Vegetation deformation under the action of open channel flow

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Vegetation provides numerous ecological benefits such as reducing soil erosion, purifying water, and providing nutrients and habitat for wildlife. Vegetation in open channels alters flow structure, which may in turn affect sediment transport and also mixing of other matters. Usually, vegetation could be flexible. However, the bending of flexible vegetation is still poorly understood due to the complicated mechanical response to hydraulic forces. To date, the prediction of vegetation deformation is mainly based on the classical beam theory, by which vegetation is considered as a cantilever beam. Yet, previous experiments have almost exclusively used thin plates to simulate vegetation, for which classical beam theory may not be sufficiently justified. Here, we attempt to apply the theory for thin plates to simulate vegetation deformation. For the thin plates, the inertia is always weak in the direction perpendicular to its width, so it is assumed that the width of the blade is perpendicular to the flow. The generalized Galerkin model in elastic mechanics, which constructs the residual equation according to the energy variational method, is used to predict the deformation of bending-vegetation under the premise of small deformation. The numerical results are shown to agree with existing experimental measured data fairly well. It is also revealed that the shear stress in the upper layer of vegetation plays a considerable role in the vertical displacement of the vegetation, which merits account into the model. Sensitivity analysis indicates that the elastic module of the vegetation and flow resistance coefficient may modify the deformation appreciably.