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Safety of overflow earthfill dams lined with concrete elements (2000-2001)

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Problem definition and state-of-the-art

Embankment dams are more than the half of existing dams, outnumbering all other types of dams for heights of less than 30 m. Failure occurs mainly by internal erosion or by overtopping. Most known failures of embankment dams were due to insufficient flood discharge capacity. **Controlled overtopping** (overflow) can represent one good alternative for flood management if dam stability is not threatened. Overflow spillways are becoming more and more an alternative to conventional spillways.

Several attempts to protect the embankment from eroding during overtopping events have been made in the past. Amongst the developed linings those made of precast concrete blocks (see Fig. 1) have been the object of most advances, due to advantages in prefabrication, in stability and also in energy dissipation by creation of a complex flow pattern.

Fig. 1 - Overflow lining in Leithen- Austria

In fact, the construction of an overflow spillways can reduce the need of excavation and the geometry of the energy dissipation basin comparatively to conventional side spillway channels, thus **reducing a dam scheme's total cost**. However, the existing systems of concrete elements have complex geometry, high stability demands, withstand low specific discharges and need to be prefabricated in plants. Alternatives are needed which can be produced in site and have a more straightforward stability concept.

Research objectives

The present research aims at the definition of a new lining system for overflow **earth** embankment dams made of concrete blocks. Such system is envisaged to be used for controlled overtopping, providing protection to the embankment against the erosive action of overtopping flow and enhancing energy dissipation along the slope. It should be self-stable, easy to realise and competitive in terms of cost. The focus will be set the on the **stability of the lining along the slope** and on the characterisation of the flow pattern over a macro-roughness bottom.

The application range for such lining systems includes the **rehabilitation of old dams**, the design and construction of **low height dams and small schemes**, as well as the design and construction of **overflow cofferdams**.

Proposed approach

1. Definition of geometrical shapes

Photo 1 –Sloped steps concrete elements

2. Realisation of a physical model (design and construction of an experimental set-up);

Photo 2 – View of channel from downstream

3. Hydraulic tests to define the "failure flow" for several lining systems (combinations of element geometry and weight, dam slope, joints and drainage);
4. Documentation of the flow condition over the created macro-roughness surfaces;
5. Analysis of experimental results;
6. Establishment of guidelines for design and construction of such lining system (including recommendations for crest, toe, foundation and drainage) ;

Expected outcome

- Concrete element geometrical definition.
- Identification of the predominant failure mechanism of such lining systems.
- Advances for the characterisation of the flow pattern over a macro-roughness bottom
- Stability criteria for the design of concrete element according to flow velocity and flow depth.

Key words

Overflow earthfill dams ; Macro-roughness concrete elements ; Stability ; Drainage.