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3D Modeling of Flow and Sediment Transport in Tanks with the Influence of Cavity

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Abstract : With increasing urbanization worldwide, it is crucial to sustainably manage sediment flows in urban networks and especially in stormwater detention basins. One key aspect is to propose optimized designs for detention tanks in order to best reduce flood peak flows and in the meantime settle particles. It is, therefore, necessary to understand complex flows patterns and sediment deposition conditions in stormwater detention basins. The aim of this paper is to study flow structure and particle deposition pattern for a given tank geometry in view to control and maximize sediment deposition. Both numerical simulation and experimental works were done to investigate the flow and sediment distribution in a storm tank with a cavity. As it can be indicated, the settle distribution of the particle in a rectangular tank is mainly determined by the flow patterns and the bed shear stress. The flow patterns in a rectangular tank differ with different geometry, entrance flow rate and the water depth. With the changing of flow patterns, the bed shear stress will change respectively, which also play an influence on the particle settling. The accumulation of the particle in the bed changes the conditions at the bottom, which is ignored in the investigations, however it worth much more attention, the influence of the accumulation of the particle on the sedimentation should be important. The approach presented here is based on the resolution of the Reynolds averaged Navier-Stokes equations to account for turbulent effects and also a passive particle transport model. An analysis of particle deposition conditions is presented in this paper in terms of flow velocities and turbulence patterns. Then sediment deposition zones are presented thanks to the modeling with particle tracking method. It is shown that two recirculation zones seem to significantly influence sediment deposition. Due to the possible overestimation of particle trap efficiency with standard wall functions and stick conditions, further investigations seem required for basal boundary conditions based on turbulent kinetic energy and shear stress. These observations are confirmed by experimental investigations processed in the laboratory.

Keywords : storm sewers, sediment deposition, numerical simulation, experimental investigation
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