Geosynthetics - 7th ICG - Delmas, Gourc & Girard (eds) © 2002 Swets & Zeitlinger, Lisse ISBN 90 5809 523 1

Geotextile in dike revetments must not oxidise for half a century

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ABSTRACT: The nonwoven geotextiles used for the reconstruction of dike revetments must function for at least 50 years . By order of the Projectbureau Zeeweringen (Dutch for: project bureau for coastal defence structures), the DWW, together with TNO Industrial Technology, producers and suppliers of geotextiles has investigated the durability of nonwoven geotextiles. If the right stabilisers are added during the production of the synthetics, the durability increases considerably.

1 INTRODUCTION

A test of the dikes by the Technical Advisory Committee on Water Defences (TAW) in 1996 showed that the dikes are insufficiently safe in some places. In the years to come, a large number of dike sections are going to be reconstructed. In Zeeland (province in the south of the Netherlands), the Dutch Directorate General for Public Works and Water Management and the Waterboards have set up the Projectbureau Zeeweringen to do this. Use of nonwoven geotextile on a dike along the Westerscheldt in Zeeland

By now, this project bureau has for several years been reconstructing dike sections.

A nonwoven geotextile (also called a fleece) is used in dike revetments as the boundary between the clay and the granular filter layer. This prevents erosion of the clay layer which causes subsidence of the block revetment and can lead to extensive damage to dikes. The design takes into account the functional demands such as sandtightness, strength and elasticity. As there was insufficient knowledge about the durability of nonwovens, this aspect has been investigated further.

2 SYNTHETICS AND DURABILITY

The nonwoven serves as a filter and should prevent erosion of clay. This means that the fibres should remain sufficiently close together during use. The strength and elasticity determine whether the filter function can be maintained at a certain wave load. Furthermore, the resistance against perforation (the imitation of the resistance of granular material against point load) is an important physical-mechanical measure to determine the quality of a geotextile. As the greatest forces on the nonwoven geotextile are exerted during installation, the properties mentioned are indicative of the demands made upon it.

Nonwoven geotextiles can be made of the synthetics polyethene and polypropene. These synthetics are made by the polymerisation of short molecules into long chains, resulting in the synthetics acquiring their final (mechanical) properties. Materials age in the long run and this also applies to synthetic materials. The most important influencing factors are sunlight, temperature and the presence of oxygen around the polymer chains. Due to ageing, the long chains break, resulting in the reduction of strength and elongation at break of the nonwoven geotextile. With material not stabilised against ageing, this already happens after a few years under relatively mild operating conditions. By applying small amounts of stabilisers, the ageing process can be slowed down considerably. An important condition is that the stabilisers do not disappear from the polymer matrix during use as a result of, for example, leaching by (sea) water. That is why so-called low-leach stabilisers are often used.

In practice, the nonwoven geotextile is covered with a granular filter layer on which the block revetment is applied, making the influence of sunlight during use minimal. The fluctuation of temperature and the oxygen content in the construction remain limited, particularly in the tidal area, due to the seawater.

3 RESEARCH AND IMPLEMENTATION OF KNOWLEDGE

The Projectbureau Zeeweringen wanted in the short term to have knowledge of the durability of nonwovens, so that it could be used in the 1999 specifications. In order to achieve this the DWW co-ordinated the research.

An advisory group was set up in which the Projectbureau, the DWW, TNO Industrial Technology and five producers and suppliers of nonwovens participated. The producers supplied the geotextile samples, which both the TNO and the laboratories of the participating producers tested. This resulted in experience with the testing and differences in the end results, if any, were revealed. In addition to this, it is useful for the quality assurance for the supply of nonwovens in the future.

The research was carried out in two phases:

Phase 1: stock-taking of testing method + testing of 5

Phase 2: development of nonwovens with an improved durabil

Research commenced in March 1998. By mutual agreement, the parties chose to test according to the European standard prEN-ISO 13438:1998. This standard is meant as a screening test for nonwovens with a durability of up to 25 years. According to this standard, strips of Polypropene are exposed to a temperature of 110 ± 1 °C in an oven. Subsequently the tensile strength of the exposed strips is determined and the residual strength is calculated relative to the tensile strength of strips which were exposed at 110 °C for 6 hours. In practical applications, where the tensile strength of the nonwoven geotextile is essential during its whole service life, the residual strength must, according to the standard, be at least 50% 28 days after testing. For the determination of the durability of nonwovens for dike revetments, the Projectbureau Zeeweringen extended the testing period to 56 days. This extension is meant to cover a period of use of 50 years. The demand of a residual strength of 50 % remained unchanged. The results (the average of five strips) can be found in table 1. Both the tensile strength in Newtons and in percentages (between brackets) are shown.

