PROTECTION AND DRAINAGE PROPERTIES OF GEOTEXTILES BY INSTALLATION DAMAGE

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ABSTRACT: 2 needle punched nonwoven geotextiles and 4 specially manufactured nonwoven geotextiles to be designed to minimize the property change under construction were used. ISO/TR 10722-1 was adopted to examine the change protection and drainage functions of the nonwoven geotextiles after installation. Index and field test for one year in the real waste landfill was performed to compare the changes of mechanical properties to the results of index tests. Drainage properties of nonwoven geotextiles were compared between index and performance tests. From these results, it was seen that the installation damage affected the protection and drainage properties of nonwoven geotextiles and these must be reconsidered to design the waste landfill construction.

1 INTRODUCTION

In general, nonwoven geotextiles are the most important geosynthetic materials to be installed above the geomembranes for protection and drainage. Also, nonwoven geotextile can be used for various functions such as reinforcement, separation, filtration, and drainage but these functions must be changed during their service periods as shown in Figure 1.

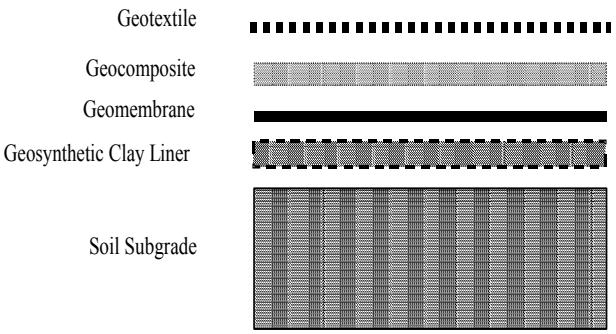


Figure 1. Schematic diagram of waste landfill illustrating the major use of geosynthetics

Especially, the protection and drainage functions of nonwoven geotextiles should be changed by many kinds of damages, external impacts etc..

Among these, the installation damage is the most important cause to change the protection and drainage functions in the waste landfill.

In Korea, most of wastes in the sanitary landfills are mixed with various type of filled materials, for example sand, soil, gravel, fly ash etc.

When the waste is completely filled, geotextile serves as materials of drainage, filtration, protection layer material for geomembrane.

Over 90% of nonwoven geotextile currently used in Korea is PP(polypropylene) nonwoven geotextile products and most research of this related was conducted for the purpose of enhancing the stability and durability of PP nonwoven geotextiles.

In this study, PVA(polyvinyl alcohol) nonwoven geotextiles to be improved the performance and durability were manufactured with weight by needle-punching method. PP nonwoven geotextiles were used to compare the tensile strength and transmissivity with PVA nonwoven geotextiles.

Protection and drainage properties by installation damage test with index and field tests were evaluated. Reduction factors for tensile strength and transmissivity of PVA nonwoven geotextiles were determined by the retention of original properties.

2 EXPERIMENTAL

2.1 *Preparation of nonwoven geotextiles*

2 needle punched PP nonwoven geotextiles and 4 PVA nonwoven geotextiles were used to compare the protection and drainage properties. Table 1 shows the specification of these nonwoven geotextiles.

Table 1. Specification of nonwoven geotextiles

Geotextile	Manufacturing Method	Raw Material	Weight (g/m^2)
GT-1	Needle Punched	PP	608
GT-2		PP	1,010
SGT-1		PVA	433
SGT-2		PVA	610
SGT-3		PVA	807
SGT-4		PVA	1,025

2.2 *Tensile strength test*

Wide width tensile tests are generally performed both in the machine and cross machine direction of the Geosynthetics, using the standard test method ASTM D4595.

The tensile test was used to evaluate the effects of damage, e.g. after installation trials for 6 kinds of geosynthetic samples.

And then the installation damage reduction factors were calculated.

2.3 *Installation damage test*

2.3.1 *Index test*

ISO standardization has been identified to develop test methods to simulate damage during installation.

This work is divided into two parts, Part 1: Installation in granular materials and Part 2: Installation on soft subsoil.

The test method for installation in granular materials, ENV 10722-1 requires the use of a rigid split box 350mm×350mm×150mm in Figure23.

The nonwoven geotextiles are placed between two boxes, which are filled with artificial aggregate, sintered aluminum oxide, and then subjected to a cyclic loading by a rectangular plate.

After the compaction the nonwoven geotextiles are extracted and evaluated for damage by visual inspection and by wide width tensile test.

2.3.2 *Field test*

To estimate the damage of geosynthetics according to various fill thickness, 100cm of fill thickness were applied.

The burial period is 1 year and Figure 3 shows the schematic diagram of the field test.

2.4 *Transmissivity evaluation test*

Transmissivity of nonwoven geotextiles under confined loading conditions were evaluated.

