Introduction to Hydrodynamic Analysis with Ansys Aqwa

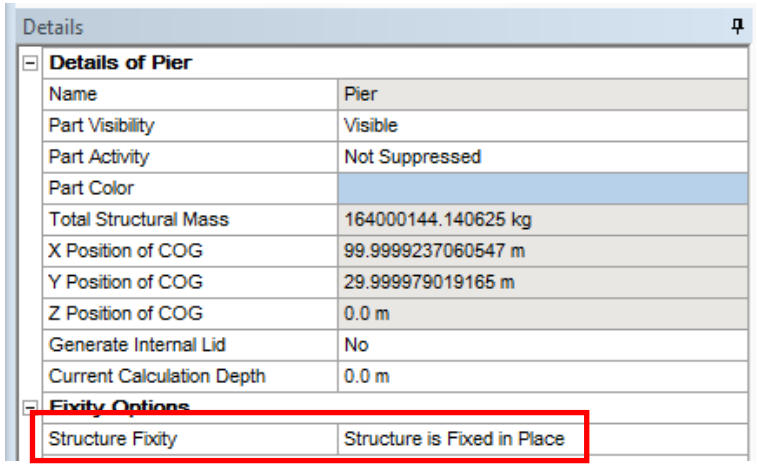
Module 07: Fixed Structures and Multi-Body Interaction

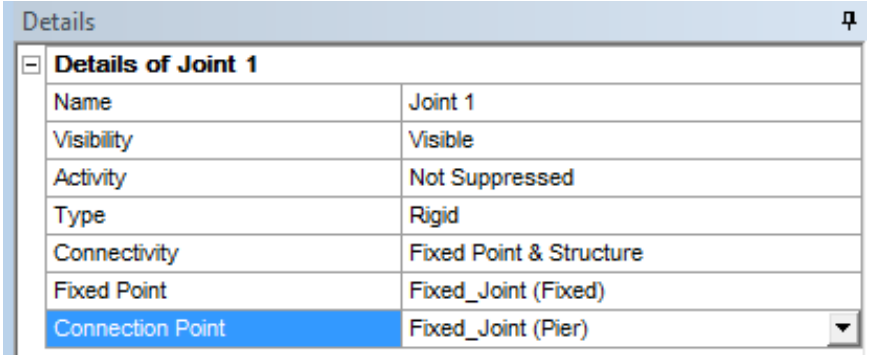
Release 2021 R2

Fixed Structures

Some special considerations have to be given to structures that are rigidly fixed in space, since their radiation effects should be eliminated.

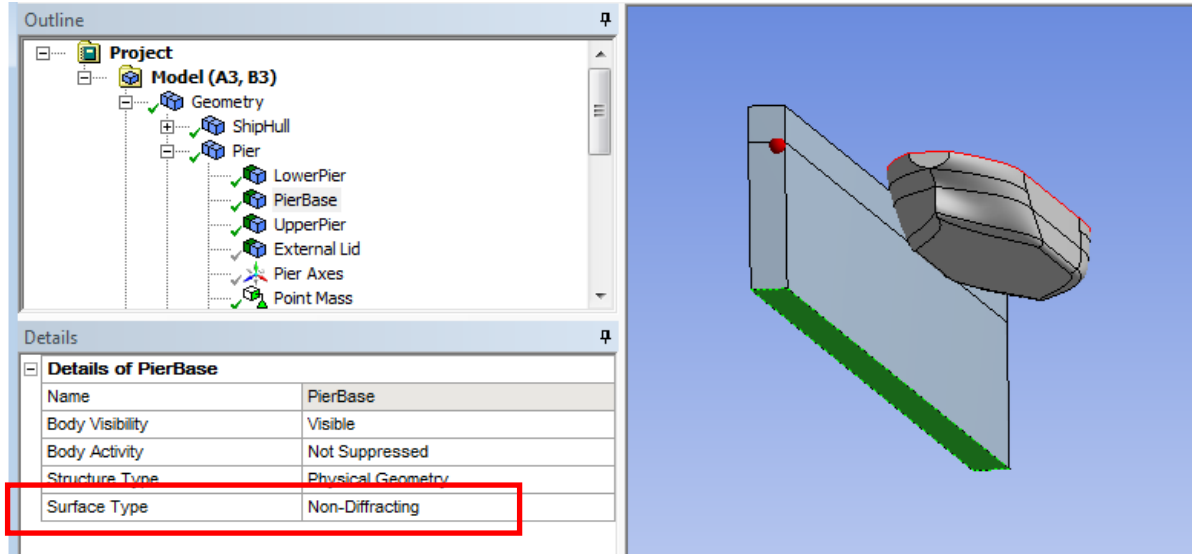
- In the Hydrodynamic Diffraction model a structure can be fixed by setting the Structure Fixity to ‘Structure is Fixed in Place’
- The ‘Structure is Fixed in Place’ setting only operates for the Hydrodynamic Diffraction analysis; for any subsequent Hydrodynamic Response analysis, a rigid articulation must be manually established between the structure and a Fixed Point





