Scour patterns on the bed downstream of a vertical cylinder

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We have investigated experimentally the scour erosion of a non-cohesive granular bed around a vertical cylinder in a small-scale water channel. Two erosion patterns have been found [1]. The classical pattern, which arises from the velocity increase in the vicinity of the cylinder and from the "horseshoe vortex" around it, is shown in Fig. 1(a) and referred here to HS pattern. Another pattern with two elongated holes may be observed downstream of the cylinder as shown in Fig. 1(b). This pattern arises from the wake vortices and is thus referred as WS pattern.

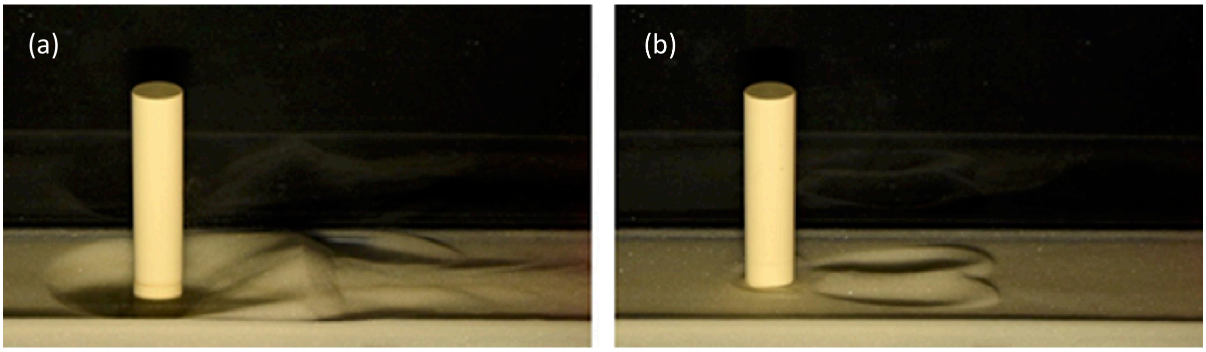

Fig. 1 : Two scour patterns observed on a bed of glass beads of diameter $d \approx 0.3$ mm around a cylinder of diameter D = 2 cm : (a) HS pattern for a water velocity $U \approx 0.9\, U_{c,0}$ and (b) WS pattern for $U \approx 0.6\, U_{c,0}$.

The erosion thresholds in terms of water velocity corresponding to these two patterns are significantly below the critical velocity $U_{c,0}$ corresponding to live bed far from the cylinder. Both thresholds depend on the Reynolds number $\mathrm{Re} = UD/\nu$ characterizing the flow around the cylinder of diameter D, but with different scaling laws : $U_{c,HS}/U_{c,0} \approx 1.12\, \mathrm{Re}_D^{-0,19}$ and $U_{c,WS}/U_{c,0} \approx 16\, \mathrm{Re}_D^{-0,66}$. The threshold of the WS pattern is a little smaller than the threshold of the HS pattern but the HS pattern grows much faster and stronger so that the WS pattern is generally hard to observe alone. A laser profilometer has been used to track the bed deformation and PIV measurements have been done to characterize for the water flow. Both patterns can also be observed in the case of non-circular cylinders, with *e.g.* square or triangular cross sections.

[1] F. Lachaussée, Y. Bertho, C. Morize, A. Sauret & P. Gondret Competitive dynamics of two erosion patterns around a cylinder, Phys. Rev. Fluids **3**, 012302 (2018)