Overflow dams - High velocity flow on steep slope over macro-roughness

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Purpose of the research project

The purpose of the proposed research is to study the behavior of high velocity flows over macro-roughness surfaces with geometry elements easy to realize and different from horizontal rectangular steps.

The project will lead to:

- A general head loss law which describes continuously the transition from nappe-flow to skimming flow.
- The proposition of an optimal energy dissipator (with regards to energy loss, self-aeration, design and cost) on the structure itself.
- Design rules and recommendations to protect overflow dams and embankments with macro-roughness surface elements.

Dissipate energy along the structure allows to avoid the building of big and expensive dissipator pools and protect the stability of the construction (application: RCC structures, overflow dams and embankments, evacuation channel…).

Principal objectives of the research project

1) Analysis and characterisation of submersible existing constructions. Deduction of promising solutions of protection.
2) Parametrical study of the hydraulic behaviour of high velocity flows over macro-roughness.
3) Development of a general, continuous law of head losses (friction law) for high velocity flows, applicable for all flow regimes.
4) Highlighting the influence of air entrainment on the energy dissipation of flow.
5) Optimisation of the energy dissipation using macro-roughness elements for given hydraulic structures.
6) Definition of the dynamic solicitations on the macro-roughness elements.
7) Behaviour of macro-roughness elements partially covered by loose materials (for example humus) at starting of overflow, process of washing out of this fine materials (environmental integration).
8) Recommendations and design rules for engineers.

Experimental approach

Because of the complexity of the flow (turbulence, self-aeration) and the great number of parameters which contribute to the energy loss, experimental study seems to be the most appropriate and prospective way to reach the objectives of the research.

Geometric characteristics :

Maximum and minimum length of the flume	8 – 2 (m)
Width	0.5 (m)
Height	0.6 (m)
Slope	From 0 to 60°

Experimental conditions :

Scale	1:5 to 1:20
Discharge	2 to 250 l/s
Approach flow depth	1 to 15 cm
Total height of macro- roughness (step + element)	4 to 18 cm
Slope of flume	20, 30, 40, 50°

Measurements :

Parameter	Instrumentation
Discharge	Alimentation pump
Water level	Point gauges
Velocity	Fiber-optical double probe
Air concentration	Fiber-optical double probe
Bubble diameter	Fiber-optical double probe
Pressure	Pressure sensors
Stream lines	Tracer

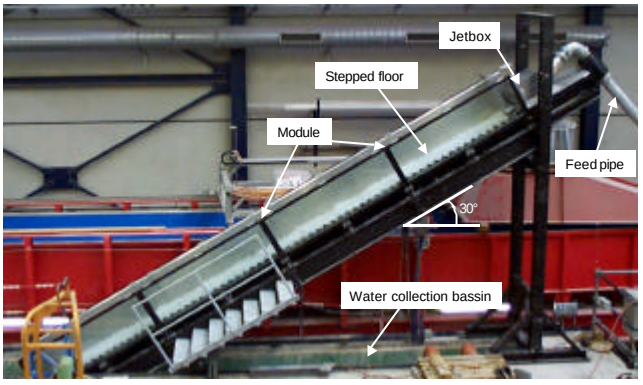

Fig.1 : Side view of the installation

Macro-roughness elements

At priori, the different families of macro-roughness elements, as shown in figure 2, will be tested. Off course, other variations of forms may be developed during the project to aim the optimal elements regarding energy dissipation.

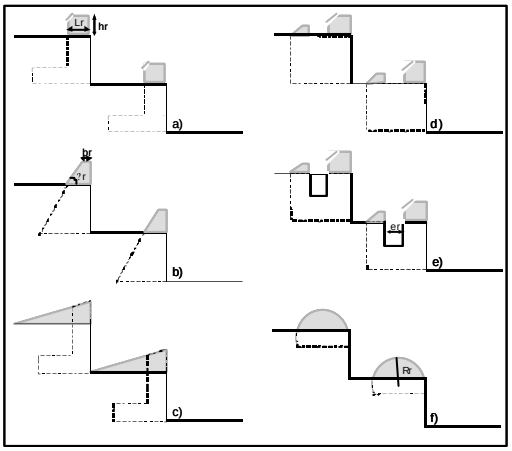

Fig.2 : Schematic drawing of the different macro-roughness elements (example for RCC constructions)