A Study on Maintenance Standards to Avoid Progress of Chain Destruction in River Crossing Structures

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1. Damage to river crossing structures due to river-bed degradation

There are cases where the foundation of revetment, etc. is exposed due to the progress of river-bed degradation and suffers damage in the event of flooding. In addition, in the downstream of river crossing structures, such as ground sills, the effect of river-bed degradation may appear more remarkably and deformation, such as subsidence of bed protective works, may arise. In such an event, some cases are reported where bed protective works were swept away in a chain and the main body of river crossing structures, such as ground sills, suffered damage. Specifically, when part of the main body of river crossing structures is swept away, levee slope may be eroded by the drift generated by the flow concentrated on the site where the body was swept away. In addition, if the entire main body is swept away, the effect of river-bed degradation may extend to an upstream section and cause damage to a bridge etc. located at the upstream. Accordingly, it is important from a viewpoint of the maintenance of river crossing structures to grasp the conditions that decide the chain destruction of bed protective works and the phenomena that arise in case of destruction.

2. Development of numerical analysis models for reproducing chain destruction

Accordingly, NILIM has been implementing "Development of technologies for forecasting deterioration / damage / destruction of river-crossing structures in river bed degradation" together with two research groups, Gunma University (Representative: Professor Yoshihiko Simizu) and Nagaoka University of Technology (Representative: Professor Satoru Otsuka), using the River Erosion Control Technical Research Development System. Gunma University develops a numerical calculation model to evaluate the fluid force that acts on bed protective works, focused on variation of flow regime due to expansion of the scouring hole in the downstream of bed protective works. Nagaoka University of Technology develops a numerical calculation model to evaluate the fluid force that acts on bed protective works, focused on seepage flow under the main body, such as ground sills. NILIM directly measures and grasps, through a large hydraulic model experiment, the effect of scouring condition in the downstream of bed protective works and difference in seepage characteristics under bed protective works on the fluid force that acts on bed protective works. Through these studies, it was found that, as a phenomenon that defines the chain destruction of bed protective works, the position of hydraulic jump greatly changes the fluid force that acts on bed protective works. As the Figure shows, the position of hydraulic jump changed in connection with the river-bed degradation in the downstream channel and the fluid force that acts on the gabion of bed protective works at downstream end increased in the case where deformation proceeds. On the other hand, in the case where no deformation proceeds, the fluid force acted so that the gabion at downstream end is stabilized by reverse whirlpool flow.

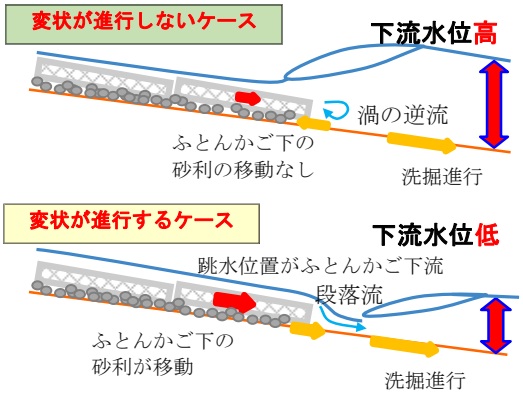

Fig.: Phenomenon that defines the chain destruction of bed protective works

3. Design considering maintenance

NILIM is going to propose specification of maintenance standards in the design phase of ground sills, etc. using the findings of these studies. Maintenance standards are intended to set forth a state in the design phase where the chain destruction of bed protective works may proceed and maintenance and repair based on inspection results are implemented by using the numerical calculation models created by these studies in the design phase.

☞See the following for details.

1) River Erosion Control Technical Research Development System
http://www.mlit.go.jp/river/gijutsu/kenkyu.html
2) Yamamoto et al.: "Study issues organized from the deformation hydraulic experiment on armor block type ground sills," Collection of Papers on River Engineering, Vol. 24, June 2018.