LABORATOIRE DE CONSTRUCTIONS HYDRAULIQUES

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# *Influence of the widening of a tributary on confluence morphology*

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## *Introduction*

River training works have been applied in many industrialized countries over the last few centuries. However, identification and mitigation of adverse impacts in the long-term were seldom considered. Therefore, river ecosystems have been strongly affected.

Nowadays, river rehabilitation is being applied worldwide with the objective to recover the vital space required for rivers degraded by human interventions.

In fluvial networks, confluences are important points marking significant flow changes. The knowledge of confluence streams acquired over the last years has been extremely important in understanding the complex three-dimensionality of flow and in connecting flow structures to the fluvial dynamics of confluences. Despite these advances, the understanding of sediment transport and morphological dynamics in confluences remains limited, jeopardizing confluence rehabilitation projects.

The aim of this thesis is to increase the understanding of the flow structure and morphological development in Alpine confluences in order to provide practical recommendations for confluence projects in the framework of river rehabilitation. Special attention is given to the widening of the tributary channel and its influence on bed morphology evolution in the confluence zone.

## *Experimental set-up*

Laboratory experiments are performed in a channel confluence, adjustable for testing several configurations. The main channel is 8.5 m long, 0.50 m wide and 0.80 m deep. A second channel (tributary), 4.9 m long, 0.15 m wide and 0.50 m deep is connected with an angle of 90°, 3.60 m downstream of the inlet of the main channel (Figure 1). The tributary channel has the possibility of being widened in its downstream reach.

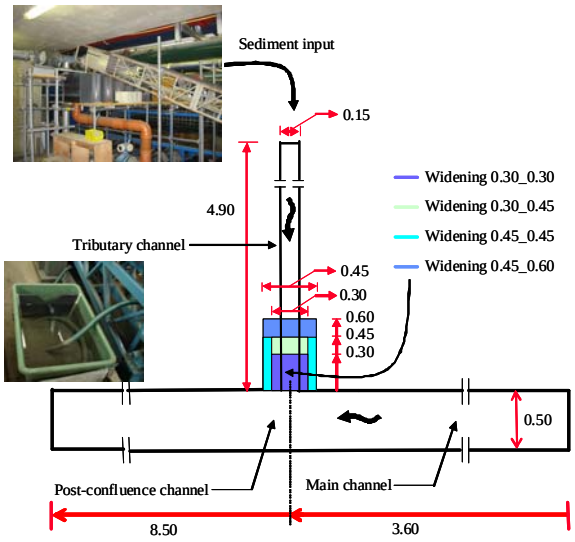


*Figure 1:* Laboratory set-up

## *Procedure*

Five different geometry configurations are considered: the configuration called “reference”, where the tributary is 0.15 m wide on the whole reach and four different tributary widening (0.30m x 0.30m, 0.30m x 0.45m, 0.45m x 0.45m and 0.45m x 0.60m). For each configuration, four different discharge scenarios ($Q_t/Q_m$=0.07, 0.15, 0.23 and 0.30) are tested. All discharge scenarios have 20 l/s on the post-confluence channel.

Poorly-sorted sediments (gradation coefficient $\sigma$ = 4.15) is used for the bed constitution and the solid discharge. The $d_{50}$ is equal to 0.82 mm and $d_{90}$ equal to 5.7 mm.

All tests are run with a sediment discharge of 0.30 kg/min on the upstream of the tributary channel. This discharge was adopted after preliminary calculations and tests carried out on the experimental set-up (Figure 2). Tests are run until bed equilibrium.

The evolution of water surface (automatic ultrasonic limnimeters), bed topography (Mini EcoSounder) and sediment balance are recorded during the experiments. At the end of the tests, surface flow velocities are measured by means of PIV techniques and sediment samplings (grain size analyze) are performed in different locations.

*Figure 2 : Final bed morphology in the confluence zone at the end of a preliminary test*

## *Expected results*

The combination of experimental and field analyses proposed for this project will increase the knowledge about morphological development and sediment transport in Alpine confluences. The influence of the available space for the tributary at confluences zones on its morphology will be highlighted.

This research should provide an answer to the following questions:

- How does bed morphology develop in a confluence zone and what are the bed-forming events for a given configuration?
- What are the consequences on bed morphology, sediment transport and flow regime in the main channel when the tributary channel is widened?
- Which are the optimal combinations of geometry, angle and channel widths for sediment transport and flood control for a given scenario?
- What is the confluence geometry that provides the greatest benefit in environmental terms?