WHEN TRUST MATTERS

Renewables and Ocean Structures, Digital Solutions

Increase your performance using the 2022 releases of our tools

Ole Jan Nekstad, Product Marketing Director

23 January 2023



The integration of the market leading tools Bladed and Sesam makes the combined offering a unique value proposition in the offshore wind industry

Our tools support a wide range of industries











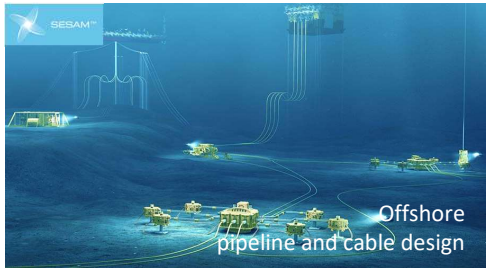














Grow your capacity and performance

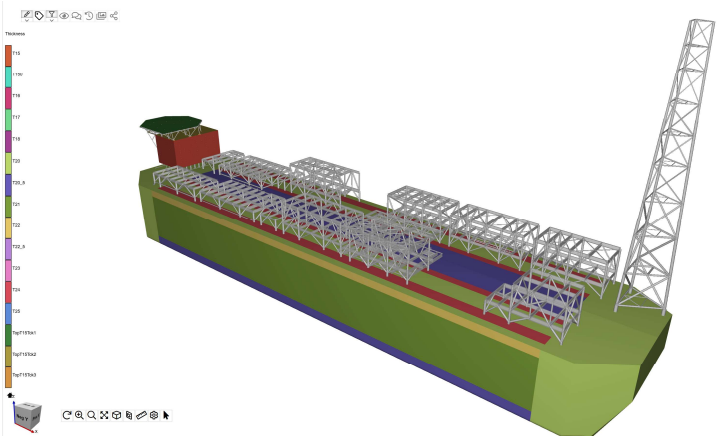
- The objective of this presentation is to show you the value of the new functionalities provided by WindFarmer: Analyst, SolarFarmer, Nauticus Machinery, Bladed and Sesam
  - Simplify collaboration
  - Supporting new standards
  - Simplify workflows for offshore wind
  - Reduce your assumptions/conservatism by use of more advanced technologies
  - Work faster with larger models
  - Bankability for offshore wind and solar PV
  - Customisability of the turbine analysis simulation
- There are also additional features delivered. See the release note of each program

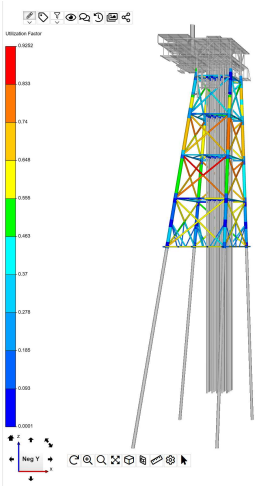
- Content

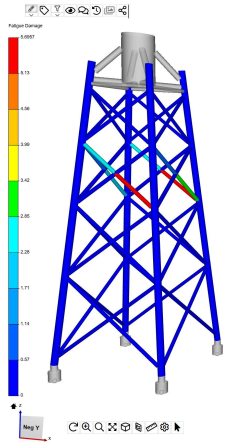
  - Page 4: Digital collaboration with your stakeholders
  - Page 7: Sub-stations, fixed OWT foundation, O&G jackets
  - Page 23: Offshore floaters for OWT, O&G, Aquaculture
  - Page 37: Turbine design
  - Page 45: Offshore wind workflows for foundation design
  - Page 56: Layout modelling and energy production assessment
  - Page 63: Offshore pipelines and cables
  - Page 66: Propulsion design and analysis
  - Page 69: List of releases during 2022

Digital collaboration with your stakeholders

- New values during 2022
  - Revisioning history
  - Share viewing of your Sesam models and results with your stakeholders. Viewing is free for a week
  - Show fatigue results based on time domain, stochastic or spectral analysis
  - Show code check results for plates with seams (segmented plates)



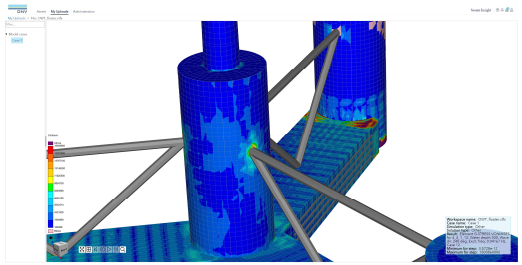




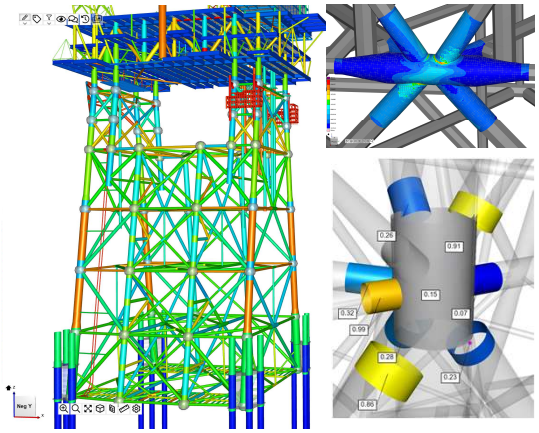
Unlock the value of Sesam data and share with stakeholders who don't have or know Sesam. All they need is internet connection and a browser on laptop, tablet or phone

Sesam Insight - real time web collaboration on your Sesam data

- Upload and share Sesam data to selected stakeholders in a secure workspace
  - Be in control of your own data and decide who can download, edit, comment or view – including drawings and data sheets
- Invite your stakeholders to collaborate on the same digital asset - view, comment and share data
  - Notification support sends a link to area of interest to the right recipients
  - All comments are attached to the model
- Visualize Sesam model and analysis results on any device
  - Structural layout, materials, sections and hydrodynamic properties
  - Code check results, fatigue results, animate finite element results in time domain – displacements, stresses, forces etc.
- Compare model parts between versions – revision control
  - Variances are highlighted graphically and in report for model parts, properties and code check results – ease your version control of your data
- Make your decision based on multiple sources of key data
  - Add custom information such as inspection and corrosion data on top of Sesam structural assessment details when making your decisions



Show stresses of floating offshore wind turbine foundation

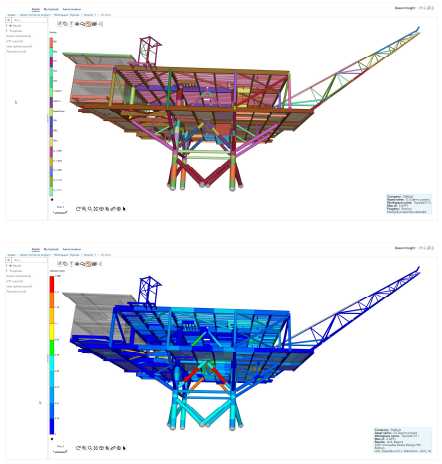


Show O&G deep water jacket with code check results and detailed stresses in embedded shell model

With a single click you and your stakeholders can view the changes of a structure and the results during the revision history of the asset. This means that tedious editing work to document changes over revisions can be avoided and lot's of time is saved

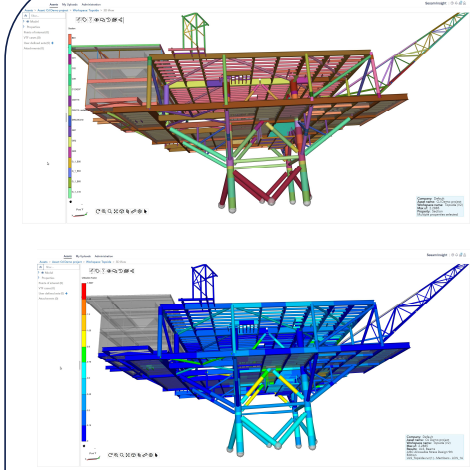
Version handling

- The new functionality for viewing changes of a model and results (code check or fatigue) makes it very easy for the designer to document and explain the differences to stakeholders. This helps in the quality control



Version 0

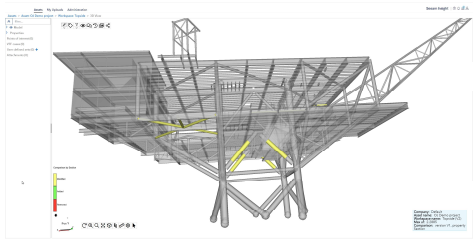
Section properties & code check results
Several main members have UF > 1.0

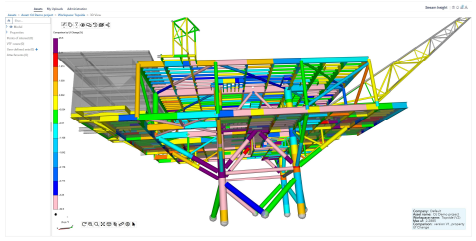


Version 1

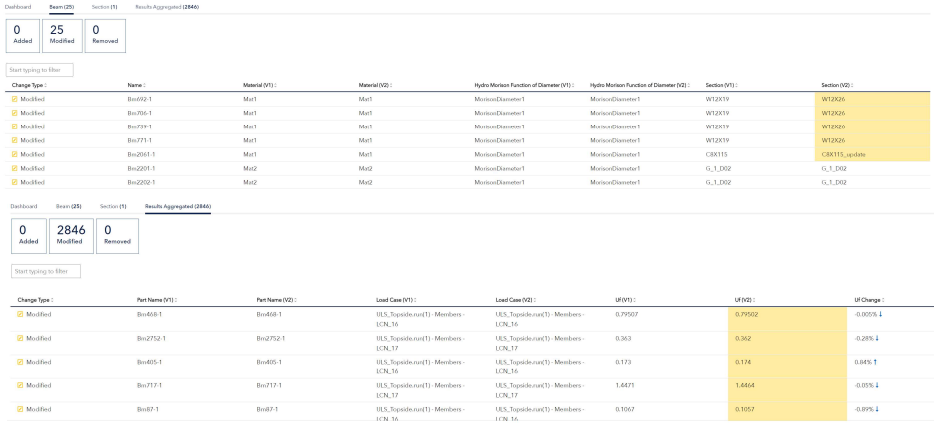
Section properties & code check results
All main members have UF < 1.0

- See the changes graphically of structure and results
  - Instead of reading a report you get an instant overview



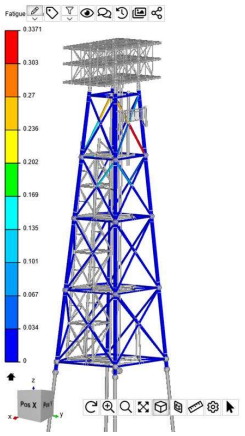


  - Or see changes tabularly

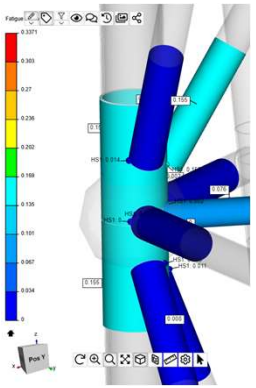


Jackets, sub-stations, fixed OWT foundations

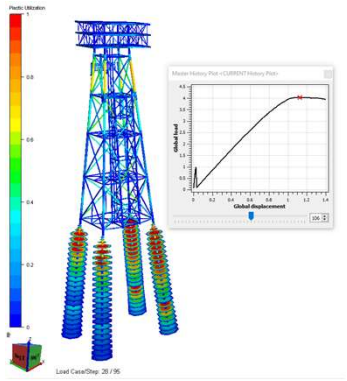
- New values during 2022
  - Overcome conservatism in the fatigue calculation of tubular joints
  - Use the model for in-place condition as basis for non-linear analysis
  - Support for ISO 19902 2020 edition
  - PISA for pile/soil analysis of large diameter monopiles
  - Decoupling of members
  - Gap (contact) analysis
  - P-delta effects
  - Corrosion analysis
  - Pile fatigue based on dynamic analysis
  - Advanced options for wave load analysis
  - Pan-cake failure check
  - Improvements in the data import from Sacs



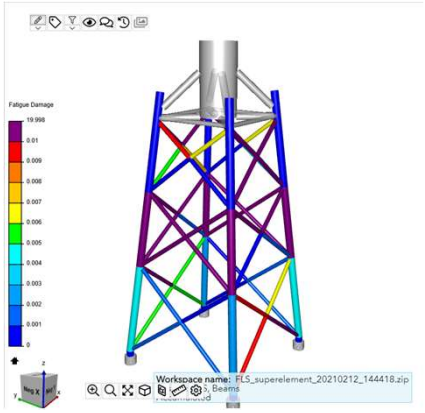
Code check based on ISO 19902 2020 edition



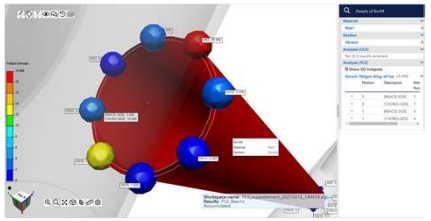
Fatigue damage



Push-over analysis using in-place as basis



Code check fixed OWT foundation – based on time domain analysis

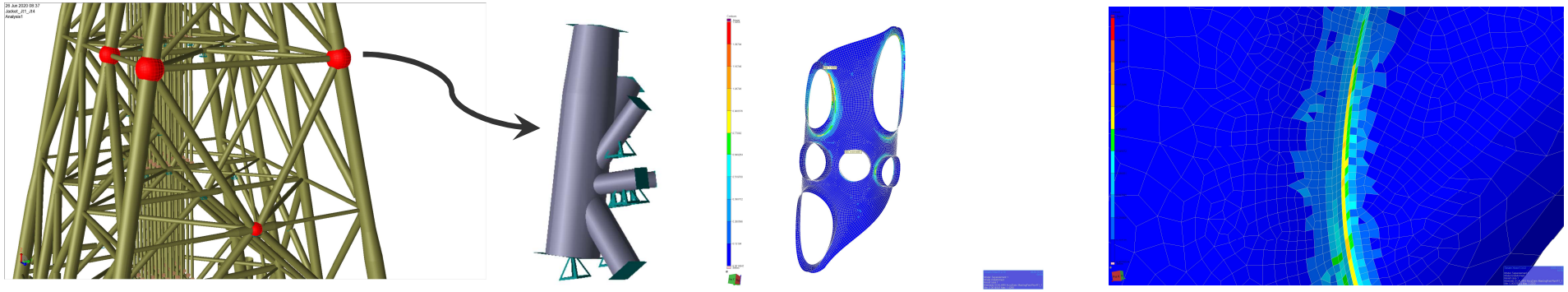


Fatigue damage of fixed OWT foundation – based on time domain analysis

Shell fatigue of tubular joints

Overcome the conservatism in fatigue analysis based on parametric SCF and beam theory
- ***editing work from days to a few minutes when converting a tubular joint***
- ***faster dynamic analysis time in the order of 50%***
- ***stochastic fatigue analysis time down from typically 30 min to 30 sec***

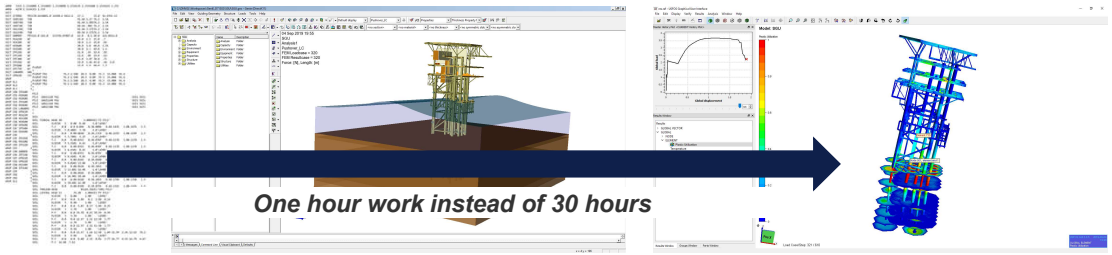
- Tubular joints can be converted with one command satisfying the FE mesh requirements of DNV RP-C203 to do fatigue analysis of shell or to calculate your own SCF
- The shell model is automatically connected to the jacket model (by use of rigid links aka master slave)
- The hydrodynamic loading of converted joints is covered by use of non-structural members
- The dynamic analysis is faster because of a new version of Sestra and exporting only relevant structure and result components
- More accurate results of shells because of 1st order thick shell element as compared to 1st order thin shell element
- Stochastic fatigue analysis is significantly faster because fatigue can be performed on selected parts only



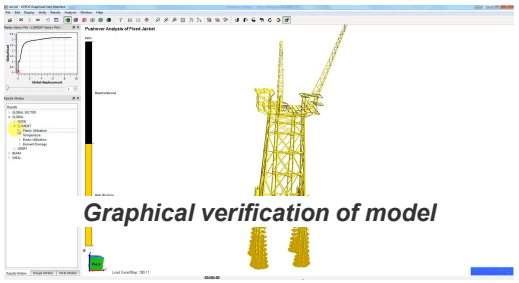
Save days of worktime when using Sesam models or imported models for non-linear analysis

GeniE is the pre-processor of Usfos

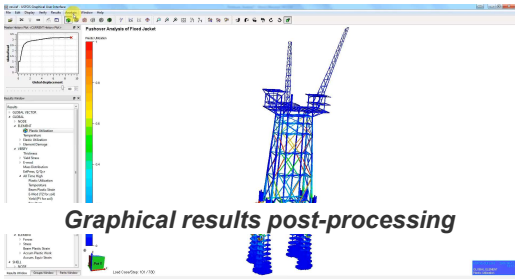
- Usfos does not have a dedicated graphical front-end pre-processor. GeniE act as gateway to perform complex operations in Usfos with ease and confidence
- The same model as in-place condition is the basis for the non-linear model
  - Modifications on concept model can be easily updated to Nonlinear model
  - Reduces errors in conversion process
  - Trusted validation of converted model when converted repeatedly
  - Full traceability of finite element numbers to concept model
- Export functionality include Structure + Environment + Pile + Soil
- Automatic creation of Usfos control file for Non-linear Static PSI Analysis and Boat Impact
  - Other analysis types such as Dynamic, Fire, Earthquake requires a minimum of data editing of the Usfos control file
  - Facilities the import from Sesam Legacy models and other systems like e.g. SACS



