DIGITAL SOLUTIONS

Sesam user course

HydroD Input

DNV GL

17 September 2018

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About the presenter

- Name: Torgeir Kirkhorn Vada
- Position: Product Manager for floating structures
- Background:
  - PhD in Applied mathematics/Hydrodynamics from University of Oslo, 1985
  - Worked in DNV since 1985, with Sesam since 1997, with hydrodynamics since 1978
  - Worked as developer and in various line management roles
  - Member of technology leadership committee for hydrodynamics in DNV GL

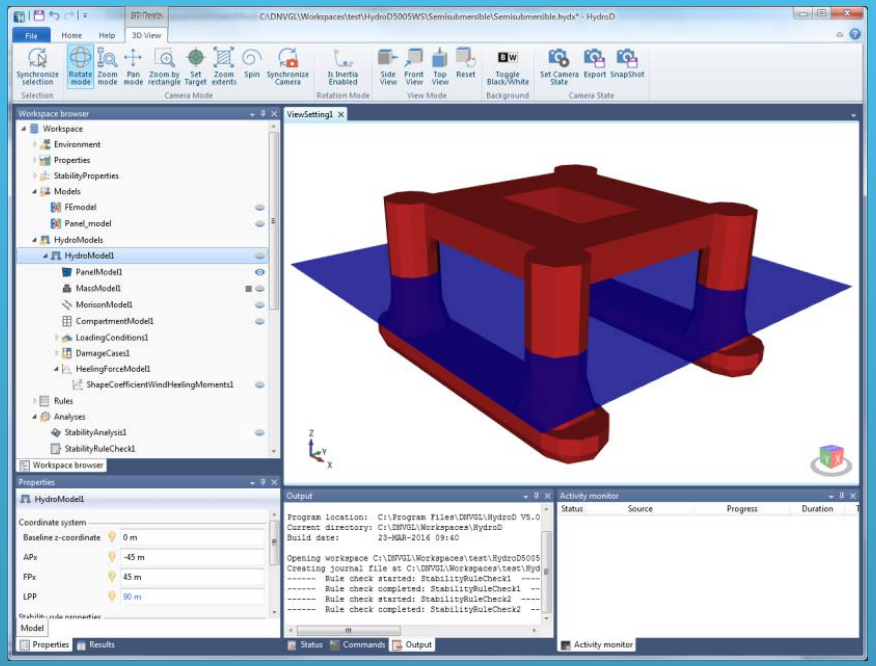
Agenda

- Tuesday
  - 8.15 – 11.00 Presentations
    - Input to HydroD
    - Stability analysis
    - Wadam
  - 11.00 - 12.00 Lunch
  - 12.00 – 16.00
    - Workshop stability analysis (Goliat)
- Wednesday
  - 8.15 – 11.00 - Presentations
    - Wadam & HydroD
    - Statistical post processing (Postresp)
  - 11.00 - 12.00 Lunch
  - 12.00 – 16.00
    - Workshop hydrodynamic analysis (Trym)

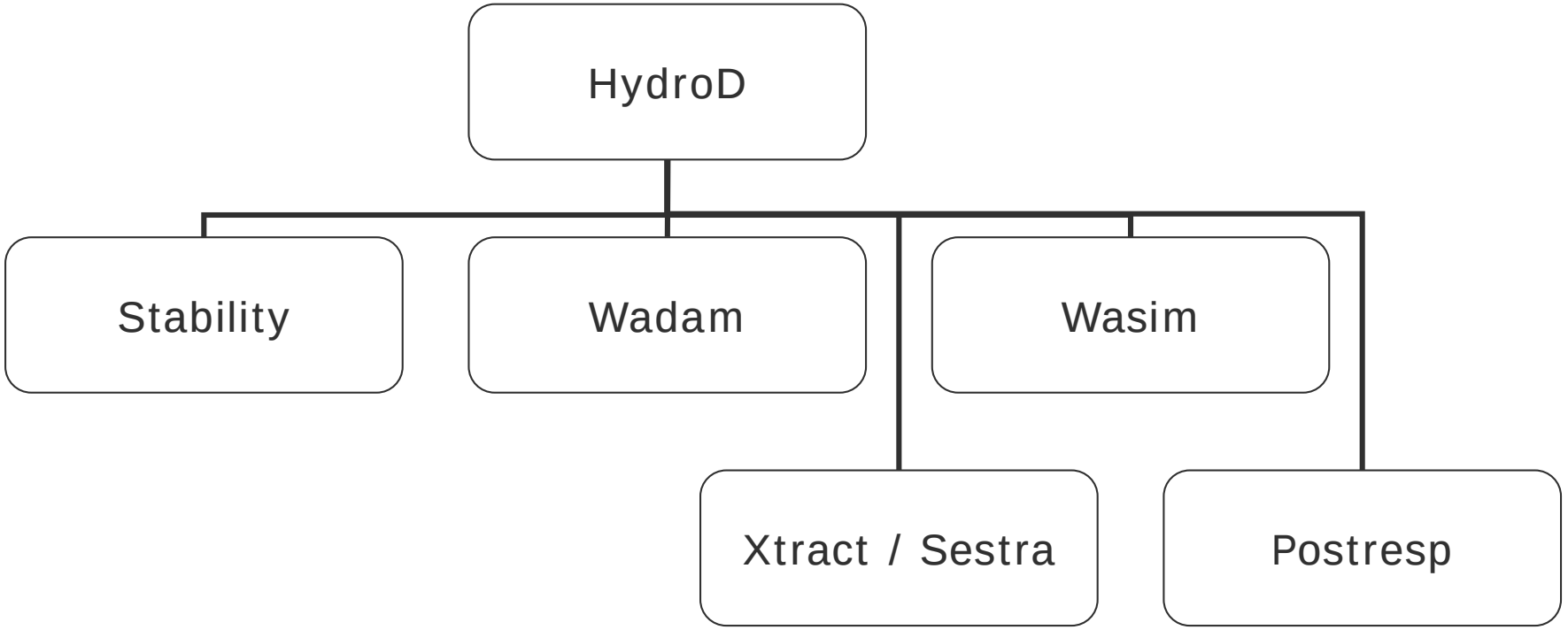
Scope of presentation

Describe commands needed for definition of environment and models, and their properties

- Environment modelling
- Compartment properties
- Analysis models
- Sectional loads
- Loading conditions

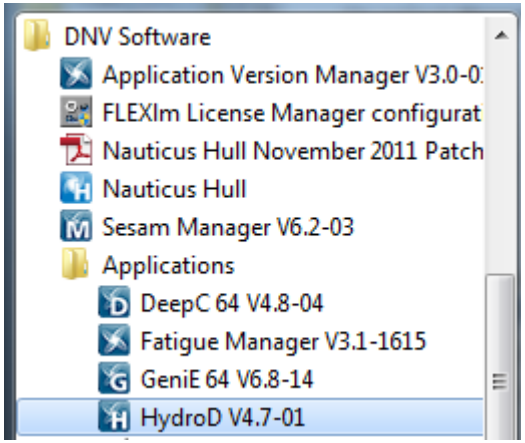


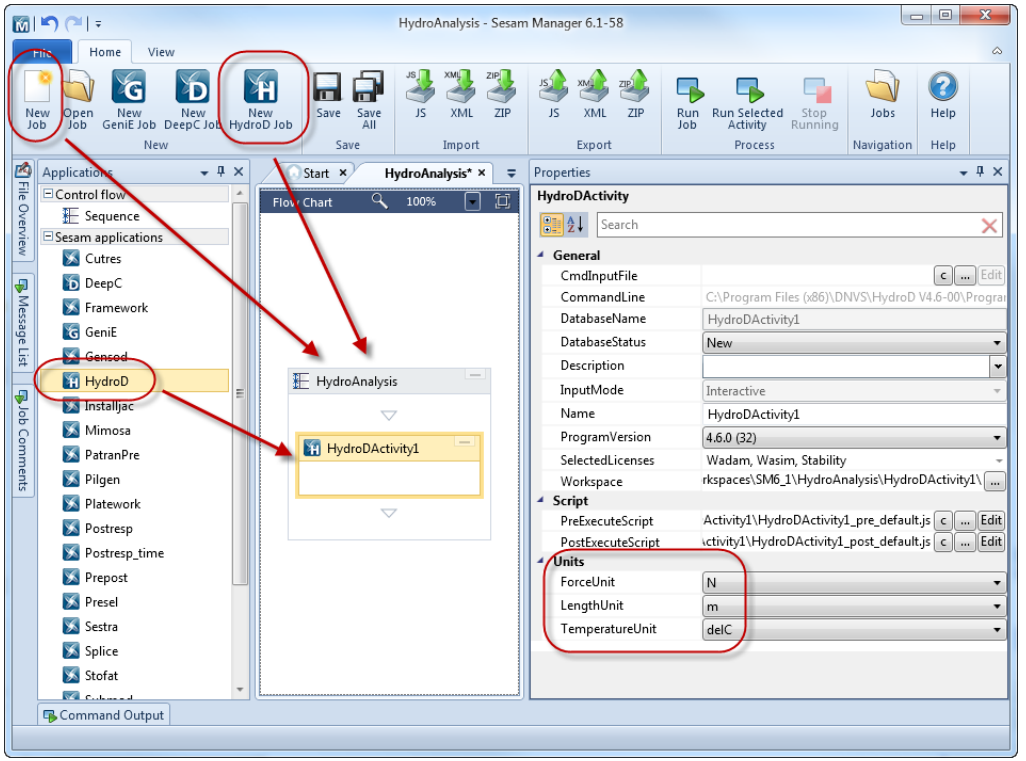
HydroD – Main modules



How to start the program

- From Sesam Manager:
  - Select the **HydroD** application
    - Drag and drop into a job
  - Or select **New HydroD job**
- From the Windows Start menu:

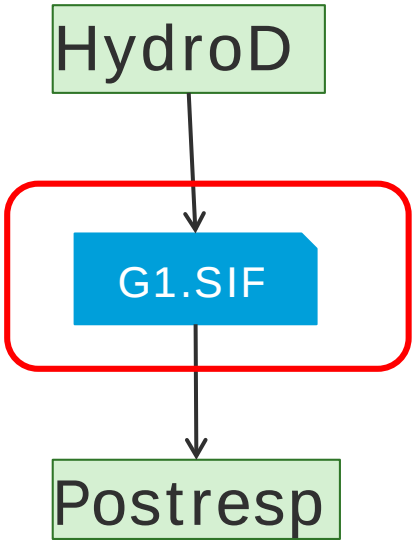




The three roles of HydroD

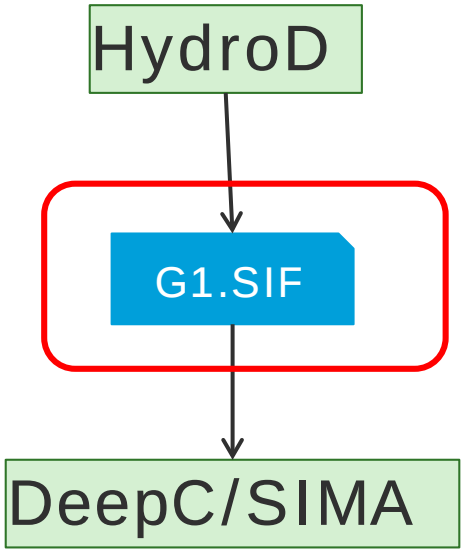
1. Direct output

- Motions (containerships, transport analysis)
  - Acceleration at selected locations
- Air gap (semisubmersibles, water on deck)
- Sectional loads
- Pressures at selected locations
- Component stochastic fatigue analysis



2. Provide hydrodynamic data for floater(s) to DeepC/SIMA

- Constant data
  - Body mass
  - Restoring matrix
- Linear data
  - Added mass and damping
  - Excitation forces
  - Rigid body motions (uncoupled analysis)
    - Computed inside SIMA in coupled analysis
- Second-order data
  - Mean drift forces
  - Second-order forces (only DeepC)
    - Sum frequency
    - Difference frequency



3. Load generator for structural analysis

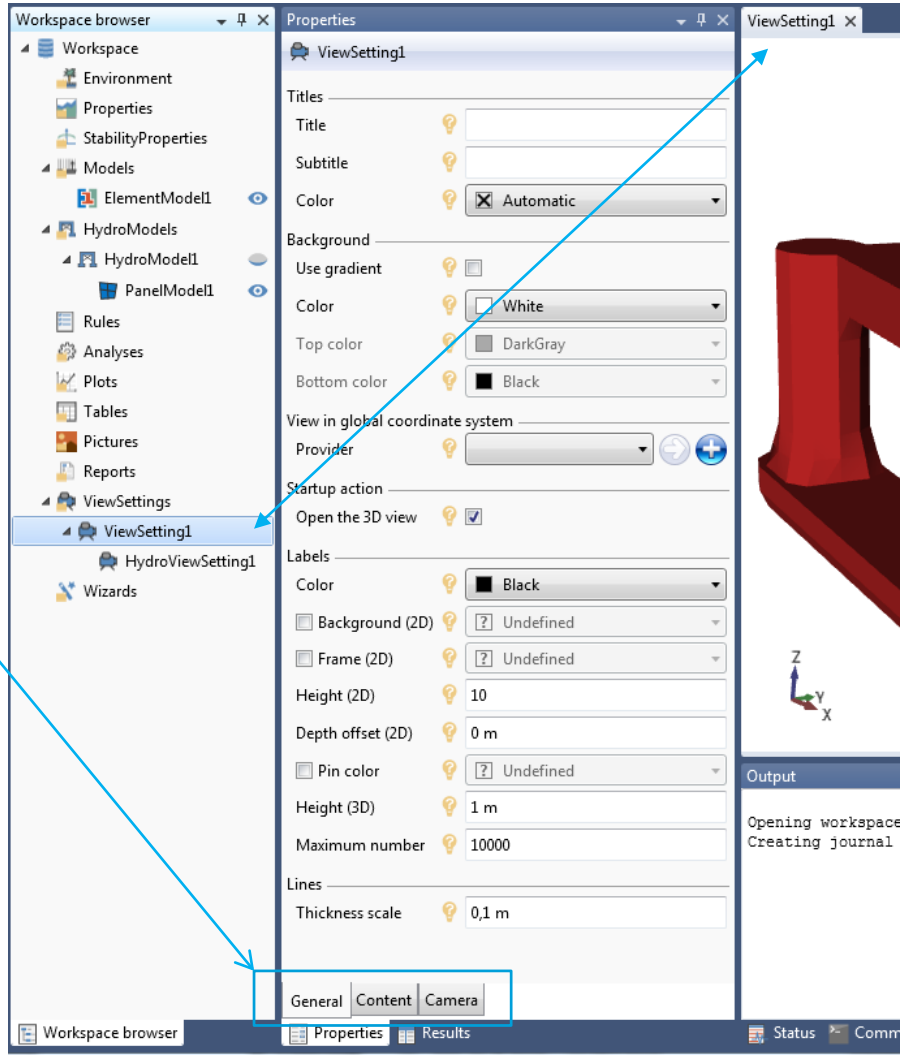
- Hydrostatic load
  - Forces in still water condition, pre-tension from tethers and mooring system
- Gravity load
  - Acceleration of gravity, load distribution computed inside Sestra

