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Flow Resistance Due to Rigid and Flexible Vegetation: A Review

Laxman V Rathod¹, Prafulkumar V Timbadiya², and Bandita Barman³

¹Ph.D. Scholar, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat 395007, India (d20ce017@ced.svnit.ac.in)

²Associate Professor, Department of Civil Engineering, Sardar Vallabhbhai National Institute of Technology, Surat 395007, India (pvtimbadiya@ced.svnit.ac.in)

³Assistant Professor, Department of Civil Engineering, Indian Institute of Technology (Indian School of Mines), Dhanbad 826004, India (bandita@iitism.ac.in)

Riverbank and floodplain vegetation substantially affects the fluvial processes and play a key role in river hydraulics and river management. Presence of vegetation influences the water levels, flow velocity profiles and resistance to flow. Therefore, better understanding of behavior of flow over vegetation is required in design of vegetative channels, construction of stage-discharge curves, determining horizontal flow structure around hydraulic structures, and to develop numerical models. A detailed review of flow resistance due to rigid and flexible vegetation has been done under both emergent and submerged conditions. Based on the flow conditions and vegetation features, the investigators made a transition between rigid, flexible, emergent, and submerged vegetation. The variation of the flow field in the vegetative open channel follows a two-layer approach, it is almost constant inside the vegetation layer and logarithmic one above the vegetation layer. Firstly, several theoretical approaches for determining the resistance due to rigid vegetation in emergent and submerged condition are discussed. For simplicity many investigators have considered a rigid cylinder without side branches and foliage, the vegetation having constant height, stem diameter, and uniform flow condition was considered as rigid. The resistance due to vegetation also depends on the uniform and staggered pattern arrangements, the latter has more impact on flow in comparison to the former. The analysis for flexible vegetation is complex due to the complex nature of vegetation, and it is difficult to take the heterogenous nature of field vegetation into the account. The resistance due to flexible vegetation is a function of the height of vegetation, vegetation density, foliage, plant form alignment of vegetation, submergence ratio, and type of vegetation. The flexible vegetation also assumes different configurations depending on the hydrodynamics of flow and bending stiffness. Furthermore, more recent approaches for describing the resistance due to flexible vegetation are presented.

Keywords: Rigid vegetation, Flexible vegetation, Resistance to flow, Rivers, Floodplains, Flow field