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SeaFEM - Validation Case 13

Cable attached to a circular rotating plate

SeaFEM

Version
15.1.0

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1 Problem description

The present case aims to simulate a dynamic cable linked to a pulling system that consits on a disc of radius r = 0.2 m. rotating at a fixed constant velocity. In particular two different rotation periods are used for the simulations (T_{r1} = 1.25 s., T_{r2} = 3.5 s.). The geometrical and parametric configuration of the present analysis reproduces the model proposed by Lindhal and Sjoberg [1] and aims to stablish a quantitative comparison against their experimental results. The characteristics of the cable are summarized in the following table.

Cable properties	
Cable length (L)	33.0 m
Apparent weight per unit length (w)	0.18 N/m
Diameter (D)	$2x10^{-3}$ m^2
Rigidity (E·A)	$1x10^{4}$ N

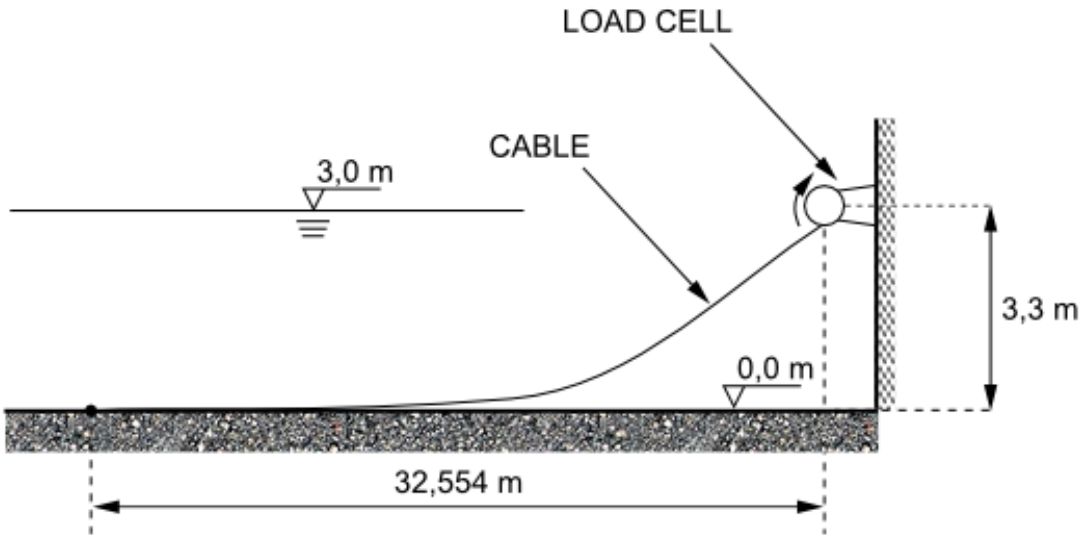
In order to reproduce the effect of the pulling rotation disc, the following functions are used to impose the corresponding movement to the upper end of the cable.

$$x(t) = 0.2 \tanh(0.5t)\left(\cos\left(-\frac{2\pi}{T_r}t + \delta\right) - \cos(\delta)\right),$$

$$y(t) = 0.0 ,$$

$$z(t) = 0.2 \tanh(0.5t)\left(\mathrm{sen}\left(-\frac{2\pi}{T_r}t + \delta\right) - \cos(\delta)\right).$$

A schema of the problem under consideration is shown in the figure below.