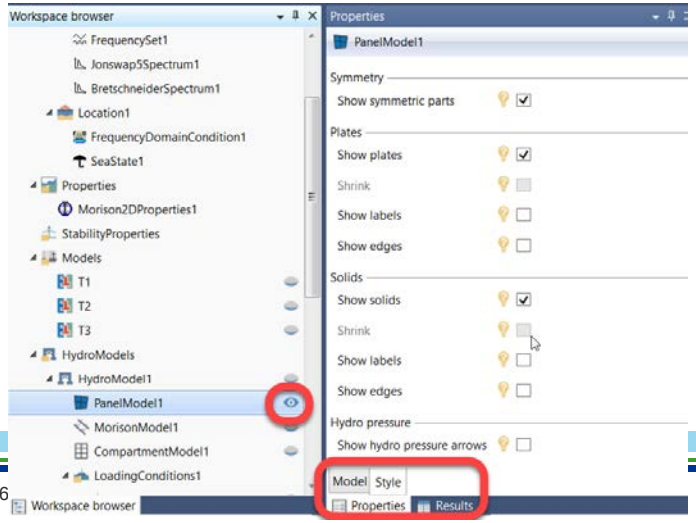
- Hydrodynamic loads
  - Inertia loads, dynamic gravity (due to rigid body motion)
  - Wave pressure, restoring pressure (due to rigid body motion)
  - Morison loads
    - Line loads
    - Point loads

General about UI

View settings

- One or more 3D view windows may be defined
- Each of these has its own view settings
  - Title
  - Colours
  - Label size and colour
  - Perspective
  - Etc.
- Specific setting for each concept in Style tab





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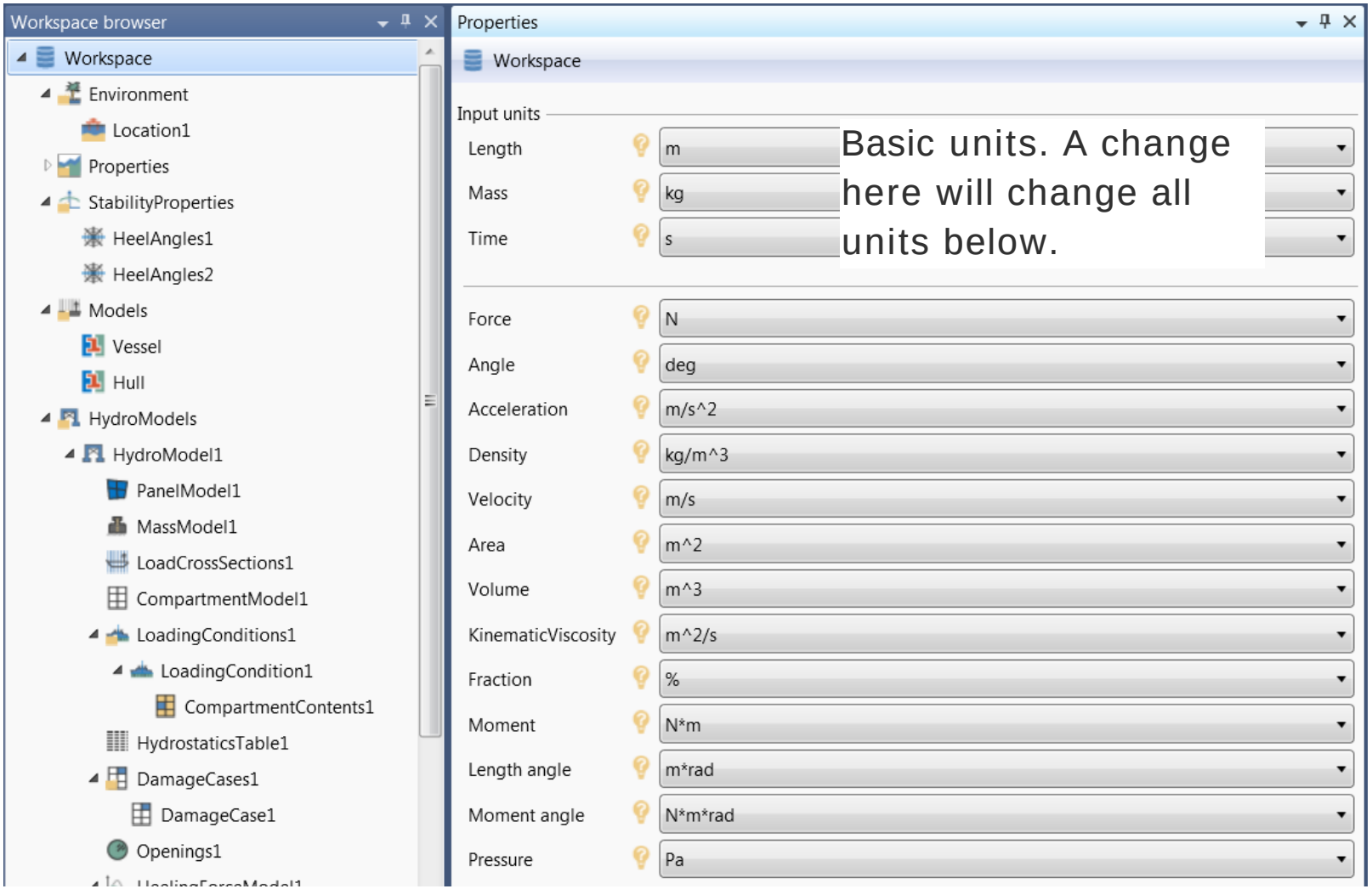
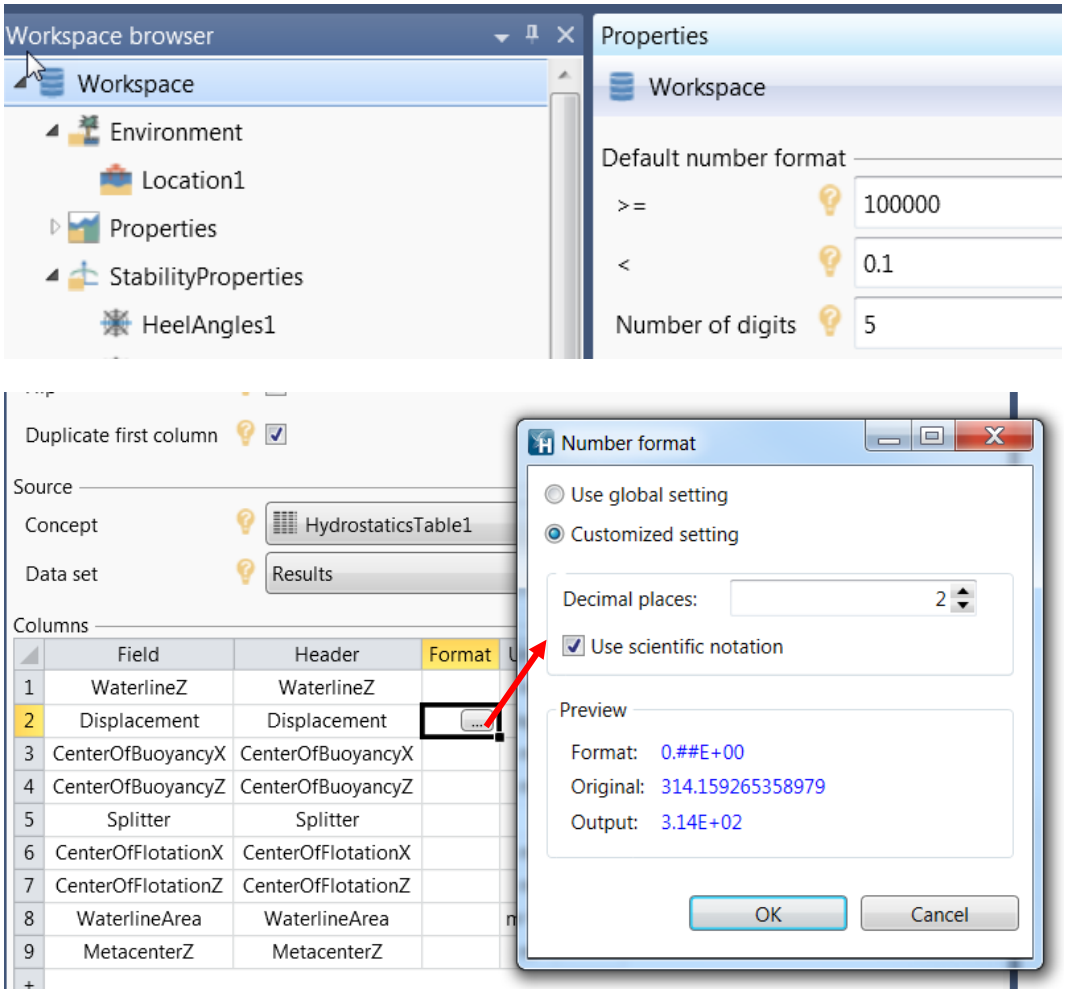
Scripting

- The Java script is used as command language
  - Documented in the help system
  - A clean script file may be created from the File menu (“Save as script”)
    - Very useful for sharing a workspace and good backup

Units


Workspace browser
Workspace
Environment
Location1
Properties
StabilityProperties
HeelAngles1
HeelAngles2
Models
Vessel
Hull
HydroModels
HydroModel1
PanelModel1
MassModel1
LoadCrossSections1
CompartmentModel1
LoadingConditions1
LoadingCondition1
CompartmentContents1
HydrostaticsTable1
DamageCases1
DamageCase1
Openings1
Properties
Workspace
Input units
Length
m
Mass
kg
Time
s
Basic units. A change here will change all units below.
Force
N
Angle
deg
Acceleration
m/s^2
Density
kg/m^3
Velocity
m/s
Area
m^2
Volume
m^3
KinematicViscosity
m^2/s
Fraction
%
Moment
N*m
Length angle
m*rad
Moment angle
N*m*rad
Pressure
Pa

Number accuracy



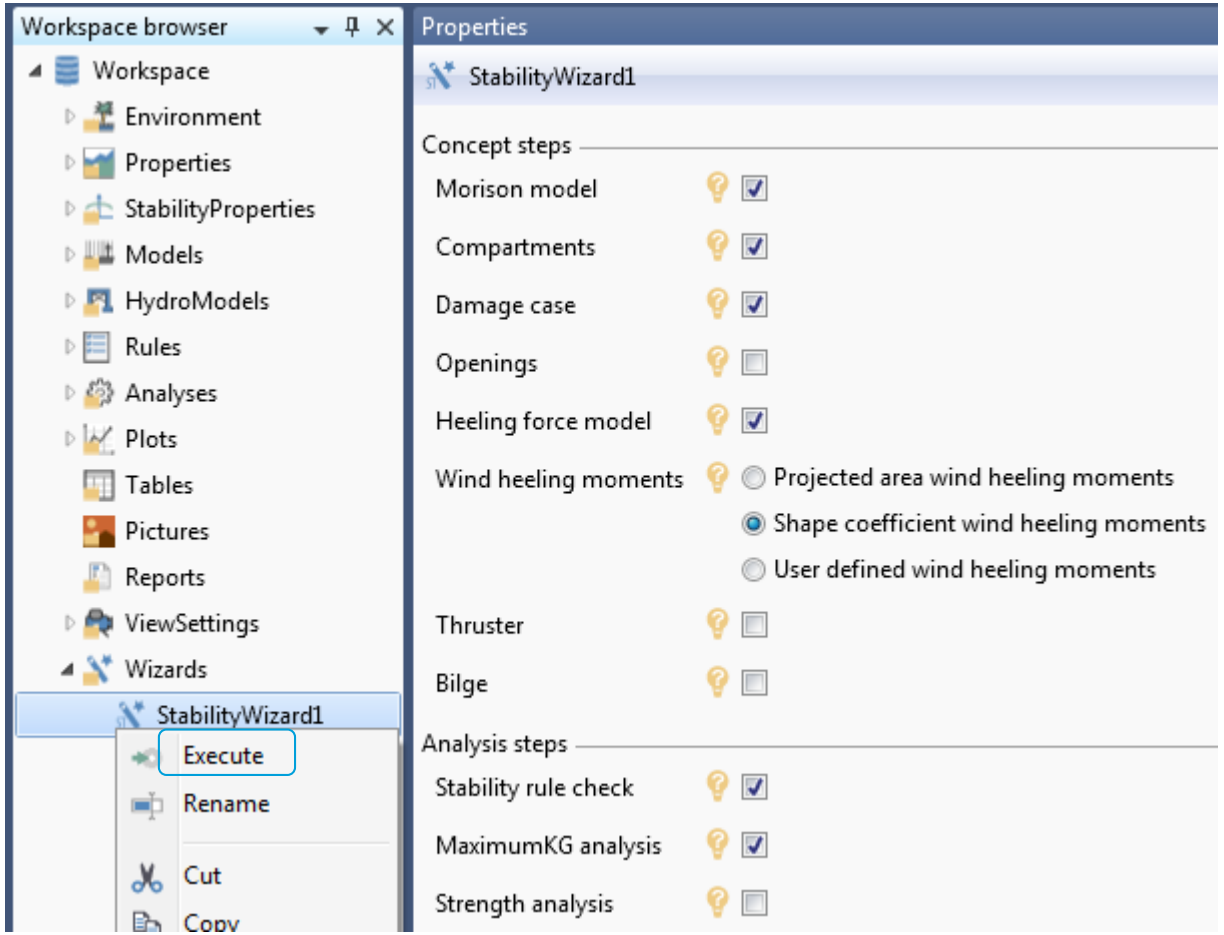
Number setting in Workspace.

