seanergy
17›18 June, 2025
Paris • France

Poster n°14

Modeling time-development of scour and backfilling processes for offshore structures using CFD

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Context and Objectives

| Current practices:

- Empirical equations
- Physical models

| Problems:

- Empirical equations are conservative and case sensitive
- CFD : computationally expensive

| To understand and simulate the time development of scour formation and backfilling around offshore structures

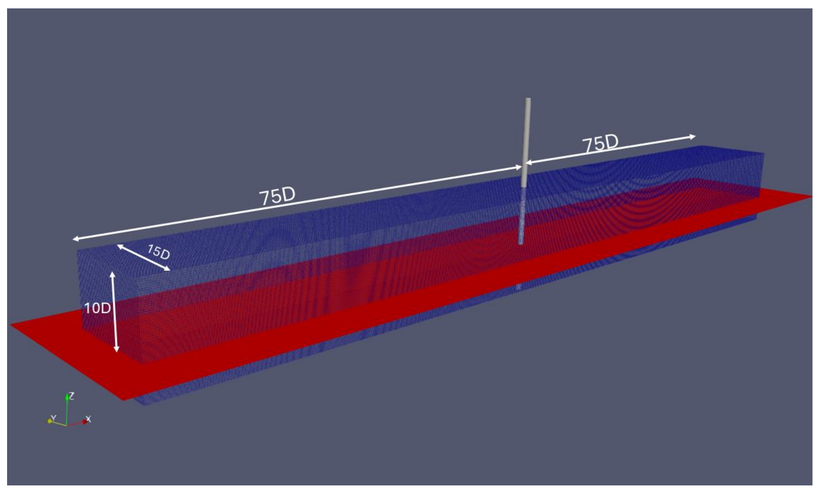
| Improve current industry standards of calculating scour analysis.

Methodology

| Uses OpenFOAM (CFD), Immersed Boundary method, single phase solver.

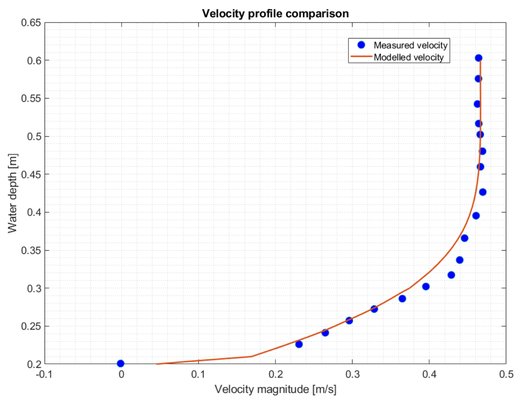
| Immersed Boundary – non-conforming grid (ignoring the obstacle) – variables are imposed on the boundary through modification of the governing equations.

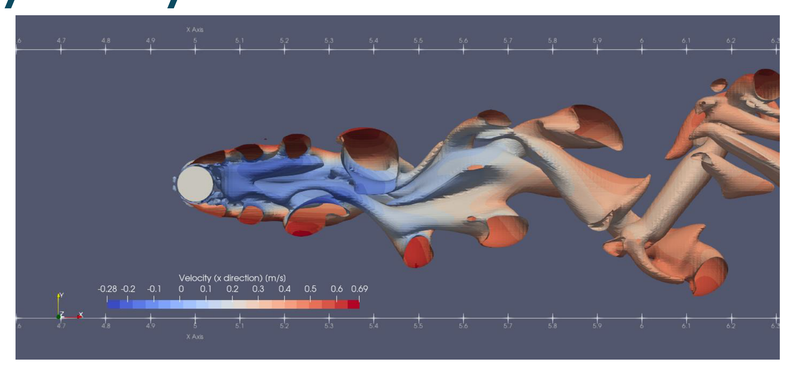
| Implemented morphological acceleration factor, including turbulence kinetic energy in wall shear stress calculations, etc.



