SOFTWARE

Sesam user course

HydroD Input

DNV GL

02 May 2016

Ungraded

SAFER, SMARTER, GREENER

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

Ungraded

Agenda

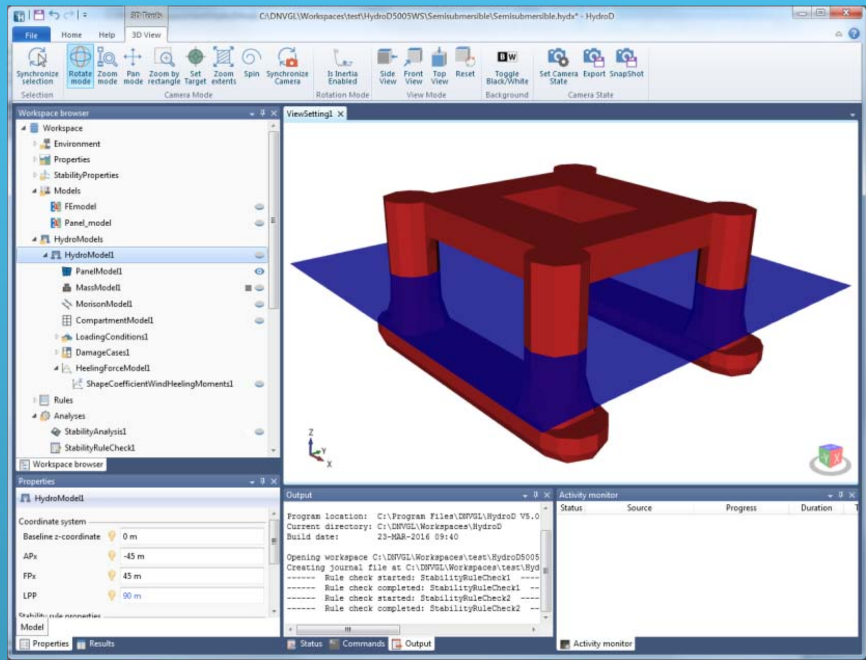
- Tuesday
  - 8.15 – 11.00 Presentations
    - Input to HydroD
    - Stability analysis
    - Wadam
  - 11.00 - 12.15 Lunch
  - 12.15 – 13.00
    - Wadam & HydroD
  - 13.00 – 16.00
    - Workshop stability analysis (Goliat)
- Wednesday
  - 8.15 – 10.00
    - Statistical post processing (Postresp)
  - 10.15 – 14.00
    - Workshop hydrodynamic analysis (Trym)

Ungraded

Scope of presentation

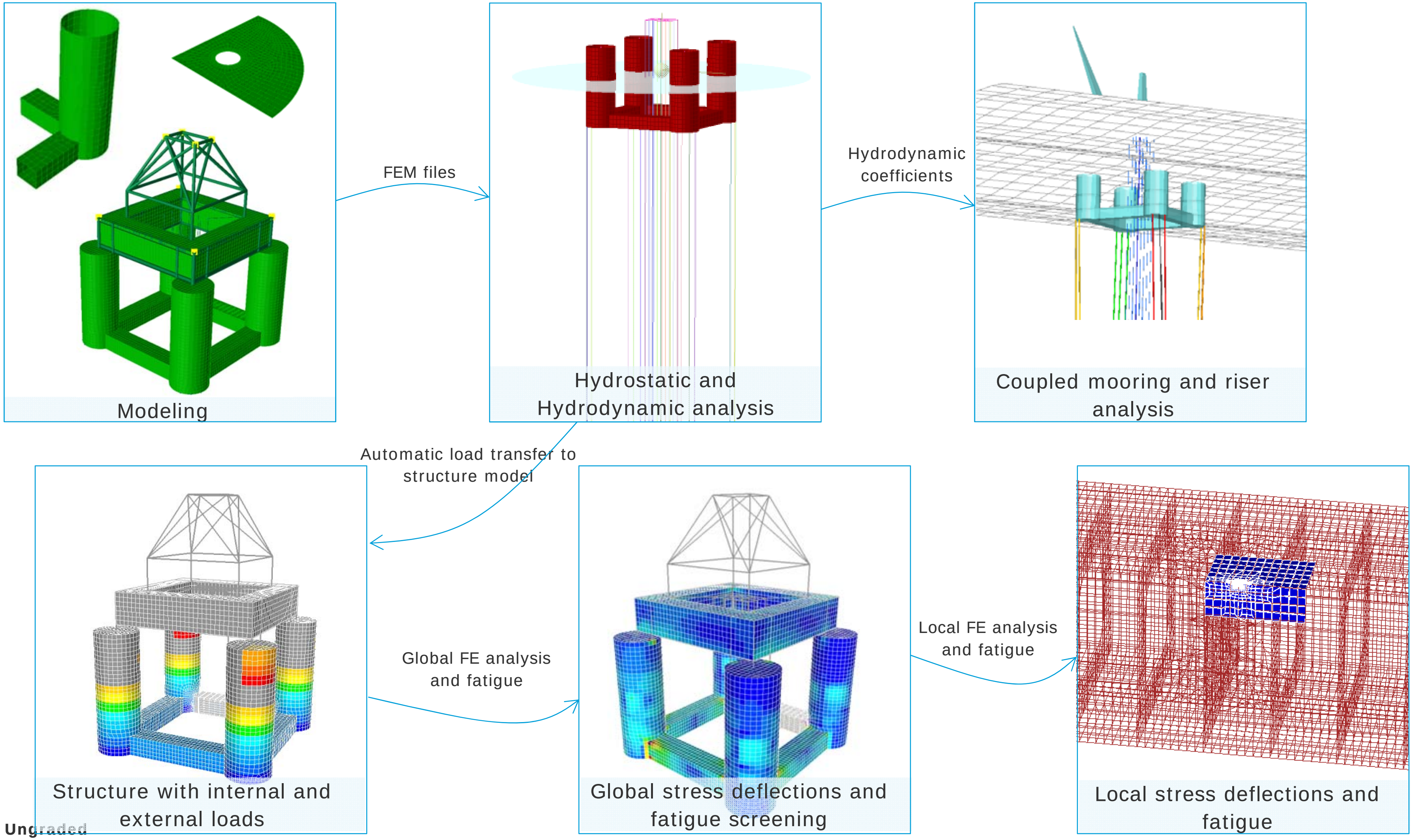
Describe commands needed for definition of environment and models, and their properties

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



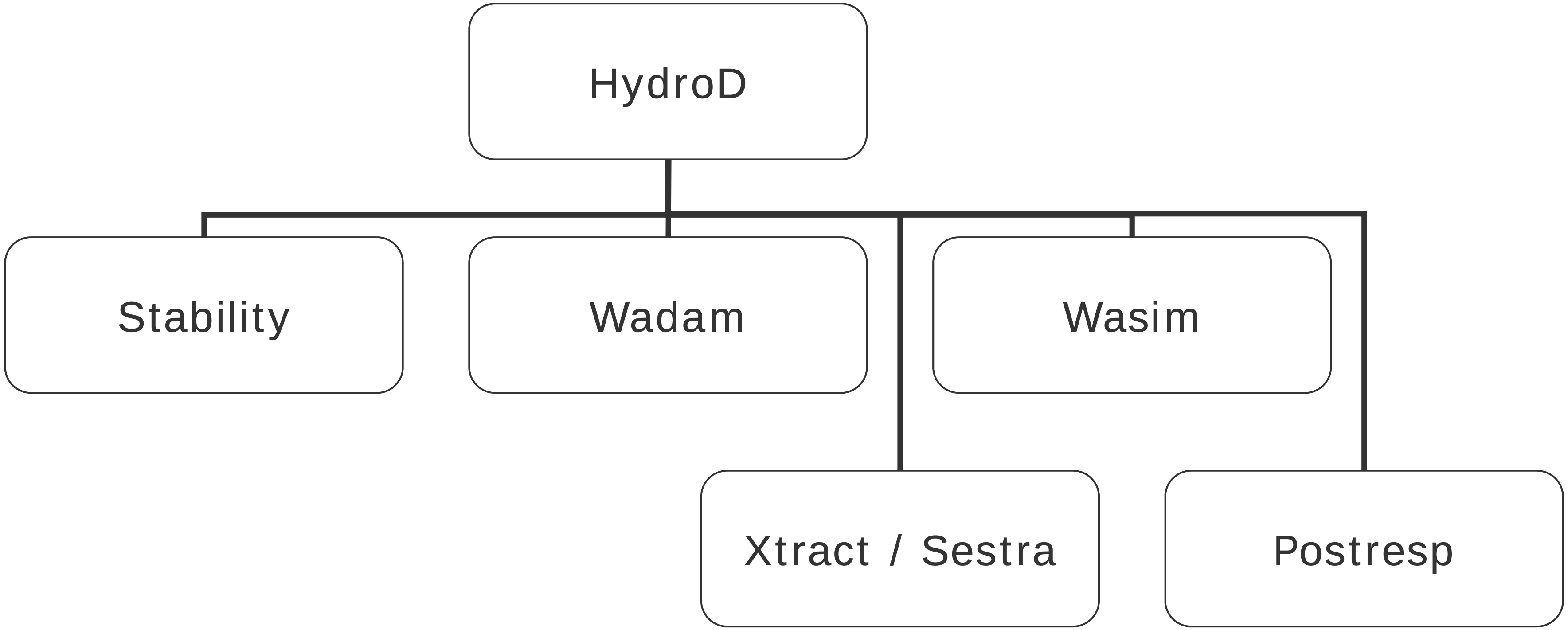
Ungraded

Sesam – a fully integrated analysis system



Ungraded

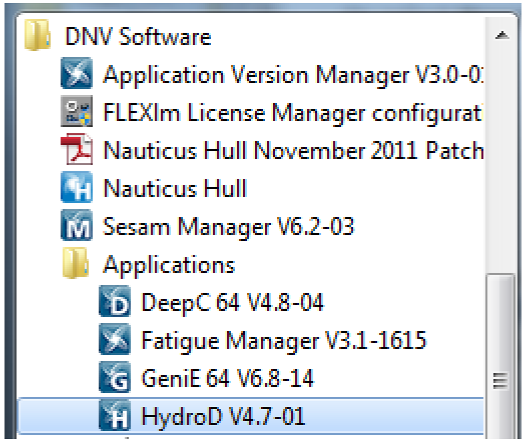
HydroD – Main modules

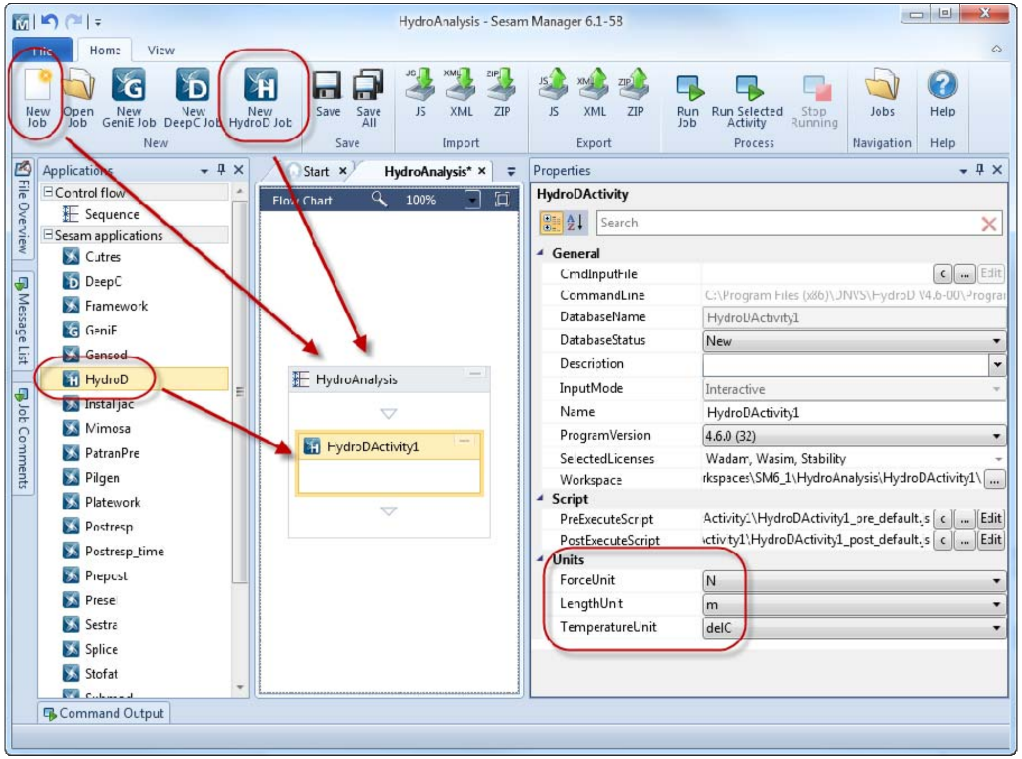


Ungraded

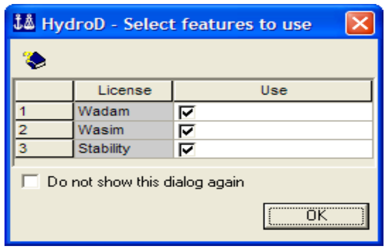
How to start the program

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





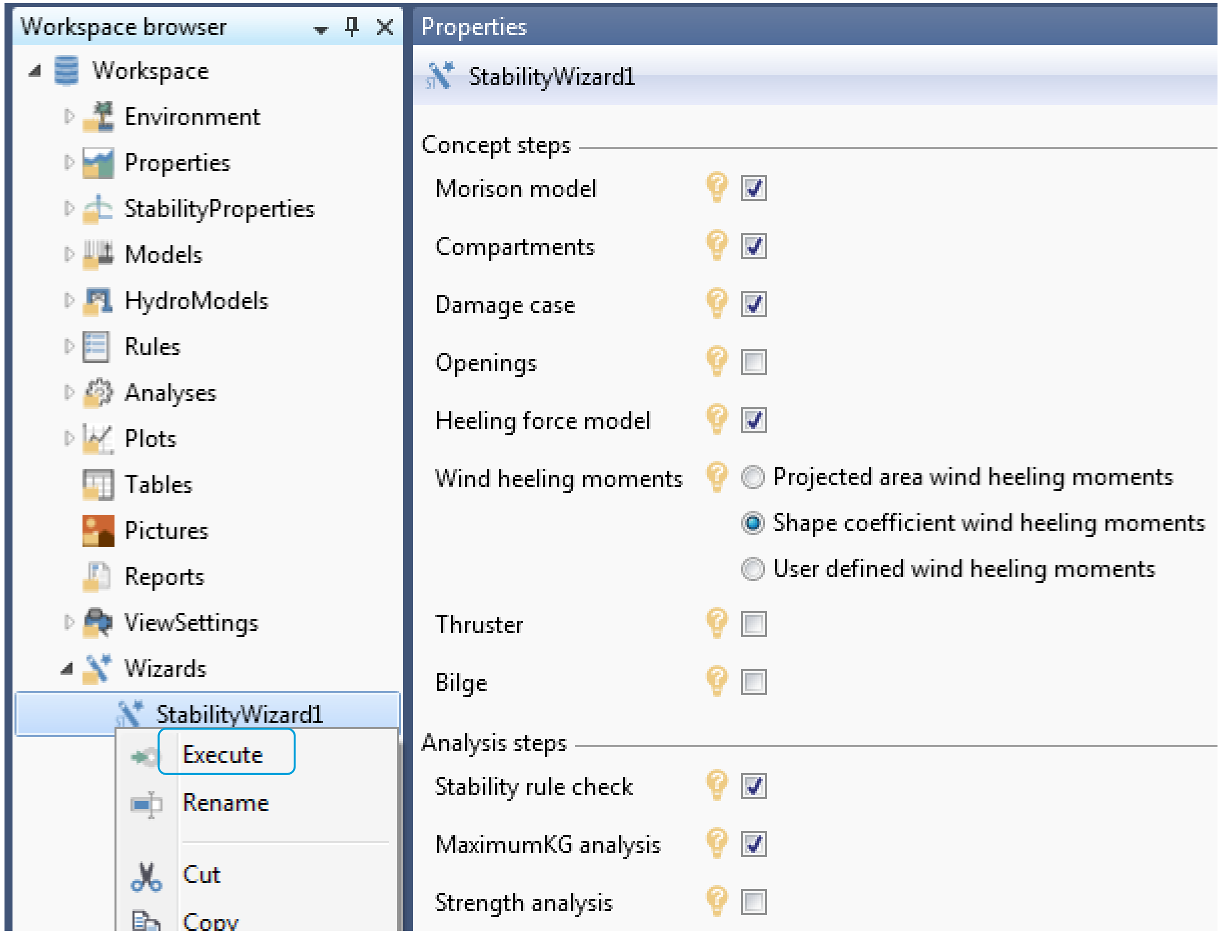
- Select licenses to use:
  - If not needed, a license can be left for other users



