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Experiment on "geotextile tube dehydration method" with nonwoven fabric tube for acceleration of dehydration work

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ABSTRACT: The tube dehydration process involves filling a geosynthetic tube with cohesive or dredged soil of high water content, extracting the water, and then using the tube for filling or reclaiming by using the tension of the tube. The tube must not break during this process, discharge turbid water of high density during dehydration, or alter the soil to allow reuse by early dehydration. The process extracts water by self-weight compaction. Bagging reduces the drain distance and addition of draining materials reduces the dehydration time further. In this study, we created a tube with enhanced drainage and evaluated its processing performance with regard to permeability and initial turbidity, and also the pressure resistance of the tube.

1 INTRODUCTION

The tube dehydration process drains water by self-weight compaction occurring from the outside to the inside of a cylindrical cross section. If a tube is filled with cohesive soil of low permeability, it takes a considerable time to drain water into the interior. Nonwoven fabric is used as a geosynthetic drainage material with excellent draining performance. Therefore, we developed a tube for dehydration taking into account the following:

- Short drain distance
- In-plane drainage

Nonwoven fabric was placed inside the tube to make the tube double-structured. Fabrication from a textile cylinder with a seamless structure can provide high pressure resistance. In a test of pressure resistance, the withstanding pressure of the tube was determined.

2 CHARACTERISTIC OF GEOTEXTILE TUBE

2.1 *Material and shape*

The tube was made of polyester-based textile formed into a cylinder by sewing together both ends with ultrahigh-tension polyethylene fibers. The tube included a check valve to prevent reverse flow after filling with the cohesive soil of high water content by a pressure pump. The tube has dimensions of 1.5 × 2.2 m (width x length) and swells into a barrel shape as shown in Figure 1 when filled with soil. The tube filling capacity is 1.3 m^3. Lifting hooks can be attached to both ends. The nonwoven fabric, of 2 mm in thickness, was arranged at the center of the tube such that dehydration was accelerated. Figure 2 shows the arrangement of the nonwoven fabric.

Figure 1ÅDShape of geotextile tube

2.2 *Selection of bag material*

Using a constant-head permeability test deviceÅisee Figure 3Åjbased on the standard of the Japanese Geotechnical Society(1993), the coefficient of permeability of the tube was calculated. Figure 4 shows the relationship between the weight and the coefficient of permeability measured by the constant head permeability test device. As the weight become large, the coefficient of permeability was

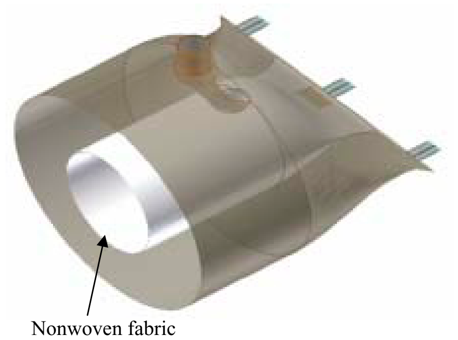

Figure 2. Arrangement of nonwoven fabric

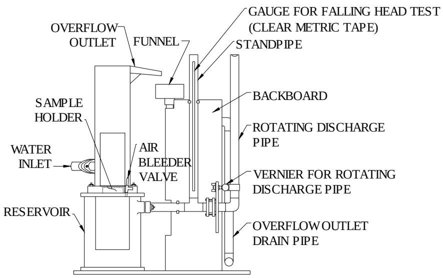

Figure 3ÅDConstant head permeability test device

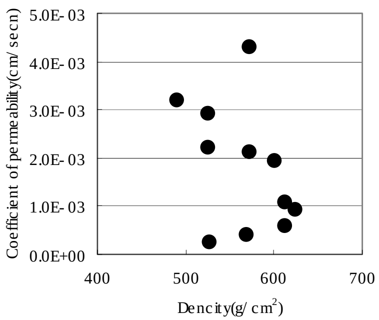

Figure 4ÅDCofficient of permeability and density

considered to decrease because the warp and woof pitches became small. However, no correlation was observed between them. For fabrication of the tube, we selected the cloth of the smallest coefficient of permeability (2.59 × 10^{-4} cm/sec) from among 11 types. Table 1 shows the physical characteristics of the tube.

Table 1. Character of geotextile tube

	Warp	Woof
Tensil strength (number/cm)	1231	2287
Density(g/cm^2)	527	
Thickness(mm)	0.69	
Coefficient of permeability(cm/sec)	2.59×10^{-4}	

3 EXPERIMENTAL METHODS

3.1 Dehydration amount and turbidity

River soil was used in the injection experiment. The river soil was made up of clay deposited in a settling basin at a purification plant. Table 2 gives the characteristic properties. The water content of the soil was adjusted to 160% for the pump pressure feed. This water-adjusted soil was injected by a squeeze pump (100 L/min) to the prescribed height of 80 cm. As Photo 1 shows, we placed the tube on an inclined bench, injected the soil, and measured the dehydration amount and turbidity every hour, and the tube height every day. For turbidity measurement, a portable nephelometric turbidity meter was used.

Photograph 1.Experiment situation

Table 2. Characteristic of soil

Density(g/cm^3)	2.436	
Gradation(%)	Gravel	1.9
	Sand	24
	Silt	47.7
	Clay	26.4
Consistency of clay(%)	Liquid limit	149.3
	Plastic limit	80.6
Classification	Sandy soil-silt	

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3.2 *Burst resistance*

According to the standard estimate data of the tube dehydration process (1998), the tube needs maximum tensile 100 N/cm for a circumferential strength of 3.3 m. The strength of the material used satisfies the requirements well as shown in Table 1. This experiment was conducted to check the safety strength of the tube.

