SESAM EXAMPLE

Sima 15MW Wind Turbine Model

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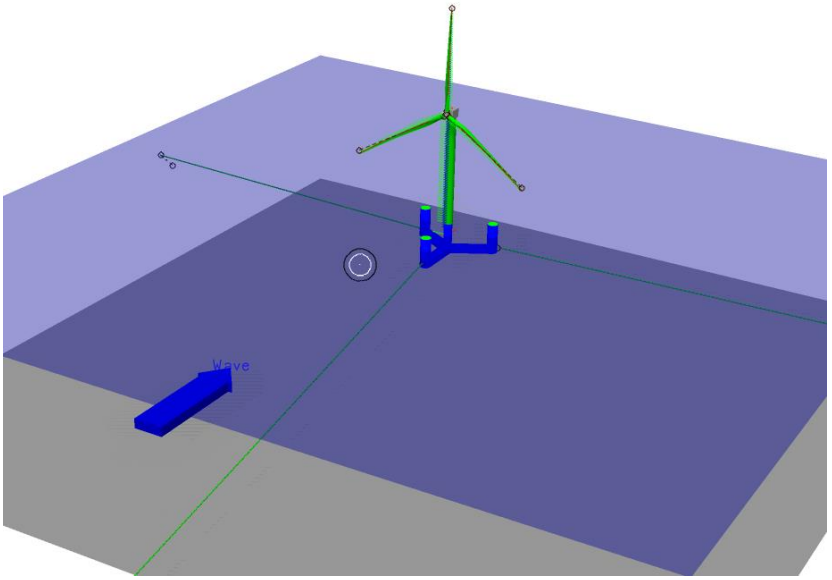
1 Introduction

This document is aimed to introduce a 15MW floating offshore wind turbine model (FOWT), that is created in Sesam Sima.

This model is basing on IEA Wind 15MW FOWT model. The rotor nacelle assembly (RNA) in the model refers to the IEA Wind 15-Megawatt Offshore Reference Wind Turbine described in [1]. The floating foundation and mooring system refer to the UMaine VolturnUS-S Reference Platform described in [2]. Some modifications are made.



The example demonstrates how to use Sima to create a 15MW FOWT model, which is only used to show the software features, not for any real project purposes.

The example is based on Sima v4.6-04, a stask file SimaExample15MW.stask can be downloaded from Sesam Portal.

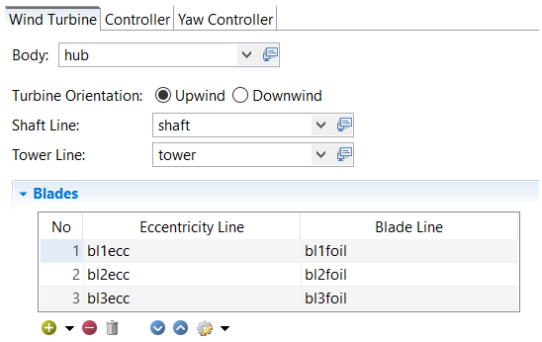
2 15MW FOWT MODEL

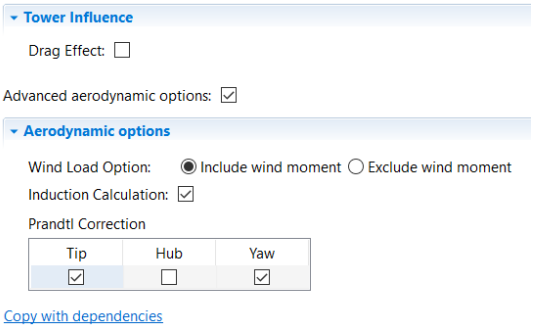
The model is a Semi-submersible-type structure, it is composed of four main parts, the wind turbine, the tower, the foundation, and the mooring system.

2.1 Wind turbine

The wind turbine in the model is defined under the Slender System folder. The following definitions are given here.

- Orientation of the turbine (upwind/downwind).
- Line names associated with blades, tower and shaft.
- Aerodynamic options for blades and tower.
- Name of the body that "measures" the wind at hub height.
- Specification of the controller.