Ungraded

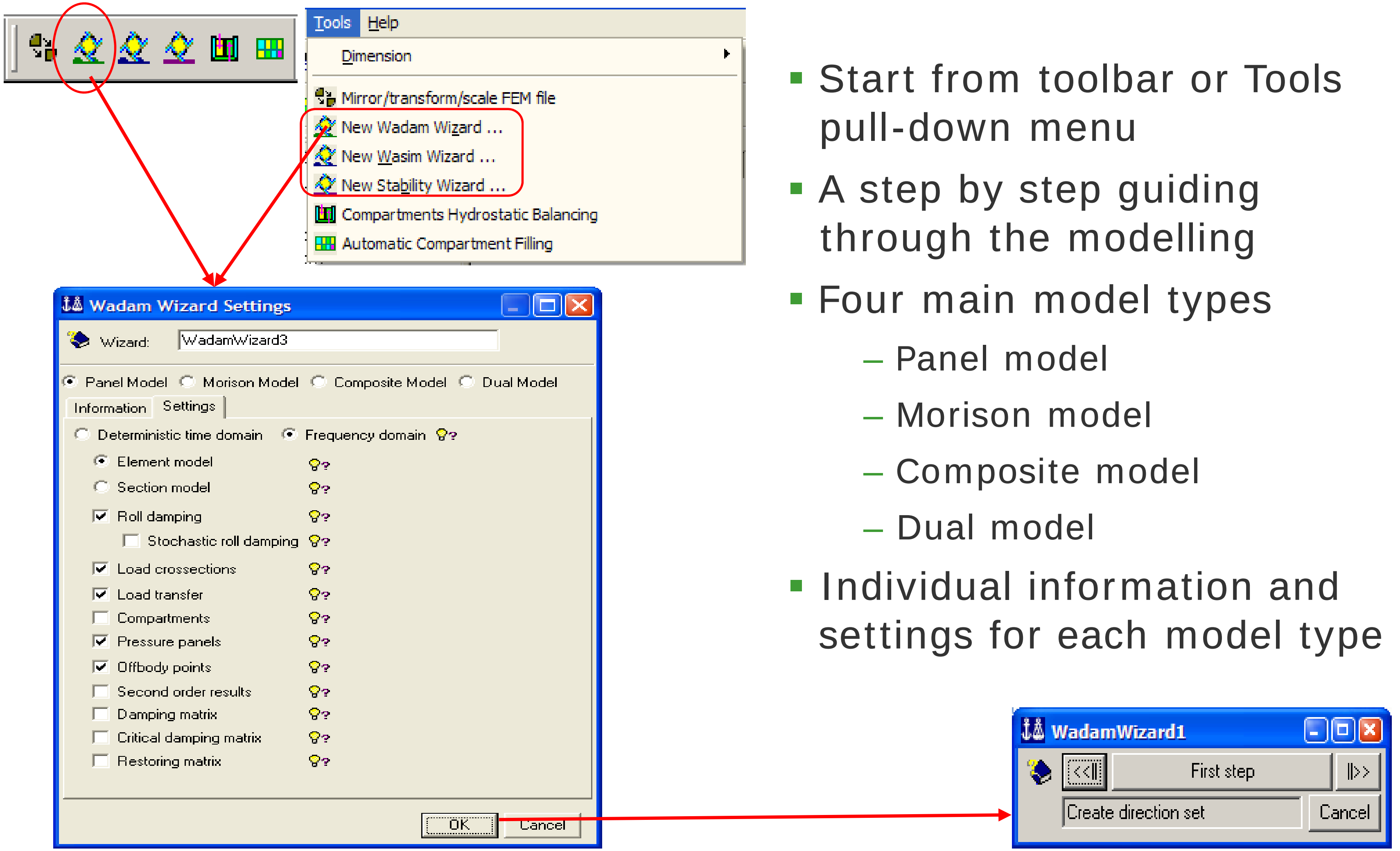
Wizard – A useful tool – H5

- 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



Ungraded

Wizard – Wadam – H4

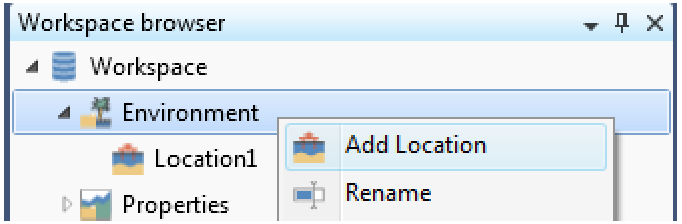


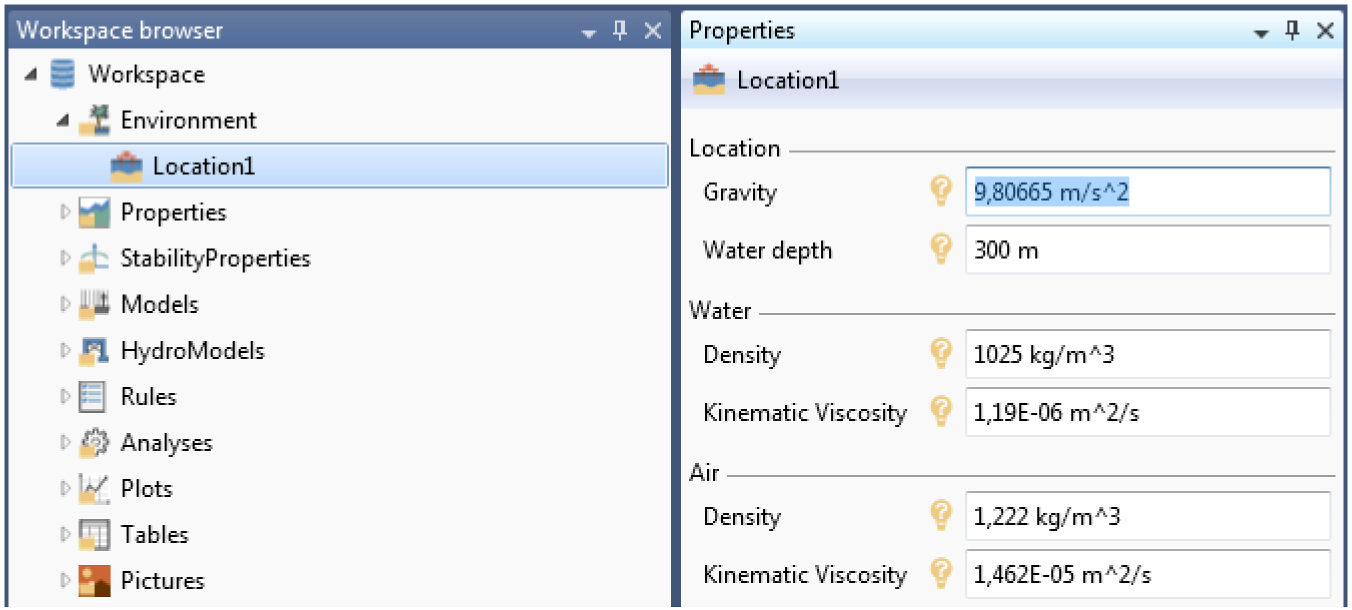
- Start from toolbar or Tools pull-down menu
- A step by step guiding through the modelling
- Four main model types
  - Panel model
  - Morison model
  - Composite model
  - Dual model
- Individual information and settings for each model type

Ungraded

Environment & location – H5

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





Ungraded

Environment folder – H4

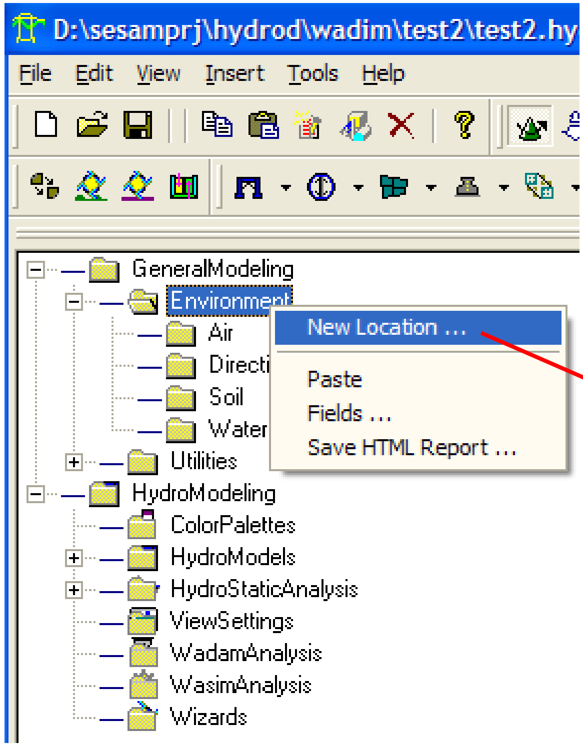
- Locations, (one ore more objects)
  - Depth, density, gravity
  - Referring to frequencies, directions, spectrum etc., defined in Directions and Water (hydrodynamic analysis)
- Air
  - Wind profiles (hydrostatic analysis)
- Directions
  - Direction set, directions (hydrodynamic analysis)
- Water
 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

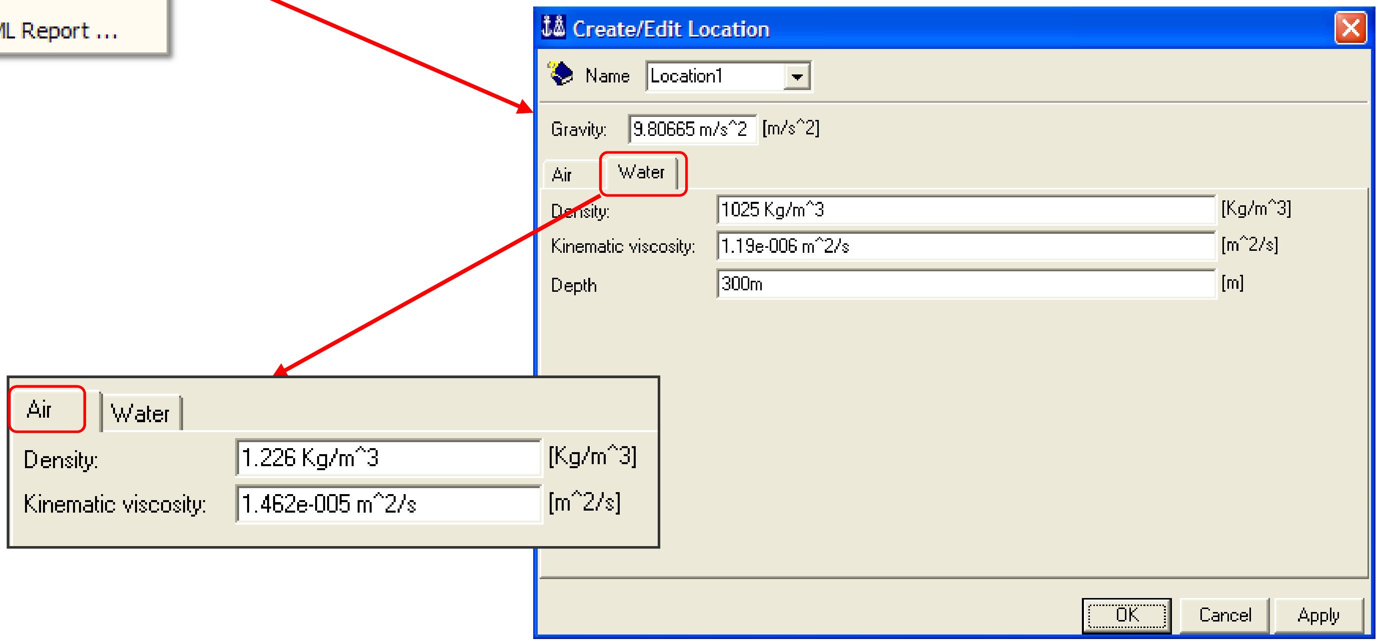
Ungraded

Create new Location

- Use RMB on the Environment folder in the browser and click **New Location**
  – Water data
  – Air data (for stability analysis)

NOTE: There might be some default values that need to be changed!





Ungraded

Models and their properties

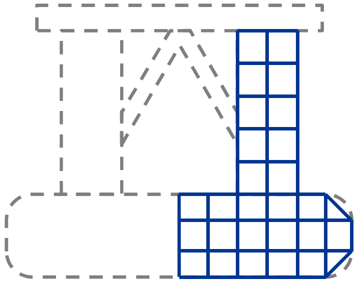
- Element models
- Hydro models
  - Panel, compartment, mass, Morison models

Ungraded

DNV·GL

Models for HydroD / Wadam

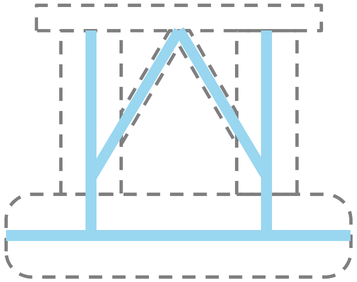
Panel model



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

e.g. T1.FEM

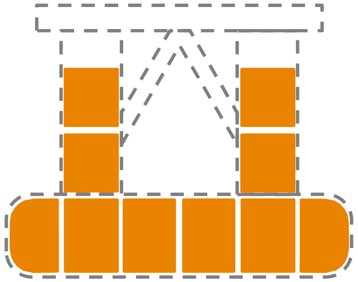
Morison model



- 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

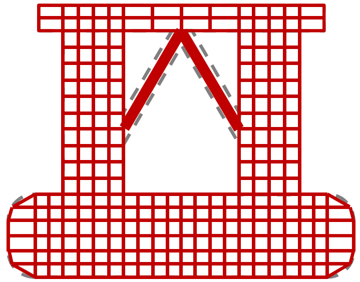
e.g. T3.FEM

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

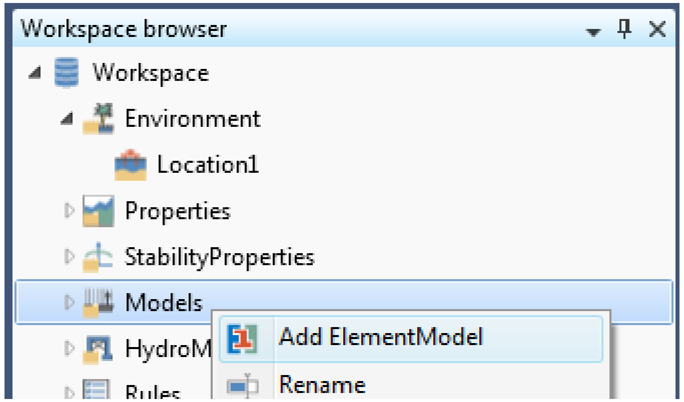
e.g. T4.FEM

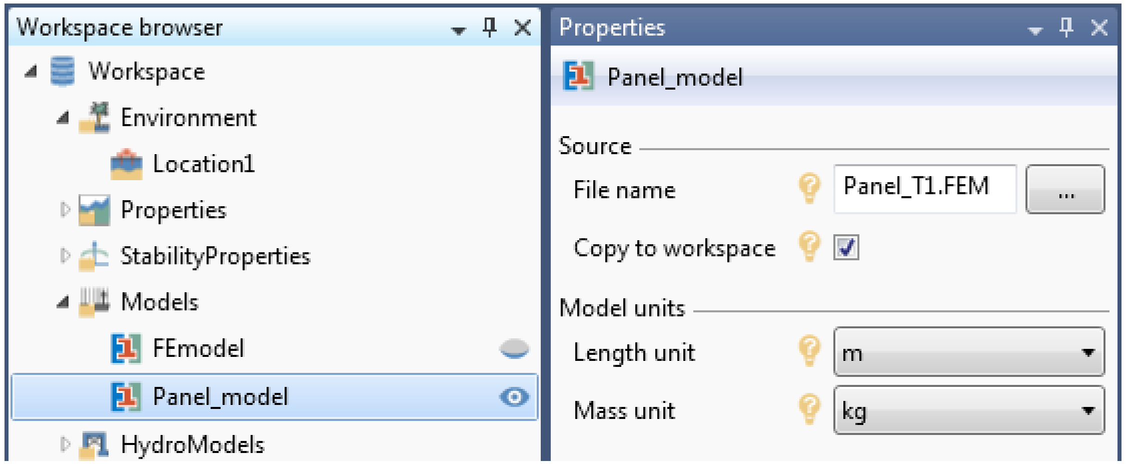
May be the same model, e.g. T4.FEM

Ungraded

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

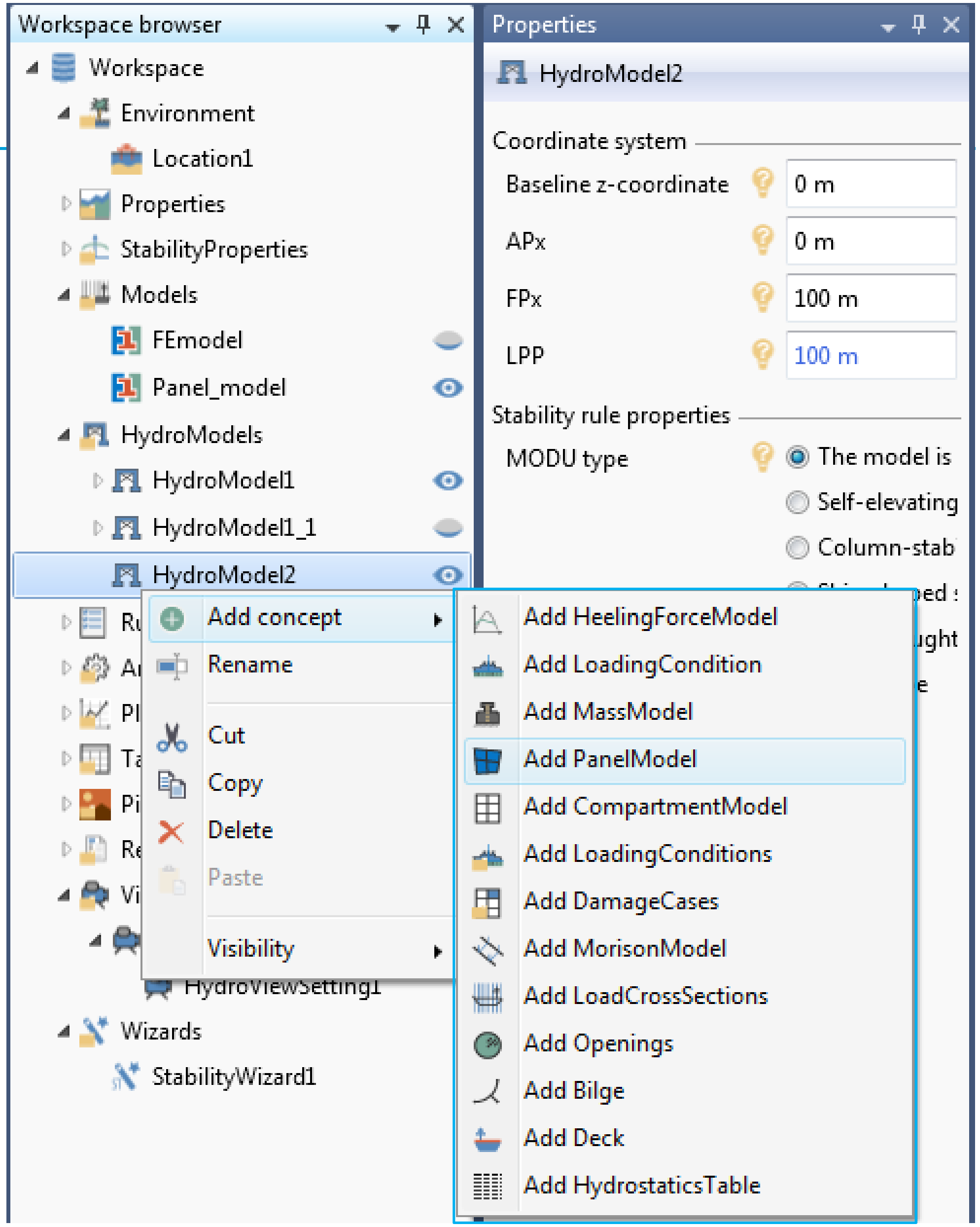




Ungraded

Hydro model

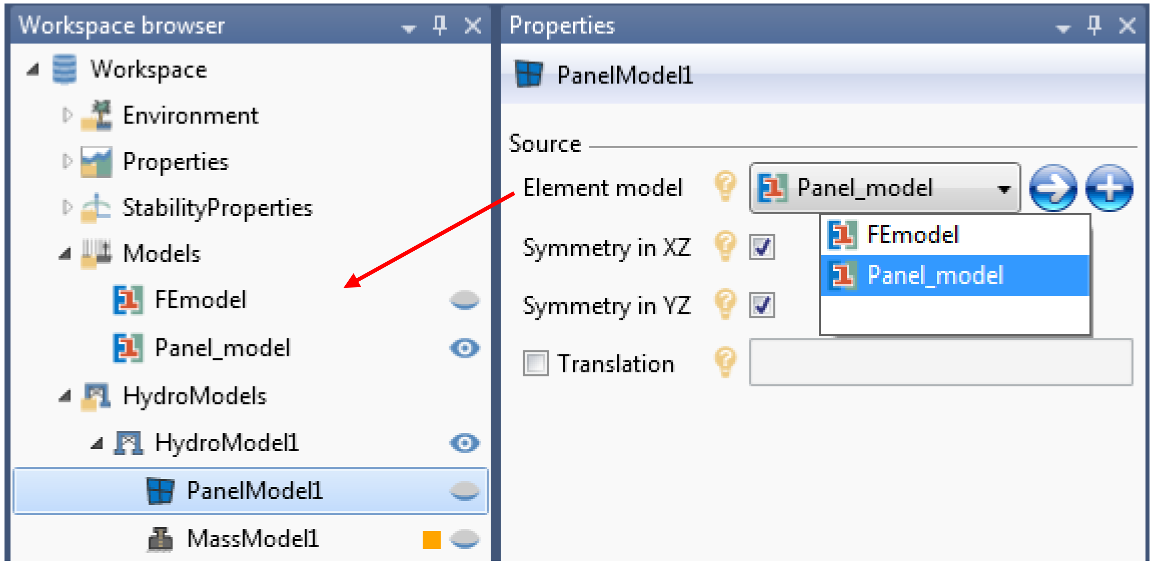
- The assembly of the models and loading conditions to be used in an analysis, including their properties
- Right-click HydroModels to add new concepts
  - Panel model
  - Mass model
  - Morison model
  - Compartment model
  - Loading conditions
  - Damage cases
  - Heeling force model
  - Load cross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



