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FACTORS INFLUENCING BENDING RIGIDITY OF SUBMERGED VEGETATION*

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Abstract: The bending rigidity of submerged vegetation is closely related with vegetative drag force. This work aims at determining the effects of flow conditions and characteristics of vegetation on the bending rigidity of submerged vegetation. Based on the dimensional analysis method, the factors influencing the bending rigidity of individual submerged vegetation were analyzed. The relationship between the relative bending rigidity and its influencing factors was investigated by experimental observation, and a relative bending rigidity expression for submerged vegetation was obtained by means of multiple linear regression method. The results show that the submerged vegetation has three states under different inflow conditions, and the each critical relative bending rigidity of individual submerged vegetation was determined for the different states of submerged vegetation.

Key words: cross section shape coefficient, submerged vegetation, relative bending rigidity, vegetation Reynolds number, vegetation Froude number

Introduction

Aquatic plant is an important part of a river ecosystem, and an effective tool for protection and restoration of water eco-environment[1,2]. In the river bank, aquatic plant has many functions, including protecting soil, preventing soil erosion, developing and protecting banks by its developed root. On the other hand, the flow structure is changed by the caudex and leaf of vegetation in the river, the roughness of river bank is increased, and flood drainage capacity of river courses is weakened[3-6]. And aquatic plant further changes the regulations of pollutant transportation, sediment deposition, and fluvial process. In recent years, the relationship between aquatic plants and hydrodynamic characteristics has been one of the hotspots that the domestic and oversea researchers pay much attention to.

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The influence mechanism of aquatic plant on flow is very complicated, which is not only dependent on the cross sectional shape of river, water depth, discharge, but also on the species, bending rigidity, distribution, shape of vegetation and whether it is submerged[7]. In accordance with the relationship between flow conditions and vegetation's characteristics, aquatic plants can be divided into rigid and flexible vegetations, or submerged and non-submerged vegetations. Previous researchers have carried out a large amount of researches on the experiment and theory for flexible and rigid vegetation respectively, and a lot of significant achievements are got in this field. White and Nepf [8] made use of the stick to simulate rigid vegetation**,** and vegetative drag, turbulence, and diffusion were studied in detail by laboratory and field observations. Subsequently, Nepf and Vivoni[9] further studied the flow structure in depth-limited vegetated flow. This study describes the transition between submerged and emergent regimes based on three aspects of canopy flow: mean momentum, turbulence, and exchange dynamics. Righetti and Armanini[10] researched the resistance due to vegetation in a river characterized by fully submerged vegetation formed by concentrated colonies of bushes, and a model was proposed based on time and spatial averaging. Muslesh