You can define your preferred default in File, Options.

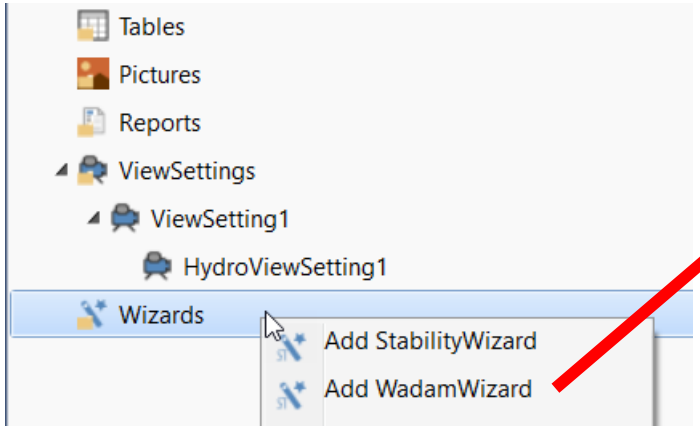
Workspace setting may be modified for individual columns in a table

Wizard – A useful tool

- Right-click *Wizards* to create a wizard
  - Right-click the created wizard to execute it
- Follow the steps for the required input
- Using this to set up a new workspace will save time



Wadam Wizard



Properties

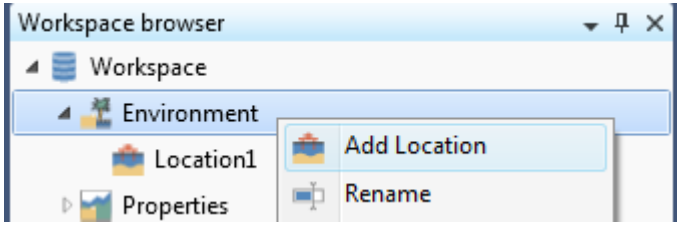
WadamWizard1

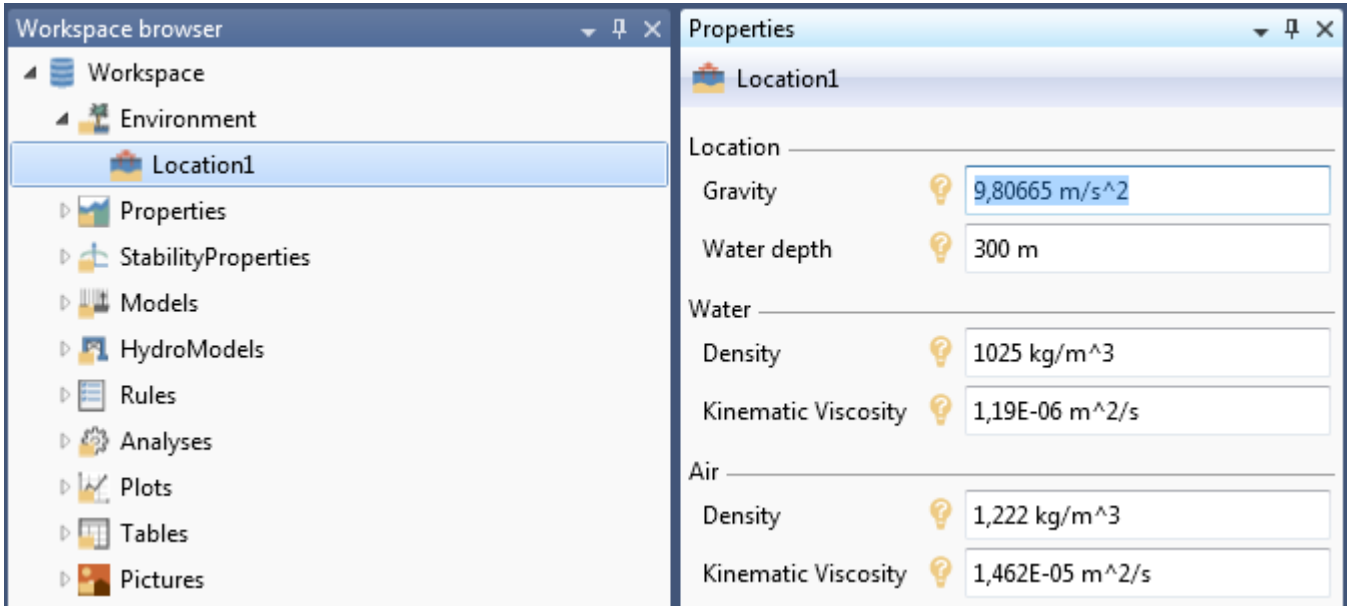
Condition type	Frequency domain condition
	Deterministic time domain condition
Panel model	☑
Morison model	☑
Roll damping	☐
StochasticRollDamping	☐
Pressure panels	☐
Wadam offbody points	☑
Drag linearization	☑
Linearization option	Stochastic drag
	Drag by waveheights
Second order results	☐
Anchor elements	☐
3D Morison elements	☐
TLP elements	☐
Load Cross Sections	☐
Load transfer	☑
Damping matrix	☐
Critical damping matrix	☑
Restoring matrix	☐
Compartments	☐
Damage case	☐

Settings

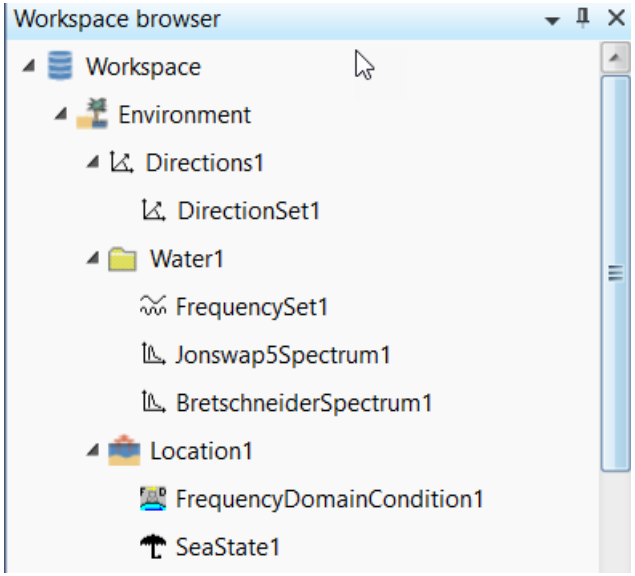
Environment & location

- Location
  - Water & air density and viscosities
  - Gravity
  - Water depth





Environment folder



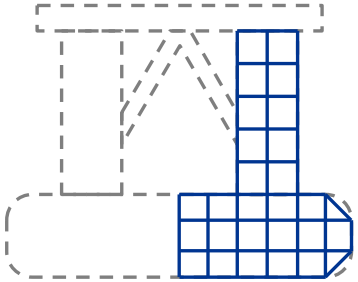
- Locations (one ore more objects)
  - Depth, density, gravity
  - Referring to frequencies, directions, spectrum etc., defined in Directions and Water (hydrodynamic analysis)
- Directions (one or more folders)
  - Direction set
- Water (one or more folders)
  - Frequency set, spectrum, current, wave spreading etc. (hydrodynamic analysis)

Models and their properties

- Element models
- Hydro models
  - Panel, compartment, mass, Morison models

Models for HydroD / Wadam

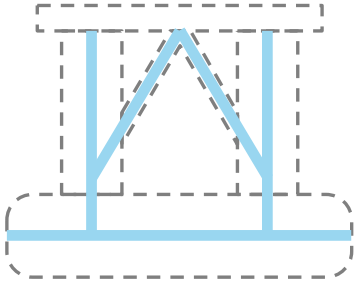
Panel model



- For radiation/ diffraction
- May be ½ or ¼ model if symmetry
- Computes motion and hydrodynamic pressures on panels

e.g. T1.FEM

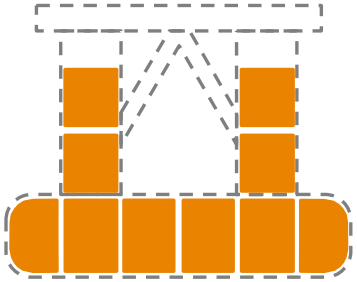
Morison model



- For forces on slender members by the Morison equation
- Computes line loads on beams

e.g. T2.FEM

Compartment model



- For tank fillings
- Contributes to mass
- Hydrodynamic pressures inside tanks

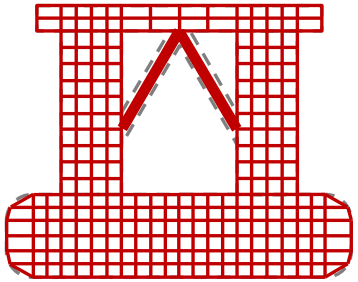
e.g. T3.FEM

Mass model

$$\begin{pmatrix} m_{11} & m_{12} & m_{13} & m_{14} & m_{15} & m_{16} \\ & m_{22} & m_{23} & m_{24} & m_{25} & m_{26} \\ & & m_{33} & m_{34} & m_{35} & m_{36} \\ & & & m_{44} & m_{45} & m_{46} \\ & & & & m_{55} & m_{56} \\ & & & & & m_{66} \end{pmatrix}$$

- Global mass data or mass matrix may be given directly
- Or structural model may be used

Structural FE model



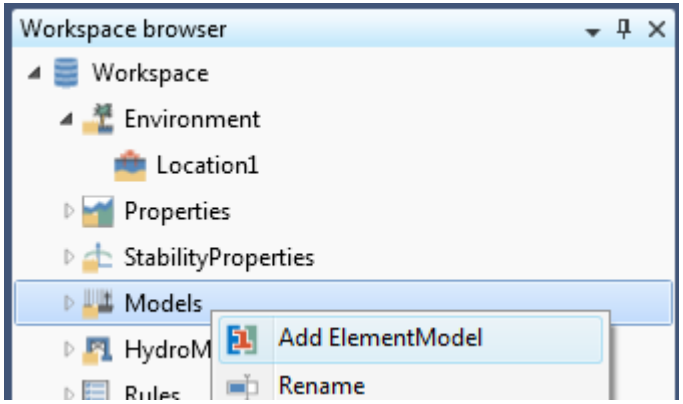
- For subsequent FE structural analysis
- Pressures on panels mapped onto FE model
- May be used as mass model