Ungraded

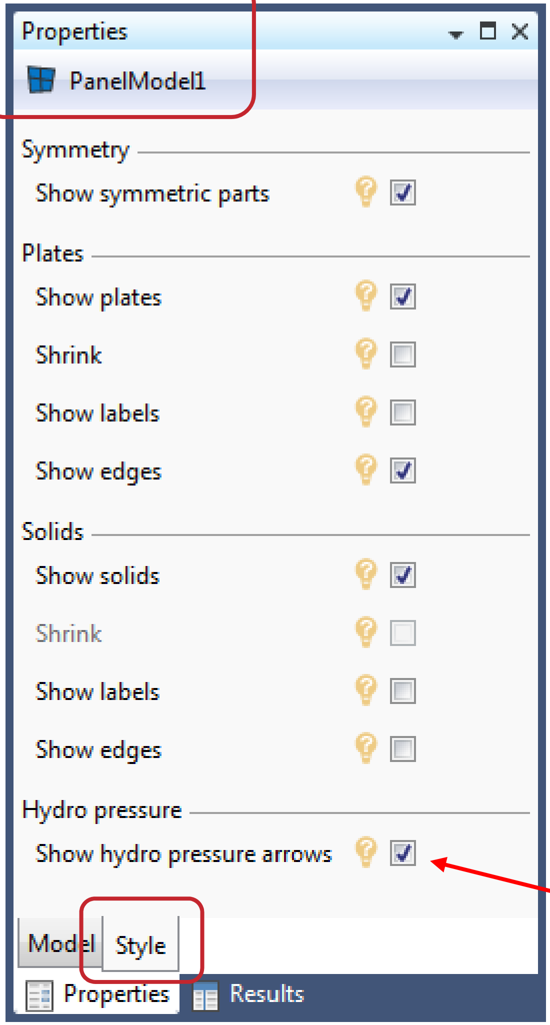
Panel model

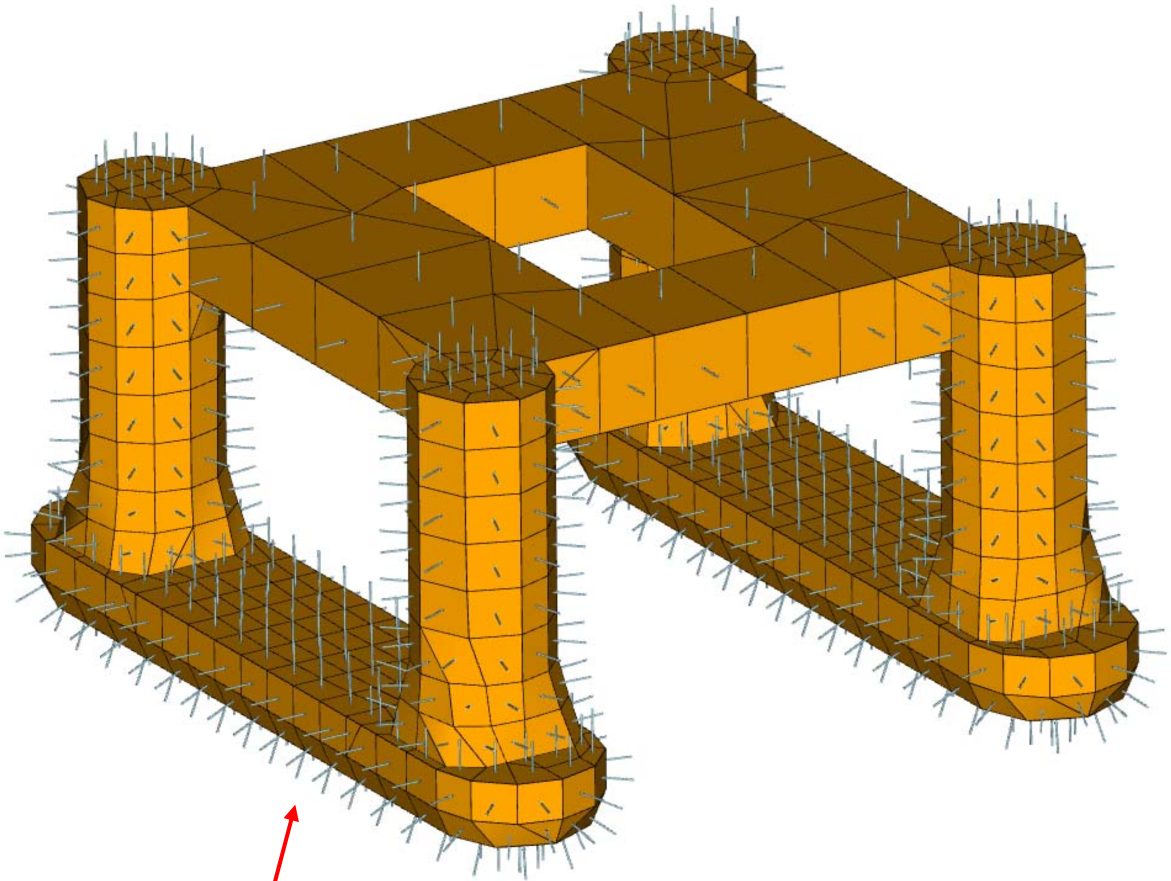
- The panel model is selected from the imported element models
- Symmetry options may be used
  - The model must be defined on the positive side of the symmetry planes (positive x- and/or y-coordinate).
- Translation in x or y direction may be defined



Ungraded

View panel model



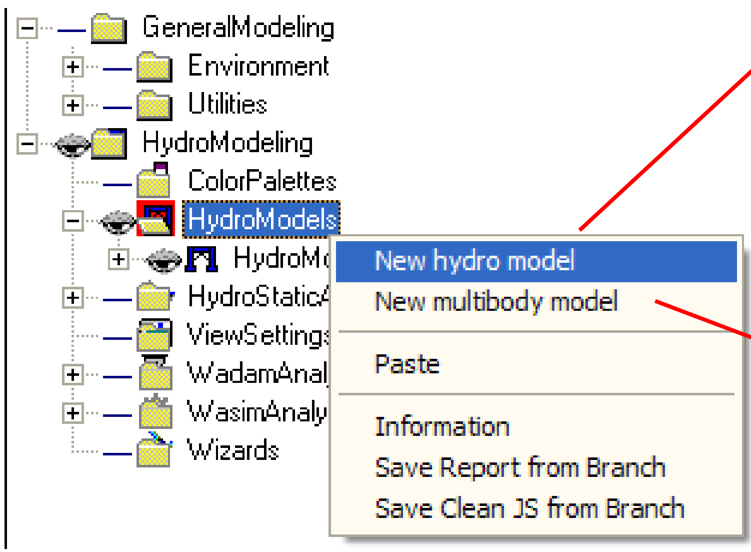


Always check this

Ungraded

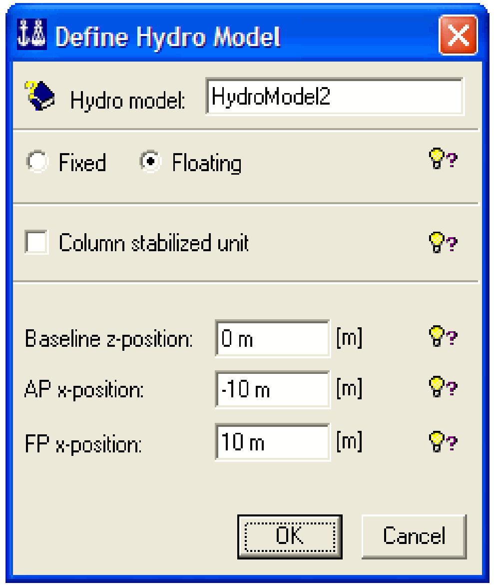
Hydro model – H4

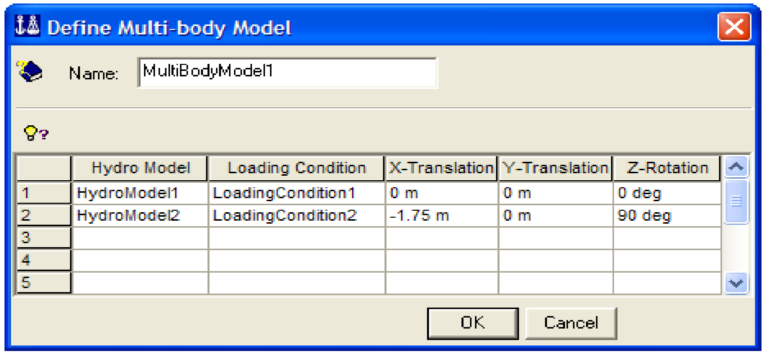
- The assembly of all the models to be used in an analysis, including their properties
- Definition of models in a multi-body analysis
  – Reuse existing hydro models



Stability

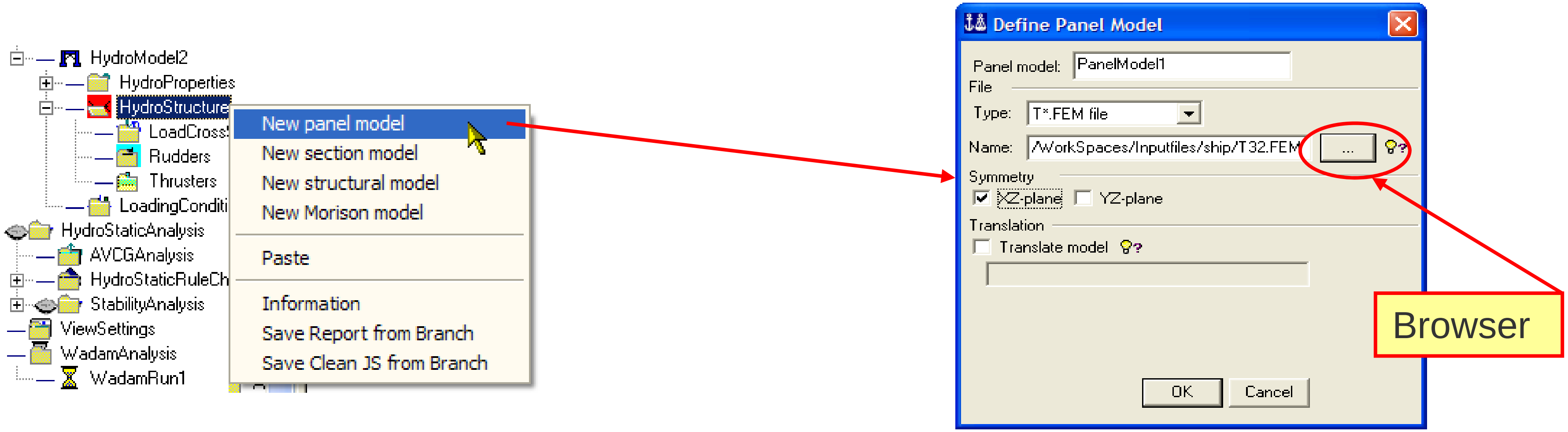
As basis to define loading condition from draft AP & FP





Ungraded

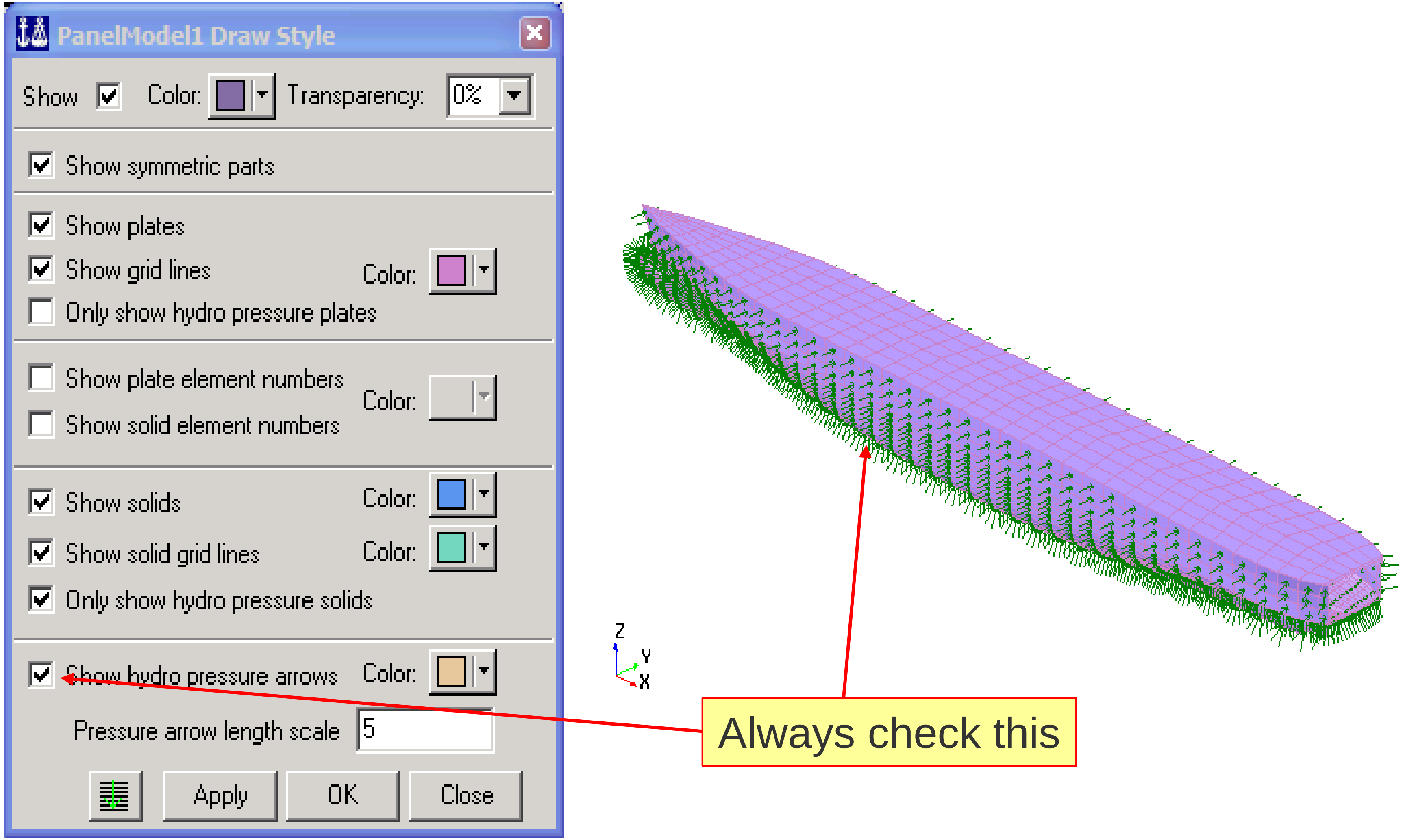
Panel model – H4



- The default panel model is a Sesam model (T*.FEM)
  – Notice that a panel model on Wamit (GDF) format can also be used
- Symmetry is not valid for hydrostatic/stability analysis
- Translation in x or y direction is only valid for models without use of symmetry, i.e. the complete model must be created in the preprocessor

