Preliminary study and prospects on the dewatering behavior of the dredged slurry with horizontal drainage layers by siphon method

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Abstract: The disposal of the dredged mud has become a worldwide problem recently. There are urgent demands for developing alternatives to dispose the dredged material in a more economical and environment-friendly manner. In this paper, the horizontal drainage layer with siphon method is proposed to dewater the dredged slurry. The preliminary dewatering tests are conducted to investigate the dewatering and strength behavior of the dredged mud with horizontal drainage layer. On the basis of the test results, the further research work on the proposed method is prospected.

Key words: dredged slurry, dewatering, horizontal drainage, siphon method

1. Introduction

Every year 10 to 15 million m^3 of dredging material is generated in Japan. 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 becoming more and more difficult owing to the lack of space as well as environmental concerns. Therefore, developing dewatering alternative to reduce 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)]. New alternatives are urgently demanded to treat the dredged material environmentally-friendly and effectively. As for the high-water-content dredged slurry, horizontal drainage could significantly increase the dewatering contact area between the drainage material and the mud. In this paper, a new dewatering method—siphon dewatering method with horizontally installed drainage plate is proposed, and the further research work on the proposed method is reviewed [2,3)].

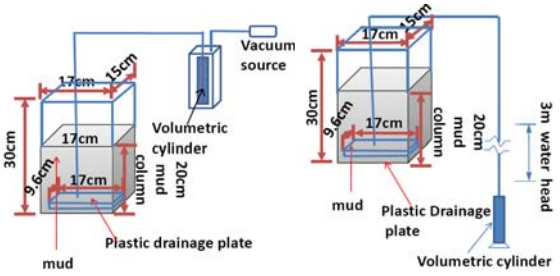
2. Preliminary test

2.1 Test scheme

A series of dewatering tests are conducted to comparatively investigate the consolidation and strength behavior of the mud under vacuum and siphon conditions. The test scheme includes 2 groups of comparative vacuum and siphon tests with horizontally installed drainage plate. The vacuum and siphon dewatering conditions can be illustrated in Figure 1(a), (b).

2.2. Test sample and equipments

The test sample used in the study was taken from Island city, Fukuoka city, Japan. According to the Unified Soil Classification System, the soil can be categorized as MH. The illustration for the test apparatus is shown in Figure 1. The detail information of the test apparatus and test method is introduced in Ref.2~5.



(a) Vacuum (b) Siphon

Fig.1. Test apparatus

2.3 Test results and analysis

Figure 2 shows the variation of the dewatered volume with time. The initial water contents of mud sample for all the tests are 92%, which is about 1.2 times of the liquid limit. The variations of the dewatering volumes with the time in the vacuum and siphon conditions show no distinct difference in the initial 20 hrs. However, the dewatered volume with vacuum method becomes greater than that with siphon method gradually. Finally, the dewatering in the siphon test is basically stopped, whereas the vacuum dewatering is still slowly developing. After 100 hrs dewatering, the dewatered volume is about 38.8%, 38.2% of the total involved

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water in the mud, respectively. It may be inferred that the siphon method is specifically efficient for dewatering the dredged mud with relatively high water content, which is generally greater than the liquid limit. More details about the dewatering and strength behavior of the dredged mud with vacuum and siphon methods are illustrated in Ref.4.

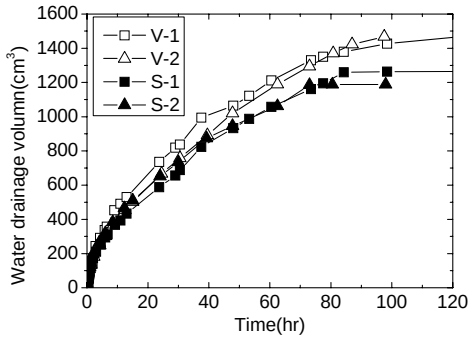

Fig.2. The variation of the water drainage volume with time in the vacuum and siphon tests

3 Further research program

In the paper, a new dewatering method—siphon dewatering method with horizontally installed drainage plate is proposed, as illustrated in Fig.3. Many siphon pipes is connected with the end of the corresponding horizontal drainage layer of the embankment, then the water can be drained by the suction generated by the siphon water head. On the basis of the engineering case, it can be inferred that the dewatering behavior of the dredged slurry is significantly influenced by the dewatering pressure as well as the drainage material. Thus, the further proposed research program mainly focuses on the magnitude of the dewatering suction and composition pattern of the layer with different drainage materials.

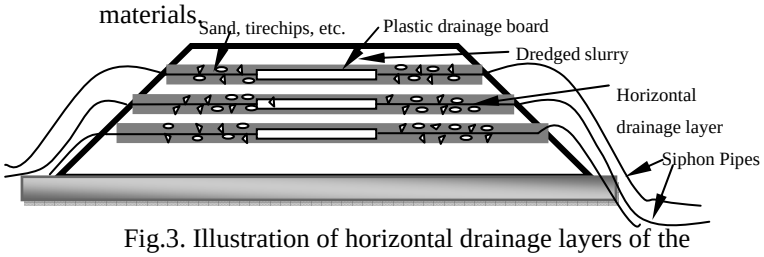

Fig.3. Illustration of horizontal drainage layers of the embankment

One of the further research programs is the influence of the suction pressure magnitude on the dewatering behavior of the dredged slurry. A series of the dewatering tests under different vacuum suctions are to carry out to investigate the magnitude of the dewatering suction on the dewatering efficiency and the effectiveness.

Another essential factor which may account for the dewatering behavior is the hydraulic properties of drainage layer. It is necessary to conduct the comparison tests on the hydraulic behavior of different composition patterns for the hybrid sandwich drainage layers. Traditionally, sand layer is commonly adopted as an effective drainage media. Another alternative is to use the tire chips instead of the sand, which could serve as the alleviation of the environmental burden to consume the waste tires. Tire chips also show some effectiveness on absorbing contaminated substance involved in the slurry. Another potential material for the drainage layer is the steel slug, which is usually the by-product in the steel plant. It would serve as strength-improvement material in the long term. From the previous analysis, 4 patterns of the sandwich drainage layers can be chosen to carry out the comparison tests, which are sand layer only, geotextile, geotextile plus sand, geotextile plus tire chips and geotextile plus steel slug, respectively.

5 Conclusions

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

1. The siphon method is specifically efficient for dewatering the dredged mud with relatively high water content, which is generally greater than the liquid limit.
2. Approximate 30% of water involved in the mud has been dewatered by the siphon tests, suggesting it is effective to dewater the dredged slurry with siphon method.
3. It is essential to conduct the vacuum dewatering tests on the influence of the suction magnitude as well as the drainage material on the dewatering behavior of the dredged slurry with horizontal drainage layer.

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