Study for selecting the solution of a dam's discharge chute canal

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Abstract

Some hydraulic studies to find an adequate solution for a discharge chute canal are presented in this paper. Tha chute canal is appropriate work of the Lechugal 2 earth dam (H=20 m), which is part of a large irrigation system from Ecuador, presently under construction.

Studies have consisted in experiments on hydraulic model of the chute canal built at geometrical scale 1:35 and by numerical simulations in one-dimensional steady flow running HecRas software. In first stage numerical model was calibrated based on experiment results and in second stage other three constructive variants of the chute canal were analysed numerically in order to improve the solution settled by hydraulic model.

The technical performances of each variant settled by these experimental and numerical studies follow to be completed with economical analyses which will allow designer to choose the best solution for discharge chute canal.

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1. Introduction

Surface spillways and bottom outlets are appurtenant works having essential function in dam's safety. When these works are not functional it is possible to provoke uncontrolled water discharge from reservoir with risk for dam's breaking generating catastrophic effects for environment.

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Presently in Ecuador, there is under Definitly Studies a large irrigation system (Proyecto Pacalori) which will ensure irrigation of a potential surface of 112900 ha in De Los Rios province. Lechugal 2 hydraulic development consisting of an earth dam with 20 m maximum height, chute canal, bottom outlet and a reservoir storing 70 million m^3 at normal retention level (NRL) is part of this irrigation system [1].

This paper presents studies which preceded the selection of the design solution for dam's surface spillway of chute canal type. Studies were particularly extensive consisting in experiments on hydraulic model of the chute canal at scale 1:35 and some numerical simulations of the flow through canal designed in different constructive variants [2], [3], [4], [5].

Numerical simulations are performed accepting the hypothesis of the one-dimensional steady flow running HecRas software.

The objectives of these studies were the followings:

- to ensure the transit through canal of the design flow rate (326 m3/s) taking into account the safety of the dam and chute canal safety;

- to limit the velocity of the flow through canal and to reduce cavitation phenomena in order to protect concrete faces of walls and apron chute canal against erosion;

- to have a good dissipation of the flow energy in different transit conditions through type II USBR dissipation basin;

- to protect against local erosions the banks and the bed of the connection canal to the natural river (restitution canal).

Experimental and numerical studies have evaluated the technical performances of each variant. They completed with economical analyses will allow designer to choose the best solution for discharge chute canal.

2. Experiments on hydraulic model

Fig. 1. shows a general view of the hydraulic model of the Lechugal 2 discharge chute canal. The canal is made up of the following areas from upstream to downstream: access platform, curved spillway with free flow, transition zone, rapid canal no.1, transition canal, rapid canal no.2 with baffle blocks in the upstream half of the canal, stilling basin type II USBR, connection canal to natural river. Figure 2 presents geometrical elements of the hydraulic model.

Hydraulic modelling is based on the similitude of the general laws of mechanical systems. Two fluid currents are similar if they are geometric similar and if for all homologous points are fulfilled the similitude conditions of their cinematic and dynamic characteristics.

Fig 1. General view of the hydraulic model.