Introduction to Hydrodynamic Analysis with Ansys Aqwa

Module 01: Introduction

Release 2021 R2

Welcome

- Welcome to the *Ansys Hydrodynamic Analysis* introductory training course!
- This training course covers the basics of using Aqwa for performing hydrodynamic analyses.
- It is intended for all new or occasional Aqwa users.

Ansys Hydrodynamic Analysis Overview

What is Aqwa?

- Aqwa is a modularised, fully integrated hydrodynamic analysis suite based around three-dimensional diffraction/radiation methods
- Ansys Workbench implementation provides a modern interface to develop and solve Aqwa models

History of Aqwa

- Developed since 1971 (by WS Atkins)
- Owned and developed by Century Dynamics since 2001
- Century Dynamics acquired by Ansys February 2005
- Now integrated into the Ansys Workbench system

Ansys Hydrodynamic Analysis Overview

Aqwa Capabilities

- Diffraction/Radiation calculations including Morison elements
- Multiple body hydrodynamic interaction (up to 50 structures, up to 20 interacting groups)
- Modelling of moorings, fenders and articulations (connectors)
- Static and dynamic stability
- Estimation of equilibrium position
- Frequency domain dynamic analyses
- Time domain with irregular waves, including slow drift effects
- Time domain with non-linear survival waves
- Coupled cable dynamics
- Transfer of motions and pressures to Ansys Mechanical models

