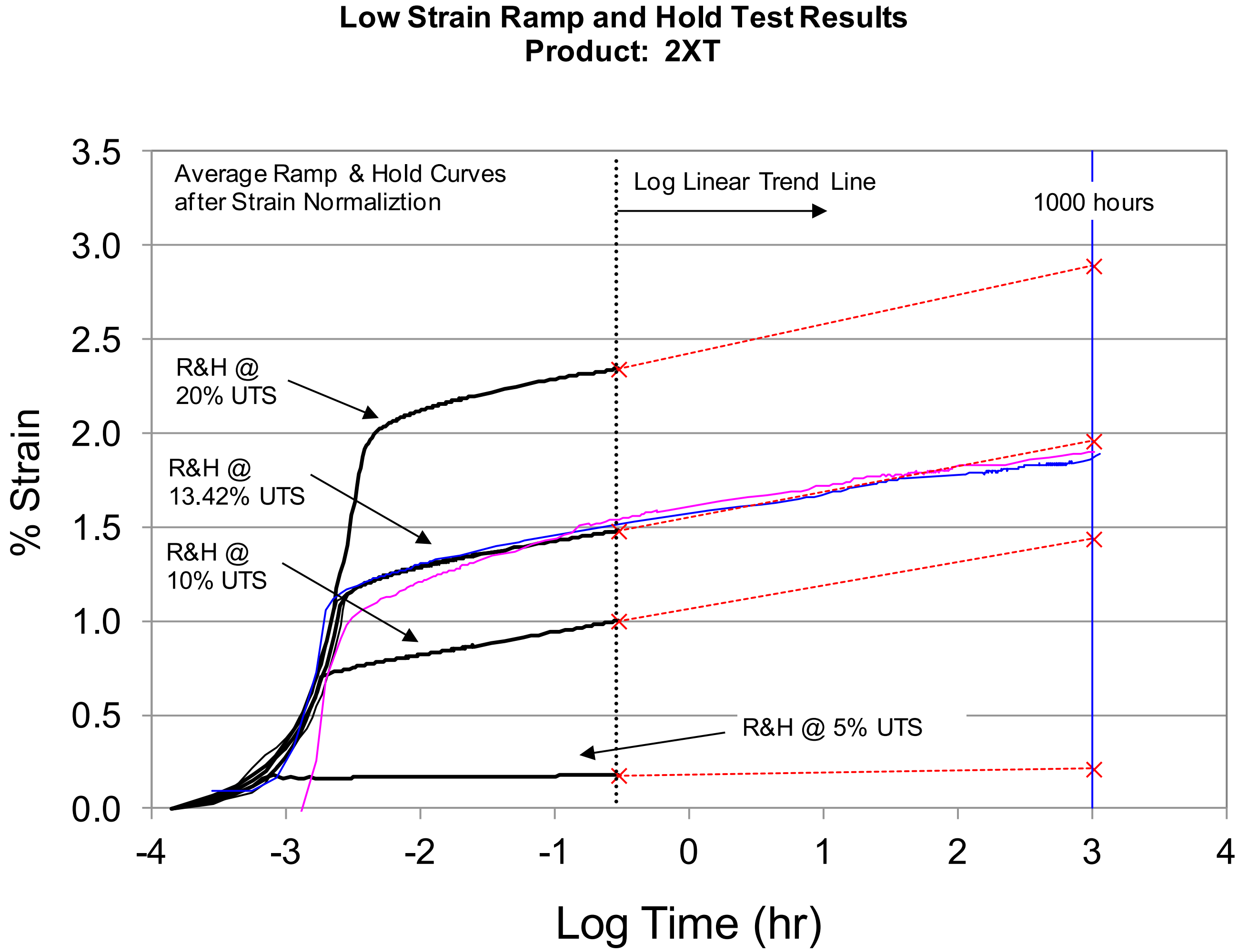

Figure H-2. Low strain ramp and hold tests for 2XT, after strain normalization, with 1000 hour low strain creep tests.