4 TEST RESULT AND DISCUSSION

Figure 5 shows the cumulative amount of dehydration. The tube with nonwoven fabric had a 1.5 times greater cumulative amount of dehydration probably because the drain distance was short and additional in-plane drainage was provided by the nonwoven fabric. The cumulative dehydration volume was checked by measuring the volume of drained water every hour. After 100 hours, however, the amount became too small to measure. Figure 6 shows the measured amount of cumulative dehydration against the tube height measured once a day. As Figure 6 shows, the height of the tube with nonwoven fabric decreased faster. The height of the tube with nonwoven fabric became almost equal to that of the tube without the material on the 5th day and was lower on the 8th day. Figure 7 shows turbidity changes over time. When nonwoven fabric was used, the initial turbidity at the start of measurement was found to be low. Adding nonwoven fabric may not only increase the cumulative dehydration amount but may also lower the turbidity of drained water by filtration. At the start of injection, in particular, nonwoven fabric absorbed turbid water and lowered the turbidity.

Figure 8 shows the injection time and pressure. When the injection pressure was 0.12 MPa, warps around the injection opening cut the material and the tube ruptured. The rupture position was the same as that identified in an experiment by Miki et al. (1998). Because the tube had an opening at this point, the concentrated stress ruptured the tube. Figure 9 shows the elongation at a specified pressure measured by drawing a checker pattern of 10 × 10 cm. The circumferential tension is theoretically

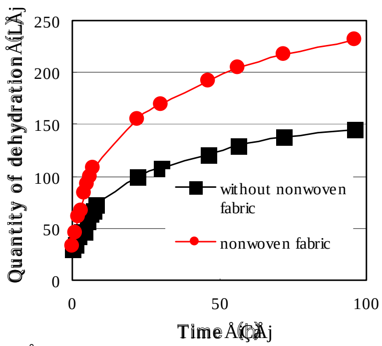

Figure 5ÅDQuantity of dehydration

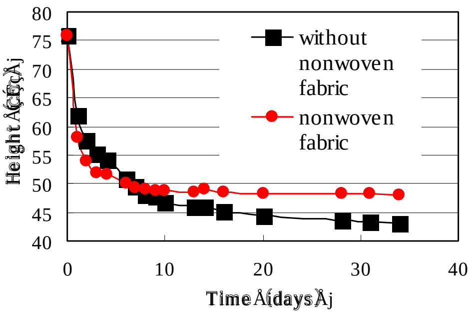

Figure 6ÅDHeight of geotextile tube

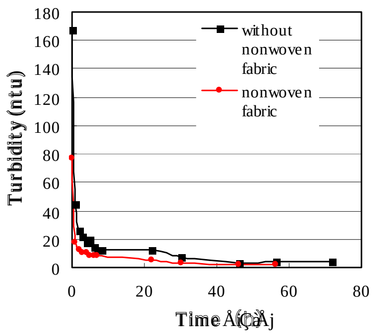

Figure 7ÅDTurbidities of dehydration

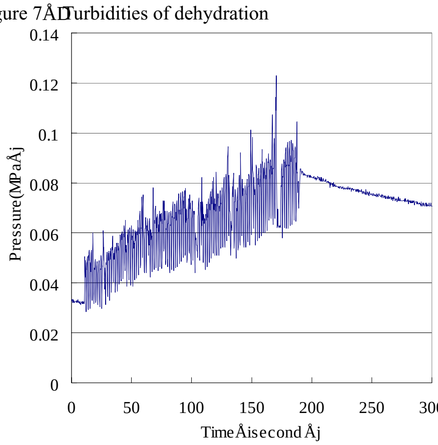

Figure 8. Pressure-resistant experiment

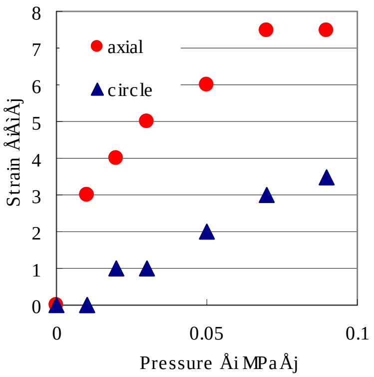

Figure 9. Strain of axial and circle direction

double the axial tension but the experiment showed the opposite result.

5 CONCLUSIONS

This study confirmed the following:
1) Nonwoven fabric increased the cumulative dehydration amount by 1.5 times.
2) Nonwoven fabric reduced the initial turbidity by filtration.
3) A pressure resistance test verified greater resistance than reported in the past.

Theoretically, a tube should experience twice the tension in the circumferential direction than the axial direction but experimentally it was found that the tension was 2.5 times greater in the axial direction than the circumferential direction.

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REFERENCES

The geotextile dehydration method standard estimate data (proposal, 1998). the mixed reinforcement ground technical examination committee the geotextile dehydration method group.

The Japanese Geotechnical Society. Test method for permittivity of geotextile in close-plane direction, (Draft,1993). Standards Japanese Geotechnical Society

Kurumada, Miki, Fujii, and Takahashi(1998).bag Functions and roles of the geosynthetic in "Geotextile tube dehydration method", the 13th geosynthetic symposium, pp.122- 130.