Ansys Hydrodynamic Analysis Overview

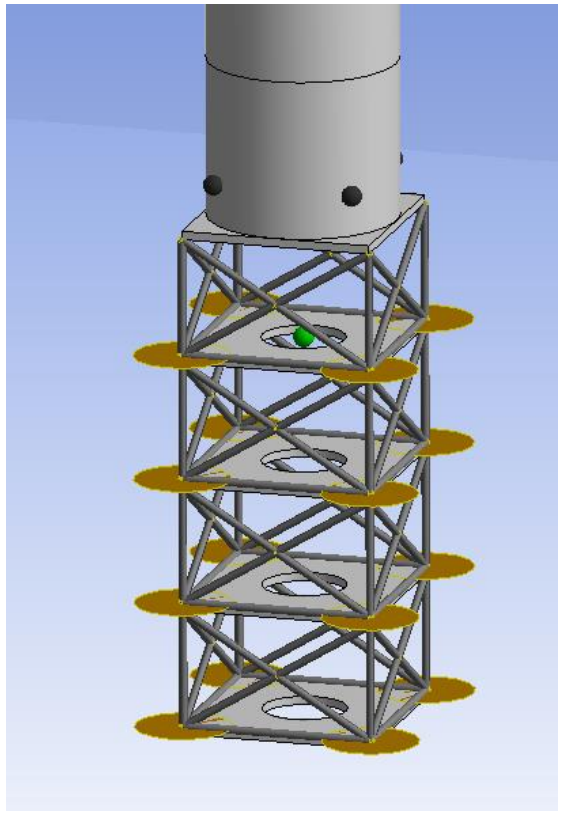
Aqwa Applications

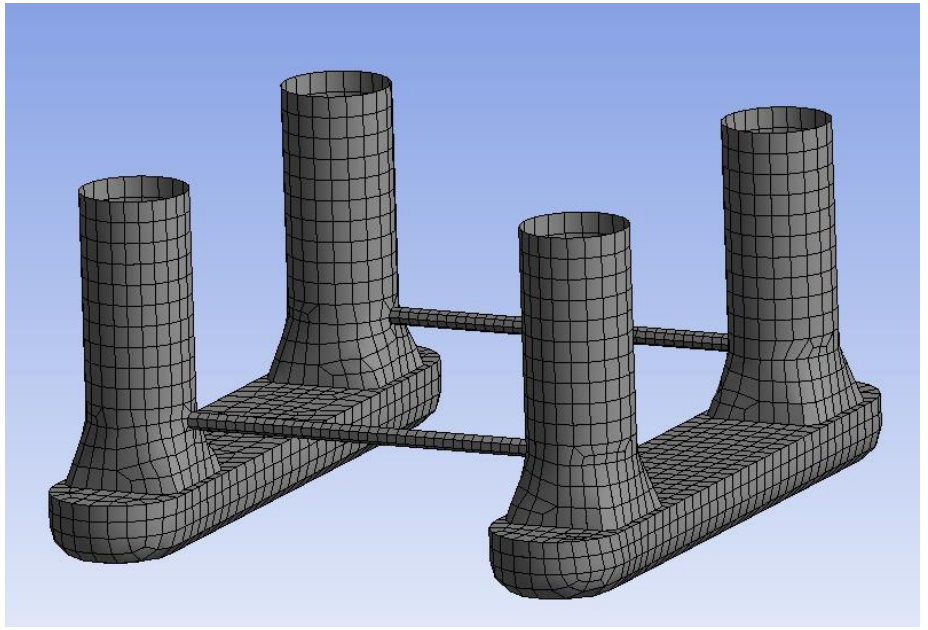
- Determination of Response Amplitude Operators (RAOs)
- Wave bending moments
- Splitting force calculations for e.g. semi-submersibles
- Design and analysis of mooring systems
- Time histories of motions and forces
- Determination of air gaps
- Calculation of shielding effects of ships and barriers
- Coupled mooring line-structure interaction
- Tension Leg Platform (TLP) tether analysis

Description of Program Capabilities

Modelling in Aqwa – Geometry

- **Diffracting or non-diffracting mesh elements**
  - **Triangular panels**
  - **Quadrilateral panels**
- **Internal Tank mesh elements**
- **Morison elements**
  - **Cylinders and cylindrical tubes**
  - **Non-axisymmetric slender tubes**
  - **Discs**
- **Point masses**
- **Point buoyancies**