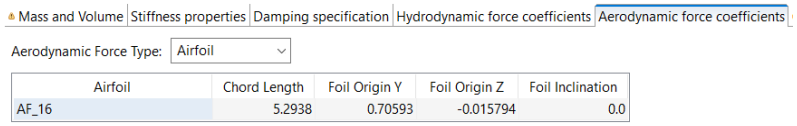
2.1.1 Wind turbine components

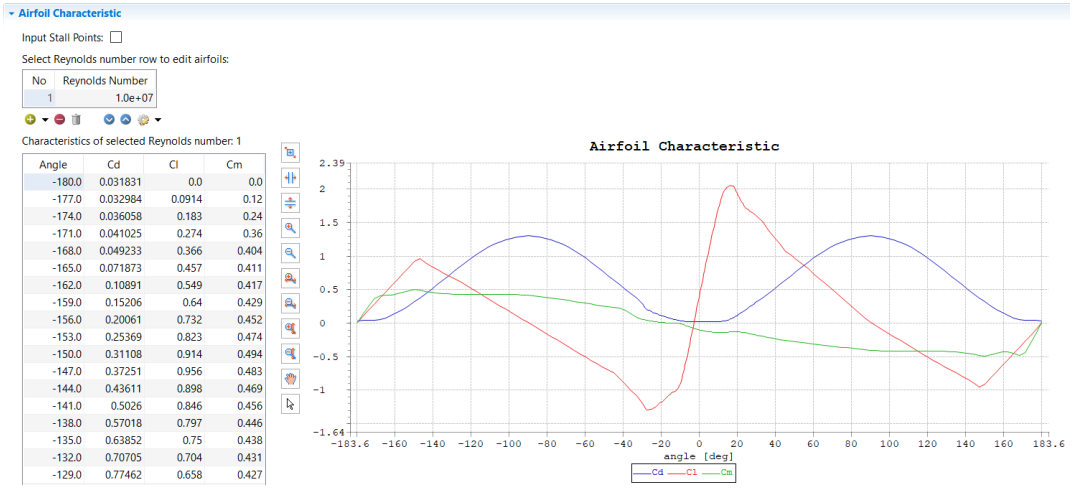
Riflex lines are defined for the wind turbine components.

- Blades (3 lines)
- Eccentricity lines (3 lines, connect the shaft and the blade root, also used for pitch control)
- Shaft (1 line, one rotating part and one non-rotating part, joined with a flex joint for the electrical torque)
- Tower (1 line)

2.1.2 Airfoils

The blade consists of 50 segments in the line type. The airfoil properties are created for the lift- drag- and moment coefficients on the blade cross sections. In this example, Re = 1.0e+07 is used as a typical Reynolds number.





2.1.3 Hub

The hub is modeled as a Simo body with Structural mass and wind force coefficients. The mass of the hub in this 15MW FOWT model is 69360kg. The wind force coefficients are used to catch the wind velocity at the hub height.

2.1.4 Nacelle

The nacelle is modeled as a Simo body with Structural mass of 675000kg. The center of gravity is eccentric. The position

of CoG and the moments of inertia are all referring to the body origin.

2.1.5 Control system

This example uses ROSCO version 2.6.0 controller. To align with the Sima requirements, LP-filtered wind speed measured at hub height is used for wind speed estimator.

2.2 Foundation

The Semi-submersible foundation is created as a Simo 6-DoF body. The hydrodynamic coefficients are pre-calculated using BEM, slender elements can be considered by generalised Morison equation. Additional damping matrices, wind/current force coefficients, etc., can be created if needed.

2.3 Mooring system

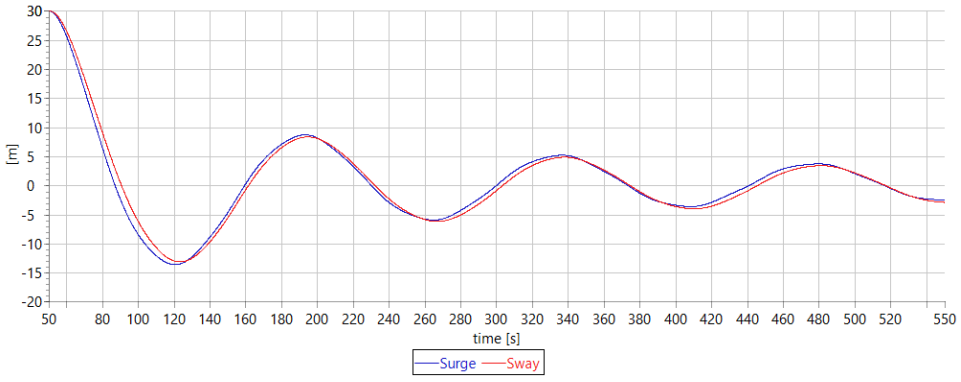
The mooring system consists of 3 mooring lines, which are defined as Riflex lines, using bar elements with only axial stiffness. The dynamic effects can be considered by added mass and drag coefficients.

