Experimental preliminarily study on an alternative method to dewater the dredged mud by siphon method

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Abstract: There are worldwide demands for developing alternatives to treat the dredged material in a more economical and environment-friendly manner. A new dewatering method is proposed to efficiently lower high water content of the dredged mud. A series of vacuum, siphon comparative tests are conducted to preliminarily investigate the dewatering and strength behavior of the mud. On the basis of the test results, the availability and effectiveness of the new method is verified. The physical and mechanical properties under the siphon condition are obtained. It could provide a reference for the engineering practice.

Key words: dredged mud, vacuum, siphon, dewatering

1 Introduction

Dredging is essential for the maintenance and development of ports, harbors and waterways for navigation, remediation and flood management. Dredging of these waterways creates large volumes of dredged material. The material can be a valuable resource although much of it is currently disposed because of economic, logistical or environmental constraints. Whereas, in many countries disposal is getting more and more difficult owing to the lack of space as well as environmental concerns. Therefore, developing techniques for dewatering to reducing the volume of dredged material is of significant necessity. However, most of traditional dewatering methods for the dredged material are featured by high energy-consumption or environmental harm [1,2]. New alternatives are urgently demanded to treat the dredged material environmentally-friendly and effectively. In this paper, a new dewatering method—siphon dewatering method is proposed, and the availability and effectiveness of the new method are preliminarily investigated.

2 Test scheme

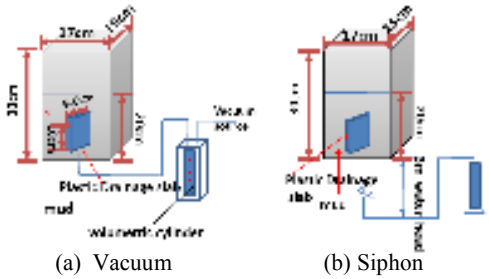
A series of laboratory tests are conducted to comparatively investigate the consolidation and strength behavior of the mud under vacuum and siphon conditions. The test scheme includes a group of comparative vacuum and siphon tests.

3 Test sample and equipments

The test sample used in the study was taken from Island city, Fukuoka city, Japan. Its basic physical properties are presented in Table 1. Its natural water content is greater than the liquid limit, so the test soil exhibits little strength. The illustration for the test equipments is shown in Fig.1. The test equipments mainly comprise of perpex tanks, a plastic drainage slabs, connectors and long pipe, as well as a micro-vane shear apparatus. As shown in Fig.1 (a), the applied vacuum pressure is 30kPa. In Fig.1 (b), the plastic drainage slab is installed in the right center of the cross-section of the mud, connected to the 3m height pipe with the connector to yield the water head difference, which is equivalent to the corresponding vacuum pressure. And the micro-vane shear apparatus is utilized to measure the initial and final shear strengths.

Table 1 Basic physical properties of test soil

Gravity specific G_S	Natural Water content (%)	Plastic limit w_L(%)	Plastic limit w_P(%)	Plastic Index I_p
2.673	89.4-93.1	77.9	36.7	41.2



(a) Vacuum (b) Siphon

Fig.1. Test equipments

4 Test results and analysis

4.1 The dewatering comparison efficiency

Fig.2 shows the variation of the water drainage volume with time in the vacuum and siphon tests. The initial water contents of mud sample for the vacuum and siphon tests are 85.6 %. The variation of the dewatering volumes with the time shows no distinct difference at the initial 12 hrs between the two tests. Although later the dewatering in the siphon test is basically ceased, whereas the vacuum dewatering is developing gradually. After 48 hrs dewatering, the water contents for vacuum and siphon tests decrease to 68.2%, 70.3 %, respectively. The comparative test results show that at the beginning of the dewatering process, the efficiency with the vacuum and siphon methods exhibit no significant differences, but with the dewatering proceeds, dewatering efficiency by the siphon method show less significance than that by the vacuum method. It can be inferred that the siphon method is specifically efficient for dewatering the dredged mud with relatively high water content.

