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DISSERTATION ABSTRACT

博士の専攻分野の名称 博士（工学） 氏名 Kim HyungSuk

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IMPACT OF FINITE VEGETATION PATCHES ON FLOW AND BED MORPHOLOGY
IN OPEN CHANNELS

(開水路における有限幅植生帯が水流と河床変動に及ぼす影響に関する研究)

For the planting management and stream restoration, isolated patches of vegetation are practical for improving stream habitat and ecology. Comprehensive understandings of flows and bed morphological changes with finite patches of vegetation are of high interest to practitioners and engineers to design stream restorations. This study is to investigate morphological responses to finite patches of vegetation in open channels and understand the sediment transport and scour processes around vegetation by means of laboratory experiments and numerical computations.

Firstly, the effect of a finite patch of vegetation on flow and bed morphology in an open channel was investigated. Laboratory experiments were carried out with a mobile bed included a finite patch placed along a side wall of the channel and various configurations (patch density, submergence ratio and obstruction ratio) were considered. Two flow conditions below and above threshold of sediment motion, were tested. Erosion and deposition near the patch of vegetation were analyzed.

Secondly, morphological responses to a finite patch in an open channel with erodible bank were described by employing laboratory experiments and numerical simulations. The patch was modeled as circular cylinders with a staggered array, and it was located in the middle of the channel. The morphological behavior of a channel with erodible bank was assessed. Numerical simulations were performed and the sensitivity to parameters related to sediment transport within the patch was investigated. The simulated results for erosion and deposition near the patch were compared with experimental data and a good agreement was found.

Thirdly, development of local scour pool produced by finite patches of vegetation was investigated by means of laboratory experiments and numerical simulations. Two finite patches were located along both side walls of the channel. Diverse ratio of the patch width was considered to examine impacts of spacing between patches with various patch densities. Local erosion at the leading edge and between patches was analyzed.

Numerical simulations with adopting bed correction model were performed and compared with experimental data. Numerical model employing bed correction model demonstrated that the development of local scour pool near the patches can be improved.

Lastly, in order to investigate local scour around cylinders, numerical simulations were performed by large-eddy simulation (LES). The sediment was simulated as particles in a Lagrangian framework and linked to the bed morphodynamic, which were directly incorporated with instantaneous flow on the bed. The numerical model was validated by comparison with experimental data available in literatures. After validation, the impact of cylinder spacing on local scour and deposition patterns was assessed. In addition, the global and local scour around square cylinder groups was examined and the influence of cylinder array on scour was assessed. Simulated maximum scour depth was compared with experimental data and showed a reasonable agreement.