# Effects of Hyper-concentrated Sediment on Large-scale Vortex in an Open-channel with Three-dimensional Square Ribs

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**Abstract**

The effects of hyper-concentrated sediment flow on flow resistance and flow structure which are essential to estimate the safety level against flood have been investigated by many researchers not only because the hyper-concentrated sediment flow causes serious problems but also shows non-Newtonian properties. Therefore, the studies regarding the flow resistance at the hyper-concentrated sediment flow have already been done under some boundary conditions. However, it still has questions as to its turbulent structure which is a cause being changed the flow resistance. In the present paper, we experimentally investigated effects of hyper-concentrated sediment on turbulence structure in terms of the characteristics of the spatial and temporal large-scale vortex in an open-channel with the two-dimensional roughness by using the poly(sodium acrylate) (PSA) solution simulating hyper-concentrated sediment flow. Particle Image Velocimetry(PIV) was employed in order to measure the flow structure. Spectral analysis was performed on the fluctuating flow velocity component at designated coordinates in order to investigate the generation frequency of the vortex, and the dominant frequency was obtained. As a result, it has been shown that the dominant frequency and the Strauhal number of separation vortex decrease with an increase in the concentration of PSA solution. In addition, since it is shown that the Strauhal number has been decreasing with a decrease in the Reynolds number, it was supposed that an increase of viscosity along with an increase in the concentration of PSA solution causes a decrease in the Reynolds number and the decrease in the Reynolds number causes a decrease of Strauhal number. Also, vortex identification was performed by using the Q criterion as a definition of a vortex at the spatial characteristic, and the results show that the path lines of vortexes which are obtained by applying vortex identification go through on the area where the shear rate and the turbulence intensity such as the Reynolds stress are great. Moreover, it found that the separation vortexes resulted from a roughness do not flow in the downstream in the case of high viscosity.