Creep and Creep-Rupture Behavior of Beijing Oriental Yuhong Waterproof Technology Co., Ltd PET Geogrids:

涤纶土工格栅蠕变和蠕变-断裂性能

60x60 kN/m

1000x100 kN/m

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February 25, 2025 2025年 2 月 25 日

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Subject: Creep Test Results for YUHONG 60x60 and 1000x100 kN/m Geogrids

主题：• • 60×60 和 1000×100kN/m 土工格栅蠕变测试结果

Dear Yang Shao Ying 尊敬的• • • • • •

TRI/Environmental, Inc. (TRI) is pleased to present this final report for creep testing of select Beijing Oriental Yuhong Waterproof Technology Co., Ltd.geogrids. The polymer-coated, PET geogrids were tested in the machine direction.
TRI 环保公司非常荣幸的为您呈上• • 东方• • • • 技术• • 有限公司送检的土工格栅产品的蠕变测试最终报告，报告中测试的是覆盖聚合物涂层涤纶土工格栅的沿机方向。

INTRODUCTION AND SUMMARY 介绍和总结

Objective 目的
The objective of this effort is to obtain the creep rupture performance and the associated creep-rupture reduction factor for select Beijing Oriental Yuhong Waterproof Technology Co., Ltd Geogrids, including 60x60 and 1000x100 kN/m. Featured herein is accelerated creep testing using the stepped isothermal method (SIM) of time-temperature superposition (TTS) as well as conventional isothermal creep-rupture testing. The results apply to the tensile strength in the machine direction.
测试的目的是获得• • 东方• • • • 技术• • 有限公司送检土工格栅样品的蠕变断裂表现和相关的蠕变-断裂折减系数，所测土工格栅的强度为 60×60 和 1000×100kN/m。这里的测试是使用时间温度叠加（TTS）阶梯等温方法的加速蠕变测试和传统的等温蠕变-断裂测试。结果中的强度是沿机方向的拉伸强度。

Scope. 范围
Rapid loading tensile (RLT) and accelerated (SIM) creep tests were conducted. The purpose of RLT tests was to determine the ultimate tensile strength (UTS) of the products in order to establish the baseline for the creep tests. Together the accelerated and conventional creep testing results were used to derive a rupture-based creep reduction factor for the products.
对样品进行了快速负载拉伸测试（RLT）和加速蠕变测试（SIM）。进行快速负载拉伸测试的目的是测定极限强度值，从而建立蠕变测试的基准值。加速测试和传统蠕变测试结果一起被用来获得基于断裂的产品折减系数。

Summary 总结

The creep-rupture results are included in the appendix. The associated creep-rupture reduction factors are summarized in Table 1. The creep-rupture reduction factor is 100 divided by the % of UTS at the lifetime and temperature of the intended service.

蠕变-断裂结果包含在附录中。相关的蠕变-断裂折减系数总结在表 1 当中。蠕变折减系数通过 100 除以样品在其使用寿命和温度条件下，材料所能达到的极限强度百分比得到。

Table 1. Summary of Creep-Rupture Results for the YUHONG Geogrids

表 1. • • 土工格栅蠕变断裂结果总结

Ref. Temp. of Regression Line 回归线参考温度	Regression Equation 回归线方程	Retained Strength (%) 残留强度		Reduction Factor 折减系数	
		75 Years 年 (log 5.8179 hrs)	114 Years 年 (log 6.0 hrs)	75 Years 年	114 Years 年
20°C	%UTS = -3.9661 log hrs + 85.3107	62.24	61.51	1.61	1.63

MATERIALS AND METHODS 材料和方法

Materials 材料

The products described herein are polyester (PET) yarn-based HOCK geogrids, identified as 60x60 and 1000x100 kN/m. The PET yarn-based grid structure is coated with a proprietary polymer coating to maintain geometric stability.
这里描述的产品是浩珂使用涤纶纺线生产的土工格栅，强度为 60×60 和 1000×100kN/m。土工格栅上有一层专有的聚合物涂层来维持其几何稳定性。

