

Introduction to Hydrodynamic Analysis with Ansys Aqwa

Module 04: Aqwa Basics – Hydrodynamic Diffraction

Release 2021 R2



Aqwa Workbench Basics

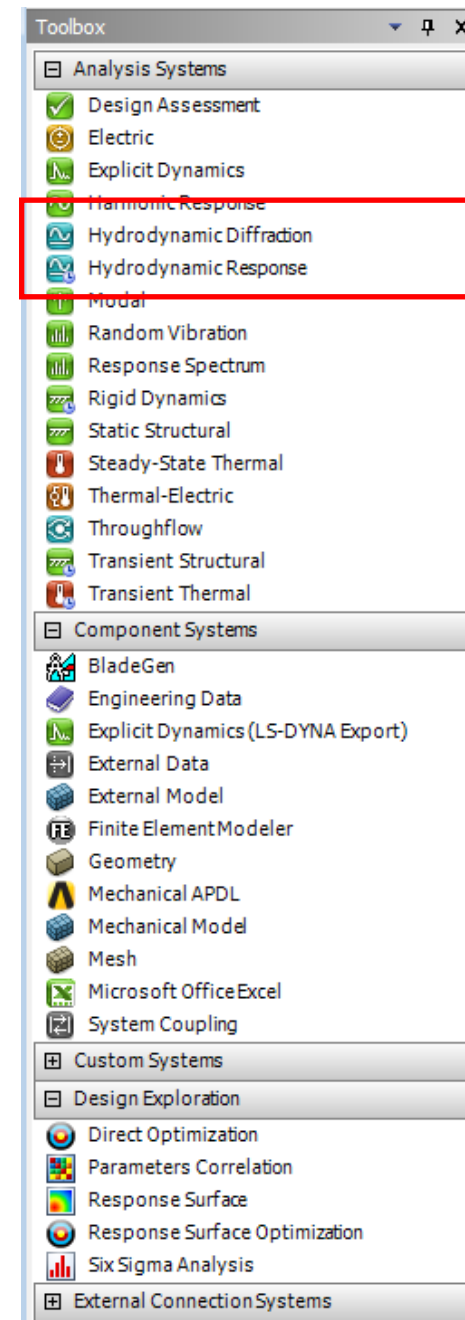
There are two Aqwa Workbench systems available:

- **Hydrodynamic Diffraction (HD)**

- Analysis of a freely-floating structure or group of structures
- Regular waves at defined frequencies analysed over defined wave directions
- Provides the hydrodynamic coefficients for use in subsequent Hydrodynamic Response systems

- **Hydrodynamic Response (HR)**

- Environment defined by wind, current, regular or irregular waves
- Connections defined as cables, joints, fenders or tethers/risers
- Estimation of equilibrium position, static and dynamic stability
- Frequency domain statistical analysis
- Time domain analysis



Aqwa Workbench Basics

Aqwa Workbench shares common conventions with other Workbench products, where appropriate.

The basic interface consists of a number of areas:

- Toolbars
- Analysis tree
- Details panel
- Graphical model representation and results presentation or textual results

