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Basic characteristics of the hose-like textiles filled with the various lightweight soil

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ABSTRACT: Geosynthetics are generally used in a planar form but have also been applied as hose-like textiles or bags. For hose-like textiles, in particular, several methods have recently been developed, named jacket processes, in which hose-like textiles are filled with mortar, clay, or sand to reinforce soil or concrete materials based on the tensile strength of the textiles. For construction on weak ground, lightweight materials are also being used to fill the hose-like textiles. To investigate the basic characteristics of hose-like textiles (jackets) filled with foam cement, we performed the bending and compression test, and compared the results with a jacket filled with Portland cement. For the foam cement filled jackets, the foam cement itself was not very resistant to axial compression as well as bending and no reinforcing effect using the tensile strength of the jacket was obtained. On the other hand, for Portland cement filled jacket, reinforcing effect using the tensile strength of the jacket was obtained. In terms of bending strength, jacket process with foam cement was available by adopting a composite type and filling the compression side with cement milk of high density.

1 INTRODUCTION

Geosynthetics are generally used in a planar form but have also been applied as hose-like textiles or bags. For hose-like textiles, in particular, several methods have recently been developed, named jacket processes (Kitamoto, Y etc 2004) in which hose-like textiles are filled with mortar, clay, or sand to reinforce soil or concrete materials based on the tensile strength of the textiles. For construction on weak ground, lightweight materials such as foam waste glass, styrene beads, and foam mortar are also being used to fill the hose-like textiles.

To investigate the basic characteristics of hose-like textiles (jackets) filled with foam cement, we performed the bending and compression test, and compared the results with a jacket filled with Portland cement. The possibility of applying foam cement to the jacket process is discussed.

2 TEST METHOD

2.1 *Molding method of specimens*

To mold specimens, three types of foam cement were forced into polyester-made hose-like textiles (jackets) of 30 mm in diameter using a drum pump. Table 1 shows the types, densities, and product names of the filled materials, Table 2 shows the blending

Table 1. Densities of filled materials.

Materials		Variety	Density (g/cm^3)
Cement		Blast furnace cement B	3.04
Mixing water		Tap water	1.00
Bubble	Foaming agent	Inter facial active agent	1.00
	Dilution water	Tap water	1.00

Table 2. Blend composition of three types of foam cement.

Foam cement	Used material per 1 m^3		
	Cement (kg)	Sand (kg)	Mixing water (kg)
Type A	268	0	210
Type B	353	0	240
Type C	400	0	272
Foam cement	Foaming agent (kg)	Dillution water (kg)	W/C (%)
Type A	2.35	32.9	91.5
Type B	2.15	30.1	77.1
Type C	1.99	27.9	68.0

composition of the three types of foam cement (Type A, B, and C), and Table 3 shows some characteristics of the foam cement. Portland cement with a water content of 60% was used as a control.

Table 3. Characteristics of foam cement.

Foam cement	Specific density	Air content (%)	Flow value (mm)
Type A	0.51 ± 0.1	67 ± 5	180 ± 20
Type B	0.63 ± 0.1	61 ± 5	180 ± 20
Type C	0.70 ± 0.1	57 ± 5	180 ± 20

2.2 *Compression test method*

The molded specimens were cut into 60 mm long pieces and an axial compression test was performed on the specimens at a loading speed of 10 mm/min using a universal testing machine.

2.3 *Bending test method*

The molded specimens were cut into 200 mm long pieces and a three point bending test was performed on the specimens at a loading speed of 5 mm/min using a universal testing machine. The span length was 90 mm.

3 TEST RESULTS AND DISCUSSIONS

3.1 *Compression characteristics of Portland cement and foam cement filled jackets and their comparisons*

Figure1 shows the compression stress–displacement curves of the Portland cement and foam cement filled jackets. For comparison, the compression strength levels of the Portland cement and foam cement alone (with no jacket) are also shown.

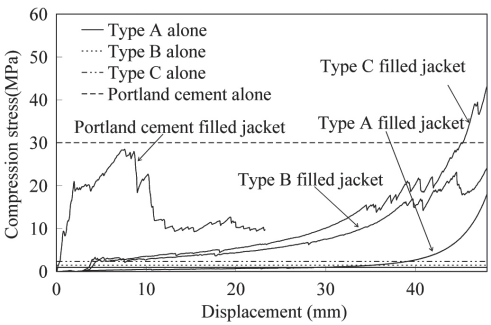

Figure 1. Compression stress – displacement curves of Portland cement and foam cement filled jackets.