Equipment 设备

Testing platforms: Instron Model 5583 & 5889 load frames under computer control (SIM); TRI model DWCR dead weight & BTI multi-station lever action creep frames (conventional)
测试平台：电脑控制的型号为 5583 和 5889 英斯特朗负载框架（SIM）；TRI 型 DWCR 固定负载和 BRI 多工位杠杆作用蠕变框架（传统蠕变）
Environmental chamber: TRI Model SIW – stepped isothermal, wide chamber;
环境试验箱：TRI 型 SIW – 阶梯等温加宽试验箱；
Grips: Demgen Hydraulic Clamps (SIM); TRI Model PM-100, Pacman x 100mm (SIM and conventional);
夹具：德姆根液压夹具（SIM）；TRI 型 PM-100，Pacmen×100mm（SIM 和传统蠕变）
Extensometer: Epsilon Model SW3542-0200-050-ST (SIM); Trans Tek LVDT-dc, Model 0245-0000 (conventional)
引伸计：Epsilon Model SW3542-0200-050-ST (SIM); Trans Tek LVDT-dc, Model 0245-0000 (传统蠕变)
Temperature controller: Watlow Series 982 programmable temperature controller;
温度控制器：Waltow982 系列可程式温度控制器；
Heating/cooling- Electrical/liquid CO2 ;
加热/冷却-电加热/液体二氧化碳
Data acquisition: Instron Bluehill 2 software(SIM); HP-3852A data acquisition and control unit & Labview V5.1 software (conventional).
数据采集：英斯特朗蓝山 2 软件（SIM）；HP-3852A 数据采集和控制单元，Labview V5.1 软件（传统蠕变）。

Creep Testing Procedures 蠕变测试过程

Accelerated (SIM) creep testing was performed in accordance with ASTM D6992. Each specimen was allowed to reach equilibrium at 20C prior to test initiation. Specimens were then ramped to the specified percentage of UTS and then held at that load until failure or 60k seconds. Temperature was stepped 14C every 10k seconds starting at 20C and ending at 90C or when the specimen ruptured. Strain was measured with an Epsilon extensometer. Conventional testing was performed in accordance with ISO 13431. Each specimen was allowed to reach equilibrium at the prescribed temperature prior to test initiation. Specimens were then ramped to the specified percentage of UTS and then held at that load until failure. Strain was measured with Trans Tek extensometers with test-specific gauge lengths.
加速蠕变测试根据 ASTMD6992 的指导进行。在测试开始之前允许每个测试样在 20℃条件下达到平衡。然后测试样被倾斜到特定百分比的极限强度下，并保持此强度直到测试样

破裂或者 60 千秒。从 14℃开始阶梯升温，每 10 千秒升温 20℃，到 90℃时结束，或者试样断裂时结束升温。使用 Epsilon 引伸计来测量应变。传统蠕变测试根据 ISO13431 的指导进行。在开始测试前允许每个测试样在规定的温度下达到平衡。然后测试样被倾斜到特定百分比的极限强度下并保持此强度直到试样断裂。使用带有测试指定标距的 Trans Tek 引伸计测量应变。

RESULTS 结果

RLT Results 快速负载拉伸结果

RLT tests were in accordance with ISO 10319 to establish the baseline tensile strength of the specific product being tested and are reported in Table 2.

RLT 测试根据 ISO10319 的指导进行，获得了所测产品的基准拉伸强度并报告在表 2 当中。

Table 2. Product Tested Tensile Strengths

表 2. 产品拉伸强度

Style 规格	UTS (kN/m) 极限强度	% Strain @ UTS 极限强度百分比
60x60	61.4	8.86
1000x100	121.6	11.0

Creep-Rupture 蠕变断裂

Table 1, presented earlier, summarizes the long-term creep-rupture regression line intercept results shown below. The details of the creep-rupture results, at a reference temperature of 20C, are presented in Table 3 and provided in graphic form in Figure 1. The creep rupture behavior as defined by the regression line is determined in accordance with recognized and accepted creep test methods.

前面给出的表一，总结了下图所示的长周期蠕变-断裂回归线截距结果。在 20℃参考温度下的蠕变-断裂结果细节，罗列在表 3 中 并在图 1 中以表的格式给出。回归线定义的蠕变断裂性质是根据公认和可接受的蠕变测试方法来测定的。