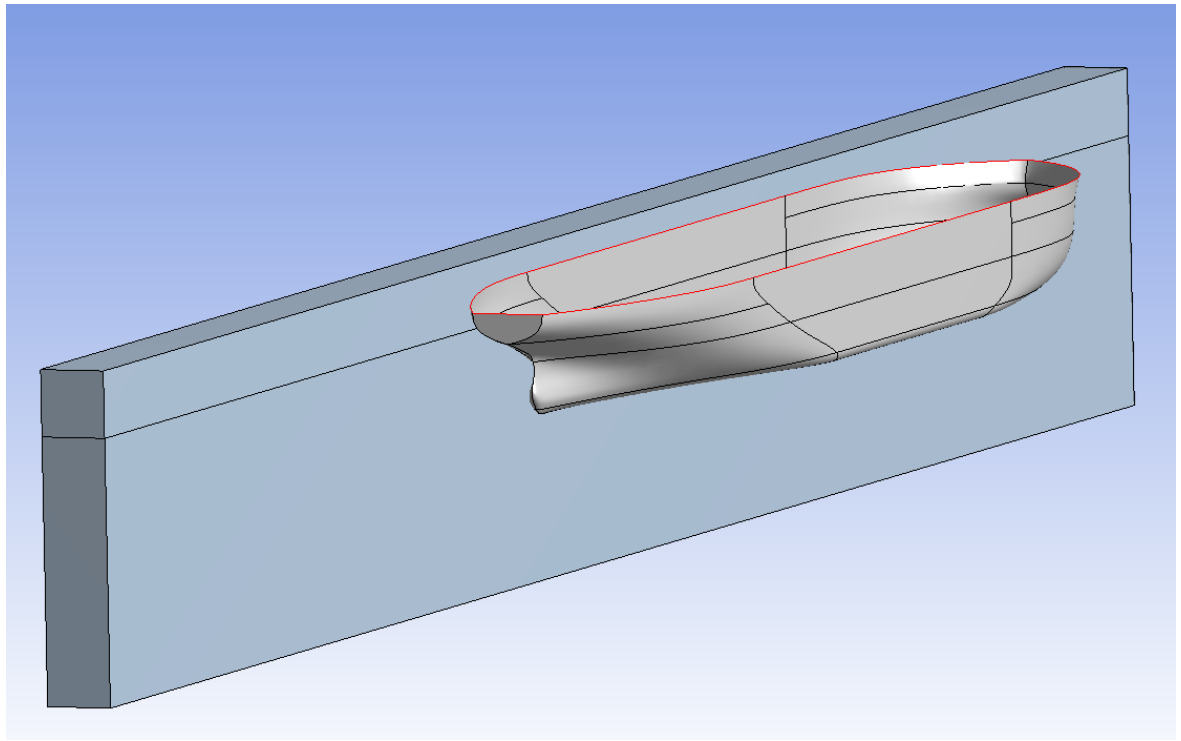
Fixed Structures

- If the fixed structure is to be placed on the seabed, an additional consideration is the modelling of its lowest surface.
- The seabed acts as a boundary condition for the radiation/diffraction computation, and if a diffracting element is placed in contact with it then an invalid condition exists.
- This is overcome by either removing the face of the structure that is in contact with the seabed, or by setting the surface body Surface Type to be ‘Non-Diffracting’.



Multi-Body Interaction

- Aqwa can analyse multiple structures in a single simulation. Where there is a relatively large separation between those structures, we may not expect any hydrodynamic interaction between them. Aqwa generates a separate hydrodynamic database for each structure individually.
- However, where there are two large structures adjacent to each other, the motions of one structure will affect the wave forces on the other, and vice versa.
- In this case, hydrodynamic interaction needs to be considered so that shielding effects and wave radiation are accounted for.



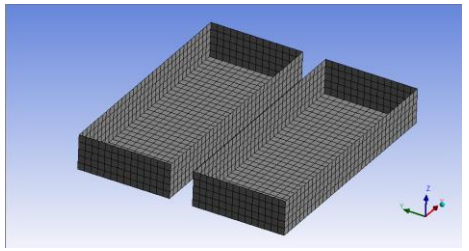
Multi-Body Interaction

- Aqwa can be used to solve problems that involve multiple structures, in up to 20 structure groups, with full hydrodynamic interaction.