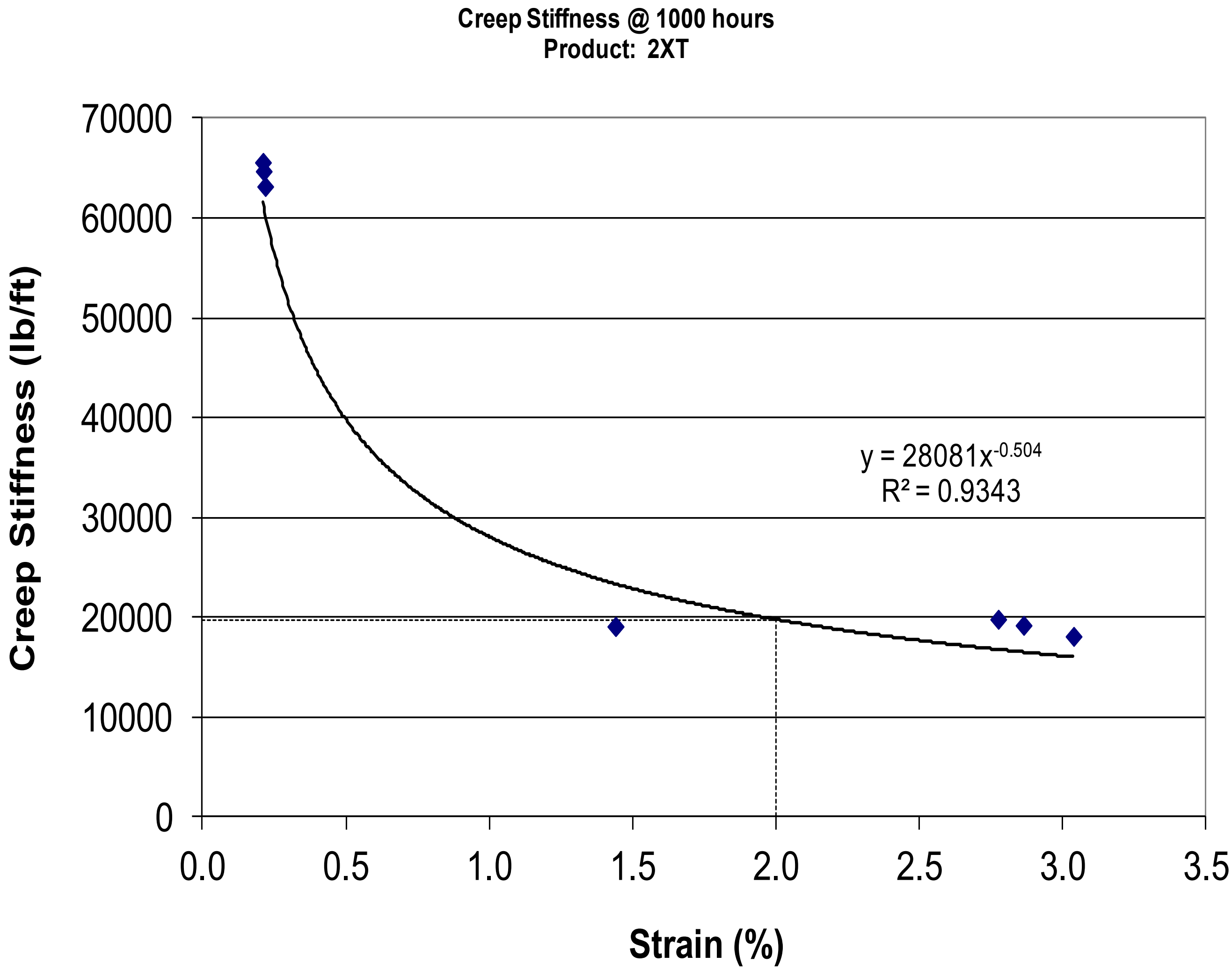

Figure H-3. Creep stiffness versus strain at 1,000 hours for 2XT.

