The evaluation of nonwoven geotextile to outdoor exposure at landfill in Korea

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ABSTRACT: In waste landfills, geotextiles are used for the various purposes, such as a filter of the leachate collection and removal system and a protector of geomembrane liner. However, geotextiles can be exposed to direct sunlight during the construction of a landfill for several months or years. The exposure of geotextile polymers to sunlight can be a major source of the degradation of geotextiles. Therefore, this study was to supply the basic data for suggesting the criteria on installation of heavy weight geotextiles at the landfill in Korea. As the results of the outdoor exposure of heavy weight geotextiles, the loss of geotextile strength was clear in the beginning of the installation and depended on the location installed and the installation point of time related to the amount of radiation. Also, lighter weight geotextiles had the retained strength less than heavy weight geotextiles did. Therefore, it needed the detailed criteria on the geotextiles installation at a landfill in Korea. In case of the relationship between the variation of tensile strength and the meteorological factors, the radiation on a horizon surface was considered one of key factors to affect on the reduction of the tensile strength significantly in short time.

1 INTRODUCTION

Recently many landfills have been constructed by using geosynthetics with earth materials. Geotextiles in geosynthetics are applied for the various purposes, such as a filter of the drainage layer and a protector of geomembrane liner. However, geotextiles can be exposed to direct sunlight during the construction of a landfill for several months or years. The exposure of polymers to sunlight can be a major source of the degradation of geotextiles. In spite of the increasing use of heavy weight geotextiles (over 500g/m^2), there are few criteria on the exposed geotextiles in landfill under the climate in Korea. Also, it is not proper to adjust the weathering test results of lighter weight geotextiles (under 500g/m^2) in previous researches.

This study is to suggest the criteria on the installation of heavy weight geotextiles exposed to sunshine at the landfill. For this purpose, several different geotextiles were evaluated by outdoor exposure test at the two different sites and under the different seasons for one and a half years.

2 MATERIALS AND METHODS

Geotextiles used in this study were needle punched nonwoven type whose weight ranged from 500g/m^2 to 1000g/m^2 with polypropylene polymer. For outdoor weathering test, geotextiles were installed at Seoul in May (Exposure I) and August (Exposure II), 1998 and at Seoul (Longitude: 127º 03'; Latitude: 37º 34') and at Cheju (Southern part in Korea, Longitude: 126º 30'; Latitude: 33º 30') in May(Exposure III), 1999. Table 1 shows the properties of tested geotextiles and the schedule of installation and sampling of the geotextiles was presented in Table 2. The geotextiles with

P.P500, P.P700 and P.P1000 in Exposure I and II were installed at Seoul, and P.P1000 in Exposure III were tested at Seoul and Cheju. Korea Standard Test Method (KS K 0520) was used to measure the tensile strength of geotextiles.

3 RESULTS AND DISCUSSION

3.1 *The variation of tensile strength of geotextiles in Exposure Ⅰ and Ⅱ*

The variation of tensile strength of Exposure I and II is presented in Fig.1. All tensile strength of P.P 500, P.P 700 and P.P 1000 were rapidly reduced in the initial stage and after then reduced slowly in Exposure I. The strength of geotextiles in Exposure II had been changed gradually because of the rainy season in the beginning of installation for a while; however, the strength of geotextiles decreased quickly after the rainy season. The total loss of geotextile strength in Exposure I was 90~120 kg_f for 16 months and in Exposure II was 50~80 kg_f for 14 months. Since Exposure I and Exposure II show different tensile strength retention with the same cumulative sunshine radiation on horizontal surface, the determination of geotextile's installation season is considered one of the important factors.

Table 1. The properties of tested geotextiles

Code	Color	Geotextile type	Polymer type	Weight per Area (g/m^2)	Thickness (㎜)	Grab strength[a] (㎏ f)
P.P500	White	NPN[b]	P.P[c]	500	3.5	127
P.P700	White	NPN	P.P	700	4.5	178
P.P1000	White	NPN	P.P	1000	6.0	280

a): KS K 0520   b): Needle Punched Nonwoven Geotextiles   c): Polypropylene

Table 2. The schedule of installation and sampling of geotextiles

No.	Installation	Sampling				
		1st	2nd	3rd	4th	5th
Exposure I	'98. 5. (Seoul)	'98. 7.14.	'98. 9. 4.	'98.11.11.	'99. 4.17	'99. 9.28
Exposure II	'98. 8. (Seoul)	'98. 9. 4.	'98.11.11.	'98.12.29.	'99. 4.17	'99. 9.28
Exposure III	'99. 5. (Seoul & Cheju)	Every half months				

As these results, strength rates of P.P700 was maintained around 40% of the initial strength after outdoor exposure with the cumulative radiation (5600MJ/m^2) on horizontal surface for 16 months; however, the PP1000 showed 65% of the retained strength in the same duration. In case of P.P500, it was reached about 50% of the retained strength after 8 months of exposure. Therefore, lighter weight geotextiles had the retained strength less than heavy weight geotextiles did

3.2 *The variation of tensile strength of geotextiles in Exposure Ⅲ*

The variation of tensile strength of geotexiles, which were installed at two different sites, was presented in Fig. 2. As the radiation on a horizon surface accumulated, the strength of geotextiles showed different degradation rate on the two sites. When the cumulative radiation on a horizon surface was 1900MJ/m^2 (4 months), P.P 1000 lost its strength as much as 40kg_f in Seoul and 70kg_f in Cheju. Then, the loss of geotextile strength at Cheju was twice as much as that at Seoul.

