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Duration of the geosynthetic container in actual sites

Masuya, Y., Mori, H., Takahashi, I., Takada, N. & Kohashi, H.
Public Works Research Institute, Japan

Kudo, Y.
Okasan Livic Co., Ltd., Japan

Nakashima, K.
Penta-Ocean Construction Co., Ltd., Japan

Hirota, O.
Fujita Co., Ltd., Japan

Honna, H.
Teijin Techno Products Ltd., Japan

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ABSTRACT: The proper disposal of construction surplus soil has become a major problem in recent years, as evidenced by the increase in unlawful disposal of the soil. Therefore, it becomes important to promote reusing construction surplus soil. The Eco-tube is a geosynthetic container developed for reusing low quality surplus soil such as dredged soil and improving its quality. But polyester material used for the tubes deteriorates rapidly due to the effect of ultraviolet. This paper describes the duration of the Eco-tube at three test sites: Lake Kasumigaura, Lake Inohana, and Niyodogawa River reaches. Each site was adopted different strategies to provide shielding from sunshine. From the investigation, covering by vegetation, placing under water, and covering by sheets, the geotextiles are able to maintain its strength.

1 INTRODUCTION

1.1 *Background*

The proper disposal of construction surplus soil has become a major problem in recent years, as evidenced by the increase in unlawful disposal of the soil. According to an investigation conducted by the Ministry for Land, Infrastructure and Transport in 2002, 245 million m^3 of soil was transported from construction sites during the year. On the contrary, 126 million m^3 of soil was required for construction in the same period. However, only 74 million m^3 (approximately 60%) of the soil was reused construction surplus soil; the remaining 40% of the soil was used new soil. Therefore, it is important to promote reusing construction surplus soil.

From FY1992 to FY1996, the Ministry of Construction (now the Ministry of Land, Infrastructure and Transport) conducted a research and development project to develop construction surplus soil reusing technique in collaboration with the Soil Mechanics Division, the Public Works Research Institute of the Ministry of Construction (now the Public Works Research Institute), the Public Works Research Center, and private companies.

1.2 *Background*

The Eco-Tube involves packing a water-permeable geotextile tube with soft and high water content soil (typically dredged soil from rivers, lakes and marshes) (Mori et al. 2002). This promotes dewater of the soil. Figure 1 shows the configuration of the Eco-Tube. The tubes after dewatering can also be used as embankments using reinforcement of the geotextiles. Recently, the Eco-Tube has been researched on filtration properties to purify the drainage during the dewatering process and trap toxic substances such as dioxins and heavy metals (Mori et al. 2002).

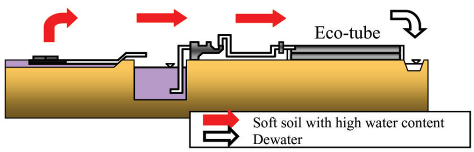

Figure 1. Construction image of the eco-tube.

The Eco-Tube made from polyester material tends to deteriorate rapidly due to the effect of ultraviolet. Exposure to artificial sunlight can affect strength by up to 50-60% over a period of 100 hours (Yamada et al. 1998). However, there have been few studies of the degradation of the geotextiles during actual use in the field. Thus it was decided to assess the durability of the Eco-Tube by monitoring the degradation of the tubes filled with dredged soil.

1.3 *Outline of experiment*

Durability assessments were conducted on the Eco-tube at three test sites: Lake Kasumigaura, Lake

Inohana, and Niyodogawa River reaches Different strategies were used to provide shielding from sunshine: vegetation covering, placement in water, and cover with sheets.

2 DURABILITY OF THE ECO-TUBE

2.1 *Lake Kasumigaura*

At Lake Kasumigaura, large tubes made of three different types of geotextiles were filled with dredged soil. Some were left exposed to the sunshine, while others were provided with vegetation covering. The degradation of the geotextiles was monitored to determine the effect of ultraviolet. The experiment was conducted from May 1994 to August 1995. Table 1 summarizes the experimental conditions. Photograph 1 shows the test site.