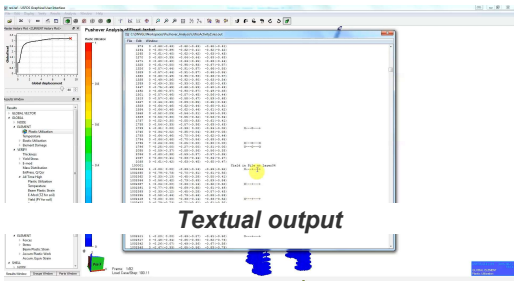
One hour work instead of 30 hours



Graphical verification of model



Graphical results post-processing

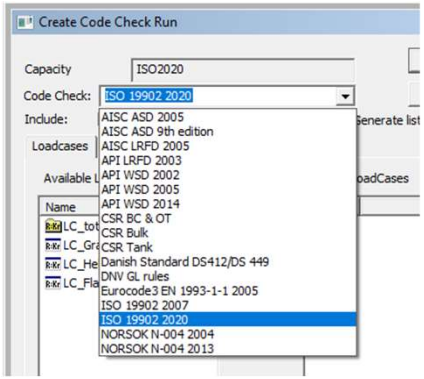


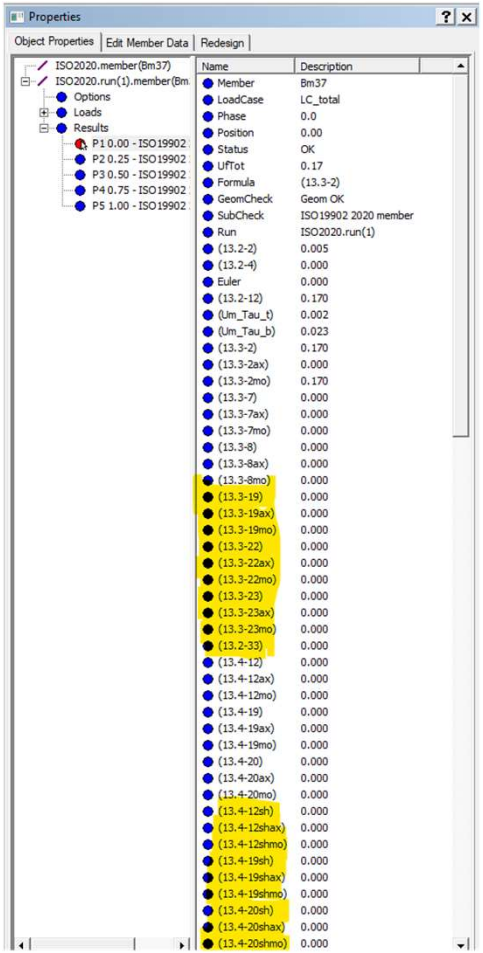
Textual output

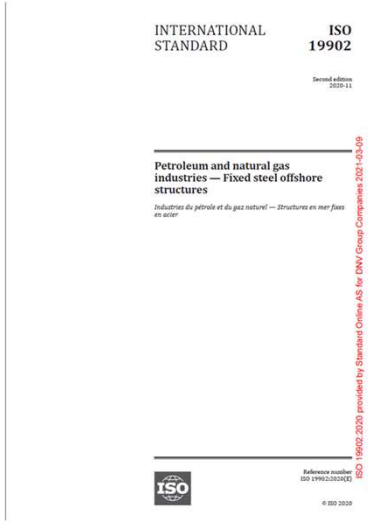
No longer a need to do a manual code check for ISO 19902 2020 edition. We believe Sesam is the only tool supporting this edition

ISO 19902 2020 edition

- The code check revision has been implemented and verified
  - Discussions with ISO committee and key users of Sesam to agree on an understanding of unclear parts
  - Member and tubular joint checking has been released
  - Conical section checking is scheduled for Q1/2023
  - Supported in GeniE







ISO 19902:2020 Update

— tubular member diameter to thickness ratio non-dimensionalized (13.1);

— shear and torsion now included in all tubular member strength formulae including those addressing hydrostatic pressure;

— tubular member strength formulae for combined axial and bending loading now of cosine interaction form instead of previously adopted linear interaction;

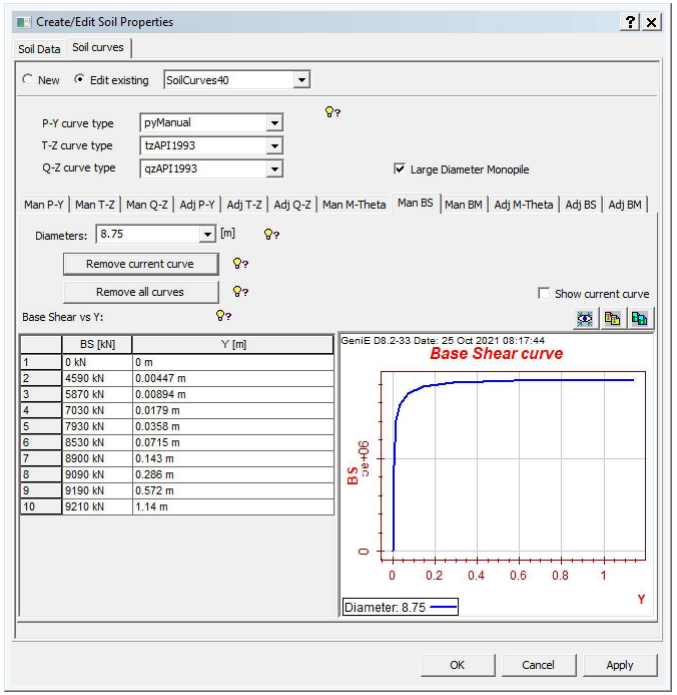
— formulae (13.6-2) and (13.6-3) relating to conical transitions corrected;

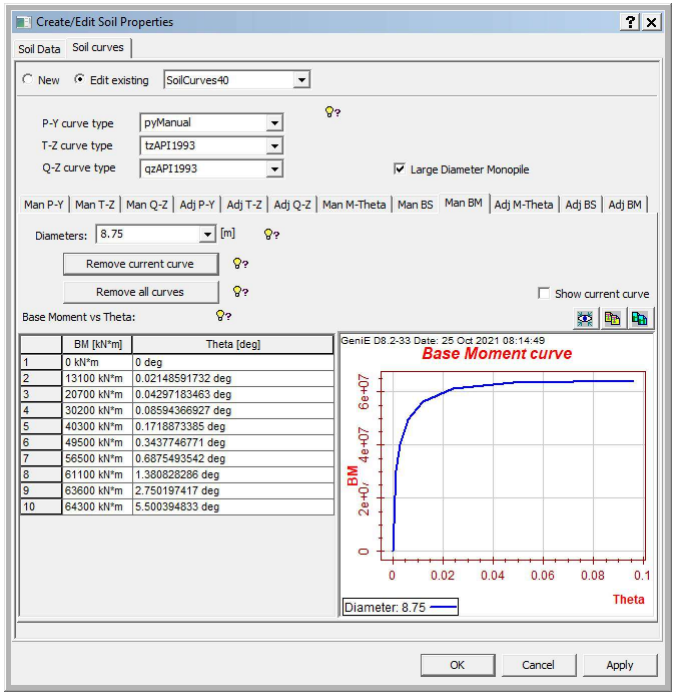
— tubular joint strength formulae nearly all changed through adoption of the API RP 2A-WSD 21st Edition Supplement 2 (October 2005) tubular joint formulae supplemented by some limited non-linear FEA;

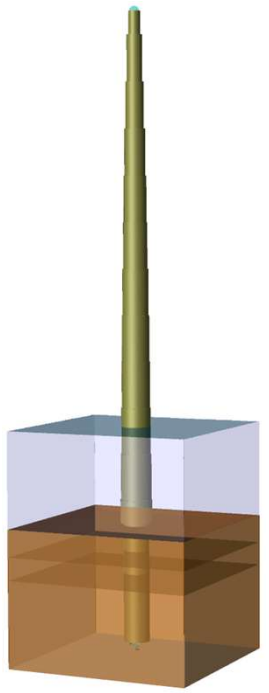
The new functionality allows for more precise pile/soil analysis in Sesam of large diameter monopiles – turbine foundation or substation

PISA for pile/soil analysis of large diameter monopiles

- PISA includes more soil curves than P-Y, T-Z and Q-Z
- Additional soil curves are M-Theta, Base Shear and Base Moment
- The implementation and verification of PISA in Splice is complete and done in collaboration with NGI (Norwegian Geotechnical Institute) and DNV Energy Systems
- Input can be defined in GeniE



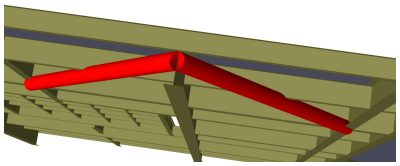


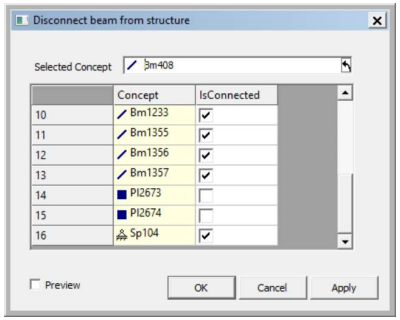


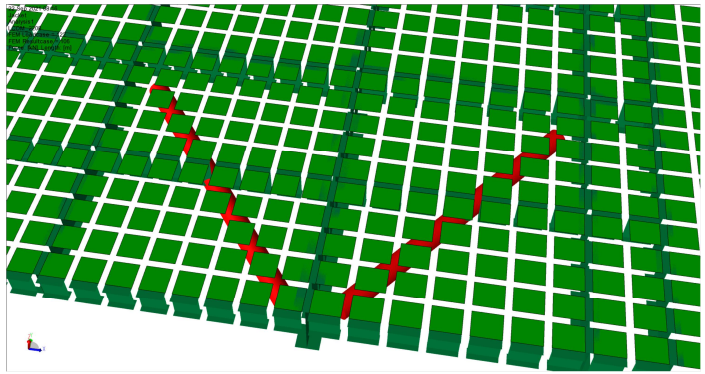
Sesam has supported decoupling through use of the super-element methodology or by use of scripting in GeniE. This is now faster and much more easy to do as the modelling can be done from the user interface of GeniE

De-coupled concepts

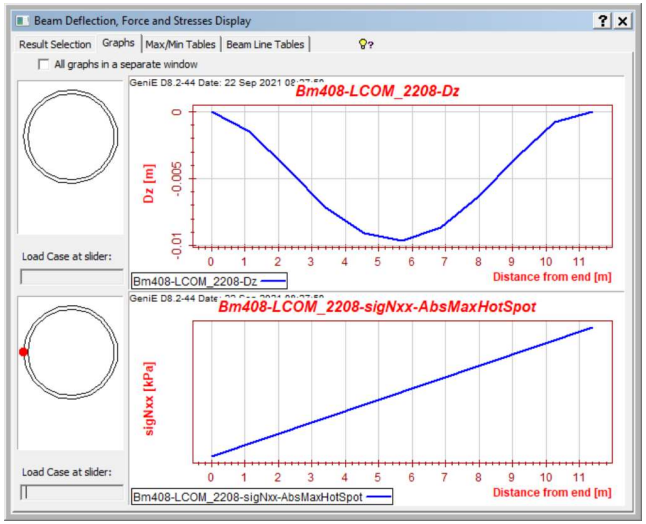
- Modelling of de-coupled concepts (beam-beam, beam-plate, plate-plate) is performed more quickly
  - Concepts are decoupled at the concept level, allowing for accurate interpretation of the intricacies of in-situ modelling
  - Easy simulation of complicated plan-braces, tie-in beams, and other structural elements on topside structures and living quarters







Beams are disconnected from plate and the beam FE mesh is different from the plate FE mesh

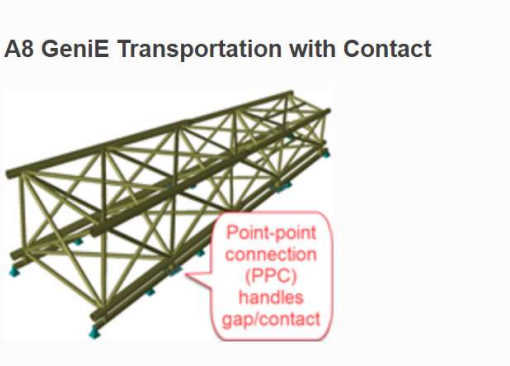


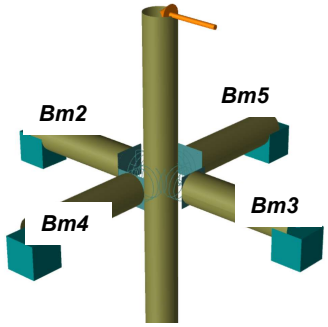
The beam deflection and axial stress are independent of the plate

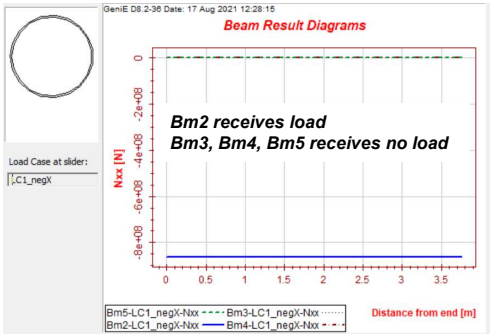
Contact (gap) analysis

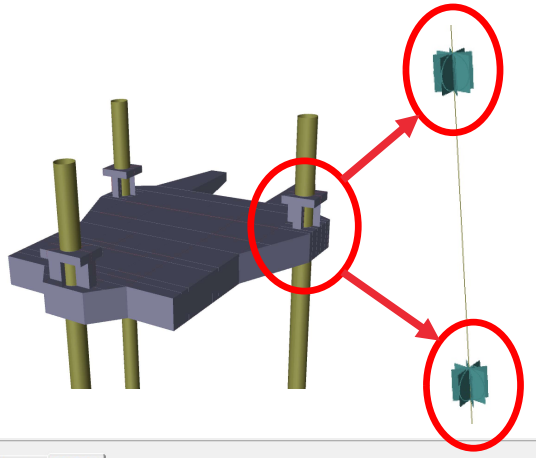
No longer a need to use super-element modelling for doing contact analysis. All input and execution can be done from the GeniE user interface, i.e. no need for cumbersome definition of gap and contact conditions

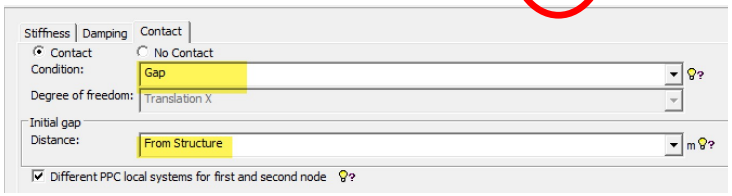
- Contact analysis performed in a more efficient manner
  - Point-Point connections are used to define gap connections
  - Manually specify the gap or use the real gap derived from geometry (“From Structure”)
  - Allows for much quicker design iterations of sea or yard transportation analysis, jack-up in-place analysis or other similar analysis
  - New tutorial explaining the use of contacts in transportation analysis







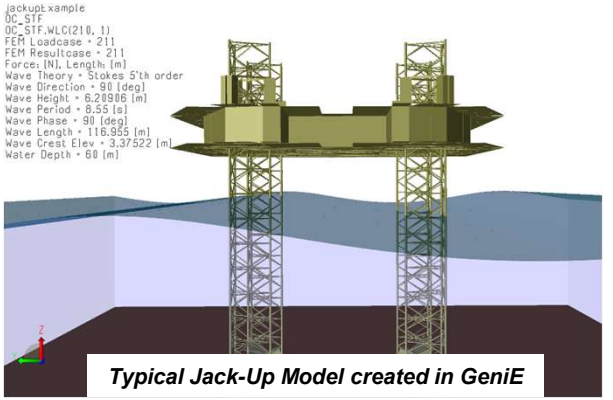




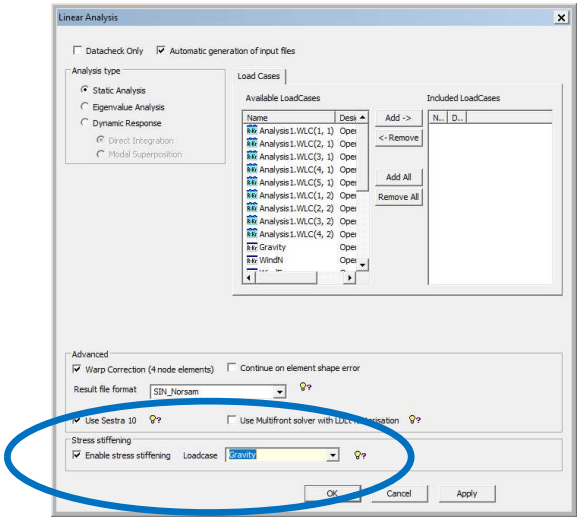
It is now much easier to set up a P-Delta analysis and the execution time is faster

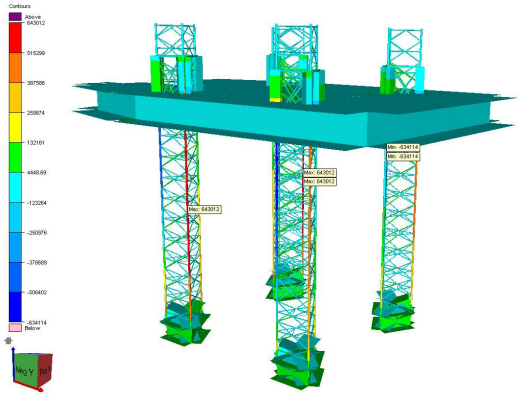
P-Delta analysis

- All input can now be specified from GeniE and analysis is done by Sestra10
  - Previously – it was necessary to edit an input file and run Sestra 8 to do P-Delta analysis
  - Previously – it was necessary to use the last load-case as basis for the P-Delta analysis. This is no longer the case