LOAD CELL
CABLE
3,0 m
3,3 m
0,0 m
32,554 m

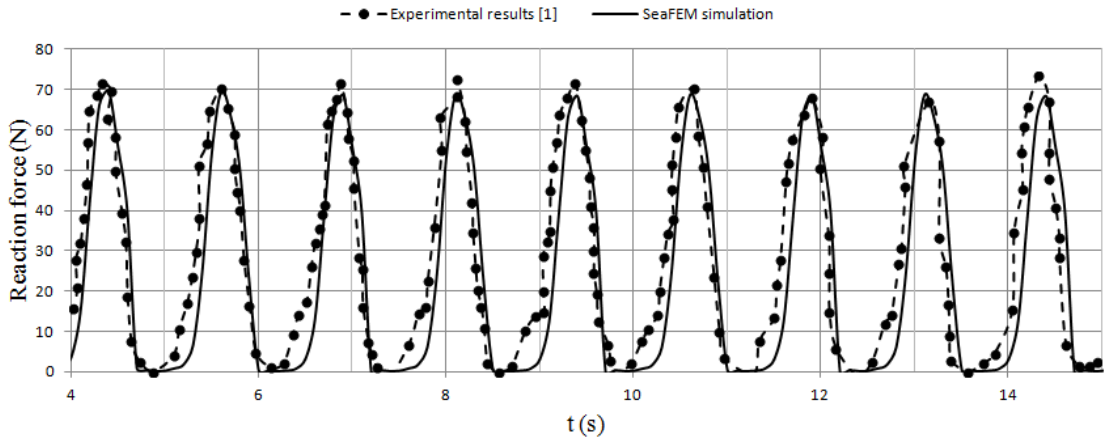
2 Mesh

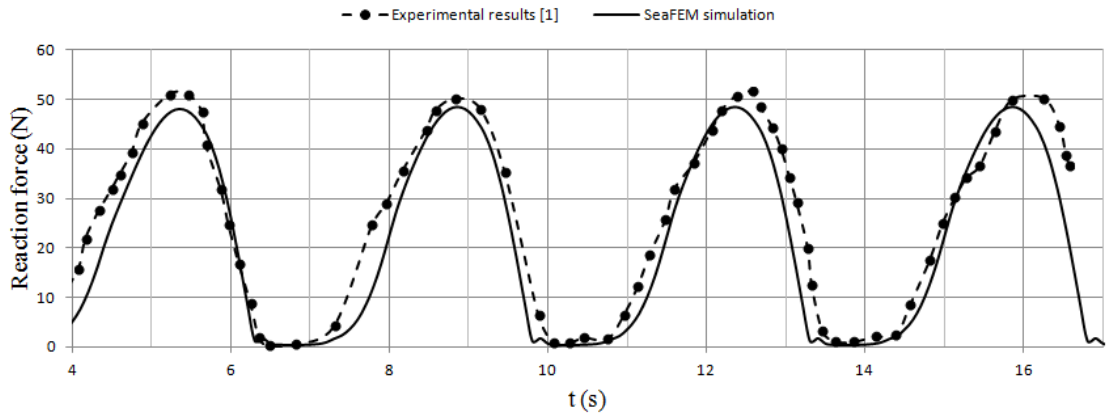
For the present analysis the cable was discretized using 50 linear elements.

The simulations are conducted using a time increment $\delta t = 0.001$ s. and maintained up to a total simulation time $t = 60$ s.

3 Results

For the sake of validation, the reaction forces at the end of the mooring line are compared against the experimental results in [1]. Such a comparison is shown in the figures below for the two different rotation periods under analysis.





4 Appendix

The following code describes the tcl script used for the present analysis. TdynTcl_CreateMooring procedure is used to create the dynamic cable and to link it to the pulling system. Additionally, the numerical calculation of the diffraction-radiation problem is deactivated. First, the tcl script concerning the case with rotation period T = 1.25 s. is presented. Next, the tcl script for the case with period T = 3.5 s.

```
proc TdynTcl_CreateMooring { } {
    # Validation Case 3
    # Time step suggested for simulation: 0.001 sec.

    # values: Body Type_Mooring Xe[3] Xi [3] w L A S E n_elements damp_ratio_1 damp_ratio_2
    set seg1 [create_mooring_segment 1 6 0.0 0.0 0.3 -32.554 0.0 -3.0 0.18 33.0 3.14159e-6 3.1831e9 1 50 0.05 0.05]
    # values: Gk Gc Gu Ms Md Cd Cf Cm alpha_bs bci
    TdynTcl_Configure_Mooring_Segment 1 3.0e6 1.0 0.3 0.0 0.0 0.5 2.5 3.8 0.05 1

    set phi -2.25

    # T = 1.25 sec
    set fun1 [::mather::create_function waves "0.2*tanh(0.5*t)*(cos(-(2*pi/1.25)*t+($phi))-cos($phi));"]
    set fun2 [::mather::create_function waves "0.0;"]
    set fun3 [::mather::create_function waves "0.2*tanh(0.5*t)*(sin(-(2*pi/1.25)*t+($phi))-sin($phi));"]

    TdynTcl_Set_Mooring_Displacement $seg1 $fun1 $fun2 $fun3 0
    TdynTcl_Configure_Analysis Solve_Dif_Rad 0
    TdynTcl_Message "TdynTcl_CreateMooringLine finished!!!" notice
}

proc TdynTcl_CreateMooring { } {
    # Validation Case 3
    # Time step suggested for simulation: 0.001 sec.

    # values: Body Type_Mooring Xe[3] Xi [3] w L A E S n_elements damp_ratio_1
```

```
damp_ratio_2
    set seg1 [create_mooring_segment 1 6 0.0 0.0 0.3 -32.554 0.0 -3.0 0.18 33.0 3.14159e-6 3.1831e9 1 50 0.025 0.025]
    # values: Gk Gc Gu Ms Md Cd Cf Cm alpha_bs bci
    TdynTcl_Configure_Mooring_Segment 1 3.0e6 1.0 0.3 0.0 0.0 0.5 2.5 3.8 0.01 1

    set phi -2.25

    # T = 3.5 sec
    set fun1 [::mather::create_function waves "0.2*tanh(0.5*t)*(cos(-(2*pi/3.5)*t+($phi))-cos($phi));"]
    set fun2 [::mather::create_function waves "0.0;"]
    set fun3 [::mather::create_function waves "0.2*tanh(0.5*t)*(sin(-(2*pi/3.5)*t+($phi))-sin($phi));"]

    TdynTcl_Set_Mooring_Displacement $seg1 $fun1 $fun2 $fun3 0
    TdynTcl_Configure_Analysis Solve_Dif_Rad 0
    TdynTcl_Message "TdynTcl_CreateMooringLine finished!!!" notice
}
```

5 References

[1] Lindahl L., and Sjoberg A. Dynamic analysis of mooring cables. Second international symposium on ocean engineering and ship handling. (1983).

6 Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018