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Hydraulic Resistance of Submerged Vegetated Oblique Weir-Like Obstacles in a Floodplain

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Reliable water level predictions for extreme river discharges (floods) are extremely important for designing flood safety measures. During floods, the water flows in the floodplain which always contains various obstacles that hamper the conveyance capacity of the river. Weir-like obstacles such as access roads, summer embankments, submerged groins etc. give rise to rapidly varying flow. Typical flow features related to these obstacles such as flow separation and hydraulic jump cause energy losses (form drag) and affect the flow levels during high water stages. It is therefore of great importance to properly understand the flow characteristics and hydraulic resistance caused by such obstacles and correctly implements these in modelling tools. In many circumstances the weir-like obstacles are oriented at an oblique angle with respect to the flow direction, sometimes even parallel to flow, as in the case of overtopping summer dykes. In this study weir-liked behaviour has been considered to determine the energy losses due to the above mentioned obstacles rather than considering the weir as a control structure.

A limited amount of literature is available on flow investigations for the oblique weirs. These studies are mostly about the discharge coefficient of the oblique smooth weirs. There is hardly a study about the flow field around the oblique weir-like structures. An experimental study has been carried out in the Laboratory of Environmental Fluid Mechanics of Delft University of Technology. The prototype dike and groin were modeled as a weir with downstream and upstream slopes of 1:4 and vegetation has been represented by the cylindrical rods on the crest of weir with 25% blockage area inside the vegetated region.

In this study, experiments have been performed to determine the energy head losses caused by the weir-like obstacles. Longitudinal and vertical velocity profiles were measured in the flume upstream and downstream of the schematized models of oblique weir-like obstacles. Turbulence intensities, Reynolds averaged shear and normal stresses and the length of recirculation zone behind such obstacles have been investigated as well.

A numerical study of the above mentioned flows has been conducted by using 3D-RANS mathematical model including free surface modeling. A non-linear k-ε model has been applied for turbulence closure. The flow conditions under which the undulations occur and the wave characteristics of the un-dular hydraulic jump caused by the weir-like obstacles have also been investigated by numerical simulations in this particular study. The computational results for the energy head loss and the velocity profiles have been compared with the experimental data and showed an overall good agreement.