Study on the Erosion and Stability of the Banks of Uji River, Japan

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1- Introduction

Erosion of riverbanks could be a disaster and may cause many serious problems like damage of bridges and infrastructures, loss of lands which compels people to displace as they become destitute. On the other hand, the altered flow of rivers due to bank erosion also affects river ecology.

Hydraulic fluvial erosion and mass failure are the two main processes responsible for river bank erosion, (Thorne 1982). Good understanding to the mechanism of riverbank erosion may help in eliminating and manage some of the previously mentioned problems.

In this study, three coupled models are used to estimate the retreat of left bank of Uji River at 43.0km then the results are compared with field observations. The objective of this paper is to evaluate the riverbank retreat at the study site and to specify the major active processes (fluvial erosion, mass failure, and seepage flow) that cause erosion.

2- Study Area and Field Measurements

Study area at 43.0km of Uji River is shown in **Fig. 1**. A remote data transmission system utilizing the mobile phone signals was used to send the water level data measured at ten observation holes normal to the left bank at 43.0km from January to September, 2011, **Fig. 2**. In addition, discharge values passed through Amagase dam were obtained. Uji river stage measured at Mukaijima gauging station (at 42.0km) were used, **Fig.3**. Riverbank retreat distance was obtained from satellite images by Google Earth, **Fig.4**

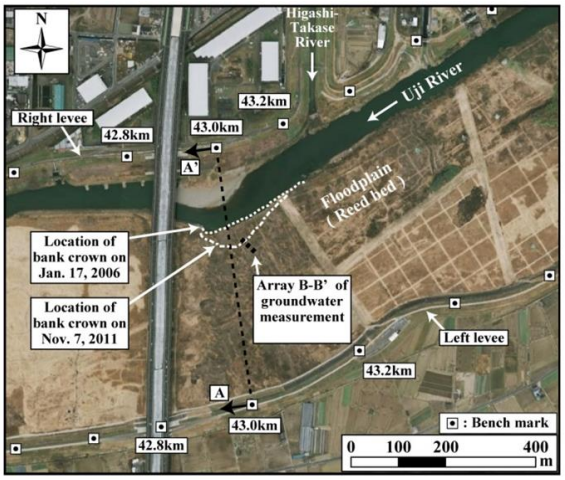

Fig.1 Study area of Uji River at 43.0km, after Azuma 2013. (Background view; Google Earth (February 1, 2007))

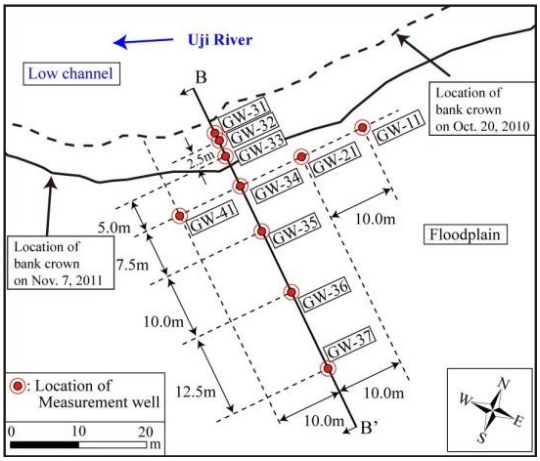

Fig.2 Location of the groundwater measurement wells

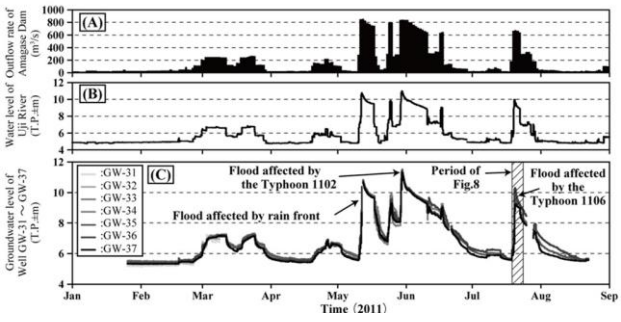

Fig.3 Data observed (A) Outflow discharge from Amagase dam, (B) Water levels at 43.0km, (C) Groundwater levels.

3- Simulation Models and Hydraulic conditions

Numerical simulations for riverbanks are done by coupling four models; 1) FERB-Model, (Fluvial Erosion of RiverBanks), which is based on the excess shear stress formula, and uses the finite elements to estimate the eroded distances for natural riverbank with different layers (Aly El-Dien et. al, 2013), 2) Seepage model based on Richard's equation is used (Gottardi and Venutelli, 2001), 3) Stability model (Smith et.al, 2013) uses the strength reduction technique is utilized to get the factor of safety of the riverbank and to obtain the failure surface, and 4) Mass wasting approach (Aly El-Dien et. al, 2017).

The response of riverbank to the oscillated water level in Uji River and the consequent groundwater table is simulated. Simulation cases with and without seepage flow are considered.

4- Results and Discussion

During the 7 months of simulation period, two failure events took place at 22nd May and 1st July. The simulated retreat distance for the bank top line was about 1.8 meters in 7 months (equivalent to 2.1 m/year), Fig.(4)

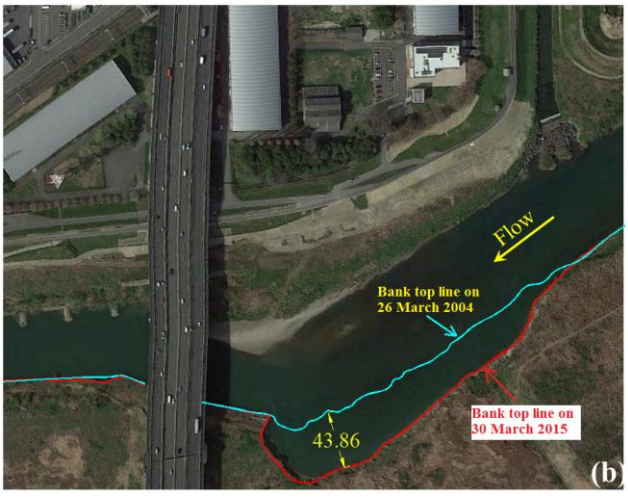

Fig.4 Bank top line (photographed March 30, 2015))

The average erosion rate as measured from satellite images is about 4.0 m/year. The reason why our simulation underestimates the bank retreat rate may return to neglecting the effect of vegetation roots which are thought to be of important effect. One more reason is that our model doesn't consider flow in curved channel.

5- Conclusions

Retreat of left bank of Uji River at 43.0km is numerically simulated and the results are compared with the field observations. Simulation underestimates the retreat rate. Further improvements to the mass wasting model are required such as 1) adding tuning parameters; 2) consider vegetation effect and tension cracks. Future research plans include coupling our model with a 2D-depth averaged flow model to improve the accuracy.

References

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