Before testing, nonwoven geotextiles were immersed in the distilled water to eliminate the vapors in the specimens.

Radial in-plane flow test apparatus in accordance with GRI Test Method as shown in Figure 4 was used to evaluate the transmissivity, in-plane pearmeability.

The size of test specimen is 100cm^2 and confining load ranges are 1~240 kg.

(b) Compaction box

Figure 2. Installation damage test equipment

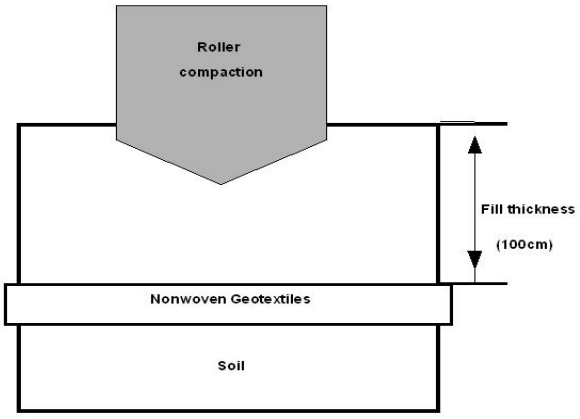
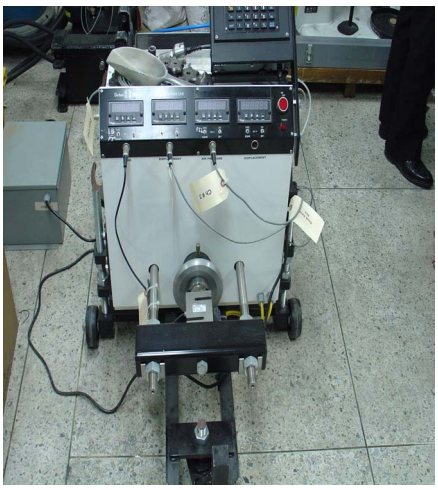


Figure 3. Schematic diagram for field test



(a) Test equipment

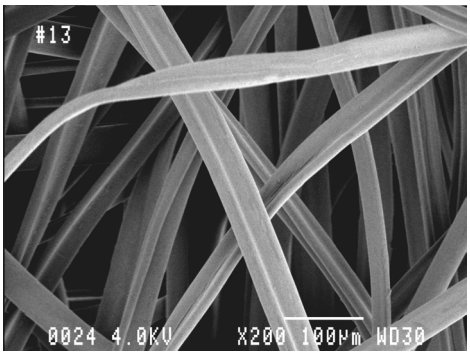
Figure 4. Schematic diagram of radial flow transmissivity apparatus

3 RESULTS AND DISCUSSION

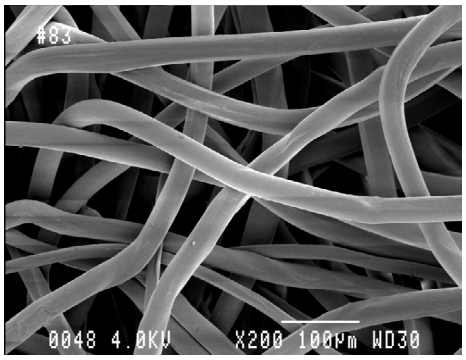
3.1 *Effects of installation damage on protection performance*

Figure 5 shows the SEM photograph of PP and PVA nonwoven geotextiles before installation damage test.

PVA fiber has more smooth and circular shape than PP fiber. Tensile strength of PP and PVA fiber is 12.3 and 22.4 g/d, respectively.



(a) PP fiber



(b) PVA fiber

Figure 5. SEM photograph of PP and PVA nonwoven geotextiles

Table 2 shows the tensile strength of nonwoven geotextiles by the installation damage test.

On the whole, PVA nonwoven geotextiles show larger tensile strength than PP nonwoven geotextiles and this is due to the high strength of PVA fiber.

For the similar weight, PVA nonwoven geotextiles show the larger tensile strength than PP nonwoven geotextiles.

But all PP and PVA nonwoven geotextiles showed the slight change by the installation damage test method.

Tensile strength of PP and PVA nonwoven geotextiles by the field test decreased slightly than index test.

This is mainly due to the non-careful handle and extraction of nonwoven geotextiles from the field by worker.

The strength retention to indicate the high performance for protection of nonwoven geotextiles means the percentage of tensile strength between before and after installation damage.

Table 3 shows the strength retention of nonwoven geotextiles by Installation damage test.

Also, PVA nonwoven geotextiles shows the excellent tensile strength retention than PP nonwoven geotextiles.

