DNV·GL



DIGITAL SOLUTIONS

Sesam user course

HydroD Input

DNV GL

17 September 2018

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





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





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 🚽 🗸	×	Properties			- ₽ ×
🔺 藚 Workspace	•	Workspace			
🔺 茸 Environment		Input units			
💼 Location1		Length	0	Basic units. A change	•
Properties			6		
🔺 📥 StabilityProperties		Mass	۷	nere will change all	
₩ HeelAngles1		Time	9	s units below.	•
 Models 		Force	9	N	•
🔁 Vessel		Anglo	0	dag	
🔁 Hull		Angle			
🔺 🛐 HydroModels		Acceleration	Ŷ	m/s^2	•
▲ 🖪 HydroModel1		Density	9	kg/m^3	•
冒 PanelModel1		Velocity	9	m/s	•
AssModel1		Area	0	m^2	
🐸 LoadCrossSections1		Alca			
CompartmentModel1		Volume	Ÿ	m^3	•
4 📥 LoadingConditions1		KinematicViscosity	9	m^2/s	•
4 📥 LoadingCondition1		Fraction	9		•
CompartmentContents1		Manant	0	Alž-s	
HydrostaticsTable1		woment	V		
🔺 🛅 DamageCases1		Length angle	Ŷ	m*rad	•
DamageCase1		Moment angle	9	N*m*rad	•
Openings1		Pressure	9	Pa	•
A 10 LingForceMedel1					



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

Workspace browser 🛛 👻 🖡 🗙	Properties	
🔺 🧮 Workspace	💦 StabilityWizard1	
Environment	Concept steps	
Properties A StabilityProperties	Morison model	
🛛 🛄 Models	Compartments	😵 💌
🛛 🛐 HydroModels	Damage case	💡 💌
🛛 📃 Rules	Openings	💡 🗖
Manalyses	Heeling force model	
Tables	Wind heeling moments	💡 🔘 Projected area wind heeling moments
Pictures		Shape coefficient wind heeling moments
🖺 Reports		O User defined wind heeling moments
🛛 🚔 ViewSettings	Thruster	💡 🗖
🔺 📉 Wizards	Bilge	💡 🔲
StabilityWizard1	Analysis stens	
* Execute	Stability rule check	0
📫 Rename		
X Cut	MaximumKG analysis	A
Copy	Strength analysis	💡 🔲



Environment & location

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



Workspace browser 🚽 🗸	μ × Properties	⊸ ∓ ×
🔺 🧮 Workspace	🚖 Location1	
🔺 🚰 Environment	1	
💼 Location1	Location	
Properties	Gravity 9,80665 m/s*2	
🛚 📥 StabilityProperties	Water depth 💡 300 m	
🛚 🕮 Models	Water	
Interpretation Provide Provide America Provide Provide America Provide Amer	Density 💡 1025 kg/m^3	
Rules	Kinematic Viscosity 💡 1,19E-06 m^2/s	
🛚 🎒 Analyses		
🛚 🚧 Plots	Air	
🛚 🔠 Tables	Density 9 1,222 kg/m^3	
Pictures	Kinematic Viscosity 💡 1,462E-05 m^2/s	

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



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

Morison model Compartment model

For forces on

members by

the Morison

Computes line

loads on beams

equation

slender



- For tank fillings
- Contributes to mass
- Hydrodynamic pressures inside tanks
- Global mass data or mass matrix may be given directly

Mass model

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

 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



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



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

Workspace browser	- ₽ ×	Properties 🗸 🕂 🗙
a 📑 Workspace		CompartmentModel1
🛚 🚢 Environment		Source
Properties		
🛚 📥 StabilityProperties		
4 📲 Models		Translation ? L FEmodel
🛐 FEmodel	•	Panel_model
🔁 Panel_model	•	
🔺 🛐 HydroModels		
🔺 🋐 HydroModel1	•	
📷 PanelModel1	Ο	
👗 MassModel1	-	
👋 MorisonModel1	•	
CompartmentModel1	-	Model Compartments Style
🛛 📥 LoadingConditions1		Properties 📰 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

Workspace	browser
🔺 🧮 Wor	kspace
Þ 👬 E	nvironment
🔷 🎽 P	Properties
	StructureReductions1
	Permeabilities1
	Contents1
	FillingFractions1