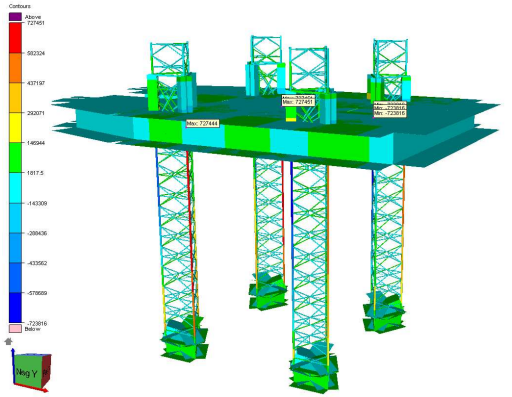


Typical Jack-Up Model created in GeniE





Analysis Result without P-Delta
Max. Member Axial Force = 643.012 KN



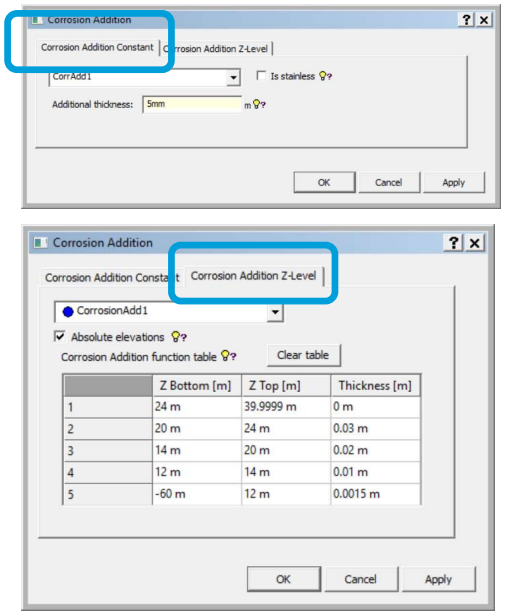
Analysis Result with P-Delta
Max. Member Axial Force = 727.451 KN
Using gravity load as stress stiffening case

Corrosion addition analysis of jackets

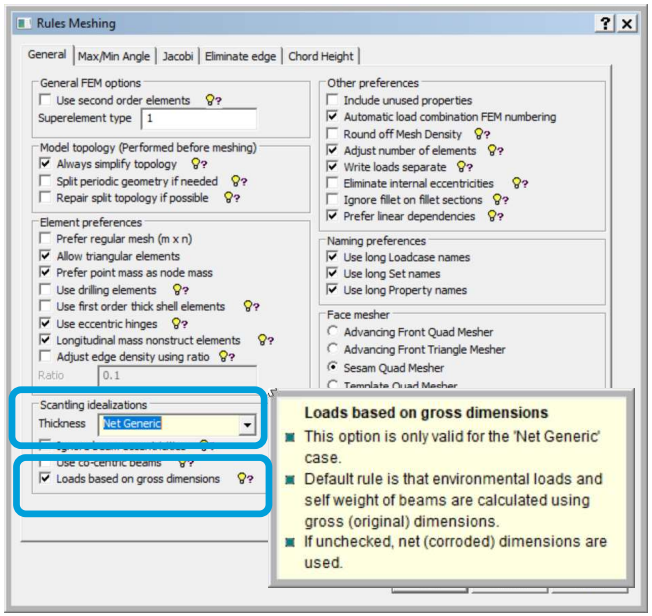
There is no longer a need to make separate models for in-place and corrosion conditions. The corrosion addition can easily be applied to the structure model, there are options to use the loads based on gross or net dimensions – and finally if one wants to adjust the scantlings during code check

- Corrosion can now be added and included in analysis and member code checking
  - The overall procedure for doing corrosion analysis based on existing ULS analysis

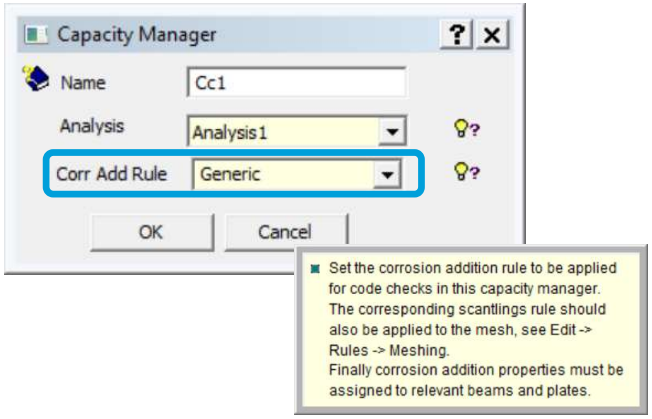
Define constant corrosion addition or varying over depth, and apply to members



Specify that corrosion addition shall be used in analysis and how to calculate the wave loads



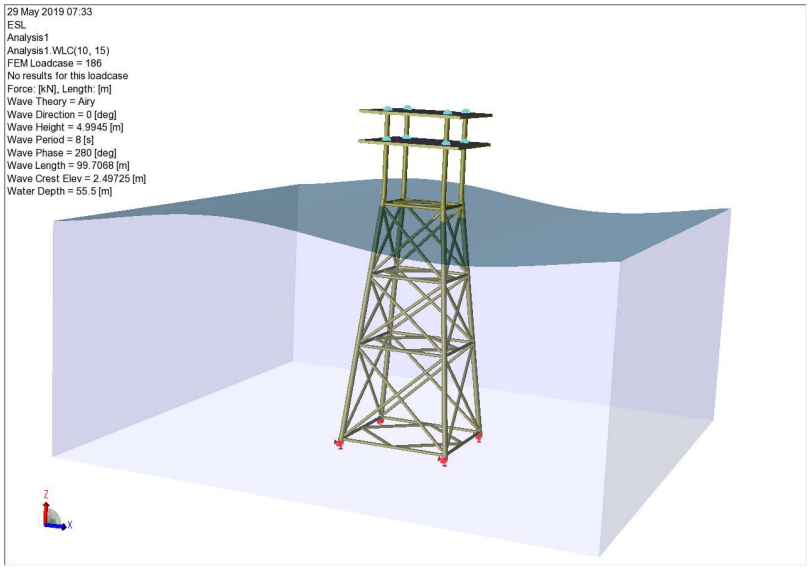
Specify that corrosion addition shall be used when making the capacity model. If the corrosion addition rule is not set to Generic, then gross section data will be used when making the capacity model and use the results from analysis where FE model includes corrosion addition



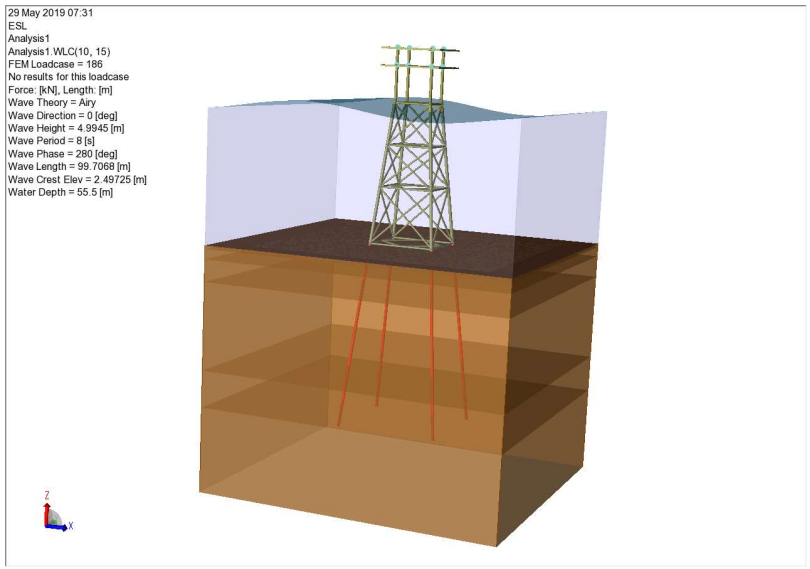
Equivalent static load approach has been introduced for fatigue and code checking. Our users can now do pile fatigue and code checking based on dynamic analysis including the non-linear effect of the soil

Pile fatigue based on dynamic analysis

- Pile fatigue and code checking based on the equivalent static load approach (ESL)
  - Previously pile code checking and fatigue could only be done based on static analysis



The dynamic effects (inertia and damping) are calculated per time step for each wave direction. The ESL is calculated for each dof for all nodes based on a time domain dynamic analysis is performed

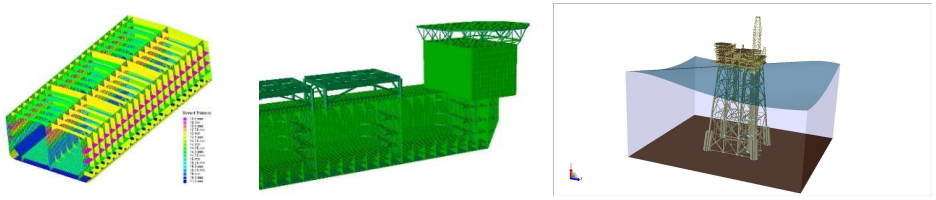


The dynamic effects are automatically re-used in a static analysis including the piles. Fatigue analysis and code checking of piles can be carried out including the dynamic contributions

Larger Sesam analysis can now be performed much faster. We parallelized the element matrix computation and processing of stresses/forces to speed up performance

Improved analysis performance

- Significant performance improvements
  - Cargo hold model (260.000 dof, 45 LC) – **52% faster**
    - Sestra 10.6: 77 sec
    - Sestra 10.4: 162 sec
  - FPSO model (345.000 dof, 71 LC) – **56% faster**
    - Sestra 10.6: 317 sec
    - Sestra 10.4: 724 sec
  - 8 leg jacket (18.000 dof, 54 LC) – **40% faster**
    - Sestra 10.6: 4.6 sec
    - Sestra 10.4: 7.8 sec
  - 8 leg jacket (165.000 dof, 500 LC) – **83% faster**
    - Sestra 10.6: 177 sec
    - Sestra 8.8: 1033 sec



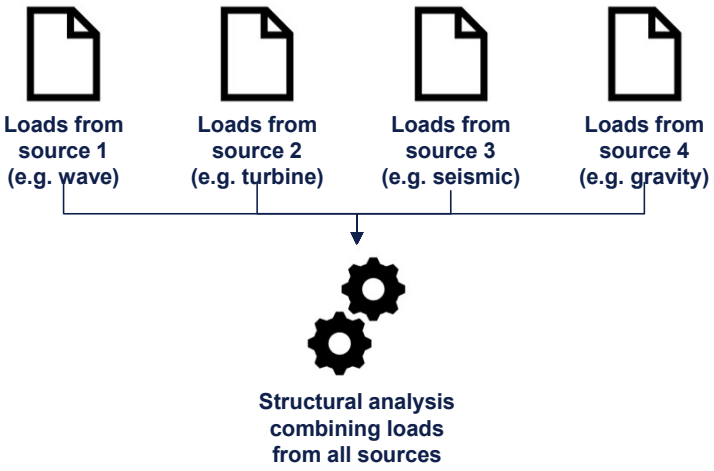
- Special considerations to low memory computers and analysis with many time steps
  - Previously Sestra kept all load cases for a load history in memory before making the result file (R*.SIN)
  - Sestra now uses the value of NUMLC (number of load cases) and exporting to the result file prior to commencing on next NUMLC load cases
  - It is recommended to use the default NUMLC (this will be calculated based on the actual computer)

108000 load cases	Sestra 10.15 Dynamic analysis	Sestra 10.16 Dynamic analysis NUMLC=100	Change
Execution time	06:03:46	02:12:55	-63%
Peak memory (physical)	36.49 GB	0.92 GB	-97%
Peak memory (total)	41.94 GB	1.12 GB	-97%

The new functionality gives users flexibility in defining the loads as well as to update parts of the load history only

Improved usability and efficiency of load input

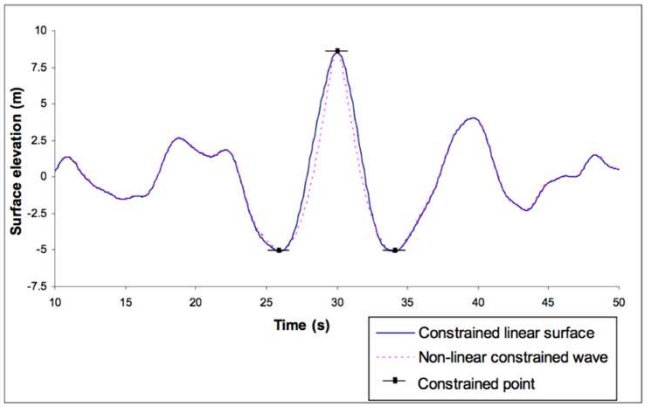
- It is now possible to specify multiple load files as input to a structural analysis in Sestra
- Previously, all loads had to be defined on a single L-file and/or included in the T-file
- With this new functionality, the user can specify different load (histories) in different load files
- The different load histories can have different time steps
- The load histories are then merged into the analysis by Sestra, and interpolated to the analysis time step
- This makes it easier to work with multiple load histories, as it avoids the need to interpolate all loads to the same time step on a single loads file, and thereby reduces the loads file size as well
- It also allows for easier updating of load histories and re-use of the different load histories



Wave load analysis is now more complete for fixed OWT foundations

Advanced options for wave load analysis

- New parameter to control stretching of current profile during irregular-sea analysis
- Use Wave Kinematics Reduction Factor and Current Blockage Factor for constrained and irregular wave analysis
  - Embedded wave includes Doppler effects
  - Irregular (background) sea includes Doppler effects
- More options for control of Doppler effect calculations in regular wave analysis

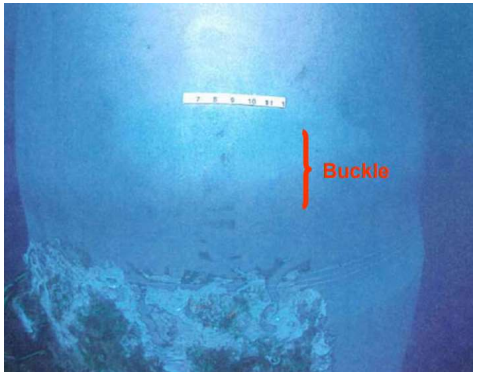


The concept of a constrained wave

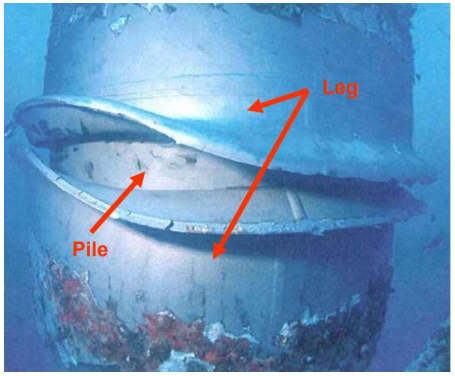
The latest release of Usfos allows for mitigating such risks. It is easy to investigate the effect of using grout or increase thickness to avoid pancake failure in extreme weather conditions

Pancake failure check

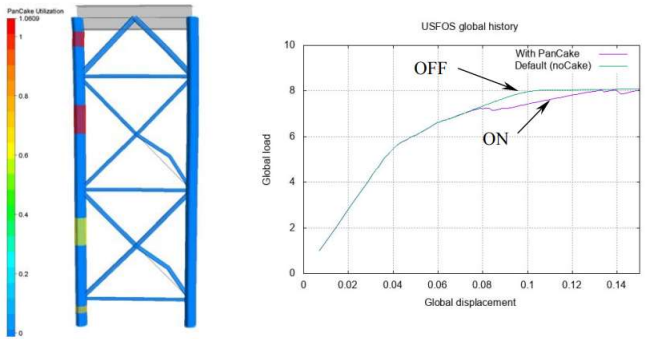
- Observations after extreme weather have shown that tubular sections with high D/T ratios could get a special local buckling mode, also known as pancake failure
  - The damage is developed as a result of the significant stiffness change between a thin-walled section and a thicker wall section. Such thickness variations are typical between jacket legs and their chord parts
  - The pancake check is done based on non-linear analysis of beams



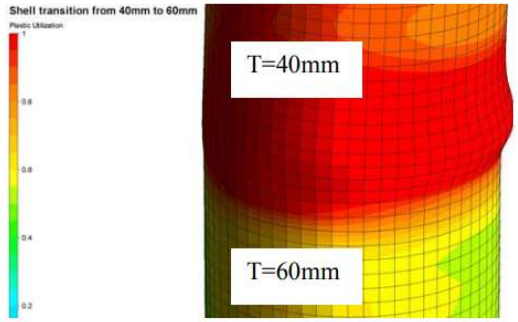
Initiating damage – local buckling of leg
Source: Energo Engineering Inc.



Pancake leg damage – final damage configuration
Source: Energo Engineering Inc.



