COOLING TANK BREAK SIMULATION WITH CARPA AND GID SOFTWARE
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Abstract. *A wall break simulation of a cooling tank in a thermoelectric plant was performed using two methods: The CARPA software (finite volume) in GiD environment and a 2D program (finite differences). The software CARPA applied with the GiD pre and post processor showed to be a powerful tool in animating the flood plans, with purposes related to interpretation of results in civil protection in a temporal and spatial way as well as to define the possible affected zones due to phenomena such as walls break.*

1 INTRODUCTION

When a dike of a reservoir breaks or fails, a great water volume is released in very little time and travels downstream with high speed which can cause human lost and severe human damages. To estimate the flooded zones and their depths, as well as stream speeds has several important applications, because this allows to know the effects over the existing downstream population, buildings, agricultural and industrial areas; or even to formulate mitigation damages measures. In order to obtain the outflow hydrograph due to the failure, it is important to performance laboratory test; for simulating the downstream effects of such hydrograph, mathematic models are needed and they must be capable to represent as much as possible the physical phenomena.

Aureli and Mignosa [i] did a laboratory model of a dike to analyze the breach's shape and the 2D flux behavior in water surface downstream of the dike; afterwards they simulated the experimental conditions, by using the Mc Cormack shock capturing explicit predictor-corrector numerical scheme, with a second order accuracy in time and space, which solves the Channel 2D flux equations and includes a softer term for numerical oscillations presented typically in second order finite differences for shocks and Froude's numbers near to one.

Finally the made comparisons between measured and calculated area, concluding the viability of the Mc Cormack scheme in a dike break or a dam break analysis. There are several studies related with mathematical models which attempt to represent the physical phenomena of a flood wave. [ii,iii,iv]

In this study the eventual cooling tank break of Jose Lopez Portillo, Río Escondido, Coah, México, Thermoelectric Plant was analyzed. Such plant has four units of 300MW using charcoal as fuel; the cooling system is open type and required a tank construction with a surface of about 300 ha ($3x10^6$ m^2). The tank was built over the natural ground using dikes with a length of about 13 km ($13x10^3$ m), with a height up 10 m; the restock water is pumped using an aqueduct with a length of 30 km ($30x10^3$ m), since Bravo river.

2 METHODOLOGY AND APPLICATION

2.1 Simulation models

CARPA model in GiD environment

The finite volume numerical algorithm used by the CARPA program is based in the WAF TDV scheme that can be interpreted as an extension of the systems of equations associated to the scheme developed by Lax-Wendroff, or otherwise as an accurate second-order extension of roe's scheme; it is based on the method of Godunov together with the so-called approximate Riemann solver by Roe [v]. Within the GiD environment the problemtype known as CARPA is selected to be able to import or to create a digital ground model; after such model is developed the boundary (or contour) conditions are established to carry out an analysis either in one or two dimensions or in a combination of both. Initial conditions are assigned as well as data to the mesh specifying if it is a one or two dimensional problem; roughness coefficients are also specified indicating the type of material and the coefficient n of Manning (more than one coefficient can be assigned depending on the land usage). Data are provided for calculation purposes and the calculation proceeds (execution of the CARPA program).

2D Model II UNAM in finite differences

The 2D Model II UNAM uses central and forward finite differences to get a numerical scheme of solution for the system formed by continuity and momentum conservation equations, in 2D, with initial and boundary conditions. The model obtains the velocity components in two directions and the water surface elevation by considering and inflow to any cell in the grid, expressed as an unitary flow.

2.2 Breach outflow hydrograph experimental determination

The analyzed cooling tank is composed by several dikes: outer, central and deflecting, built mostly with clay, a sand center filter as protection against eventual dike's filtrations or cracks, and a rock wall. In Figure 1 a plant view and its elevation –volume curve is presented. A water body is located to the North of the tank, which is considered helpful to regulate the flood produced by an eventual dike break. To estimate the shape of the outflow hydrograph there were made lab models getting experimental results (Figure 2) and later, with dynamic similitude (Le=64) the prototype hydrograph shape was obtained (Figure 3), such hydrograph was used to feed the simulation models.