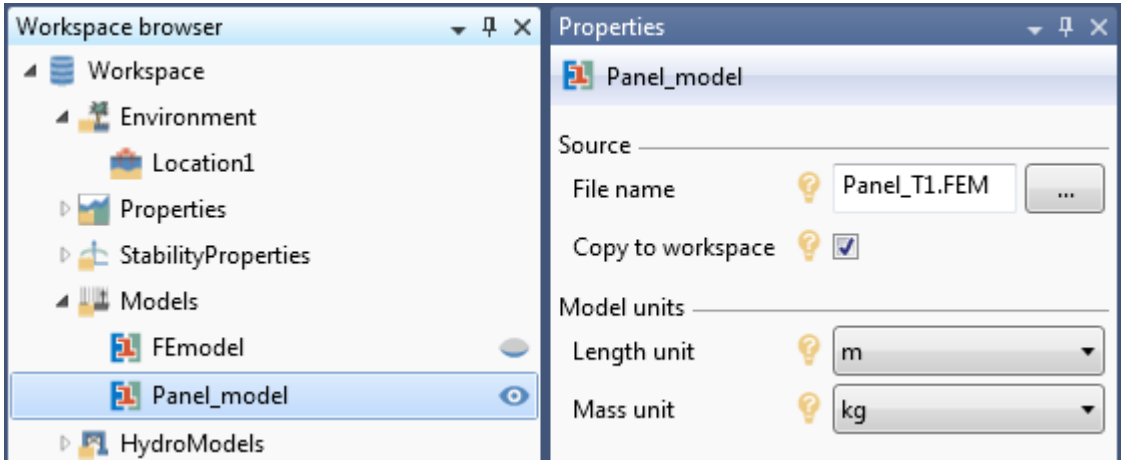
e.g. T4.FEM

May be the same model, e.g. T4.FEM

Element models

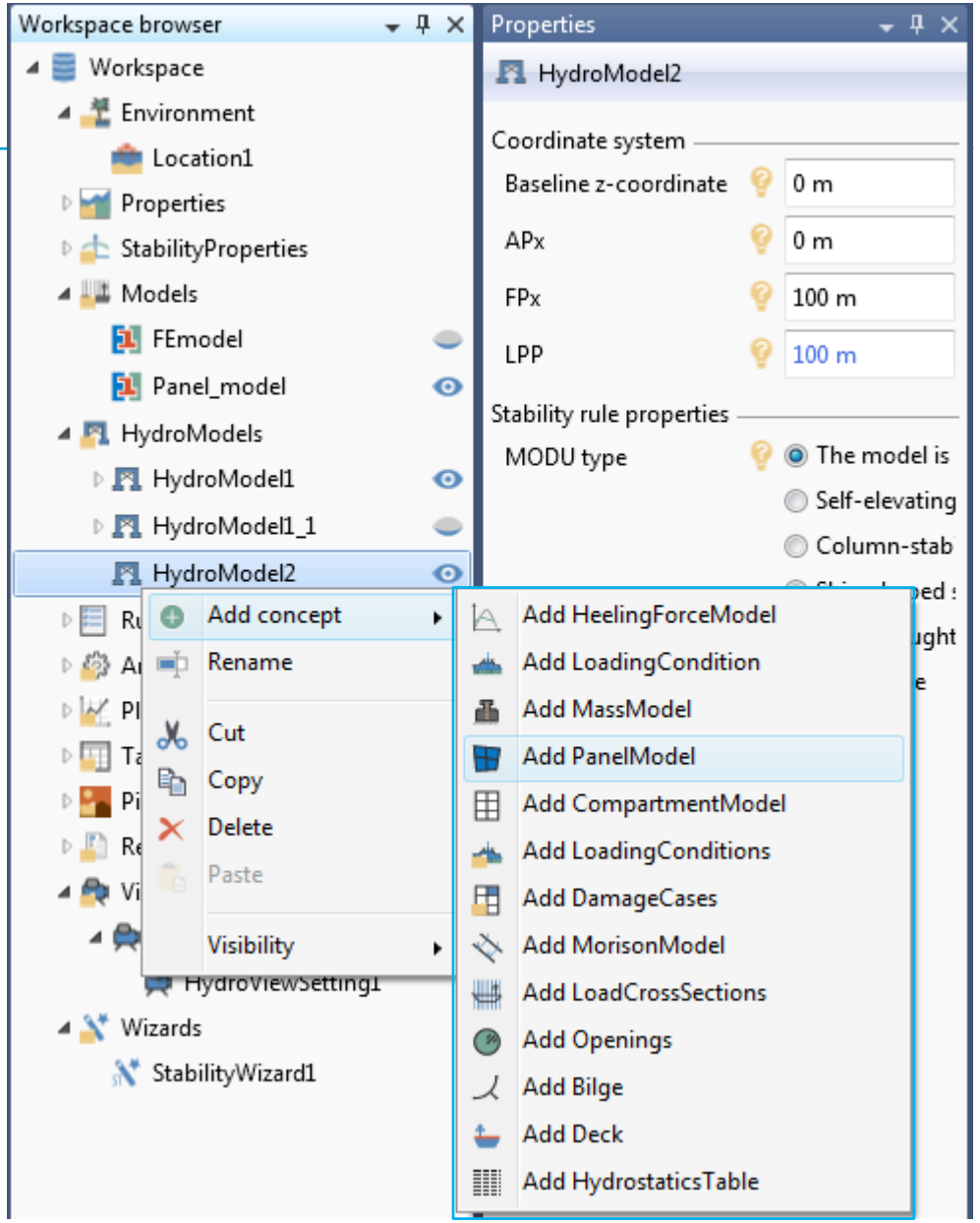
- Element models are imported into HydroD
  - Predefined Sesam T#.FEM files
- Use in analysis as
  - Panel model
  - Mass model
  - Compartment model
  - Heeling force model
- Models may have different length and mass units
- One model may be reused several times
- A model will be displayed when included
- Notice that an element model may be dragged into HydroD





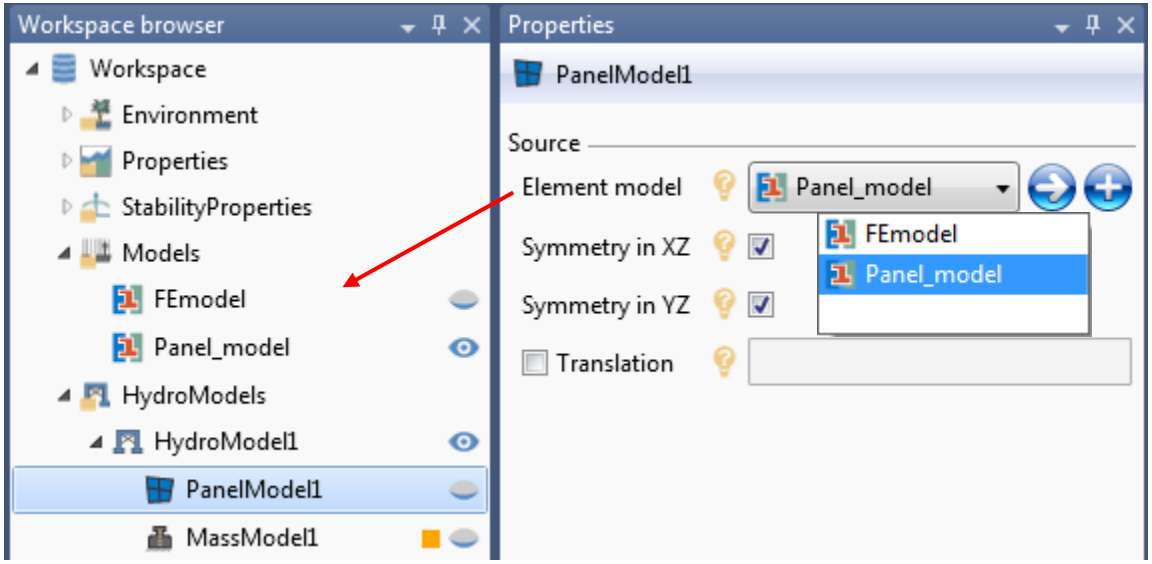
Hydro model

- The assembly of the models and loading conditions to be used in an analysis, including their properties
- Right-click HydroModels to add new concepts
  - Panel model
  - Mass model
  - Morison model
  - Compartment model
  - Loading conditions
  - Damage cases
  - Heeling force model
  - Load cross sections
  - Openings
  - Hydrostatic table
  - Etc.

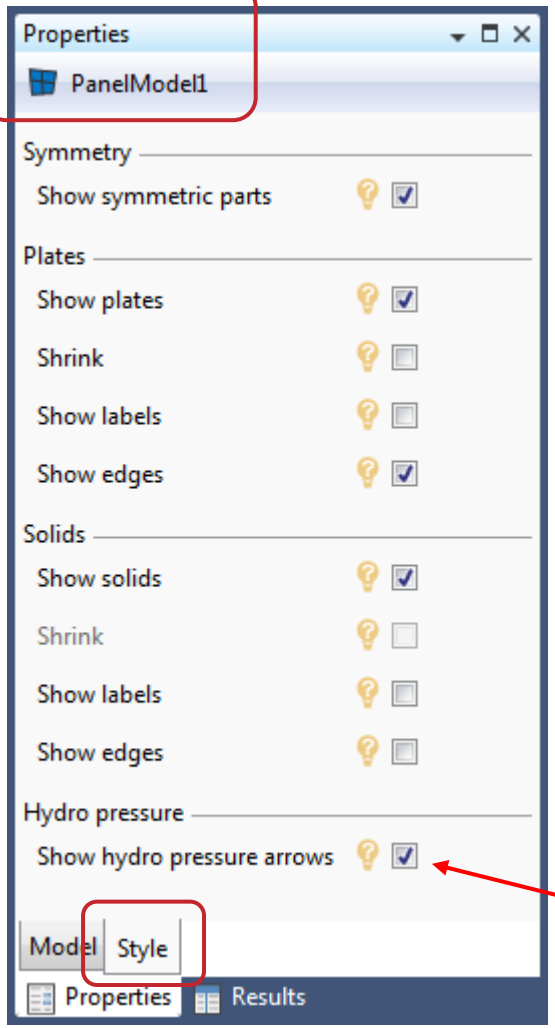


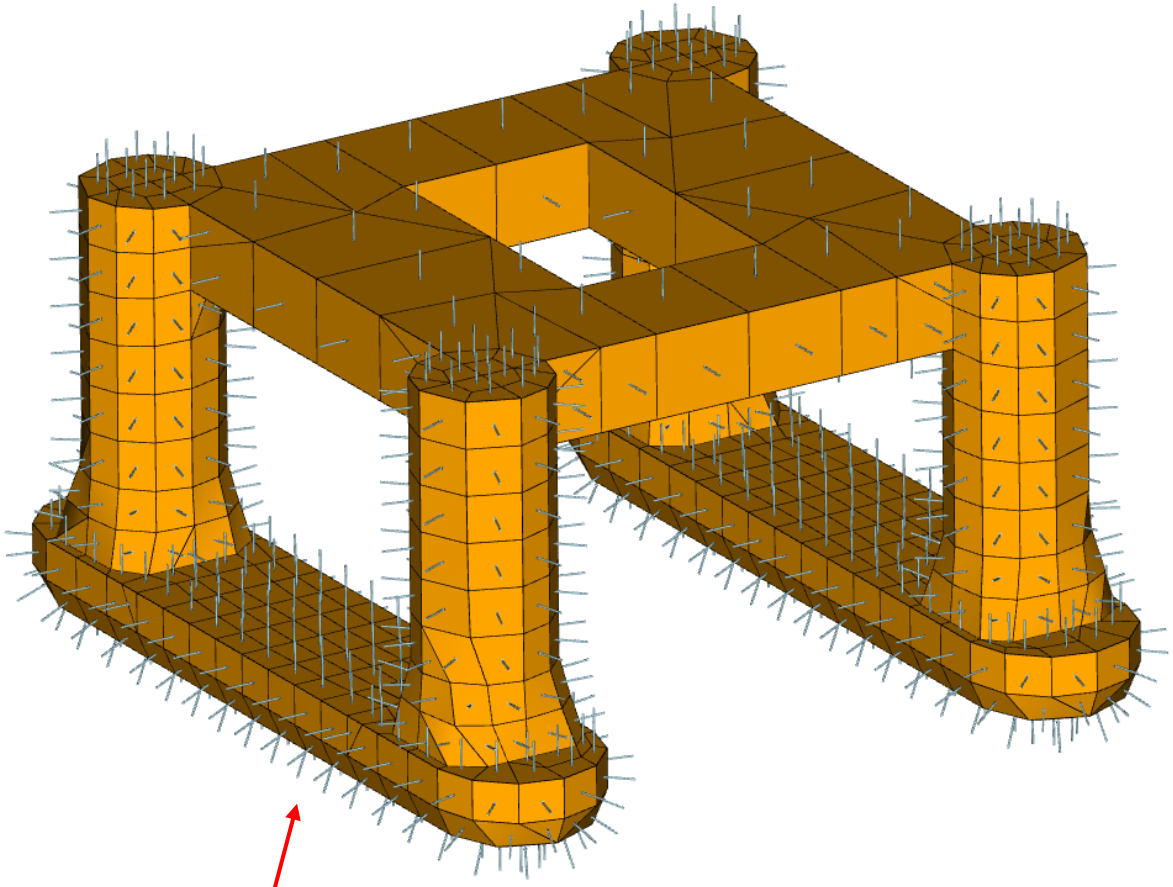
Panel model

- The panel model is selected from the imported element models
- Symmetry options may be used
  - The model must be defined on the positive side of the symmetry planes (positive x- and/or y-coordinate).
- Translation in x or y direction may be defined