Filling fractions in %				🖌 🗾 Nam	ne Va	alue	Color
				1 StructureRe	duction1 2	%	
Properties	- □ ×		Propertie	+ c	_	- 🗖	×
Contents1			Pern	- neabilities1		• •	
Name Density C	olor			News	Malaus	Calar	
1 Seawater 1025 kg/m^3				Name	value	Color	
2 Oil 900 kg/m^3			I Pe	rmeability1	98 %		-
+	Properties		- □ ×				
General	FillingFraction	s1	al and				
Properties 📰 Results	Mame	Value	Color	erties 📄 Result	ts		
	1 Full	100 %					
	2 Empty	0 %					
	3 .		+				

Properties

StructureReductions1

- 🗆 ×

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.

	percies											
	Compartr	mentModel	1									
	Selected	Loadcase#	Name	Group	eability pro	Permeability	e reduction	cture reduc	nicknessCor	Deck tank	Visibl	e
1		2	LC2_TANK	Sub	ermeability	98 %	:tureReduct	2 %	v		1	*
2		3	LC3_TANK	Sub	ermeability	98 %	:tureReduct	2 %	v		1	
3		4	LC4_TANK	Sub	ermeability	98 %	:tureReduct	2 %	v		1	
4		5	LC5_TANK	Sub	ermeability	98 %	tureReduct:	2 %	1		1	
5		6	LC6_TANK	Sub	ermeability	98 %	:tureReduct	2 %	v		1	=
6		7	LC7_TANK	Sub	ermeability	98 %	tureReduct:	2 %	1		1	
7		8	LC8_TANK	Sub	ermeability	98 %	tureReduct:	2 %	1		1	
8		9	LC9_TANK	Sub	ermeability	98 %	:tureReduct	2 %	v		1	
9		10	LC10_TAN	Deck	ermeability	98 %	:tureReduct	2 %		v	1	
10		11	LC11_TAN	Deck	ermeability	98 %	:tureReduct	2 %		v	1	
11		12	LC12_TAN	Deck	ermeability	98 %	:tureReduct	2 %		v	1	
12		13	LC13_TAN	Deck	ermeability	98 %	tureReduct:	2 %		1	1	
13		14	LC14_TAN	Deck	ermeability	98 %	tureReduct:	2 %		1	1	
14	4	4.5	LOID TAN	D 1	1.00	00.0/		2.07		(ma)		
M	del Com	antmonte	Style									
	Com	partments	Style									
	Properties	Result	ts									

Mass model

- Interview And America And A Interview And America And A 🖶 PanelModel1 晶 MassModel1 🔌 MorisonModel1 CompartmentModel1 0 A dia LoadingConditions1 Image: A standard 📕 CompartmentContents1 🥥 MassModel1 - 🗆 X Properties A diagonal diagona MassModel1 Ħ CompartmentContents1 🧅 Source From element model Type O User specified Point mass table Element model - 00 **E**FEmodel Element model Translation Model User specified Point mass table Options Style Properties 📰 Results
- 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

🔺 📥 LoadingConditions1				
🔺 📥 LoadingCondition1				
CompartmentContents1				
👗 MassModel1				
🔺 📥 LoadingCon	±	Fill from buoyancy		
🗄 Comparti 🐣 Change to user specified mass model				

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

Properties	; - □ ×
👗 Mass	Model1
Coordinat	te system
Mass	💡 💿 Input
	 Global
Mass —	
Mass	Ŷ
	A value is required.
Centre of	gravity
х	Ŷ
	A value is required.
Y	Ŷ
	A value is required.
Z	@
	A value is required.
Model L	Jser specified Point mass table Options Style
Prope	erties 📰 Results

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

Results	+ □ ×						
👗 MassMo	👗 MassModel1 🛅						
Mass							
Mass	9 5650 kg						
Centre of gra	vity						
x (? -0,17699 m						
Y (2,0708 m						
z (9,3274 m						
LCG 🤇	? -0,17699 m						
TCG 🤇	2,0708 m						
VCG 🤇	9,3274 m						
KG 🤇	9,3274 m						
Actual							
Propertie	s Results						

Pro	Properties 👻 🗖 🗙								
👗 MassModel1									
	Mass	Х	Y	Z					
1	1000 kg	0 m	0 m	0 m					
2	1250 kg	10 m	0 m	10 m					
3	900 kg	-15 m	-15 m 13 m						
4	2500 kg	0 m	0 m	15 m					
+									
Model User specified Point mass table Options Style									
	Properties Results								

