ABSTRACT

Improving the performance of the major irrigation projects is one of the economically viable options in meeting the growing water demands and sustaining the productivity of irrigated agriculture under present financial, environmental and physical constraints. Hydraulic simulation models offer unlimited opportunities for improving the performance of the irrigation systems, by studying the flow behavior in a large and complex canal network, through repetitive runs under variety of design and management scenarios. A number of hydraulic simulation models are available for modeling flow in open-channel network. However, higher cost, lack of technical support and unavailability of source code are some of the major constraints in adoption of the commercial software. Thus, there is a need to develop a flexible and user friendly canal hydraulic simulation model, for simulating steady and unsteady flow conditions in irrigation canal network.

In this study, different solution algorithms and matrix solution techniques are compared. The algorithm using the branch-segment transformation technique requires less computer storage and is found to be faster than that using the forward-elimination approach. The sparse matrix solution technique is found to be faster than the Gauss-elimination method for the solution of global matrix. A canal hydraulic simulation model, referred as 'CanalMod', is developed, which uses the four-point Preissmann scheme for discretization of the continuity and momentum equations and solves the discretized equations for full channel network using the sparse matrix solution technique. The developed model consists of three components, namely, data editor, steady flow and unsteady flow simulation modules. The different boundary conditions considered in the model are discharge hydrograph at the source node(s) and stage hydrograph, rating curve, uniform flow, and discharge hydrograph at the downstream/terminus node(s). The model is capable of handling different hydraulic structures such as weirs, sluice gate, drops/falls, pipe-outlet, and imposed discharge (pumping in and out). The model also allows computation of gate opening for a given full supply level and discharge at the cross-regulator and offtaking points, respectively.

The numerical accuracy and stability of the developed model is tested using mass conservation test as well as test with ramp discharge as inflow. The model is also tested

for both logical and algorithmic accuracies using different test examples. The CanalMod and HEC-RAS models are applied to the Right Bank Main Canal of Kangsabati Irrigation Project, West Bengal, India for simulating Kharif irrigation spanning over three years (1995-1997) and their results are compared.

The mass conservation test as well as test with ramp discharge as inflow indicated that CanalMod performs satisfactorily in both the cases. Further, it computes depth and discharge for different networks accurately. Comparison of computed and observed discharges at the tail regulator of RBMC showed that model performs satisfactorily for most of the irrigation events. Further, CanalMod and HEC-RAS computed discharge and stage are found to be almost identical. Therefore, the developed user friendly canal hydraulic simulation model 'CanalMod' can be used as a tool for managing different types of canal networks.