

EB532 ULTRAVIOLET LIGHT DEGRADATION OF GEOTEXTILES

BACKGROUND

Ultraviolet (UV) light degradation is a process in which the strength of a geotextile is damaged or reduced by exposure to sunlight. The type of geotextile and the location of exposure affect the time it takes to degrade a geotextile. The basic mechanism for photo-initiated degradation is the same for all polymer materials. Ultraviolet light degradation occurs when energy from sunlight breaks the bonds within the polymer structure. The energy from sunlight can be divided into three categories by wavelength; ultraviolet, visible, and infrared. Wavelength distributions for sunlight are shown in Figure 1. Those wavelengths above 400 nm form the visible and infrared light spectrums and do not cause degradation of the polymers used in geotextiles. For polymers commonly used in geotextiles, degradation is typically caused by wavelengths in the UV range, less than 400 nm. Photons with wavelengths longer than the critical wavelengths for any bond making up the molecular chains will have no effect on the chemical structure, therefore causing no degradation. Wavelengths less than about 280 nm, while potentially very damaging to polymer materials, are filtered by the earth's atmosphere and are not generally a factor as can be seen in Figure 1.

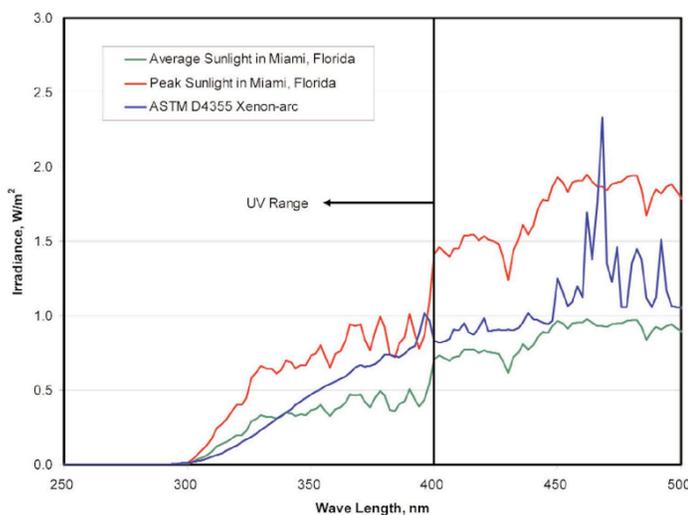


Figure 1 - Wave lengths in natural sunlight at Miami, Florida and in the xenon-arc device used in ASTM D-4355. From Atlas Material Testing Technology

VARIABLES IN UV STABILITY OF GEOTEXTILES

There are a number of variables affecting the UV stability of geotextiles related both to the fabric and the environment in which it is exposed. The local environment has a significant impact on the rate of UV degradation, both with respect to the intensity of sunlight and the temperature. Even the exposed slope orientation toward the sunlight makes a difference. Figure 2 shows the results of tests on samples of Propex geotextiles exposed at three locations in the United States. In general, the United States southwest is more severe than the southeast and the rate of degradation is much less in the north.

Manufacturers add a number of stabilizers to geotextile fibers and yarns to enhance their stability. The amount and nature of these stabilizers impact the stability of fabrics. UV degradation penetrates into the yarn or fiber from the surface toward the core. Thus, a larger diameter yarn or fiber will degrade more slowly than a smaller yarn or fiber of the same composition. Woven geotextiles, with their much coarser yarns, will generally degrade more slowly than nonwoven geotextiles. This can be seen in Figure 2. Since UV degradation starts at the surface of geotextiles, a thicker fabric will also degrade more slowly than thinner fabrics. So Propex nonwoven Geotex® 801 (about 8 oz/sq. yd.) will degrade more slowly under the same exposure conditions than Geotex 351 (about 4 oz/sq. yd.). This difference in degradation rate is less pronounced for nonwoven geotextiles above about 8 ounces per square yard. Heavier weight nonwovens are at the high side of the nonwoven bands shown for nonwovens in Figure 2.

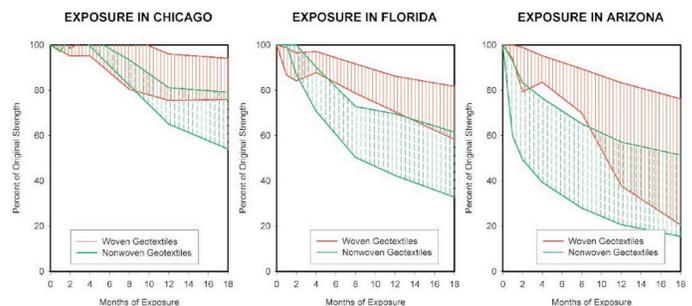


Figure 2 - Results of tests on Propex geotextiles exposed outdoors for up to 18 months at three locations

(continued)

TESTING UV STABILITY

The standard method for evaluating the UV stability of a geotextile is given in ASTM D-4355. In this method, a xenon-arc light source is used and specimens are exposed to the light under controlled conditions of temperature and humidity. This light source closely mimics natural sunlight in the UV range as shown in Figure 1. There are also exposure methods that use fluorescent light sources. These are not approved for use on geotextiles. The xenon-arc exposure test is considered an index test and results cannot be used directly for an end use. There is a general correlation between the xenon-arc exposure and outdoor exposure, but the results cannot be used directly. The test uses a combination of high light intensity and elevated temperature to degrade the specimens more rapidly than would be experienced in a natural environment in the same amount of time. The samples are typically exposed for 500 hours in the device. After exposure, a specific physical property (usually two inch strip tensile strength, ASTM D-4632) is tested. This is then compared to the properties of the unexposed fabric to determine percent of the original strength the exposed specimens retained for the specific time period under consideration. The nationally recognized AASHTO M 288 specifications for geotextiles used in highway applications require minimum strength retentions of 50% of their pre-exposure strength after 500 hours of exposure as specified in ASTM D-4355 for most applications and 70% after 500 hours of exposure for silt fence. All Propex geotextiles are stabilized to provide at least 70% strength retention after 500 hours exposure according to ASTM D-4355.

PROTECTING GEOTEXTILES FROM UV DEGRADATION

The simplest way to prevent ultraviolet light degradation in a geotextile is to prevent sunlight from reaching the fabric. Once covered by soil, asphalt or other material, the potential for degradation is removed. Thus geotextiles should be covered as soon as possible after removing the protective wrapper. Geotextile manufacturers add a variety of stabilizers or additives to the resin used in producing geotextiles to make the polymers more stable against ultraviolet light degradation. These stabilizers limit degradation for typical installation times but do not provide protection for extended periods. To minimize UV degradation, project specifications should be written to limit exposure to a maximum of 14 days. Where longer exposure may be required, samples of the exposed fabric should be taken periodically and tested to verify that a detrimental amount of strength loss has not occurred. The protective wrapper on rolls of geotextile when shipped should remain in place until the material is installed.

REFERENCES

1. ASTM, 2014, "ASTM D-4355-14: Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus," American Society for Testing and Materials, West Conshohocken, PA.
2. Baker, T.L., "Long-Term Relationship of Outdoor Exposure to Xenon-Arc Test Apparatus Exposure," Geosynthetics '97, Long Beach, March, 1997, pp 177-190.
3. ASTM, 2008, "ASTM D-4362-08: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles," American Society for Testing and Materials, West Conshohocken, PA.
4. AASHTO, "Standard Specification for Geotextile Specification for Highway Applications, AASHTO Designation: M 288-05," American Association of State Highway and Transportation Officials, Washington, D.C., 2005.

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