SIMA EXAMPLE

Wet Towing of a Spar Wind Turbine

Valid from Sima version 4.6

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Wet Towing of a Spar Wind Turbine

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1 INTRODUCTION

This document introduces an example of a spar-type floating offshore wind turbine wet-towed by three towboats in a relatively calm wave and wind condition. In this example, a common towing configuration with a leading towboat and two supporting towboats as shown in Figure 1-1 is used. The functionality of dynamic positioning (DP) system equipped to the towboats is also showcased.

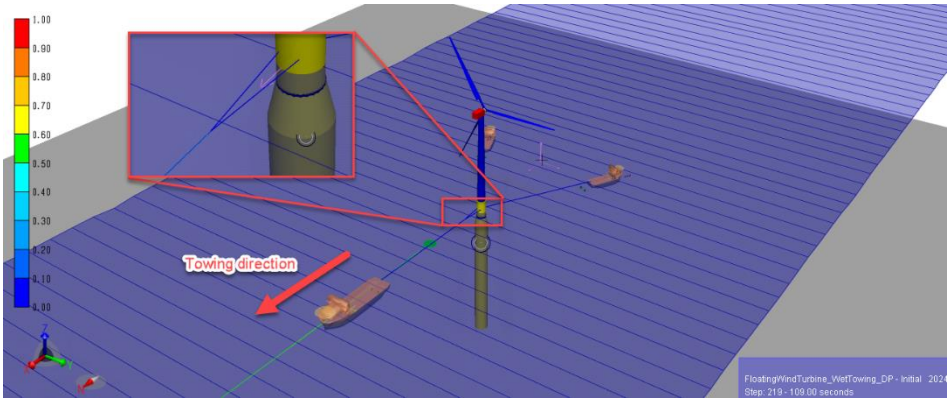

Figure 1-1 The 3D view of the model

To open the example model, create a new Sima workspace and import the **"wettowing_spar.stask"** file (*File > Import > SIMA > SIMA Task Archive (stask)*).

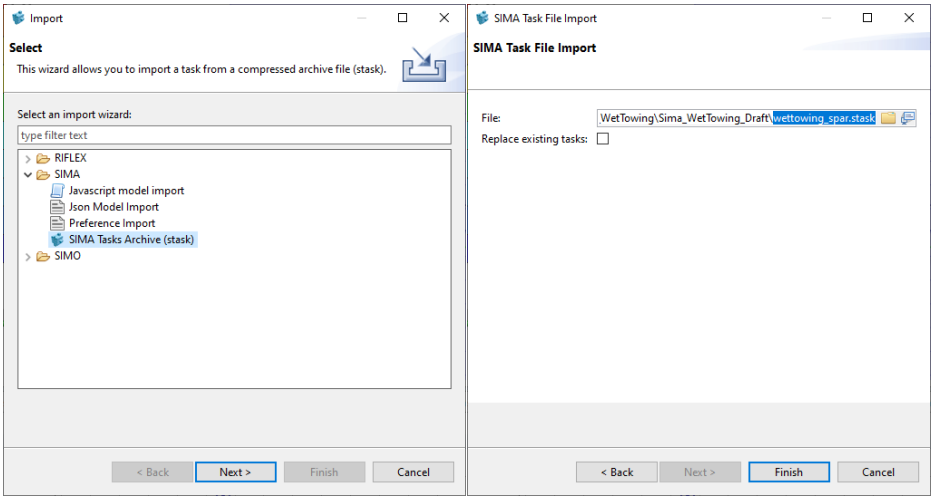

Figure 1-2 Importing the stask file

This action will import two Riflex tasks (models):

- Towboats as Simo bodies with DP system waypoints (**FloatingWindTurbine_WetTowing_Waypoints**)
- Towboats fixed in place and towing speed modelled as current (**FloatingWindTurbine_WetTowing_Fixed**)

Note: Any parameters in this example are for practice purpose only and should under no circumstance used directly for real projects.