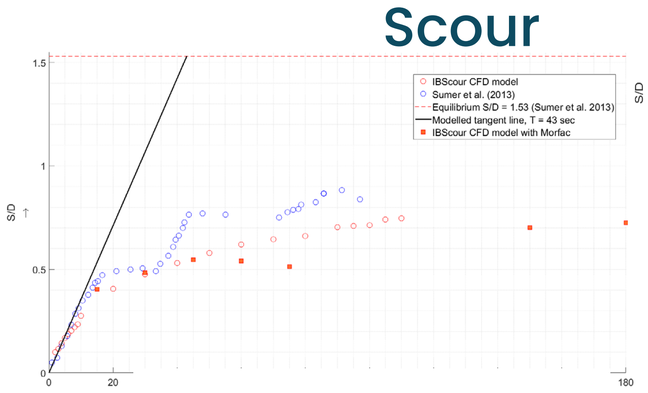
Results

Hydrodynamics

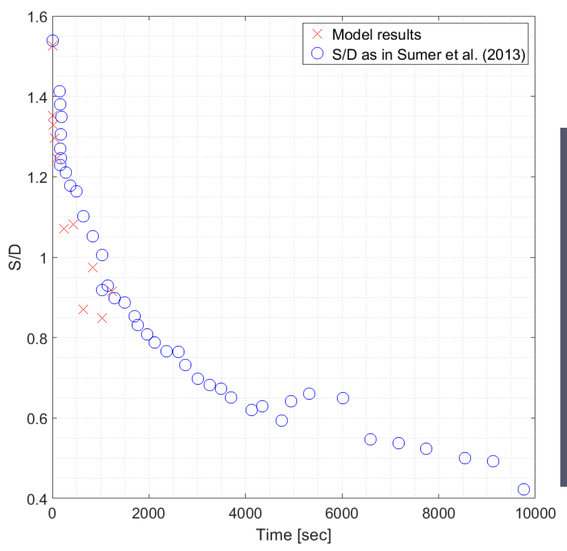


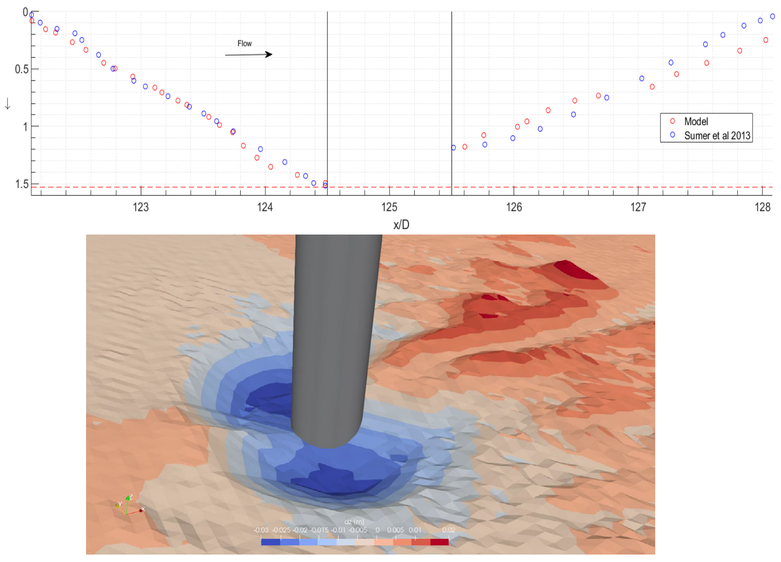


Scour

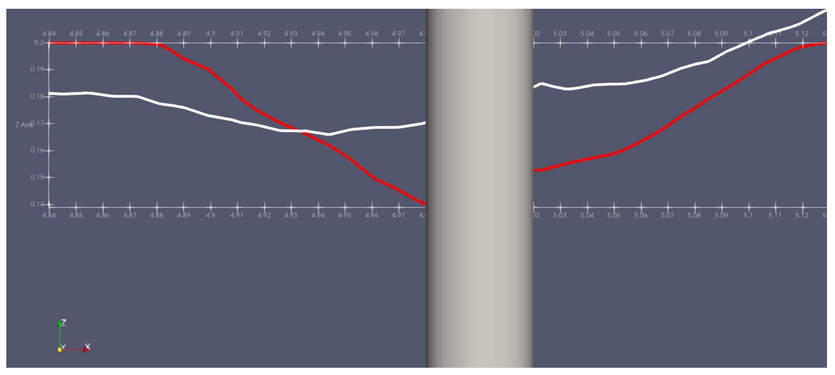


$$T^* = T^*\left(\frac{\delta}{D}, \theta\right) = \frac{1}{2000}\frac{\delta}{D}\theta^{-2.2}$$





Backfill



Discussion

| Hydrodynamics:

- Model validated against physical model measurements.
- Strouhal number of 0.17 for vortex shedding corresponds with Reynolds number of the experiment.

| Scour development:

- Scour dimensions / scour depth (S/D) values correlate well with the measurements and literature.
- Scour dimensions (S) ~ 3 x pile diameter

| Backfill comparison:

- Reduction in scour hole depth is consistent with measurements and literature along with change in scour hole dimensions.

Conclusion

| Scour time development corresponds with measurements and literature data

| Equilibrium scour hole dimensions are also calculated accurately within realistic time frames

| Realistic time scales allow usage of CFD as a tool to calculate scour hole dimensions providing optimized values of scour protection

| Time to calculate equilibrium scour and backfill ≈ 15 days on HPC