hydrique.

Lake Vernex sedimentation

Introduction

Between 1972, the year of Rossinière dam construction, and 2010, Lake Vernex lost half of its impounding capacity (initially 2.7 Mio m³). Without intervention, the hydropower plant will lose its ability to generate electricity at flow peak well before the expiry of the concession (2052).

Commissioned by Group e, Hydrique has investigated the possibility of promoting the transit of sediments across the Lake Vernex by constructing a side channel for bringing sediment behind the dam.

Fig. 1: Lake Vernex, with visible sediment deposition in 2010

Methodology

A series of interviews with people concerned by the lake silting problem helped to define the canal's layout, namely a left bank canal. Channel dimensions have been established from several sediment transport models to conserve the upstream section transmission capacity.

Based on the conceptual layout, 3 two-dimensional sediment transport 2D models (BASEMENT, ETHZ) are carried out to verify proper operation of the canal:

- Lake Vernex in its current situation (data from 2010)
- Lake Vernex with the proposed canal
- Lake Lessoc with the proposed canal (dowstream of the power house)

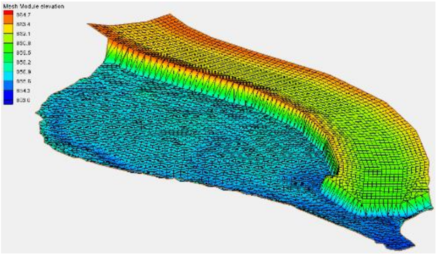

Fig. 2: Mesh of Lake Vernex model and the proposed canal (z amplified 8x)

Grading curve and sediment yield

The particle size used in the models is derived from surveys conducted in the lake by UNIGE (2011).

The solid material content, Qs, is calculated from the following relationship :

$$Qs = \alpha \cdot Q^{\beta} \text{ si } Q \geq Q_{\lim}$$

It is calibrated based on the total sediment yield of 90'000 m³/year. A validation is performed on the basis of existing turbidity data (EPFL, 1996).

Sediment transport model – Lake Vernex

BASEMENT purely hydraulic simulations are used to establish the initial conditions for the calculations with sediment. The sediment transport simulations are then carried out for suspended and bed load for different scenarios (inflow, duration, initial water level, turbine flow, bottom outlet opening). The model of the lake in its current state (without channel) is used to validate the results.

The results show that the suspended load deposited in the lake is reduced to 15% with the channel when it is 57% in the current state. Moreover, the simulations show that there is no evidence of problems in the channel. In case of extreme flood, the main part of sediment is deposited in front of the intake and bottom outlets, that can be evacuated by pressurized flushing.

Fig. 3: Deposition in Lake Vernex for an inflow of 100 m³/s during 10 hours

Sediment transport model – Lake Lessoc

The effect of the increased sediment load of Lake Lessoc (DS of the Lake Vernex) is assessed by considering the sediment load from simulations on Lake Vernex.

The results show that during one year of operation, a maximum local deposition of 15 cm appears. It can be easily removed by the regular flushing.

Fig. 4: Lake Lessoc. Deposition difference between current and future state for turbining of 40 m³/s during 48 hours.

Construction method

To achieve the desired flow condition, as simulated by numerical models, a dike is proposed to be constructed at the left bank of the lake. For this purpose, use of Geotubes is considered. Sediments are taken from the lake and introduced into the tubes from a floating platform. Depending on the soil's characteristics, a flocculent might be added during this step. The tubes are then placed one over the other in the form of a pyramidal structure of 7 m high and 850 m long. For such a concept, the tax-included cost is just less that 10 Mio CHF.

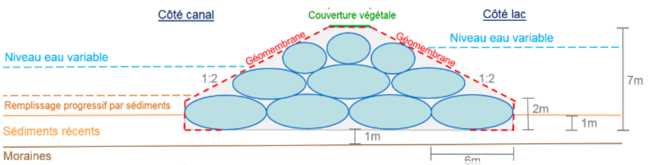

Fig. 5 : Transversal section of a dyke built by Geotubes.

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