CHARACTERIZATION ANALYSIS ON HARBOUR SILTATION IN JAPAN

by

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1. INTRODUCTION

The purpose of the present study is reviewing the current situation of the dredging activities for navigation channels around Japan, especially in Kyushu district, and characterizing the siltation mechanisms and sedimentary conditions around a navigation channel through the field data analysis. The present study discusses on the results from 1) a data analysis of historical records of dredging volume for several ports and 2) field data analysis for understanding the siltation mechanism and fluid mud formation, considering the applicability of the nautical depth concepts for the ports.

2. DREDGING VOLUME FOR ACCESS CHANNELS

In order to characterize the dredging activity for access channels to the port in the Kyushu district in Japan (Figure 1), the dredging records for fifteen years since 2002 through 2017 were collected from the Kyushu Regional Development Bureau of Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The total volumes of dredging for development of navigation channels at the ports are calculated as shown in Figure 2. The figure demonstrates the relationship between the designated depth of the navigation channel and dredged volume for the recent 15 years. The dredging volume for the navigation channel mainly depends on the bathymetrical condition and the length of the channel to approach the required depth at the offshore. The dredged volume, therefore, does not have proportional relationship with the required depth or designated depth, showing the case with relatively smaller dredging volume for deeper navigation channel at Port KK2, where the bathymetry condition is suitable for deeper access channel with natural deeper basin. On the other hand, the Port K required the relatively larger dredging volume in spite of the channel depth is less than 8 m, since the port locates in the shallow coast as demonstrated in the following chapter.

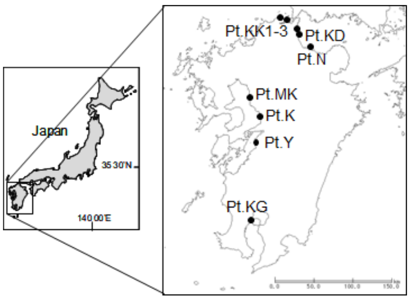

Figure 1: Map of Study Site

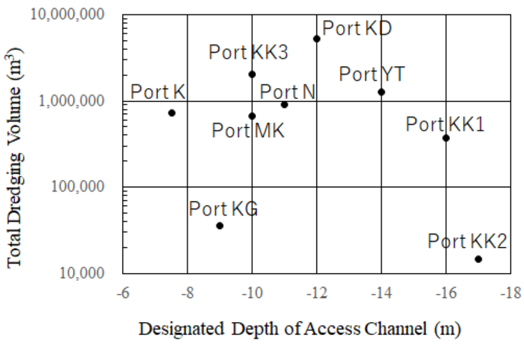

Figure 2: Total Dredging Volume for Access Channels

3. SEDIMENTATION PROCESS AROUND ACCESS CHANNELS

Field monitoring were carried out at the offshore of the port of Kumamoto, indicated as Pt. K in Figure 1, with the deployment of bottom mounted instruments for current and turbidity measurements (Takashima et al. 2015). By using the observed current and SSC data set, suspended sediment flux was also analyzed with the estimation of contribution by several factors including tidal current and wave event to the total flux. According to this estimation, dominant transport at a measurement point was eastward (blue line in Figure 3) and 91% of the flux was due to tidal current, 9% was due to waves including wind wave and boat traffic waves, respectively. Contribution of SS concentration due to waves (wind waves) and boat traffic is relatively small but the tidal current during the spring tide period is dominant factor of SS transport.

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4. FIELD SURVEY FOR CHARACTERIZING VERTICAL STRUCTURE OF MUDDY SEDIMENT

For the density measurement, the tuning folk type densimeter was used and the instrument consists of the mono folk type sensor with the length of 10 cm and the diameter of 1.5 cm. The data shows the highest water content and fluid mud layer at the monitoring point in the navigation channel, where is dredged to the level of -7.7 m from the original bottom level of -4 m. This fact indicates that fine particles accumulates in the dredged deeper channel with so high concentration that fluid mud layer is formed. The measured profile of the bulk density by the in-situ densimeter for the station is shown in Figure 4 with the fluid mud layer thickness of around 20 cm where the bulk density is between 1.02 and 1.2 g/cm^3. Although the present study area was relatively small amount of fluid mud layer as much as 20 cm, this information is critical for the maintenance of navigation channel depth under muddy environment. The present monitoring techniques can be applied for better understanding of the fluid mud dynamics around the port and harbors in estuarine environment, considering application of the nautical depth for the maintenance of navigation channels (e.g. Mehta et al. 2014).

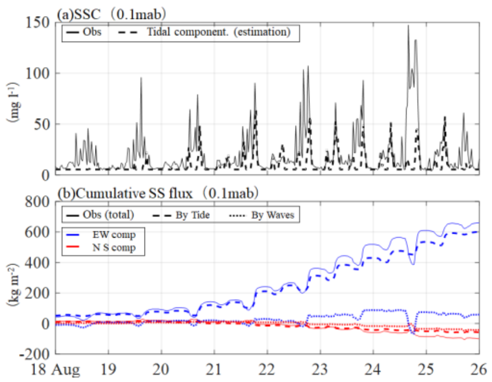

Figure 3: Estimated Suspended Sediment Flux

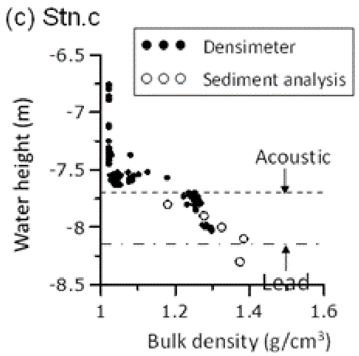

Figure 4: Measured fluid mud layer in a channel

5. CONCLUSIONS

Maintenance of navigation channel is crucial topics for the of port and harbors under soft muddy environment. By the analysis of total amount of dredging volume to develop access channels for Japanese port, the relationship between the required cannel depth and dredging volume showed non-linear relation and dependency of the dredging volume on bathymetry condition. As a case study at the port, which is surrounded by shallow intertidal mud flat area, the field data analysis of the measured current and turbidity shows several factors of resuspension forces such as tidal current, wind waves and waves generated by ferry boat traffic and the tidal current is the most dominant for the horizontal transport among them in the present study site. Furthermore, field data of muddy sediment structure around the navigation channel was also presented and the data shows fluid mud layer with the thickness of around 20 cm in the study site. The monitoring technique can be applied for a maintenance of navigation channel in soft muddy sediment environment considering the nautical depth approach

References

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