View panel model

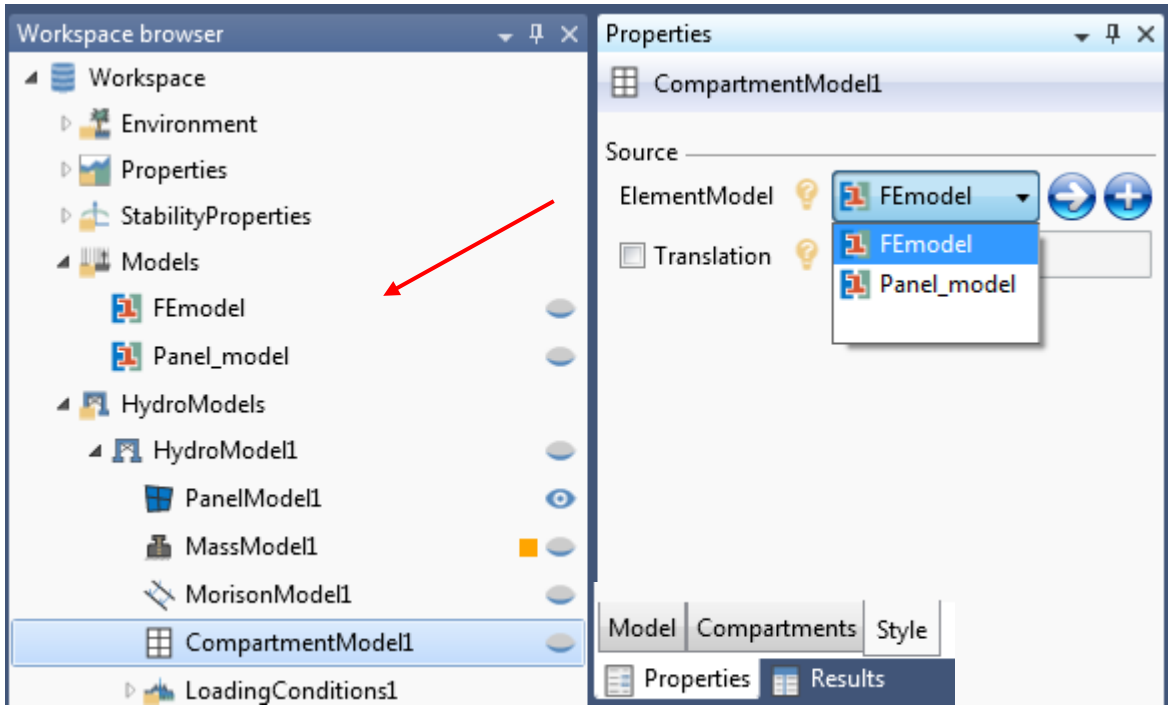


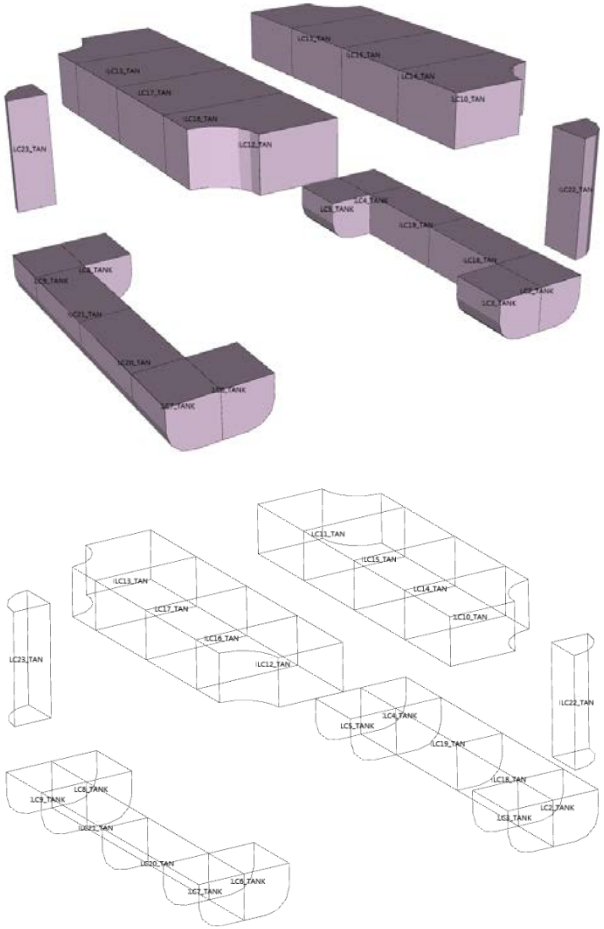


Always check this

Compartment model

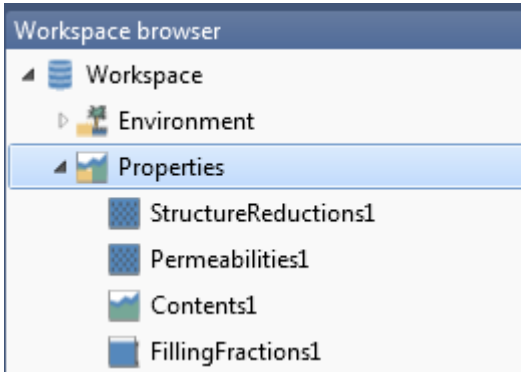
- The panel model is selected from the imported element models
  - Allows compartment modelling (mass modelling)
- No symmetry is permitted
- Notice options for Compartments, Style and Results

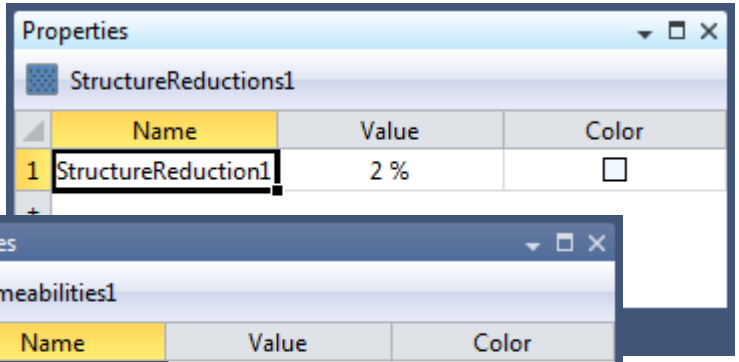


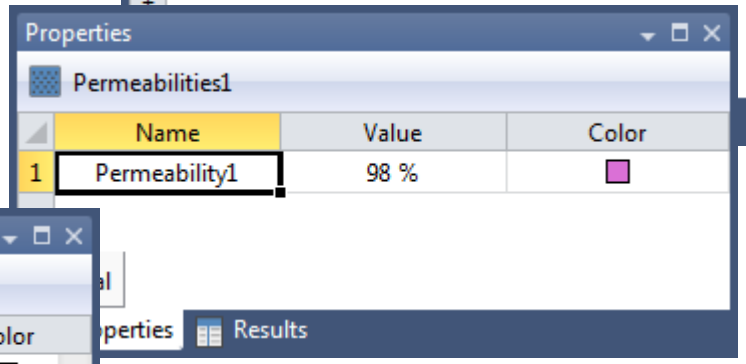


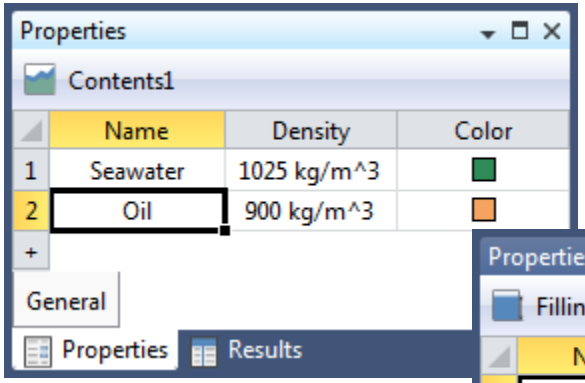
Compartment properties

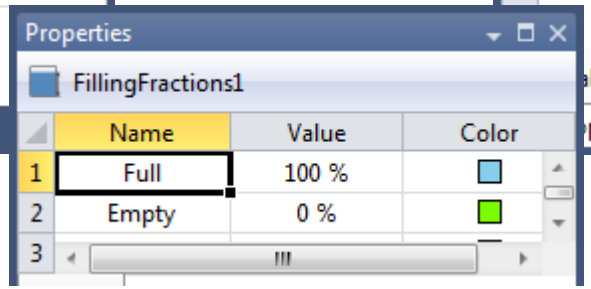
- Structure Reduction
  - Fluid capacity of intact compartments, in %
  - Total capacity = 1 - SR
- Permeability
  - Total fluid capacity of damaged compartments, in %
- Contents
  - Density of contents
- Filling fractions, in %





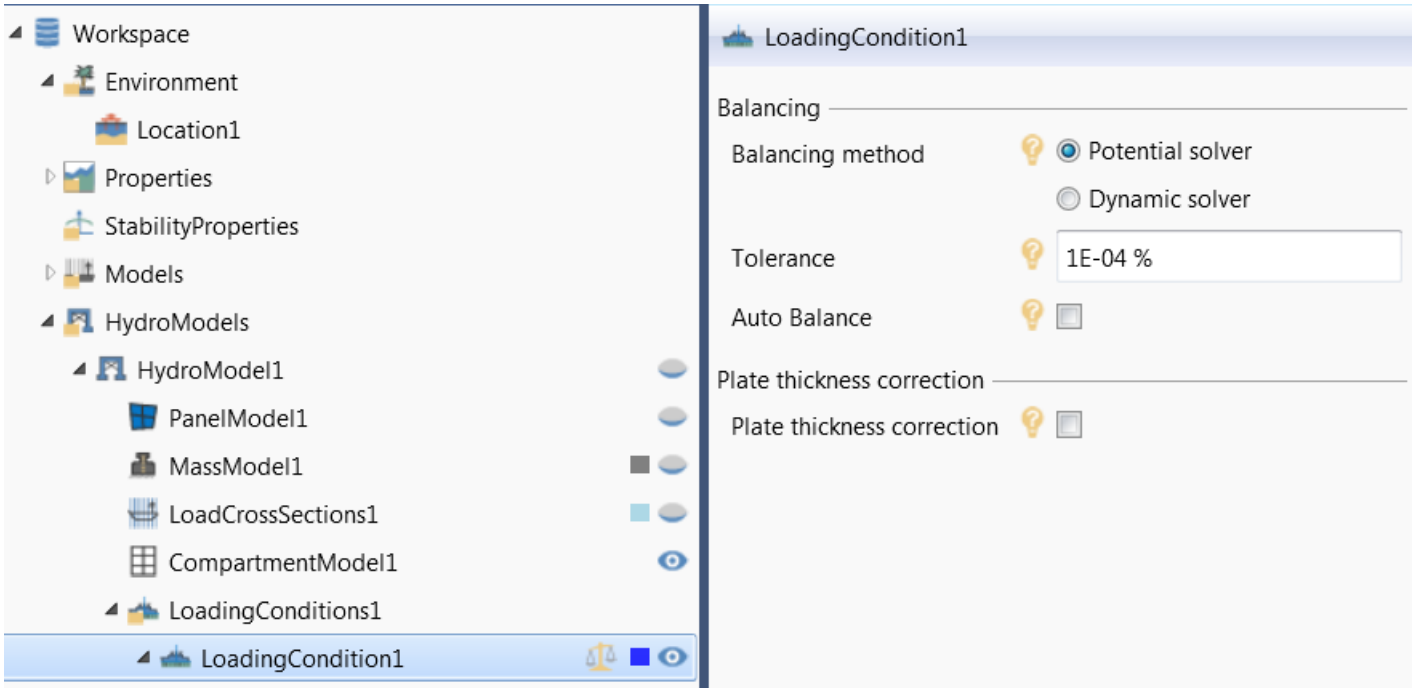






Additional adjustment of compartment volume

- When checking *Plate thickness correction* the volume of the compartments will be reduced using one half of the thickness of the plates defining the wall
  - *Structure reduction* and *Permeability* will be defined relative to this reduced volume
  - This is a property of the Loading condition, not the compartment

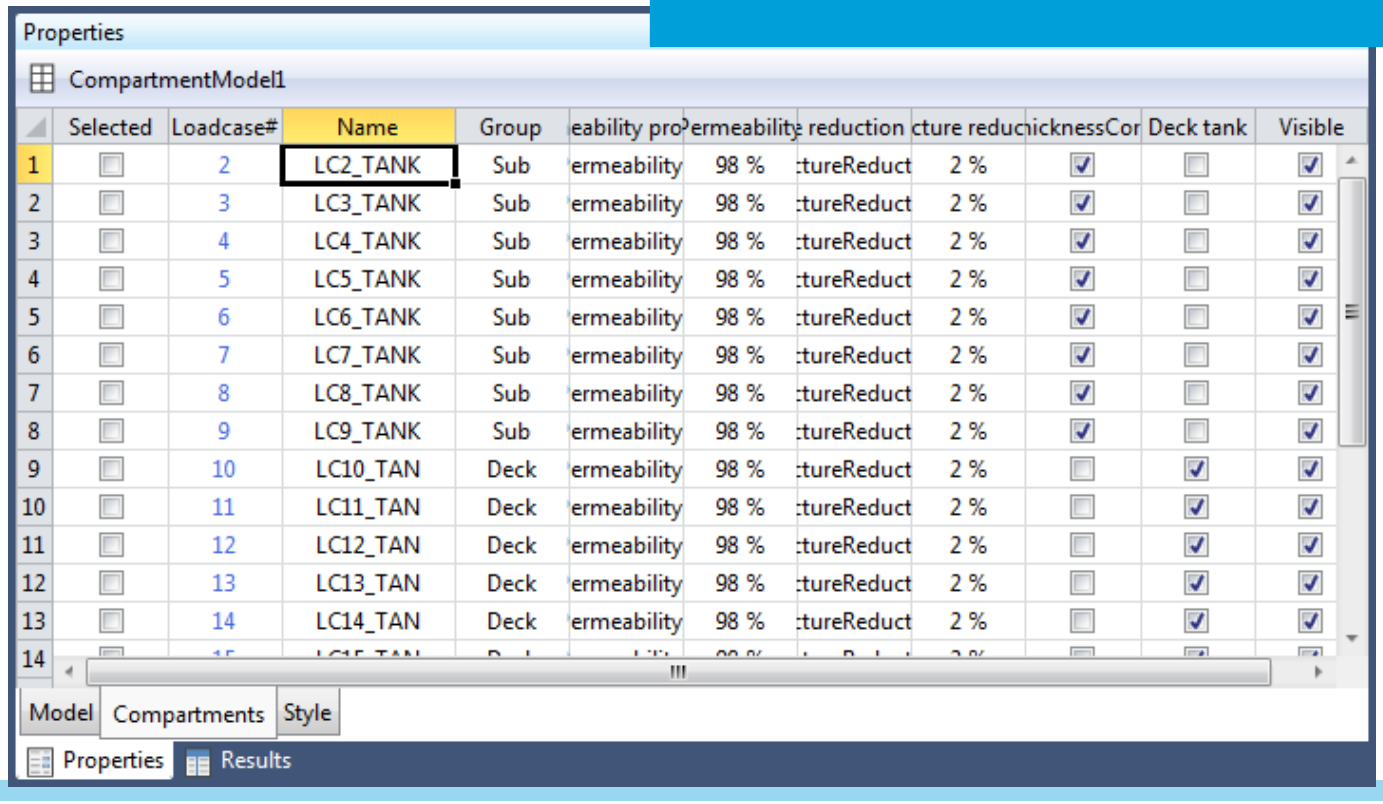


Compartment model properties

- Defining general properties and visibility of compartments
  - Defined in separate load cases, starting with no. 2
  - Permeabilities and Structure reduction
  - Deck tanks

Permeabilities for damaged comp.