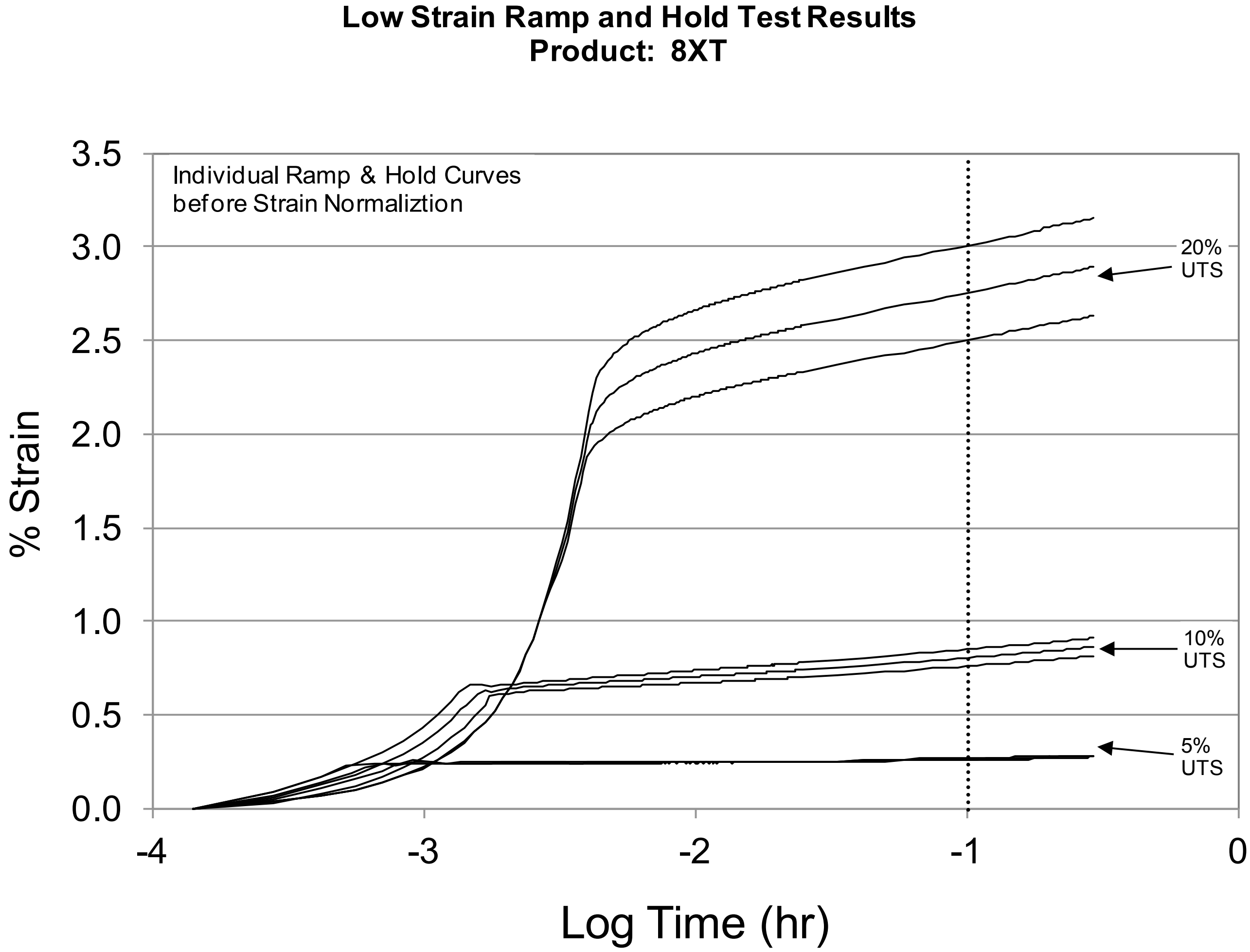

Figure H-4. Low strain ramp and hold tests for 8XT, before strain normalization.

