



BETTER SHIPS, BLUE OCEANS

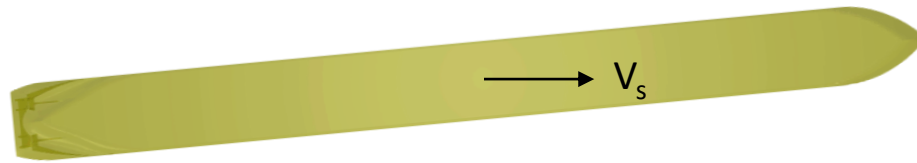
Combining numerical and experimental methods to explain ship-bank interactions

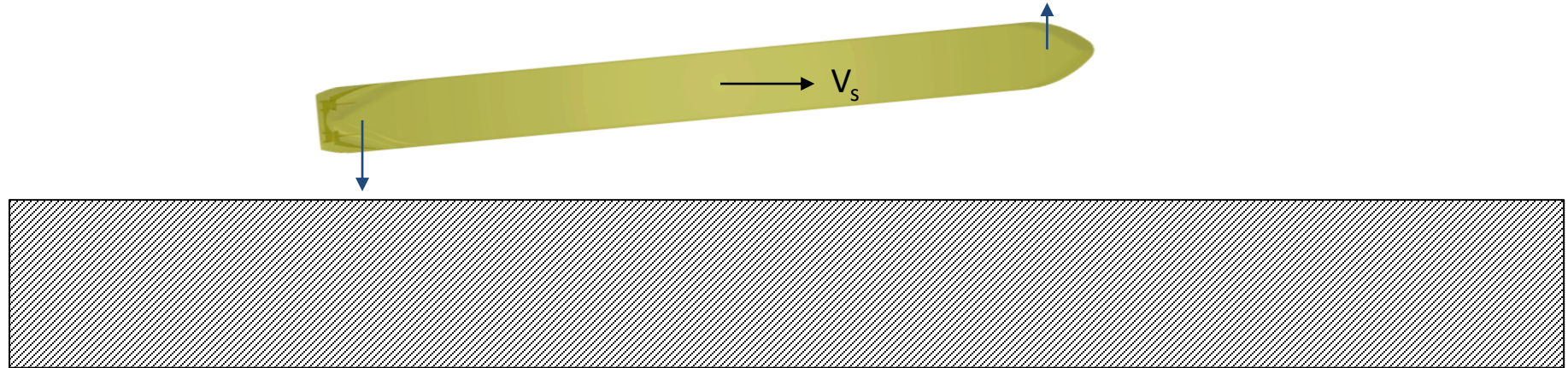
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MASHCON7, Bruges, Belgium