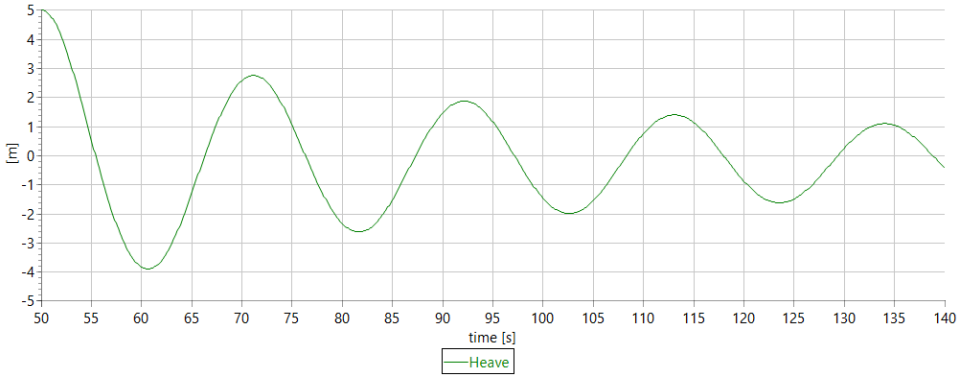
3 Analysis results

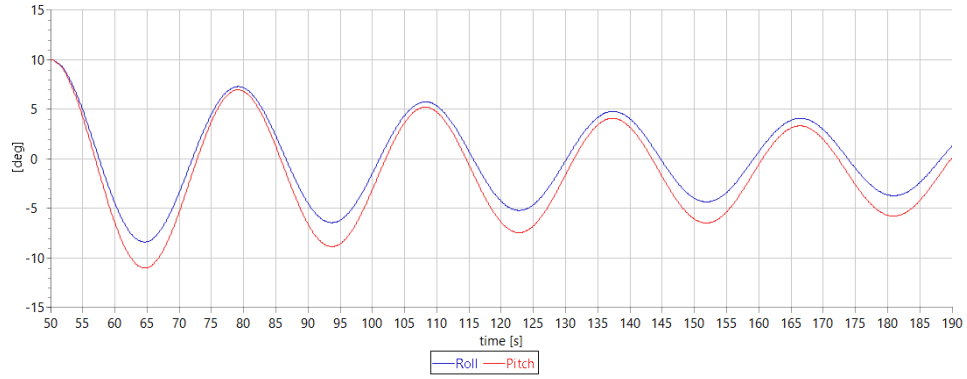
3.1 Decay tests

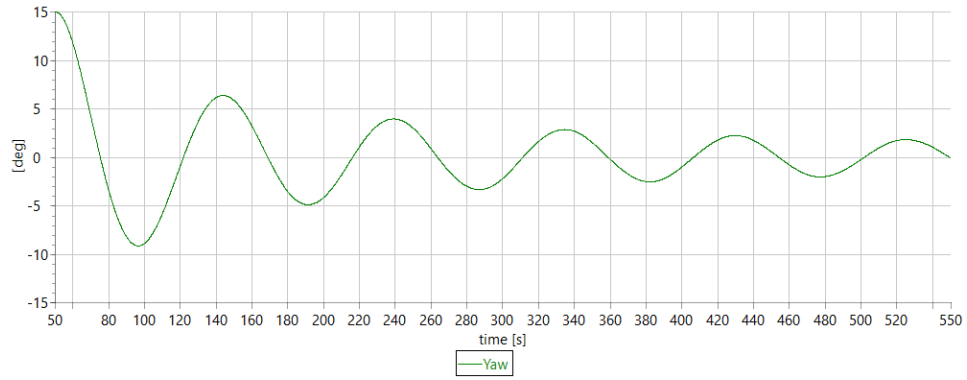
The decay tests can be simulated with an offset at initial of the dynamic analysis and then release the model. The mooring system is considered.

The motions of the origin of Semi foundation in 6-DoF decay tests with mooring lines are shown as below.