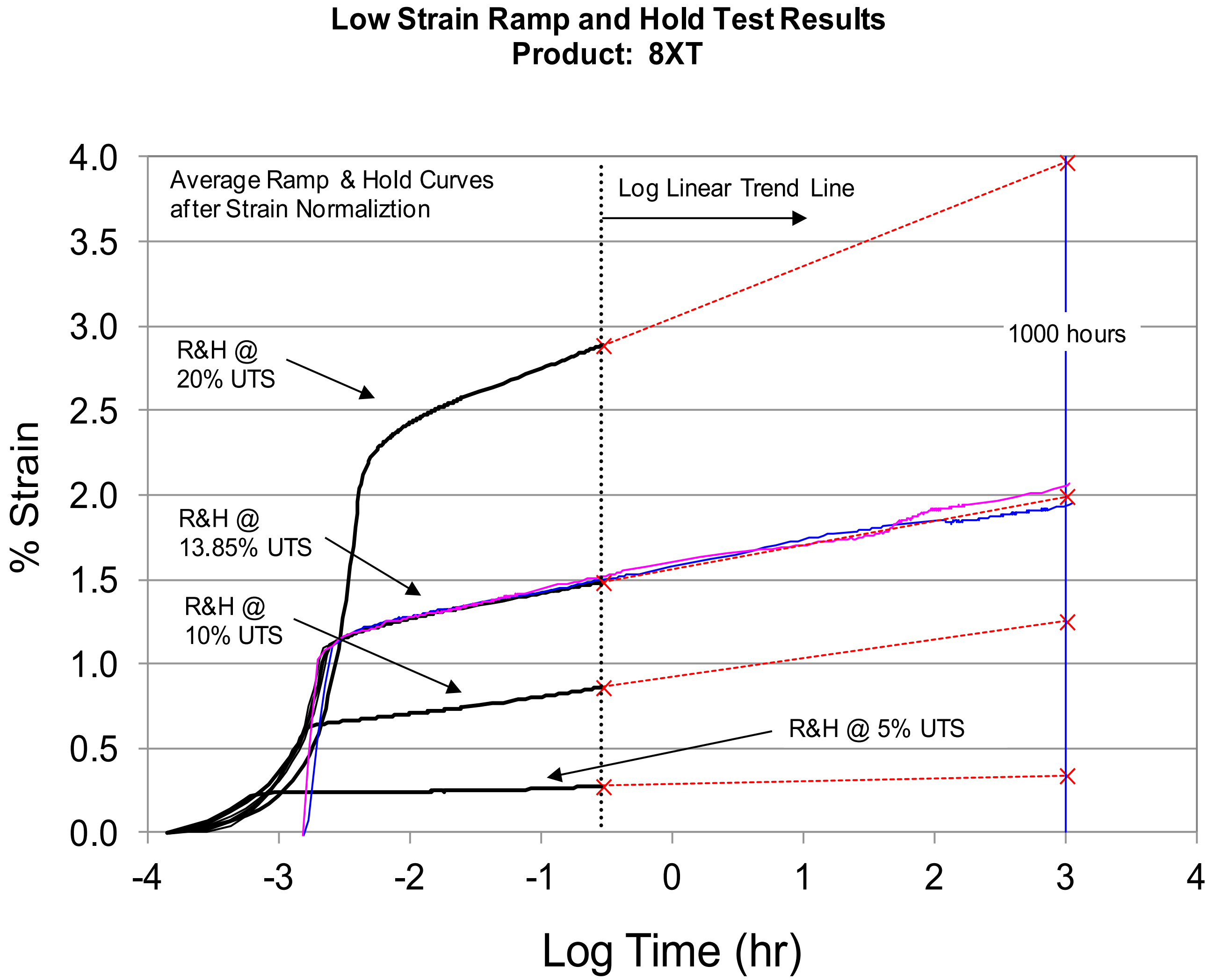

Figure H-5. Low strain ramp and hold tests for 8XT, after strain normalization, with 1000 hour low strain creep tests.

