PHYSICAL VS. MATHEMATICAL MODELLING OF THE CANOE/KAYAK SLALOM WATERCOURSE FOR THE ATHENS 2004 OLYMPIC GAMES

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The canoe/kayak slalom competition in the Athens 2004 Olympic Games took place in an artificial watercourse of unique design. The main Olympic course formed a 270 m long loop, of total angle about 330°, followed by the training stretch and a surf-wave branch, as shown in Fig. 1. Water was supplied by pumping from a large (25000 m^2) artificial lake filled with seawater into a circular starting pool. The channel had a variable width and slope and included a large number of patented movable obstacles [2] of three kinds: Cylindrical obstacles of three different heights, wedge-shaped bottom obstacles and bank obstacles in the form of inclined prisms; all these could be fitted at desired positions to perforated slabs fixed on the bottom of the channel.

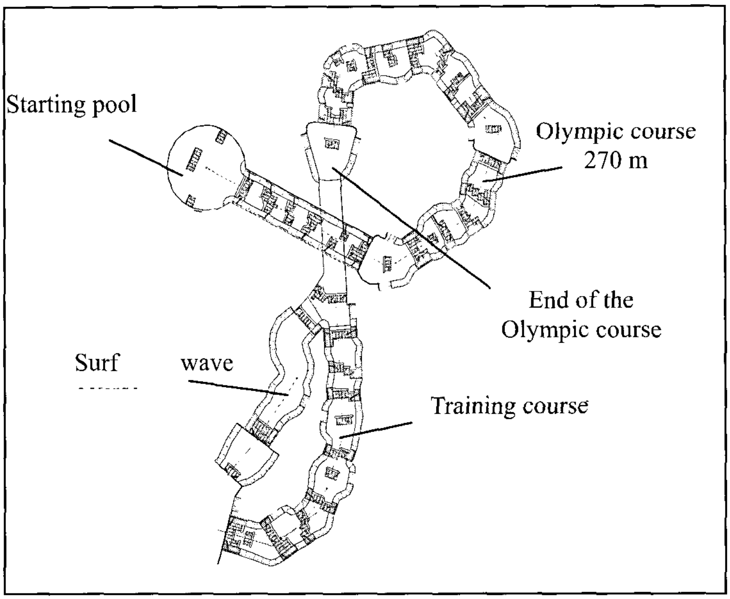

Fig. 1 Plan of the model

Two initial configurations of the obstacles (denoted as A and B) had been proposed, partly supported by simulations performed with a mathematical model, code-named Mascaret [2], solving the one-dimensional St. Venant equations. Subsequently, a 1:20 physical model was built in the Applied Hydraulics Laboratory of NTUA for a detailed investigation of the flow so as: (a) to secure an adequate minimum depth exceeding 60 cm everywhere; (b) to avoid overflow along the banks; (c) to provide flow features satisfactory for the athletic event.

A total of 10 runs were carried out, with flowrates ranging between 10.5 and 21 m^3/sec. Depths were measured at many points with an estimated accuracy of 0.2 to 0.5 cm depending on the waviness of the water-surface. The flow field was in general highly complicated, with localized hydraulic jumps, recirculation zones, areas of flow convergence, standing waves and sudden changes of flow direction. It was found that for the design discharge of Q=17.5 m^3/sec the initial (Olympic) configuration A of obstacles would lead to overflow on several parts of the water course, especially along the curved outer bank, as well as to a few unacceptably shallow areas. The experimental study succeeded in determining modified configurations for both cases A and B, with satisfactory flow conditions for the design flowrate discharge as well as for the other flowrates tested.

Fig. 2 shows the comparison of the experimental results for the design discharge of Q=17.5 m^3/sec obtained for the initial and the modified configuration A with those obtained with the 1-D mathematical model for the some initial configuration. It is seen that both the max and the min water levels are improved with the modified configuration; the mathematical model is partly successful in predicting the insufficiency of freeboard, but cannot trace well the free surface profile along the channel.

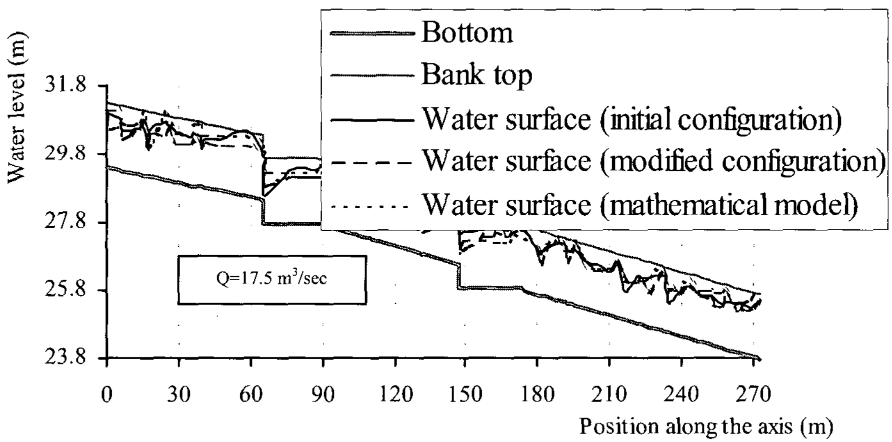

Fig. 2 Comparison of experimental results with the 1-D model

Overall, the study on a 1:20 physical model led to significant modifications of the initially suggested obstacles configurations, which were mostly implemented in the operation of the prototype during the Olympic Games. It is concluded that for flows of such complexity, a 1-D mathematical model can serve only for a preliminary assessment and a physical model is indispensable.

Keywords: Canoe/Kayak Slalom; Physical Model; Mathematical Model; Olympic Games

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