19 May 2025



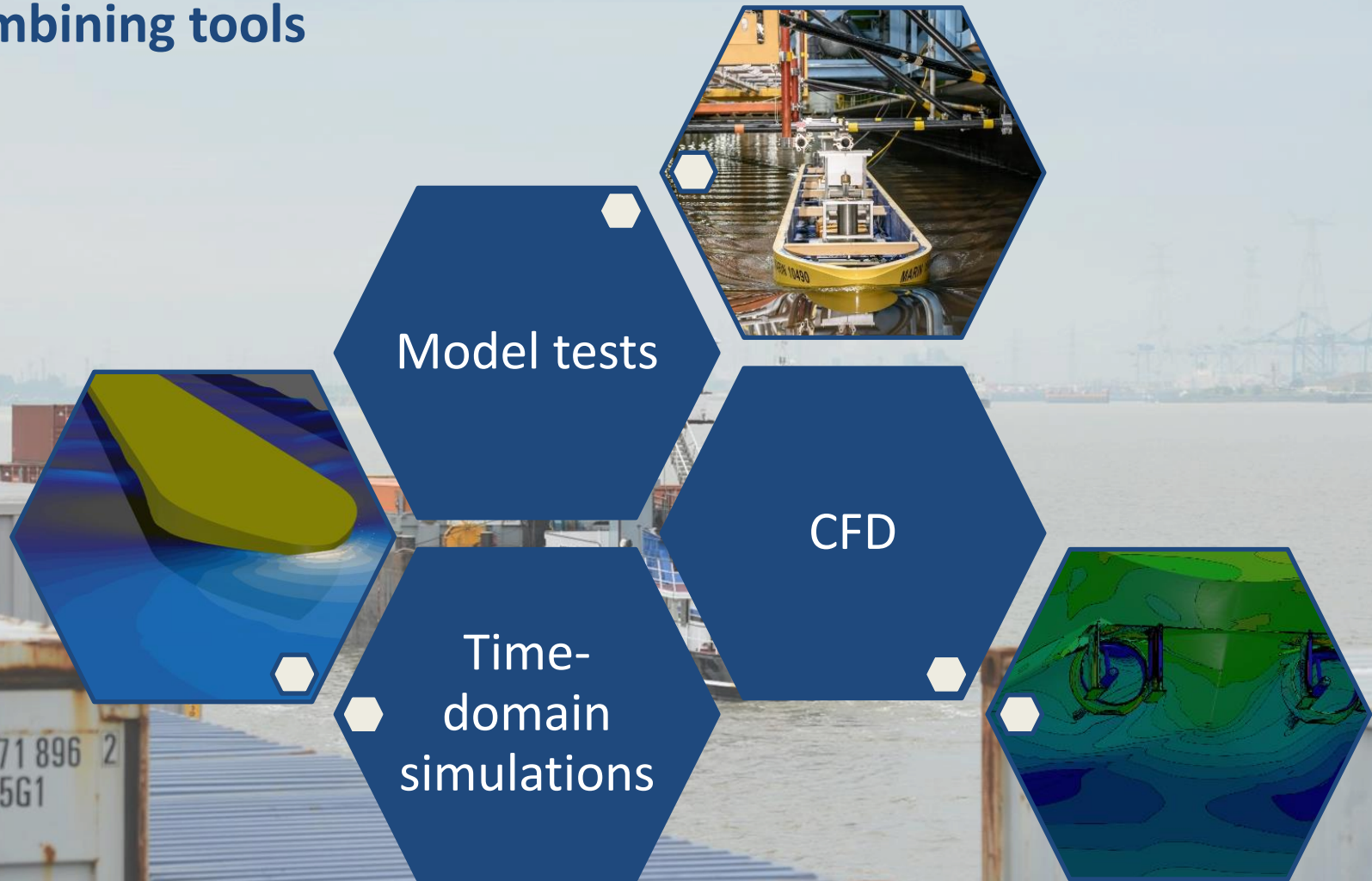




Complex underlying physics



Combining tools



Ship-bank interaction tests

- 135m reference inland ship, fully appended.
- Sailing at a fixed distance from a vertical bank.
- Semi-captive: free to trim and sink.

Three approaches

- **EXP:** model tests
- **CFD MS:** CFD at model scale
- **CFD FS:** CFD at full scale

Configuration	h/T (-)	V_s (m/s)	d/B (-)	RPM (1/min)	δ (deg)	F_{rh} (-)	V_s/V_{cr} (-)	EXP (-)	CFD MS (-)	CFD FS (-)
Appended	3.0	0.972	1.5	303	0	0.38	0.45	✓	✓	✓
Appended	1.5	0.972	1.5	322	0	0.54	0.69	✓	✓	✓
Appended	1.2	0.972	1.5	341	0	0.61	0.79	✓	✓	✓
Appended	1.5	0.972	2.5	322	0	0.54	0.69	✓		
Appended	1.5	0.972	2.0	322	0	0.54	0.69	✓	✓	
Appended	1.5	0.972	1.0	322	0	0.54	0.69	✓	✓	
Appended	1.5	0.972	0.5	322	0	0.54	0.69		✓	

EXP: experiments, CFD MS: CFD calculations at model scale, CFD FS: CFD calculations at full scale