2 ABOUT THE MODELS

2.1 Towboats as Simo bodies with DP system waypoints

This model consists of four floating objects: the floating offshore wind turbine (**WT**), the left towboat (**TowboatL**), the right towboat (**TowboatR**), and the leading towboat (**TowboatA**). There are three towlines connecting the towboats to the floating offshore wind turbine: one connected to the left towboat (**TowlineL**), one to the right towboat (**TowlineR**), and another to the leading towboat (**TowlineA**). These objects are shown in Figure 2-1.

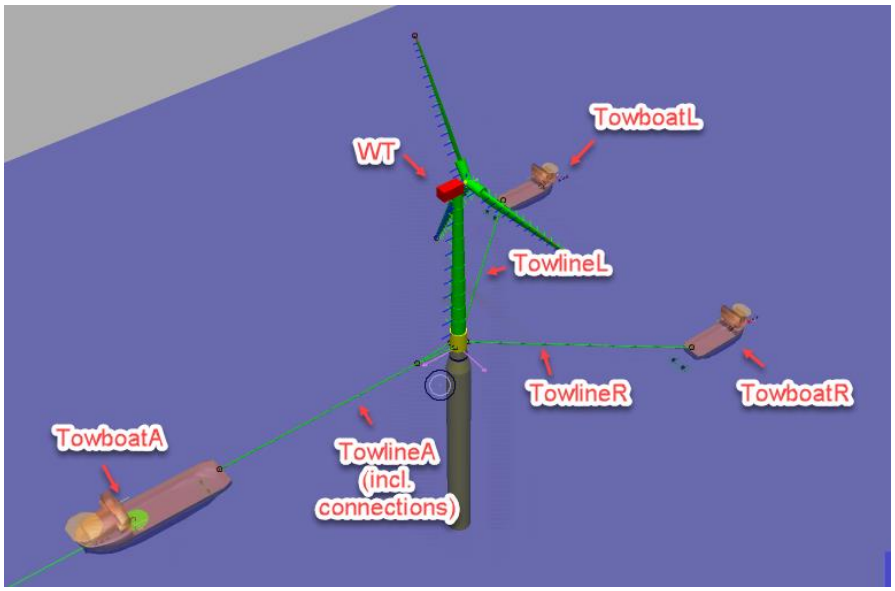

Figure 2-1 The objects in the model

The floating offshore wind turbine is based on NREL 5-MW wind turbine on a spar-type floater. The wind turbine is set to a parked condition (blade pitch is set to 90 degrees). For more information about the wind turbine model, refer to the built-in Sima example that can be accessed from menu bar *Help* > *Examples* > *Wind Turbine* > *Floating Wind Turbine*.

The towboats are each equipped with a *DP system* consisted of 2 variable-direction main thrusters and 3 fixed-direction smaller ones. For **TowboatL** and **TowboatR**, the *DP system* is set to maintain position in respect to **TowboatA**. The *DP system*'s waypoint parameter for **TowboatL** and **TowboatR** is shown in Figure 2-2.

Reference type: Body Relative

Reference position

X Ref	Y Ref	Dir Ref
-274.44	-66.657	200.0

Body relative reference:

Relative Body	Xy Relative	Dir Relative	Reference Cut Off
TowboatA	☑	☐	20.0

Figure 2-2 Left and right towboats' positioning control system parameters

TowboatA is set to follow a waypoint which tells it to go forward 600 m with a constant speed of 1.0 m/s starting from 5 s time stamp as shown in Figure 2-3. The relative position of the towboats to the wind turbine are controlled by the double variables in the *Variables* folder.