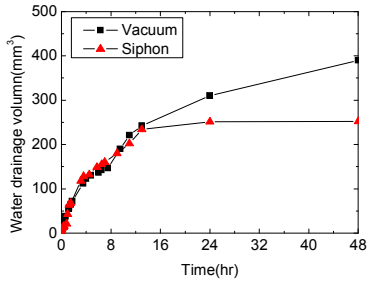
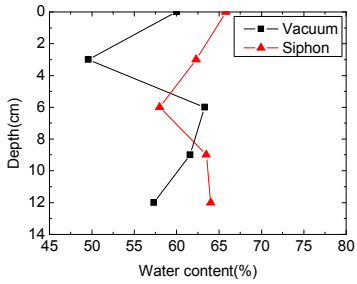


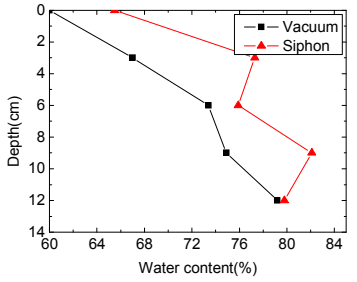
Fig.2. The variation of the dewatering volume with time in the vacuum and siphon tests

4.2 The dewatering comparison of the effectiveness

In order to investigate the dewatering effectiveness, Fig.3 (a), (b) show the comparison of the final water content profiles between the vacuum and siphon dewatering methods. The water contents with the two methods generally increase significantly with the depths. As indicated in Fig.3(a), the central water contents between the vacuum and siphon methods differentiate as much as 13%; whereas as shown in Fig.3(b), the water contents decrease more linearly with the depths.



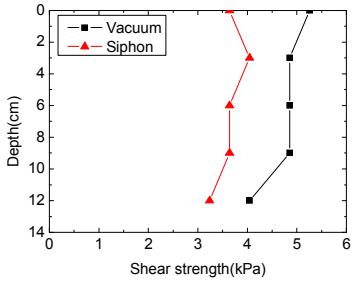
(a)Center



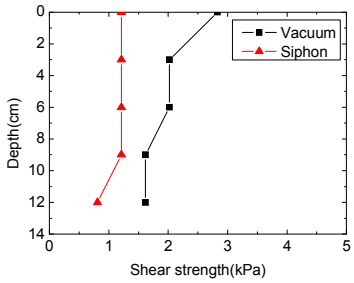
(b)Corner

Fig.3. The comparisons of the final water content profiles between the vacuum and siphon dewatering methods

Fig.4 (a), (b) show the comparisons of the final strength profiles between the vacuum and siphon dewatering methods. The shear strength values of different layers are obtained by the micro-vane shear apparatus. As shown in Fig.4 (a), for the central part soil, which is close to the drainage plate, the shear strength with vacuum and siphon methods shows the similar variation principle; whereas the shear strengths in the vacuum case is approximately 30% greater than that of the siphon case. However, as shown in Fig.4 (b), in both the vacuum and siphon cases, the shear strengths exhibit less variation with the depth, the strength profile of the siphon case is less than that of the vacuum case. It may suggest the effective range with the vacuum method is greater than that with the siphon method. As with the process of dewatering, the mud turns from the saturated to the unsaturated state gradually, the long pipe for the siphon method would be partially filled with bubble, which results in less suction for dewatering.



(a)Center



(b)Corner

Fig.4. The comparisons of the final strength profiles between the vacuum and siphon dewatering methods

5 Conclusions

Through a series of vacuum, siphon comparative tests, the following conclusion can be drawn.

The siphon method is specifically efficient for dewatering the dredged mud with relatively high water content.

In the view of the long-term dewatering performance, the efficiency and the effective range by the siphon dewatering method are less than by those by the vacuum method.

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