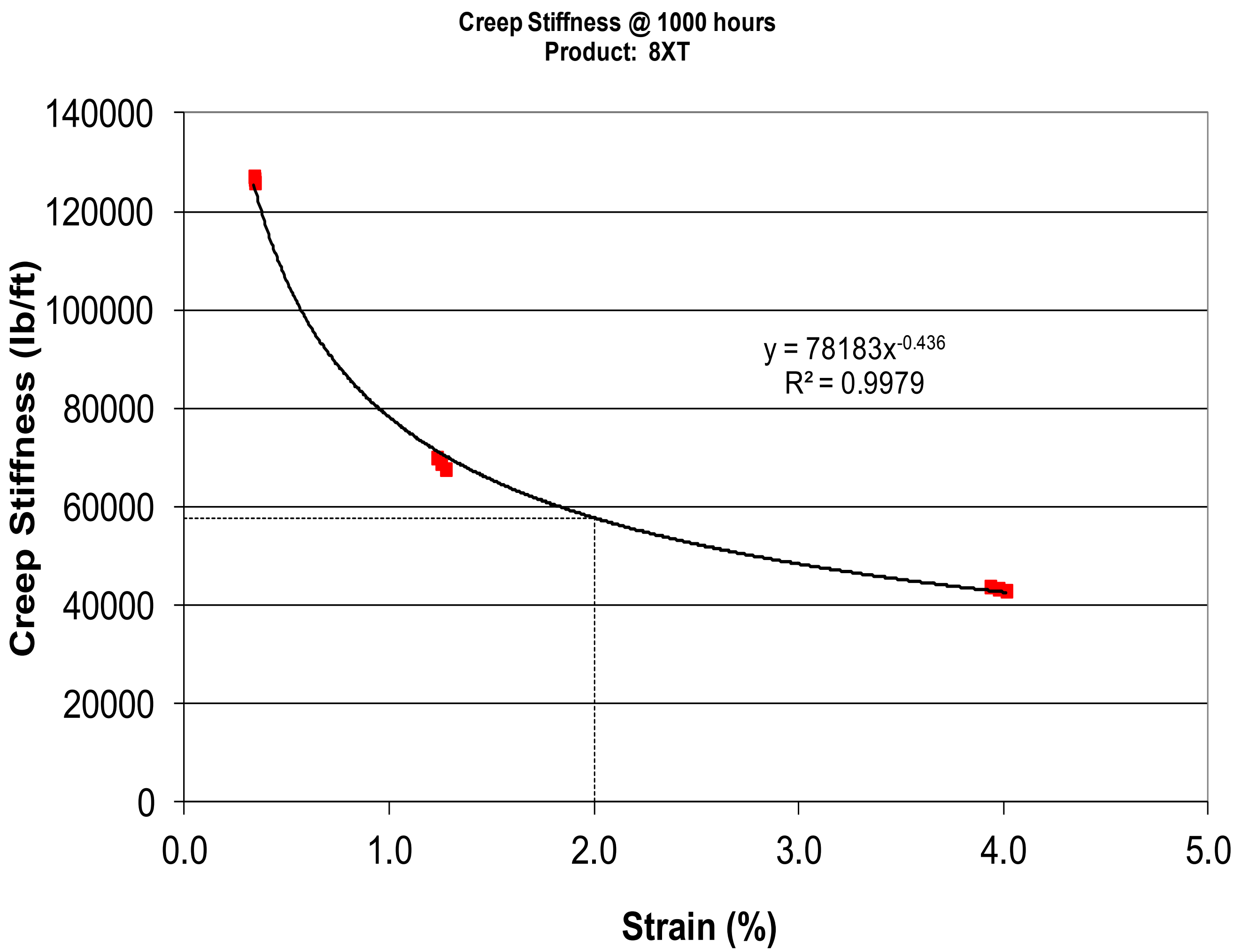

Figure H-6. Creep stiffness versus strain at 1,000 hours for 8XT.