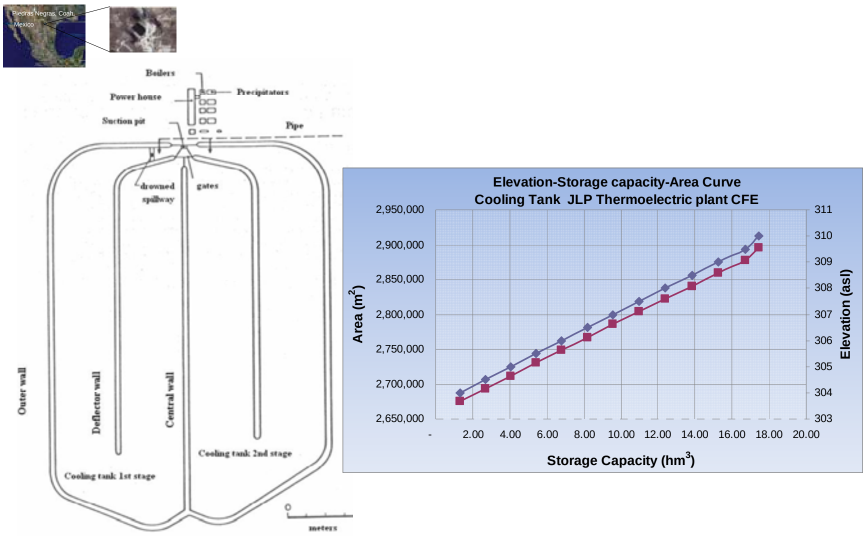


Figure 1: Cooling tank general plant and elevation volume curve

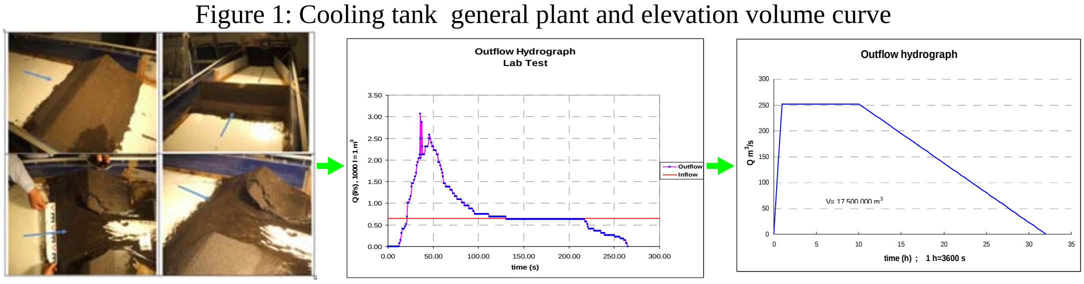


Figure 2: breach outflow hydrograph experimental determination

2.3 Input data to simulation models

In Table 1 representative input data applied in simulation models are reported.

Concept	**CARPA-GiD**	**2D II UNAM**
Mesh	Tin triangles 8253 elements	Grid 100x100
Method	Finite volumes	Finite differences
Dt (s)	1.0	1.5
time calculation (s)	1,360 (11.5 h)	6,240 (11.5 h)
n manning	0.032	0.040
Language	Fortran, TCL/TK	Visual Basic

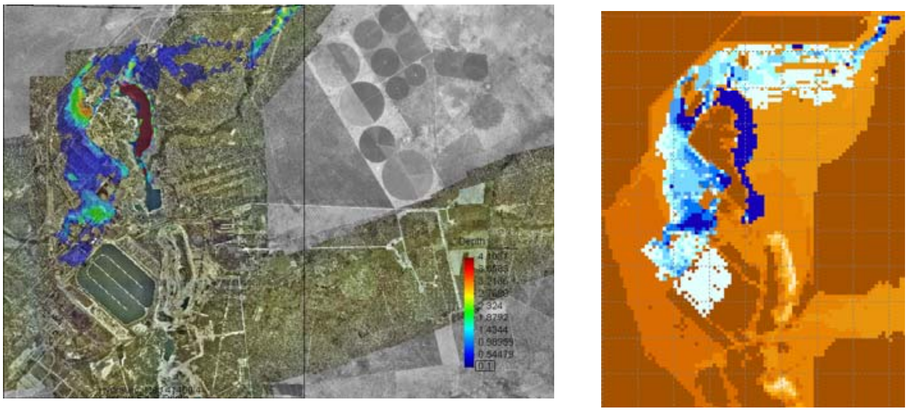
Table 1: Input data

3 RESULTS

3.1 Depth maps

In figure 3 a results comparison is presented, for the instant 11.5 hours (an hour and a half after the break peak hydrograph), time at which the flood attenuation begins. a direct map is obtained with GiD in which a depth graphic scale is shown, apart from the possibility of running animations, whereas with 2d program some additional work with another software must be done to get less detailed maps.

CARPA-GiD **2D II UNAM**



t=11.5 h

Figure 3: Depth maps comparison t=11.5 h

4 CONCLUSIONS

The application of CARPA program in GiD environment and a 2D model in Visual Basic was compared. GiD allowed to get more detailed maps of the possible affected zones by a dike break of a cooling tank. Furthermore, with GiD animations of the analyzed phenomena can be performed.

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