LOCAL SCOUR DOWNSTREAM OF AN APRON FOR INTERMEDIATE TAILWATER DEPTH CONDITIONS

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Local scour due to 2-D submerged horizontal jets is a well-known topic of hydraulic research. If the jet is directly injected on the erodible bed and the tailwater depth is either *deep* or *shallow*, the equilibrium state characteristics of the scoured bed profile are mainly a function of the densimetric Froude number. If the submergence is between these two extremes, for fixed Froude number, three different scour regimes are possible. For relatively shallow tailwater depths, the jet mainstream directs towards the free surface (*surface-jet scourhole regime*), determining shallow and elongated scourhole profiles. For relatively large tailwater depths, the jet remains attached to the channel bottom (*bed-jet scourhole regime*), leading to deeper and shorter scourhole profiles. For intermediate conditions, the flicking of the jet between the erodible bed and the water free-surface is possible. When this instability occurs, the shape of the scourhole rapidly changes as a response of the jet mainstream position (*bed-surface jet scourhole regime*).

This paper aims to give an experimental description of the three mentioned regimes, during the local scour process caused by a 2-D horizontal wall-jet issuing from a sluice and developing on a rigid apron before interacting with a non-cohesive sand bed.

The experiments have been performed in a 4.50 m long, 0.102 m wide and 0.440 m deep horizontal glass-paneled channel. A 2.50 m long and 0.20 m deep bed of non-cohesive sediments is disposed between two steel boxes: the upstream one (the rigid apron) has length L of 0.50 m and depth of 0.20 m. A sketch of the channel is given in Fig. 1.

A set of tests at variable sluice opening Y_0 and weir height Y_w (and consequently Y_t) has been conducted. The flow rate (Q = 0.003 m^3/s), the apron length L (0.50 m), the grain diameter D_g (0.001 m) have been held constant in all the experiments. Each test has been conducted for at least 8 hours.

A digital photo-camera has been used to collect images of the visualizations and of the erodible bed profiles. The profile images have been then processed to obtain quantitative measures of the evolution of the bottom shape. A single component back-scattering Laser Doppler probe has been used to measure vertical profiles of the horizontal velocity component above the apron and the scourhole.

It has been shown that in the *surface jet* regime, the jet tends to reach the free surface at the end of the apron and the scour and dune follow an elongated profile with low vertical dimensions (Fig. 2.a), evolving logarithmically while bed profiles tend to similarity.

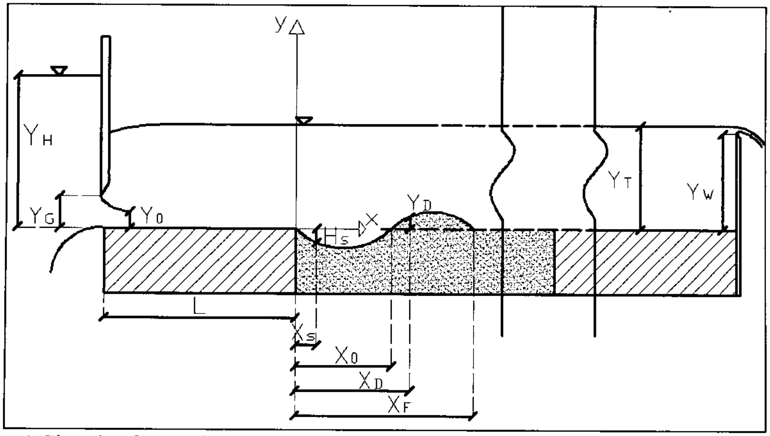
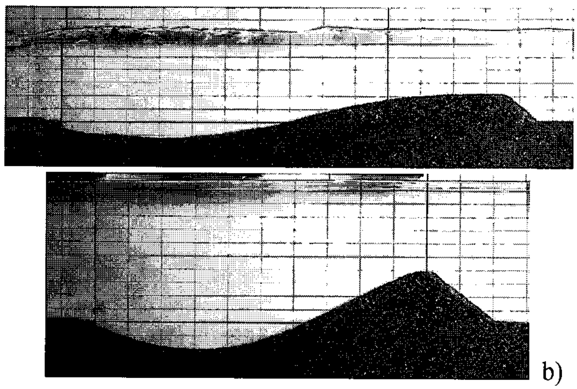


Fig. 1 Sketch of experimental channel with adopted reference system (X, Y axes)



a)

b)

Fig. 2 Erodible bed profile for *surface jet* (a) and *bed-jet* (b) scourhole regime

In the *bed jet* regime, the jet adheres to the erodible bed and the resulting scour and dune are shorter and deeper (fig. 3.a), reaching more quickly an equilibrium state.

An intermediate regime exists in which an unsteady cyclic flow onsets, the jet switching intermittently between the previous flow regimes: the resulting scour and dune shapes are also unsteady, but their vertical dimensions reach their maximum value at the end of the *bed jet* phase of the flow cycle.

LDA measurements have shown that the wall jet development on the apron is only marginally affected by the presence of the erodible bed.