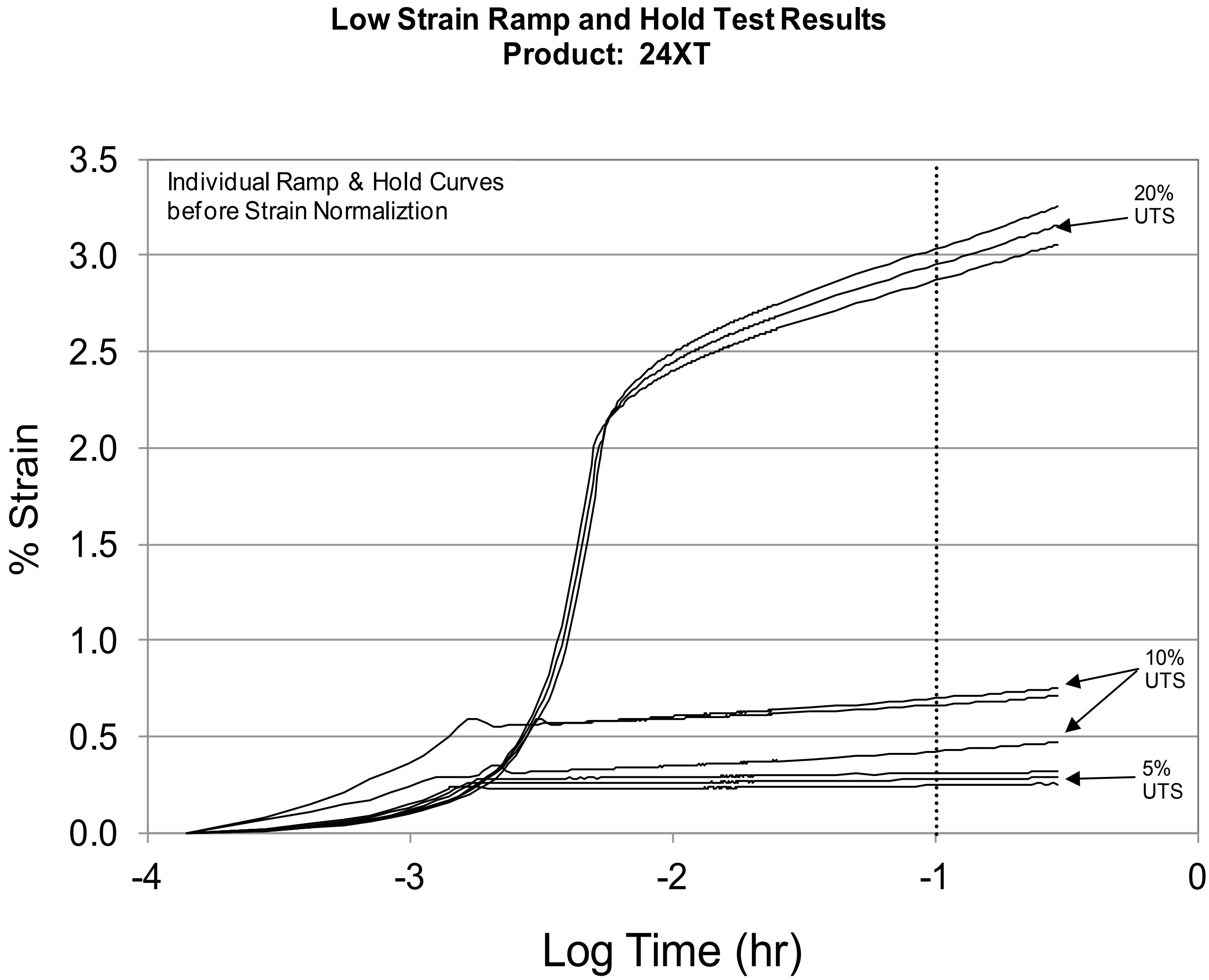

Figure H-7. Low strain ramp and hold tests for 24XT, before strain normalization.

