SIMA EXAMPLE

Air Gap Analysis of Tension-Leg Platform

Valid from Sima version 4.6

Sima Example

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1 Introduction

This document introduces an example model of a tension-leg platform with defined diffracted wave fields and air gap check points, as shown in Figure 1-1. There are 10 risers and 12 tendons connected to the TLP. Two air gap check points are defined with one above the body origin of the TLP and another one close to the column of the TLP.

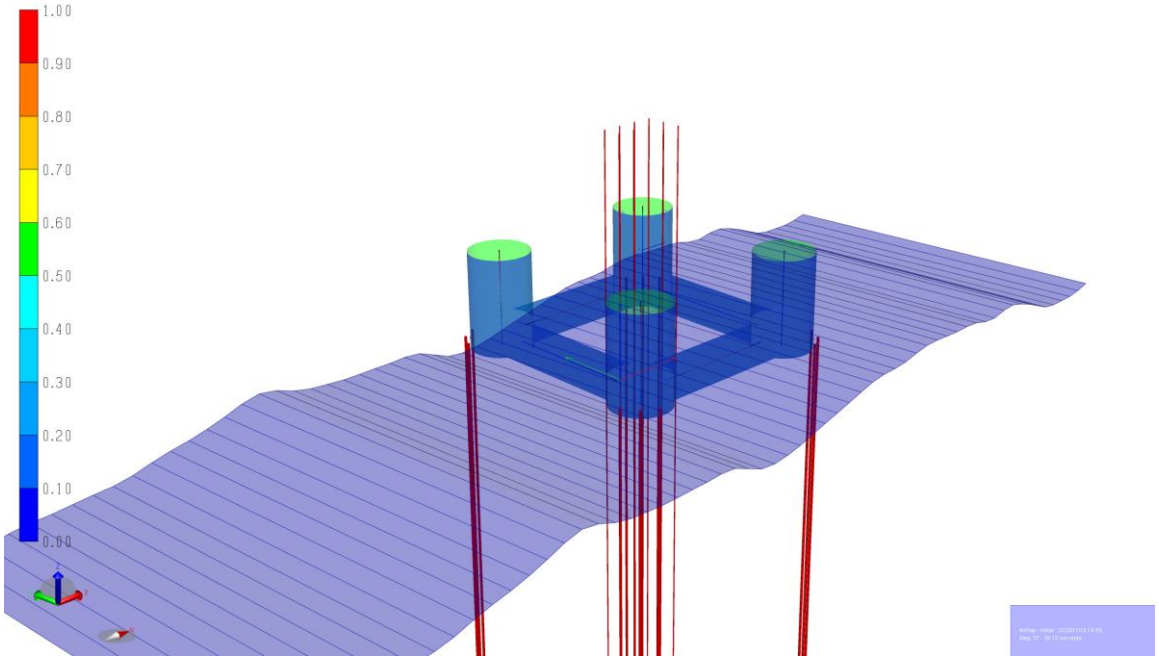

Figure 1-1 TLP air gap dynamic analysis model's 3D view

To open the example model, create a new Sima workspace and import the "AirGap_TLP.stask" file (*File → Import → Sima → Sima Task Archive (.stask)*). This will import a Riflex coupled analysis model containing the example.

