



Lecture 4: Aqwa Articulations and Fenders

Introduction to Hydrodynamic
Analysis with ANSYS Aqwa

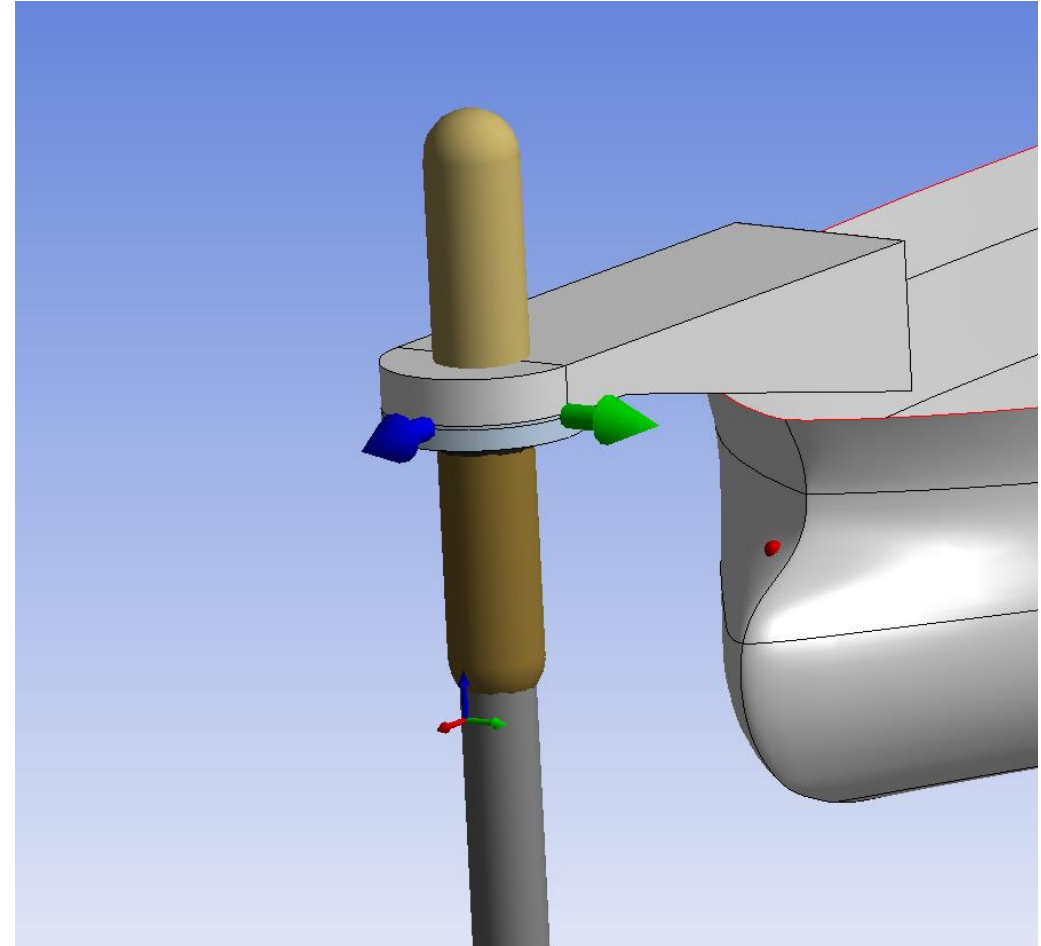
ANSYS Release 19.2



Aqwa Articulations

In the previous lecture it was shown that connections, such as moorings, can be defined as a restraining system for a vessel.

We will now consider another form of connection: physical joints, or articulations.



Aqwa Articulations

Joints are added from Connections.

Available joint types:

- Ball and Socket (3 free rotational DoFs)
- Universal (2 DoFs)
- Hinged (1 DoF)
- Rigid (locked)

Stiffness, damping and friction may be associated with the joint freedoms.

Joint local axes can be defined to correctly orientate the connection.