For the Portland cement filled jacket, the stress increased quickly with displacement but initial fracturing of the Portland cement in the jacket caused a reduction in stress. The stress increased again but decreased with partial fracture of the jacket. This was repeated until eventually the entire jacket had fractured at the bottom of the specimen as shown in Photo 1. From Figure 1, we see that the fracture strength was about 30 MPa. The strength is almost equal to that (30 MPa) of the Portland cement alone (without jacket). This indicates that the reinforcing effect using the jacket tension effectively is small.

Photo 1. Typical aspect of compression fracture for Portland cement filled jacket.

For the foam cement filled jackets, the stress increased slowly with displacement. As the stress increased, the foam cement progressively fractured in the three types of the foam cement filled jackets. However, the final position of fracture could not be observed clearly as shown in Photo 2.

Figure 2 shows an enlarged view of the section of low displacement values from Figure 1. With no jacket,

Photo 2. Typical aspect of compression fracture for foam cement filled jackets.

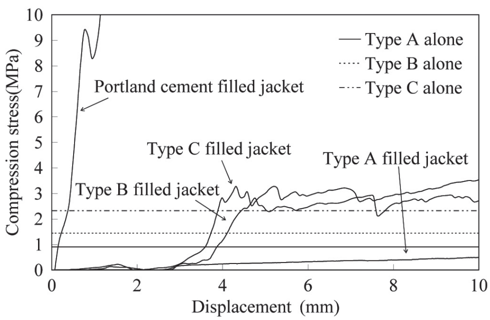

Figure 2. Enlarged view of the section of low displacement values from Figure 1.

type C containing the least air showed the greatest strength and type A containing the most air showed the smallest strength. From the curve in Figure 1, we see the same tendency and no stress increase even with a jacket. These results suggest the reinforcing effect using the jacket tension is small for foam cement.

The above results indicate that both the Portland cement and foam cement filled jackets require further investigation in order to utilize the jacket tension effectively for compressive loads.

3.2 *Bending characteristics of Portland cement and foam cement filled jackets and their comparisons*

Figure 3 shows the bending stress-deflection curves of the Portland cement and foam cement filled jackets. The stress of the Portland cement filled jacket increased quickly with deflection but initial fracture of the Portland cement in the jacket caused a reduction in stress. The stress increased again but decreased with partial fracture of the jacket. This continued and eventually resulted in fracture of the jacket on the side under the load point as shown in Photo 3. From Figure 3, we see that the fracture strength was about 42 MPa. The Portland cement filled jacket showed about sixth times greater strength than the value of about 7 MPa for the Portland cement alone (without jacket). Considering these results, Probably Portland

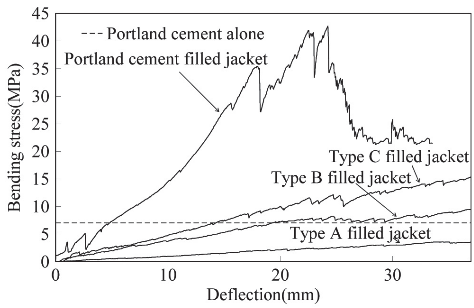

Figure 3. Bending stress – deflection curves of Portland cement and foam cement filled jackets.

Photo 3. Typical aspect of bending fracture for Portland cement filled jacket.

cement effectively provide a reinforcing effect utilizing the jacket tension.

For the foam cement filled jackets, the stress increased slowly with deflection. As the stress increased, foam cement progressively fractured in the three types of foam cement filled jackets. However, the final position of fracture could not be observed clearly as shown in Photo 4. Probably the foam cement fractured before a reinforcing effect utilizing the jacket tension was provided.

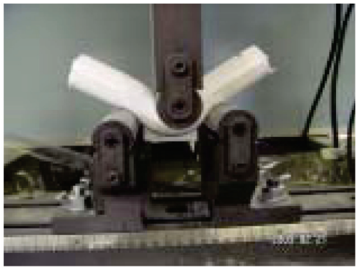

Photo 4. Typical aspect of bending fracture for foam cement filled jackets.

