FLOW IN A FOUR BRANCH CHANNEL INTERSECTION – A COMPARATIVE STUDY OF SUBCRITICAL AND SUPERCRITICAL REGIMES.

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This study focuses on the discharge distribution in an intersection of four channels, similar to a city crossroad. For such problems, because of their complexity and the number of different situations that have to be considered, the most suitable approach is by numerical simulation, usually by solution of the St. Venant equations. In general, the 1D St. Venant equations provide a reasonable model for the flow in individual streets, but they are not well-suited to model street intersections where the flow is necessarily strongly three-dimensional, and where the slope of the free surface can be significant. There have been few experimental studies of flow in channel junctions, and most published studies have concerned flow distribution in networks of irrigation channels, where the intersection is usually formed by the junction of three channels (in the form of a T or a Y), and where the flow regime is sub-critical. In urban applications, the basic configuration is more likely to be a cross, with one or possibly two of the streets feeding the junction. Moreover, the slope of a city street can easily be of the order of a few percent, so it is quite common for the flow regime to be supercritical in certain areas.

Thus, this paper investigates both subcritical and supercritical flows in a four channel junction. The first aim of the work is to show, from experiments, which parameters control how the flow divides up when a fourth branch is added. The flow is characterised in terms of flow rates and stage-discharge relationships, rather than water depths directly. The second objective is to compare flow behavior in the two regimes, and, in particular, the different roles played by upstream or downstream controls. Although the problem contains a relatively large number of variables, physical and dimensional analysis enables to reduce the problem to a more manageable set of totally independent variables. Some of the variables are common to both flow regimes, but the boundary conditions are different – downstream (outlet) conditions for subcritical flow and upstream (inlet) Froude number for supercritical flow.

In subcritical regime, the experimental results show that when the outlet boundary conditions are identical the dimensionless outlet flows depend linearly only on the ratio of flowrates in the two inlet channels. The relationship is more complicated when the outlet conditions are not identical: the intercept at the origin of the linear dependency depends on the other independent variables in the problem. The relative simplicity of this result makes it possible to envisage some empirical relationship that could be used to close existing analytical models for the outlet flows, and thus enable them to be used predictively. In the

supercritical regime the dimensionless outlet flow depends on the other variables in a much more complex fashion. The form of the curves depends strongly on the presence, position and type of hydraulic jumps in the intersection.

Keywords: Hydraulic jump; Channel junction; Subcritical flow; Supercritical flow

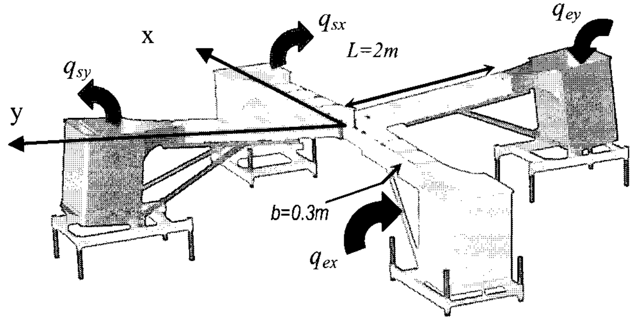

Fig. 1 Experimental set-up