Figure 2 shows the results of tensile tests on samples of geotextiles taken at 4, 8 and 16 months. The samples were 5 cm in width, 20 cm length between clamps. The tensile test conformed to JIS1908, using a tension speed of 2 cm/min.

Table 1. Test conditions (Lake Kasumigaura).

Case	Type	Ingre-dients	Thickness (mm)	Strength (N/cm)	Remark
1	Woven	PET	0.25	520	Air
2	Woven	PET	0.35	716	Air
3	Woven	PET	0.50	1010	Air
4	Woven	PET	0.35	716	Air covered with plant

Photograph 1. Test site at Lake Kasumigaura.

2.1.1 *Exposed sections*

Degradation is the most pronounced during the first 4 months. The samples of exposed geotextiles with no vegetation covering shows 50% decline in strength. Strength continued to decline over time thereafter, falling to 10%-20% of initial strength after 16 months.

2.1.2 *Vegetation covered section*

On section covered with vegetation, grass growth was vigorous. After 4 months, the grass height had reached 20-30 cm, and in some cases the roots penetrated the tubes. Tensile tests showed residual

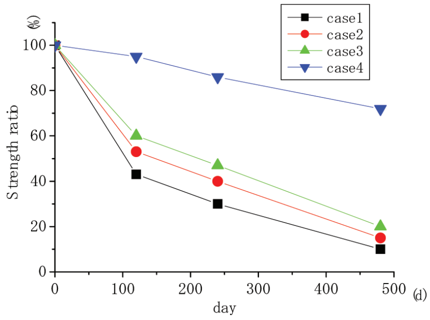

Figure 2. Strength ratio (Lake Kasumigaura).

strength of 96% after 4 months, and around 70% after 16 months. These results indicate that vegetation covering is effective in preventing degradation of the geotextiles.

2.2 *Lake Inohana*

2.2.1 *Duration of the geotextiles*

At the Lake Inohana test site, geotextiles were immersed in water. The experiment was conducted from July 2004 to November 2004. Table 2 summarizes the experimental conditions and Fig. 3 shows test results. The tensile tests were conducted as JIS1908.

Table 2. Test conditions (Lake Inohana 1).

Case	Type	Ingredients	Thickness (mm)	Strength (N/cm)	Remark
1	Woven	PET	0.35	719	Under water
2	Woven	PET	0.33	764	Under water
3	Woven	PET	0.5	1010	Under water
4	Woven	PET	0.5	1010	Air

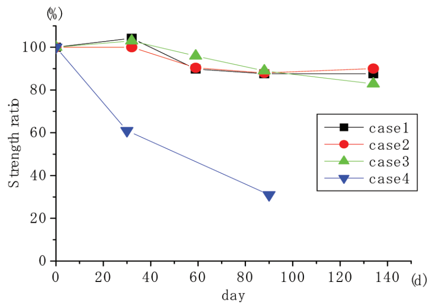

Figure 3. Strength ratio (Lake Inohana 1).

(1) *Exposed section*

Tests on the geotextiles exposed to the sunshine for 1 month showed a sharp decline in strength, with the residual strength ratio at around 60%. After 3 months, strength had fallen further, to around 30%.

(2) *Underwater sections*

The underwater geotextiles showed virtually no signs of deterioration in strength. After 2 months, it had fallen to around 90%, but thereafter it remained stable: after 5 months the ratio was still in the range 80%-90%.

These results indicate that placing the Eco-Tube underwater is an effective way to prevent deterioration, since it maintains a residual strength ratio of 80%-90% relative to the initial condition of the geotextiles.

2.2.2 *Duration of the Eco-Tube*

Dredged soil from Lake Inohana was packed in about 1 m^3 tubes made from three types of geotextiles. The dredged soil was obtained from an adjacent construction site. Degradation of the geotextiles was monitored.

The experiment was conducted from June 2003 to March 2005. Photograph 2 shows the test site, and Table 3 lists the test conditions. In cases 1, 2 and 4, the geotextiles were high-strength general-purpose geotextiles. Meanwhile, the non-woven geotextiles used in case 3 had a high coefficient of water-permeability but low tensile strength. The tensile tests were conducted as JIS1908.