/ Aqwa Workbench Basics

Standard Workbench Toolbars



View manipulation

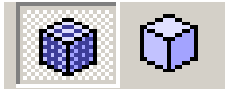


Selection control



File shortcuts

Aqwa Specific Toolbars



Show/Hide element boundaries



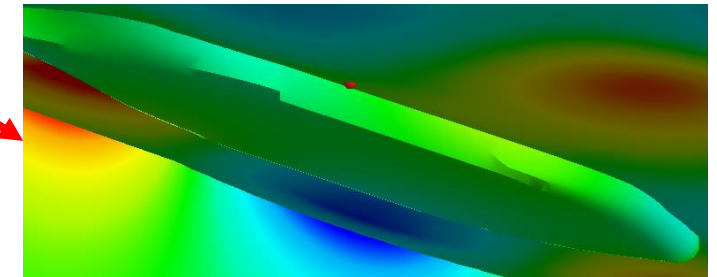
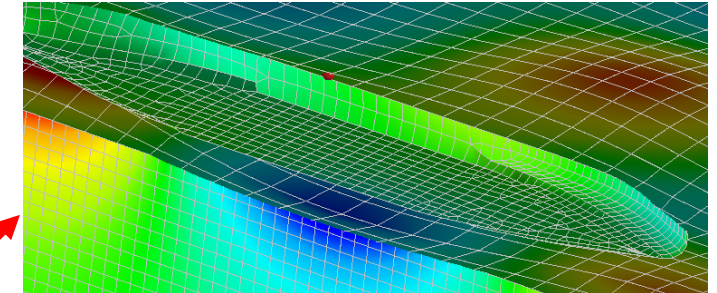
Turn on/off object highlighting



Show/Hide Seabed and Water Surface



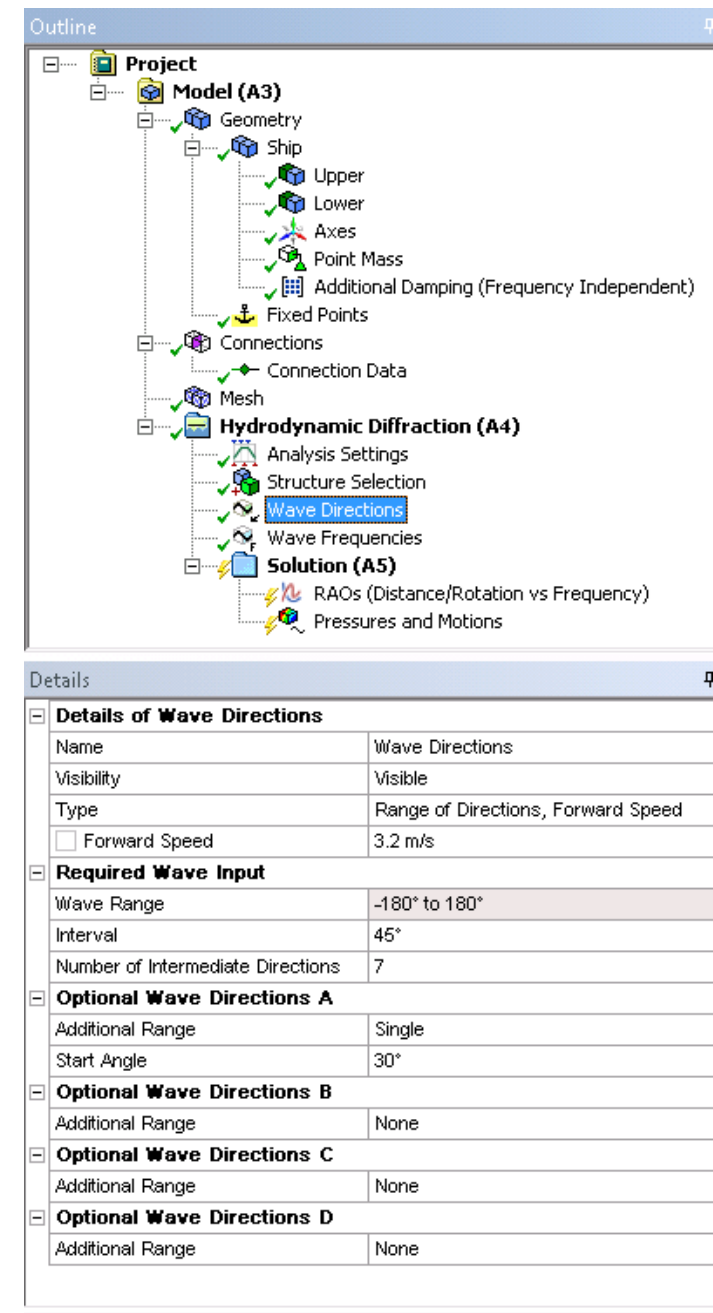
Solve shortcuts



Aqwa Workbench Basics

Tree view

- As with other Workbench applications, the Outline tree and Details panel are used to define the organization of the simulation requirements and associated data.
- As a tree object is selected the data related to that object will be presented in the Details panel.



