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FLOODS TRANSIT THROUGH HYDROTECHNICAL WORKS IN RIVERBEDS

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Abstract

The reservoirs are water management works that modify watercourses flow regime by retaining a part from their stock and sending it towards the downstream at lower flows. In this paper a front lake has been considered and its effect on the maximum flow in the riverbeds has been numerically simulated. Numerical simulation was performed using the NEPERM software. This software is based on the Saint-Venant equations, knowing that the water discharge from the reservoir is performed by a bottom discharge and a spillway. Boundary conditions of simulation were represented by tributary flood characteristics in the reservoir and wasteways operating characteristics. The results of the software are hydrographs of flows and levels in cross sections.

Keywords: *flood, front lake, Saint-Venant equations, numerical simulation*

INTRODUCTION

Frontal accretions are made by crossing the minor and the major riverbeds of the water courses, and are designed to change the temporal regime of the medium and high water courses to mitigate flood waves and/or satisfaction with water of uses. The main components of the frontal accumulation in relation with the functions of mitigate the flood waves are: lake basin, dam, surge of high waters. In this paper a front lake has been considered and its effect on the maximum flow in the riverbeds has been numerically simulated with the NEPERM software, which was developed by PhD. Eng. Dan Marinovici [1] and it is based on the Saint - Venant equations.

MATERIAL AND METHOD

It was considered a frontal accretion lake with an impermanent operating regime, respectively the variation of the water level in the dam section, knowing that the water from the accretion is drained, through a bottom drain and a hydraulic ram. Attenuation in accretion was made with the model of non-permanent movement. The gradually non-permanent and varied movement of the currents with free level is described by the system of differential equations with partial derivate:

$$\frac{\partial \omega}{\partial t} + \frac{\partial Q}{\partial s} = 0$$

$$\frac{\partial}{\partial s}(z + \frac{v^2}{2g}) + \frac{1}{g}\frac{\partial v}{\partial t} + I = 0$$

where which "I" represents the hydraulic gradient $I = Q^2/K^2$. These written equations with variables Q represents flow and z – the free level of a water surface are known as equations Saint – Venant.

$$B\frac{\partial z}{\partial t} + \frac{\partial Q}{\partial s} = 0$$

$$\frac{\partial z}{\partial s} + \frac{1}{g\omega}\frac{\partial Q}{\partial t} + \frac{2Q}{g\omega^2}\frac{\partial Q}{\partial s} - \frac{Q^2}{g\omega^3}\frac{\partial \omega}{\partial s} + \frac{Q^2}{K^2} = 0$$

To solve the system of equations, the initial conditions must be known, which can have the following form:

$t = 0$; $Q = Q(s)$ (flow distribution along the river); $z = z(s)$ (free level of water surface).

And the limit (boundary) conditions:

$s = 0$; $Q = Q(t)$ (upstream flood wave hydrograph);

$s \in (0, l)$; Q = $Q(z)$ (water discharge characteristic of a frontal accretion lake);

$Q_{av} = Q_{am} \pm q$ (Continuity equation), in which q represent the inflow or outflow from the river (a tributary or a side accretion lake);

$s = l$; $Q = Q(z)$ (limnimetric key in cross section or water discharge characteristic of a front accretion lake).

These are nonlinear hyperbolic equations, with variable coefficients which cannot be analytically integrated in this form. But one can find approximate solutions of this differential equation system for some particular situations, if upon the phenomenon that it describes are made a number of simplifying assumptions. Best results are obtained by numerical integration of the equation system, being previously transformed in equations with finite differences. The results obtained in this way are acceptable and can be used in practice.
The front accumulation can be located in downstream profile of calculation sector or on the way.
The flood wave hydrograph from the upstream cross section it consists by characteristics such as $Q_{\max}$, T_{cr} , T , γ .

$$Q = Q_{\max}\left(\frac{t_1 - t_1'}{T_{cr} - t_1'}\right)^{\left(1-\frac{t_1'}{t_1}\right)\cdot\frac{1-\gamma}{\gamma}} \cdot \left(\frac{t}{t_1}\right)^{\frac{1-\gamma}{\gamma}} ;$$

$t \in [0, t_1]$

$$Q = Q_{\max}\left(\frac{t - t_1'}{T_{cr} - t_1'}\right)^{\left(1-\frac{t_1'}{t_1}\right)\cdot\frac{1-\gamma}{\gamma}} \quad ; \; t \in [t_1, T_{cr}]$$

$$Q = Q_{\max}\left(\frac{t_2' - t}{t_2' - T_{cr}}\right)^{\frac{1-\gamma}{\gamma}\cdot\frac{t_2'-t_2}{T-t_2}}$$