Ungraded

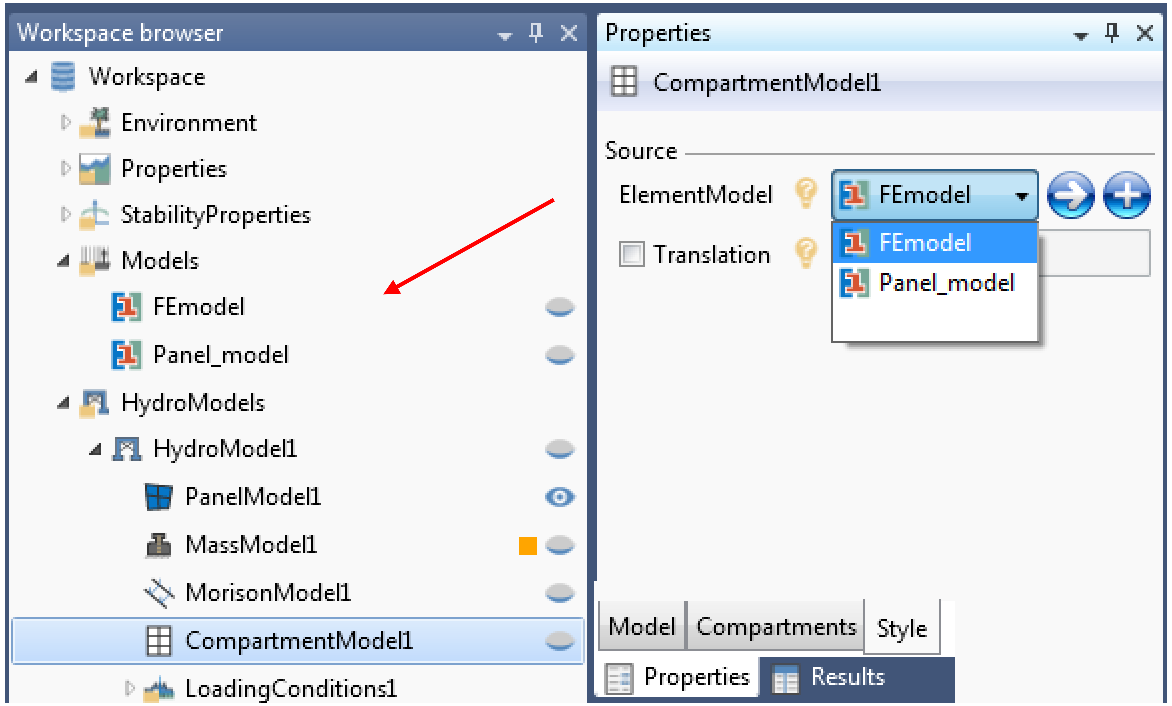
View panel model

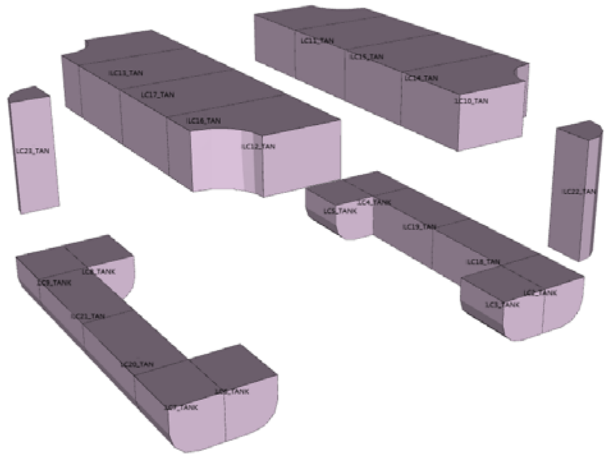


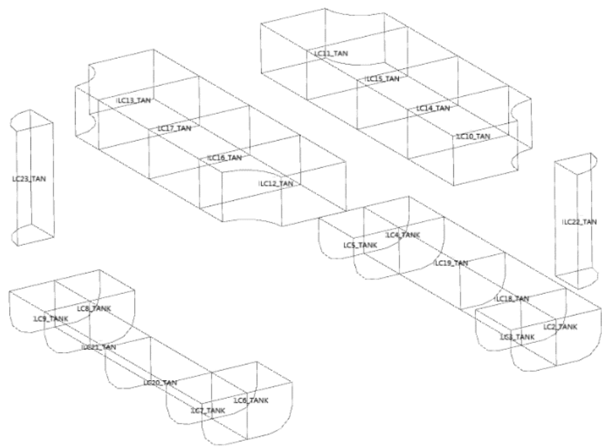
Ungraded

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



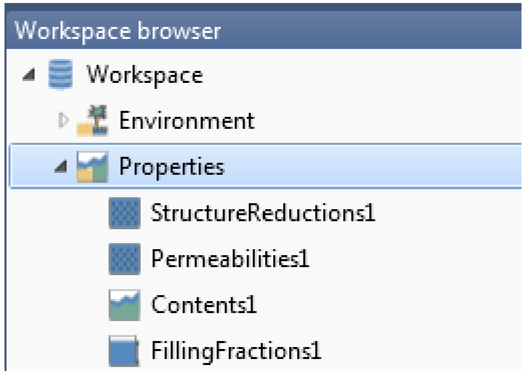


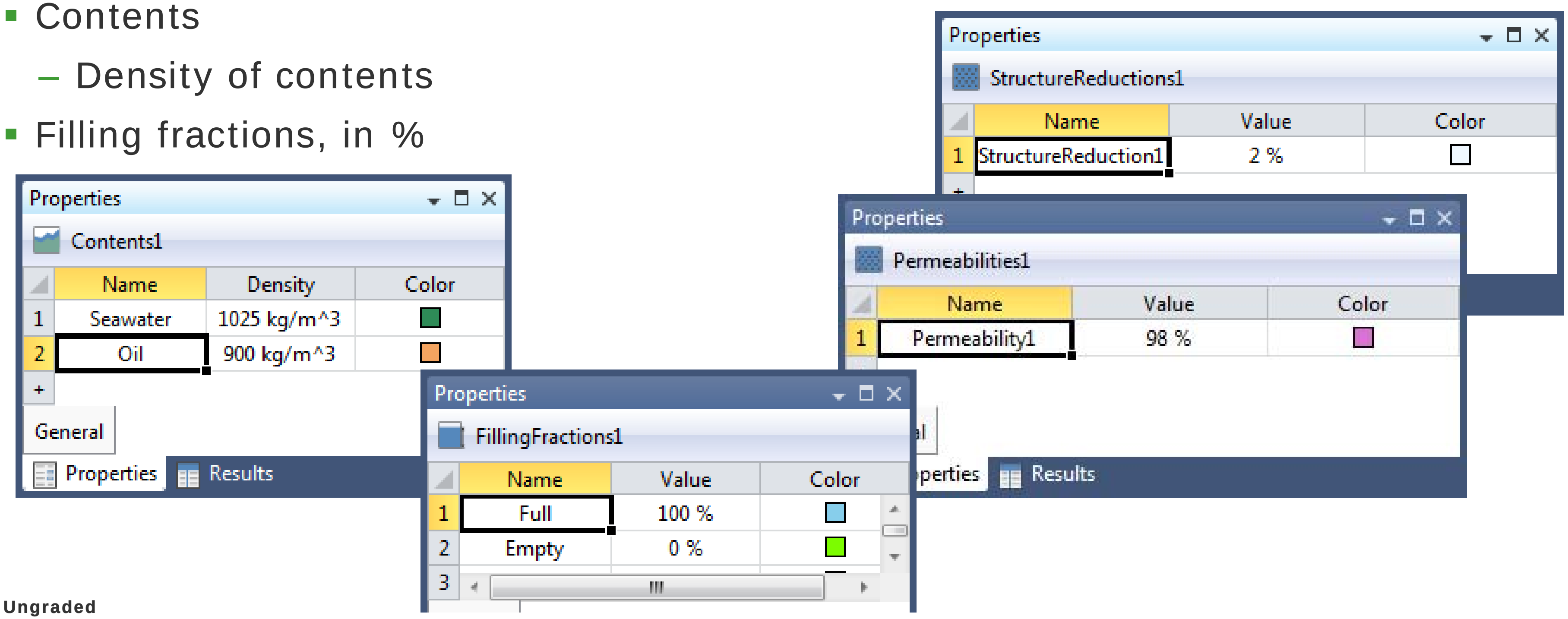


Ungraded

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 %

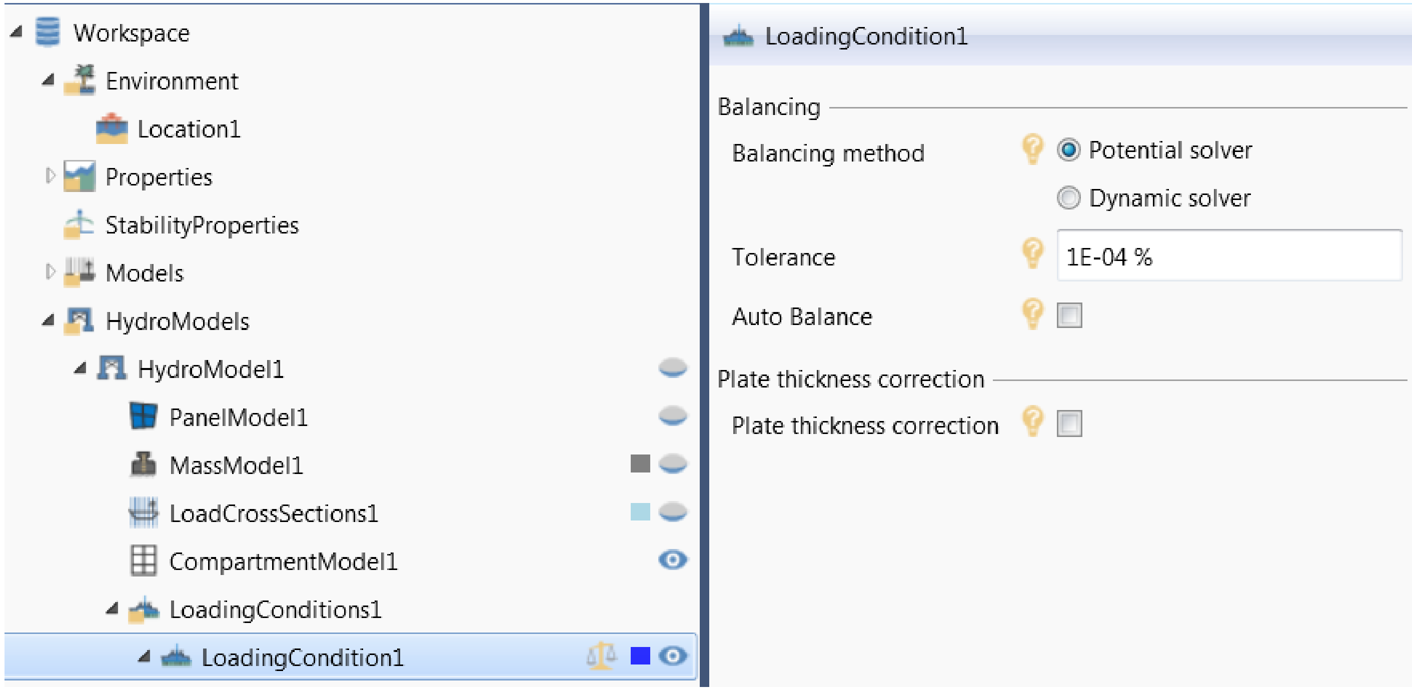




Ungraded

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 property of the Loading condition, not the compartment



Ungraded

DNV·GL

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.

Properties

CompartmentModel1

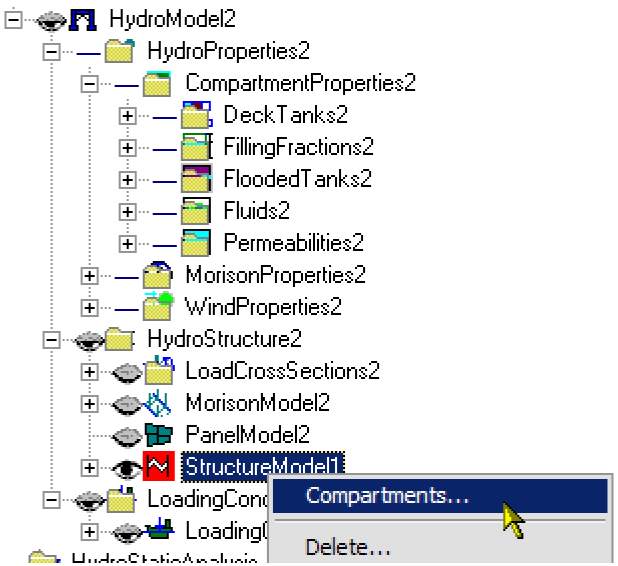
	Selected	Loadcase#	Name	Group	eability pro	Permeability	e reduction	cture reduc	icknessCor	Deck tank	Visible
1	☐	2	LC2_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
2	☐	3	LC3_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
3	☐	4	LC4_TANK	Sub	ermeability	98 %	tureReduct	2 %	☑	☐	☑
4	☐	5	LC5_TANK	Sub	ermeability	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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

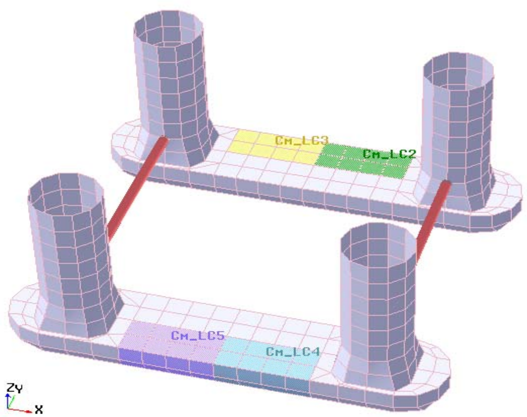
Model | Compartments | Style

Properties | Results

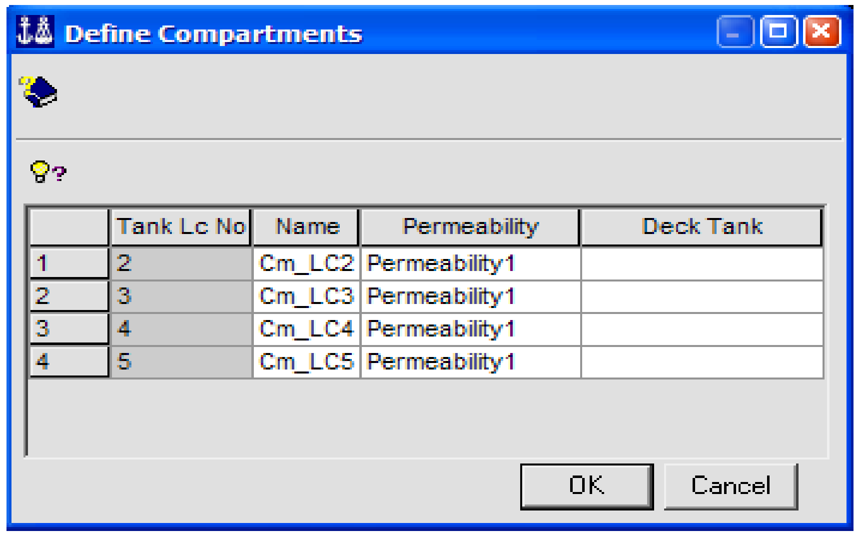
Ungraded

Internal fluid in tanks – Definition – H4





- The tanks must be defined in the **structural model** by use of wet surfaces/hydro pressure load cases,
  – First tank is defined in the 2nd load case (e.g. LC 2), second tank in the 3rd load case etc.
- Deck tanks are only relevant for stability analysis of mobile offshore units

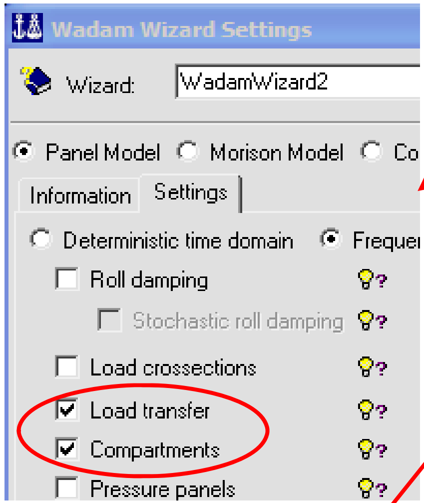


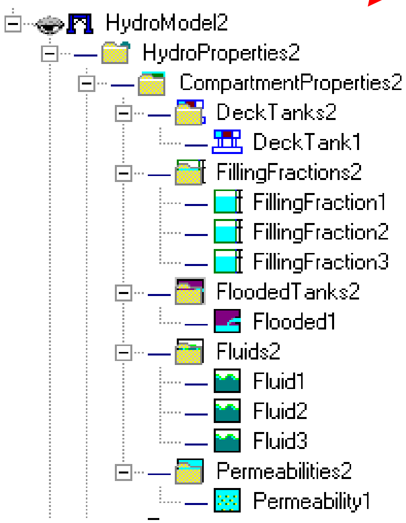
	Tank Lc No	Name	Permeability	Deck Tank
1	2	Cm_LC2	Permeability1	
2	3	Cm_LC3	Permeability1	
3	4	Cm_LC4	Permeability1	
4	5	Cm_LC5	Permeability1	

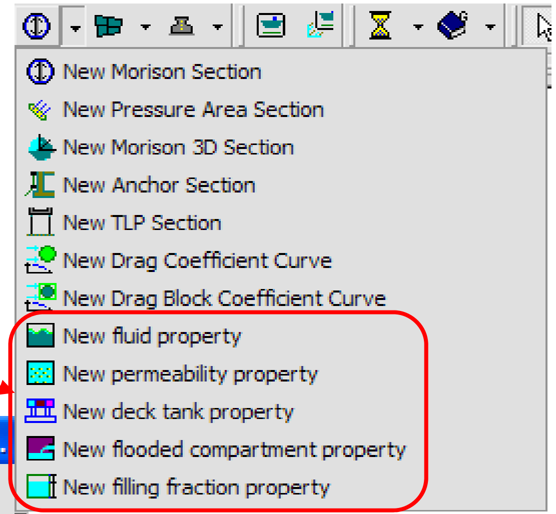
Ungraded

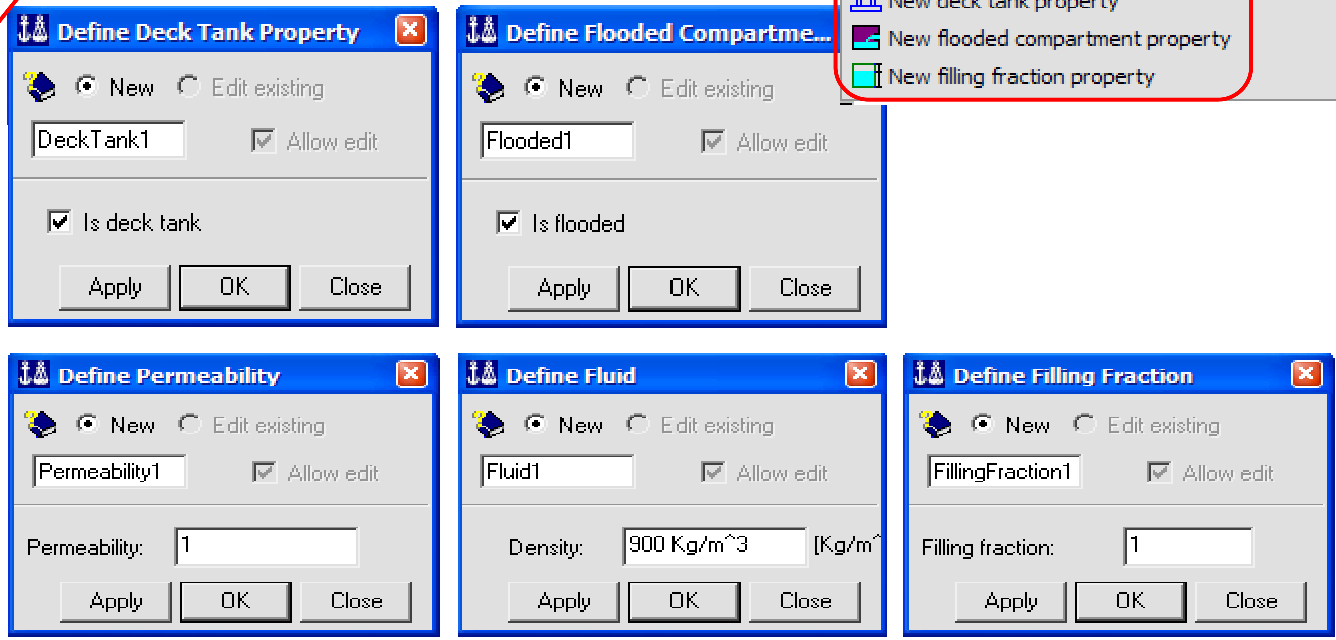
Internal fluid in compartments – Properties

- Define use of Compartments in the wizard
- Define properties from the browser/tool bar



