EXPERIMENTS AND ANALYSES ON THE DEFORMATION OF THE BED PROTECTIVE WORKS DOWNSTREAM OF A WEIR

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Bed protective works are installed on the bed downstream of a weir to prevent failures and collapses of the structure due to bed scouring. Because failures of bed protective works endanger the main structure, it is important for designing a weir to maintain a safety of the bed protective works downstream of the structure.

In general, the bed downstream of bed protective works is eroded. So, many researchers have been concerned with the local scour downstream of the bed protective works. On the contrary, the bed protective blocks should have enough weight against flood flow. We indicated the drag force acting on the last row elements of the bed protective works are greater than that of any other elements (Uchida and Fukuoka, (2001)). This indicates that the downstream end of the structure is a weak point due to not only bed scouring but also large hydrodynamic forces and the completely protection of the last low blocks of the bed protection works is difficult. So, it is required to establish the method for evaluating the stability of the bed protective blocks and estimating the deformation range of the structure.

We examined the deformation process of the bed protective blocks, degrading the water level downstream of the structure for the condition of a constant discharge. The blocks deformation breaks out downstream end of the blocks on which the large hydrodynamic forces were acted. Then the deformation goes to upstream direction by the degradation of water level downstream of the structure, as shown in Fig. 1 (a). To design the bed protective works, whether the blocks survive is important rather than the motion of the blocks. So, we assumed that the block got into rotating motion at the outset and formulated the threshold of a block movement, considering the moment equilibrium of a block overlapping between the blocks. Then, we presented measurement method of threshold drag forces of a block to discuss the adequacy of the threshold model. The comparison between measured drag forces and computed drag forces by the threshold model clarified that we can determine whether blocks can move or not by the threshold model if hydrodynamic forces are given.

The computation method in which all the shape and arrange of the blocks are taken into account will be not suitable for practical use, because the blocks are randomly arranged and the protrusion scales of the blocks are considerably small compared with water depth of the typical scale of flood flow. In this case, we know that it is better to add the resistance terms to the momentum equations of flow (e.g. Uchida and Fukuoka, (2001)). We presented how individual hydrodynamic force acting on a bed protective block is taken into the flow model to estimate the stability of bed protection block. Then we developed the numerical model for deformation of the bed protective works downstream of a weir using the threshold model.

Fig.2 shows comparisons of the blocks deformation processes between measured and computed results. The blocks profile by computed results deforms from the downstream-end, and then the blocks deformation goes upstream by the degradation of water level downstream of the blocks, as in the similar way of the experiment. Because the motions of the blocks are not computed in the model, the blocks profiles of moved blocks (downstream part of the blocks) are different between measured and computed results. However, the computed profiles of the blocks by surviving blocks (upstream part of the blocks) are similar to that of the experiment.

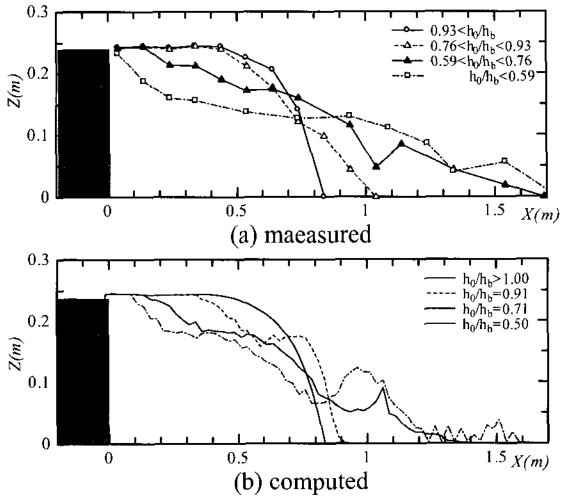

Fig. 1 Comparisons of blocks deformation process between measured and computed results

REFERENCES

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