Back analysis on surface distribution of bearing layer under soil-cement columns by construction management record

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1. Introduction

As Saga Prefecture is existed in lowland region surrounded with Ariake Sea, it can say that the soil quality of Saga lowland is soft ground, plenty of mineralogy, organic content, high salt concentration and so on[1]). When implementing the Ariake Sea Coastal Road Project, the deep mixing method (DMM) is widely used to improve the soft ground by mixing of cement and water with soil and constructing soil-cement columns in situ. The history of DMM in Japan is about 60 years, but it still suffers from many construction troubles[2]). In this research, the construction management records of DMM from the Saga-Fukudomi Road which is a part of Ariake Sea Coastal Road, are applied and analyzed to understand the formation and distribution of bearing layer in Saga lowland.

2. Research location and soil-cement columns layout

Fig. 1 shows the construction site of the DMM that was the subject of this study. The main research area is indicated in **Fig. 1** and named as Saga-Fukudomi Road. The construction site exists in Fukudomi, Shiroishi Town, Kishima District, Saga Prefecture. **Fig. 2** and **3** describe the arrangement and position of soil-cement columns.

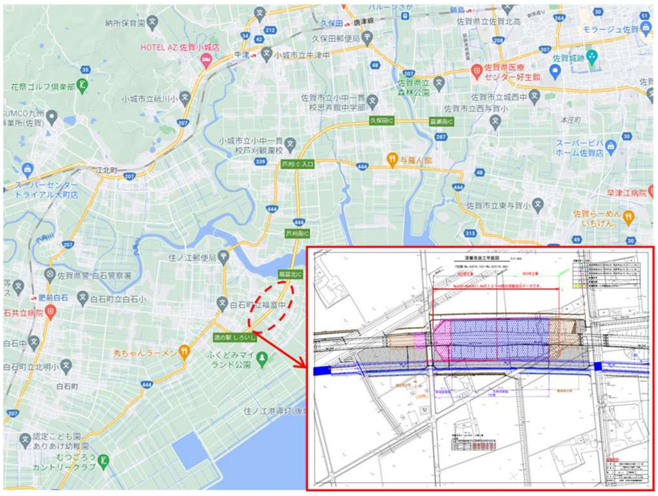

Fig. 1 Construction site of DMM

The total ground improved construction length is 120 meters, and the width is 40 meters. The soil-cement columns are built from the designated boundaries of number 420 to 426 and are plotted from A to X gridlines.

3. Research methodology

The initial DMM on Saga-Fukudomi Road was a floating type[3]). However, when the construction of the road reached the construction area shown in Figure 1 targeted in this study, the method became ineffective.

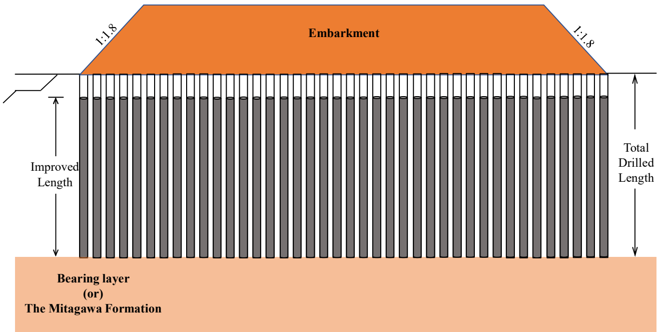

Fig. 2 Arrangement of soil-cement columns

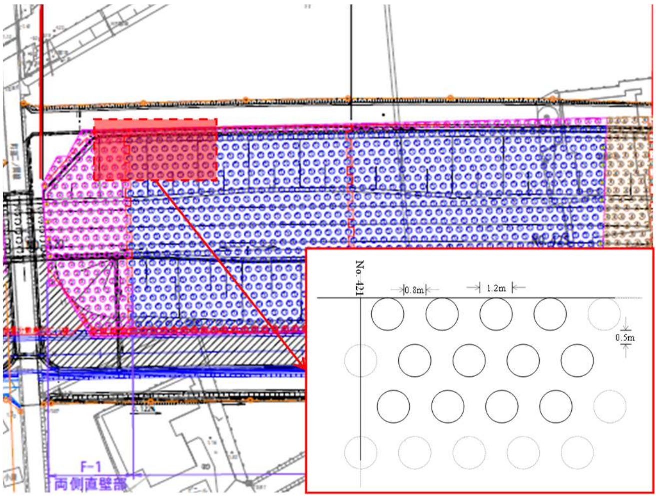

Fig.3 Positions of soil-cement columns in Saga-Fukudomi Road

Therefore, the DMM in the construction area was changed to the advanced support method. In the case of fully penetrating type of DMM[4]), construction torque was increased significantly and exceeded the specified value based on the soil specification and qualification of construction sites.

So, it was taken that the lower member of the Hasuike Formation penetrated the Mitagawa Formation[1]). The construction depth is the bottom layer determined by the excavation resistance of the ground improvement machine and does not accurately indicate the geological boundary of the stratum, but it indicates the boundary from the soft part to the hard part. It was estimated that the initial design depth is G.L.-15m. Based on the soil-cement columns data, the improved lengths or landing elevations of the pile are determined from the tip of soil-cement columns to the ended place of the deep mixing operation.