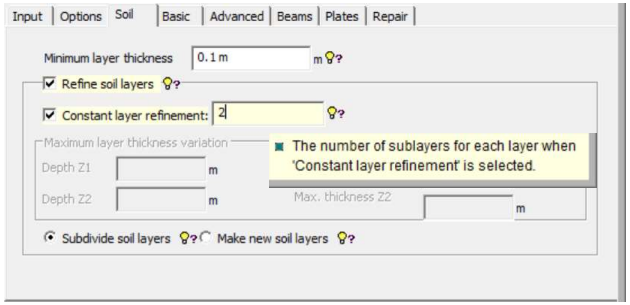
Example of pancake utilisation and the effect on the global response

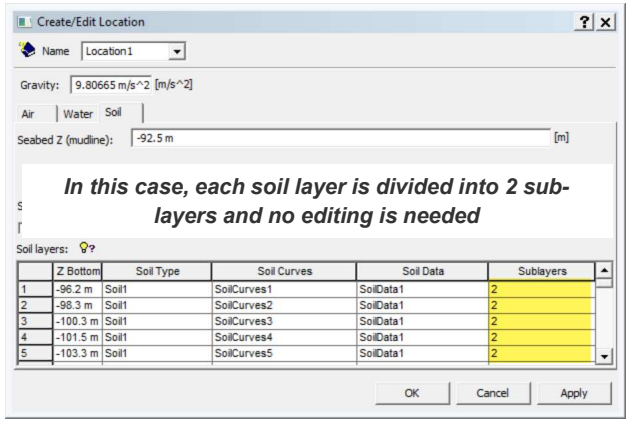


Non-linear buckling analysis of a shell model to demonstrate the physical behaviour. Note that the pancake check is based on beams

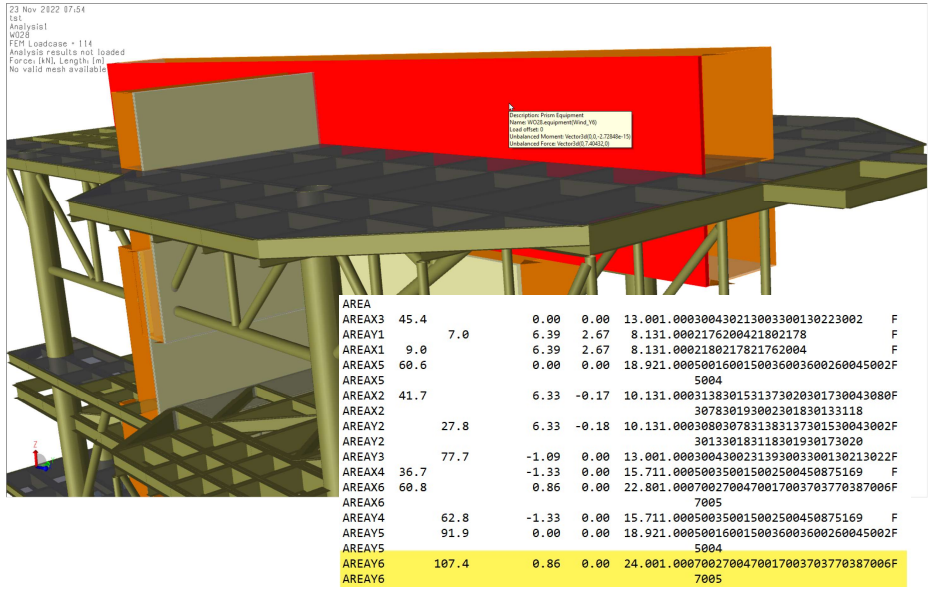
Improvements in the data import from Sacs

- Sometimes it is necessary to refine the soil layers to make the soil analysis converge. It is now possible to refine the soil layers during the import of data from Sacs
  - Previously it was necessary to edit the soil data after import





- Previously it was not possible to import a wind area from Sacs if it was defined by use of more than one line in the input filed. This is no longer a limitation
  - Consequently, the data import process is not stopped



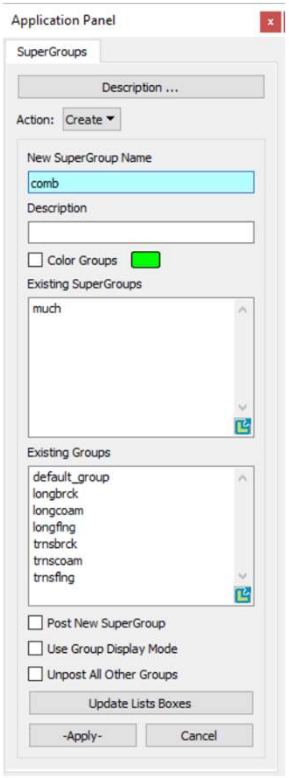
```
AREA
AREAX3  45.4              0.00   0.00  13.001.000300430213003300130223002    F
AREAY1         7.0        6.39   2.67   8.131.000217620042180217 8            F
AREAX1   9.0              6.39   2.67   8.131.000218021782176 2004            F
AREAX5  60.6              0.00   0.00  18.921.000500160015003600360026004 5002F
AREAX5                                                              5004
AREAX2  41.7              6.33  -0.17  10.131.000313830153137302030173004 3080F
AREAX2                                                 3078301930023018301331 18
AREAY2         27.8       6.33  -0.18  10.131.000308030783133813730153004 3002F
AREAY2                                                 3013301831183019301730 20
AREAY3         77.7      -1.09   0.00  13.001.000300430023139300330013021 3022F
AREAX4  36.7              -1.33   0.00  15.711.000500350015002500458751 69    F
AREAX6  60.8               0.86   0.00  22.801.000700270047001700370377038 7006F
AREAX6                                                              7005
AREAY4         62.8      -1.33   0.00  15.711.000500350015002500458751 69    F
AREAY5         91.9       0.00   0.00  18.921.000500160015003600360026004 5002F
AREAY5                                                              5004
AREAY6        107.4       0.86   0.00  24.001.000700270047001700370377038 7006F
AREAY6                                                              7005
```

Wind layers defined over 2 lines are now imported as shown above

More flexibility in the handling of groups and a more seamless export of data to Abaqus format

Improvements to Patran-Pre for geometry modelling

- Easier viewing and selection is now available through SuperGroups that contains existing Groups
- Easier add-ons to existing groups by associativity(adjacent or connected) entities
- New list dialog for easy and quick search through many groups, property sets, loads etc.
- The list of supported CAD standards for import has been extended
  - Licenses for these CAD interfaces are available from MSC Software/Hexagon
- Conversion from Sesam to Abaqus and export to Abaqus format has been made more robust

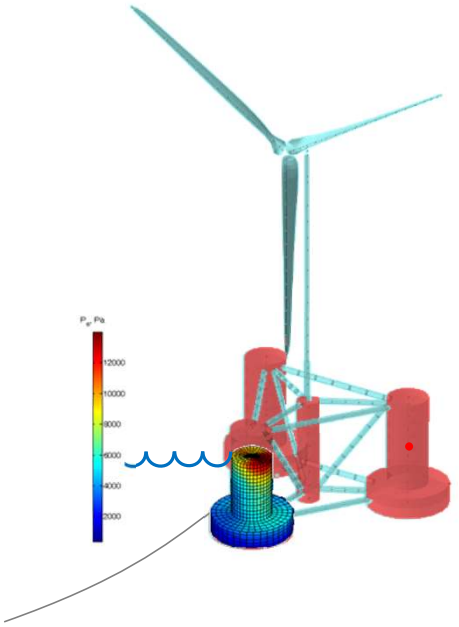


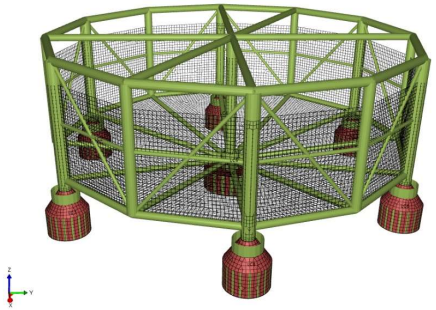


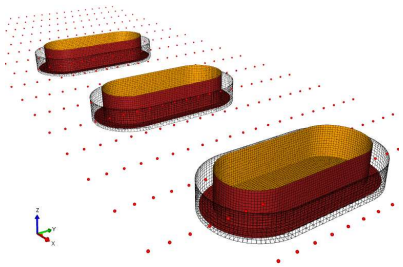
	Windows
ACIS	Up to R27
CATIA V4	All 4.xx
CATIA V5	R10 to R32
CATIA V6 (.3dxml)	2011 to 2013X
IGES	3, 5, 5.2, 5.3
Pro/ENGINEER / Creo (.prt/.asm)	WF 4, WF5, to Creo 8
SolidWorks	Up to 2022
STEP	203, 209, 214, 242
Unigraphics	NX 5.0, 6.0, 7.0, 7.5, 8.0, 9.0, 10, 11, 12, 1847, 1903, 1957, 2007
Parasolid	33.1

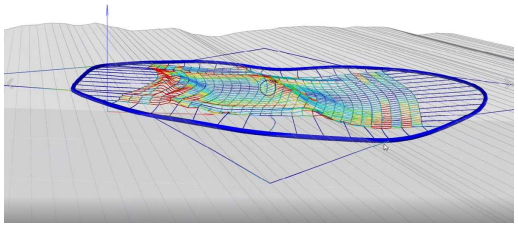
Offshore floaters for OWT, O&G, Aquaculture

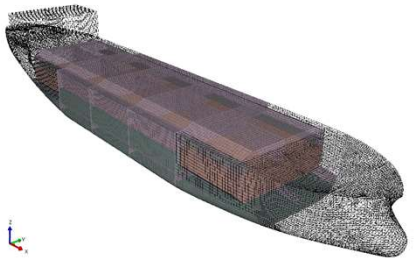
- New values during 2022
  - New user interface for stability and hydrodynamic analysis; HydroD 6
  - Hydrostability analysis of floating OWT
  - Thin plates with dipole elements
  - Improved 2nd order calculations
  - Nonlinear free surface condition for spectral wave models
  - Better support for time domain analysis workflow of floating OWT foundations
  - New model supporting more realistic fishnet and floating pipe simulation
  - Automation in the modelling of coupled analysis
  - A new online help system for Sima
  - Improvements to concrete post-processing







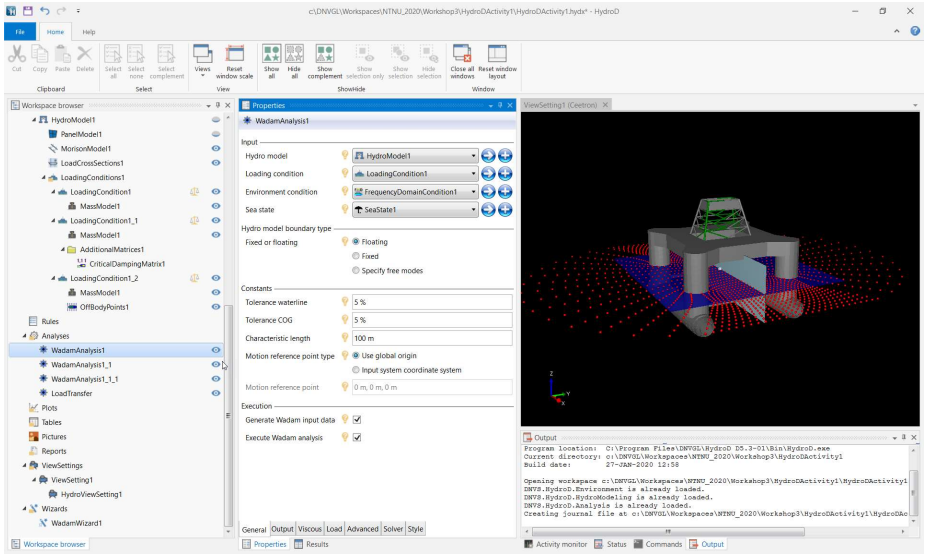


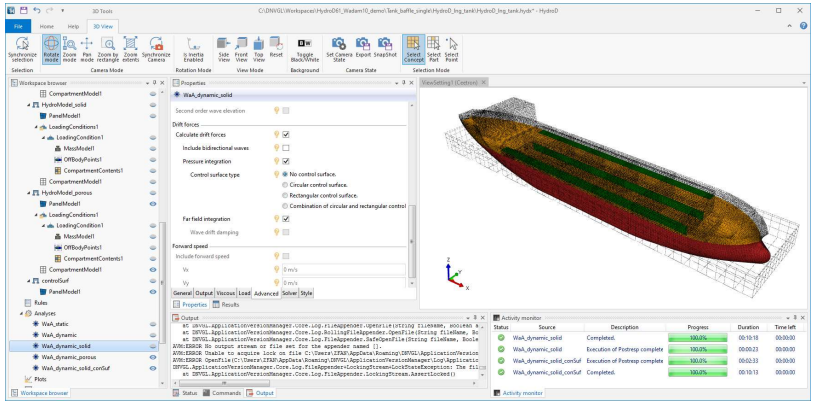


HydroD 6 will be replacing HydroD 4 over several releases. The HydroD 6.1 release addresses hydrostability and all Wadam analyses

Introducing HydroD 6

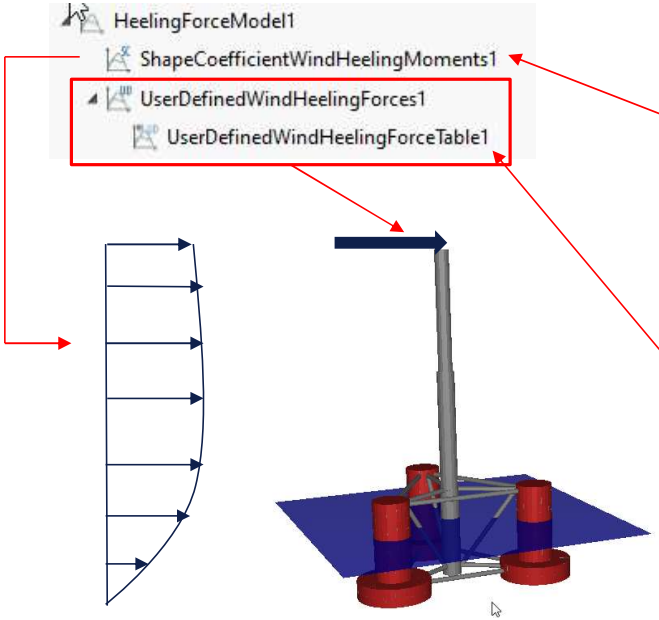
- High level benefits
  - Full support for stability and hydrodynamic analysis (Wadam)
    - Inclusive of new functions in Wadam and OWT stability calculation
  - Import from HydroD 4.10
  - Backward compatibility on database
  - State of the art user interface
  - Multiple mass and damping models
  - Separate compartment model (i.e. may be different than structure model)
  - Much easier definition of Morison beams





Introducing HydroD 6

- Hydrostability analysis of floating offshore wind turbine foundation
  - It is now possible to combine heeling moment on floater according to offshore rules with additional heeling force due to wind turbine



DNV

OFFSHORE STANDARDS

DNV-OS-C301 Edition July 2020
Amended August 2021

Stability and watertight integrity

10.1.1.11

$$F_{thrust} = \frac{1}{2} \cdot \rho \cdot C_T \cdot A_{rotor} \cdot U_{10}^2$$

DNV

STANDARD

DNV-ST-0119 Edition June 2021

Floating wind turbine structures

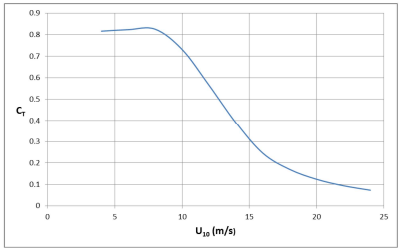
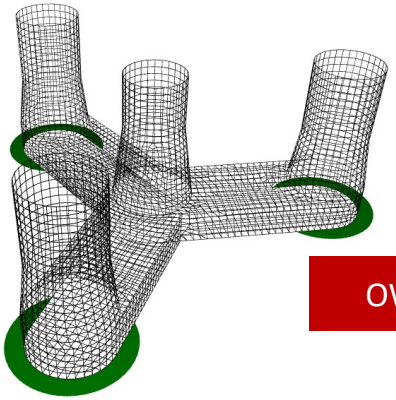


Figure 10-1 Thrust coefficient vs. 10-minute mean wind speed; rotor diameters 100-120 m

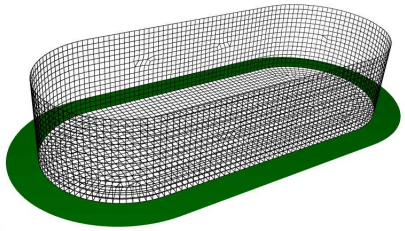
DNV

Dipole elements in Wadam allow for calculation of hydrodynamic results on both sides of a plate. This include the effect of porous surfaces. This means there is no longer a need to make double plates

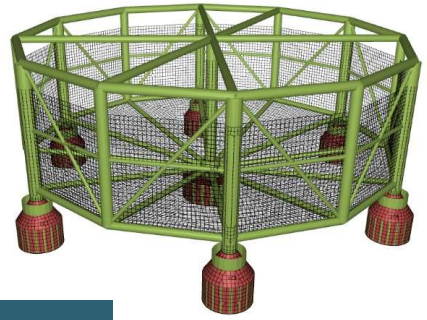
Dipole element – supports a wide range of usage



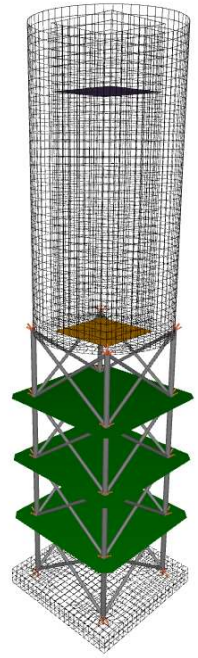
OWT



Bridge

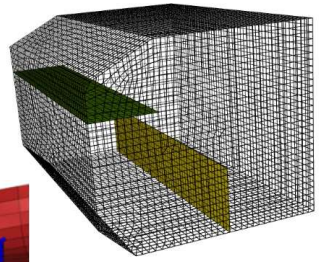


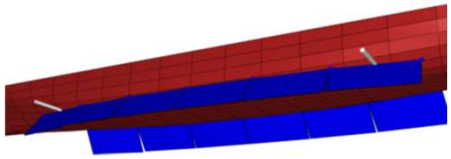
Aquaculture



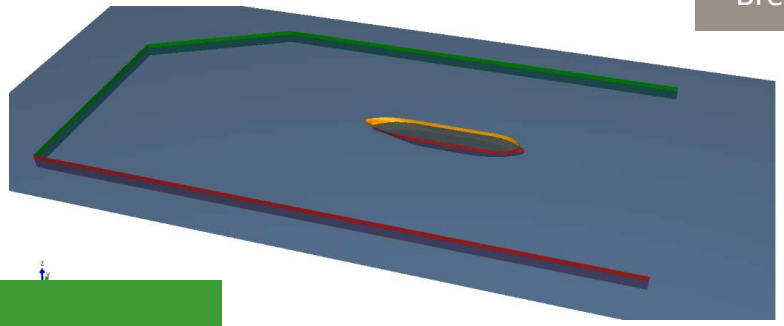
O&G

Breakwater





Maritime



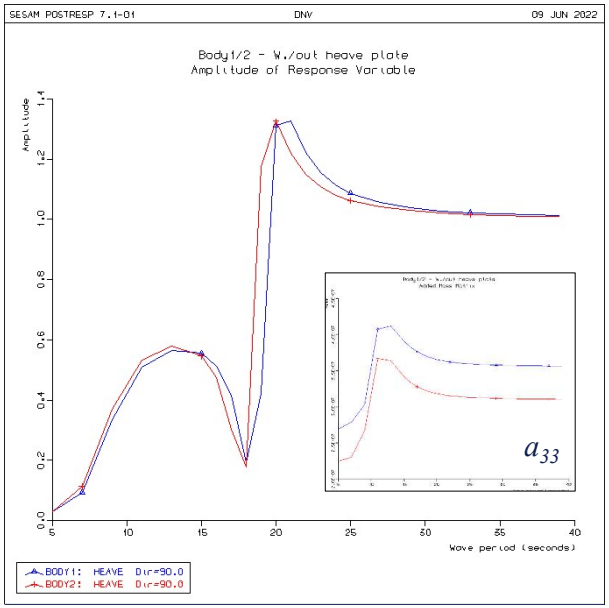
Renewable Energy

Wave energy

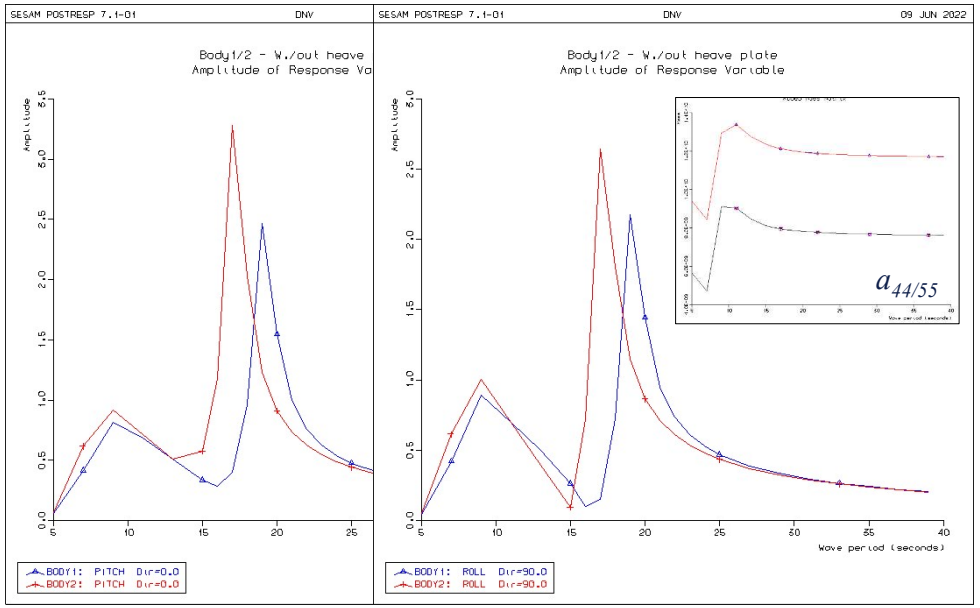
DNV

The dipole elements will impact the hydrodynamic coefficients used in a coupled analysis