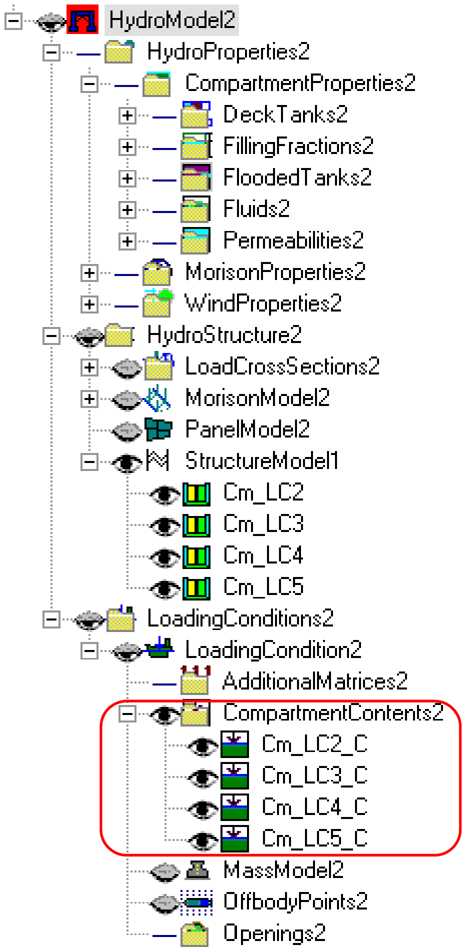




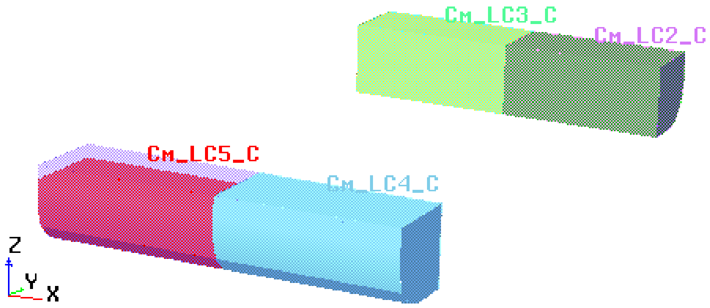


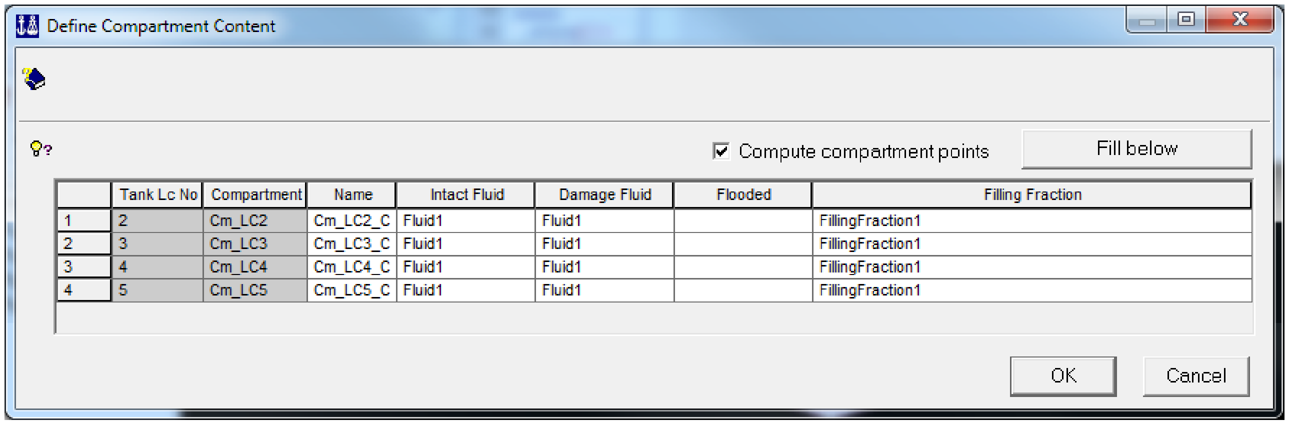
Ungraded

Internal fluid in tanks – Contents



- The contents of the tanks are assigned in the loading condition
- The tanks may be displayed, showing the filling fraction

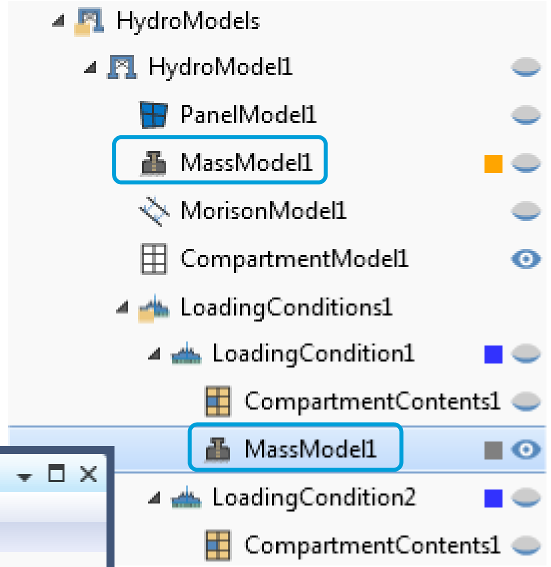


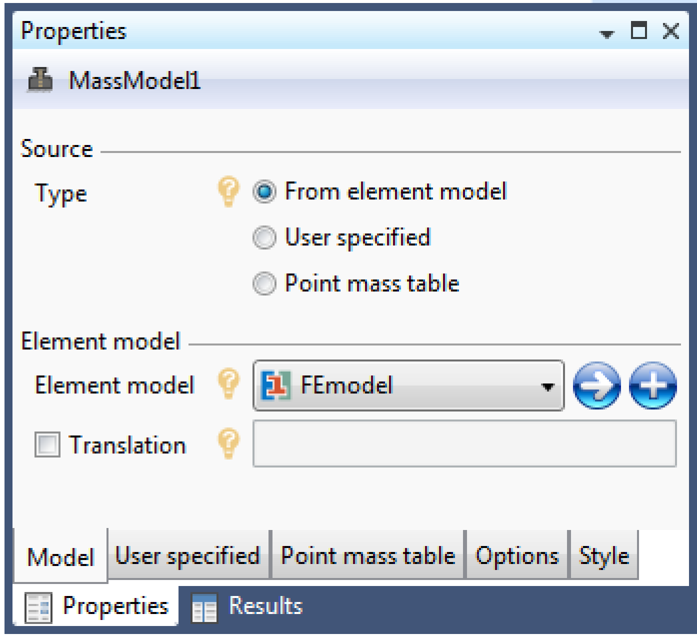


Ungraded

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

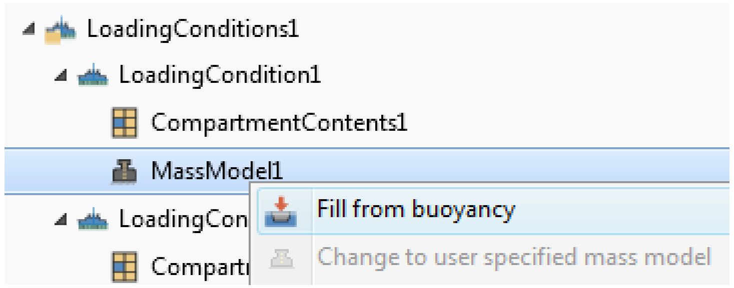




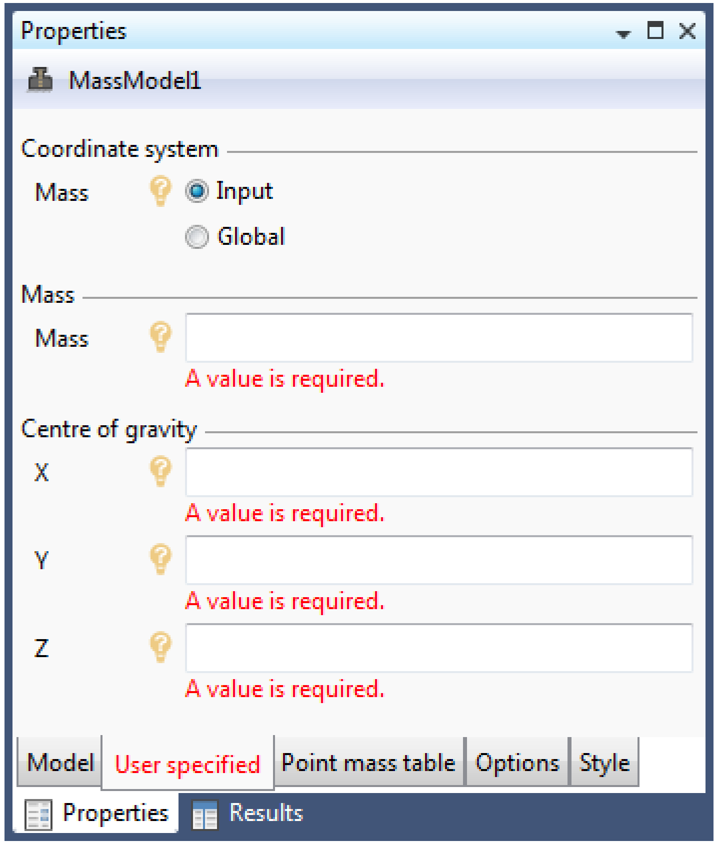
Ungraded

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



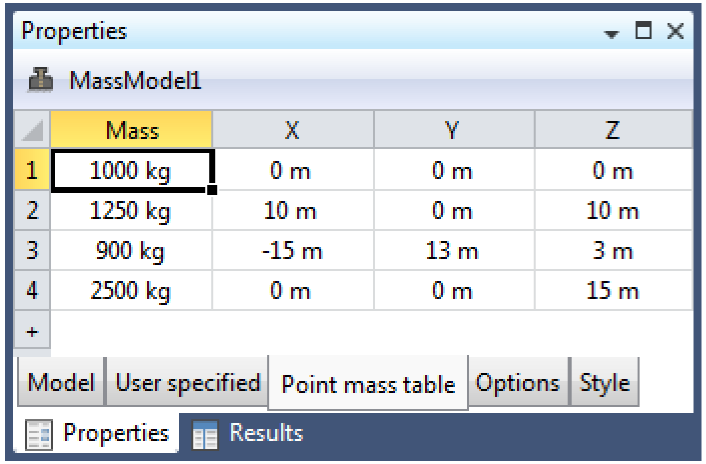
- An existing mass from an element model may optionally be changed to a user specified mass



Ungraded

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

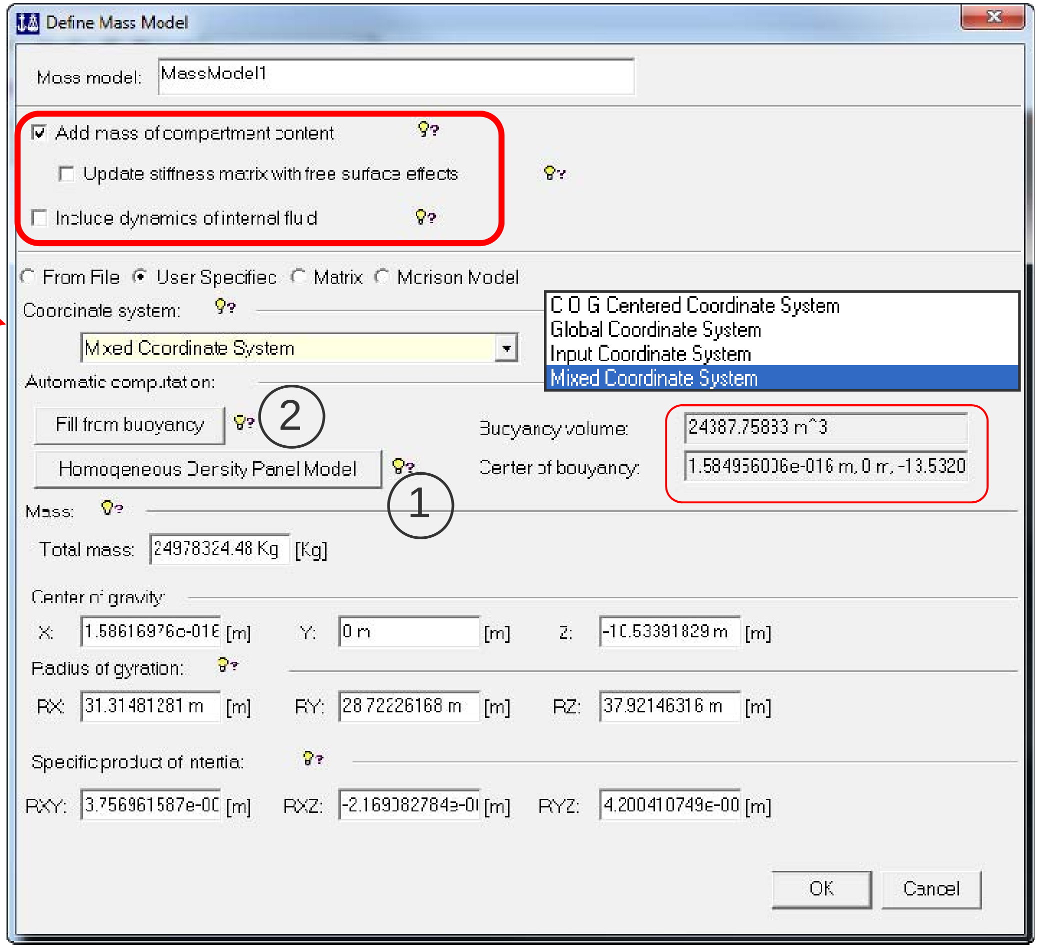


Ungraded

Mass model – H4 - Option 1

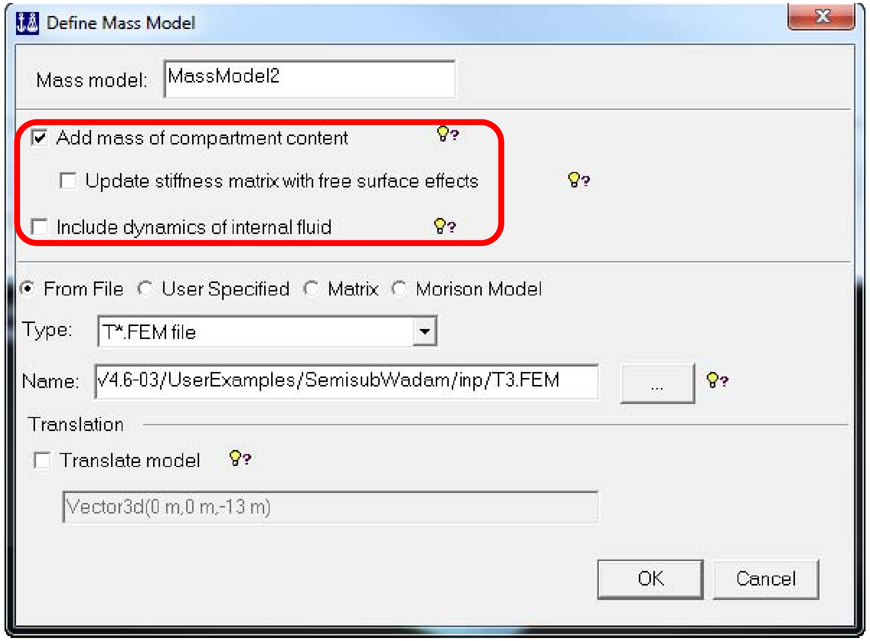
Option 1: user defined mass data

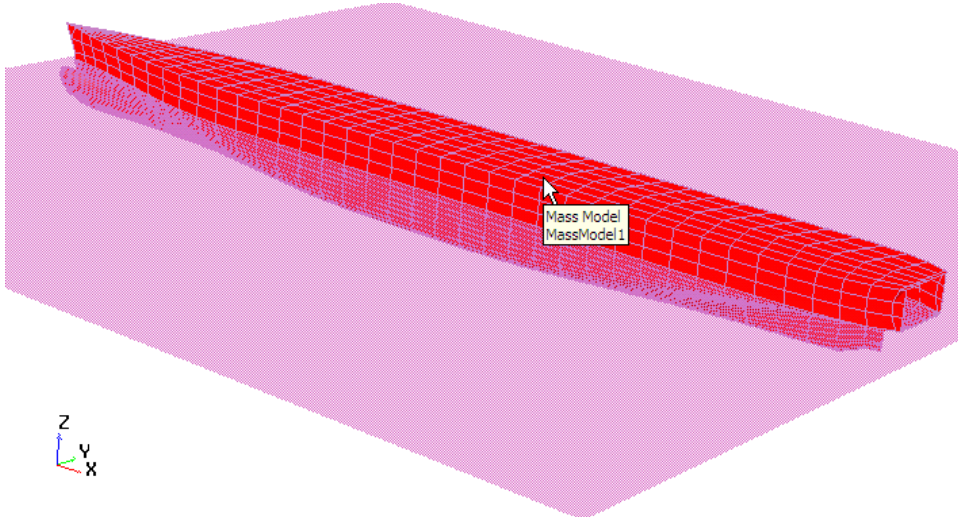
- Data may be given in different coordinate systems
  – The Mixed system is reported in the print file from Wadam
- Mass data may be calculated from the panel model.
  – All data may be calculated by assuming a homogeneous density in the panel model (1)
  – The mass and COG (x, y only) may be calculated from the buoyancy (2)
  – **Press (1) first, then (2)**



Mass model – Option 2

Option 2: Mass distribution from file

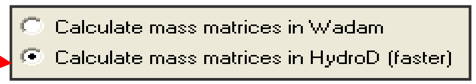




Display mass model with panel model to verify consistent coordinate systems. Point masses may be displayed

No symmetry planes allowed in mass model

Note option for calculation of the mass model in the Wadam run set-up (Advanced part)

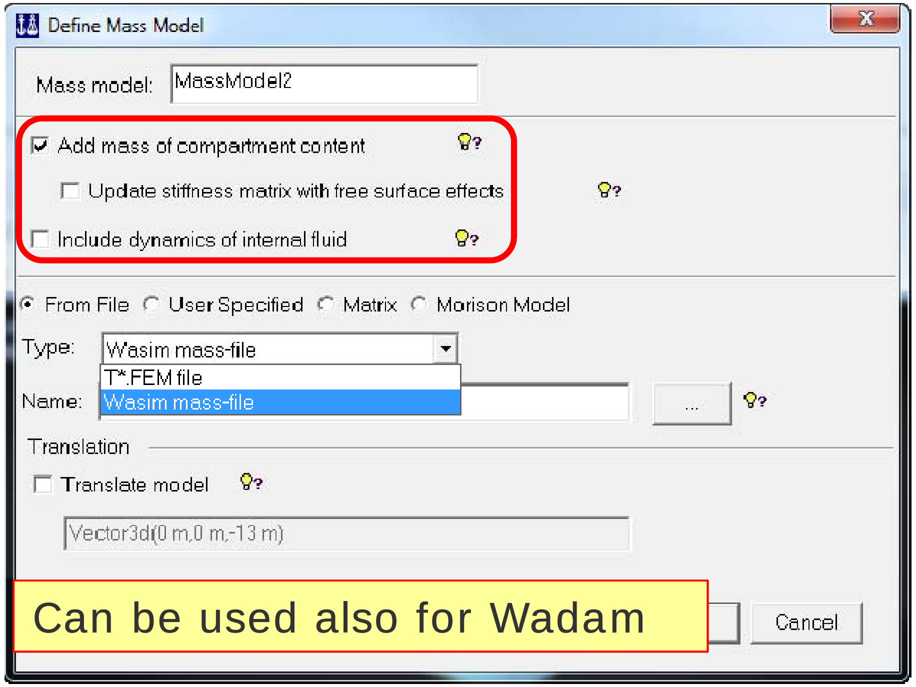


Ungraded

Mass model – Option 2 – Point mass file

Title
Number of point masses
Scaling factors
$M_i \quad x_i \quad y_i \quad z_i$

```
s175_original_model
   420
 1.         1.      1.         1.
8.70E+03  -91.4375       8    0.02
8.70E+03  -90.5625       8    0.02
8.70E+03  -89.6875       8    0.02
8.70E+03  -88.8125       8    0.02
8.70E+03  -87.9375       8    0.02
8.70E+03  -87.0625       8    0.02
8.70E+03  -86.1875       8    0.02
8.70E+03  -85.3125       8    0.02
8.70E+03  -84.4375       8    0.02
8.70E+03  -83.5625       8    0.02
2.52E+04  -82.6875       8    0.02
2.52E+04  -81.8125       8    0.02
2.52E+04  -80.9375       8    0.02
2.52E+04  -80.0625       8    0.02
2.52E+04  -79.1875       8    0.02
2.52E+04  -78.3125       8    0.02
2.52E+04  -77.4375       8    0.02
2.52E+04  -76.5625       8    0.02
2.52E+04  -75.6875       8    0.02
2.52E+04  -74.8125       8    0.02
4.09E+04  -73.9375       8    0.02
4.09E+04  -73.0625       8    0.02
4.09E+04  -72.1875       8    0.02
4.09E+04  -71.3125       8    0.02
4.09E+04  -70.4375       8    0.02
4.09E+04  -69.5625       8    0.02
4.09E+04  -68.6875       8    0.02
4.09E+04  -67.8125       8    0.02
```