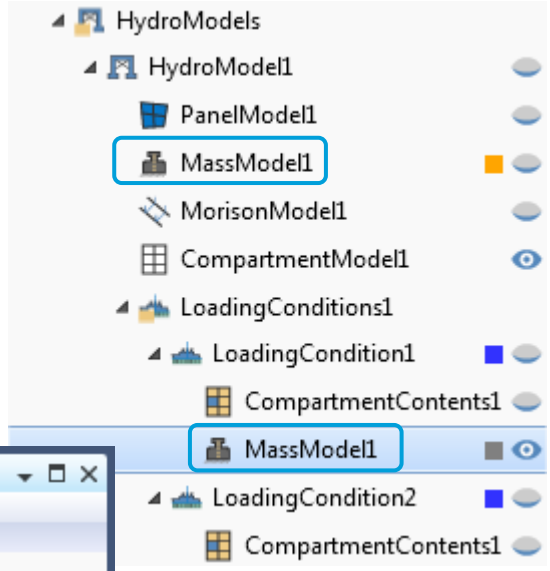
StructureReductions for intact comp.

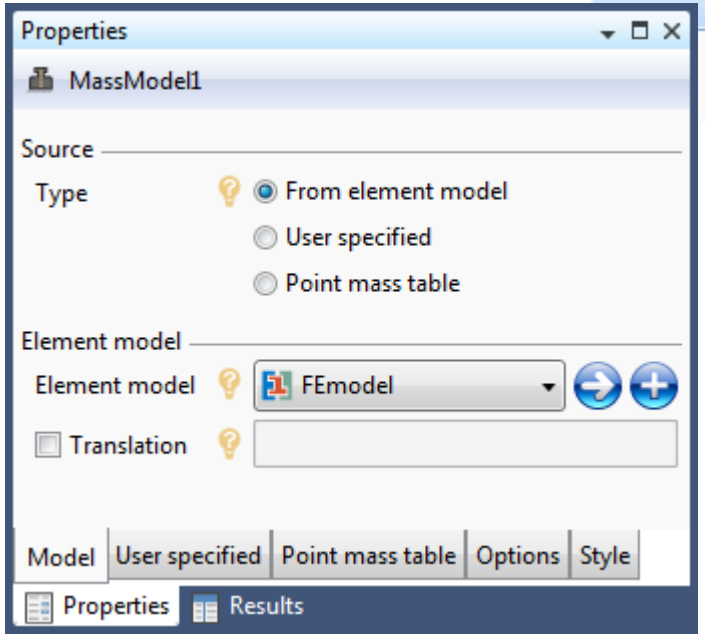


	Selected	Loadcase#	Name	Group	eability pro	ermeability	reduction	cture reduc	ickness Cor	Deck tank	Visible
1	☐	2	LC2_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
2	☐	3	LC3_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
3	☐	4	LC4_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
4	☐	5	LC5_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
5	☐	6	LC6_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
6	☐	7	LC7_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
7	☐	8	LC8_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
8	☐	9	LC9_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
9	☐	10	LC10_TAN	Deck	ermeability	98 %	tureReduct	2 %	☐	☑	☑
10	☐	11	LC11_TAN	Deck	ermeability	98 %	tureReduct	2 %	☐	☑	☑
11	☐	12	LC12_TAN	Deck	ermeability	98 %	tureReduct	2 %	☐	☑	☑
12	☐	13	LC13_TAN	Deck	ermeability	98 %	tureReduct	2 %	☐	☑	☑
13	☐	14	LC14_TAN	Deck	ermeability	98 %	tureReduct	2 %	☐	☑	☑
14											

Mass model

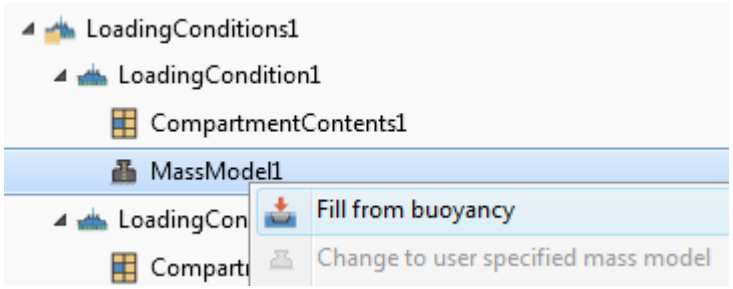
- **Several mass models may be defined for one hydro model**
- A general, light-ship type, mass model in the hydro model
- Separate mass models for additional mass in the loading conditions, optionally together with compartment mass
- All mass model may be defined either
  - From element model
  - User specified
  - Point mass table



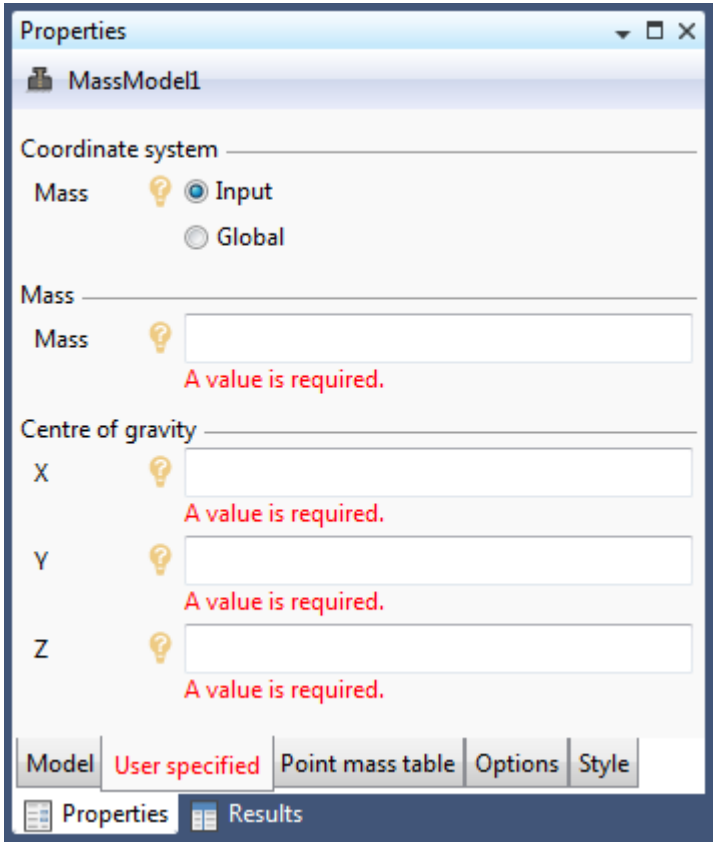


Mass model – User specified

- Mass data defined by the user
  - Total mass
  - COG
- For a mass model in a loading condition, the mass can be computed from the buoyancy

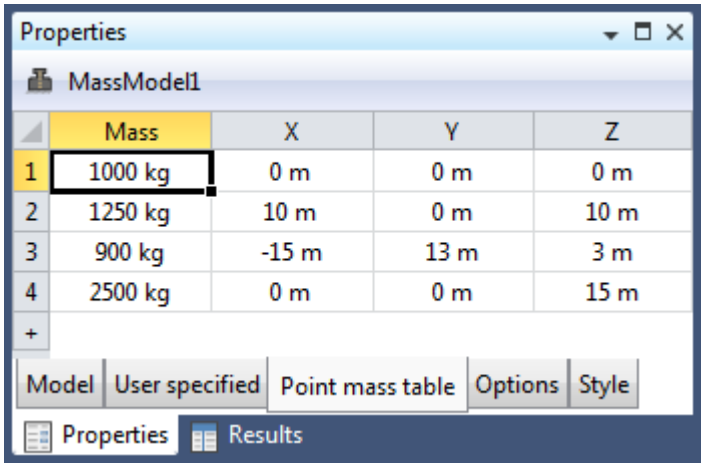


- An existing mass from an element model may optionally be changed to a user specified mass

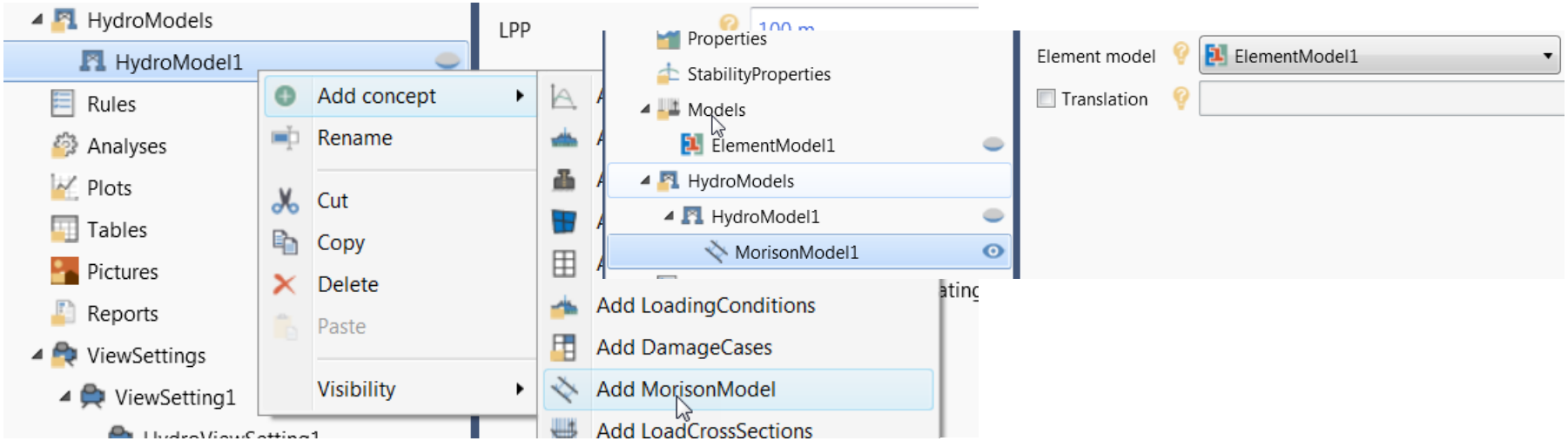


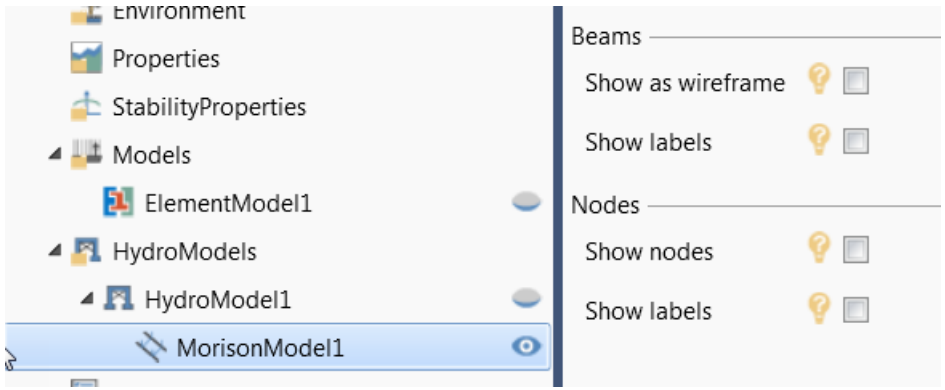
Mass model – Point mass table

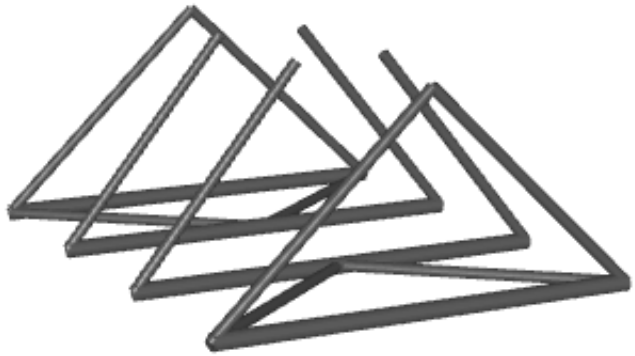
- Mass data defined by the user
  - Mass points with coordinates
- For all mass models, the actual mass values can be seen in the results tab