3.3 *The correlation between the tensile strength and the meteorological factors*

In order to analyze the differences in the two sites, the relationship between the variation of tensile strength and the meteorological factors (radiation on a horizon surface, radiant time, and temperature) was plotted in Fig. 3. The factors were expressed as the daily average values of the sampling interval. Comparing the meteorological data of the two sites during the test, the average radiation on a horizon surface was 20MJ/m^2 at Cheju for the first 40 days while 16~18 MJ/m^2 at Seoul for the first 60 days. However, the other factors of Seoul had higher average values than those of Cheju. Therefore, the radiation on a horizon surface was considered the most affected factor in the reduction of the tensile strength. In addition, the reduction of the tensile strength appeared clear when the mean radiation on horizontal surface was over 13MJ/m^2. From correlation analysis, the correlation coefficients between the changes of strength and each of the meteorological factors were important elements in this test.

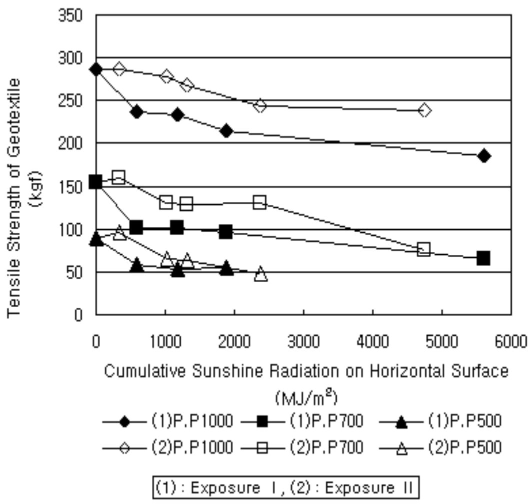

Figure 1. The variation of tensile strength of geotextile in exposure I and II

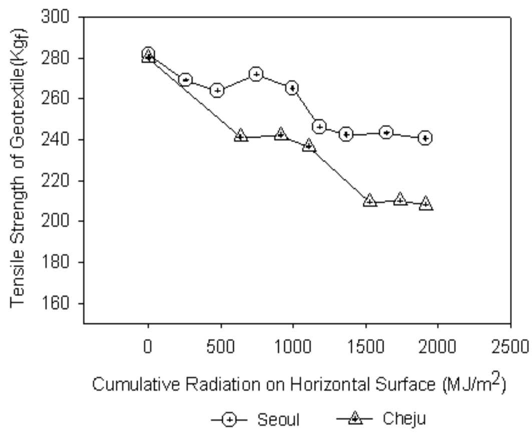

Figure 2. The variation of tensile strength of geotextiles in exposure III

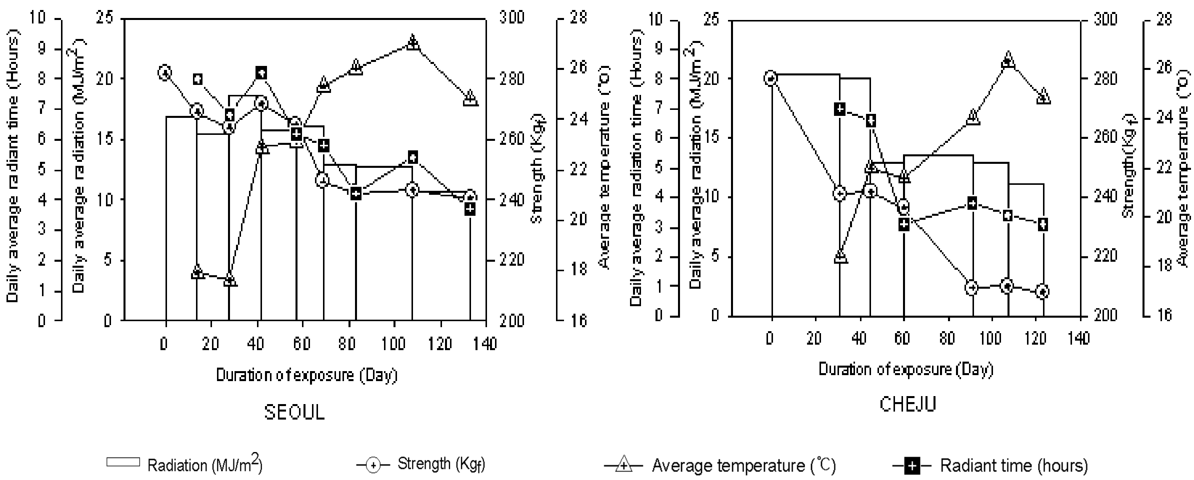

Figure 3. The relation between the strength of geotextiles and meteorological data in exposure III

4 CONCLUSIONS

As the results of the outdoor exposure test of lighter and heavy weight geotextiles, authors concluded followings.

The loss of geotextile strength was clear in the beginning of installation and was affected by the installed time as well as the installed location. Also, lighter weight geotextiles had the retained strength less than heavy weight geotextiles did.

It needed the detailed criteria on the geotextile installation at a landfill in Korea, because the variation of the tensile strength of geotexiles showed different behavior.

From the relationship between the variation of tensile strength and the meteorological factors, the cumulative radiation on a horizon surface was considered the most affected factor on the reduction of the tensile strength in short time.

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