VELOCITY MEASUREMENTS IN A STRAIGHT RIVER WITH A SERIES OF GROYNES BY A SHIP-MOUNTED ADCP

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Groynes and spur dykes are primary used for bank protection and channel stabilisation. In recent years, in addition, a new function is given to these structures, i.e. creation and preservation of a good habitat. Groynes disturb water flow, and then cause bed evolution around them. This means that groynes produce variety of flow velocity and water depth, which improves simple river coast geometry of prismatic channels. Acting in such a manner, groynes can provide various ecological conditions for riverine natural lives.

Flow structure around groynes are quite complex. Owing to the existence of groyne itself, flow diversion occurs and the diverted flow is accelerated. Such acceleration causes severe local scouring around the top of the groyne. On the other hand, a circulating flow is usually induced behind the groyne, in a so-called groyne area. A good portion of the sediments in the main flow is trapped by this circulation, and then is deposited in the groyne area. This story on the flow and sediment movements in a groyne area is widely studied experimentally (Fukuoka et al., 1998; Yossef & de Vriend, 2004). Furthermore recent advanced numerical models can simulate these processes quite reasonably (Zhang et al., 2005). In contrast, field data which verify both experimental results and numerical simulations are quite limited.

In this paper velocity measurements were carried out in a river of straight reach with a series of groynes on one side of the main channel, where the authors have once carried out the measurements by the LSPIV method (Fujita, Muto et al., 2004). A broadband Acoustic Doppler Current Profiler (ADCP) mounted on a small boat was used. The measurements were performed in the area of 60m times 200m, the channel width and the longitudinal distance of the straight reach including four groynes respectively, under three depth conditions including two submerged cases during floods. Flow patterns induced in the groyne fields, exchange processes between the main channel and the groyne fields, and relation among the flow dynamics, sediment movements and vegetations on the bank, are mainly of interests.

Comparing the velocity distributions in a plan view under three depth conditions, the effect of depth dependency on the flow dynamics in the groyne fields can be summarised as the structure of circulating flow. That is, in the non-submerged case a 2-D horizontal circulation is dominant, whereas when the groyne is submerged a vertical circulation is formed behind the groyne and the horizontal circulation cannot be seen. When the water

depth much increases, however, size of the vertical circulation becomes quite small and nearly the whole area runs downstream.

Whereas, when looking into the velocity distributions in a cross sectional view, the difference of the exchange process between the main channel and the embayments can be seen quite clearly. In the non-submerged case the exchange process is governed also by the 2-D circulation described above, thus exchange takes place only around the groynes. On the other hand, in the submerged case, a weak secondary flow cell is formed in the junction region, and its developing and decaying processes, which is completed within one embayment, is deemed to have strong influence on the exchange processes. The exchange occurs over the whole length of the junction. In addition this secondary flow cell seems to capture a slow water body around the groyne and then drives it towards the water surface, and then this water body shows a boil-like motion when reaches at the water surface.

In and around the groyne fields, fine sediments are deposited whose mean diameter is 2 orders smaller than that in the main channel. A good portion of the deposited sediments in the embayments is wash lord whose diameter is less than 0.1mm, and this ratio varies from one embayment to the others, i.e. the upstream embayment possesses a larger portion of wash load than the downstream. Sediment deposition in one embayment is strongly affected by the local flow structure, especially around the groyne and the river bank. Patches of vegetations on the bank can therefore be well correlated to the flow dynamics and the resultant sediment movements.

REFERENCES

Fujita, I., Muto, Y., Shimazu, Y., Tsubaki, R. and Aya, S. (2004). "Velocity Measurements around Non-submerged and Submerged Spur Dykes by Means of Large-Scale Particle Image Velocimetry", *J. Hydroscience and Hydraulic Engineering*, Vol.23, No.1, pp.51-61.

Fukuoka, S., Nishimura, T., Okanobu, M. and Kawaguchi, H. (1998). "Flow and bed topography around groins installed in a straight channel", *Annual J. of Hydraulic Engineering, JSCE*, Vol.42, pp.997-1002. (in Japanese)

Yossef, M.F.M. and de Vriend, H.J. (2004). "Mobile-bed experiments on the exchange of sediment between main channel and groyne fields", *River Flow 2004*, Naples, Italy.

Zhang, H., Nakagawa, H., Ishigaki, T. and Muto, Y. (2005). "Prediction of 3D flow field and local scouring around spur dykes", *Annual J. of Hydraulic Engineering, JSCE*, Vol.49, pp.1003-1008.