Mechanism of Sedimentation in Bangkok Bar Channel and Estimation of Sedimentation Volume in the Channel

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1. Introduction

Bangkok Bar Channel is a unique approach channel to Bangkok(Kron Toi)Harbor that is the representative river port constructed along the river mouth of Chao Praya River. Various facilities are scattered along the both sides of the river between the river mouth and the bridge located about 50km upward. The construction of the channel began in 1951 and was completed in 1954. The volume of capital dredging was about 16 milion m^3. The length of the channel is 18km and the channel crosses Bangkok Bar, the depth of which is less than 2m at low tide. A mean depth of the channel is about -8.5m under the mean sea level and the width of the channel varies from 100m(at straight part) to 200m(at the bend). Due to the heavy sedimentation discharge from the river and severe sedimentation around the bar, the channel is barely maintained its fair way through the continuous dredging of about 5milion m^3/year.

The aim of this study is to investigate the mechanism of sedimentation in Bangkok Bar Channel and to estimate the volume of sedimentation in the channel through the statistical analysis of measured time history of river discharge, dredged volume and bottom profiles during August 1989 and August 1991. The volume of discharge sediment from the river mouth is estimated from the depth averaged discharge velocity and siltation concentration measured in August 1991. The sedimentation around the Bangkok Bar caused by waves and tidal current is predicted through the numerical simulation.

2. Statistical Analysis of Sedimentation Volume in the Channel

We evaluated the sedimentation volume in the channel based on the measured channel topography and records od dredged volume within 18 sections of the channel set at the distance of 1km along the channel. The sounding of the channel have been carrying out by The Port Authority of Tailand twice a month. We investigated the characteristics of the time and spatial variation of the sedimentation volume by comparing the time histories of river discharge and wind data. A so-called empirical eigenfunction analysis was also carried out to distinguish the difference between the sedimentation from the river and that caused by waves and tidal current.

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3. Estimation of Sedimentation Volume from the River

We carried out field mesurements of discharged velocity and silt concentration at the river mouth in August 1991 and obtained the following relation between the depth averaged discharge velocity U and the depth averaged silt concentration:

$C(ppm) = 400U\ (m/s)$

Based on this relation, we estimated the sedimentation volume discharged from the river assuming the triangle distribution of the river discharge that has a peak discharge of $3000m^3/s$ and continues for two months. The discharged sedimentation volume caused by the model discharge was estimated about $2*10^6m^3$ that was a half the averaged annual total sedimentation volume in the whole channel during 1989 and 1991.

4. Estimation of Sedimentation Volume Caused by Waves and Tidal Current

The volume of sedimentation in the channel caused by waves and tidal current was evaluated by conducting numerical simulations. For the sake of simplicity and to grasp the rough figure of sedimentation caused by waves and current, we assume that the waves and current cross the channel at right angle. In such case, severe sedimentation takes place due to the non-equilibrium suspended sediment transport caused by the abrupt change in water depth.

We apply two procedures to simulate non-equilibrium suspended sediment cocentration precisely(Sawaragi et al.,1991). One is to solve a usual turbulent advection-diffusion equation by using Split-Operator Approach where the advection term and the diffusion term are discreized by 4-th and 5-th order difference equations. In the other method, a depth averaged advection and dispersion equation is solved by using ADI method.

The simulated result predicts the amount of the sedimentation caused by waves and current to be about $3*10^6m^3$/year that is the same order of the sedimentation volume discharged from the river.

5. Conclusions

Through the statiscal analysis of the topographic change in the channel, it is found that sedimentation in the upper and the sections of the Bangkok Bar Channel is mainly caused by the river discharge. In the lower sections, the river discharge has little influence. Waves and tidal current also play an important role in sedimentation in the middle and lower sections and they become a unique agitation and transporting agency of bed material to deposit in the channel of lower sections.

From the results of simplified numerical simulation of the sedimentation in the channel, we can judge that the order of the amount of sedimentation caused by waves and current in the middle sections is almost the same as that brought about by the river discharge.

Reference

Sawaragi T., I. Deguchi,M. Ono and K.S. Bae(1991), Numerical simulation for shoaling process of navigation channel,Int'l.Sympo.on Natural Disaster Reduction and Civil Engineering,JSCE,pp.117-126.