Potential of River Bottom and Bank Erosion for River Restoration after Dam Slit in the Mountain Stream

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Abstract

Severe sediment erosion during floods occur disaster and economic losses, but general sediment erosion is basic mechanism to move sediment from upstream to downstream river. In addition, it is important process to change river form. Check dam, which is constructed in mountain stream, play a vital role such as control of sudden debris flow, but it has negative aspects to river ecosystem. Now a day, check dam of open type is an alternative plan to recover river biological diversity and ecosystem through sediment transport while maintaining the function of disaster control. The purpose of this paper is to verify sediment erosion progress of river bottom and bank as first step for river restoration after dam slit by cross-sectional shear stress and critical shear stress.

Study area is upstream reach of slit check dam in mountain stream, named Wasada, in Japan. The check dam was slit with two passages in August, 2010. The transects were surveyed for four upstream cross-sections, 7.4 m, 34 m, 86 m, and 150 m distance from dam in October 2010. Sediment size was surveyed at river bottom and bank. Sediment of cobble size was found at the wetted bottom, and small size particles of sand to medium gravel composed river bank. Discharge was 2.5 m^3/s and bottom slope was 0.027 m/m. Excess shear stress (τ_{ex}) was calculated for hydraulic erosion by subtracting the values of critical shear stress (τ_c) from the value of shear stress (τ) at river bottom and bank ($\tau_{ex} = \tau - \tau_c$). Shear stress of river bottom (τ_{bottom}) was calculated using the cross-sectional shear stress, and bank shear stress (τ_{bank}) was calculated from the method of Flintham and Carling (1988).

$\tau_{bank} = \tau * SF_{bank}((B+P_{bed})/(2*P_{bank}))$

where $SF_{bank} = 1.77(P_{bed}/p_{bank}+1.5)^{-1.4}$, B is the water surface width, P_{bed} and P_{bank} are wetted parameter of the bed and bank.

Estimated values for τ_{bottom} for a flow of 2.5 m^3/s were lower as 25.0 (7.5 m cross-section), 25.7 (34 m), 21.3 (86 m) and 19.8 (150 m), in N/m^2, than critical shear stress (τ_c= 62.1 N/m^2) with cobble of 64 mm. The values were insufficient to erode cobble sediment. In contrast, even if the values of τ_{bank} were lower than the values for τ_{bottom} as 18.7 (7.5 m), 19.3 (34 m), 16.1 (86 m) and 14.7 (150 m), in N/m^2, excess shear stresses were calculated at the three cross-sections of 7.5 m, 34 m, and 86 m distances compare with τ_c is 15.5 N/m^2 of 16mm gravel. Bank shear stresses were sufficient for erosion of the medium gravel to sand. Therefore there is potential to erode lateral bank than downward erosion in a flow of 2.5 m^3/s. Undercutting of the wetted bank can causes bank scour or collapse, therefore this channel has potential to become wider at the same time.

This research is about a potential of sediment erosion, and the result could not verify with real data. Therefore it need next step for verification. In addition an erosion mechanism for river restoration is not simple because discharge distribution is variable by snow-melting or rainy season, and a function for disaster control will recover by big precipitation event. Therefore it needs to consider the relationship between continuous discharge change and sediment erosion.

Key words: Dam Slit, River Restoration, Cross-sectional Shear Stress, Bank Shear Stress, Bank Erosion

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