REMR Technical Note HY-MM-1.2

SCREENING OF REHABILITATION ALTERNATIVES THROUGH NUMERICAL MODELING OF APPROACH FLOWS

PURPOSE: To describe a tool for computing approach flows around hydraulic structures.

PROBLEM: Determining the nature of adverse flow conditions and screening alternative designs to improve these current patterns.

DESCRIPTION: Many hydraulic structures, such as spillways, experience adverse flow conditions because of complex approach or structural geometries that with time necessitate repair and maintenance actions. Further, changes in project hydrology, such as an increase in the probable maximum flood event to be released by the project, often require rehabilitation and modification of the existing hydraulic structure. Physical models have traditionally been used as an integral part of the evaluation of the effectiveness of repair, maintenance, and rehabilitation alternatives. The exclusive use of physical models to test and evaluate these proposed modifications to existing hydraulic structure approaches is expensive and time-consuming. Much of the preliminary screening work can be done more quickly and cheaply via numerical modeling.

MODEL DESCRIPTION: The STREMR code provides an effective means of evaluating flow patterns for screening of proposed structural modifications. The complex geometry of the structure and approach are handled using a boundary-fitting capability. This numerical grid may be generated relatively quickly using the WESCOR code or a similar boundary-fitted geometry grid generator. The STREMR code is a two-dimensional model that may be used in either a depth-averaged or width-averaged fashion. An example of the numerical grid produced for a river reach with dike fields is shown in Figure 1.

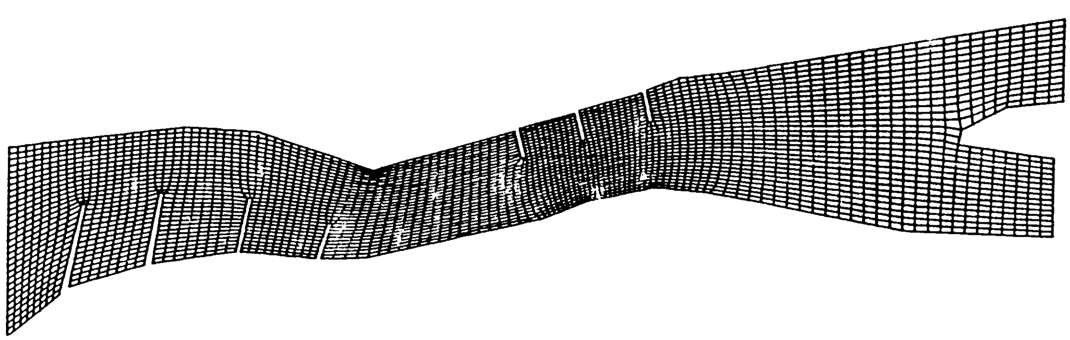


Figure 1. WESCOR-generated grid of river reach showing dike fields

Impermeable dikes are simulated by the gaps shown in the grid. The STREMR code has great capability for reproducing the intricate geometry associated with hydraulic structures.

The essential features of the STREMR model are:

a. Finite difference model.

b. Boundary-fitted coordinate system.

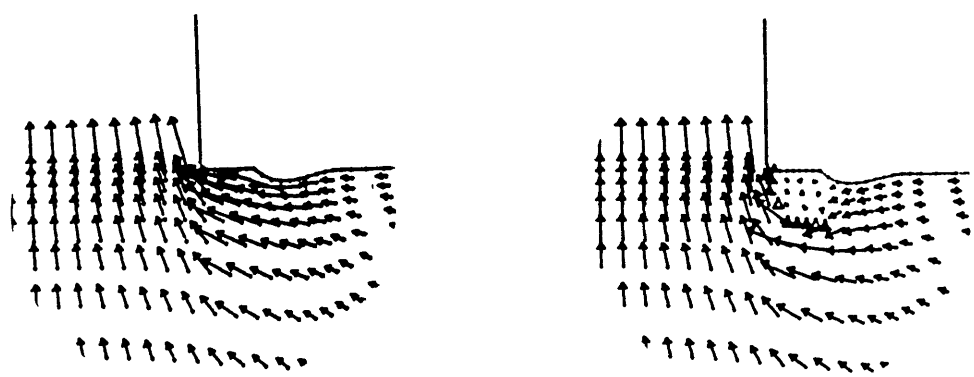
c. Friction simulated using Manning's n formulation.

d. Constant flow rate (steady state).

e. Ability to operate as rigid-lid or to calculate water surface for subcritical conditions in a depth-averaged application.

f. Two-dimensional (laterally or depth averaged).

An application of the STREMR code is demonstrated by the flow patterns shown in Figure 2. The velocity vectors demonstrate the current velocities approaching a spillway. The adverse flow velocities approaching the spillway near the right abutment are shown to be improved by the training structures (shown in triangles) which guide the flow more smoothly into the spillway. These modifications may be made quite rapidly in the numerical model, allowing many trials in a relatively short time period.



a. No training structure

b. Training structure (indicated by triangles)

Figure 2. STREMR-generated flow patterns approaching a spillway with and without additional training structures

The STREMR code provides sufficient flexibility, boundary conforming, and rapid manipulation to address the approach conditions in and about many hydraulic structures and may be an effective tool for screening rehabilitation and maintenance alternatives. The operation of the STREMR model requires a basic knowledge of computational fluid mechanics. The preliminary documentation of the model and some additional discussion with personnel of the Hydraulics Laboratory, Reservoir Water Quality Branch, US Army Engineer Waterways Experiment Station, (or the Point of Contact) will be sufficient for many Corps engineers. The model itself may be obtained from the same source as the documentation.