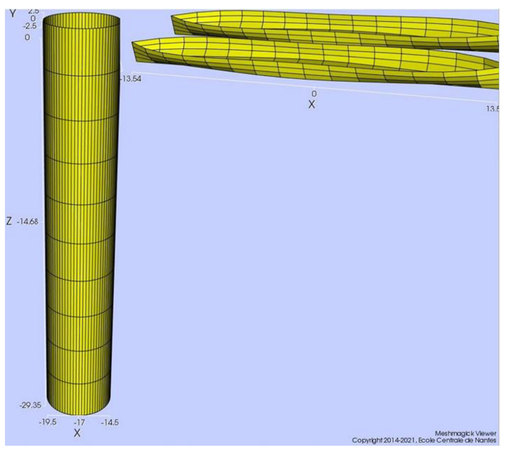
seanergy
26›28 June, 2024
Nantes, Pays de la Loire • France

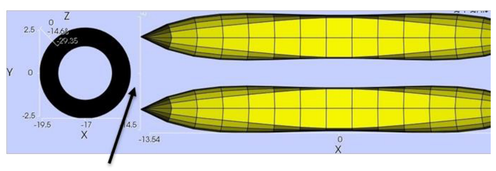
Poster n°4

ENSM
ÉCOLE NATIONALE SUPÉRIEURE MARITIME

# Berthing of CTVs against Offshore Wind Turbines by Kinetic/Static Friction

## Berthing catamaran Crew Transfer Vessel (CAT CTV) against monopile

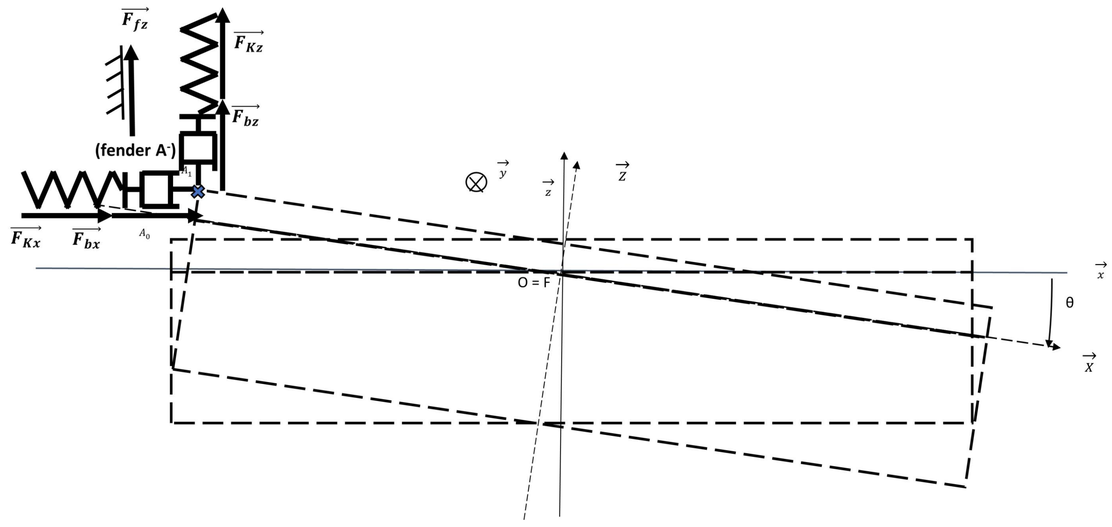


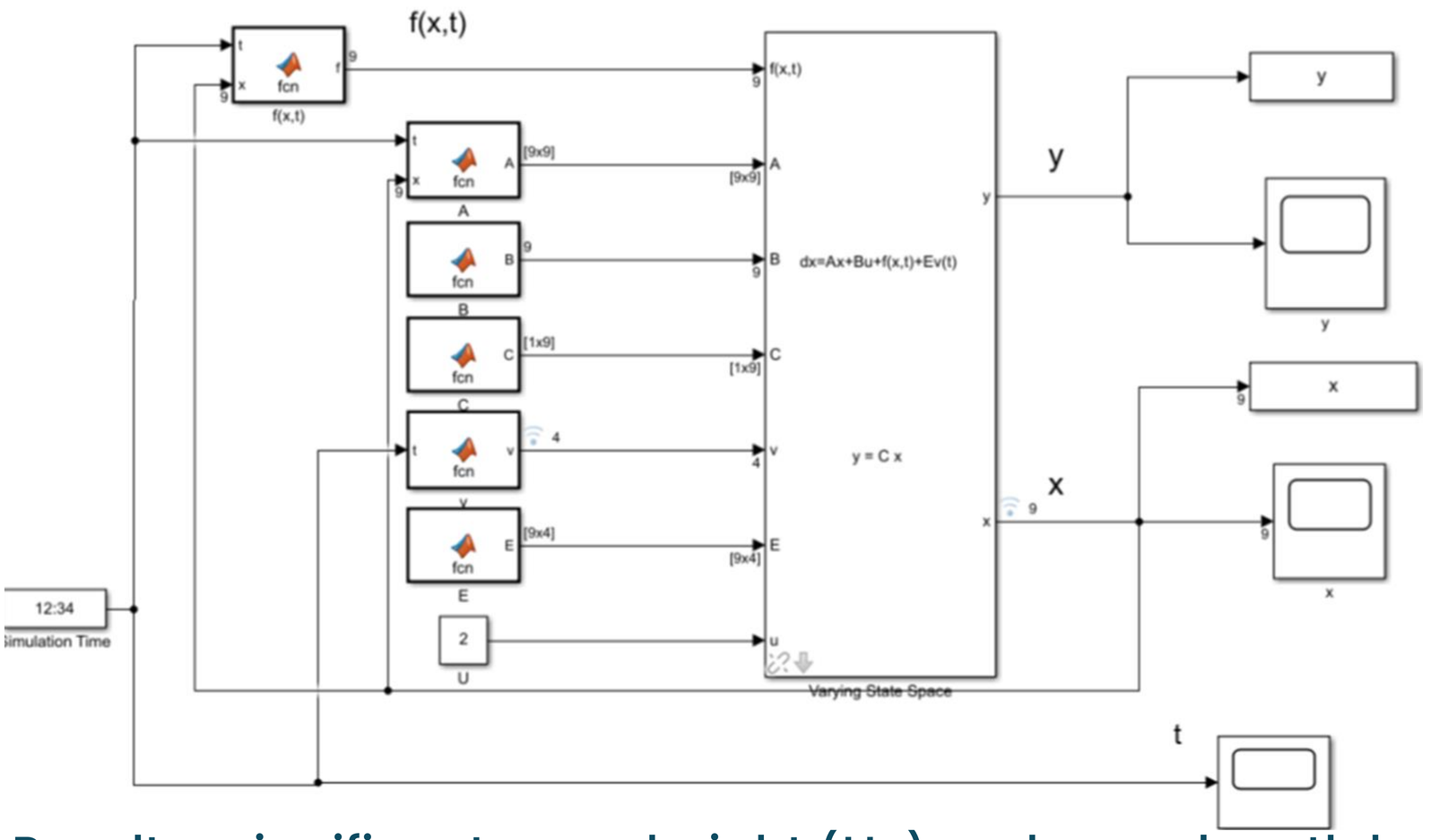
Deformable fender

Approximation: CAT with Wigley hulls

## CAT/monopile contact: horiz. & vertical springs & dampers, vertic. friction force




## MATLAB/SIMULINK model




## Equations ruling CTV motion [1]

$$\begin{bmatrix} m+m_a & 0 & I_{GA15} \\ 0 & m+m_{a3} & 0 \\ I_{GA15} & 0 & I_{GA55} \end{bmatrix} \begin{bmatrix} \ddot{x} \\ \ddot{z} \\ \ddot{\theta} \end{bmatrix} + \begin{bmatrix} B_{11} & 0 & B_{15} \\ B_{31} & B_{33} & B_{35} \\ B_{15} & B_{53} & B_{55} \end{bmatrix} \begin{bmatrix} \dot{x} \\ \dot{z} \\ \dot{\theta} \end{bmatrix} + \begin{bmatrix} K_{11} & 0 & K_{15} \\ K_{31} & K_{33} & K_{35} \\ K_{15} & K_{53} & K_{55} \end{bmatrix} \begin{bmatrix} x \\ z \\ \theta \end{bmatrix} = F$$

## Fender fictitious mass motion [1]

$$m_* \cdot \ddot{z}_{M_C} = F_{fz} - F_{Kz} - F_{bz}$$

## SIMULINK State-space model [1]

$$\dot{x} = Ax + f(x) + Ev$$