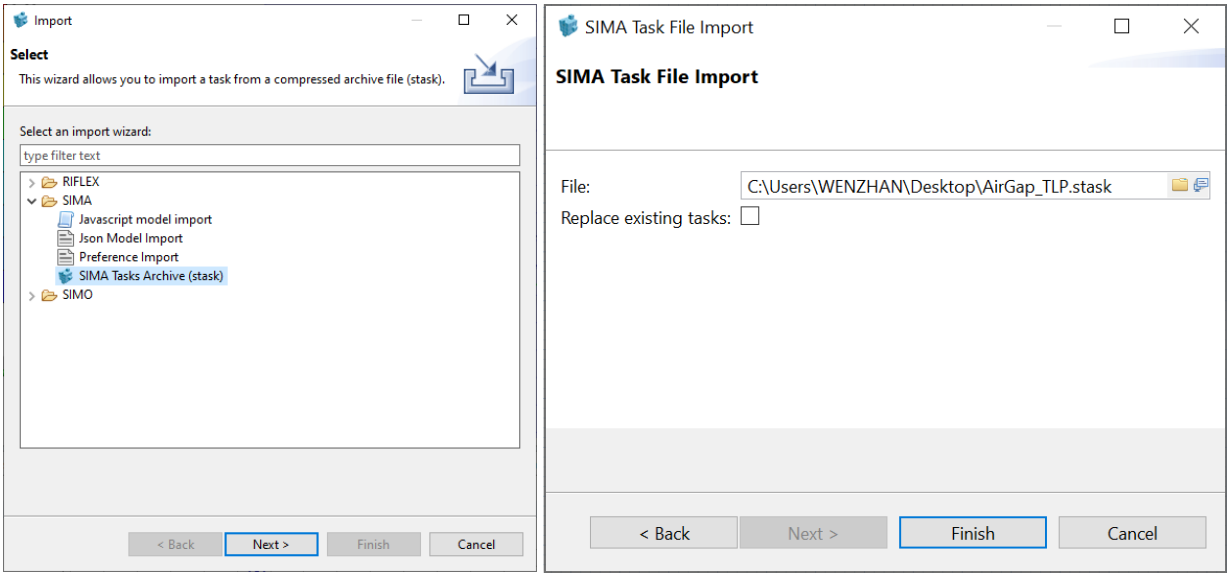

Figure 1-2 Importing the .stask file

2 About the Model

The model consists of several objects: the tension-leg platform (**TLP**), the risers (**Riser#**) and the tendons (**Tendon#**). There are also defined diffracted wave field points (**TLPWaveField Point#,** calculated and imported from WADAM) and TLP air gap check points (**TLP_AG#**). The bolded words in the parentheses are the name of the objects. The objects are shown in Figure 2-1.

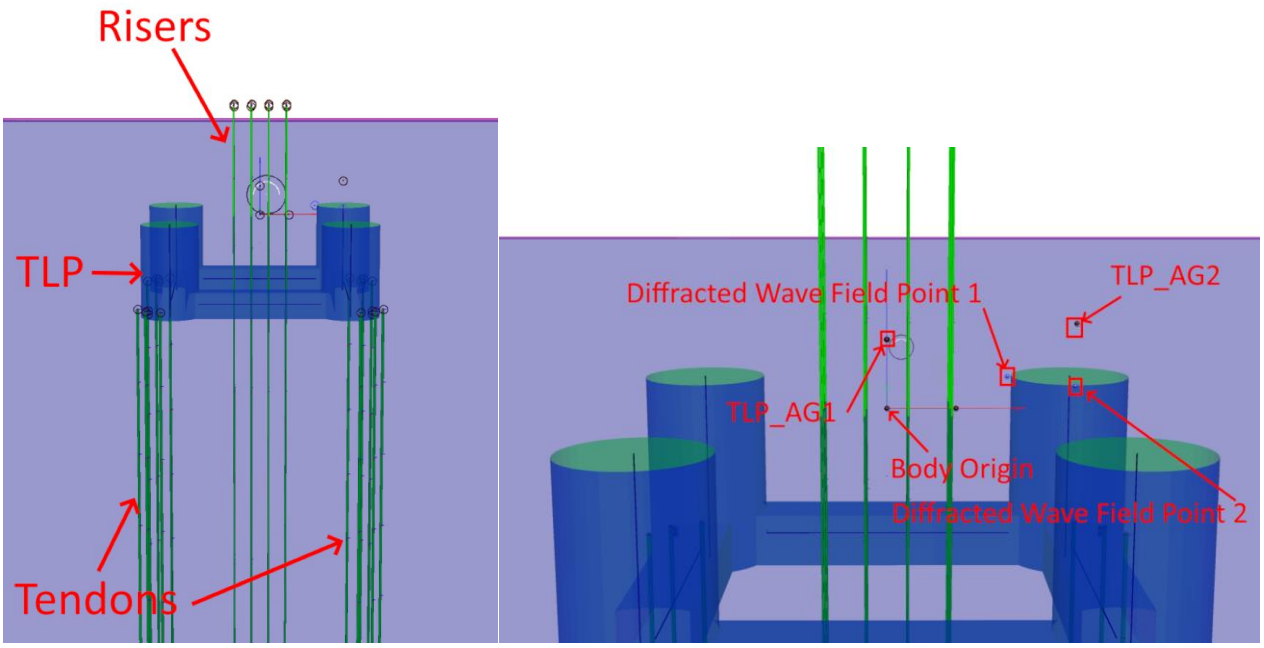

Figure 2-1 The objects in the model

The TLP is about 35500 tons with four columns and pontoons that connected to 12 tendons and 10 risers. The water depth is 1828 m. Jonswap wave spectrum is used with Hs = 12.19 m and Tp = 14.0 s, NPD wind with average velocity = 41.13 m/s and depth dependent current with 1.292 m/s surface velocity are applied as environmental loads.