The screenshot displays the ANSYS Aqwa software interface. At the top, a tree view shows the project structure: Project > Model (A3, B3) > Geometry > Ship > Fixed Points > Connections. A context menu is open over the 'Connections' folder, showing options: 'Insert Connection', 'Insert from Aqwa Legacy File', 'Joint', 'Fender', 'Cable', 'Tether/Riser', and 'Connection Stiffness'. The 'Joint' option is selected. Below the tree view, the 'Details' panel for 'Details of Joint 1' is visible. It shows properties: Name (Joint 1), Visibility (Visible), Activity (Not Suppressed), Type (Hinged), Connectivity (Ball and Socket), Connection Point On Structure A (Universal), and Connection Point On Structure B (Hinged). To the right, another 'Details' panel for 'Details of Joint 1' shows 'Joint Properties' with checkboxes for Stiffness About X (1000 N.m²), Damping About X (20000 N.m/(°/s)), Transverse Force Friction C... (0.0 m), Overturning Moment Friction ... (0.0), Axial Force Friction Coeffic... (0.0 m), and Constant Friction Moment (k4) (0.0 N.m). At the bottom, a third 'Details' panel for 'Details of Joint Axes On Structure A' shows 'Axes Alignment' with fields for Alignment Method (Direction Entry), Rotation About Global Z (0.0°), Rotation About Local Y (90°), Rotation About Local X (0.0°), Unit Vector X ([0.0, 0.0, -1]), Unit Vector Y ([0.0, 1, 0.0]), and Unit Vector Z ([1, 0.0, 0.0]).

Aqwa Articulations

As with mooring lines, joints also require Connection Points to be defined.

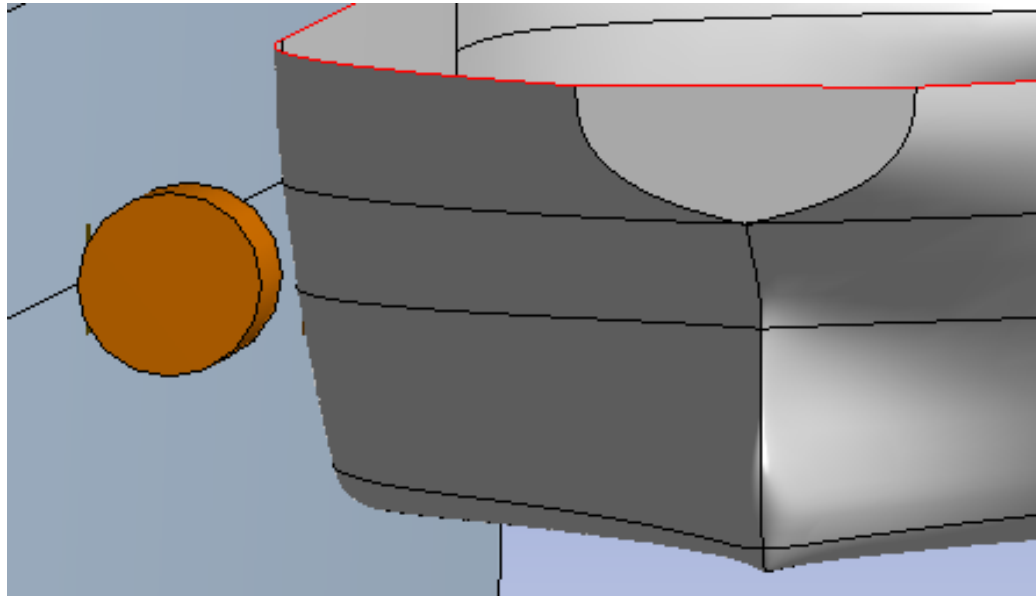
Joints may be associated with either two structures, or a structure and ground (via a Fixed Point). Connection Points are assigned to the vessel(s) and/or at Fixed Point locations as required.