Photograph 2. Test site at Lake Inohana.

Table 3. Test conditions (Lake Inohana 2).

Case	Type	Ingre-dients	Thickness (mm)	Strength (N/cm)	Remark
1	Woven	PET	0.5	1014	Air
2	Woven	PET	0.5	1040	Air
3	Non-woven	PET	3.0	186	Air
4	Woven	PET	0.5	1014	Under water

(1) *Exposed sections*

Figure 4 shows the test results. The tubes in case 1 to 3 were repeatedly exposed to the air due to fluctuations in the water level. The residual strength rates were found to be 60%-70% of the initial strength.

(2) *Under water section*

The tubes in case 4 were almost entirely underwater, being exposed only occasionally. The residual strength ratio was much higher, at 94%. Degradation due to ultraviolet was less than on the top layer.

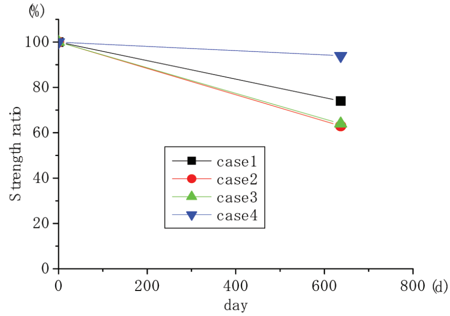

Figure 4. Strength ratio (Lake Inohana 2).

2.3 *Niyodogawa river reaches*

Dredged soil from the Niyodogawa River reaches was packed in about 1 m^3 tubes, and then used to create river levees. In order to observe the decline in strength of the geotextiles, some tubes of soil were left in the yard. Two tubes were covered with sheets, while the other two were left exposed to the sunshine.

The tensile tests were conducted as JIS1908. The Eco-Tube was set up in November 2003 and follow-up observations were taken on March 2005. Photograph 3 shows test site, Table 4 shows the test conditions, and Fig. 5 shows test results.

Photograph 3. Niyodogawa River reaches.

Table 4. Test conditions (Niyodogawa River reaches).

Case	Type	Ingre-dients	Thickness (mm)	Strength (N/cm)	Remark
1	Woven	PET	0.35	715	Under sheet
2	Woven	PET	0.35	715	Air

The Shikoku region was hit with heavy rainfalls during 2004, and the test site was flooded several times within the first six months. However, the Eco-Tube was not found to be adversely affected.

2.3.1 *Exposed section*

After 16 months, the residual strength ratio had fallen to approximately 65%. This is considerably better than the corresponding figure of 10%-20% from the

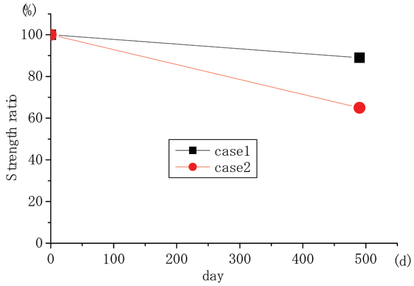

Figure 5. Strength ratio (Niyodogawa River reaches).

exposed tubes in the Lake Kasumigaura as described in Section 2.1 above. The discrepancy seems to be attributed to external factors such as differences in climate and conditions at the test site.

2.3.2 *Under sheet section*

The residual strength ratio was approximately 90% in sections of the geotextiles protected by sheet. As Photograph 4 shows, the underside of the sheet was covered in moss.

Photograph 4. The Eco-Tube after 16 months (Niyodogawa river reaches).

3 CONCLUSIONS

Several investigations were conducted to assess the durability of the Eco-Tube. The following conclusions were derived from the results of the investigations.

(1) With vegetation covering, the geotextiles are able to maintain a strength retention ratio of around 70% after 16 months.
(2) The geotextiles situated below the waterline has a residual strength ratio of around 90% after 21 months.
(3) Covered in sheets, the geotextiles are able to retain a residual strength ratio of around 90% after 16 months.

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