The air gap is calculated as the distance between the vertical position of the air gap check point that defined by the user and the wave surface elevation that underneath the defined check point. In this coupled analysis. Vessel SIF file may include radiation/diffraction surface elevation transfer functions in off body points. The effect of diffracted/radiated waves may be considered when doing air gap calculation in Sima. In that case, the option for off body kinematics has to be used when running HydroD / WADAM. The settings and diffracted wave transfer function is shown in Figure 2-2. You can find more information here:

https://sima.sintef.no/doc/4.6.0/simo/theory/force_models.html#tm_force_body_forces_diffracted

https://sima.sintef.no/doc/4.6.0/simo/userguide/body_data_specification.html#ug_body_diffracted

Including diffraction/radiation effects in free surface elevation by HydroD:

1. Effect of diffracted/radiated waves may be considered when doing air gap calculation in Sima. In that case, the option for off body kinematics has to be used when running HydroD.
2. It is suggested to specify wave headings close to, or preferably equal to, the headings corresponding to the vessel static equilibrium position in Sima.
3. Specify off body positions at SWL. Either a mesh or single points at z=0 may be specified. Note that the off body points must be given in the HydroD global frame of reference. This e.g. means that for a point on the vessel in the model coordinate system, the user manually has to account for trim and heel when the coordinates are specified in HydroD.

4. Run Wadam. For all off body points, diffracted/radiated free surface elevation transfer functions for all wave headings will be written to SIF file.

5. In cases where the moorings have an important effect on the WF motion, anchor/TLP elements should be used, or stiffness matrix should be modified directly.

Some considerations:

1. The air gap point in the vessel frame of reference has radiation/diffraction surface elevation transfer function calculated for a number of wave headings.

2. For the vessel in static equilibrium position, i.e. horizontal offset and yaw motion, surface elevation time series is pre-calculated by Simo in the air gap point. If the main wave heading is not coincident with any of the transfer function wave headings, Simo will perform an interpolation in between values for the two adjacent transfer function wave headings.

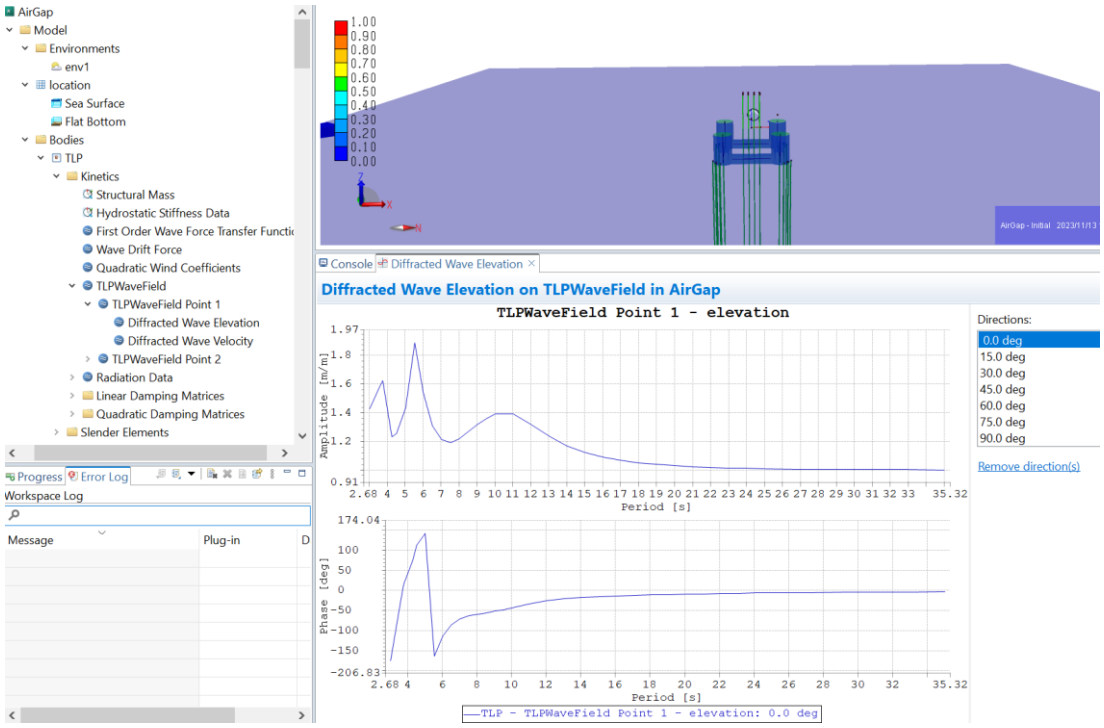

Figure 2-2 Diffracted wave field (transfer function) in the model

3 Results

To run the simulation, run the dynamic analysis in the Initial condition. The simulation length has been set to 100s with 0.1s time step just for demonstrate purpose, in your own analysis, you may set longer simulation length. Some results are already set to be stored in the model. For example, the displacements of TLP_AG1 and TLP_AG2, the force response on some of the risers and tendons and the 3D visualization of dynamic analysis etc.