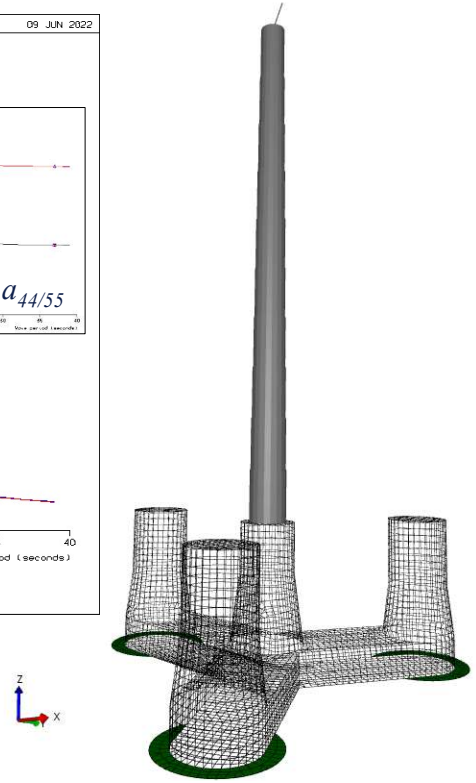
Efficient handling of heave plates for FOWT



Heave
Red curve: Without dipole elements
Blue curve: With dipole elements



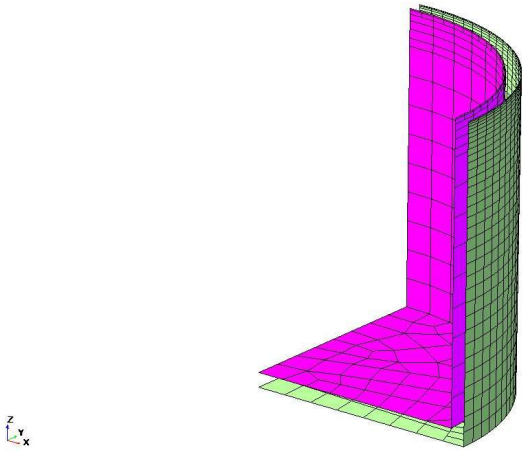
Pitch/Roll
Red curve: Without dipole elements
Blue curve: With dipole elements



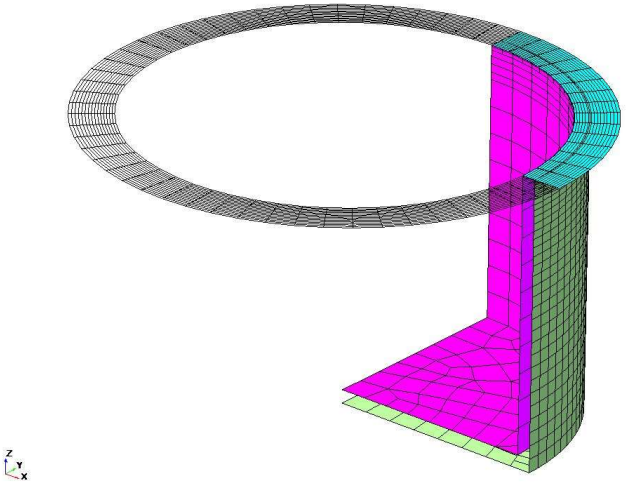
The control surface option has much better convergence performance than pressure integration option

Control surface integral for vertical components of drift forces

- Without vertical component (ICSFS=0)
  - Does not include free surface integral, only horizontal components to be evaluated. The vertical component of drift force (i.e. heave, pitch and roll) are kept the same as computed from the wet hull pressure



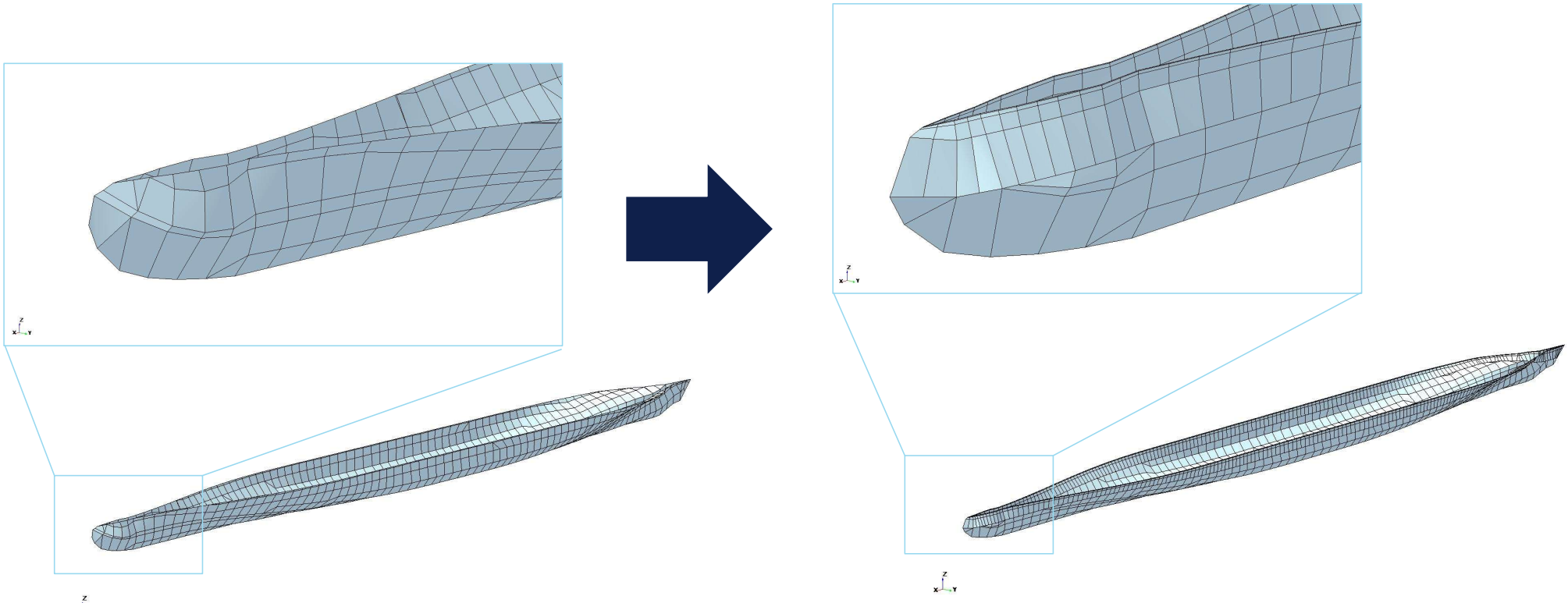
- With vertical component (ICSFS=1/2)
  - Free surface integral is used, and the vertical components are calculated



Much better mesh along the waterline automatically generated, resulting in more accurate 2nd order analysis

Automatic refinement along waterline with COS spacing

- The new functionality for refining the mesh gives a much better panel model close to the waterline



200 frequencies for 2nd order analysis

- 60 frequencies limitation in Wadam V10.1.03
  - Previously only diagonal pairs were calculated

```
+-------------------------------------------------------------------------------+
:+-----------------------------------------------------------------------------+:
::                                                                             ::
::  2 N D   O R D E R   D I F F E R E N C E - P E R I O D  = infinite          ::
::                                                                             ::
::  Ang. freq. indices   : 60 60          Ang. frequencies:  3.0695E-01  3.0695E-01 ::
::  Heading angle indices:  1  1          Heading angles  :  0.0000E+00  0.0000E+00 ::
::                                          (In Degrees)                       ::
::                                                                             ::
:-------------------------------------------------------------------------------:
+-------------------------------------------------------------------------------+
```

QUADRATIC SECOND-ORDER DIFFERENCE-FREQUENCY FORCES AND MOMENTS FOR BODY 1

	REAL PART	IMAGINARY PART	ABSOLUTE VALUE	PHASE (DEGREES)
-F1-	-4.0596E-08	1.7462E-12	4.0596E-08	0.00
-F2-	-2.2420E-09	2.1684E-20	2.2420E-09	0.00
-F3-	1.6716E-02	0.0000E+00	1.6716E-02	0.00
-F4-	2.7487E-09	1.0575E-25	2.7487E-09	0.00
-F5-	1.8411E-08	0.0000E+00	1.8411E-08	0.00
-F6-	1.0636E-10	6.5274E-22	1.0636E-10	0.00

- 200 frequencies limitation in Wadam V10.2.2
  - In the latest release, both diagonal and off-diagonal pairs will be calculated

```
+-------------------------------------------------------------------------------+
:+-----------------------------------------------------------------------------+:
::                                                                             ::
::  2 N D   O R D E R   D I F F E R E N C E - P E R I O D  = infinite          ::
::                                                                             ::
::  Ang. freq. indices   :200200          Ang. frequencies:  3.0063E-01  3.0063E-01 ::
::  Heading angle indices:  1  1          Heading angles  :  0.0000E+00  0.0000E+00 ::
::                                          (In Degrees)                       ::
::                                                                             ::
:-------------------------------------------------------------------------------:
+-------------------------------------------------------------------------------+
```

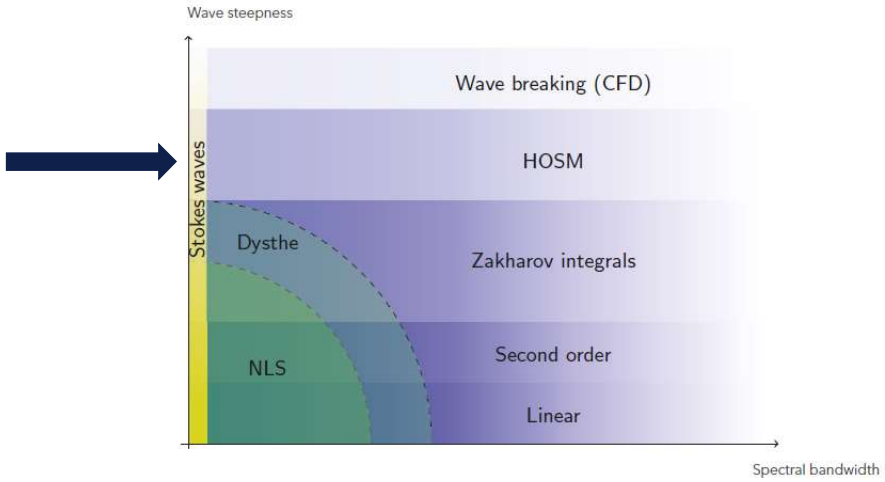
QUADRATIC SECOND-ORDER DIFFERENCE-FREQUENCY FORCES AND MOMENTS FOR BODY 1

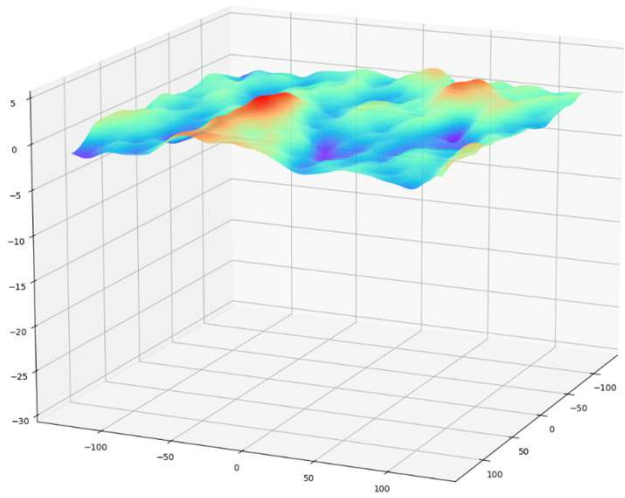
	REAL PART	IMAGINARY PART	ABSOLUTE VALUE	PHASE (DEGREES)
-F1-	-4.1418E-08	-4.0745E-12	4.1418E-08	0.00
-F2-	9.0363E-10	1.2468E-20	9.0363E-10	0.00
-F3-	1.6128E-02	0.0000E+00	1.6128E-02	0.00
-F4-	7.2792E-09	8.7351E-26	7.2792E-09	0.00
-F5-	6.9035E-09	0.0000E+00	6.9035E-09	0.00
-F6-	8.9986E-11	2.8649E-21	8.9986E-11	0.00

You can now simulate higher order nonlinear waves. These can be generated once and re-used in different analysis to save time

Nonlinear free surface condition for Spectral Wave Model waves

- Available for any wave model supported through SWD (Spectral Wave Data) wave models
  - Calculated by Wamod
- More nonlinear terms may be included
  - In the free surface conditions for wave-body interaction problems
- Non-linear coupling terms retained, e.g.
  - Coupling between the incoming wave velocity potential and elevation
  - Coupling between the radiation/scatter velocity potential and the wave elevation due to the radiation/scatter and steady velocity potential

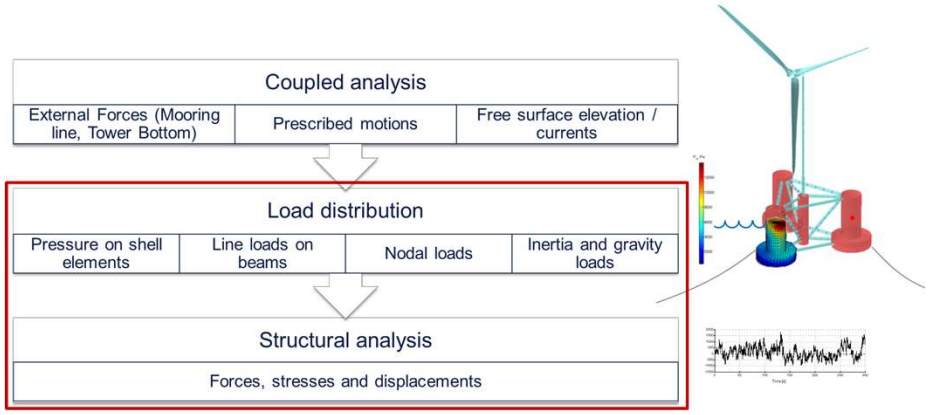


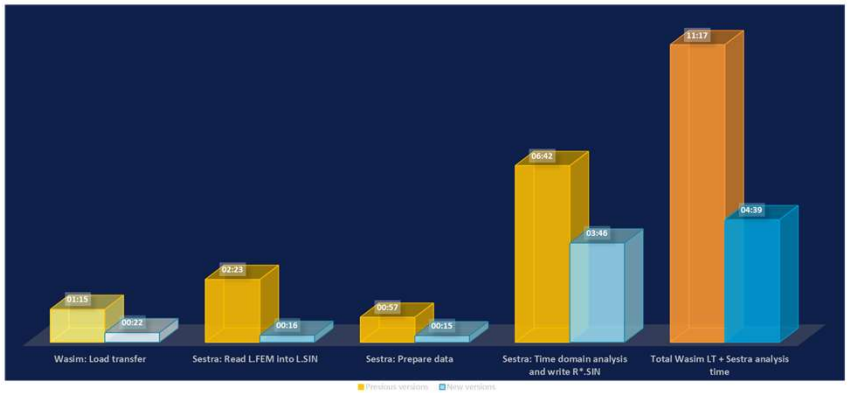


The load transfer and subsequent structural analysis time has been reduced with 60%

Direct time domain floater OWT structural analysis

- An important part of the workflow is the regeneration of load actions from a coupled analysis into a hydrodynamic analysis
  - A coupled analysis cannot create loads acting on a hull since it is represented as a single point
- The loads from the hydrodynamic analysis is used in structural analysis for stress evaluations, code checking and fatigue of the hull and topsides
  - Time history fatigue analysis of floater OWT normally has a very large number of time steps. Often there are 110.000 time steps (load cases) representing a 3 hour simulation with 0.1 sec/step
  - The latest releases significantly speed up the load transfer and structural analysis

