Increasing The Capacity Of Small Reservoirs By Concrete Fuseplugs: The Saloun Dam

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Introduction

In their paper «Very Economical Concrete Fuseplugs to Improve Safety or Storage of Existing Dams» (Q90-R39), MM. JP. Vigny and F.Lempérière have already described the principles of the fuseplugs with their technical aspect, theoretical calculations, hydraulic model tests, preliminary design and construction. They indicated that the two first implementations of fuseplugs are: Saloun Dam actually in operation in Vietnam and Wedbila Dam under construction in Burkina Faso. These two works allow to increase the capacity of the reservoirs and consequently to extend the irrigated areas.

The purpose of this oral presentation is to illustrate some aspects of the design, construction and operation of the Saloun project and to give the conclusions that can be drawn from this experience.

The Wedbila dam project is exposed by M. A. Nombre in the report Q90-R23.
General Purpose and Principle of Fuseplugs

• Possibility of increasing the storage capacity of small reservoirs without changing the MWL and consequently the dam height.
• The fuseplugs are simply massive blocks placed side by side on a spillway sill. They are free standing and self stable until the water level in the reservoir reaches a certain elevation, but start tilting when this elevation is exceeded.
• The fuseplugs are designed to be overtopped by a water nappe before tilting. The blocks placed on the same sill have the same height but different thickness, so that they tilt progressively for different water levels.
• The water elevations for tilting can be predicted quite accurately since the blocks are designed with a total uplift at their base.
Cross Section and Plan View of the Blocks on the Sill

Flow

Intermediate walls

abutments
The Saloun Irrigation Dam in Vietnam
Laboratory Tests on the Fuseplugs

In a first stage, tests were performed in the Hydraulic Laboratory of the HCM City University of Technology in order to compare the calculated and the measured nappe depths when the tilting occurs and to evaluate the influence of the other parameters.

The model tests show that, when the plugs are overflowed, the vertical force applied on the block can be calculated assuming an uniform pressure of 0.60h and the dynamical effect and friction can be neglected after the tilting of the plugs.
The Project

- Free overflow spillway, 30 m long, with a capacity of 160 m$^3$/s for the Design Flood.
- Installation of 3 groups of 10 concrete blocks, 0.80 m high and with US/DS length of 1.10 m, 1.25 m and 1.35 m respectively. The first blocks tilt for the 5-year flood and all the blocks tilt in order to keep the same MWL for the Design Flood.
- The tilted blocks can be easily and quickly replaced by new prefabricated ones by mean of a winch suspended to a footbridge.

Main results

- Increase of the reservoir capacity = 150 000 m$^3$ = + 30%.
- Total cost of the works = 20 000 USD.
- Duration of construction = 2 months.
- B/C = 1.47
Construction

The construction was carried out simply by a local contractor with very light equipment and labour. The concrete blocks are prefabricated and then placed on the weir.
Saloun Spillway with the Fuseplugs
(before the construction of the footbridge)
At the heel of the dam, prefabricated fuseplugs will be stored and can replaced the tilted ones as soon as the reservoir returns to the fixed weir level. This allows to refill immediately the reservoir. This replacement will be made by the winch suspended to the footbridge.

The mark of the maximum water level, reached during the last flood, shows that the fuseplugs were overflowed (about 10 cm).
Operation of the Saloun Reservoir

Thanks to its larger capacity, the reservoir was not empty in April 2009, near the end of the dry season, such as during the previous years. However, it is to note that the additional irrigated area has not been yet fully equipped.
Conclusion

Many small irrigation reservoirs worldwide must be heightened for the following reasons:

- Lack of food leading to irrigate new reclaimed land (particularly in Africa).

- Loss of capacity of many existing small reservoirs due to silting.

- Increase of the check floods considering the too low values adopted formerly and consequently necessity to increase the capacity of the spillway.
Concrete fuse plugs placed on the top of fixed weir may be an interesting solution to address this issue as they present many advantages:

- Automatic functioning without any electro-mechanical device, and then very safe.

- No expensive maintenance.

- Low investment cost (compared with a dam heightening).

- Can be easily adapted to existing structures.

- Can be easily constructed in developing countries with low labour cost and technology.

- Not sensitive to possible negligence or theft as with flashboards.
Thank you for your attention