At each time step, the actual vertical position of the air gap check points on the vessel are evaluated. The air gap is then obtained as the vertical distance between the air gap point on the vessel and the precalculated free surface elevation.

The Z position (global) of TLP_AG2 and Wave Field Point 2 surface elevation are shown in Figure 3-1. Surface elevation at Wave Field Point 2 has take diffracted waves into consideration. From the plot below, you can find that the around 60s and 73s, there will be negative air gap, which means water on deck. The data here can be exported and

then the air gap can be calculated.

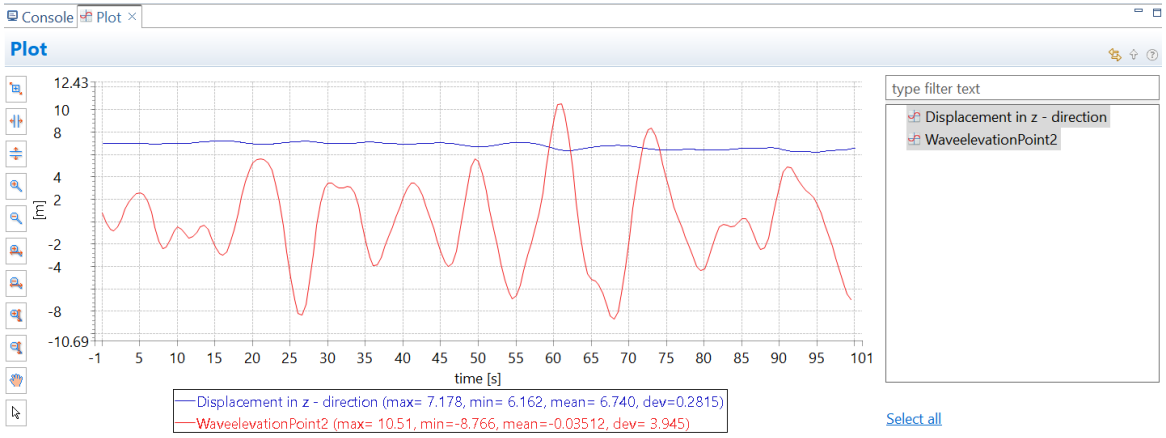

Figure 3-1 Vertical displacement of TLP_AG2 and wave elevation of Wave Field Point 2

You may check other results as well, such as tension on the tendons as shown in Figure 3-2 and the global position of the TLP.

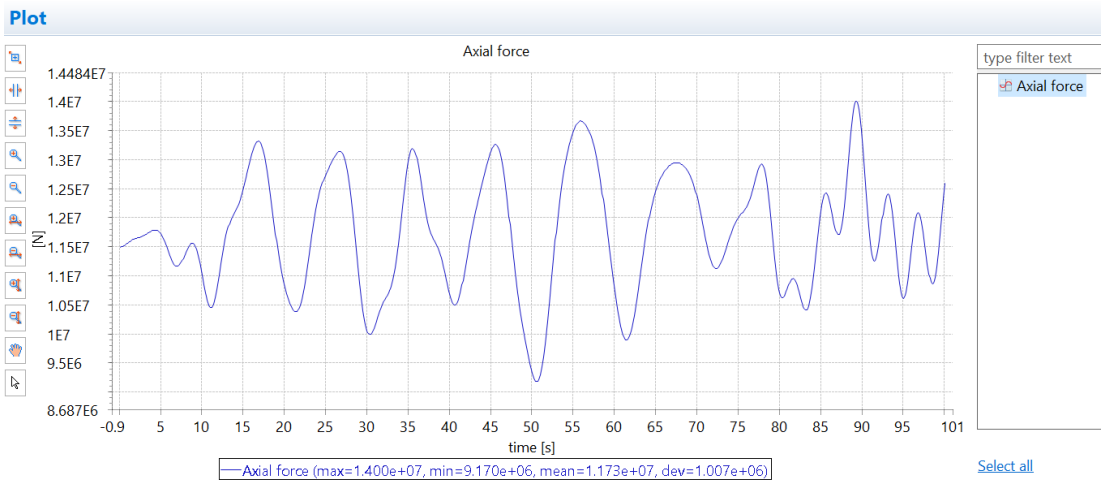

Figure 3-2 Tension on one of the tendons of the TLP

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