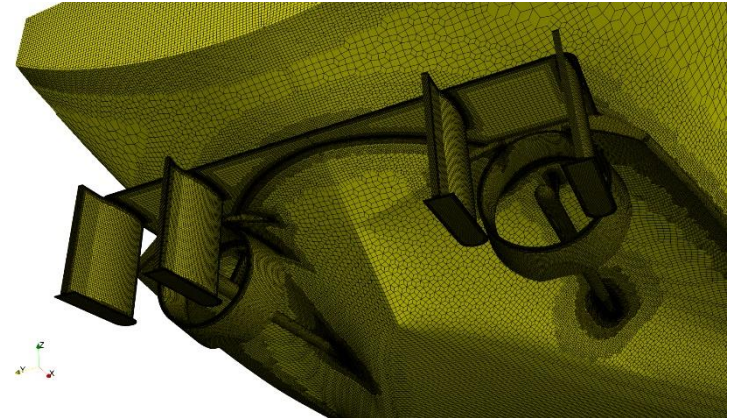
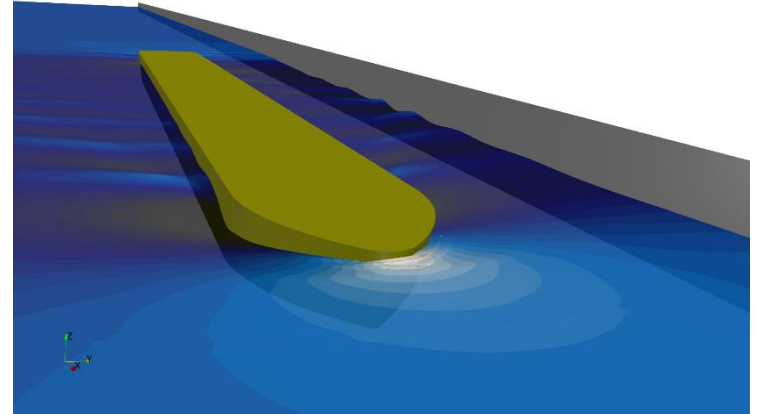


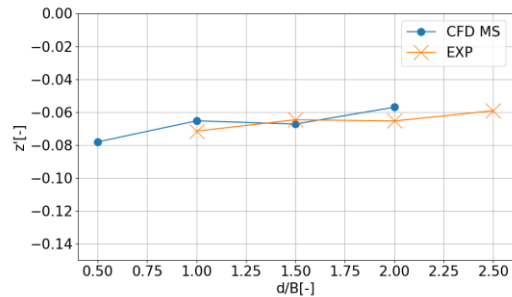
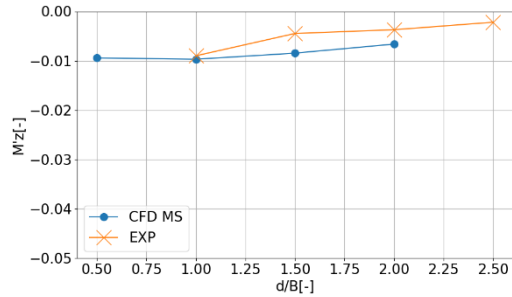
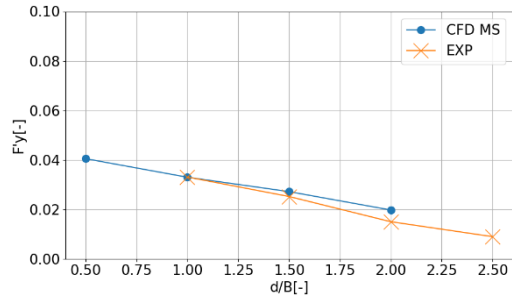


Experimental set-up

URANS calculations with ReFRESCO

- Domain: $11 L_{pp} \times 22.1 B$ (same width as basin)
- Unstructured grid, 30-50 million cells
- Free to trim and sink through grid deformation
- Turbulence model: $k-\omega$ SST (2003)
- Two-phase flow: VoF
- Propeller model: actuator disc