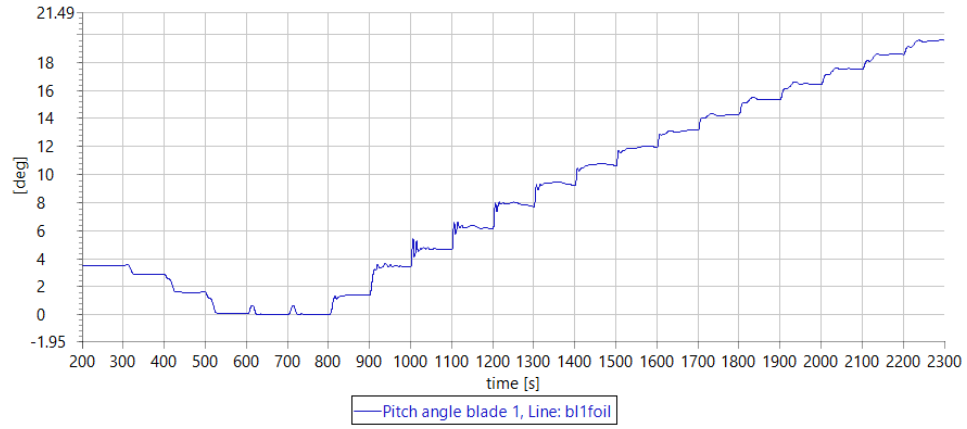


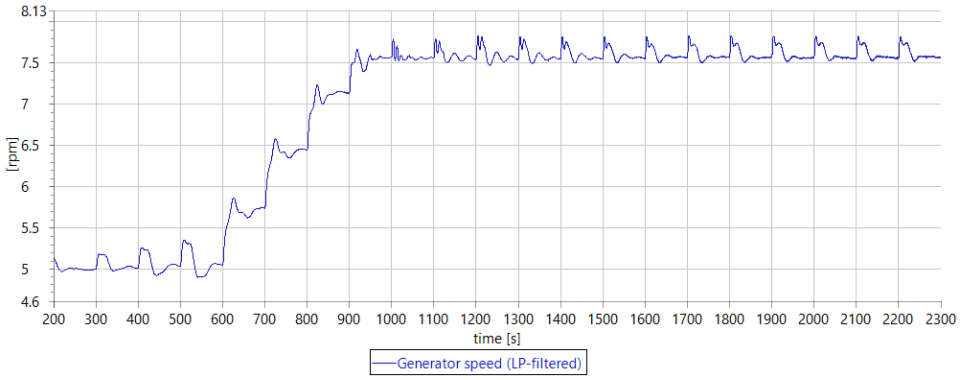


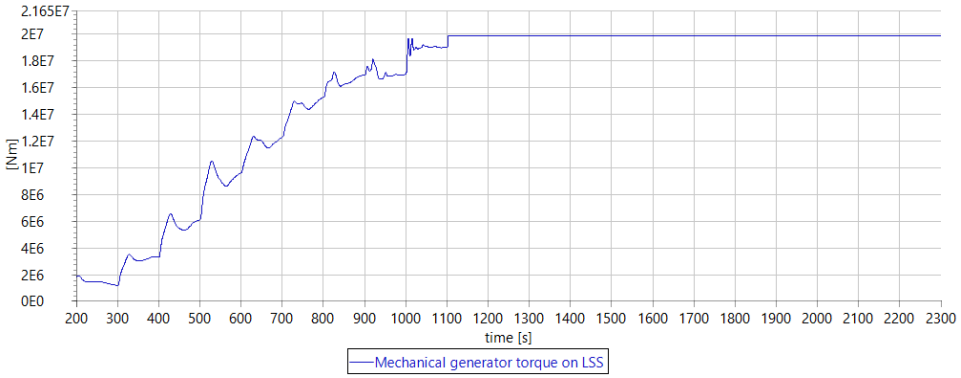
3.2 Step wind speed analysis

A step wind speed condition is defined using a wind time series file, with the wind speed steps ranging from 4 to 24m/s, the step is 1m/s and the time increment is 100s. An additional duration of 200s with constant 4m/s wind speed is added at the start to help the analysis get stable.

The settings of Static offset increments and Wind turbine faults defined in last section should be removed.







4 Future work

This is the first version of Sima 15MW FOWT model. The model data and results will be further verified with the reference documents. DLC conditions will be calculated.

5 Reference

[1] Gaertner, Evan, Rinker, Jennifer, Sethuraman, Latha, Zahle, Frederik, Anderson, Benjamin, Barter, Garrett E, Abbas, Nikhar J, Meng, Fanzhong, Bortolotti, Pietro, Skrzypinski, Witold, Scott, George N, Feil, Roland, Bredmose, Henrik, Dykes, Katherine, Shields, Matthew, Allen, Christopher, and Viselli, Anthony. IEA Wind TCP Task 37: Definition of the IEA 15-Megawatt Offshore Reference Wind Turbine. United States: N. p., 2020. Web. doi:10.2172/1603478.

[2] Allen, Christopher, Viscelli, Anthony, Dagher, Habib, Goupee, Andrew, Gaertner, Evan, Abbas, Nikhar, Hall, Matthew, and Barter, Garrett. Definition of the UMaine VolturnUS-S Reference Platform Developed for the IEA Wind 15-Megawatt Offshore Reference Wind Turbine. United States: N. p., 2020. Web. doi:10.2172/1660012.

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