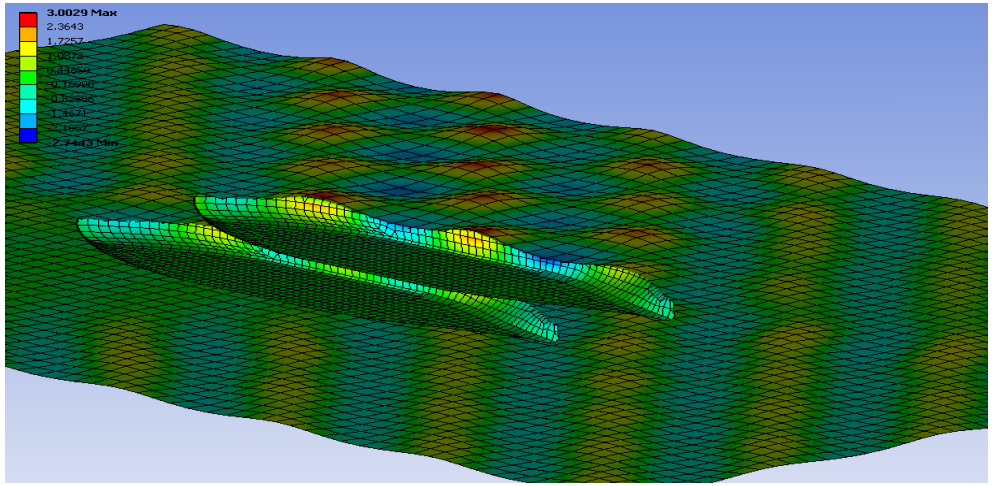


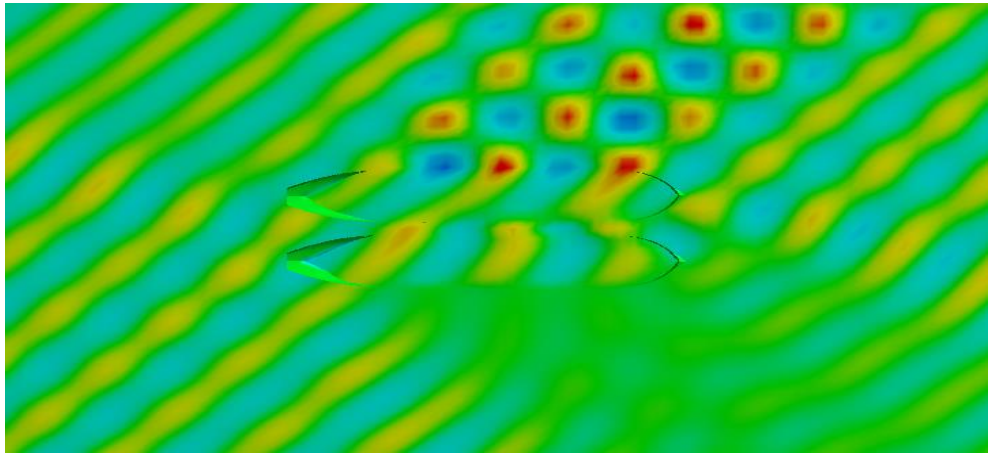


Description of Program Capabilities

Radiation/Diffraction

- Multiple structures including hydrodynamic interaction
- Hydrodynamic coefficients (added mass and damping)
- Response Amplitude Operators (RAOs)
- Drift coefficients (Near/far field, full QTF matrix)
- Drag linearization for Morison components
- Shear force/bending moment
- Splitting forces
- Pressure distribution for transfer to structural model





