SYNTEC, LLC
4800 Pulaski Highway
Baltimore, Maryland 21224 • USA
Phone: 410-327-1070 • Toll Free: 1-800-874-7437 Fax: 410-327-1078
www.synteccorp.com

Geonet Creep and its Dependence on Temperature

I. Temperature at Landfill Liner

Biochemical reactions which occur during the degradation of waste generate heat, while the rate of waste degradation tends to increase with temperature. Landfill waste temperature was reported ranging from 100 - 135 °F at the Sullivan landfill by Hansen and Shaw (2002). The optimal temperature for a bioreactor landfill has been reported to be 40°C (104°F) by Gurijala et al. and 34 to 38 °C (95 to 100 °F) by Mata Alvarez and Martina-Verdure (Reinhart and Townsend, 1998). On-going research by Geosynthetics Research Institute provides valuable in-situ temperature monitoring of liner and cover system in a municipal solid waste (MSW) landfill in Pennsylvania. During this study 20 thermocouples were installed to record temperature, 8 thermocouples on the geomembrane liner, one in the drainage gravel, 4 were within the waste, 6 were on the GM cover and one was used to measure ambient temperature. After 10 years of data collection, GRI has measured the following temperature data (Koerner, 2004):

LOCATION	MIN. TEMP. (°C)	AVG. TEMP. (°C)	MAX. TEMP. (°C)
Geomembrane beneath waste	17	27	38
Leachate collection stone beneath waste	14	17	22
Within the solid waste	15	25	36

Yoshida and Rowe (2003) also reported typical landfill liner temperature in the range of 35°C – 45°C degrees in their paper entitled “Consideration of landfill liner temperatures”.

II. Effect of Temperature on HDPE Geonet Creep

It is a well known fact that creeps of HDPE geonet increases with the increasing temperature, as illustrated in the below Figure from a paper by Narejo and Allen (2004). Elevated temperature increases creep reduction factor, thus lowering the allowable transmissivity.

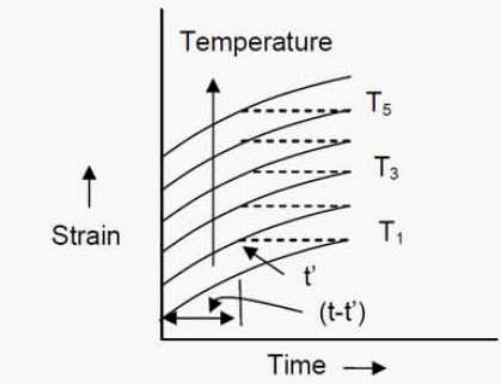

Figure 1
Effect of stress and temperature on creep

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Furthermore, there is a specific ASTM test method, under Geosynthetic Committee D35, ASTM D7361 (2007) “Standard test method for accelerated compressive creep of geosynthetic materials based on time-temperature superposition using the stepped isothermal method”. This test method is specifically developed based on time–temperature superposition theory. Results of this method are used to augment compressive creep results under standard 20°C temperature.

In summary, landfill liner temperature can be rather high, and geonet creep behavior is dependent upon temperature. The higher the temperature, the greater the compressive creep of the geonet. Without laboratory testing data to support the use of the geonet at elevated temperature, its behavior under such a field condition is uncertain with respect to its long term structural stability and long term transmissivity performance.

The amount of creep reduction that will occur over time can vary between specific geocomposite products and manufacturers. The amount of reduction that occurs due to creep is utilized as a reduction factors in determining the design transmissivity values of any geocomposite in accordance with the industry standard GRI GC8. Therefore, it is important that the manufacturer be required to provide their specific test data to ensure the specific geocomposite submitted for use on a project will meet the specified values at 40 degree C used in design.

References

ASTM D7361 (2007) Standard Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method.

GRI Standard GC8, (2001) “Determination of the Allowable Flow Rate of a Drainage Geocomposite”, Geosynthetic Research Institute, Philadelphia, PA, USA.

Koerner, G. (2004), In-situ Temperature Monitoring of Liner and Cover Geomembranes in Dry and Wet Landfills, Overview of GRI Projects, GRI Newsletter/Report, Vol. 18, No. 2

Narejo, D. and Allen, S (2004) Using the Stepped Isothermal Method for Geonet Creep Evaluation, 3rd European Geosynthetic Conference, Germany.

Yoshida, H. and Rowe, R. K (2003) Consideration of Landfill Liner Temperatures, 9th International Waste Management and Landfill Symposium, Italy.