If the actual drilled length is taken by the actual construction torque of DMM machine, the location and the Mitagawa Formation can be examined in the different

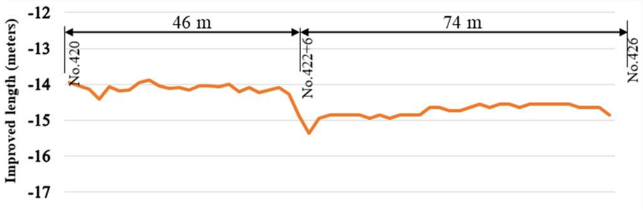

Fig. 4 Cross-sectional profile of bearing layer in D gridline (From E to W)

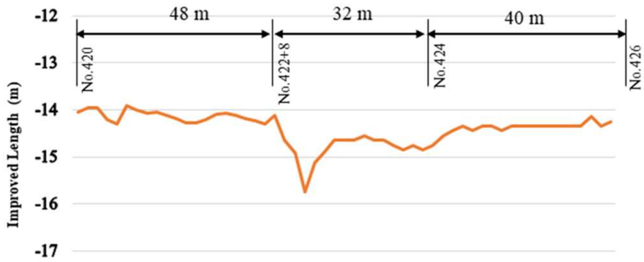

Fig. 5 Cross-sectional profile of bearing layer in K gridline (From E to W)

perspectives such as three dimensional and two-dimensional shapes. Therefore, the actual boring length are organized from the field and analyzed to find out the formation of bearing layer or the Mitagawa Formation (See **Fig. 2**).

4. Results and discussion

In **Fig. 4**, two-dimensional formation of bearing layer in construction line D, is clearly seen that there are two levels in bearing layer. It can be identified that the bearing layer is about G.L.-14m between No.420 and No.422+6 and about G.L.-15m from No.422+6 to No.426. In the centered line K as shown in **Fig. 5**, the bearing layer is typically unique, and characteristic. The supporting layer exists in about G.L.-14m between No.420 and No.422+8, about G.L.-15m from No.422+8 to No.424. From No.421 to No.426, it exists about G.L.-14.5m below the ground. Remarkably, the central area of the K line bearing layer, which began at No.422+8, developed a deeper dip into the 15.8 meters depth.

Fig. 6 shows three-dimensional bearing layer under Saga-Fukudomi Road. According to this result, the darken boundary situates a lowland with a width of about 20 m from No.422+8 to No.424. The red route is similar to the V-shaped valley terrain from north to south direction.

Fig. 7 shows distribution of past rivers along the Ariake sea coast[5)]. According to **Fig. 6**, V shaped valley terrain may be caused by the deposition of organic matter. Additionally, by comparing with distribution of past rivers along Ariake Sea coast, deep terrain or creek may be the old river in the past. When applying DMM in such a V shaped valley terrain, it is necessary to pay attention to the quality of the tip of the soil-cement columns.

5. Conclusion

(1) The back analysis of deep mixing method in construction site is found as the bearing layer under Saga lowland by using the construction management data.

(2) There is a big change in the depth of bearing layer in a short distance under Saga lowland.

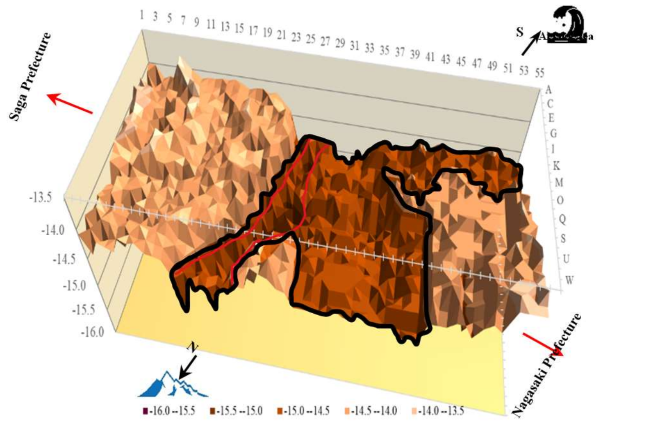

Fig. 6 Three-dimensional profile of bearing layer under Saga-Fukudomi Road

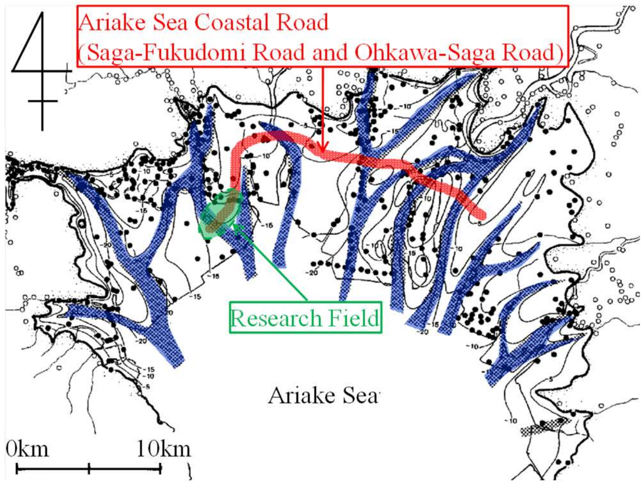

Fig. 7 Distribution of past rivers along the Ariake sea coast (Modified from Shimoyama et al. (2010)[5)])

Acknowledgments

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