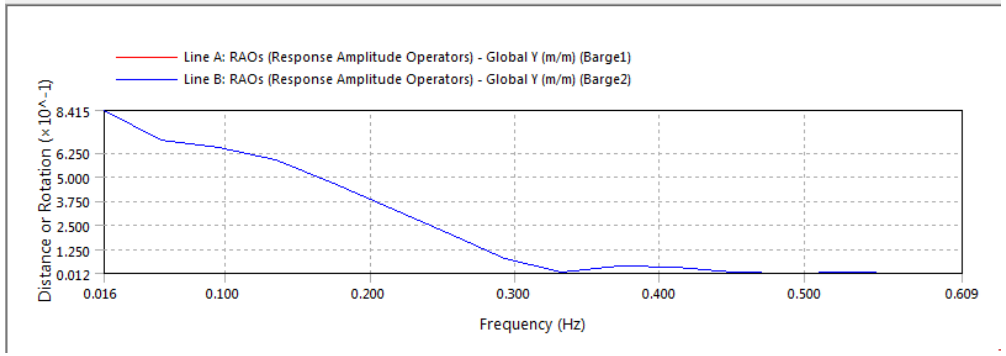
- The Response Amplitude Operators (RAOs) for each of the hydrodynamically-interacting structures will be different from those that would have resulted if each of these structures were on its own.

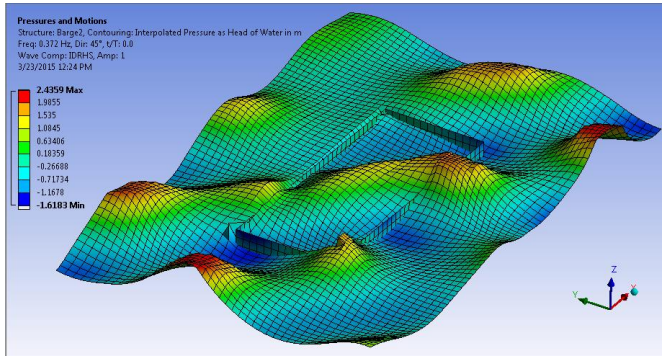
- RAOs are not a physical property of a structure but depend on the radiation and diffraction forces. These forces change in the case of hydrodynamic interaction, and therefore the RAOs of the structures will also change.

Multi-Body Interaction

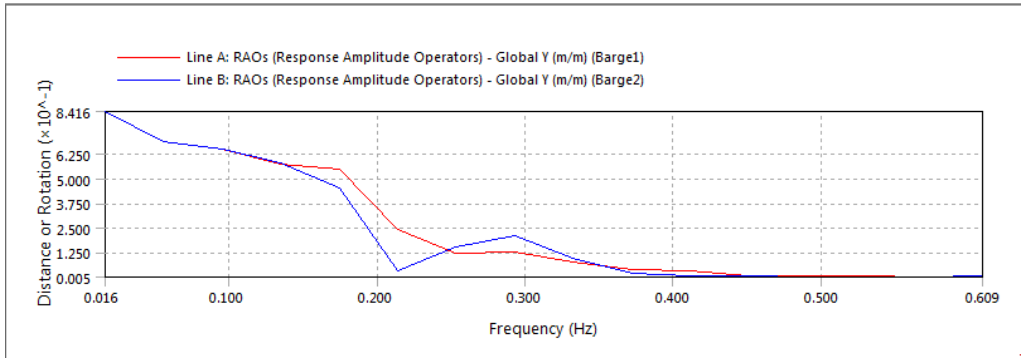


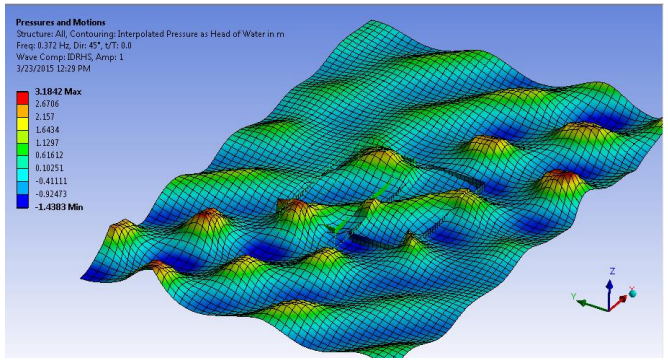
- As an example, consider two barges alongside each other.
- When the two barges are considered as non-interacting, the RAOs are the same:





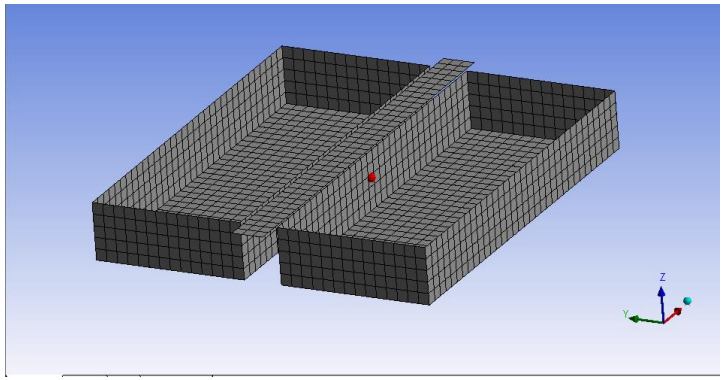
- When we include hydrodynamic interaction the RAOs are different, and the wave pattern is modified:





Multi-Body Interaction

- When analyzing multi-body problems, it is often necessary to consider the effects of standing wave formation between the structures: waves can build up to a point where they exceed the breaking wave limit, due to the absence of viscous flow effects.
- This is mitigated by including an external lid between the structures. This can also be used for enclosed areas, such as moon-pools.
- The lid consists of special diffracting elements at the water surface which are assigned a Structure Type of Abstract Geometry, and an Abstract Type of External Lid.
- A Lid Damping Factor is assigned and a characteristic Gap is given (normally the spacing between structures). These properties control how the lid attenuates the unrealistic waves.



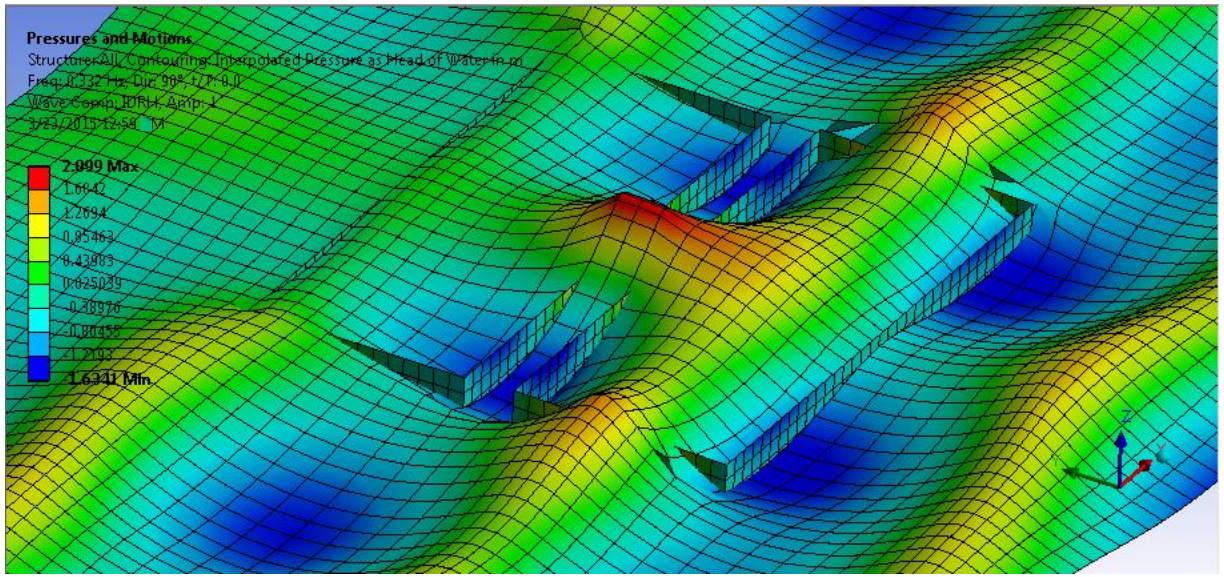
Details

Details of External Lid	
Name	External Lid
Body Visibility	Visible
Body Activity	Not Suppressed
Body Color Definition	Inherited from Part
Structure Type	Abstract Geometry
Abstract Type	External Lid
Lid Damping Factor	0.02
Gap for External Lid	7 m

Multi-Body Interaction

- The plots below show a typical wave surface elevation for a beam sea crossing two parallel barges.

Without an external lid: η = [-1.63, 2.10] m



With an external lid: η = [-1.42, 1.27] m