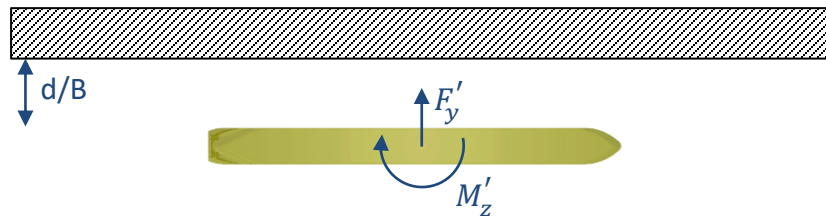


Bank suction forces and induced squat

Ship closer to the bank

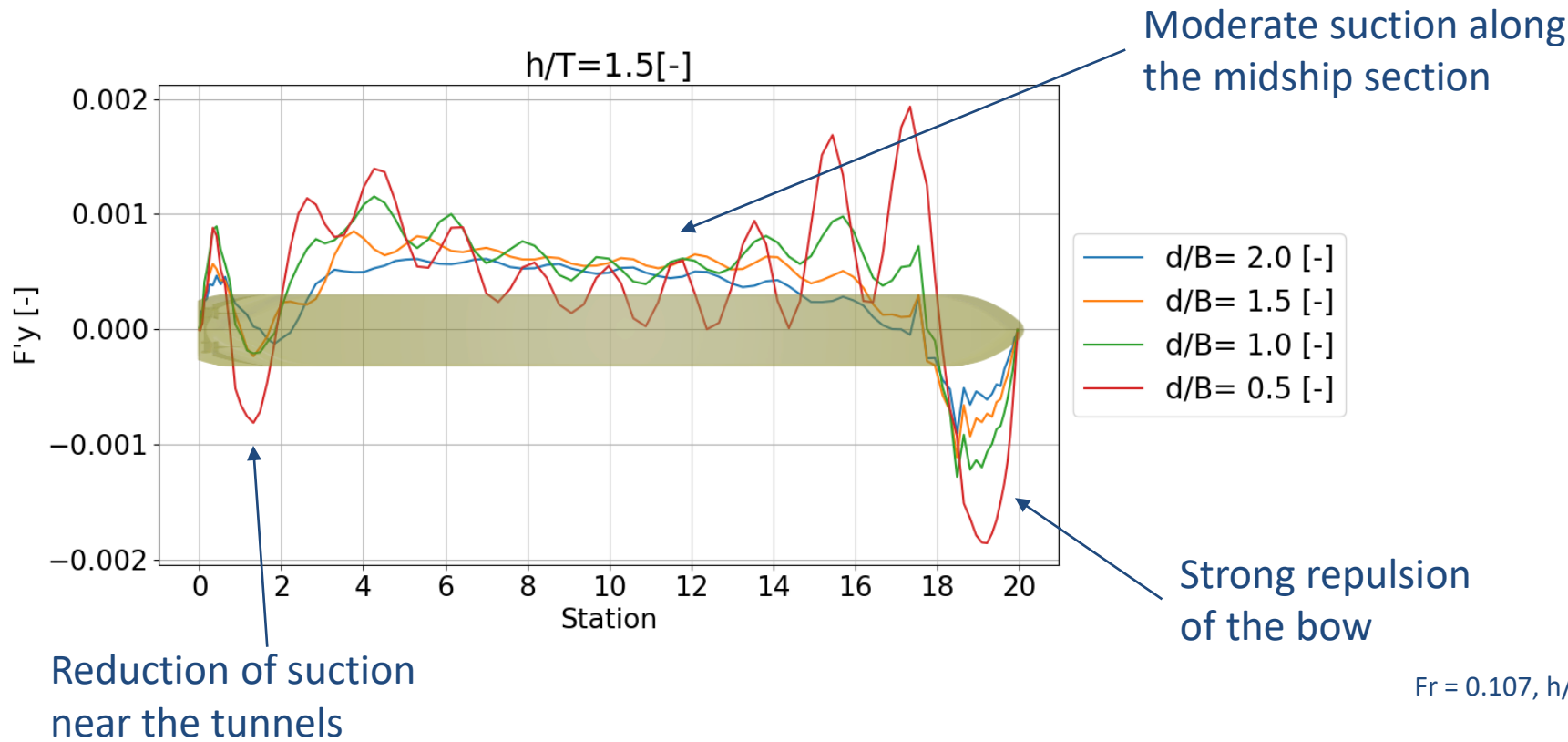


Intensity of bank-suction forces and squat increases

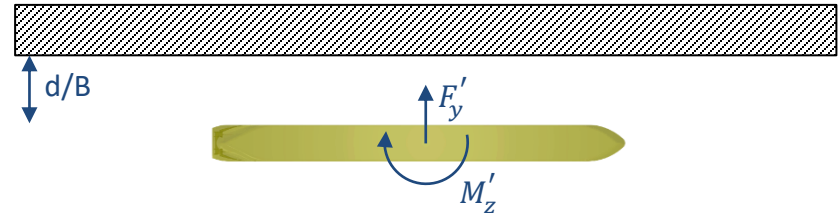


$$Fr = 0.107, h/T = 1.5$$

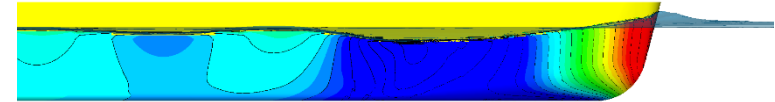
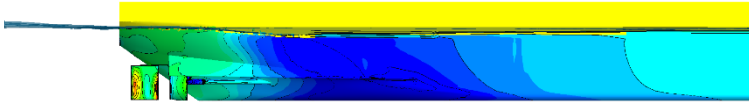
Distribution of transverse force along the ship length



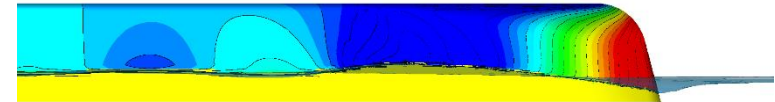
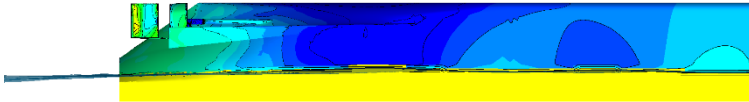
Pressure coefficient on the ship hull