; $t \in [T_{cr}, t_2]$

$$Q = Q_{\max}\left(\frac{t_2' - t_2}{t_2' - T_{cr}}\right)^{\frac{1-\gamma}{\gamma}\cdot\frac{t_2'-t_2}{T-t_2}} \cdot \left(\frac{T - t}{T - t_2}\right)^{\frac{1-\gamma}{\gamma}} ;$$

$t \in [t_2, T]$

Where $t_1 \approx (0{,}90 \div 0{,}95)T_{cr}$, $t_2 \approx T_{cr} + (T_{cr} - t_1)$,
$t_1' \approx (0{,}95 \div 0{,}99)t_1$
$t_2' \approx t_2 + (0{,}01 \div 0{,}05)(t_2 - T_{cr})$.

For the example are considered the characteristics of the flood influx in the barrier lake:

- Duration T = 48 hours;
- Growth duration : Tcr = 16 hours;
- Maximum flow : Qmax = 350 m³/s;
- Form coefficient: γ = 0,25.

The operating characteristics of the high water evacuators are:

- Bottom drain: ω = a x b = 3 x 3 = 9 m², flow coefficient μ = 0,56;
- For hydraulic ram: level of the hydraulic ram z_{cr} = 148 mdM, flow coefficient m=0,40.

Were given seven transverse profiles in upstream of the dam, inclusively the section of the dam, describing the lake section. The cross sections are described by a number of points for which are registered the cumulated levels and the distances for the minor river bed, respectively the major riverbed. Also it is required the limnimetric key and the upstream hydrograph.