Details	
Details of Joint 1	
Name	Joint 1
Visibility	Visible
Activity	Not Suppressed
Type	Hinged
Connectivity	Structure & Structure
Connection Point On Structure A	Turret Connection (FPSO)
Connection Point On Structure B	FPSO Connection (Turret)

Aqwa Fenders

In addition to mooring lines and articulations, Aqwa also offers the fender (compression element) to model structure-to-structure or structure-to-ground interactions.

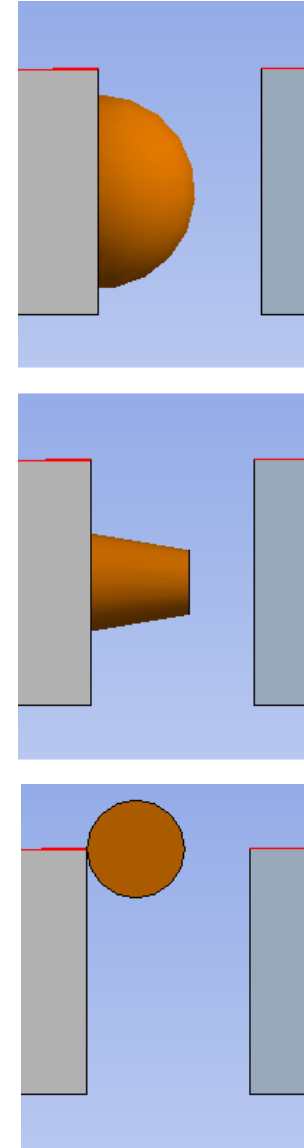
Aqwa does not detect collisions between structures, but fenders can be used to keep them separate.



Aqwa Fenders

There are three types of fender:

- Fixed, Omni-Directional – The fender is connected to one of the structures (or ground) and contact with the second structure may be anywhere on the surface of the fender (assumed spherical).
- Fixed, Directional – The fender is connected to one of the structures (or ground) and contact with the second structure is assumed to act in a given direction.
- Floating – The fender is not connected to either structure. Contact with either structure acts in a given direction. Note that the fender is vertically located at the still water level.



Aqwa Fenders

Fender data consists of:

- Connectivity
- Type
- Action
- Contact Points, using previously defined Connection or Fixed Points
- Fender Properties:
 - Damping Coefficient
 - Friction Coefficient
 - Size
 - Nonlinear stiffness coefficients
- Two sets of fender local axes, to define the fender direction and contact plane normal

Connectivity	Fender And Contact On Structures
Type	Fender And Contact On Structures
Action	Fender On Structure, Contact On Fixed Point
Fender Connection Point	Fender On Fixed Point, Contact On Structure

Type	Floating
Action	Floating
Fender Connection Point	Fixed

Action	Y Direction Only
Fender Connection Point	Omni-Directional
Contact Connection Point	X Direction Only
Fender Properties	Y Direction Only
<input type="checkbox"/> Damping Coefficient	Z Direction Only

Details	
Details of Fender 1	
Name	Fender 1
Visibility	Visible
Activity	Not Suppressed
Connectivity	Fender And Contact On Structures
Type	Floating
Action	Fender Y-Direction Only
Fender Connection Point	Fender_Aft (Pier)
Connection Point on Contact Pla...	Fender_Aft (ShipHull)
Initial Attachment Point Separation	6.98374800000093 m (Plane to Plane)
Fender Properties	
<input type="checkbox"/> Damping Coefficient	0.2 s
<input type="checkbox"/> Friction Coefficient	0.0
<input type="checkbox"/> Size	6 m
<input type="checkbox"/> Coefficient A	50000 N/m
<input type="checkbox"/> Coefficient B	3000 N/m ²
<input type="checkbox"/> Coefficient C	0.0 N/m ³
<input type="checkbox"/> Coefficient D	0.0 N/m ⁴
<input type="checkbox"/> Coefficient E	0.0 N/m ⁵