Starboard:
opposite to
wall

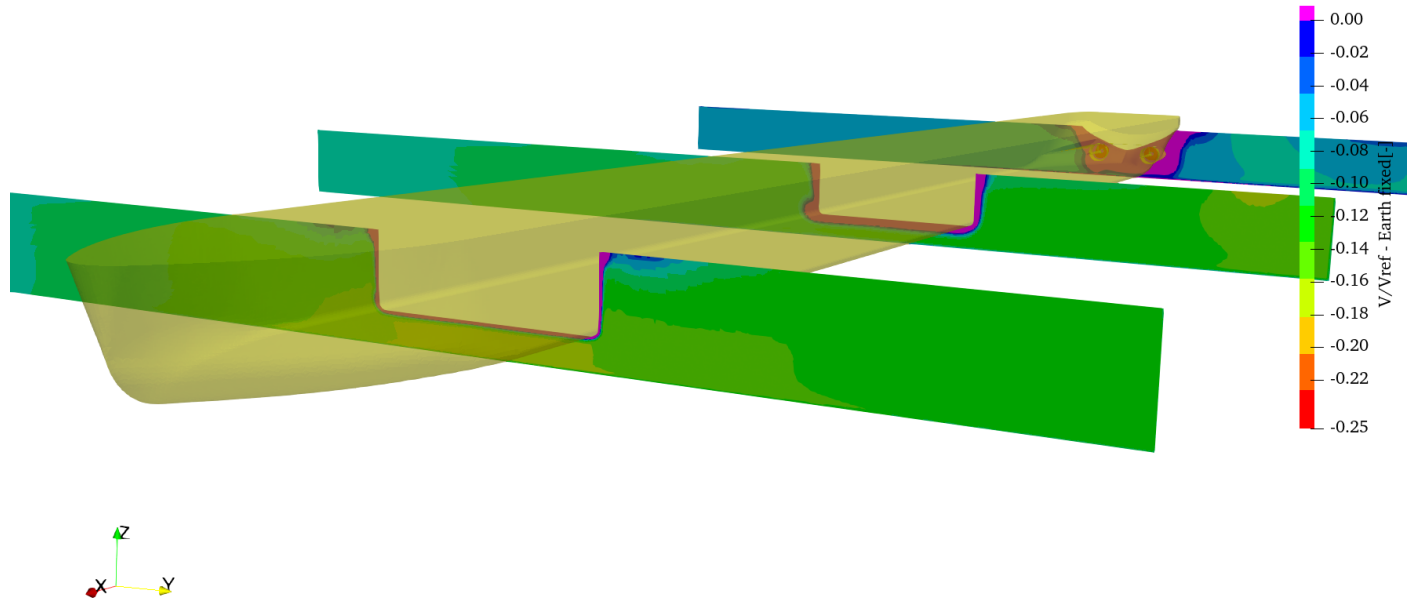


Portside:
facing the
wall



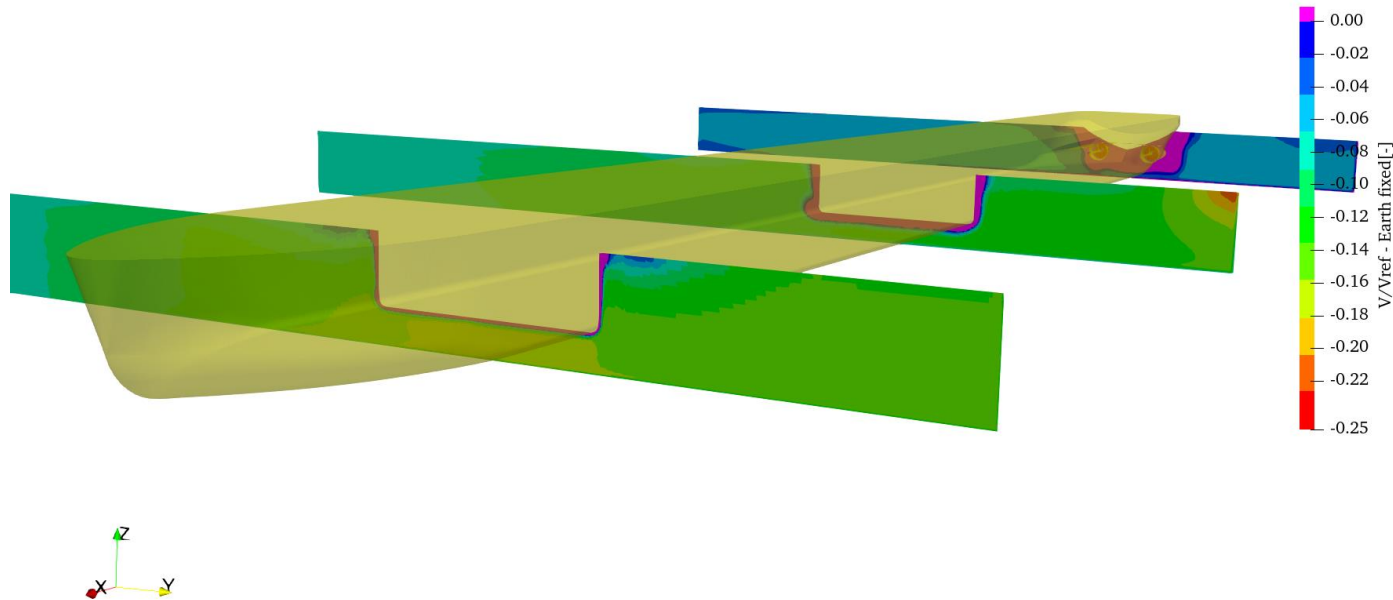
$$Fr = 0.107, h/T = 1.5, d/B = 1.5$$

Longitudinal velocity field: $d/B = 2.0$



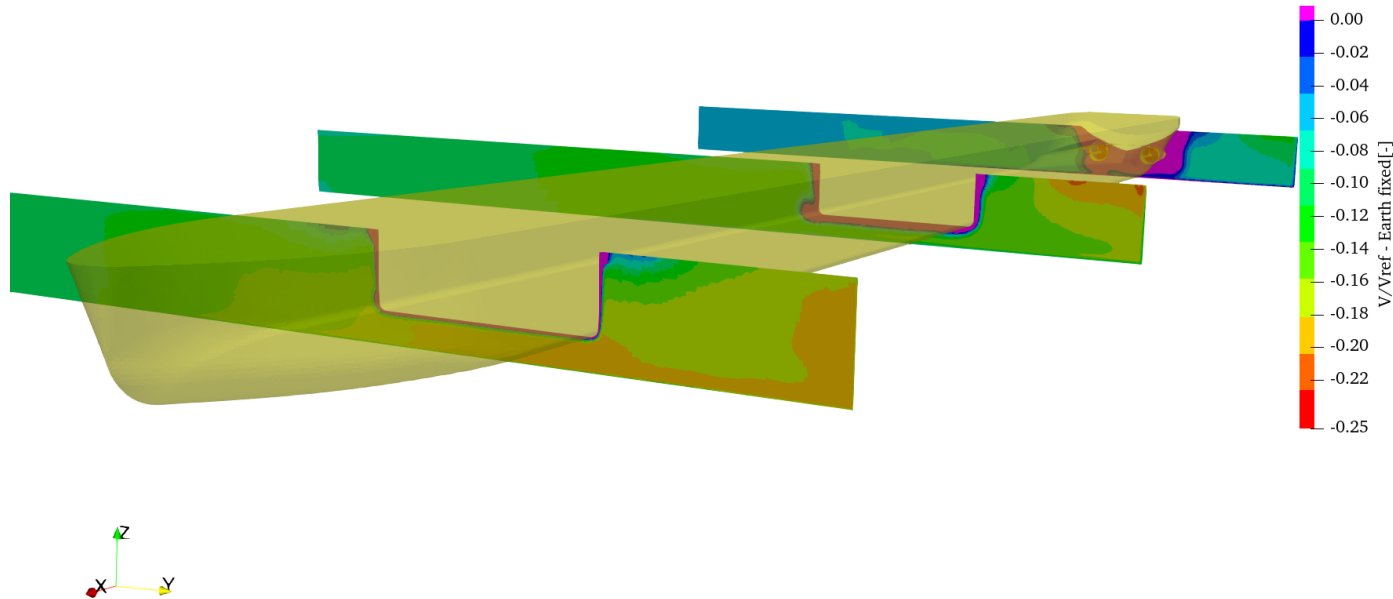
$Fr = 0.107, h/T = 1.5$