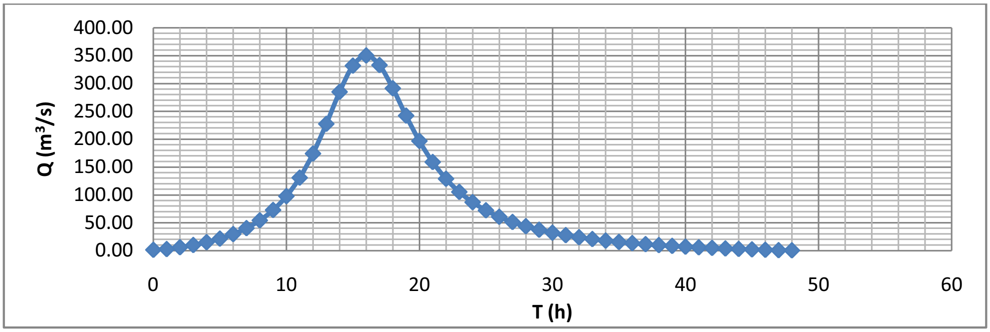

Fig. 1. The upstream hydrograph

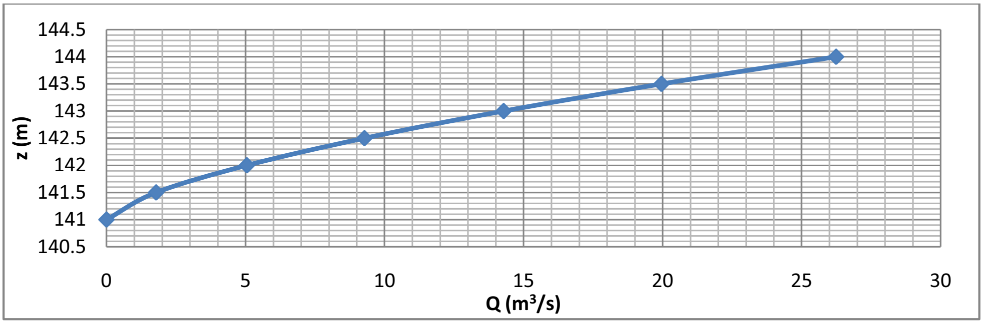

Fig. 2. The limnimetric key for bottom drain 0-3 m

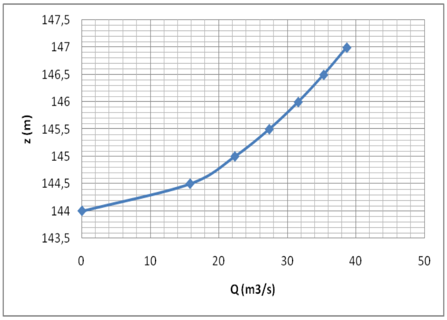

Fig. 3. The limnimetric key for bottom drain 3-5 m

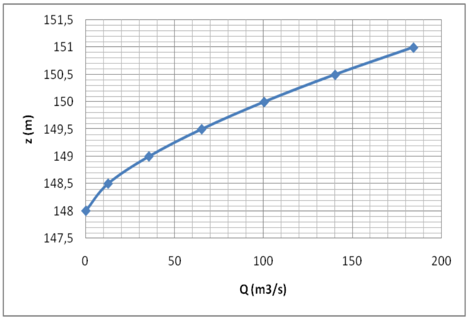

Fig. 4. The limnimetric key for overflow 5-8 m

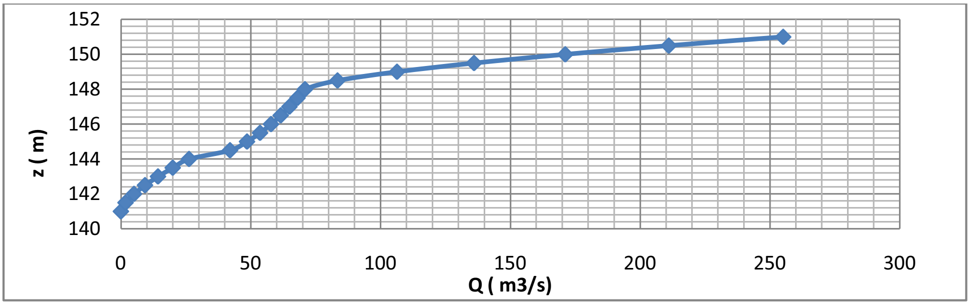

Fig. 5. The total limnimetric key

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RESULTS AND DISCUSSIONS

Hydraulic calculations were performed in non-permanent movement and by numerical integration of the differential equation and of the movement results the hydrograph of the flows and of the levels in the transverse profiles.

Therefore, by evaluating the two hydrographs, was determined the mitigation level of a flood in a frontal barrier lake with an impermanent operating regime, respectively the variation of the water level in a dam section.

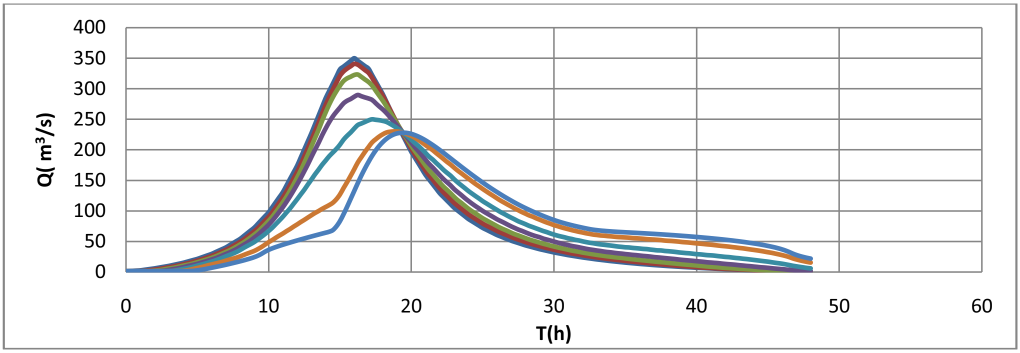

Fig. 6. The flows hydrographs

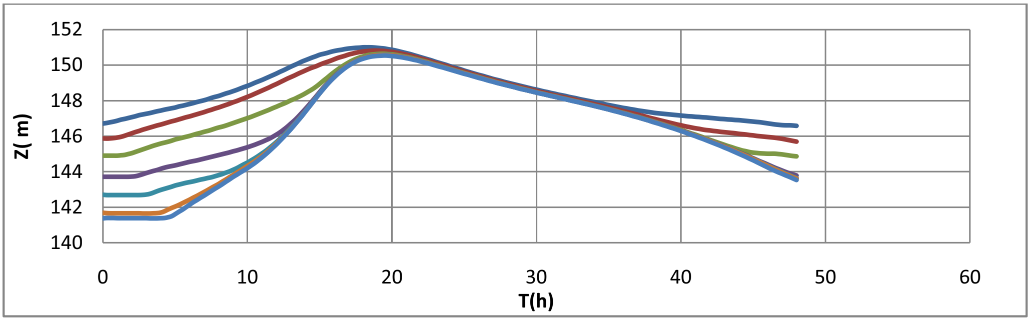

Fig. 7. The levels hydrographs

CONCLUSIONS

By evaluating those two hydrographs, easily it can be observed the influence of a frontal accumulation lake and how it modifies the watercourses flow regime by retaining a part from their stock and sending it towards the downstream at lower flows, according to the flood protection needs.

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