enka®solutions

TECHNOTE

UV-STABILITY OF ENKAMAT® EROSION CONTROL SYSTEMS

ENKAMAT LONG-TERM RESISTANCE AGAINST UV-EXPOSURE

EnkaMat is a strong and very flexible 3-dimensional geosynthetic matting with a very open structure. It is designed to control erosion and retain soil by reinforcing the root zone of vegetation development in difficult site conditions. However, depending on specific conditions and applications, vegetation growth can be poor or absent. Such circumstances can result in exposure of the matting to several external influences, all of which causing ageing (weathering).

UV-radiation from sunlight significantly accelerates ageing processes. This UV-exposure can have a major impact to the performance of geosynthetics, and be devastating for the integrity of polymers. This technote presents information and research on the high UV-stability of EnkaMat.

Durability aspects

The service life of a structure with geosynthetics depends for a large part on the durability of the geosynthetics. Several factors can affect the properties of geosynthetic materials over time[1]:

a. Mechanical loading, which can lead to creep
b. Weathering, where aspects of UV-radiation temperature, and humidity can be combined
c. Chemical and biological attack, including oxidation and hydrolysis
d. Mechanical damage, abrasion, and dynamic loading

The effect of weathering[2] on the properties of geosynthetics is technically relevant for many applications. Since natural weathering requires testing over long periods of time, there is a need to obtain information rapidly and more reproducibly using accelerated laboratory procedures.

The procedure for laboratory testing of the resistance to weathering is specified in the international standard EN 12224: 2000. For this purpose, weathering devices with specific artificial-light sources are used[1], so called UV-test cabinets. Here, the resistance of geosynthetics to weathering is determined by exposing them to continuous artificial UV-light in wet/dry cycles. The dry cycle of five hours at a high temperature (50° C) is followed by a wet cycle lasting one hour with a water spray at medium temperature (25° C). The radiant exposure must total 50 MJ/m² in the standardized laboratory setup.

Laboratory research on the UV-resistance of EnkaMat

The quality and intensity of solar radiation at the earth's surface vary with climate, location, and season of the year. Besides solar radiation there are other important factors that affect natural weathering and ageing process, such as temperature, temperature cycling, humidity, etc. Therefore a maximum outdoor exposure of six summer months – as the basis of this index test – can cause a broad variability of results. A minimum of two years of natural exposure at a particular location may be required to minimize the variability among results from repeat exposures.

Our R&D laboratory in Arnhem, The Netherlands, has been performing multiple long-term weathering tests on EnkaMat since the product's launch in the 1980s.

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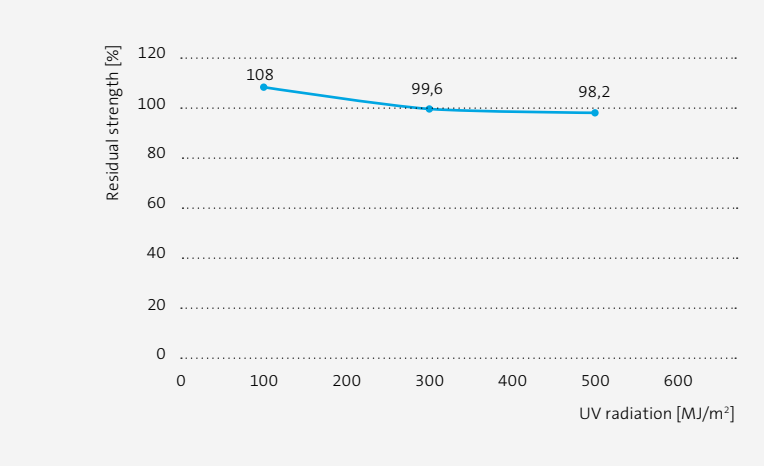
New long-term UV-exposure tests were carried out on EnkaMat 7020 in 2020. The UV-stability of EnkaMat is obtained by the use of additives such as carbon black. The resin material of polyamide (PA) and the carbon black type and its percentage is generally used and set as standard for the full EnkaMat range. Therefore the test results observed are representative for the full range of EnkaMat high-performance materials.