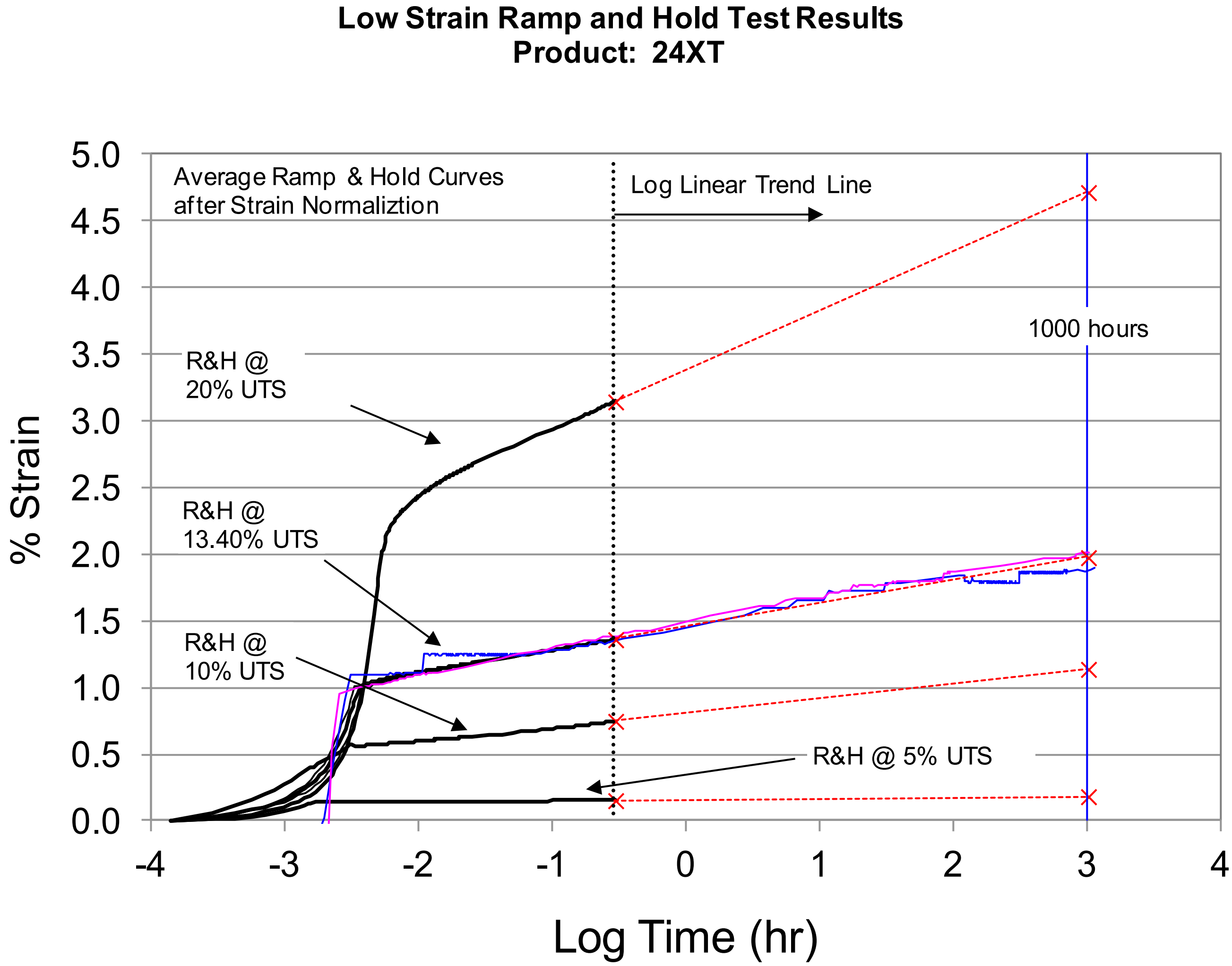

Figure H-8. Low strain ramp and hold tests for 24XT, after strain normalization, with 1000 hour low strain creep tests.

