Applicability of TELEMAC 3D for fine-scale Hydraulics

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Abstract TELEMAC-3D is an open source software created by Electricité de France (EDF) applied for Computational Fluid Dynamics (CFD) in the area of Hydraulics. This software is constantly tested and improved by academic and private organizations such as ARTELIA, engineering group which continually collaborates with enhancements and practical applications of TELEMAC-3D. At the moment, ARTELIA is interested in employing this software for simulating scour, and the first step is to study the fine-scale hydraulic phenomena. Therefore, this work focuses on evaluate TELEMAC-3D for fine-scale-hydraulics based on two cases: Flat-Bed-Channel and Flow-Around-Pile, both have been analyzed and compared with other published experimental studies.

Keywords: Hydraulic-Numerical-Modelling, Computational-Fluid-Dynamics CFD, TELEMAC-3D, Fine-Scale-Hydraulics.

Methods

Flat-Bed-Channel results are compared with vertical velocity profiles obtained in an open channel with smooth surface by M.F. Tachie. For the simulations, horizontal element size is about 0.05 m for meshes MA and MA3. Concerning vertical element size, MA elements has a constant size of 0.01 m, while MA3 elements grow from the bottom to the water surface with its first vertical element at 0.0002 m. In addition, each mesh has been simulated with two turbulence models: k-epsilon and k-omega. This first case explores how turbulence model and mesh influence the dimensionless wall distance y+.

Regarding the second case, Flow-Around-Pile case utilizes this rigid bed configuration (Roulund, 2005) and (Nagel, 2018) for the comparison. The horizontal element size varies from 0.2 m to 0.003 m; vertical element size is 0.01 m and k-epsilon has been chosen due to its practicality.

Results

Flat-Bed-Channel: As expected, inside the viscous sublayer, a higher mesh resolution better approximates physical measurements. MT_4 (MA3 and k-omega model) presents the most acceptable behavior. This be in accord with the fact that k-omega model works well as long as the first element is ubicated on the viscous sublayer. In contrast, inside the logarithmic sublayer, MT_2 (MA3 and k-epsilon model) presents furthest behavior from the measurements. This would suggest that k-epsilon needs the first element to be found in the logarithmic sublayer.

Flow-Around-Pile: Regarding flow velocities ***u***, at elevation z=20 cm there is a good agreement with the other studies. For vertical velocities ***w*** TELEMAC 3D is closer to Roulund numerical model. In general, none of the numerical models perfectly approximates the phenomena, but there is an acceptable concordance in order of magnitude.

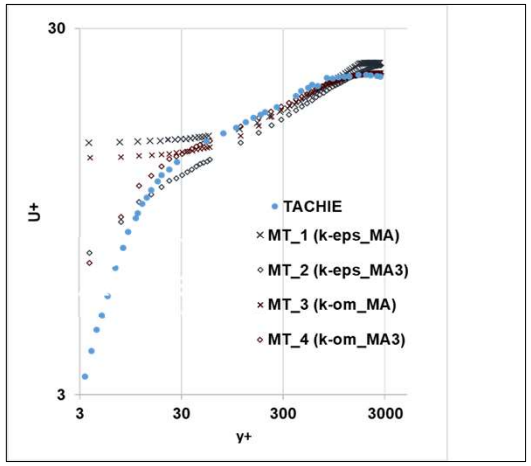

Figure 1: Comparison inside Boundary layer

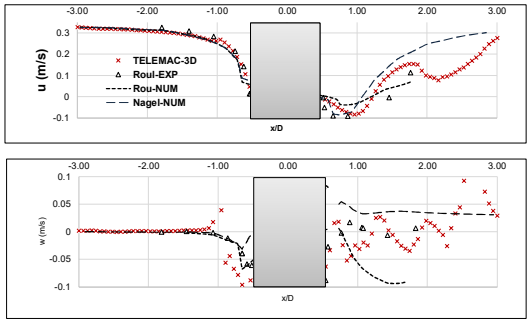

Figure 2:Mean-stream u (left) and vertical velocity w (right) at z=20cm

Conclusions

The Flat-Bed-Channel is a suitable example for analyzing a wall function behavior. Results confirm that a wall function only "transmits" viscosity effect to the main flow but without simulating it. For obtaining the "direct" representation of the viscosity, it would require elements smaller than the thickness of the viscous sublayer.

From the two cases with their respective comparisons, it can be seen that TELEMAC-3D is certainly capable of representing phenomena close to the boundary layer in order of magnitude, as well as vertical velocities. Deeper code changes would allow for better results.

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