(fig. 1) EnkaMat 7020 residual strength after 500 MJ/m² UV exposure[3]

The samples were tested for UV-stability according to EN 12224:2000 up to a UV-load of 500 MJ/m² (equal to 3000 hours UV-resistance – 125 days). This extremely long exposure is ten times that required according to the standard test procedure, which is 50 MJ/m². For the purpose of an adequate uniform artificial-weathering procedure, practicable for both Xenon-arc and fluorescent UV-light sources, it was decided to expose the samples to a defined one year equivalent UV-radiant dose of 200 MJ/m² (EOTA[5]). Based on the laboratory results,

(fig. 2) Laboratory testing setup

(fig. 3) Laboratory testing setup detail with EnkaMat sample

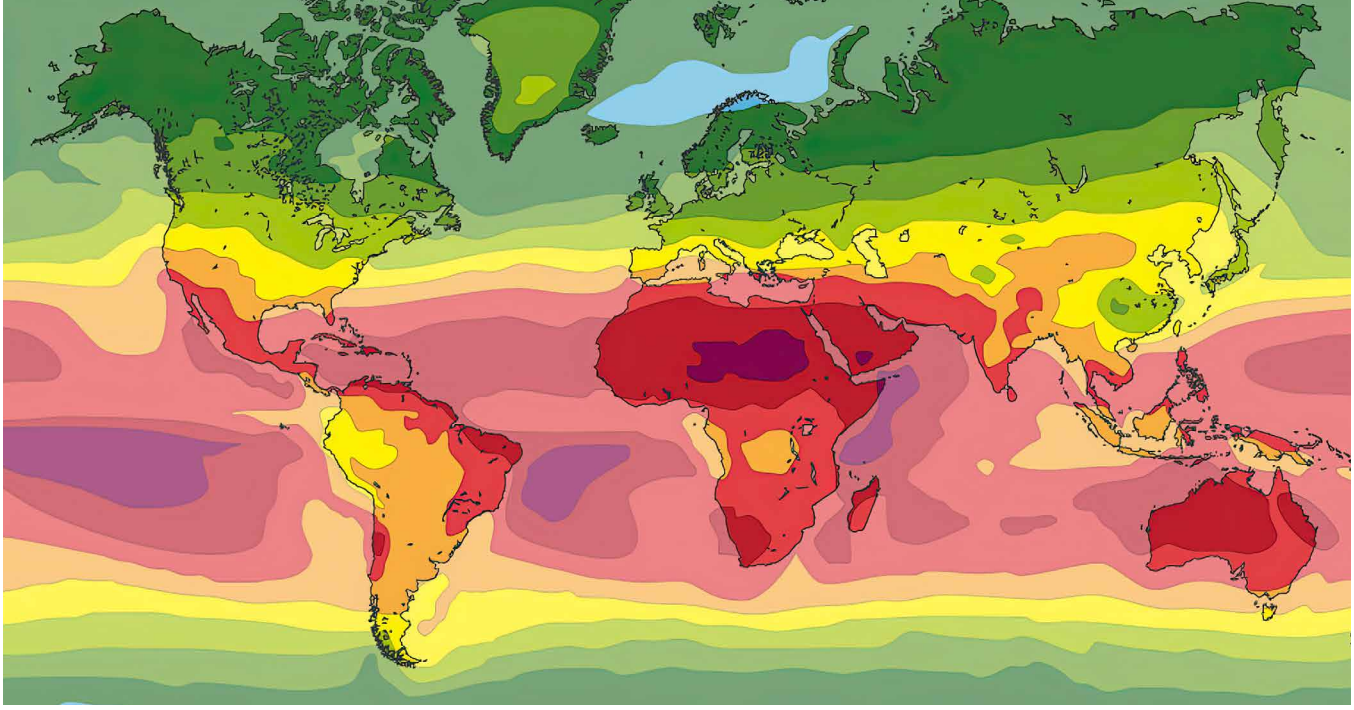
the residual strength of the EnkaMat was determined as 98.2% after 500 MJ/m². EOTA technical report TR010 classifies this as 2.5 years' full exposure to weathering in Europe.