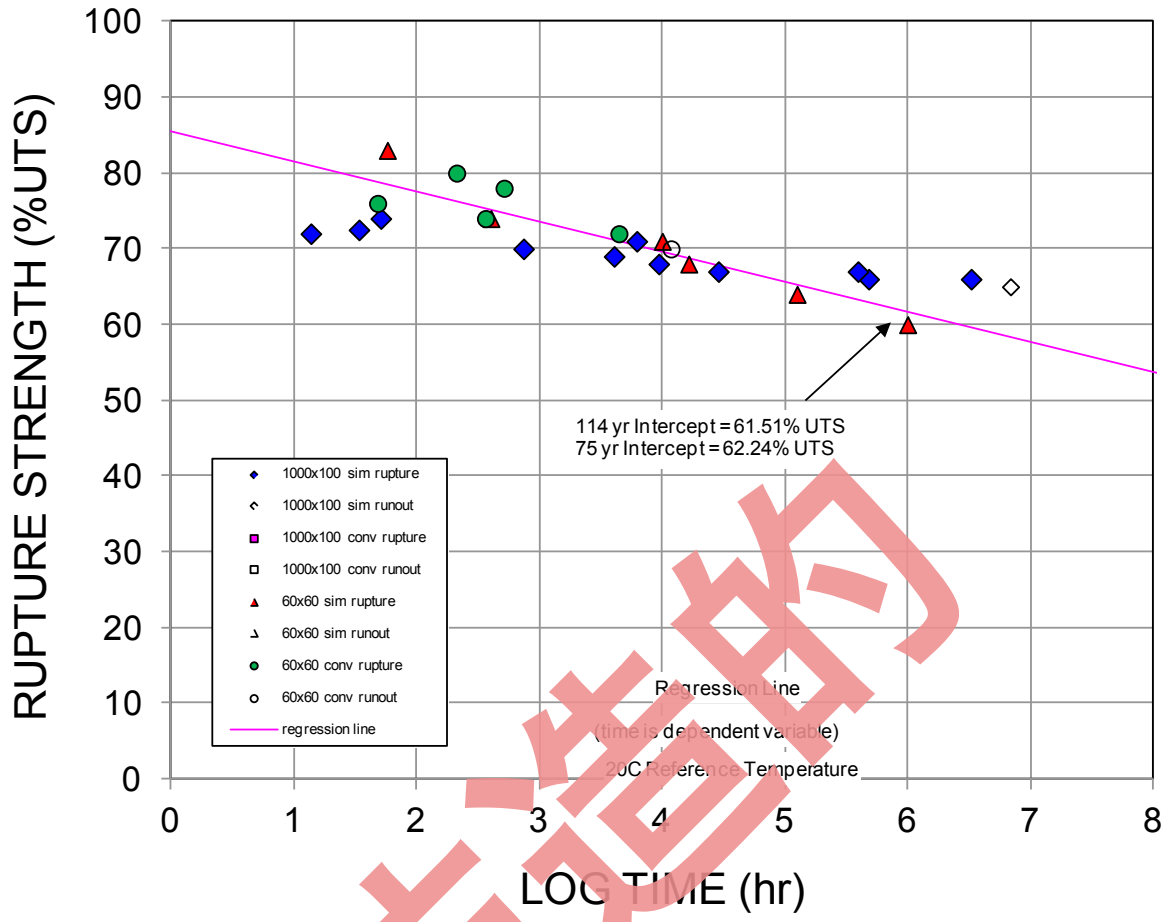


Figure 1. Composite Creep Rupture Curve: 60x60 and 1000x100 kN/m Geogrid
图 1. 符合蠕变断裂曲线：60×60 和 1000×100kN/m 土工格栅

Table 3. YUHONG Geogrid Creep Rupture Data (20C)

表 3.• • 土工格栅蠕变断裂数据（20℃）

product	loghrs	SIM rupture	conv'l rupture	Sim runout	conv'l runout		Time on y axis	Time on x axis	
1000x100	6.8300			65.0		intercept	-0.25214	-3.96611	
	6.5094	66.0				R^2	21.50993	85.31069	
	5.6748	66.0				intercept	0.648604	0.648604	
	5.5878	67.0							
	4.4514	67.0							
	3.9659	68.0				1.63	6	61.51	= 114 Yr intercept
	3.6021	69.0				1.61	5.817863	62.24	= 75 Yr intercept
	2.8646	70.0					4	69.45	= 10k hr intercept
	3.7866	71.0					3	73.41	= 1k hr intercept
	1.1327	72.0							
	1.5244	72.5							
	1.7023	74.0							
60x60	5.9923	60.0							
	5.0921	64.0							
	4.2099	68.0							
	3.9943	71.0							
	2.5986	74.0							
	1.7556	83.0							
	4.0651				70.0				
	3.6408		72.0						
	2.5547		74.0						
	1.6760		76.0						
	2.7059		78.0						
	2.3195		80.0						

CONCLUSIONS AND RECOMMENDATIONS 结论和建议

Creep reduction factors have been determined for the products tested using conventional and accelerated (SIM) creep testing. The creep rupture reduction factors for the **YUHONG** 60x60 and 1000x100 kN/m geogrids are 1.61 and 1.63 for 75 and 114 years, respectively.
使用传统蠕变和加速（SIM）蠕变测试来测定产品的蠕变折减系数。• • •60×60 和 1000×100 kN/m 的土工格栅 75 年的折减系数为 1.61,114 年的折减系数为 1.63.