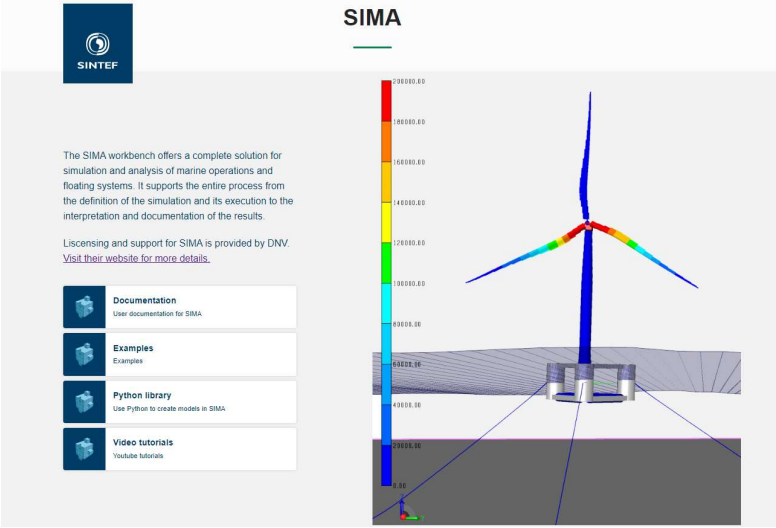


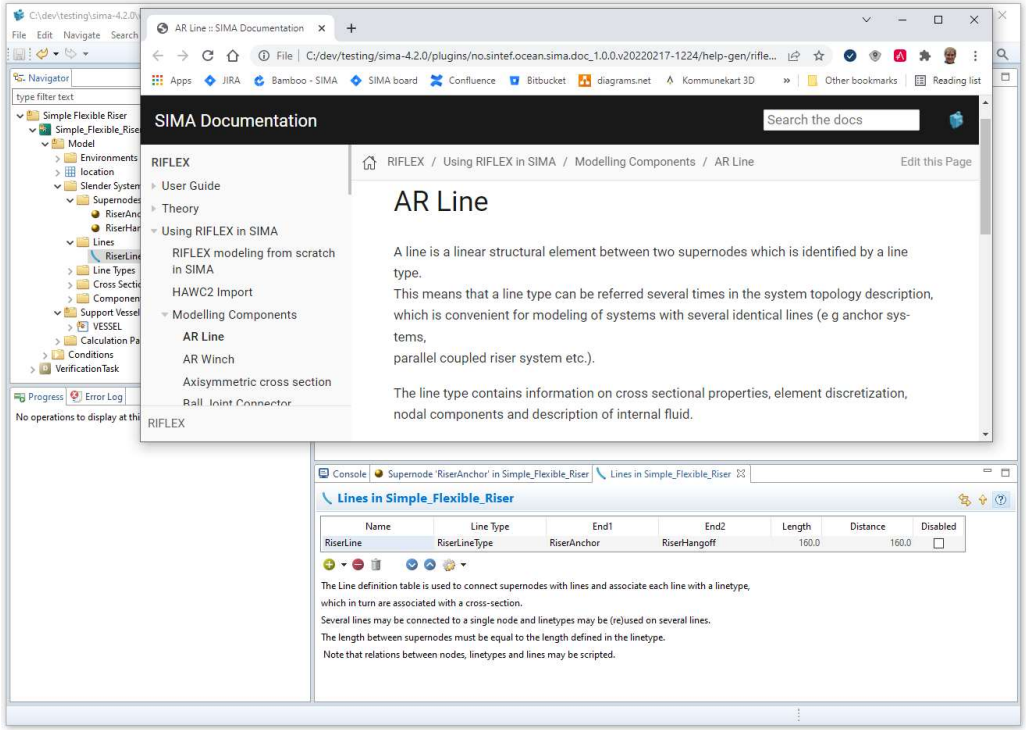


Much easier to search information with dynamic updates of examples

A new help system in Sima

- A new help system is developed
- The old context help has been removed and replaced by links into the main help
- The new help system will open in an external web browser





Decrease the time for modelling complex concepts from days to seconds

SIMA python library and Runtime Engine

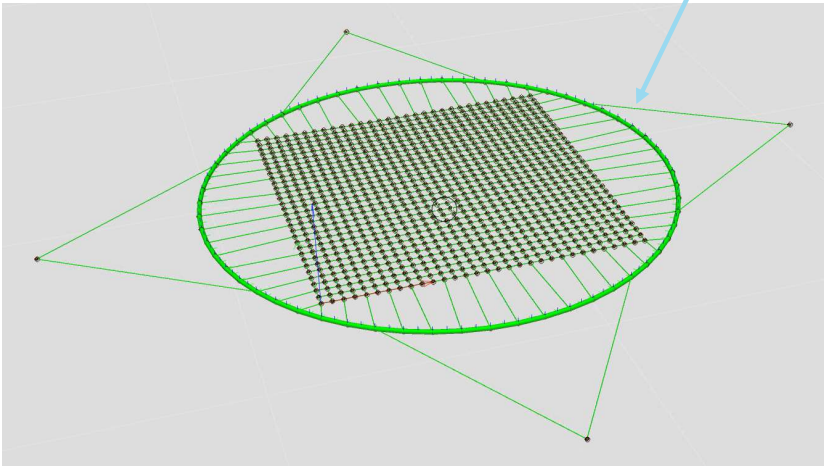
- Using the newly developed open source **simapy** library it is now possible to create models using code run from outside of SIMA.
  - Install simapy: **pip install simapy**
- The integration is maintained through the new json file import/export functionality:
  - File->import->json model import.
- The library can also be used to run Sima from the command line

```
model = task.model
lines = model.slenderSystem.lines
nodes = model.slenderSystem.superNodes

max_x=32 #max layer in x direction
max_y=31 #max layer in y direction

spacing =2.0 #line length/spacing

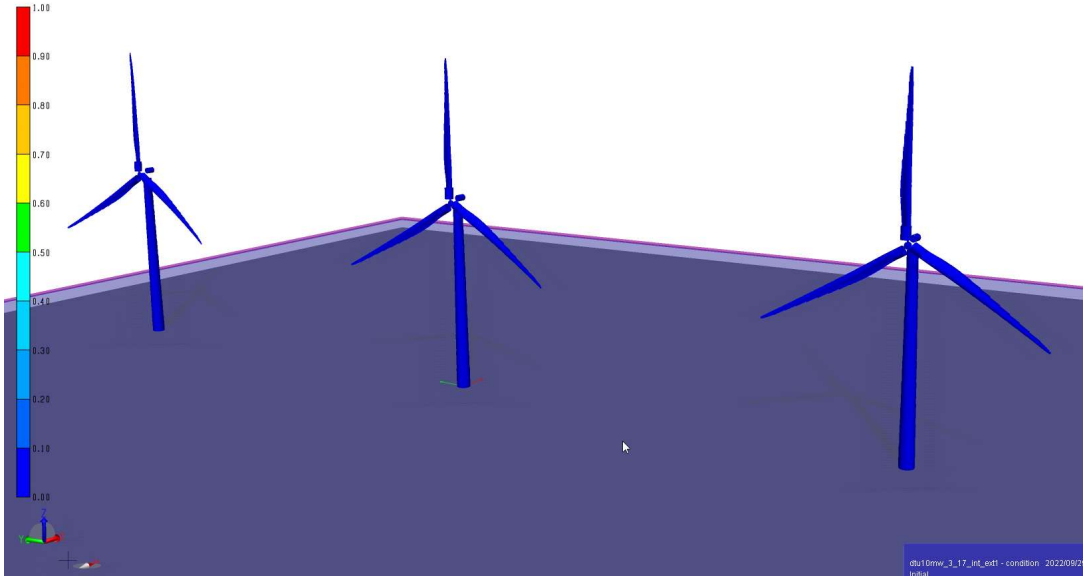

for a in range(max_y):
    _offset_y=a*spacing
    _ini = 3 if a==0 else 1 #avoide duplicate the orginal line, could be sim
    for i in range(_ini, max_x):
        _offset_x = spacing
        sn_i = nodes[0].copy()
        sn_i.name = "sn" +str(a)+"_"+str(i)
        sn_i: SuperNode() = __copy_and_move(sn_i, _offset_x*(i-1),, _offset_
        # print(sn_i.name)
        nodes.append(sn_i)
    for j in range_(0,max_x-2):
        # k=(max_x-1)*a+j
        line_j=lines[0].copy()
        line_j.name="line_u"+str(a)+"_"+str(j)
        line_j.end1=nodes[(max_x-1)*a+j]
        line_j.end2=nodes[(max_x-1)*a+j+1]
        # print(line_j.name)
        lines.append(line_j)
```



More flexible and realistic to model multiple wind turbines in one analysis

Wind turbines

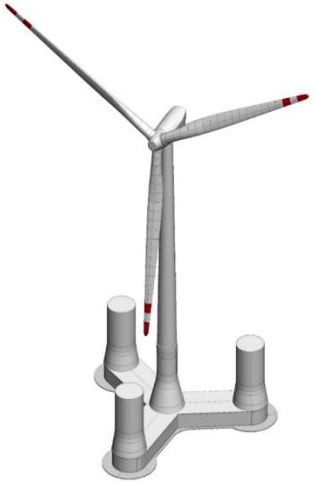
- Sima now supports multiple wind turbines with external control systems
  - Previously only one wind turbine could have an external control system, any additional turbines had to have internal control systems
  - Control systems operate individually on each turbine
  - It is also possible to make control systems interact e.g., for park level control logic



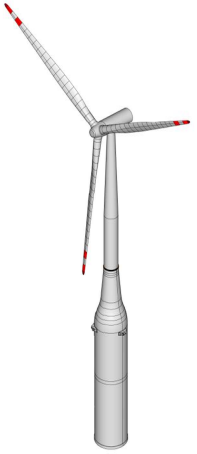
Access to a much faster analysis tool (Sestra 10) when doing the analysis workflow

Improvements to concrete structures post-processing

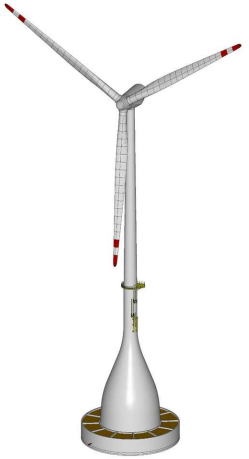
- Support results from Sestra 10
- Analyse tightness check results better with improved result tables and plots
- More detailed information in the verification table for FLS analyses
- Improvements in relation to design code calculations and for the Consistent Stiffness Method



OO-Star Wind Floater



Hywind



GBS

Turbine design

- New values during 2022
  - Simulations up to 5x faster in Bladed
  - Couple Bladed to external models more effectively
  - Couple Bladed to external drive train dynamics tools
  - Example turbine controller provided with Bladed
  - Model pitch drive flexibility and backlash
  - Model yaw drive flexibility, backlash and preload
  - Higher throughput in Bladed Batch and Bladed Cloud



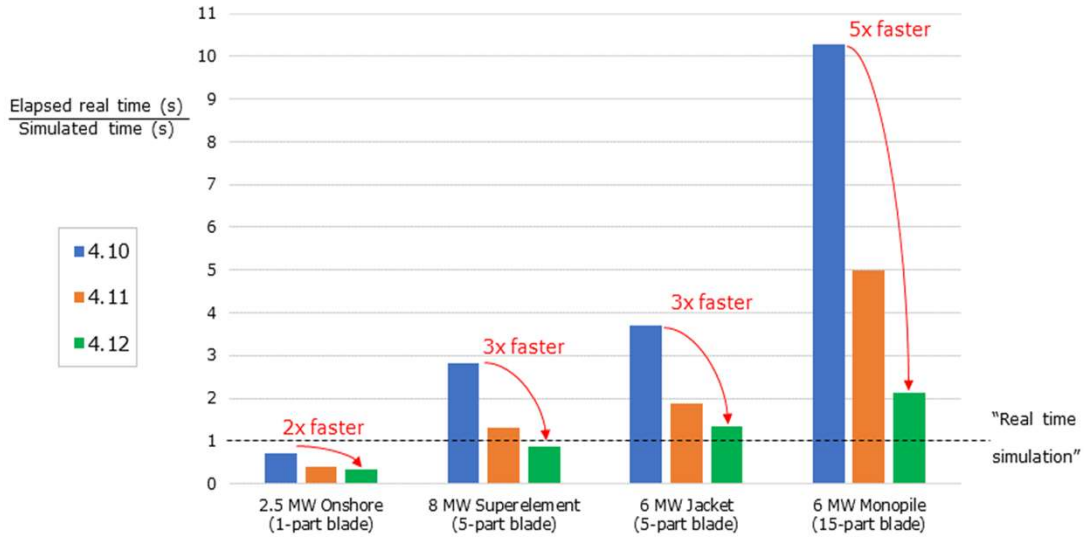



Simulations up to 5x faster in Bladed

- Modern larger turbines need higher fidelity non-linear simulations for accurate results. Bladed's simulation speed has been improved up to 5x to get results faster and reduce costs
  - Largest effect for non-linear blade models
  - Many models run real time or faster

- Simulation in the cloud now possible in Linux, which is ~2x cheaper than Windows. Overall, simulation in the cloud can be up to 10x cheaper than in older Bladed versions

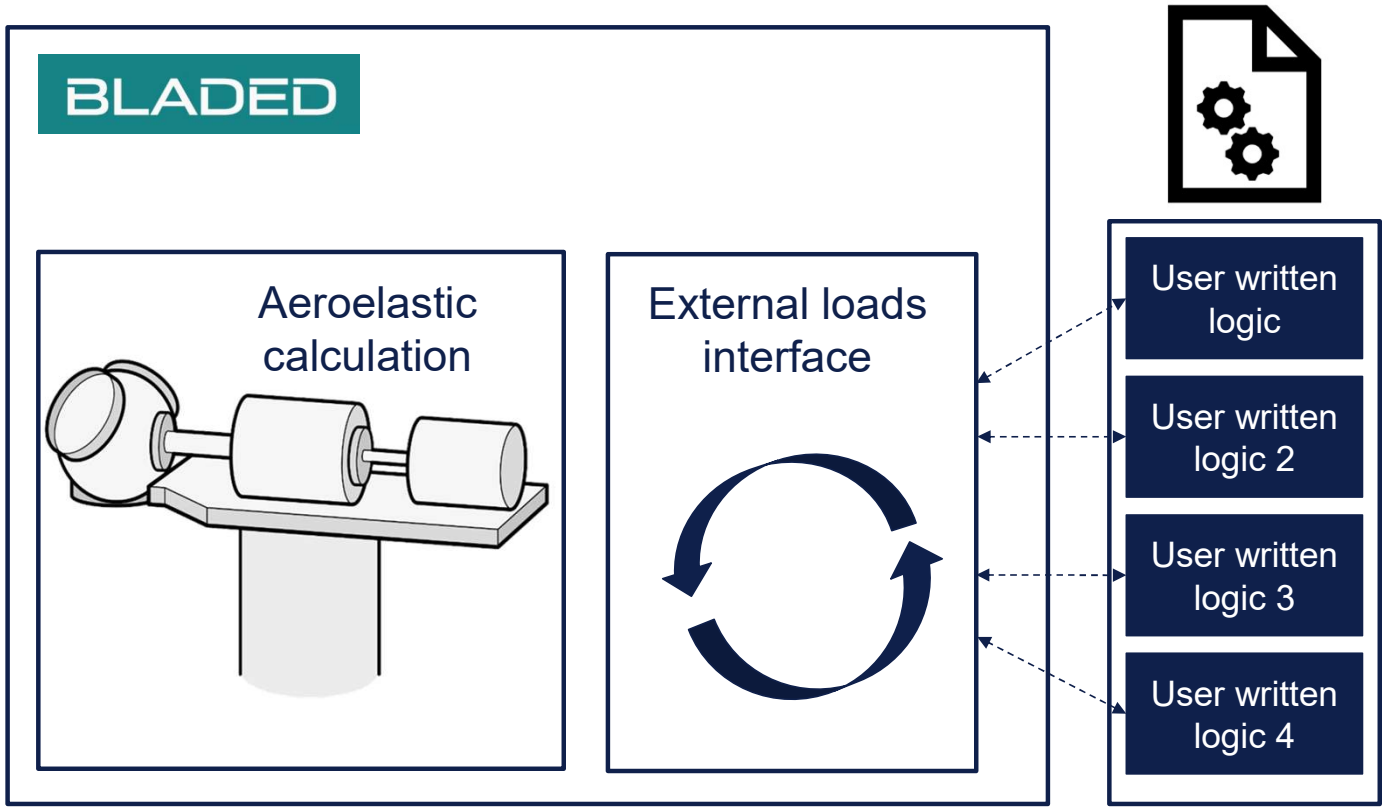
An order of magnitude cost reduction for simulation from Bladed 4.10 to 4.12



The Bladed External Loads DLL interface is now more powerful, flexible and maintainable

Couple Bladed to external models more effectively

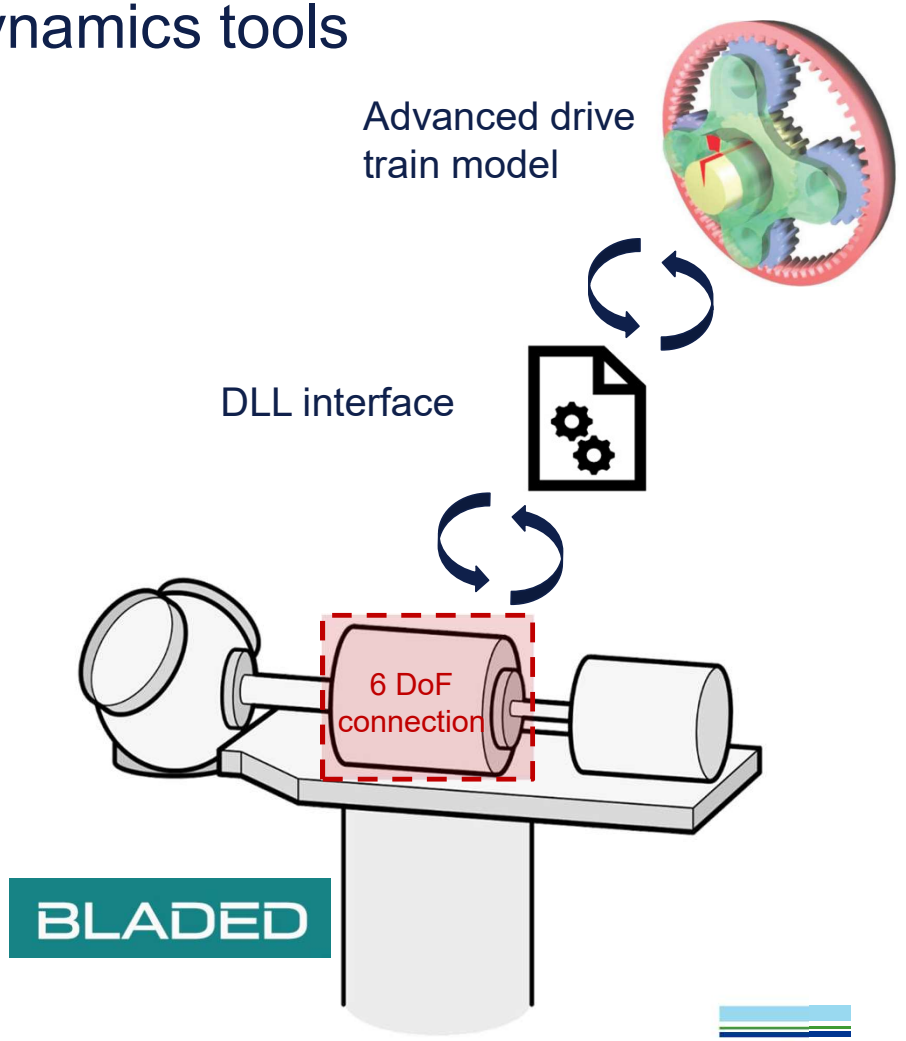
- Many wind turbine designers capture their own expertise and know-how in numerical models
- The Bladed External Loads DLL interface allows coupling between Bladed and customer models in the time domain, by exchanging loads and kinematics
- The interface has been extended as follows
  - Multiple independent user written DLLs can be used at once
  - More options for application of loads and interrogation of results
  - New interface to ensure correct usage of functions