Global UV-exposure

The amount of UV-exposure differs depending on the location on the globe. Solar radiation has the highest values near the equator. At temperate latitudes (like Northern Europe) it is less intense and varies more with the seasons. UV-radiation also depends on altitude: at high elevations such as in mountainous areas, the exposure is higher. Typical values are summarized in Table 1. Visualized contours of UV-exposure globally are given in the world map on the next page. UV-exposure can be assessed in kLangley/year or in GJ/m².

(table 1) **Overview UV-exposure depending on region**

Region	Exposure [kLangley/year]	Exposure [GJ/m²]
Northern Europe	60 – 80	2.5 – 3.3
Central Europe	80 – 100	3.3 – 4.2
Southern Europe	100 – 160	4.2 – 6.7
Middle East	140 – 200	5.9 – 8.4
Africa	160 – 220	6.7 – 9.2



(fig. 4) kLangley world map

(fig. 5) EnkaMat 7018 application in desert area to prevent wind erosion with high UV-exposure (project Kazakhstan)

(fig. 6) EnkaMat 7220 application storm water channel with high UV-exposure in dry season (project Taranto South Italy)

Case study UV-field performance test Hungary

In the summer of 2015, EnkaMat 7010 was installed to control erosion on a steep slope at road no. 8 in Hungary. In a rockfall-protection system, the top slope above a retaining wall was stabilized using soil nails. EnkaMat and steel netting were then installed over the surface and the netting pre-tensioned and fixed to the slope with steel anchors. Located under this netting, and fully exposed to UV, the function of EnkaMat in this construction is to prevent any loss of soil and/or fragmented rock due to erosion. See Figure 7 and 8.

With the poor vegetation development on the slope, EnkaMat was directly exposed to UV, wind and all weathering degradations. In September 2020, a sample was retrieved from the structure to test the remaining strength. Safe retrieval of the sample was possible at a location with a stable shotcrete subsurface. The EnkaMat sample was sent to the laboratory to test the residual strength after > 5 years exposure. Tests were carried out in the length direction (MD) and mean values of five test series are given in the table on the next page.

The results indicate a residual strength of 82% of the original properties (retained strength), which shows that the product is highly UV-stable. It must be noted that the material was not only exposed to UV, but also to installation damage and some creep (see factors mentioned under durability aspects).

Conclusion

Erosion-control matting can be exposed to several external influences which will affect the durability of the geosynthetic material. The effect of weathering on the properties of geosynthetics is of technical importance for many applications. Weathering has combined aspects of UV-radiation, temperature and humidity. Resistance to weathering can be determined in two ways: using natural

(fig. 7) Situation steel slope construction completed (2015)

(fig. 8) Situation steep slope after five years (2020)

(table 2) **EnkaMat residual strength after 5+ years of exposure**[4]

Parameter	Original sample	Retrieved sample	Retained property
Thickness – under 2 kPa pressure	8.5 mm	8.0 mm	94 %
Max. tensile strength	1.79 kN/m	1.46 kN/m	82 %
Strain at max. tensile strength	79.9 %	80.3 %	100 %

weathering (samples from projects in actual conditions) or using accelerated weathering in laboratory conditions according to international standards. Both methods have been used to investigate EnkaMat's properties after exposure, and these have been compared with initial product batch parameters. The results confirm that EnkaMat has an extremely high resistance to weathering.

Since the same polyamide resin, the same carbon black type and its percentage are used for the whole product family, and all products are manufactured to the same standards with a strict quality-management system, the tests results can be considered representative of the entire range of EnkaMat high-performance materials.

Literature

1. EN 12224:2000 Geotextiles and geotextile-related products – determination of the resistance to weathering, November 22th 2000.
2. Greenwood, J.H., Schroeder H.F., Voskamp, W., Durability of geosynthetics, CUR 243, CUR committee C187, June 2012.
3. Low & Bonar Research and development, UV resistance of PA EnkaMat 7020, RD&I-RQ2289, May 6th 2020.
4. Low & Bonar Research and development, Tensile strength of EnkaMat 7010 after 5 years of use (Hungary), RD&I-RQ2759, October 29th 2020.
5. EOTA technical report, Exposure procedure for artificial weathering, TR 010, Edition May 2004, European Organization for Technical Approvals.

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