3.3 *Applicability of the jacket process to foam cement filled jacket*

Considering sections 3.1 and 3.2, the foam cement in the Foam cement filled jacket is fractured without effective use of the jacket tension. The Portland cement filled jacket did not exhibit a reinforcing effect against compression but did against bending. To utilize the lightweight characteristics of foam cement for the jacket process, an effective option seems to be to create a lightweight soil filled jacket (hereinafter, composite lightweight soil filled jacket) from foam cement and Portland cement. Figure 4(a), shows a structure with an outer layer of Portland cement and an inner filling of foam cement. Figure 4(b) shows an example where the inner filling of foam cement is shifted from the center to effectively use the strength of the Portland cement according to the load direction. Figure 4(c) shows the Portland cement and foam cement arranged half-and-half. In this study, we performed a bending test on the composite lightweight soil jacket shown in Figure 4(a) and discuss application to the jacket process.

The molded specimens had dimensions of 55.6 mm diameter for the outer layer, 30 mm diameter for the inner filling, and 400 mm length. Portland cement with a water content of 60% was used for the external layer and foam cement of type C was used for the inner filling. Using a universal testing machine, we performed a three-point bending test at a test speed of 5 mm/min and a span length of 168 mm.

Figure 5 shows the bending stress - deflection curve of the composite lightweight soil filled jacket with the strength level of Portland cement alone. The stress

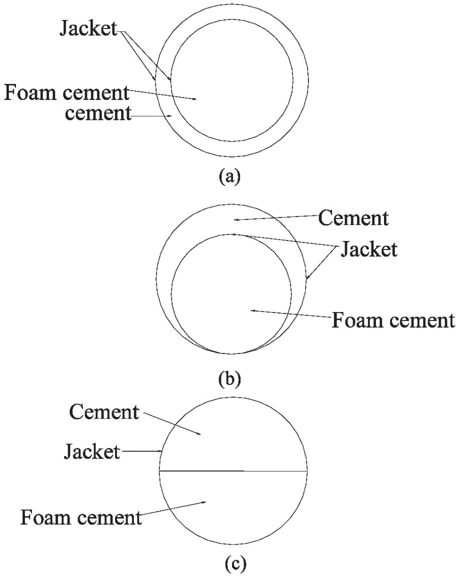

Figure 4. Examples of composite lightweight soil filled jackets.

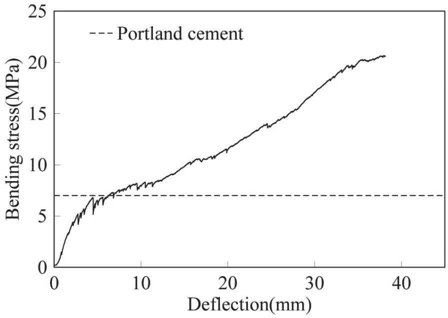

Figure 5. Bending stress – deflection curve of composite lightweight soil filled jackets.

of the composite lightweight soil increases quickly with displacement and causes fracture of the inner filling, after which the stress continues increasing. As Photo 5 shows, a stress of 21 MPa caused the jacket to fracture under the load point. The strength of the jacket was found to be three times greater than that (7 MPa) of the Portland cement alone. By observing the fracture cut off as shown in Photo 6, the outer layer of the Portland cement and the inner

Photo 5. Aspect of bending fracture for composite type.

Photo 6. Aspect of cross section for composite type.

filling of the foam cement can be clearly seen as shown in Figure 4. From the above results, it was determined that the foam cement filled jacket did not make an effective use of jacket tension. However, the composite lightweight soil filled jacket shown in Figure 4(a) probably utilizes the jacket tension effectively.

4 CONCLUSION

In this study, we confirmed the following:

(1) For the foam cement filled jackets, the foam cement itself is not very resistant to axial compression as well as bending and no reinforcing effect using the tensile strength of the jacket was obtained.
(2) In the foam cement density range of this study, a jacket is available as a textile mold for filling but not for the jacket process.
(3) In terms of bending strength, jacket process with foam cement is available by adopting a composite type and filling the compression side with cement milk of high density.

REFERENCE

Kitamoto, Y. etc. "Jacket method of construction" Geosynthetics Technical Information Vol. 20, No. 3, Nov. 2004.