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



Properties 👻 🗖									
🖶 Loa	LoadCrossSections1								
Referen	ce point								
Х	9	0 m							
Y	9	0 m							
z	9	15 m							
Section	position			_					
	From	То	Step						
1	-45 m	45 m	10 m						
+									
				-					
Model Sections Style									
Pro	perties	Results							

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



Creating a loading condition

 One or more loading hydro model 	i≙. ≜	Add HeelingForceModel Add LoadingCondition					
Civo waterline er d	b	Add MassModel					
- Give water line of t	-	Add LoadingConditions					
Multiple loading conditions may be defined efficiently							
Workspace browser	- ₽×	Properties - I × IN HydroModel1					
A 📑 Workspace	A	📥 LoadingCondition1 🛛 📅 PanelMode	11				
🛚 🚰 Environment		Environment 👪 MassModel	1				
Properties		Location 💡 🚔 Location1 🚽 🌍 🛟 🐟 MorisonMo	del1				
StabilityProperties		Specify By	antMo				
		Type 📀 💿 Waterline & Trim		1			
		O Drafts	naitio	Generate multiple concepts			
PanelModel1	0	Waterline & Trim — Loading		oenerate maniple concepts			
🕌 MassModel1		Waterline Z 💡 15 m	<u></u>	Add LoadingCondition			
👋 MorisonModel1	•	Trim 📀 0 deg 👗 Mas	т,	Rename			
CompartmentModel1	•	Derffe					
4 📥 LoadingConditions1		Draft ΔP 😵 15 m					
🔺 📥 LoadingCondition1 🛛 🖉 🛛	0						
CompartmentContents1	•	Draft FP 🦞 15 m					
👪 MassModel1		Heel					
🔺 📥 LoadingCondition2	•	Heel 🦞 0 deg					

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



Properties	- □ ×
📥 LoadingCondition1	
Balancing ————Balancing method	 Potential solver Dynamic solver
Tolerance	💡 1E-04 %
Auto Balance	💡 💌
Plate thickness correction —	
Plate thickness correction	💡 🗖
Model Advanced Style	

Compartments in loading condition

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



Properties											
E CompartmentContents1								_			
	Selected	d Name	Fluid	Fluid density	lling proper	tilling fractio	tact fluid ma	Damaged	FreeSurface	Group)
1		LC2_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg		V	Sub	4
2		LC3_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg		V	Sub	
3		LC4_TANK	Oil	900 kg/m^3	Empty	0 %	0 kg		v	Sub	1
4		LC5_TANK		1000 kg/m^		20 %	98337 kg		v	Sub	
5		LC6_TANK	Oil	900 kg/m^3	Half	50 %	,2126E+05 kg		v	Sub	
6		LC7_TANK	Oil	900 kg/m^3	Full	100 %	,4252E+05 kg	1	v	Sub	
7		LC8_TANK	Seawater	L025 kg/m^3	Full	100 %	,0398E+05 kg		v	Sub	
8		LC9_TANK	Seawater	L025 kg/m^3	Full	100 %	,0398E+05 kg	1	v	Sub	,
9	•	1 1				1			1	•	
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

j io o			Coaung	Conditions	
			🔺 📥 Load	lingCondition1	
			🗄 C	ompartmentContents1	0
			📇 M	las 🔒 Adjust filling	
Properties				Rename	
E Compartment	tContents1			ing p Rename	
Min/Max filling fra	oction				
Min 💡	0 %				
Max 💡	100 %				
Adjust filling —				Ξ.	
Type 💡 🖗	Adjust by compartment				
0	🕽 Adjust by group				
Exhaustive 💡 🛛	7				
Timeout 💡	60				
Commentation	·				
Name	Eluid density	Filling fraction	Damaged	Adjustable	
1 LC2 TAN	IK 900 kg/m^3	86.393 %	g-u		
2 LC3_TAN	IK 900 kg/m^3	100 %		V	
3 LC4_TAN	IK 900 kg/m^3	0 %			
4 LC5_TAN	IK 900 kg/m^3	100 %			
5 LC6_TAN	IK 900 kg/m^3	100 %			
6 LC7_TAN	IK 900 kg/m^3	0 %		V	
Contents Ortige	- Style		_		
Contents Option	is oryle				
Properties	Results				

4 📥 LondingConditions1

Creating a damage case

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



Add HeelingForceModel
 Add LoadingCondition
 Add MassModel
 Add LoadingConditions
 Add DamageCases
 Add MorisonModel



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