Morison model

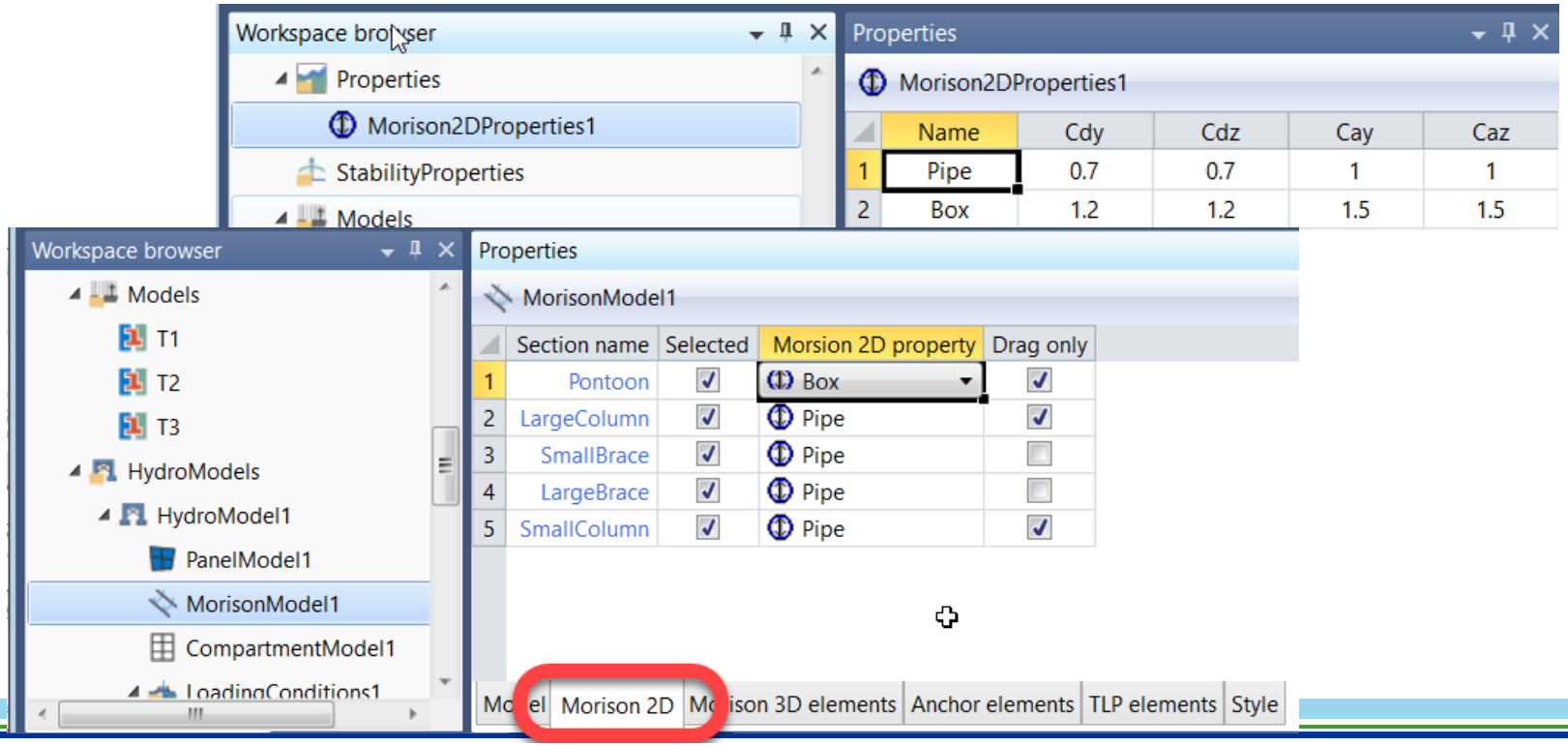






Morison section

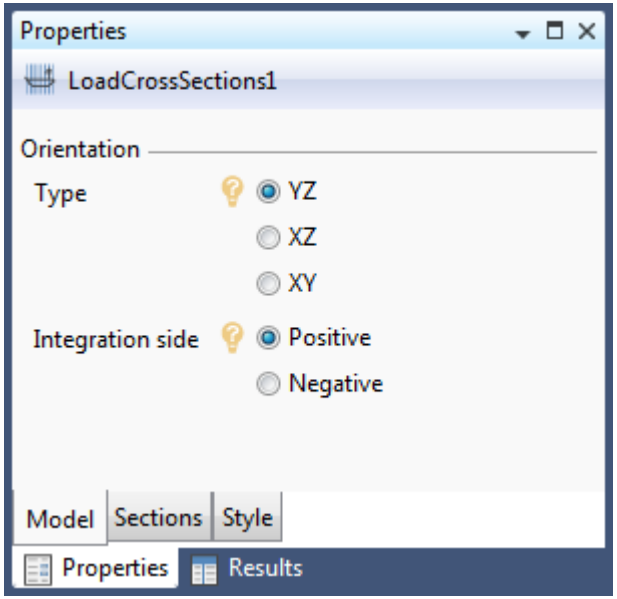
- HydroD will use cross sections as defined in the model (T-file)
- The user must define drag and added mass coefficients
- Coefficients must be assigned to the sections
- Use “Drag only” for sections that are also included in the panel model
  - Added mass and buoyancy will be taken from the panel model

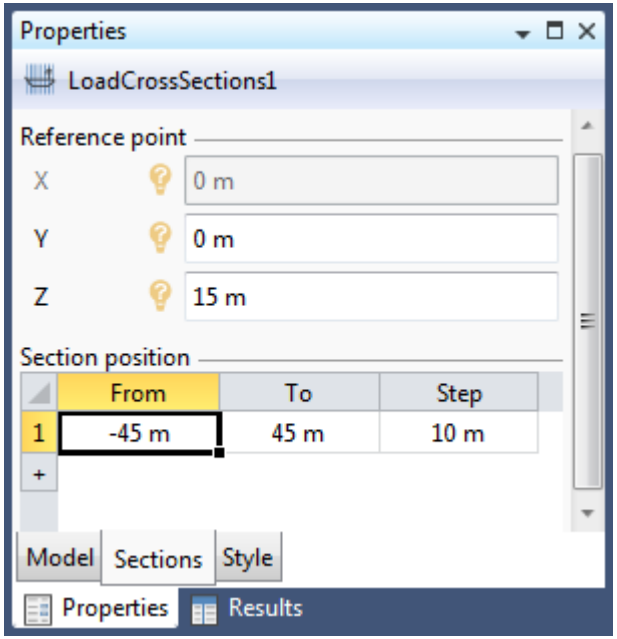


Cross sectional loads

Sectional loads

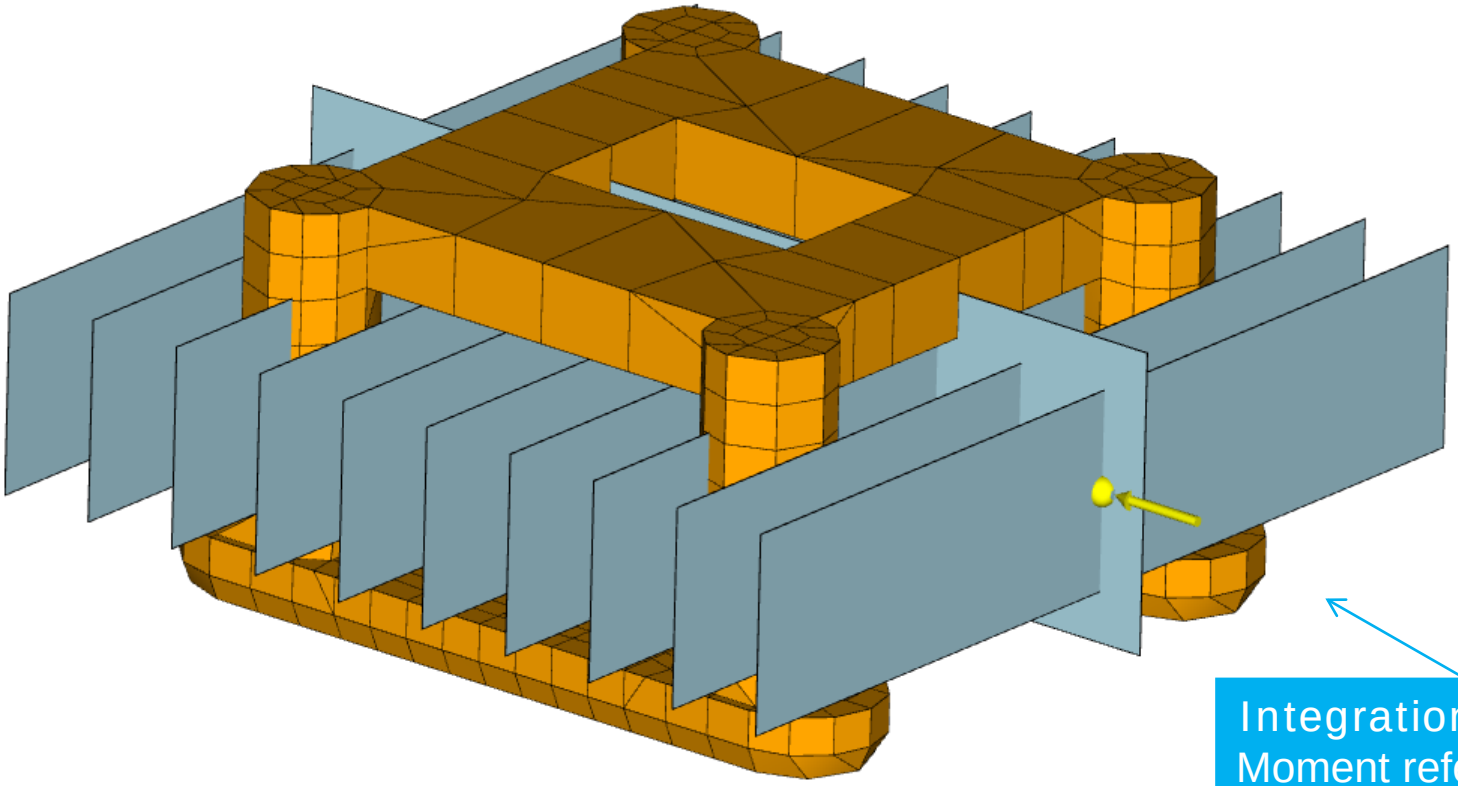
- Cross sections may be defined for calculation of still water cross sectional forces and moments.
  - Requires a mass model defined from element model
- The section is parallel with one of the planes XY, XZ, YZ
- Single or multiple sections





Sectional loads continued

- More than one load cross section concept may be added, in different directions and positions



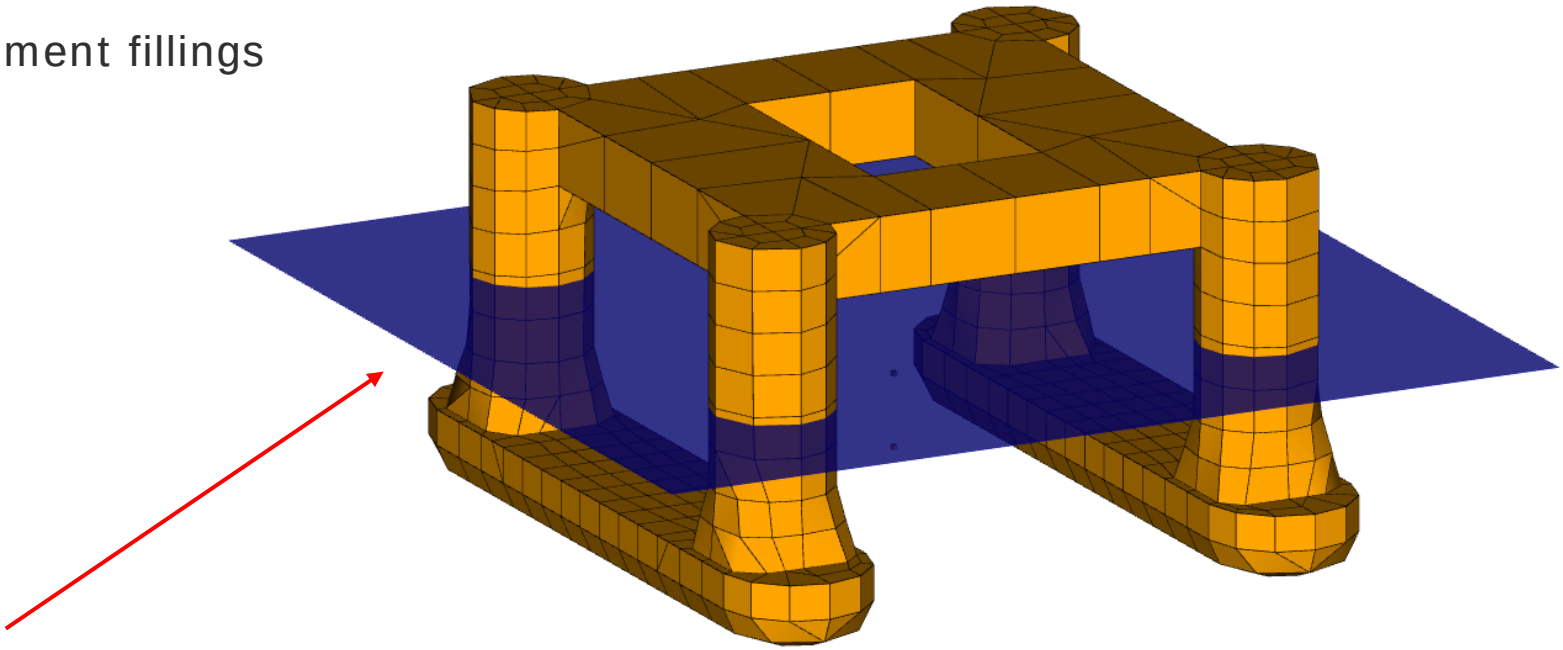
Loading conditions

- Draught
- Trim & heel
- Compartment data
- Damaged case

Loading condition

A loading condition is a place-holder for data that relates to a certain draft and Trim / Heel angles:

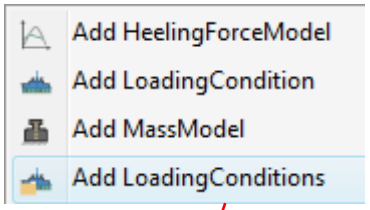
- Free surface position
- Optional Mass model
- Compartment fillings