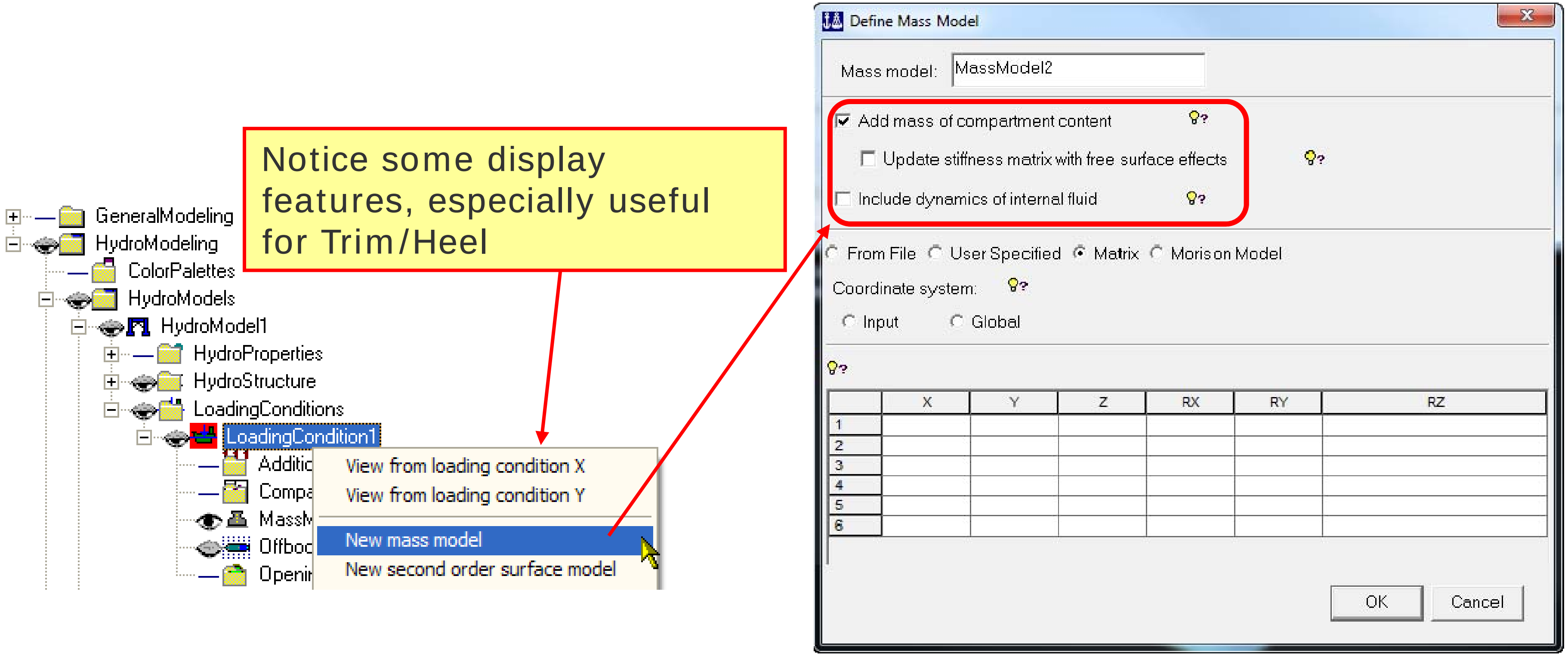
Can be used also for Wadam

Ungraded

Mass model – Option 3

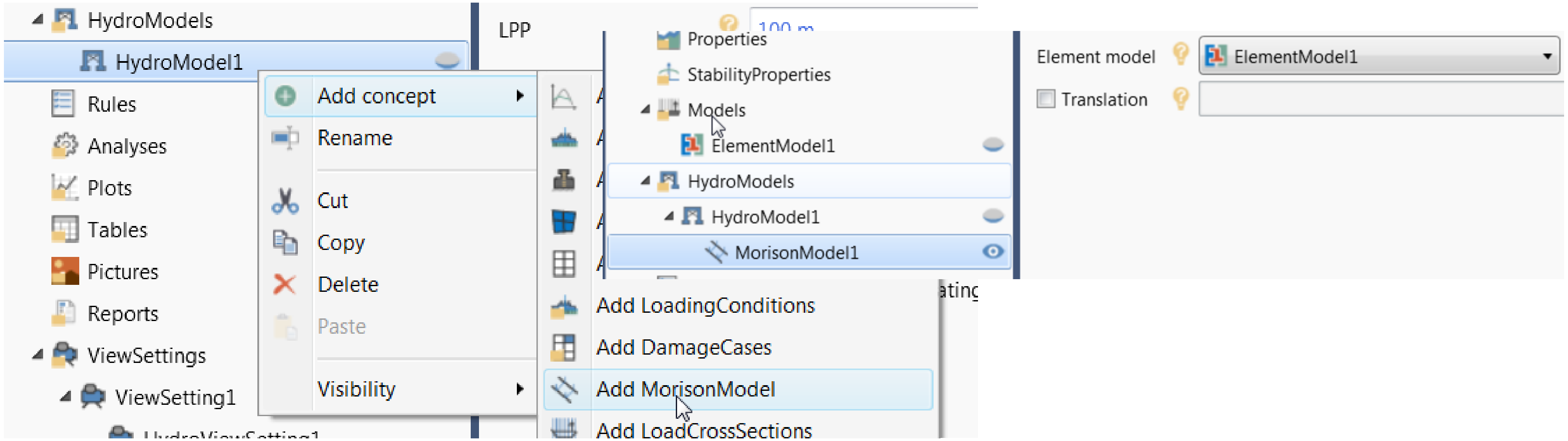
Option 3: Specify mass matrix

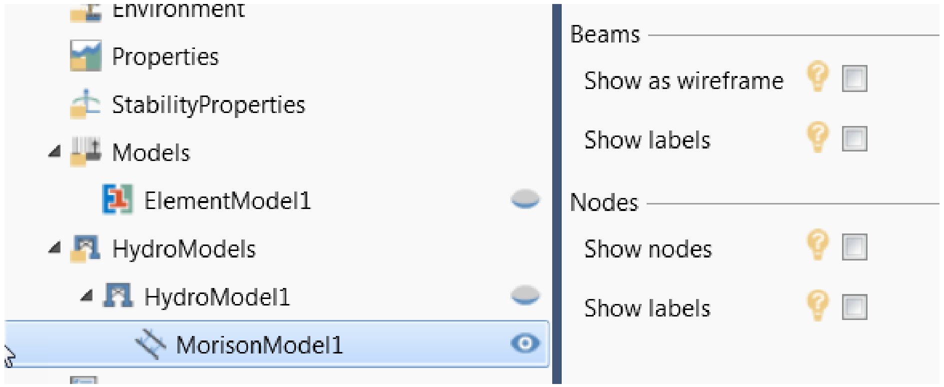
Notice some display features, especially useful for Trim/Heel

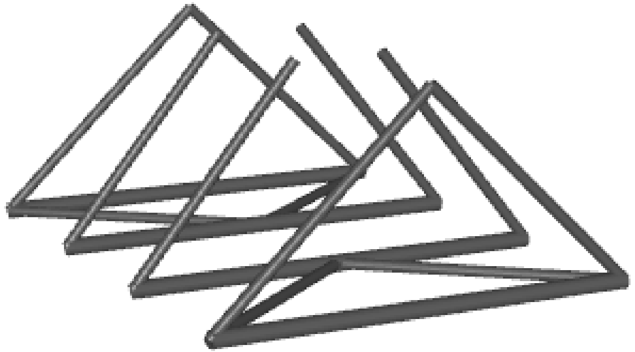


Ungraded

Morison model – H5



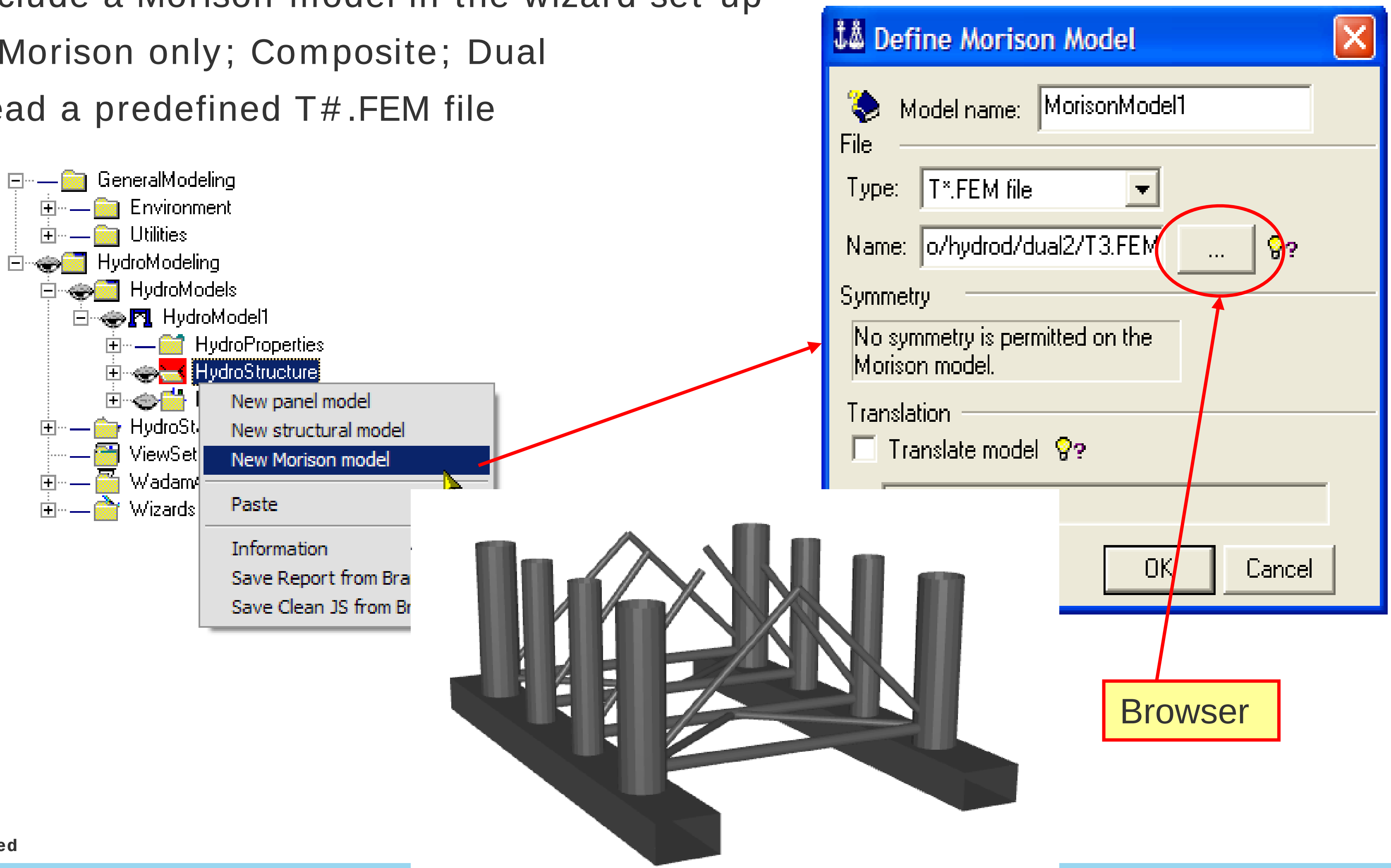




Ungraded

Morison model – H4

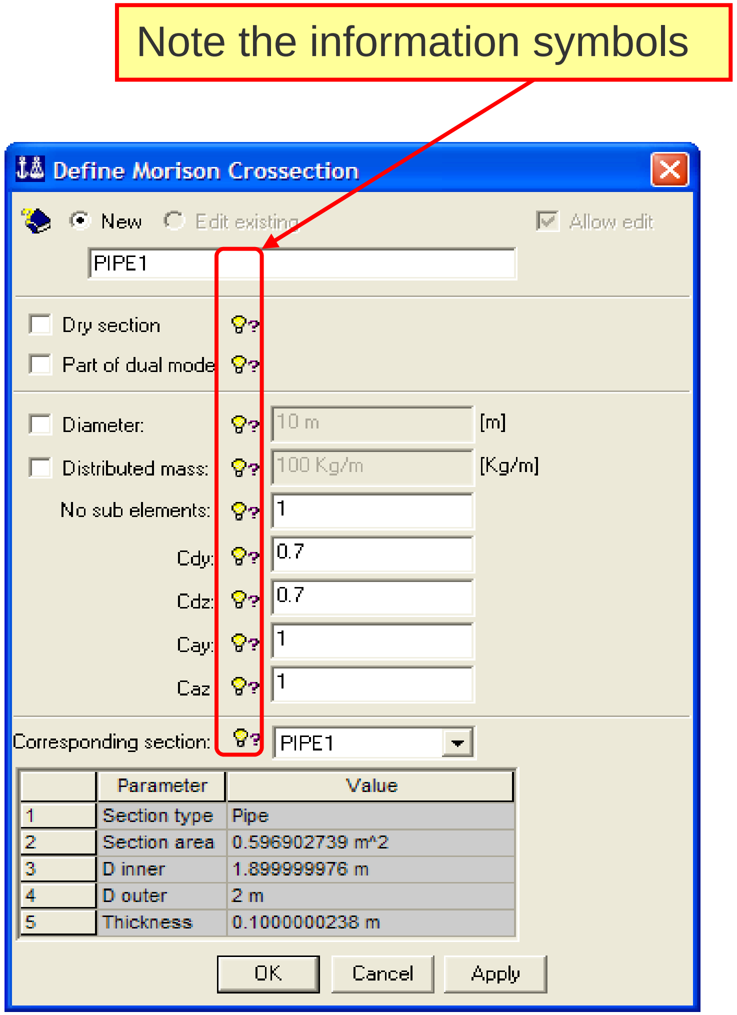
- Include a Morison model in the wizard set-up
  - Morison only; Composite; Dual
- Read a predefined T#.FEM file



Ungraded

Morison section

- HydroD will list the cross-sectional data for the predefined Morison model
  - From the T-file
- The user must define additional data like drag and added mass coefficients
- Diameter (and mass) may be changed
  - Diameter must be specified for non-pipes
- Specify part of dual model
- Dry section: Used for transferring pressure from panels
  - No Morison load



Ungraded

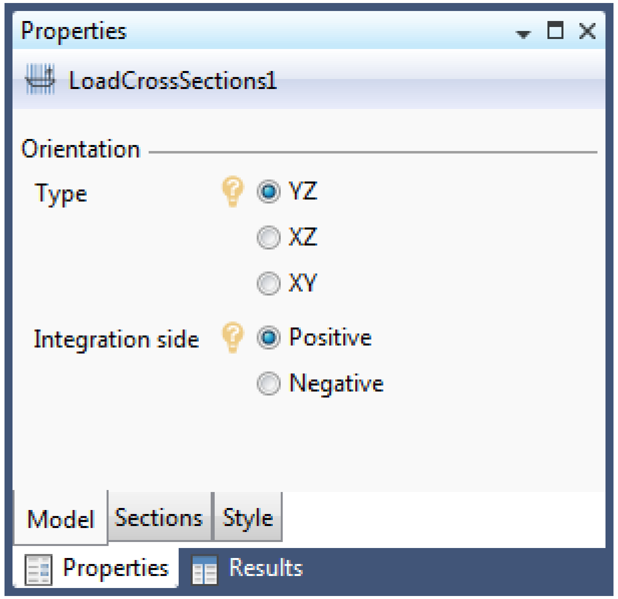
Cross sectional loads

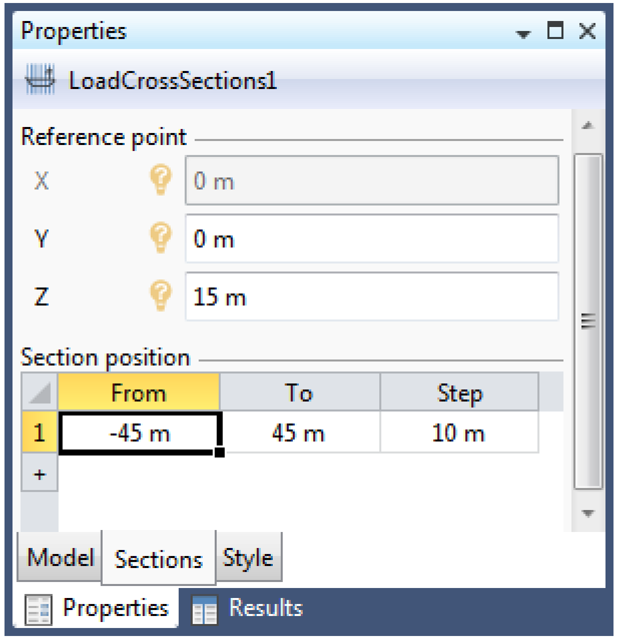
Ungraded

DNV·GL

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

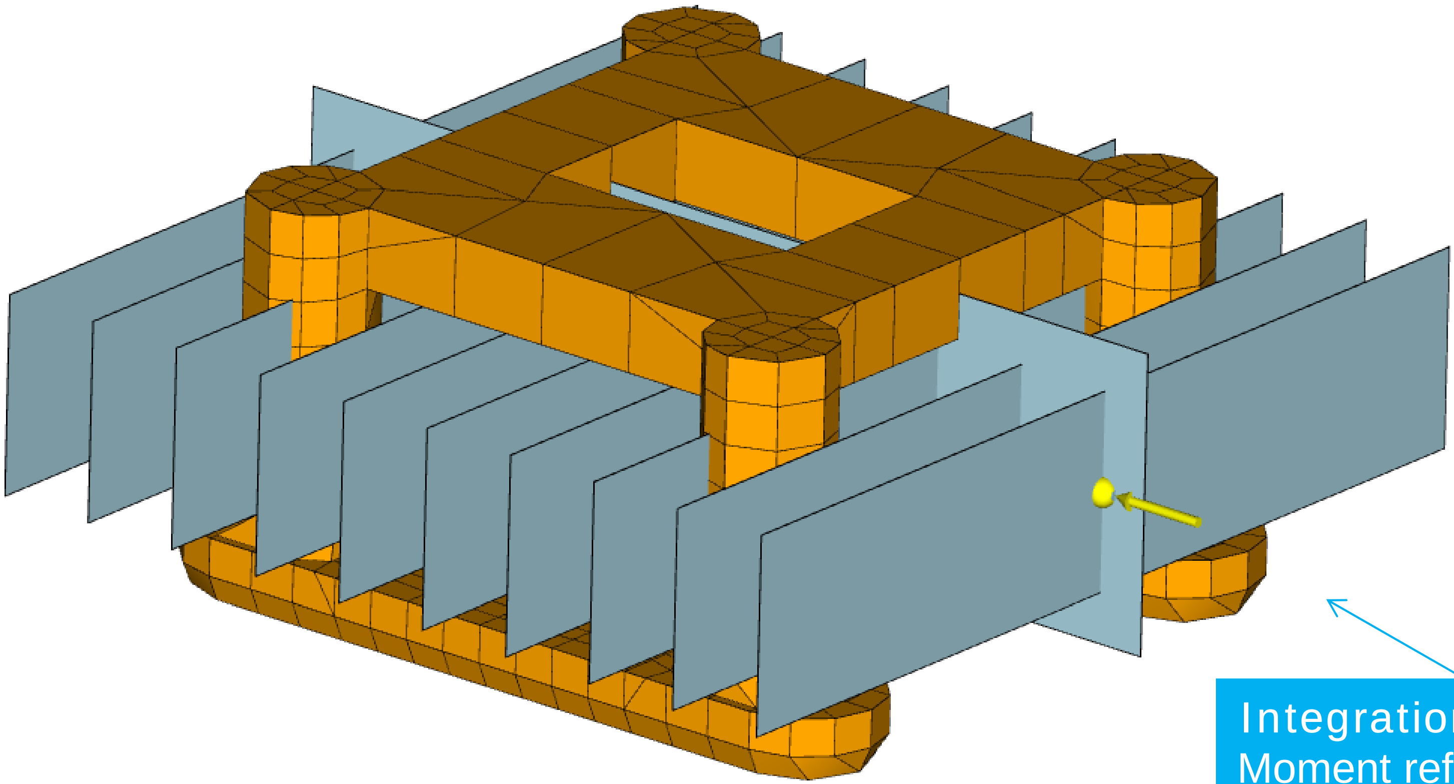




Ungraded

Sectional loads continued

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



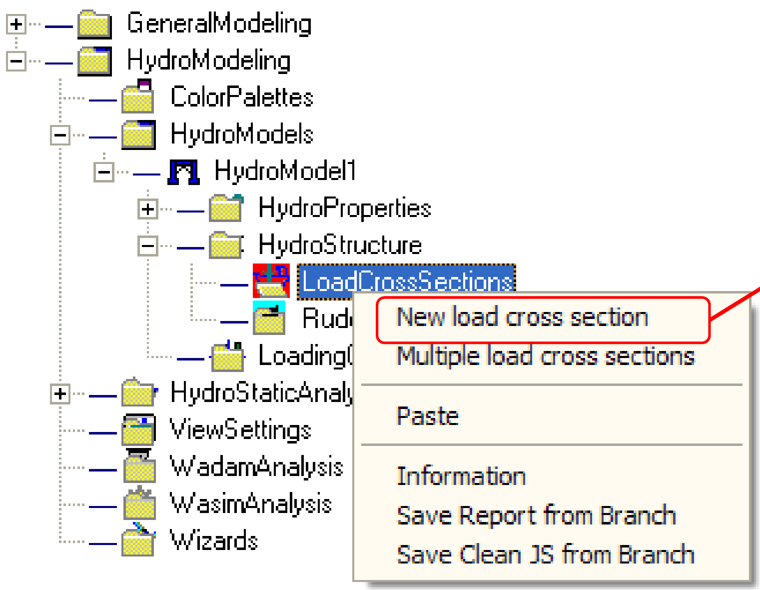
Integration side and Moment reference point