APPENDIX:
附录

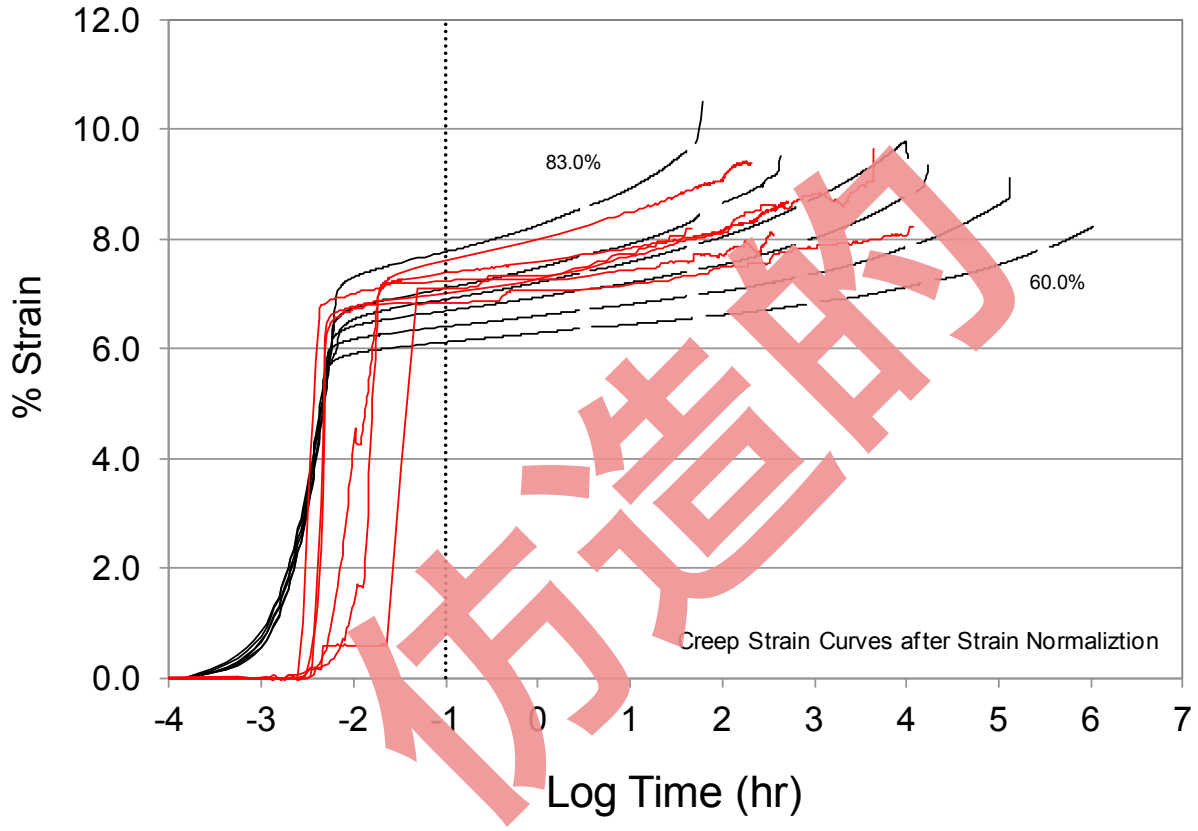
Creep Strain Data
蠕变应变数据

• • 东方• • • • 技术• • 有限公司

蠕变测试结果

产品：60×60kN/m 涤纶土工格栅

Beijing Oriental Yuhong Waterproof Technology Co., Ltd.
Creep Strain Test Results
Product: 60x60 kN/m PET Geogrid



• • 东方• • • • 技术• • 有限公司
蠕变测试结果
产品：1000×100kN/m 涤纶土工格栅

Beijing Oriental Yuhong Waterproof Technology Co., Ltd
Creep Strain Test Results
Product: 1000x100 kN/m PET Geogrid