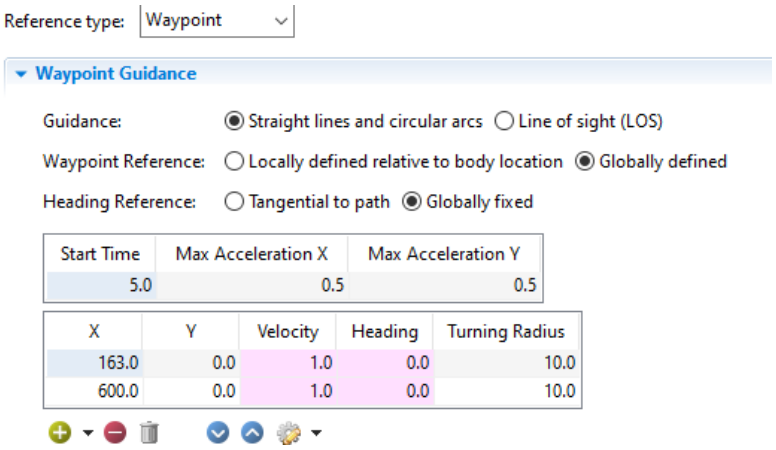

Figure 2-3 Leading towboat's positioning control system parameters

2.2 Towboats fixed in place and towing speed modelled as current

For longer analysis, it might be more practical to keep the towboats at fixed positions while applying sea current to model the towing speed as shown in Figure 2-4 instead. Albeit very small, the wind speed is also adjusted to consider the increased wind drag from the towing speed.

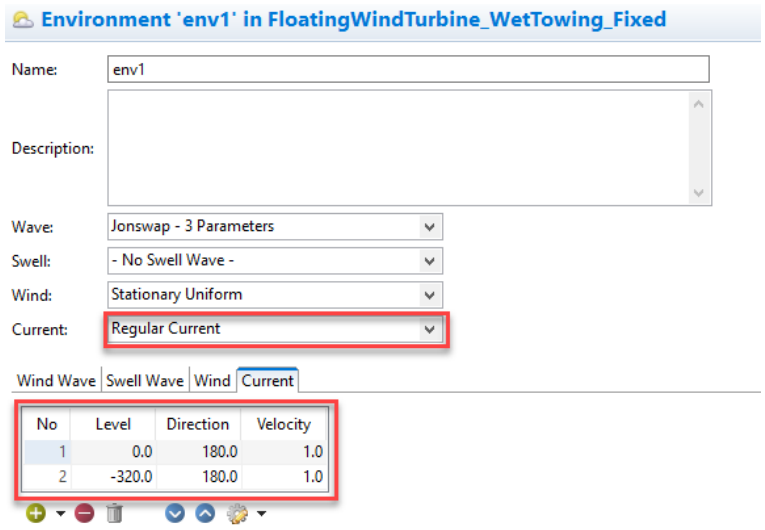

Figure 2-4 The current parameters in the environmental condition

In this example, the reference type of the *DP systems* is set to fixed points around the **WT**. Note that the leading towboat is positioned a bit further forward to adjust the pretension.

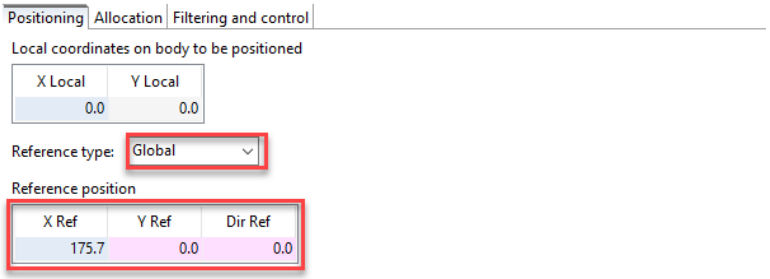

Figure 2-5 Leading towboat's positioning control system parameters set to a fixed position

3 RESULTS

To execute the simulation, run the dynamic analysis in the Initial condition. Some results are already set to be stored in the model. For example, users can see the total X-velocity of the spar body as shown in Figure 3-1. Another result of interest is the tension of the towlines. The tension of the leading towline is shown in Figure 3-2 for the 'Waypoint' model, and Figure 3-3 for the 'Fixed' model.