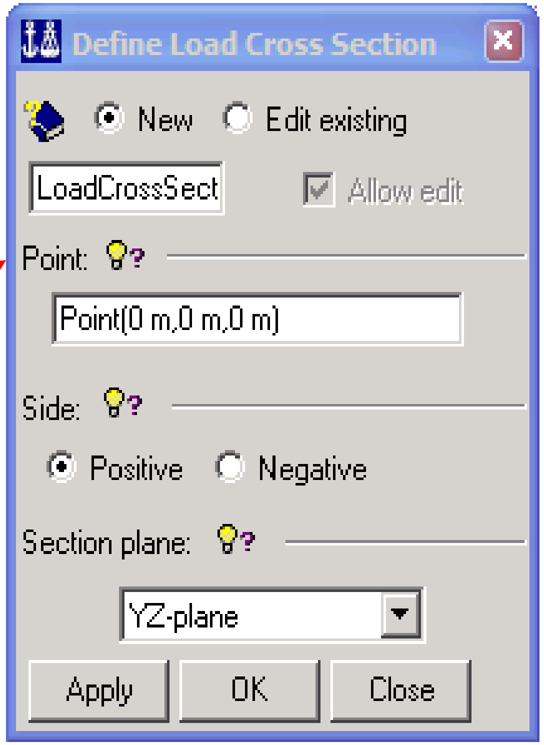
Ungraded

DNV·GL

Sectional loads – H4

- Cross sections may be defined for calculation of cross sectional forces and moments.
  – Requires a mass model defined “From File”.
- The section is parallel with one of the planes XY, XZ, YZ

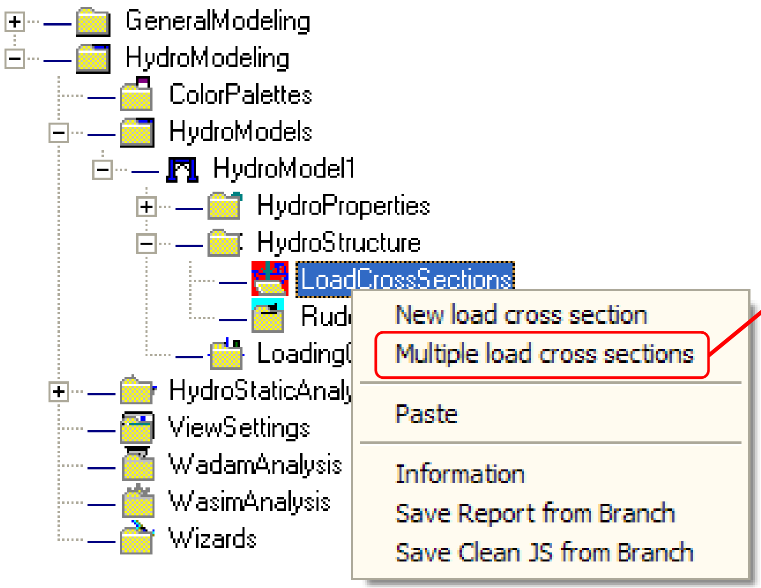


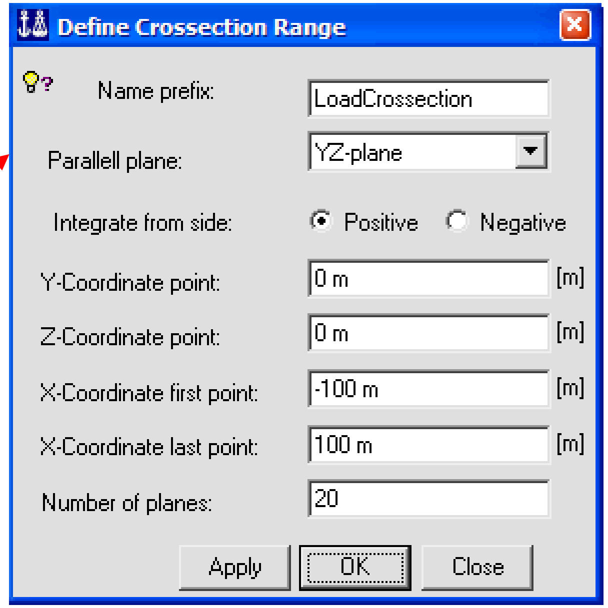


Ungraded

Sectional Loads – Multiple Sections

- A range of cross sections may be defined
- Only available from the browser
- Wadam has a maximum of 25 and Wasim 100 sections
- Stability has no limitation on number of sections





Ungraded

Loading conditions

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

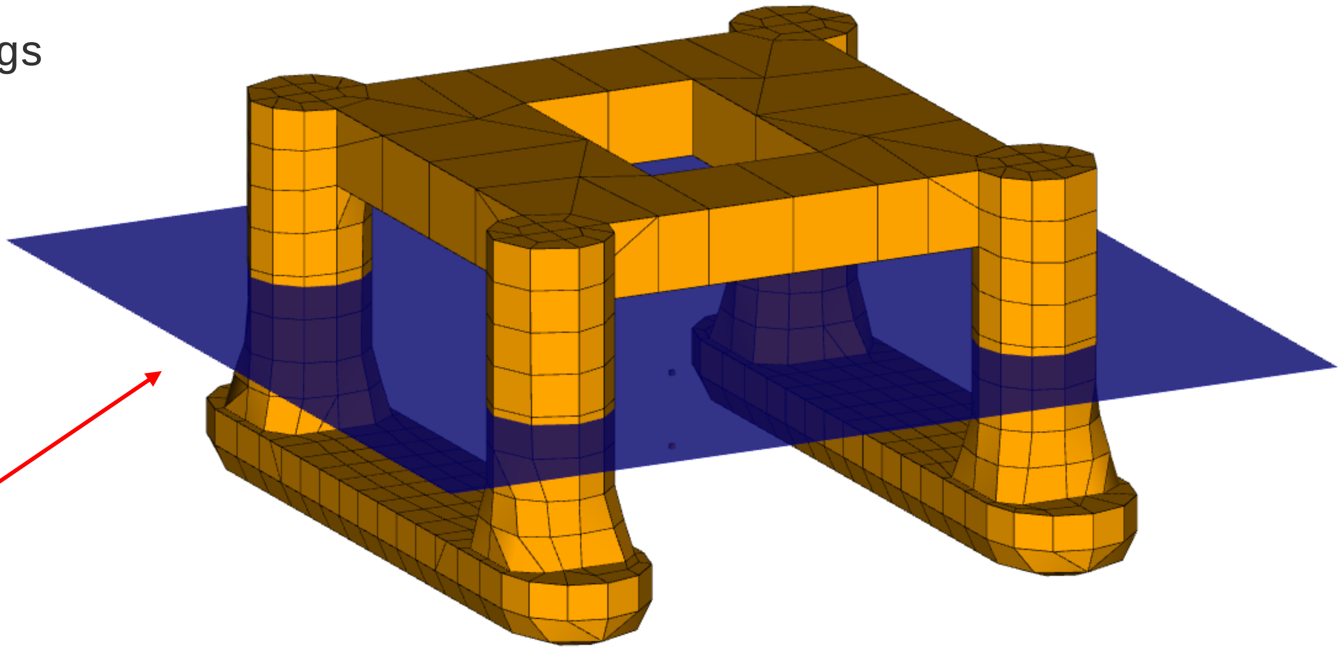
Ungraded

DNV·GL

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

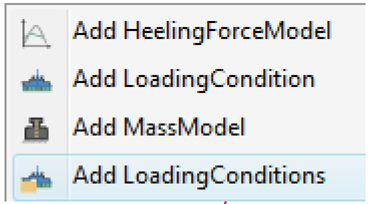


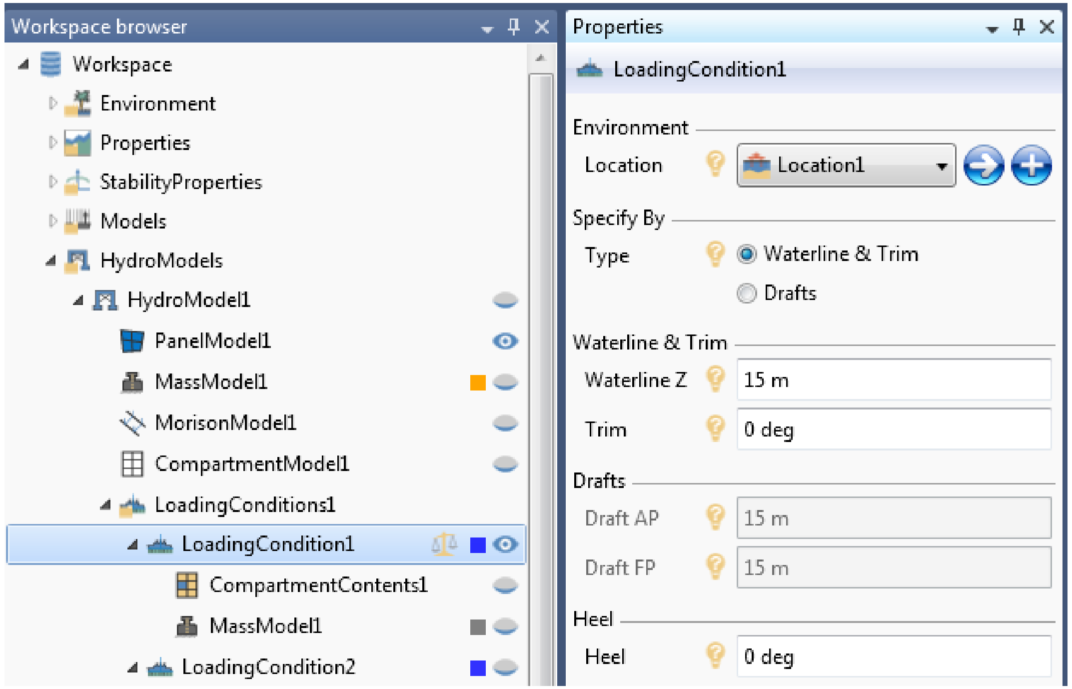
Display of loading condition by displaying the mean free surface

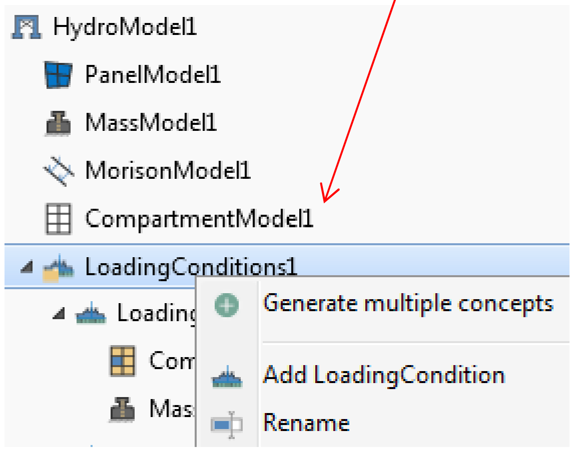
Ungraded

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



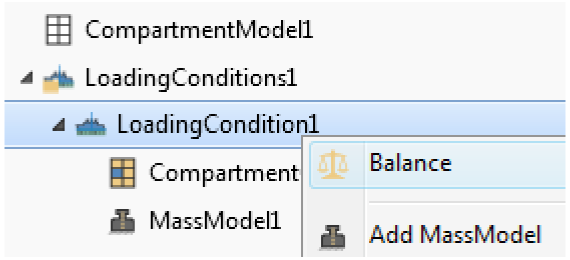


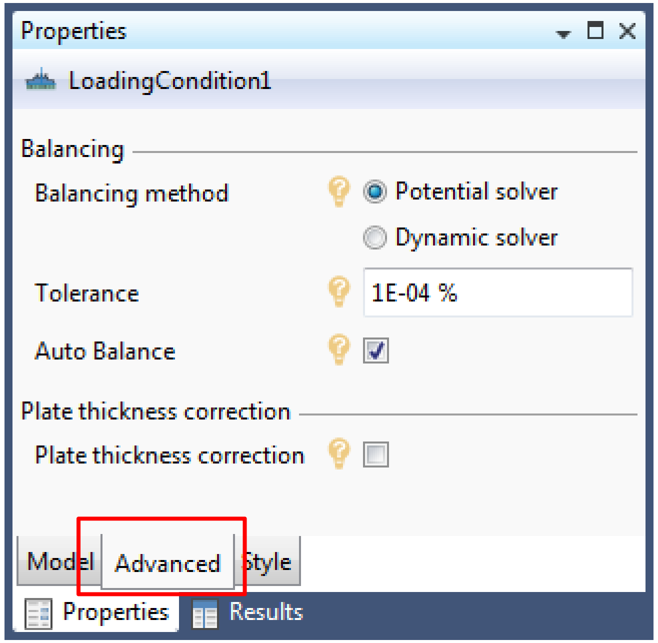


Ungraded

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

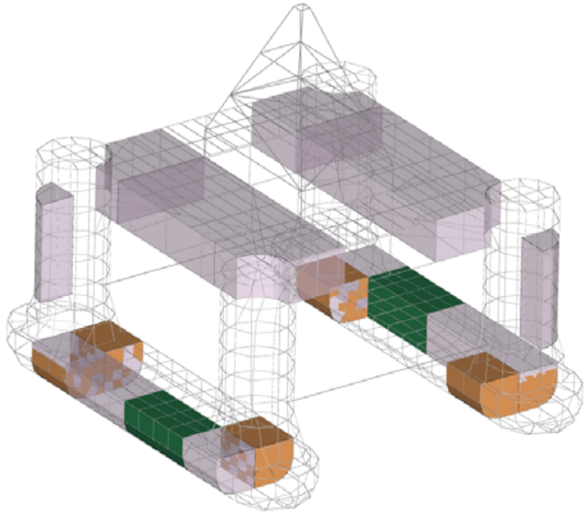




Ungraded

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 propert	illing fractio	act 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 kg	☐	☑	Sub
6	☐	LC7_TANK	Oil	900 kg/m^3	Full	100 %	,4252E+05 kg	☑	☑	Sub
7	☐	LC8_TANK	Seawater	1025 kg/m^3	Full	100 %	,0398E+05 kg	☐	☑	Sub
8	☐	LC9_TANK	Seawater	1025 kg/m^3	Full	100 %	,0398E+05 kg	☑	☑	Sub
9										