/ Aqwa Workbench Basics

Tree view

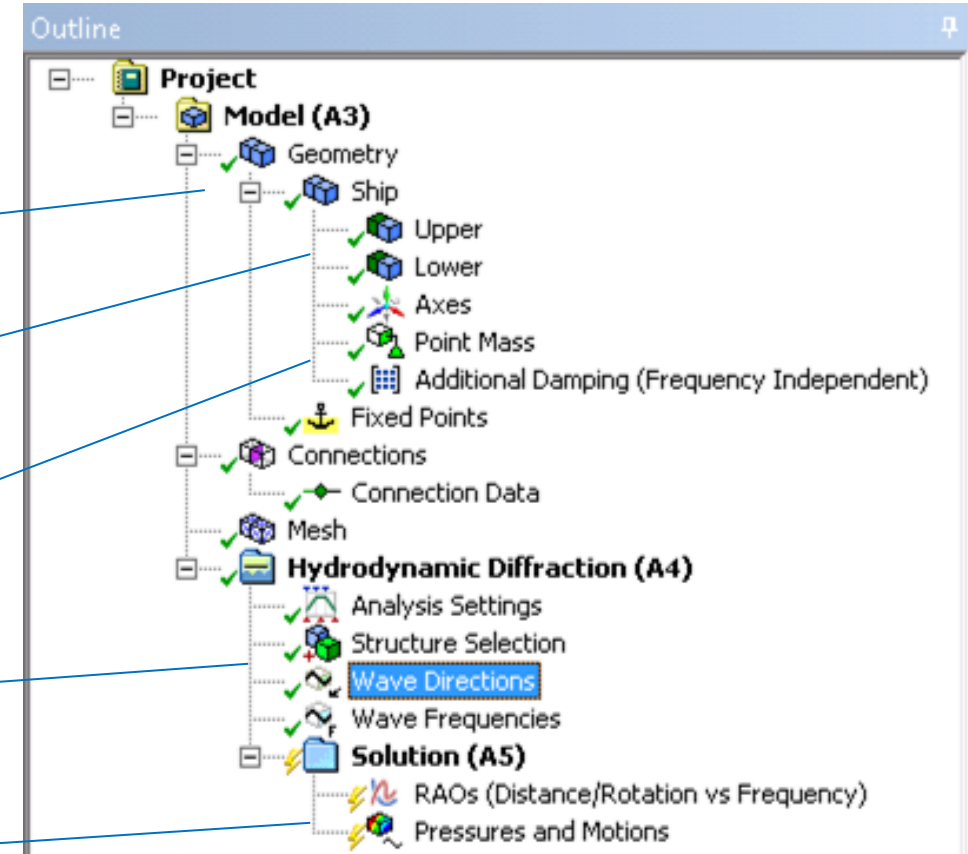
Each vessel/structure is associated with a Part – in this case “Ship”

Bodies make up a Part. These are defined in the CAD system (e.g. SpaceClaim)

Some Aqwa-specific geometry-based objects may be added directly within Aqwa Workbench

Objects that define the additional data required for undertaking the Hydrodynamic analysis

Results objects that may be added as required. When selected, they change the view in the main Graphics window




Object states:

 Object excluded

 Object included, and up-to-date

 Object invalid or requires attention

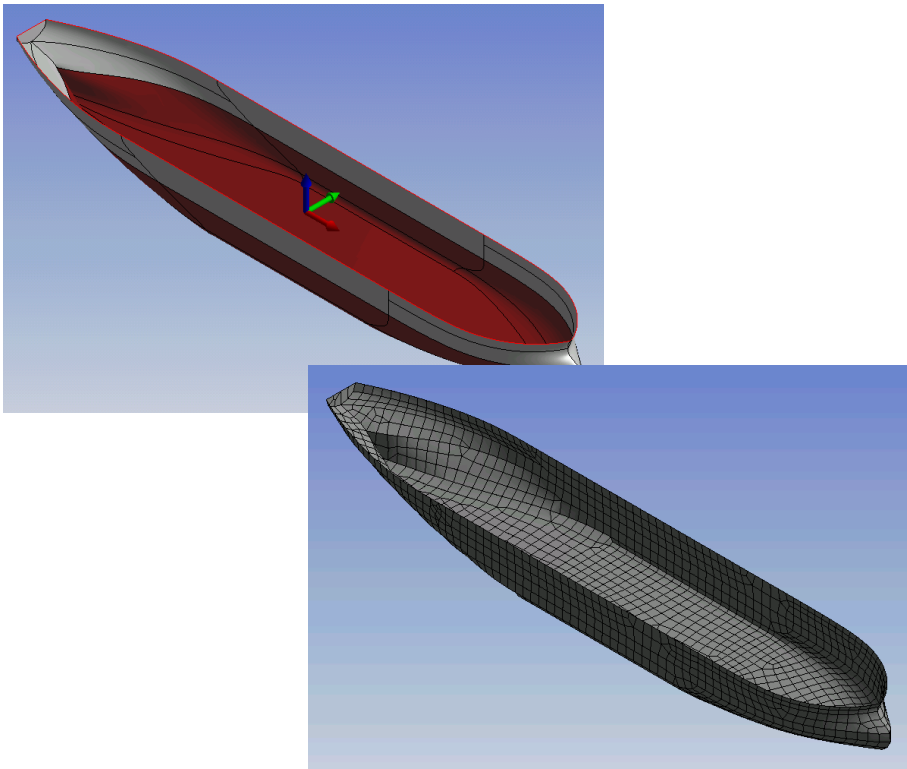
 Object requires update

 Object is up-to-date for the Hydrostatics solve

Aqwa Workbench Basics

The main graphical area responds to what is selected in the object tree

- If geometry or mesh-based information is selected, this will show a visualization of the information requested on the Geometry tab.
- If textual results are requested (such as Hydrostatic information) these will be shown on the Properties tab.



ANSYS Mechanical Enterprise PrepPost

Outline

- Project
 - Model (A3)
 - Geometry
 - Ship
 - Upper
 - Lower
 - Axes
 - Point Mass
 - Additional Damping (Frequency Independent)
 - Fixed Points
 - Connections
 - Connection Data
 - Mesh
 - Hydrodynamic Diffraction (A4)
 - Analysis Settings
 - Structure Selection
 - Wave Directions
 - Wave Frequencies
 - Solution (A5)
 - RAOs (Distance/Rotation vs Frequency)
 - Hydrostatic

Details

Details of Hydrostatic

Name	Hydrostatic
Structure	Ship

Graphical Representation

Show Centre of Gravity	Yes
Show Centre of Buoyancy	Yes
Show Centre of Floation	Yes

Results

Actual Displaced Volume	43993.219 m ³
Metacentric Height GMX	9.2645416 m
Out of Balance Force/Weight, Fz	7.2364e-7

Hydrostatic Results

Structure: Ship

Hydrostatic Stiffness

Centre of Gravity (CoG) Position:

X:	108.9753 m	Y:	-2.2207e-3 m	Z:	0. m
----	------------	----	--------------	----	------

Heave (Z): 60457844 N/m
Roll (RX): 134081.81 N.m/m
Pitch (RY): 1.4396e8 N.m/m

Hydrostatic Displacement Properties

Actual Volumetric Displacement: 43993.219 m³
Equivalent Volumetric Displacement: 43993.219 m³

Centre of Buoyancy (CoB) Position:

X:	108.97536 m	Y:	-2.2208e-3 m	Z:	-3.8297486 m
----	-------------	----	--------------	----	--------------

