First Pan American Congress on Computational Mechanics
PANACM 2015
April 27-29, 2015, Buenos Aires, Argentina

Numerical Model for Local Sedimentation and Scour with Moving Mesh

Nicolás D. Badano*†, Angel N. Menéndez*†

[*] INA, Hydraulics Laboratory
Autop. Ezeiza-Cañuelas, Tramo J.Newbery km 1,62 (1804) Prov. Buenos Aires, Argentina
nicolas.d.badano@gmail.com http://laboratorios.fi.uba.ar/lmm

[†] Univ. Buenos Aires, Eng. Dept., LaMM
Av. Las Heras 2214, (1127) Ciudad Buenos Aires, Argentina

ABSTRACT

Flow currents and waves tend to produce local sedimentation and scour around civil structures located on granular sediments. These changes in the boundary gradually modify the local hydrodynamic conditions, leading to a coupling of the fluid and sediment dynamics that produce characteristic bed forms, which may have important impacts over the functionality of the structure, and even lead to structure collapse or loss of functionality. The coupled nature of the phenomenon makes the prediction of the bottom evolution very difficult, so engineers typically depend on either rough empirical correlations or physical modeling, usually out of rigorous scale.

In this paper a numerical treatment of the problem is implemented, following the proposal by Liu & García [1]. The model has two coupled regions, representing the fluid domain in 3D and the sediment domain in horizontal 2D, both solved using the Finite Volume Method. The Reynolds Averaged Navier Stokes equations are solved on the fluid domain over a deforming mesh, which follows the evolution of the bottom. The advection, dispersion and settling of suspended sediments are also calculated on this 3D region. The bottom sediment volume conservation is solved on the 2D mesh, including the horizontal sediment fluxes due to saltation, and the deposition and resuspension rates. The evolution of the bottom sediment level is then mapped to the bottom of the 3D domain, motorizing the mesh deformation. All the sediment fluxes on the 2D mesh are computed using empirical formulas based on the bottom shear stress resulting from the hydrodynamic region. Additionally, on the fluid region an air-water free surface may be present, which is solved using a volume of fluid scheme. A new nondimensional relation for computing horizontal sediment fluxes due to sliding is implemented as well as a methology for defining additional solid boundaries initially buried inside the sediment. A time acceleration coefficient is added to the sediment conservation equation to speed-up computations when the sedimentologic time scale becomes large compared to the hydrodynamic timescale.

The numerical model is validated by comparing experimental results for the scour and deposition pattern produced by a turbulent wall jet. The same methodology is then applied to the case of flows around a breakwater and over a dredged navigation channel.

REFERENCES

[1] Liu, X., García, M.H., *Three-Dimensional Numerical Model with Free Water Surface and Mesh Deformation for Local Sediment Scour*, Journal of Waterways, Port, Coastal, and Ocean Engineering, 134:4, 2008.