Description of Program Capabilities

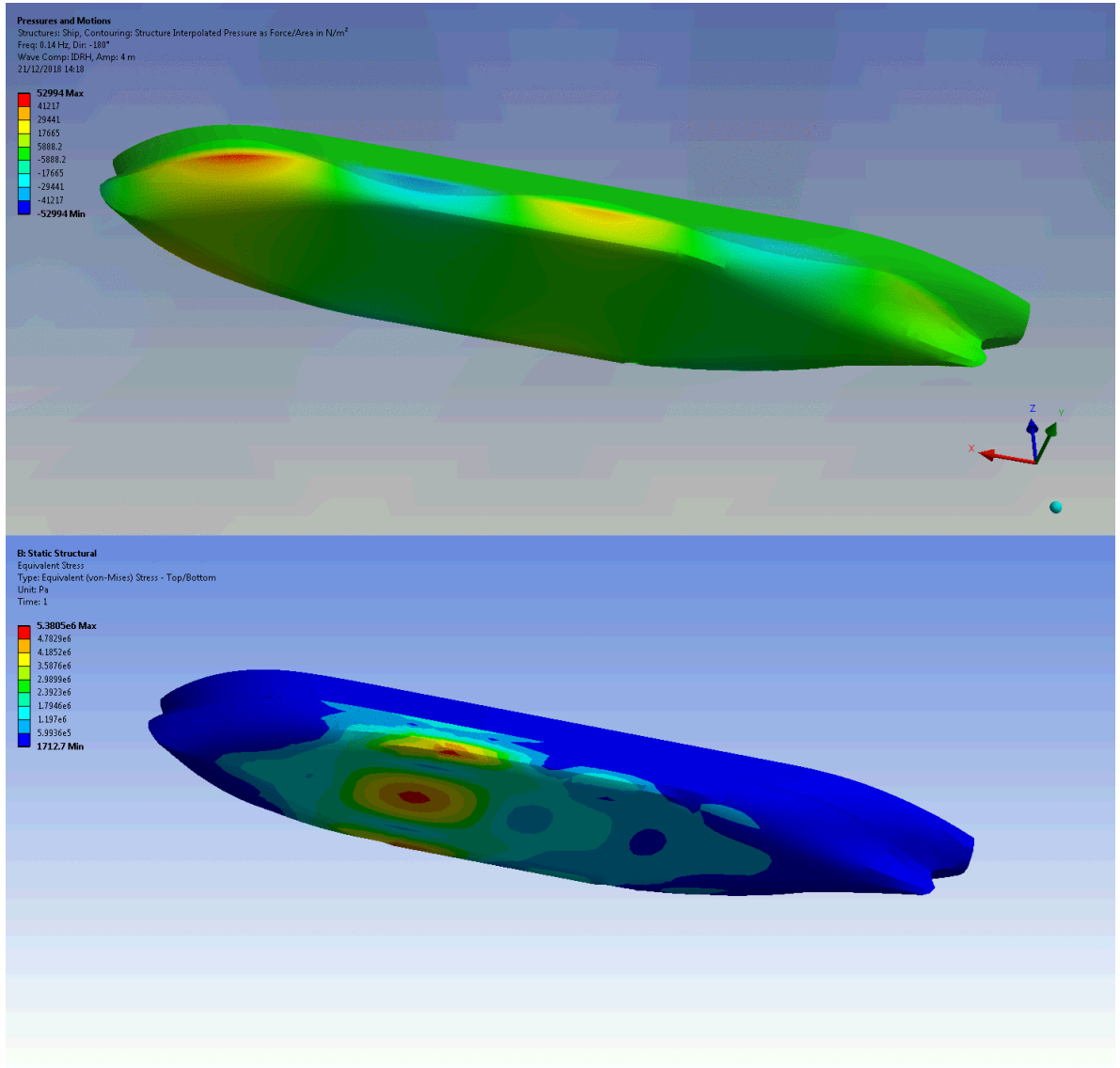
Hydrodynamic Pressure Transfer

- Calculation and transfer of hydrodynamic loads to Ansys Mechanical Static Structural analysis

