# ADDITIONAL RESULTS ON SCOUR AT BRIDGE PIERS

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Based on laboratory tests, still further results on local scour at bridge piers were elaborated. Equations providing useful information on the analysis of literature data, theoretical models and field investigations were developed by using the approach of Oliveto and Hager (2002). In total four topics were considered, namely (1) the switch time of maximum scour from the sides of a cylindrical bridge pier to its front, (2) the temporal evolution of maximum scour depth at the rear side of such piers, (3) local scour at piers founded on piles, and (4) test of Oliveto and Hager's (2002) scour equation with large-scale experiments by Sheppard et al. (2004) on prototype size piers.

Figure 1 shows a definition sketch of the scour pattern that develops around a circular bridge pier in an initially plane sediment bed. The plot includes the essential observational points considered in previous and in the present researches. These include the maximum scour depths at the pier front, along the pier sides, and at the rear of the pier. A distinction was made between observations in the turbulent viscous and in the turbulent transitional regime. The latter may approximately be modeled using Froude similitude.

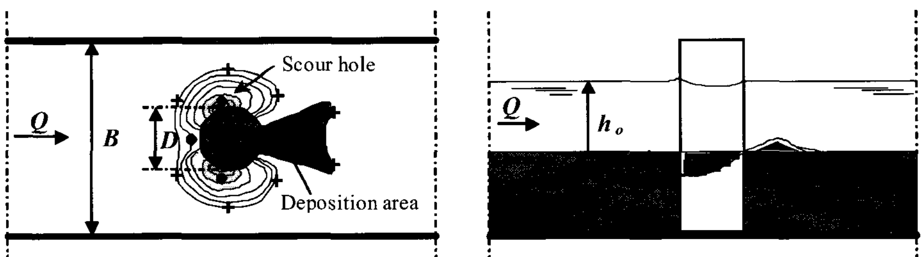


Fig. 1 Definition sketch and observational points for pier experiments a) plan and b) longitudinal section. $Q$ is discharge

The switch time $T_{sw}$ is defined as the dimensionless time $T$ at which the maximum scour depth migrates from the pier sides to the axial pier front. The switch did not occur for flows with a small threshold Froude number $\mathsf{F}_t=V_o/V_t$ with $V_t$ as the sediment entrainment velocity; it is demonstrated that the switch time depends essentially on $\mathsf{F}_t$ only.

The temporal evolution of clear-water scour depth $z_r$ at the rear of cylindrical piers increases semi-logarithmically with dimensionless time, as given in (4) and (5) of the paper. In the transitional regime scour starts at $T\approx10^2$, whereas smaller times $T$ produce sediment aggradation or an undisturbed bed.

Experiments performed at University of Basilicata involved cylindrical piers of diameter *D*, a square pile cap of width *W* and thickness *S*, and four cylindrical piles of diameter *d*, spaced each by *s*. The experiments were run under steady discharge for plane bed conditions in the clear-water regime. More details on experimentation and procedures are provided by Oliveto et al. (2005) and Oliveto and Rossi (2003). At the beginning of the scour process the maximum scour depth was located at the downstream edge of the pile cap. Successively, it migrated toward the pile cap front so that the exposition of the piles to the flow occurred first upstream and only after a long time downstream. The main findings were:

- Temporal growth of scour depth for the complex pier geometry may be modeled using the approach of Oliveto and Hager (2002) provided an appropriate shape factor is introduced;
- For relatively small time the pile cap performs as a scour mitigator whereas the element exhibits a behavior between a uniformly circular-shaped pier of diameter *D* and a uniformly square-shaped pier of side *W* for longer times; and
- The thickness of the pile cap seems to play an important role.

Selected tests of Sheppard et al. (2004) were compared with the approach of Oliveto and Hager (2002). The overall agreement was reasonable. In general the data are slightly lower than according to the prediction because of a reduced turbulence level due to the presence of suspended sediment in all experiments, as remarked by Sheppard et al. (2004).

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