Couple Bladed to external drive train dynamics tools

- Complex drive train dynamics may interact with the overall turbine response. These dynamics can be modelled in a specialist tool, and coupled to Bladed via the “6 degree of freedom” drive train DLL interface.
- The functionality is upgraded in the latest version
  - Improved coupling method for better accuracy and stability
  - Comprehensive documentation and examples

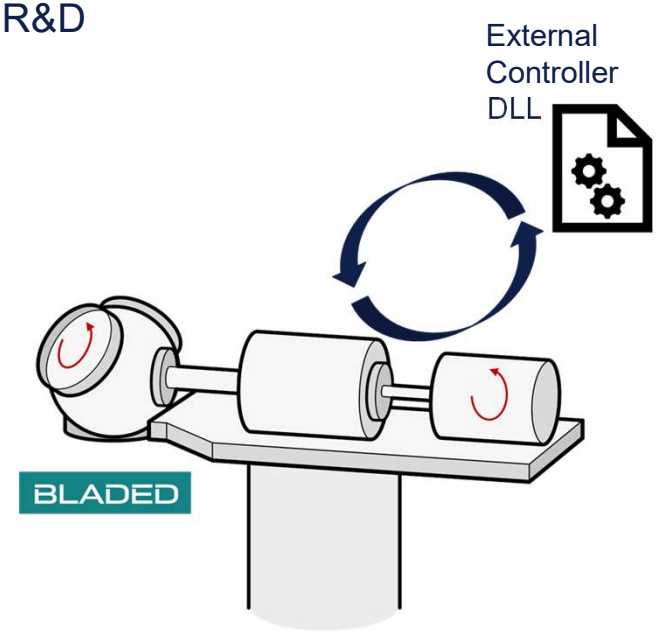
Model drive train dynamics in an external package and couple it to Bladed

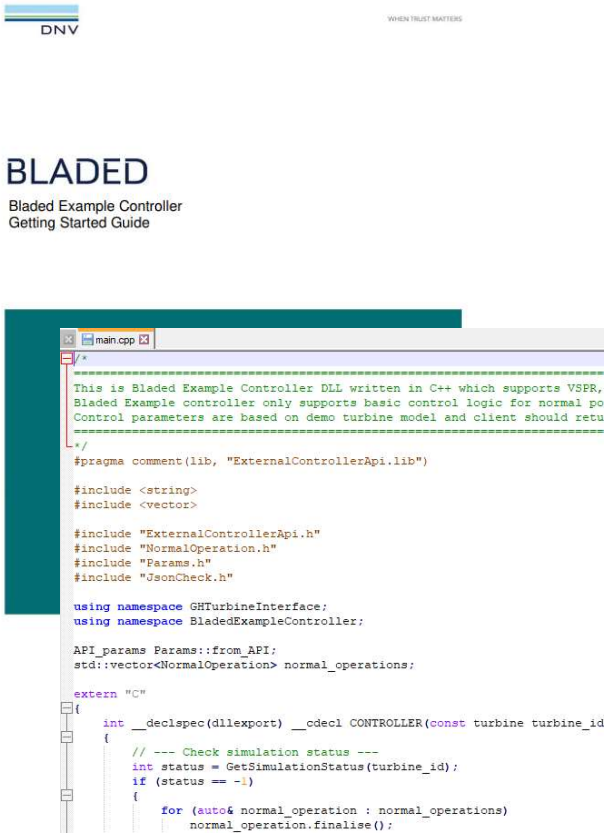


An example turbine controller to help you get started and support R&D work

Example turbine controller provided with Bladed

- The turbine controller controls the turbine pitch angle and generator torque to maximise power and minimise loads
- An example controller is now provided with Bladed, written in C++
- It can be used as an example to get started, as a basis for a more complex controller, or for R&D

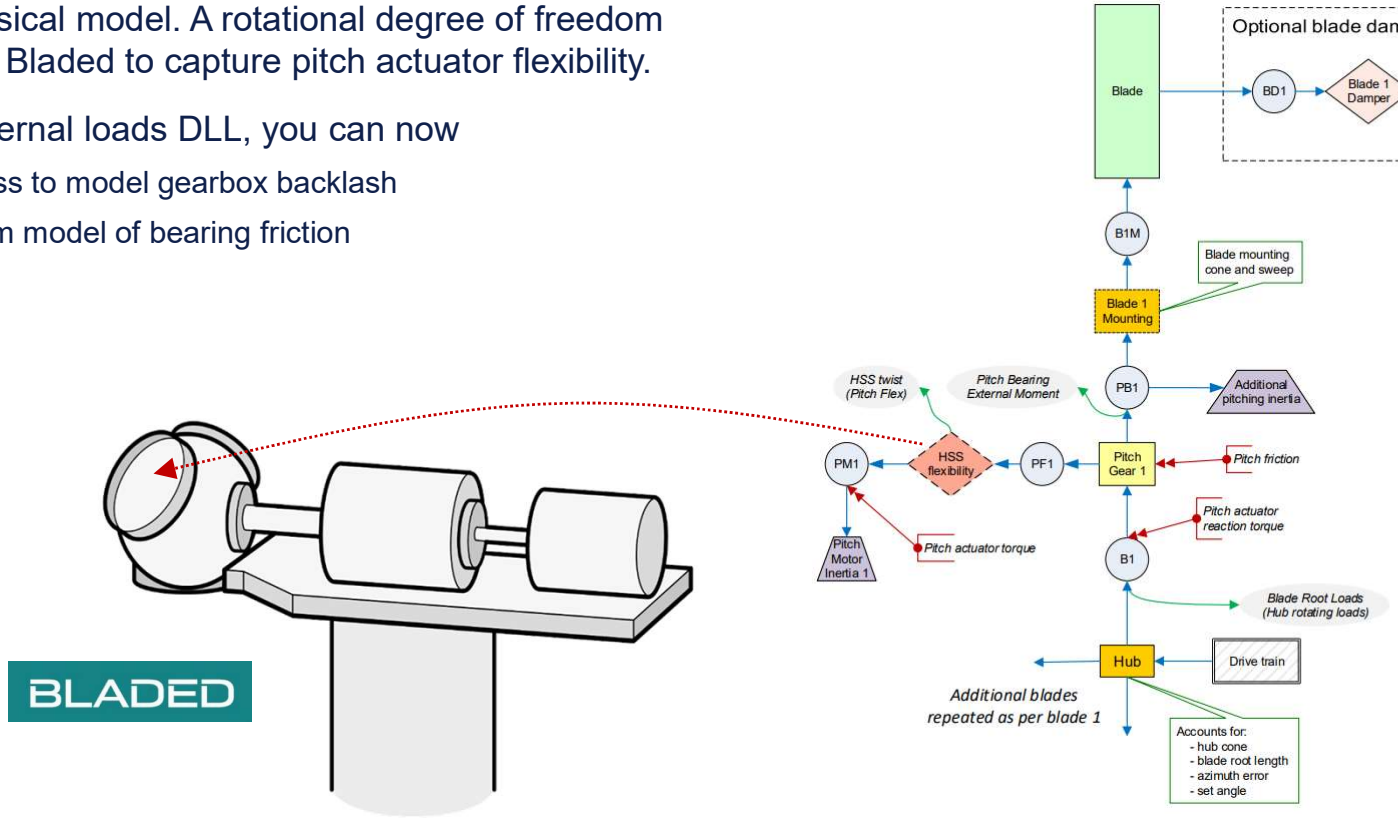




Account for flexible pitch actuator dynamics in your Bladed simulation

Model pitch drive flexibility and backlash

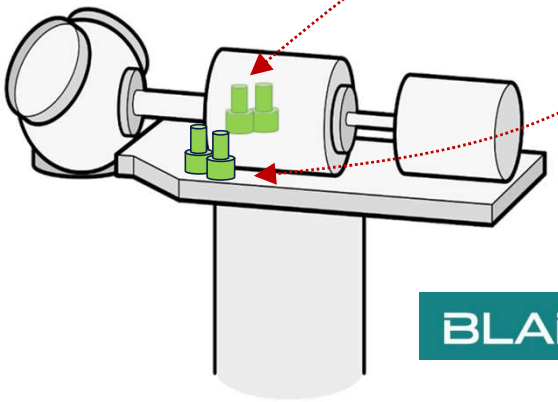
- To accurately determine pitch actuator loading, it's important to use an explicit physical model. A rotational degree of freedom has been added in Bladed to capture pitch actuator flexibility.
- Combined with external loads DLL, you can now
  - Modify pitch stiffness to model gearbox backlash
  - Implement a custom model of bearing friction



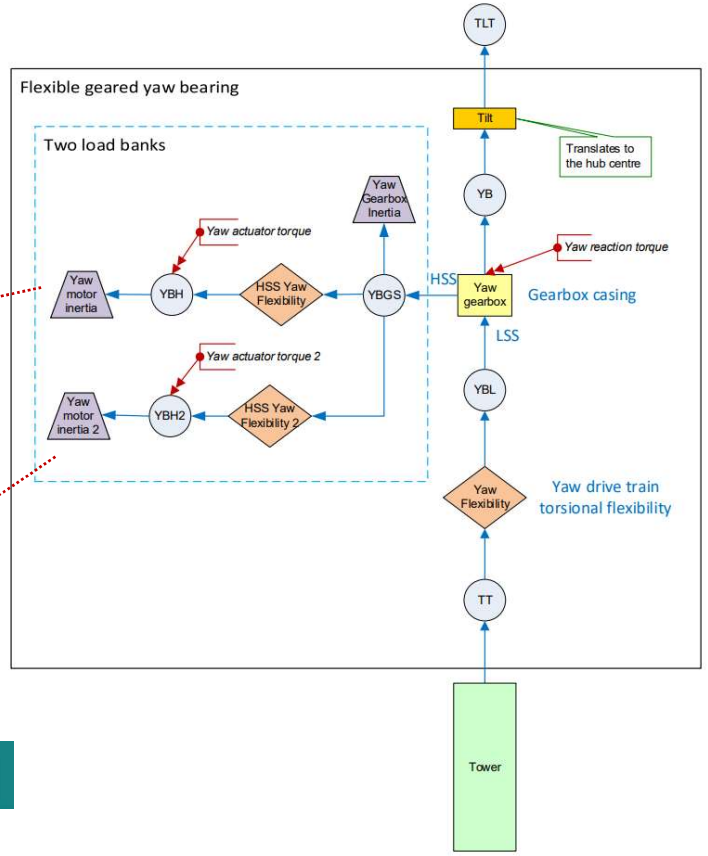
An physical model of yaw dynamics including backlash and actuator preload

Model yaw drive flexibility, backlash and preload

- Some turbine OEMs use actively controlled yaw, with pre-loaded yaw actuator banks to mitigate backlash.
- Rotational flexibility can now be included in the yaw system model for more realistic yaw dynamics.
- Combined with external loads DLL, you can now
  - Modify yaw stiffness to model gearbox backlash
  - Include yaw drive pre-load to mitigate backlash



BLADED

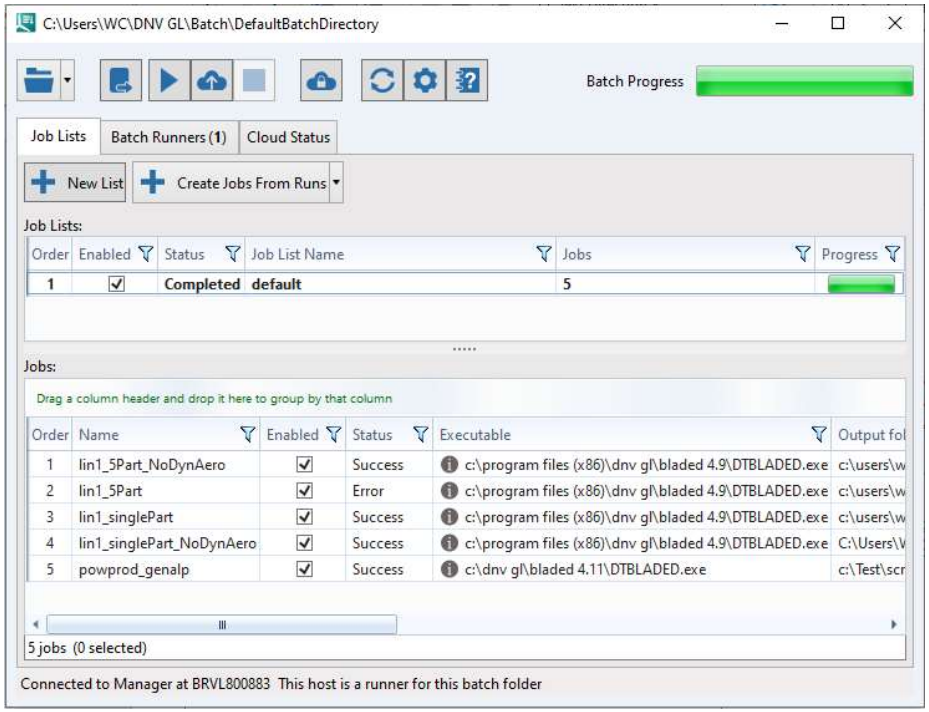


Higher throughput in Bladed Batch and Bladed Cloud

- Some batch operations are computationally expensive, but can now make use of multiple GUI instances for higher throughput

- Multiple GUI instances can work in parallel to
  - Upload / download to Bladed Cloud
  - Import / create jobs / redirect output in Bladed Batch

- There is now also support for local post processing of simulations run in the Cloud





Going forward, offshore wind is a priority for DNV Digital Solutions

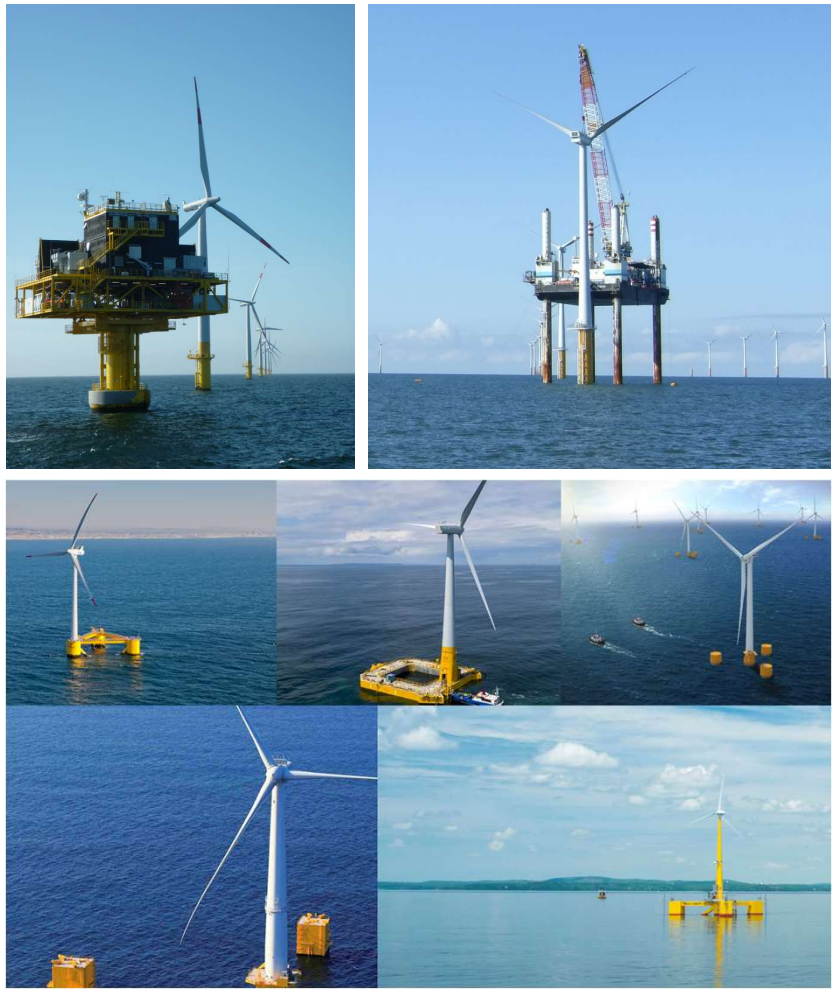
RISKS REDUCED. PROJECTS DELIVERED. GOALS MET.