Tensile strength retention of PP and PVA nonwoven geotextiles by the field test decreased slightly than index test. These are the same phenomena as the case of tensile strength as observed before.

Table 2. Tensile strength of geotextiles by installation damage test

Geotextile	Tensile Strength(kg)		
	Before Index Test	After Index Test	After Field Test
GT-1	248.5	138.2	112.8
GT-2	283.7	166.8	135.1
SGT-1	302.4	215.9	177.8
SGT-2	387.7	298.1	242.3
SGT-3	422.5	351.9	264.1
SGT-4	488.3	406.8	325.7

Table 3. Tensile strength retention of geotextiles by Installation damage test

Geotextile	Tensile Strength Retention (%)		
	Before Index Test	After Index Test	After Field Test
GT-1		55.6	45.4
GT-2		58.8	47.6
SGT-1	100	71.4	58.8
SGT-2		76.9	62.5
SGT-3		83.3	62.5
SGT-4		83.3	66.7

Whereas the reduction factor to affect on the tensile strength of nonwoven geotextiles for protection function could be calculated from the following relation:

Reduction Factor of Tensile Strength

= Tensile strength before installation damage

/Tensile strength after installation damage

Table 4 shows the reduction factor for tensile strength by installation damage of nonwoven geotextiles and PVA nonwoven geotextiles showed the more excellent than PP nonwoven geotextiles with installation damage test method and weight.

Table 4. Reduction factor for tensile strength of geotextiles by installation damage test

Geotextile	Reduction Factor For Tensile Strength		
	Before Index Test	After Index Test	After Field Test
GT-1	1.0	1.8	2.2
GT-2		1.7	2.1
SGT-1		1.4	1.7
SGT-2		1.3	1.6
SGT-3		1.2	1.6
SGT-4		1.2	1.5

3.2 *Effects of installation damage on drainage performance*

Table 5 shows the effects of installation damage on drainage performance of PP and PVA nonwoven geotextiles before installation damage test.

PVA nonwoven geotextiles showed the larger transmissivity value than PP nonwoven geotextiles.

And this is due to the fiber shape and composition of nonwoven geotextile structure as shown in Figure 5.

Table 5. Transmissivity of geotextiles by installation damage test

Geotextile	Transmissivity ($x10^{-6}$ m^3/s-m)		
	Before Index Test	After Index Test	After Field Test
GT-1	5.3	3.31	3.12
GT-2	6.7	4.47	3.94
SGT-1	4.8	3.69	3.43
SGT-2	6.3	4.85	4.85
SGT-3	7.2	5.54	5.14
SGT-4	7.8	6.49	5.54

Table 6 shows the transmissivity retention of nonwoven geotextiles by Installation damage test.

PVA nonwoven geotextiles shows the excellent transmissivity retention than PP nonwoven geotextiles.

In here, the transmissivity retention to indicate the high drainage performance of nonwoven geotextiles means the percentage of transmissivity between before and after installation damage.

Transmissivity retention of PP and PVA nonwoven geotextiles by the field test decreased slightly than index test as same as tensile strength as before.

Table 6. Transmissivity retention of geotextiles by installation damage test

Geotextile	Transmissivity Retention (%)		
	Before Index Test	After Index Test	After Field Test
GT-1	100	62.5	58.8
GT-2		66.7	58.8
SGT-1		77	71.4
SGT-2		77	77
SGT-3		77	71.4
SGT-4		83.3	77

And the reduction factor to affect on the transmissivity of nonwoven geotextiles for drainage function could be calculated as following:

Reduction Factor of Transmissivity

= *Transmissivity before installation damage*

/ *Transmissivity after installation damage*

Table 7 shows the reduction factor for transmissivity by installation damage of nonwoven geotextiles.

PVA nonwoven geotextiles showed the more excellent than PP nonwoven geotextiles with installation damage test method and weight.

Table 7. Reduction factor for transmissivity of geotextiles by installation damage test

Geotextile	Reduction Factor for transmissivity		
	Before Index Test	After Index Test	After Field Test
GT-1	1.0	1.6	1.7
GT-2		1.5	1.7
SGT-1		1.3	1.4
SGT-2		1.3	1.3
SGT-3		1.3	1.4
SGT-4		1.2	1.3

4 CONCLUSION

In this study, PP and PVA nonwoven geotextiles were used to compare the protection and drainage properties by installation damage test for the case of waste landfill application.

From the experimental results, it can be concluded that PVA nonwoven geotextiles with weight showed the excellent protection and drainage properties than PP nonwoven geotextiles.

But this is not the sufficient solution to replace the PP nonwoven geotextiles for all the case of waste landfill application.

It must be on going through the further study of PVA nonwoven geotextile, for example, chemical resistance, UV resistance, clogging effect etc..

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