Out of Balance Forces/Weight: FX: 1.8075e-8 FY: 2.3956e-8 FZ: 7.2364e-7
Out of Balance Moments/Weight: MX: -3.9291e-8 MY: -6.0104e-5 MZ: 9.786e-7 m

Cut Water Plane Properties

Cut Water Plane Area: 6014.6187 m²
Centre of Floation: X: 106.59414 m Y: -2.9264e-6 m
Principal 2nd Moments of Area: X: 576039.94 m⁴ Y: 14653266 m⁴
Angle between Principal X Axis and Global X Axis: -1.2243e-5°

Small Angle Stability Parameters

CoG to CoB (BG): 3.8297486 m
Metacentric Heights (GMX/GMY): 9.2645416 m 329.25037 m
CoB to Metacentre (BMX/BMY): 13.09429 m 333.08011 m
Restoring Moments (MX/MY): 71504200 N.m° 2.54117e9 N.m°

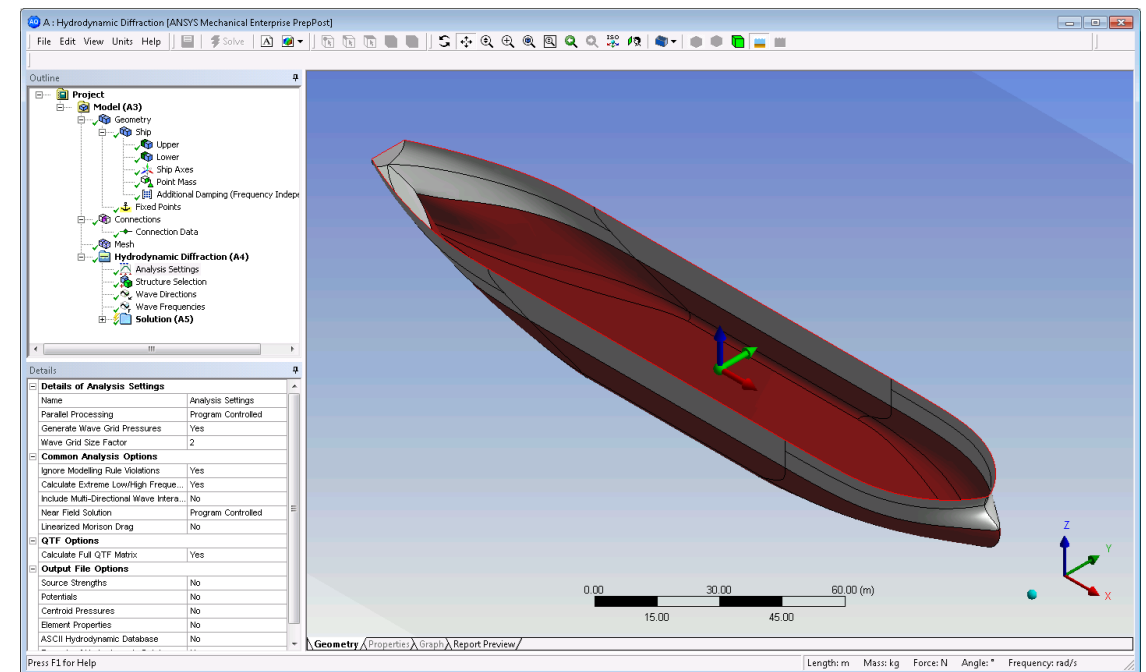
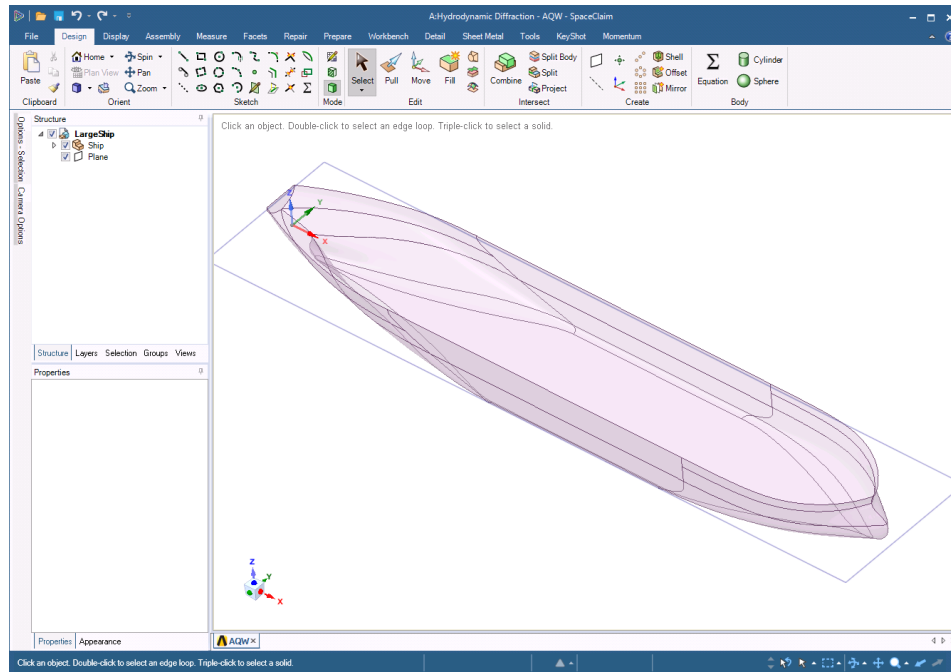
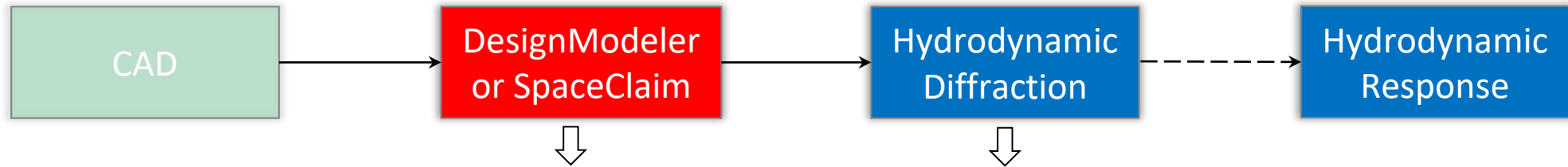
with respect to Principal Axes