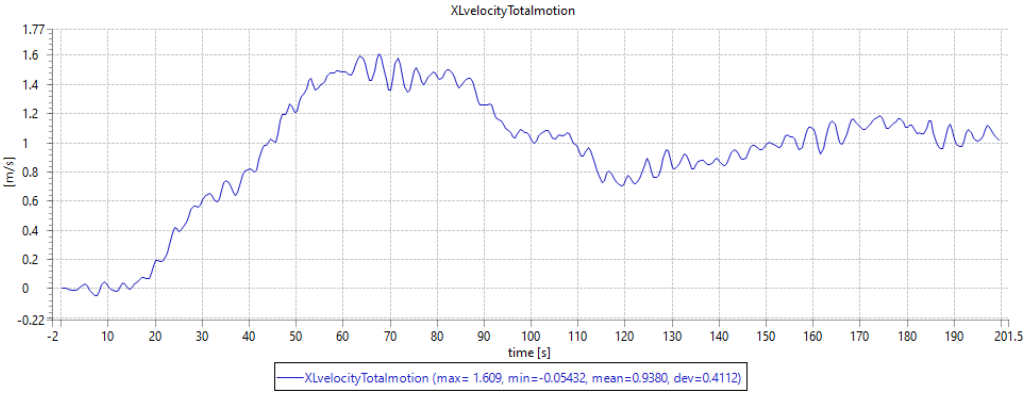

Figure 3-1 X-velocity of the spar floater (WT_Spar/Local Velocity/XLvelocityTotalmotion) in 'Waypoint' model

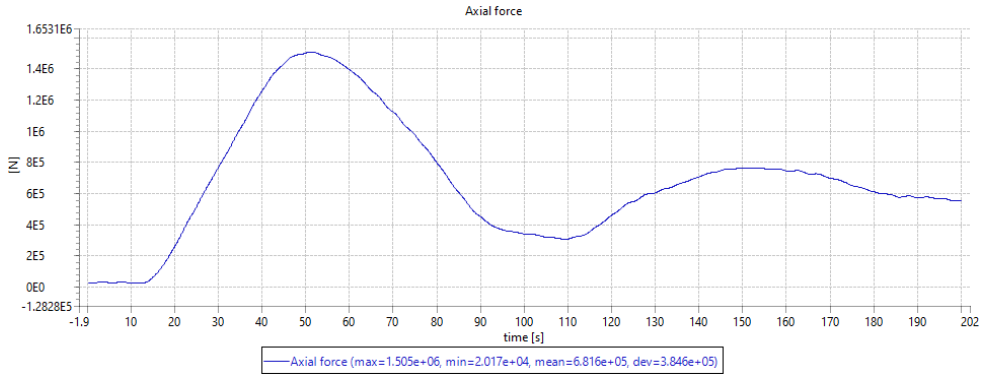

Figure 3-2 Tension of TowlineA (TowlineA_ln/segment_1/element_40/Axial Force) in 'Waypoint' model

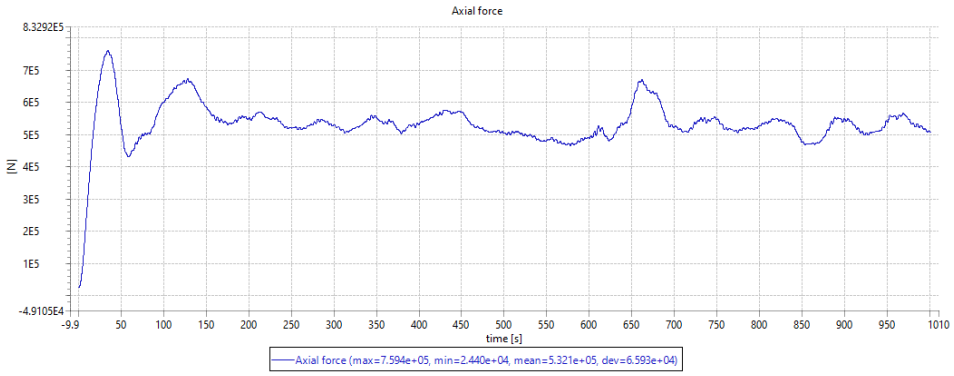

Figure 3-3 Tension of TowlineA (TowlineA_ln/segment_1/element_40/Axial Force) in 'Fixed' model

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