Longitudinal velocity field: $d/B = 1.5$



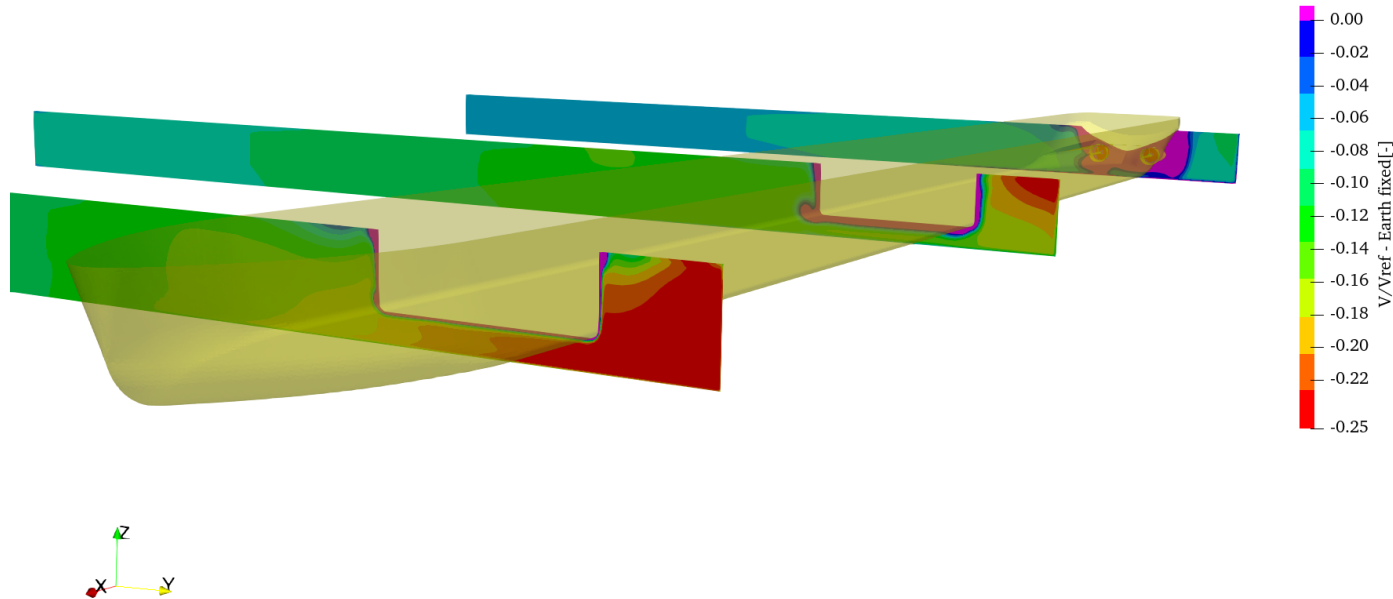
$Fr = 0.107$, $h/T = 1.5$

Longitudinal velocity field: $d/B = 1.0$



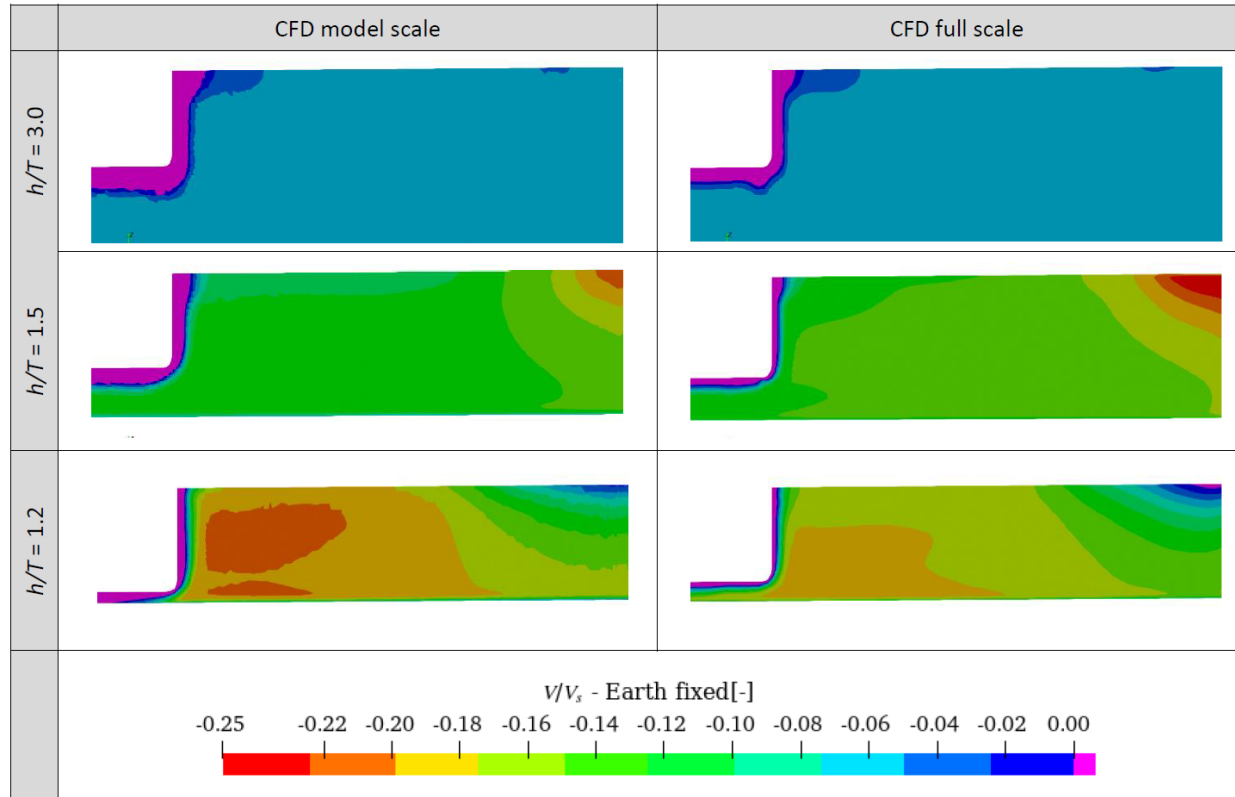
$Fr = 0.107$, $h/T = 1.5$

Longitudinal velocity field: $d/B = 0.5$



$Fr = 0.107$, $h/T = 1.5$

Longitudinal velocity field at station 10



$Fr = 0.107$, $d/B = 1.5$

- Ship-bank interactions are very sensitive to waterway cross-section. Sudden variations in bathymetry may result in unexpected ship motions.
- CFD and model tests show similar trends in mild conditions, but deviations increases in very shallow water ($h/T = 1.2$).
- Numerical predictions and experiments provide complementary insights on ship-bank interactions. Together, they provide reliable validation material for simulator models, but also a detailed outlook of the underlying physical phenomena.



Thank you!

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