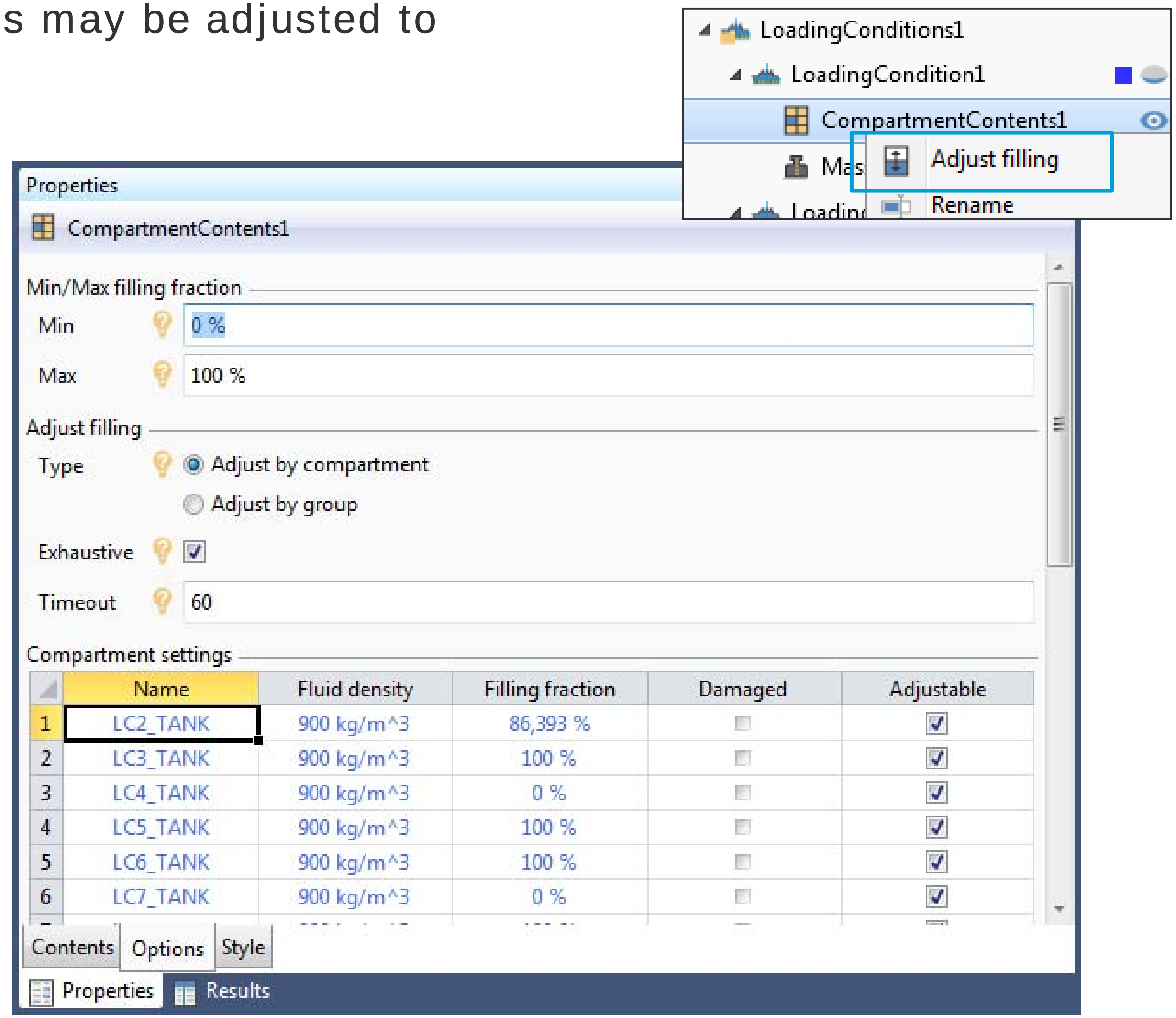
Contents | Options | Style

Properties | Results

Ungraded

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

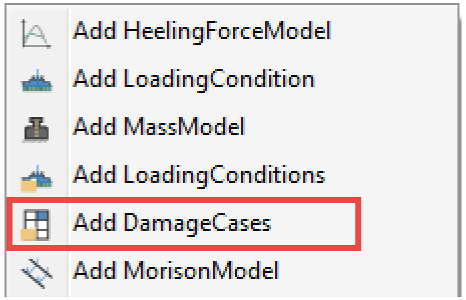


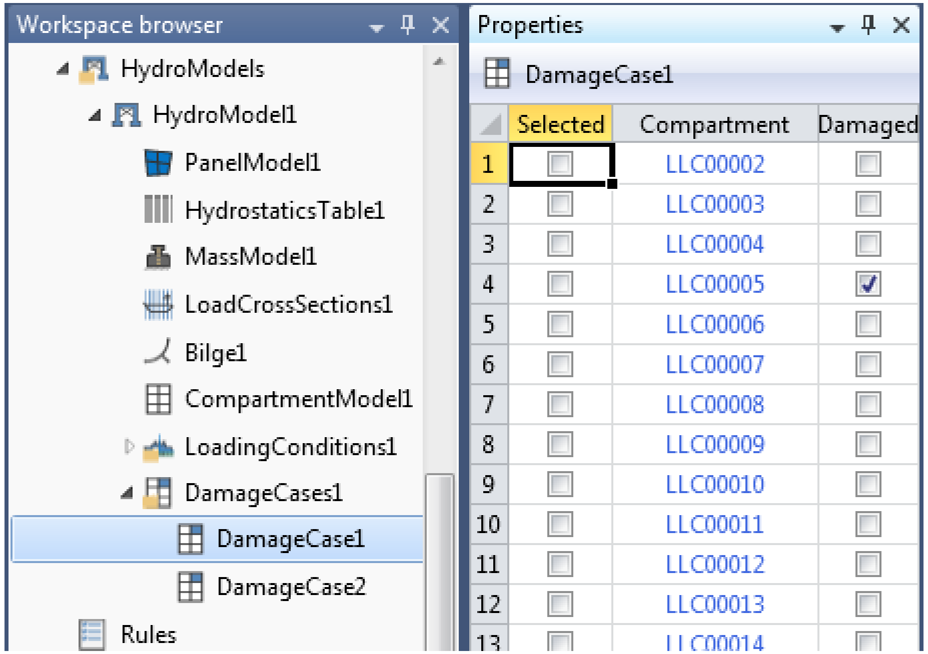
Ungraded

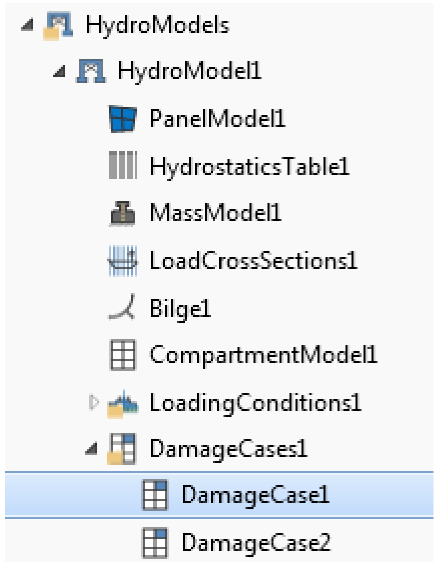
DNV·GL

Creating a damage case

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

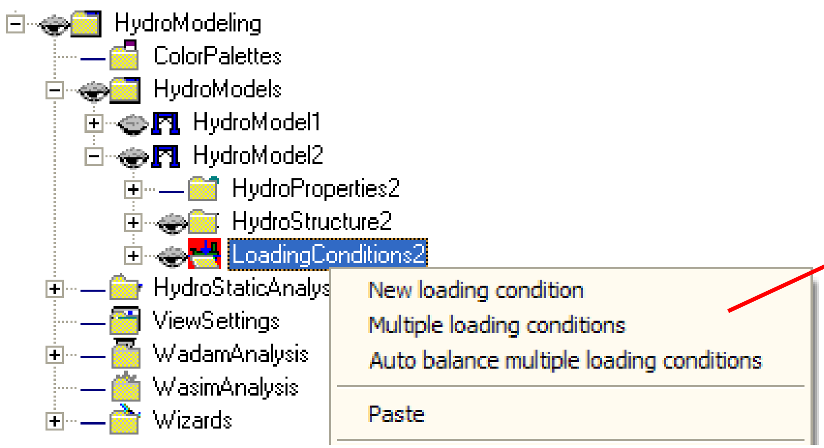


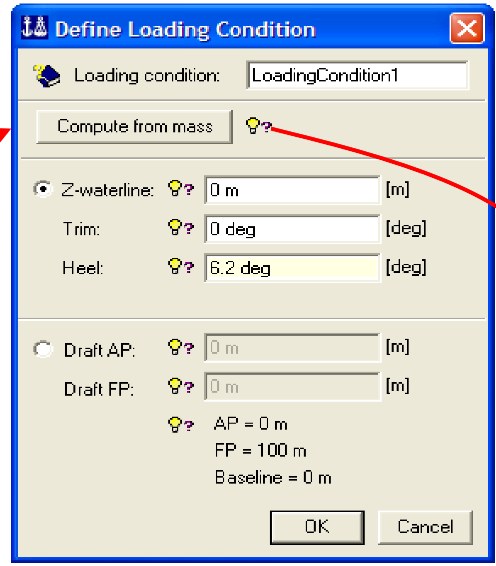


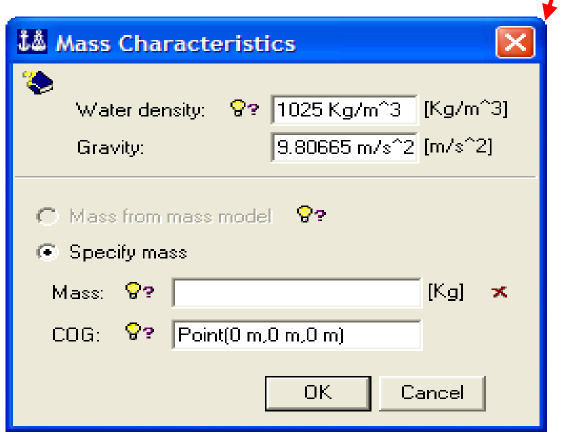


Ungraded

Creating a loading condition – H4







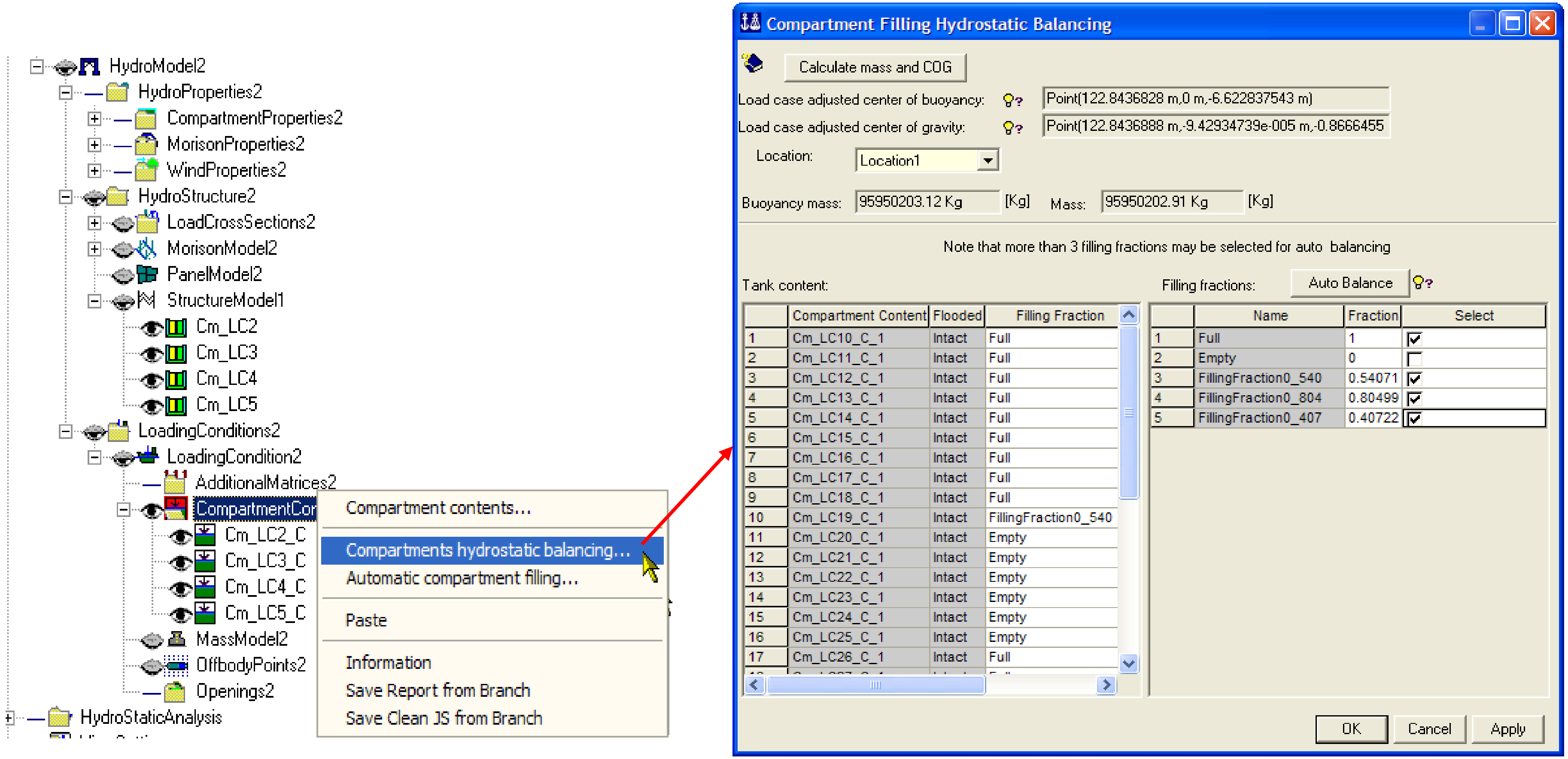
- The loading condition must have equilibrium between buoyancy and mass
  - Defined from the mass (model)
  - Given explicitly by the user
- A mass model is needed for all floating structures

Ungraded

DNV·GL

Internal fluid in tanks – Balancing by properties

- Adjust the tank filling to match the loading condition
- For Auto Balance: select three or more filling fraction properties



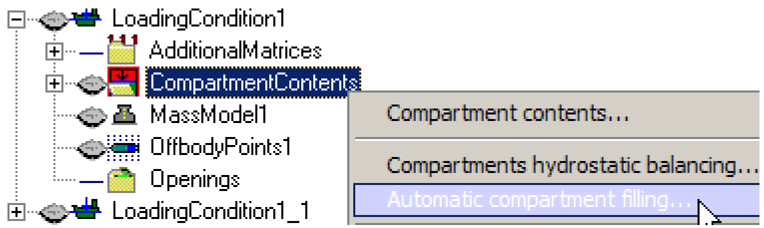
	Compartment Content	Flooded	Filling Fraction
1	Cm_LC10_C_1	Intact	Full
2	Cm_LC11_C_1	Intact	Full
3	Cm_LC12_C_1	Intact	Full
4	Cm_LC13_C_1	Intact	Full
5	Cm_LC14_C_1	Intact	Full
6	Cm_LC15_C_1	Intact	Full
7	Cm_LC16_C_1	Intact	Full
8	Cm_LC17_C_1	Intact	Full
9	Cm_LC18_C_1	Intact	Full
10	Cm_LC19_C_1	Intact	FillingFraction0_540
11	Cm_LC20_C_1	Intact	Empty
12	Cm_LC21_C_1	Intact	Empty
13	Cm_LC22_C_1	Intact	Empty
14	Cm_LC23_C_1	Intact	Empty
15	Cm_LC24_C_1	Intact	Empty
16	Cm_LC25_C_1	Intact	Empty
17	Cm_LC26_C_1	Intact	Full

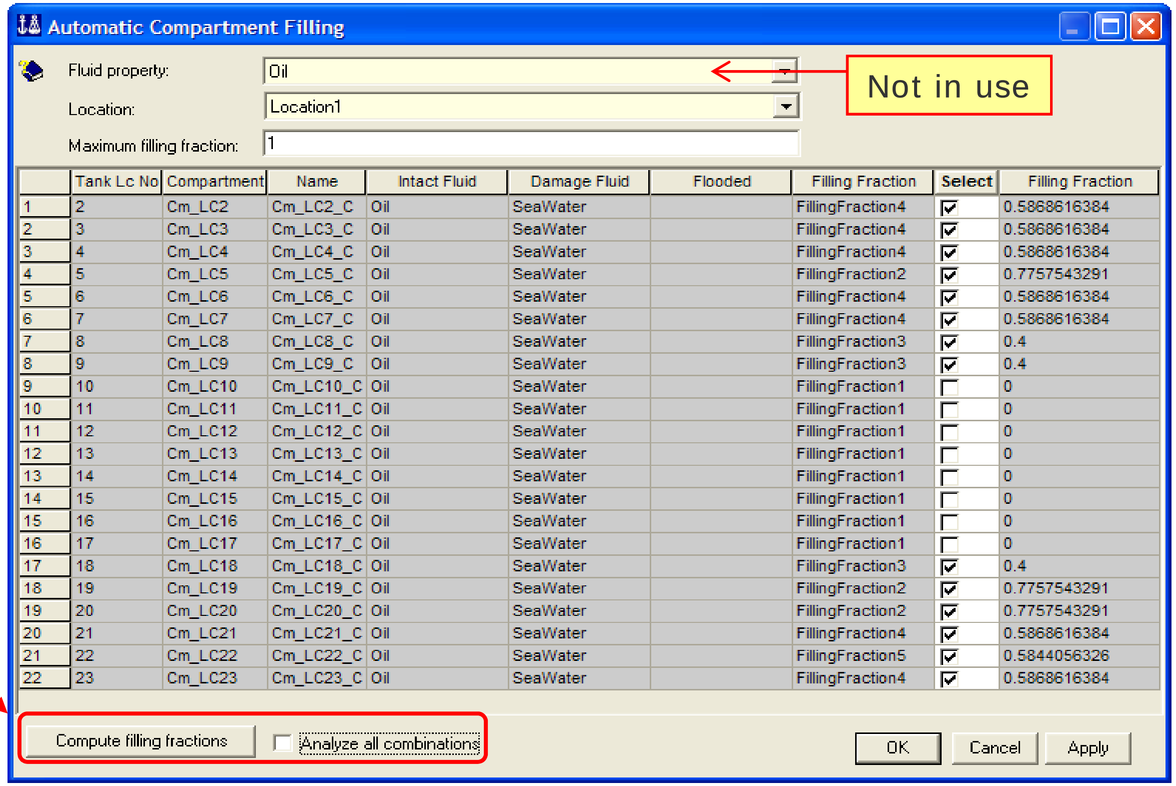
	Name	Fraction	Select
1	Full	1	☑
2	Empty	0	☐
3	FillingFraction0_540	0.54071	☑
4	FillingFraction0_804	0.80499	☑
5	FillingFraction0_407	0.40722	☑

Ungraded

Balancing vessel using many tanks

- Will try to have tanks full or empty
- Will try to maximize GM
- Need to tune three tanks at the end
- Required filling fractions are automatically created as properties
- Combinations are tried in ”intelligent” order
- “All combinations” may need a very long time to finish





	Tank Lc No	Compartment	Name	Intact Fluid	Damage Fluid	Flooded	Filling Fraction	Select	Filling Fraction
1	2	Cm_LC2	Cm_LC2_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
2	3	Cm_LC3	Cm_LC3_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
3	4	Cm_LC4	Cm_LC4_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
4	5	Cm_LC5	Cm_LC5_C	Oil	SeaWater		FillingFraction2	☑	0.7757543291
5	6	Cm_LC6	Cm_LC6_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
6	7	Cm_LC7	Cm_LC7_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
7	8	Cm_LC8	Cm_LC8_C	Oil	SeaWater		FillingFraction3	☑	0.4
8	9	Cm_LC9	Cm_LC9_C	Oil	SeaWater		FillingFraction3	☑	0.4
9	10	Cm_LC10	Cm_LC10_C	Oil	SeaWater		FillingFraction1	☐	0
10	11	Cm_LC11	Cm_LC11_C	Oil	SeaWater		FillingFraction1	☐	0
11	12	Cm_LC12	Cm_LC12_C	Oil	SeaWater		FillingFraction1	☐	0
12	13	Cm_LC13	Cm_LC13_C	Oil	SeaWater		FillingFraction1	☐	0
13	14	Cm_LC14	Cm_LC14_C	Oil	SeaWater		FillingFraction1	☐	0
14	15	Cm_LC15	Cm_LC15_C	Oil	SeaWater		FillingFraction1	☐	0
15	16	Cm_LC16	Cm_LC16_C	Oil	SeaWater		FillingFraction1	☐	0
16	17	Cm_LC17	Cm_LC17_C	Oil	SeaWater		FillingFraction1	☐	0
17	18	Cm_LC18	Cm_LC18_C	Oil	SeaWater		FillingFraction3	☑	0.4
18	19	Cm_LC19	Cm_LC19_C	Oil	SeaWater		FillingFraction2	☑	0.7757543291
19	20	Cm_LC20	Cm_LC20_C	Oil	SeaWater		FillingFraction2	☑	0.7757543291
20	21	Cm_LC21	Cm_LC21_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384
21	22	Cm_LC22	Cm_LC22_C	Oil	SeaWater		FillingFraction5	☑	0.5844056326
22	23	Cm_LC23	Cm_LC23_C	Oil	SeaWater		FillingFraction4	☑	0.5868616384

Ungraded

The world-leading provider of software for a safer, smarter and greener future

DNV GL – Software
software.support@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER

Ungraded