Aqwa Hydrodynamic Model

Pressures, Accelerations, Beam Loads

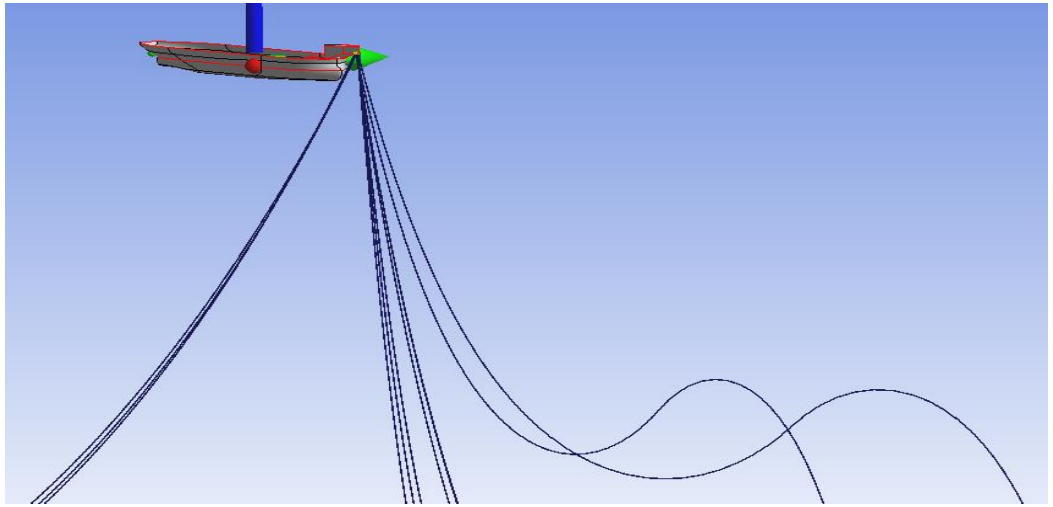
Ansys Mechanical Model

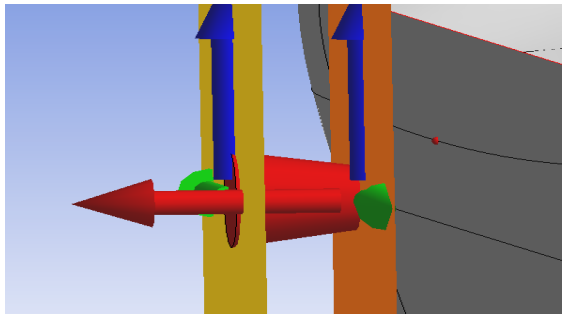


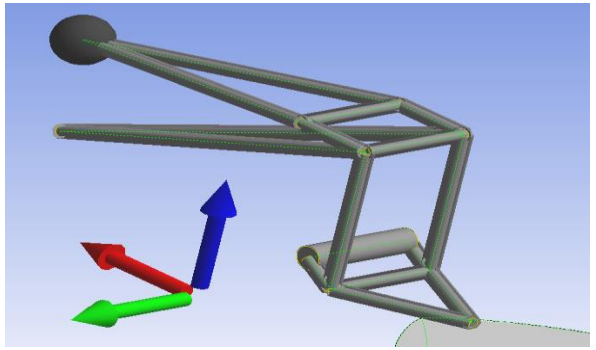
Description of Program Capabilities

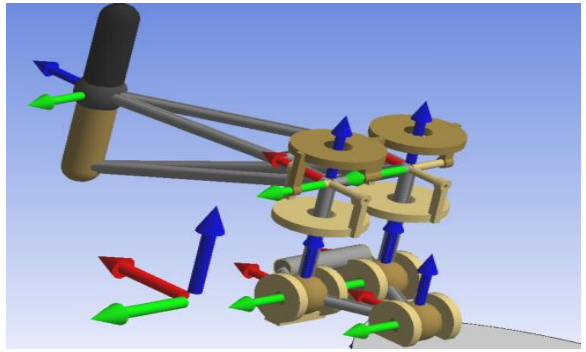
Modelling in Aqwa – Connections

- Cables
  - Linear springs
  - Elastic catenaries
  - Intermediate buoys
  - Clump weights
  - Pulleys
  - Tethers
  - Winches and cable failures
- Fenders
- Joints
  - Rigid
  - Ball-and-socket, universal, hinged
- Tethers/Risers









Description of Program Capabilities

Modelling in Aqwa – Environment

- Regular waves
- Multi-directional wave spectra
- Current
- Wind
- Additional structure forces
    - Thrusters (rotate with structure)
    - Constant direction
    - Time-varying
    - External user-defined function

Description of Program Capabilities

Equilibrium and Stability

- Computes static equilibrium position for given environmental and mooring configurations
- Preliminary mooring design
- Calculates static/dynamic stability, including natural modes

Description of Program Capabilities

Frequency Domain

- Significant motions at low frequency/wave frequency in frequency domain
- Drag linearization for Morison components
- Permits rapid analysis using linearized parameters of mooring systems
- Graphs for response spectra/RAOs and other parameters

Description of Program Capabilities

Time Domain

- Time history analysis of multiple structures with irregular waves
- Can use full QTF matrix for shallow water conditions
- Import of wave height time history
- Input of forces via user-defined .dll or Python server
- Output of motions and forces
- Graphical and animation results
- Large amplitude motions
  - Non-linear time-history analysis with large (survival) waves
  - Regular or irregular waves
  - Integration of pressure over wetted surface

Description of Program Capabilities

Cable Dynamics

- For more rigorous simulation of mooring line behaviour
- Provides full coupled vessel/mooring line analyses

Excel Interface

- Aqwa specific functions add-in for Excel for data and results retrieval, processing and report generation

AqwaReader executable

- Provides command line access to most Aqwa binary output
- Can be used for automated results extraction

Description of Program Capabilities

Currently in Workbench

- Import of geometry from Ansys DesignModeler and SpaceClaim
- Interactive data modification and editing
- Native meshing or using Ansys Mesh application
- Diffraction/radiation analysis
- Wave surface and pressure contour plots
- Definition of internal tanks for sloshing effects
- Definition of moorings, articulations, tethers and fenders, ocean environment
- Static and dynamic stability analysis; frequency domain analysis; time domain analysis
- Graph plotting and visualization