Table 1: results tensile strength of nonwovens after different testing times (phase 1)

Sample Codes	Tensile strength in Newtons at a strip width of 50 mm				
	0 hours	6 hours	14 days	28 days	56 days
980827	698 (108)	643 (100)	451 (70)	216 (34)	8 (1)
980817	**1551 (108)**	**1441 (100)**	**-**	**1443 (100)**	**414 (29)**
980843	435 (109)	401 (100)	363 (91)	141 (35)	57 (14)
980815	780 (106)	734 (100)	742 (101)	Nil	-
980816	1130 (119)	948 (100)	80 (8)	Nil	-

The results show that the nonwovens do not meet the requirements set by the Projectbureau Zeeweringen

After consultation with the advisory group, phase 2 of the research was subsequently carried out. For which four producers developed nonwovens with extra additives added, with the aim of improving the durability. The results (table 2) show that after 56 days there was no appreciable change in the tensile strength compared to the tensile strength measured after 6 hours. By adding extra stabilisers, the durability of the nonwoven geotextiles has improved under the test circumstances.

Table 2: results tensile strength of improved nonwovens after different testing times (phase 2)

Sample Codes	Tensile strength in Newtons at a strip width of 50 mm	
	6 hours	56 days
AB-B-98-042	1330 (100)	1360 (102)
981848-2 *	497 (100)	506 (102)
98H10	950 (100)	893 (94)
9812	622 (100)	642 (103)

* this sample was investigated by TNO Industrial Technology as a result of a lack of capacity at the producer's.

4 PRACTICAL VALUE OF LABORATORY RESEARCH

As nonwoven synthetic geotextiles have not yet been used 50 years and there are therefore no real-life data about the properties of nonwoven geotextiles over such a period, the results of the research cannot be tested by practical experience. From the literature (research in practical circumstances of nonwovens by Delft Hydraulics by order of an Austrian producer) it is known that the tensile strength decreases by less than 5 % after 14 years of use. Research in practical circumstances carried out by the Maritime Institute Gdansk in Poland[1)] shows similar results.

In several investigations, TNO Industrial Technology has found that the tensile strength and elongation at break do decrease during the use of the geotextiles in practice, but that this decrease in properties is not caused by ageing of the material. The decrease is a result of mechanical damage to the geotextile. Furthermore, research shows that the stabiliser content in the material decreases in the long run, but that the material still contains stabilisers after a period of use between 7 and 15 years[2)].

The Projectbureau chose a practical solution by declaring the test method valid for practical applications. The addition of additives results in considerable longer exposure times whereas it only makes the geotexile a few percent more expensive. Replacing the nonwoven halfway through the design life would not only be very time-consuming, but also a factor 10 more expensive than the geotextile itself.

5 REGULATIONS

In the specifications for dike revetments carried out in 1999 in Zeeland, adapted demands (specification demands) for the durability of the nonwoven geotextiles have been included. These were formulated by the DWW and the Projectbureau in consultation with the producers and TNO. At this moment, nonwoven geotextiles can be supplied according to specification demands. The producer must show, on the basis of their own research, that the durability of the nonwoven geotextile meets the specification demands. In addition to this, the Projectbureau Zeeweringen will also carry out random research into the quality of the nonwoven, so that the durability of the nonwoven geotextile in the dike revetments is guaranteed. At the Kiwa in Rijswijk (NL), rules for certification were formulated for nonwoven geotextiles. When certified nonwovens are used, inspection is carried out by the certifying institute.

6 OTHER AREAS OF APPLICATION

All the knowledge acquired about the durability of nonwoven geotextiles is also important for other applications, for example steep constructions and combination sealings of rubbish dumps and for the isolation of constructions of secondary structural materials such as waste incineration ash and contaminated soil.

7 REFERENCE

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