Geometry Properties Graph Report Preview

Press F1 for Help

Length: m Mass: kg Force: N Angle: ° Frequency: rad/s

The Hydrodynamic Diffraction Simulation Process



Creating Geometry for Import to Aqwa Workbench

Aqwa Workbench imports geometry from SpaceClaim or DesignModeler, which is used to create the majority of the Aqwa model (using either the generation capabilities of SpaceClaim/DesignModeler directly, or importing from an external CAD system)

- Hull definition
- Morison elements

For Aqwa-specific geometry this is input via the Aqwa Workbench user interface

- Point masses/buoyancies
- Disc elements

The main requirements for an Aqwa Workbench analysis can be summarized as follows:

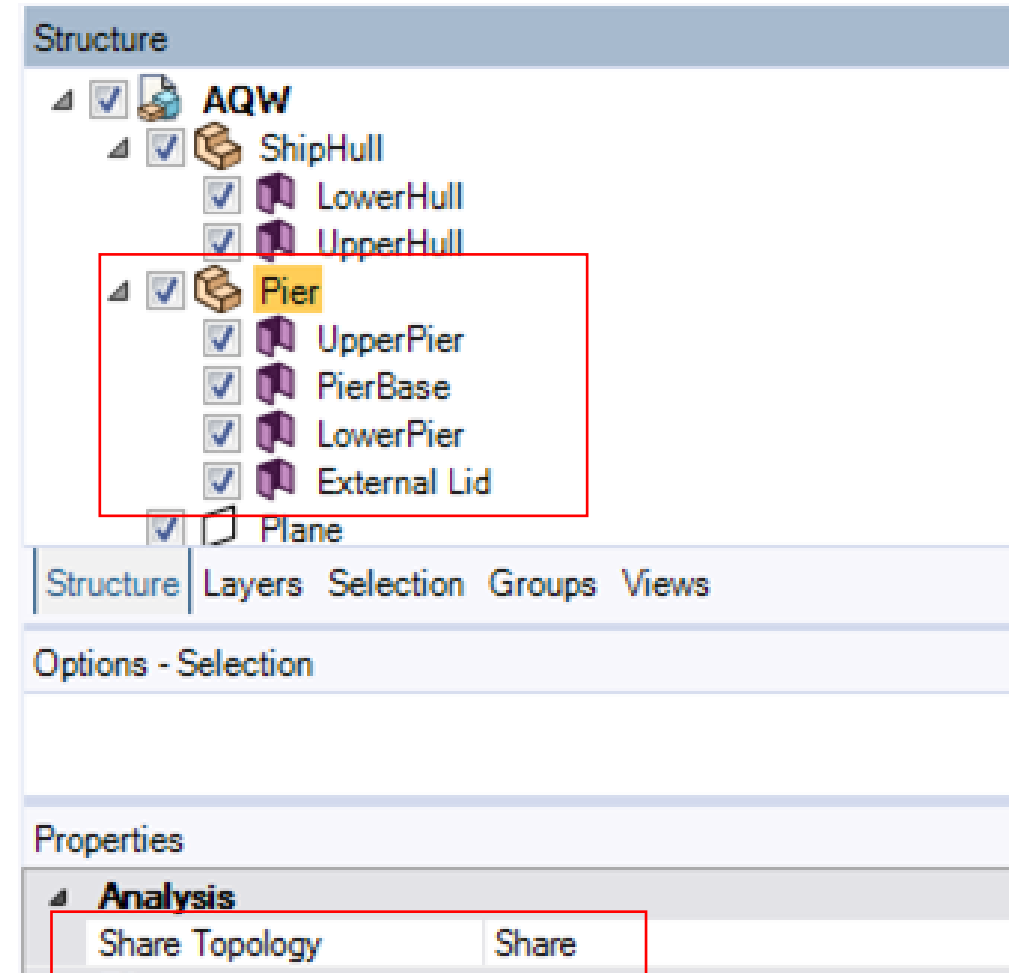
- Each vessel (or structure) is represented as a component with **shared topology**, as generated in SpaceClaim/DesignModeler.
- Only a surface definition of the panel model is required, there is no thickness associated with the hull(s)
- The panel model must be such that the mesh is up to the waterline.
- The water line defines the global vertical origin for the analysis.

/ Vessel/Structure Definition

Each vessel or structure may consist of one or more bodies, but must be contained within a component with shared topology.

Here we have a ship and a pier:

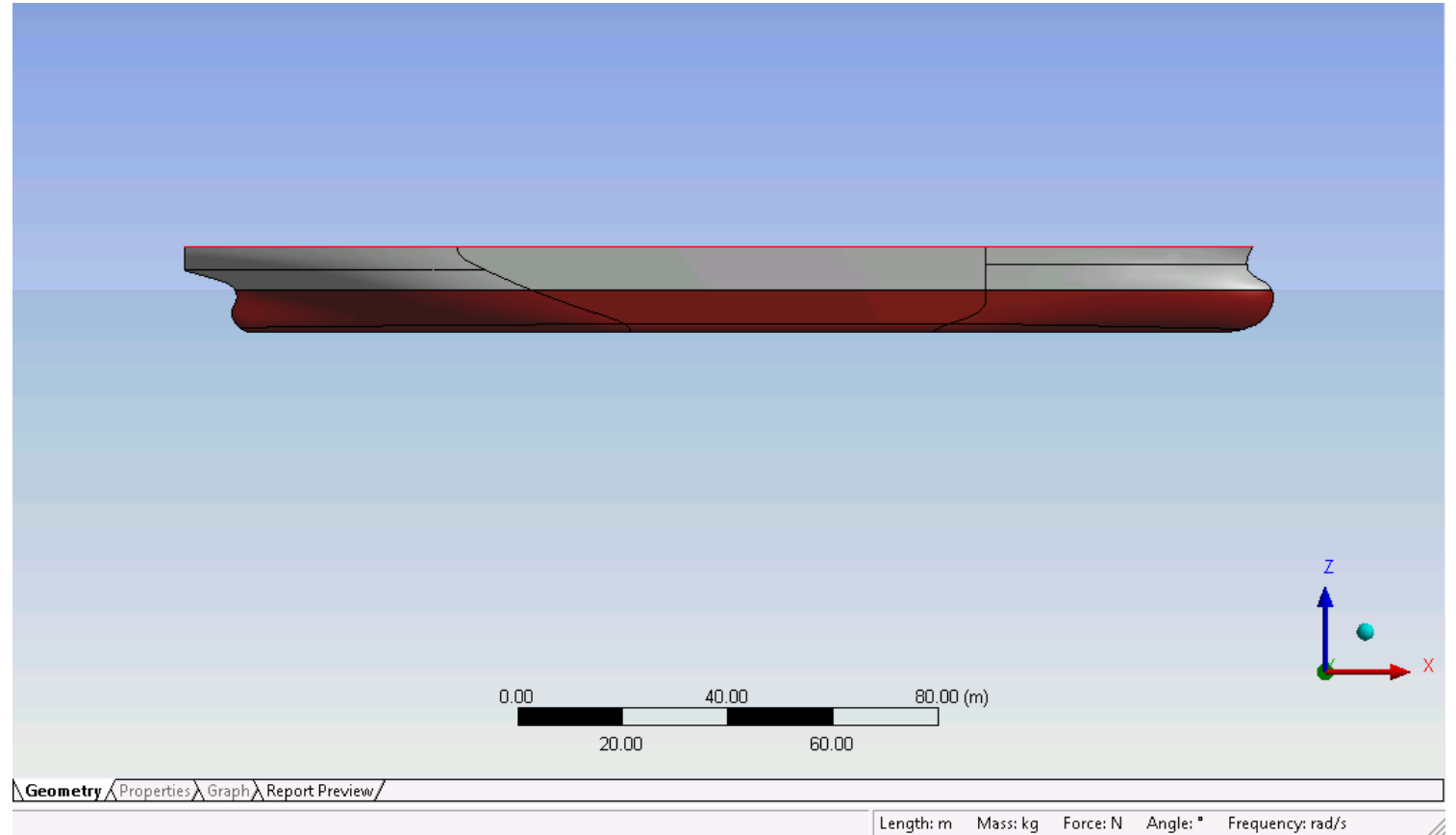
- The ship consists of two bodies – one above the water line, and a second below the water line.
- The pier has three bodies, defining the above and below water sections, plus the base, which has special considerations (more on this later).



/ Global Axis System in Aqwa

The water line defines the Aqwa Fixed Reference Axes (**FRA**)

The geometry is divided at this point to allow meshing above and below the water line



Radiation/Diffraction Analysis Stages

The Hydrodynamic Diffraction analysis consists of the following stages:

- Insert Hydrodynamic Diffraction system and associate Geometry/Mesh on the Project Schematic
- Add Aqwa-specific elements (Point Mass etc) in the Aqwa Workbench editor
- Define general Aqwa-specific parameters
 - Water Geometry
 - Part properties
- Set up Hydrodynamic Diffraction analysis
 - Analysis Settings
 - Structure Selection (interacting structure groups)
 - Wave Directions (optional forward speed correction)
 - Wave Frequencies
- Mesh
- Solve
- Post-processing