## Results : significant wave height (Hs) and wave length berthing limitations

| Wave length / boat length | CAT CTV 27m [2] 2017 benchmark | CAT CTV 27m [3] 2022 linear calc. (pseudo-kinetic friction) | CAT CTV 27m 2024 non linear calc. (either kinetic or static friction) |
|---|---|---|---|
| 0<br>1,76<br>1,80<br>1,85<br>14 | 2m Hs | 2m Hs | 2m Hs |
| | 1,5m Hs | 1,5m Hs | 1,5m Hs |

**Conclusion: Non-linear calc. meets wavelength boarding criteria from ref. [2] (benchmark) and [3] (linear calc.) with respectively -3% and +2% accuracy. Next step : irregular wave analysis.**

Références: [1] AUESTAD Oyvind, GRAVDAHL Jan, PEREZ Tristan, SORENSEN Asgeir, & ESPELAND Trygve (2015): "Boarding control system for improved accessibility to off-shore wind turbines: Full-scale testing", Control Engineering Practice, 45, pp. 207-218
[2] Nere G. Skomedal and Trygve Halvorsen Espeland (2017) Cost-effective Surface Effect Ships for Offshore Wind, FAST 2017 conference, Nantes, France. ESNA AS, KRISTIANSAND S, NORWAY, 7.
[3] Laurent BARTHELEMY (2022): "Optimizing Berthing of Crew Transfer Vessels against Floating Wind Turbines – A Comparative Study of Various Floater Geometries", ECOLE NATIONALE SUP. MARITIME, NANTES, FR, SEANERGY 2022 conference, Le Havre, FR.