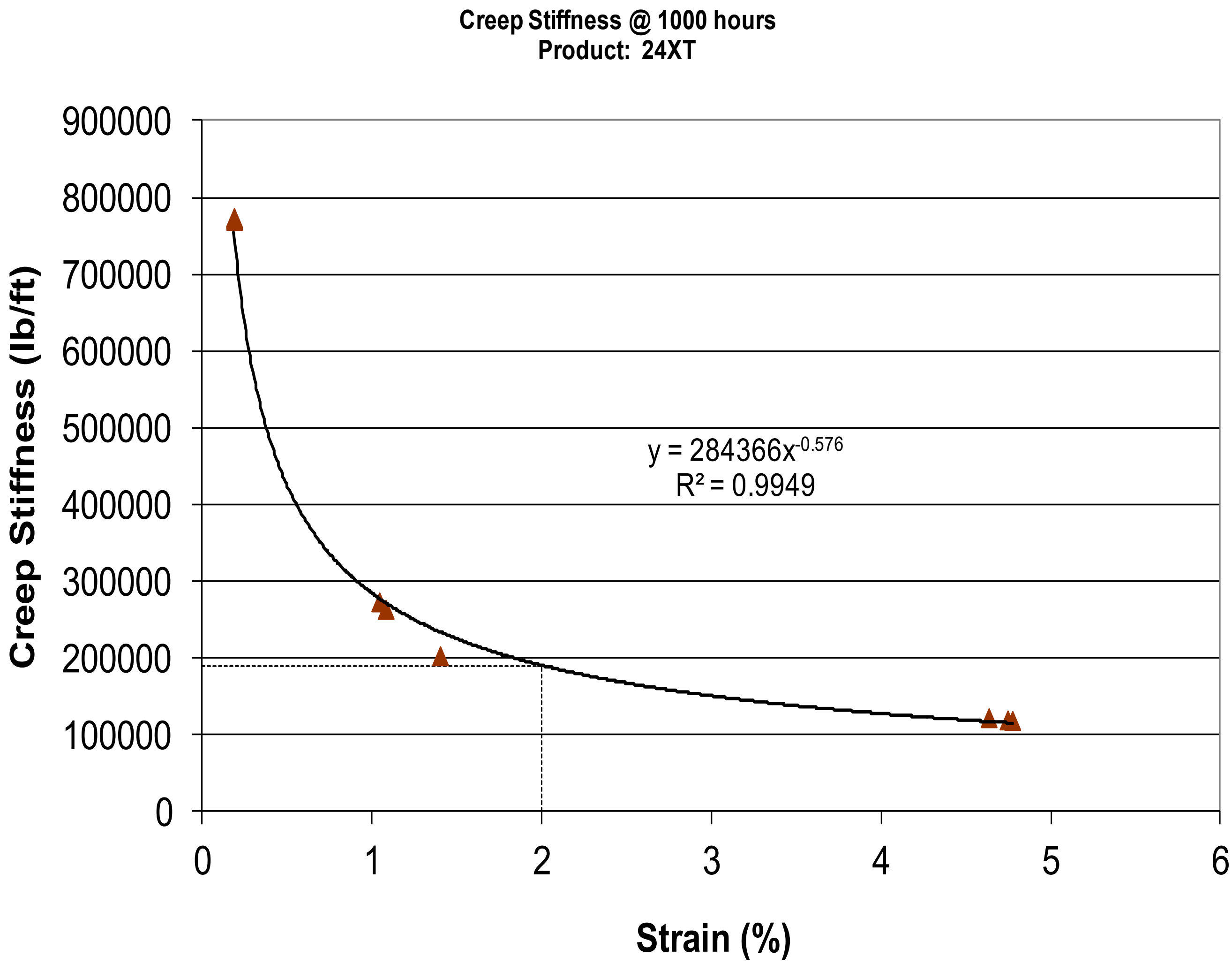

Figure H-9. Creep stiffness versus strain at 1,000 hours for 24XT.

"The National Transportation Product Evaluation Program (NTPEP) was established by the American Association of State Highway and Transportation Officials (AASHTO) in early 1994. The program pools the professional and physical resources of the AASHTO member departments in order to test materials, products and devices of common interest. The primary goals of the program are to provide cost-effective evaluations for the states by eliminating duplication of routine testing by the states; and to reduce duplication of effort by the manufacturers who produce and market commonly used proprietary, engineered products." **NTPEP**

-- Rick Smutzer (IN), former NTPEP Chairman

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