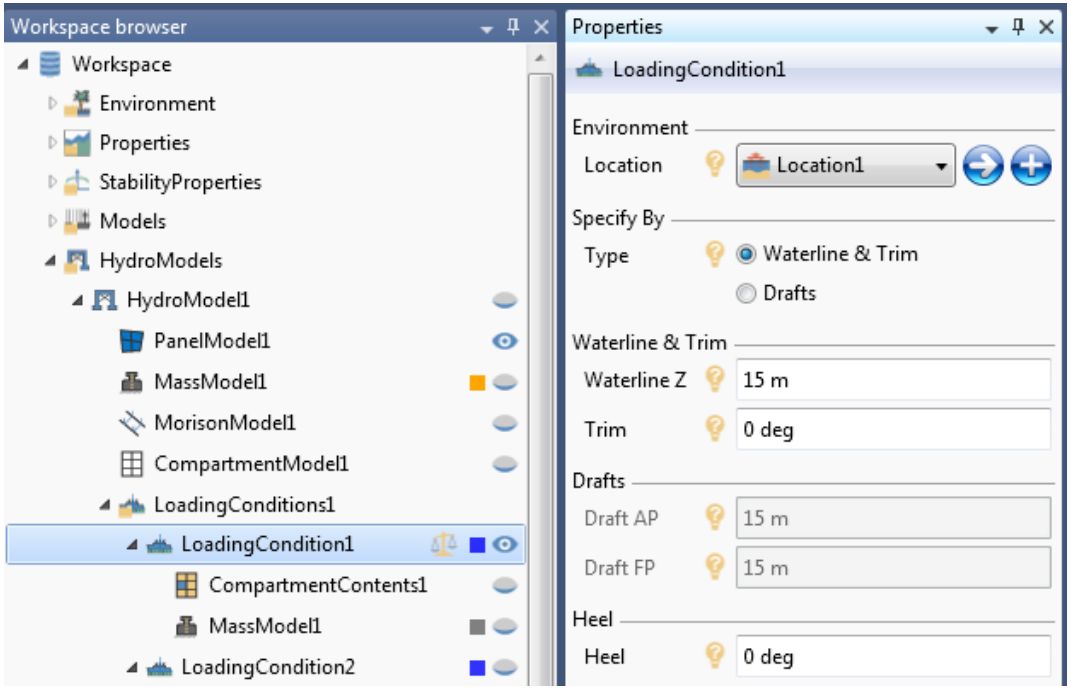


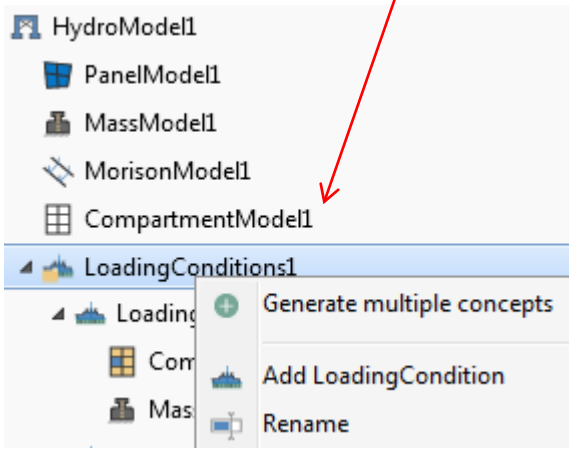
Display of loading condition by displaying the mean free surface

Creating a loading condition

- One or more loading conditions may be defined in the hydro model
  - Give waterline or draughts at AP and FP, input system
- Multiple loading conditions may be defined efficiently

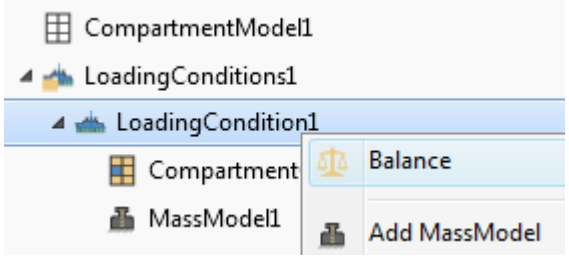


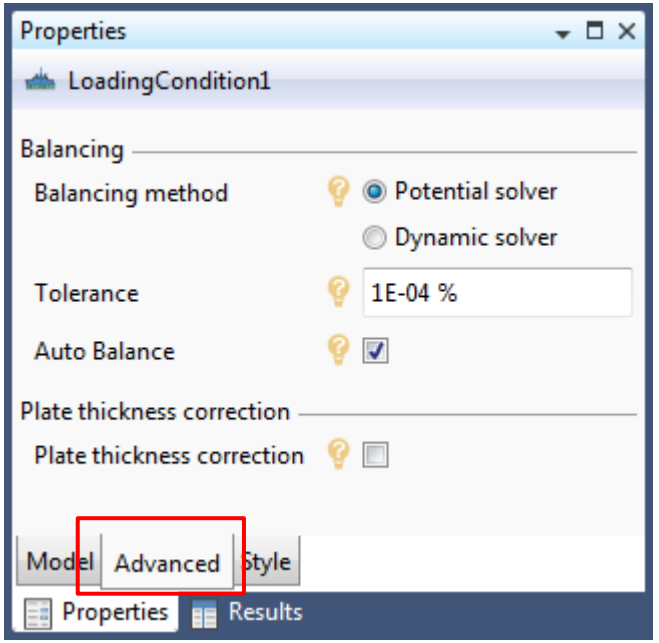




Creating a loading condition continued

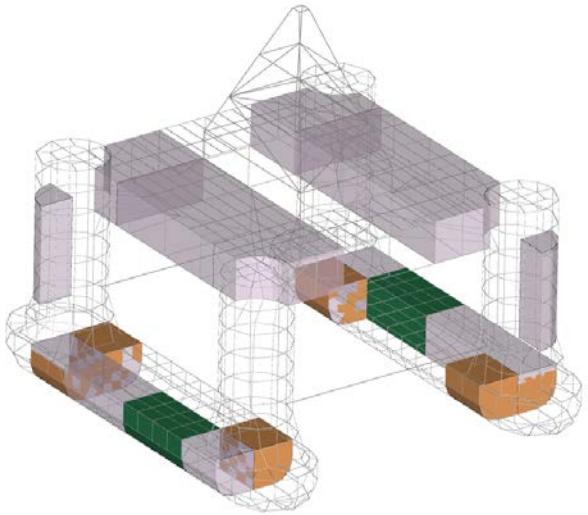
- To obtain equilibrium between buoyancy and mass, either
  - Use the Balance option (right-click)
  - Use the advanced options:
    - Potential solver: Find the equilibrium condition by minimizing the hydrostatic potential energy.
    - Dynamic solver: Find the equilibrium by solving a set of equations of motion with artificial damping.
    - Auto Balance: Automatically balance the loading condition when a dependency is modified
    - Plate thickness correction
- Calculated data are found in the Results tab





Compartments in loading condition

- Define contents and filling fractions
- Using predefined properties or direct input
- Definitions reflected in the display
  - Colours and fillings



Properties

CompartmentContents1

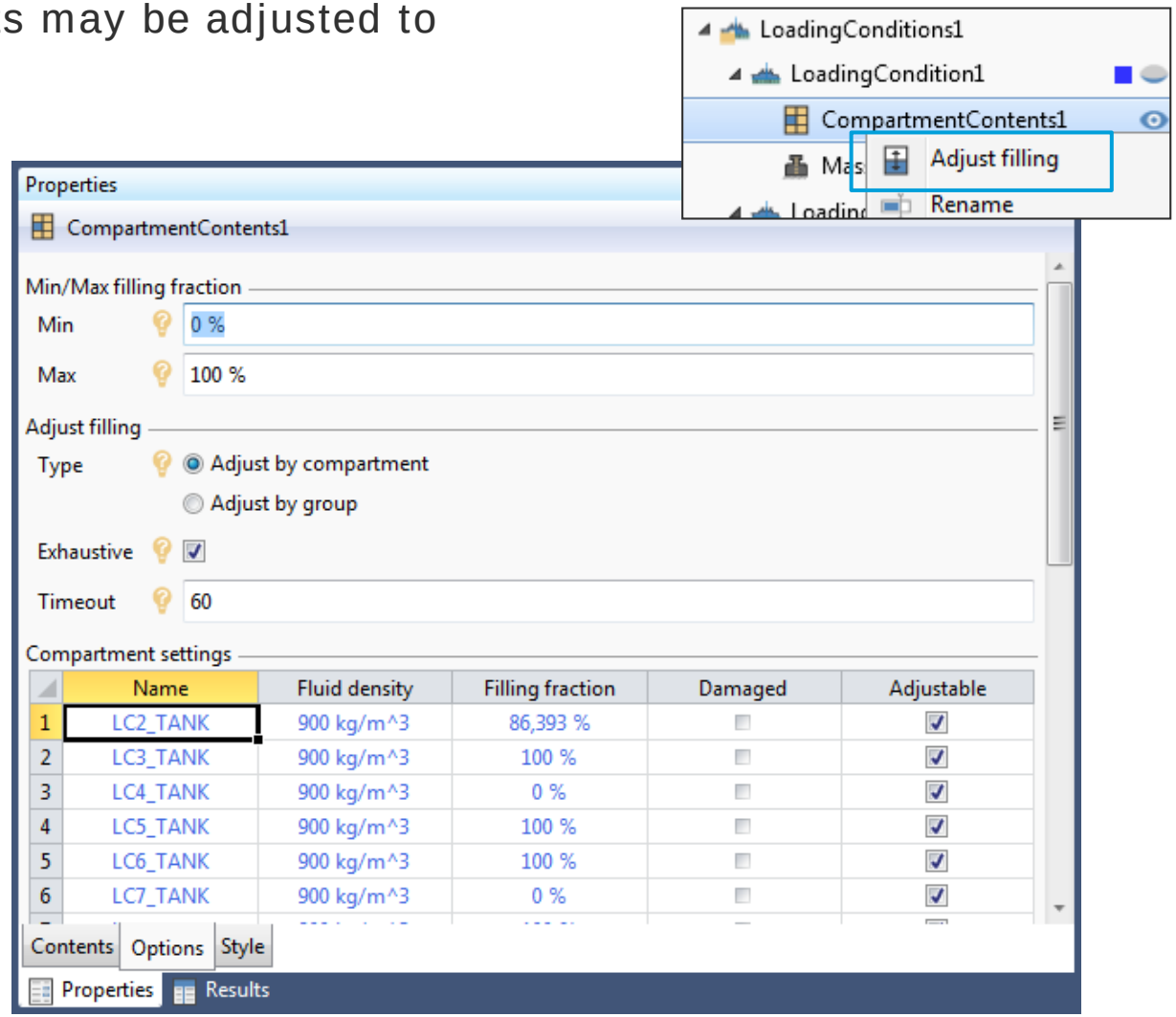
	Selected	Name	Fluid	Fluid density	illing proper	illing fractio	tact fluid ma	Damaged	FreeSurface	Group
1	☐	LC2_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg	☐	☑	Sub
2	☐	LC3_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg	☐	☑	Sub
3	☐	LC4_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg	☐	☑	Sub
4	☐	LC5_TANK		1000 kg/m^		20 %	98337 kg	☐	☑	Sub
5	☐	LC6_TANK	Oil	900 kg/m^3	Half	50 %	,2126E+05 k	☐	☑	Sub
6	☐	LC7_TANK	Oil	900 kg/m^3	Full	100 %	,4252E+05 k	☑	☑	Sub
7	☐	LC8_TANK	Seawater	1025 kg/m^3	Full	100 %	,0398E+05 k	☐	☑	Sub
8	☐	LC9_TANK	Seawater	1025 kg/m^3	Full	100 %	,0398E+05 k	☑	☑	Sub
9										

Contents | Options | Style

Properties | Results

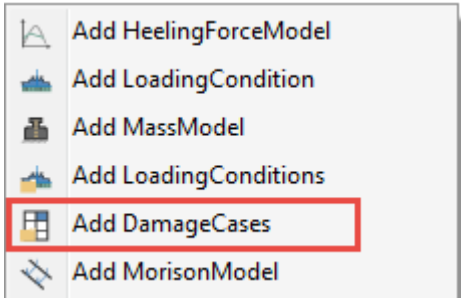
Compartments – Balancing

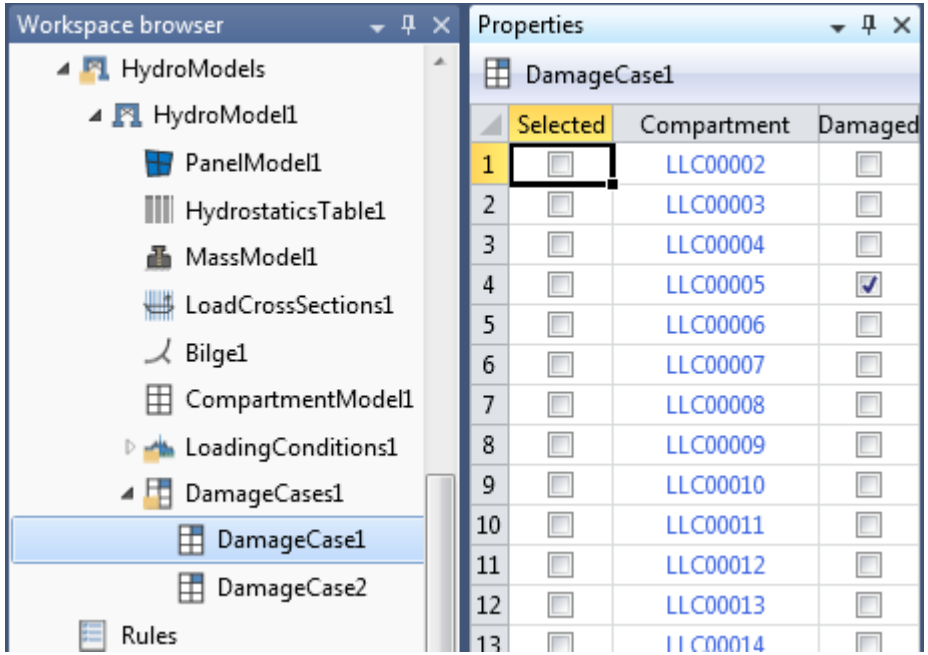
- The compartment contents may be adjusted to the buoyancy
- Compartments are selected from the Options tab in the Property view
- Compartments may be grouped to keep the same filling fraction

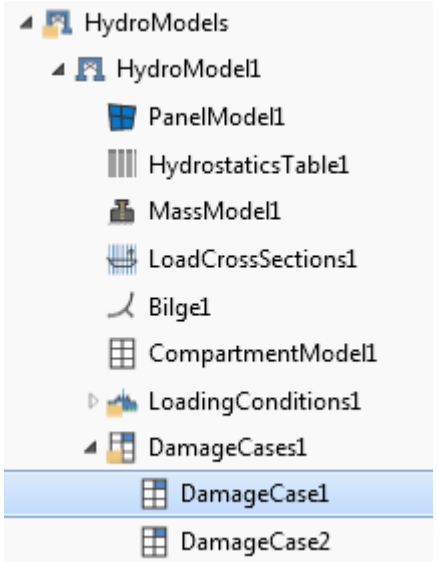


Creating a damage case

- One or more damage cases may be defined in the hydro model
- Select one or more compartments as damaged







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