Digital Solutions for offshore wind:
Rise to the challenge

DNV

Offshore wind workflows for foundation design

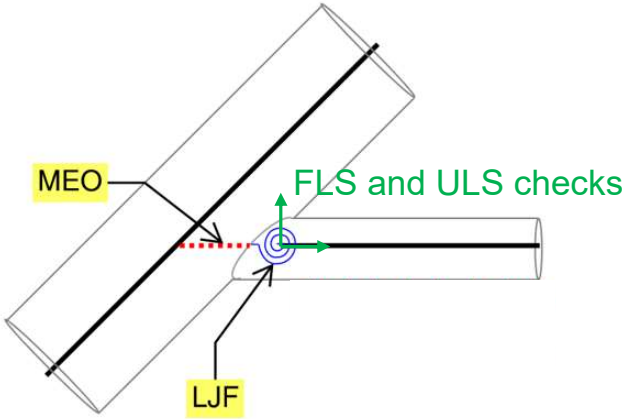
- New values during 2022
  - Sesam-Bladed integrated design improvements
  - Bladed line loads output
  - Improved analysis workflows for fixed OWT
  - Seamless analysis workflows for floating OWT
  - Load transfer and structural analysis performance improvements for floating OWT
  - New floating wind workflow for fatigue analysis
  - Turbine Concept Models for integrated load analysis

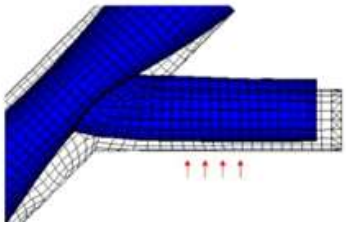


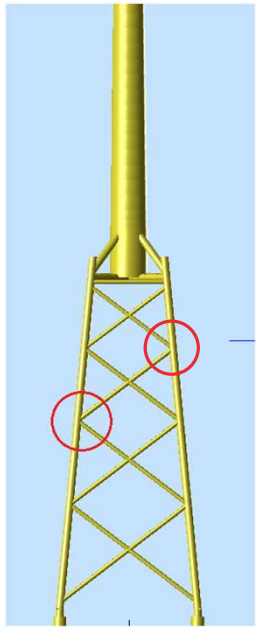
Better integration between Bladed and Sesam and less need for editing

Sesam-Bladed integrated design now supports member end offsets and LJF's

- Offshore wind turbine jacket joints typically have **member end offsets** (MEO) applied to the braces
- To account for flexibility at the chord-brace connection, **local joint flexibilities** (LJF) can be used
- This is important to take into account as they will impact the effect on natural frequency (stiffness) and fatigue life
- Bladed now models these in the same way as Sesam, allowing correct FLS and ULS checks to be performed of Bladed results for jackets in Sesam
  - Member end offsets and local joint flexibilities are now transferred with the rest of the Sesam jacket model to Bladed
  - Bladed results are transferred to Sesam including member end offsets in the mesh, and the effect due to member end offsets and local joint flexibilities in the results, so that the FLS and ULS checks take this into account

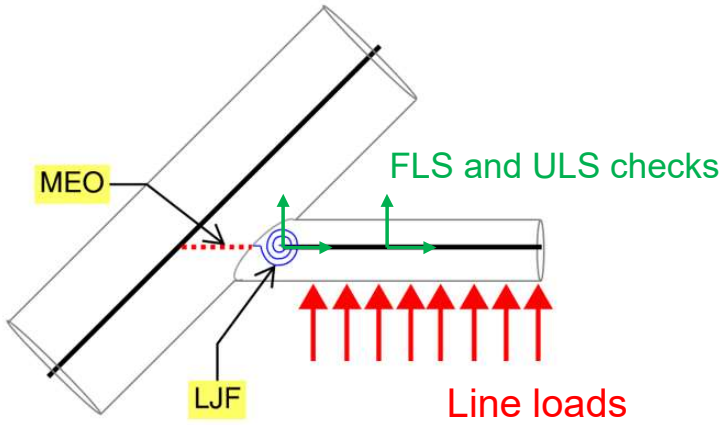




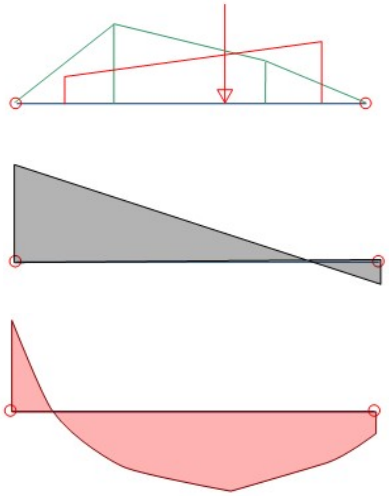


Bladed now outputs line loads along members for improved FLS and ULS checks

- Previously Bladed only outputted member end forces
- Bladed now also outputs line loads along the member
- The correct load is now not only available at the member end points, but can also be determined along a member, giving more accurate FLS and ULS check results along the member



- Sesam will start using these line loads in the near future to improve the FLS and ULS checks accuracy at points along the members when post-processing Bladed results directly
  - This will result in a more correct ULS and FLS check along members as compared to a linear interpolation of member end forces



Beam with applied loads and acceleration

Linear interpolation of member end forces

Incorrect loads along beam

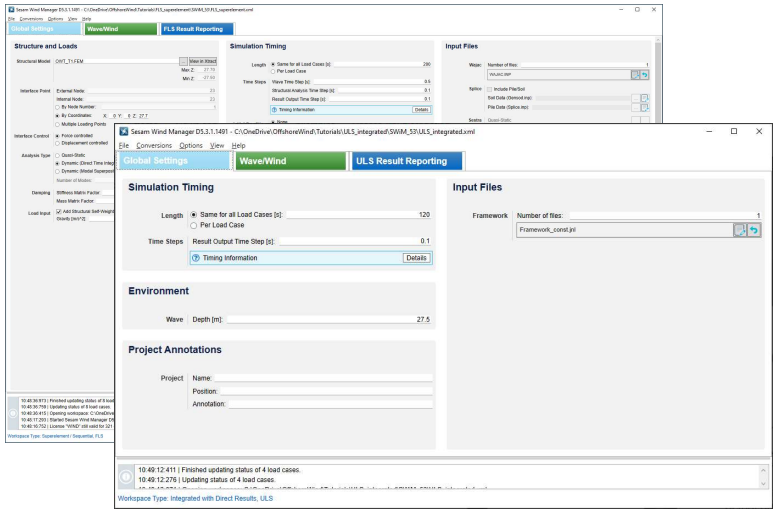
True solution of section forces

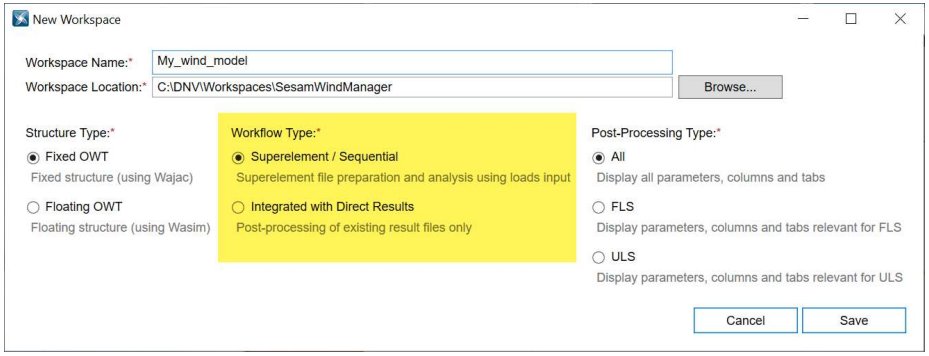
Requires line loads input + beam end loads

The latest versions of Sesam Wind Manager improves usability, ULS analysis efficiency and adds additional wave input setting options

Improved analysis workflows for fixed OWT

- Separate views for integrated design and superelement/sequential analysis
  - Simplifies usage by only showing and verifying the relevant options and input for the selected workflow type
- ULS analysis with load factors now also allows to use buoyancy and marine growth weight based on calm sea
  - Instead of buoyancy and marine growth weight per time step
  - This reduces data size and analysis times, and avoids database size limitations in Framework
- Possibility to specify double-peaked wave spectra input per design load case
  - From Sesam Wind Manager you can now the select double-peaked wave spectra six-parameter Ochi-Hubble, full and simplified Torsethaugen



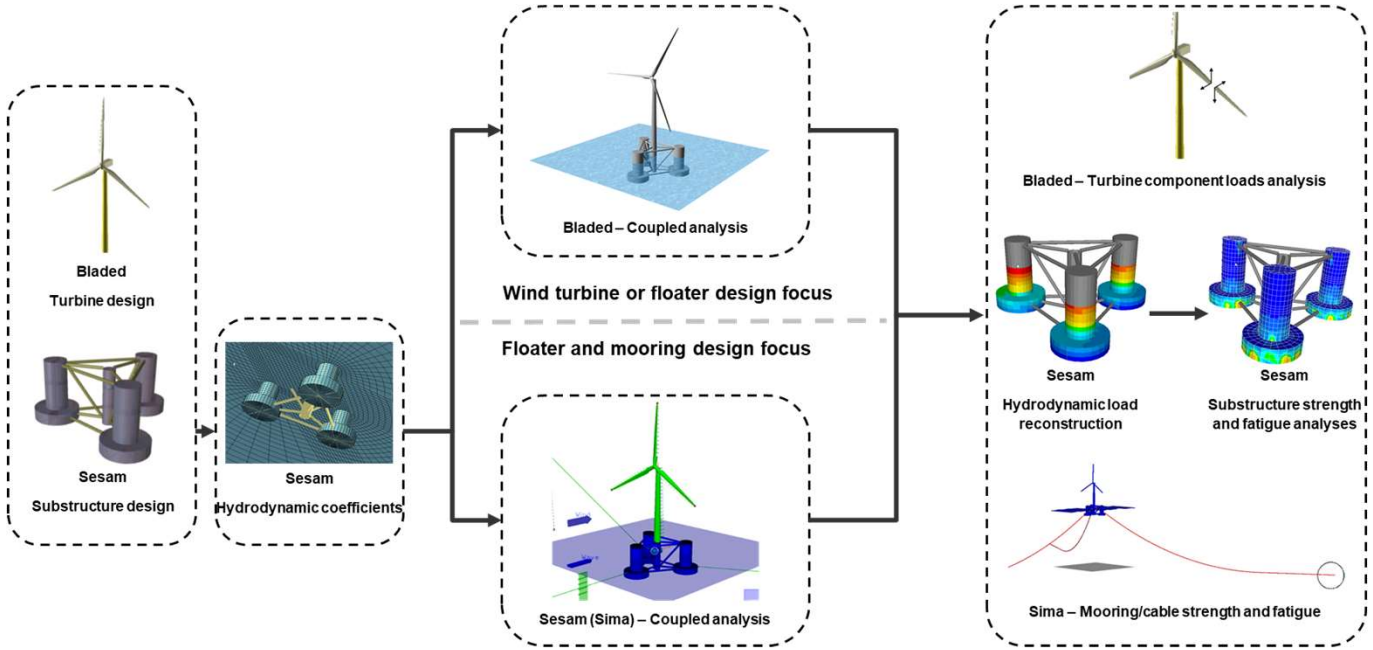


Separate user interfaces for integrated and superelement workflows to simplify input

Seamless data transfer from the creation of hydrodynamic coefficients, through coupled analysis to the reconstruction of hydrodynamic loads has been completed. There is no need for manual data transfer or editing

Seamless analysis workflows for floating OWT

- Transfer of hydrodynamic coefficients
  - Constant data
    - Body mass
    - Restoring matrix
  - Linear data
    - Added mass and damping
    - Excitation forces
  - Second-order data
    - Mean drift forces
    - Second-order forces
    - Seamless to Sima. To Bladed soon, a workaround exists
- Coupled analysis in Bladed or Sima
  - Bladed for rotor or floater design
  - Sima for floater or mooring design
- Coupled analysis data passed to Sesam for hydrodynamic time domain analysis
- Time domain floater fatigue post-processing in the new module Sesam Core – now in preview release stage



Much faster load transfer thanks to optimizations in Wasim, and much faster structural analysis in Sestra

Load transfer and structural analysis performance improvements for floating OWT

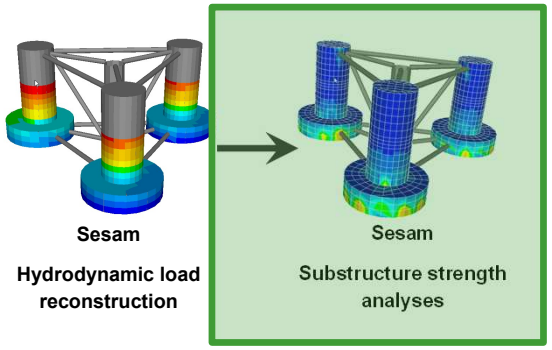
- The combination of Wasim 6.3 and Sestra 10.16 leads to significant performance improvements
  - Major speed improvements for load transfer and structural analysis, because of changing the structure of the produced loads on the interface file
  - Additional speed and memory improvements for the structural analysis itself
  - Example timings with 3-hour time simulation, with time step 0.1s, i.e. 108 000 time-steps:

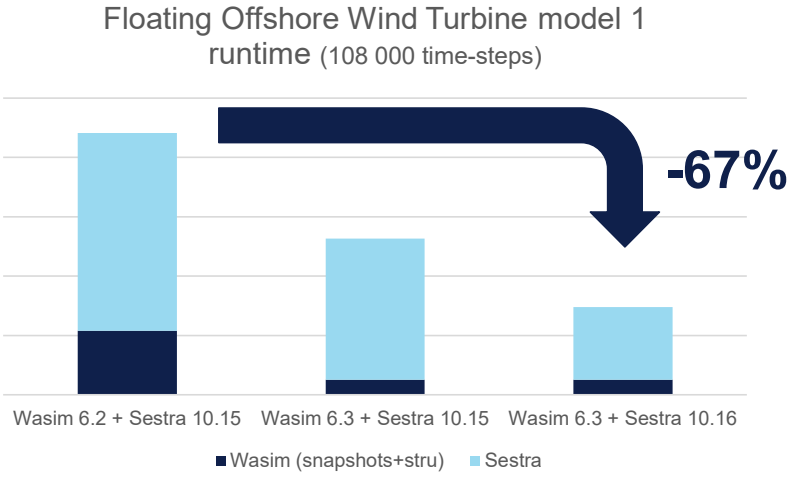
					Wasim snaps + stru		
Model	Include tanks	Number of panels	Number of elements	Number of nodes	Wasim 6.2	Wasim 6.3	Change
1	Yes	3420	8602	4829	01:17:48	00:18:21	-76%
2	Yes	3420	21033	14485	02:29:46	00:50:44	-66%
3	No	14300	20400	11294	01:15:49	00:22:05	-71%

	Loads from Wasim 6.2	Loads from Wasim 6.3		
Model	Sestra 10.15	Sestra 10.15	Sestra 10.16	Change
1	03:59:54	02:51:13	01:28:15	-63%
2	17:11:18	12:31:40	05:33:36	-68%
3	10:04:04	08:28:57	03:25:44	-66%

Dynamic analysis	Sestra 10.15	Sestra 10.16, with NUMLC=100	Change
Execution time	06:03:46	02:12:55	-63%
Peak memory (physical)	36.49 GB	0.92 GB	-97%
Peak memory (total)	41.94 GB	1.12 GB	-97%

- Wasim 6.4 includes additional hydrodynamic simulation performance improvements for deep water or models without Morison elements

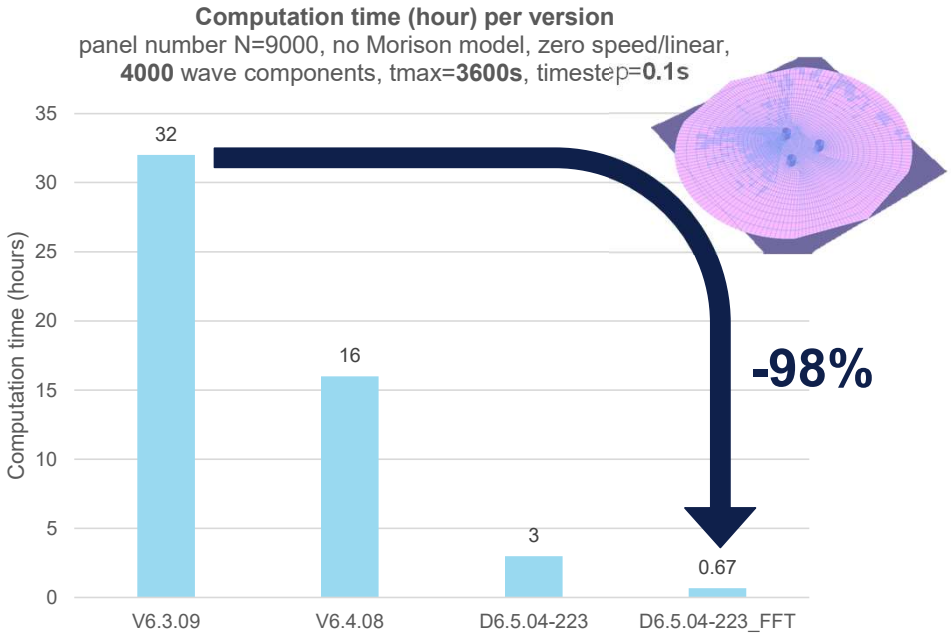


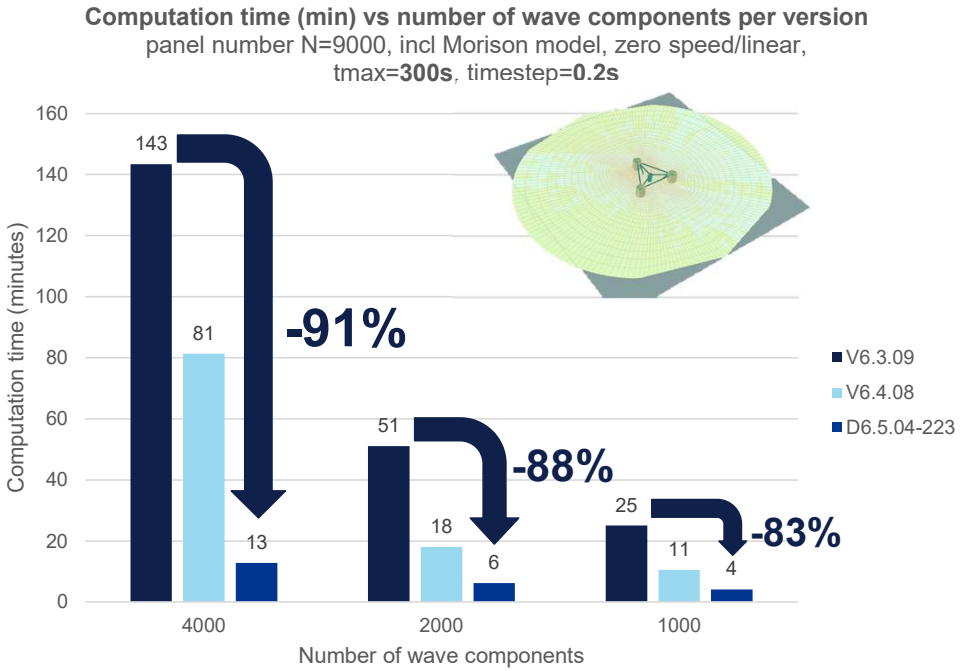


Much faster time domain hydrodynamic analysis because of improved arithmetic methods in Wasim

Performance improvements of hydrodynamic simulation

- Major speed improvements for models with and without Morison
  - Part of the Wasim 6.5 release

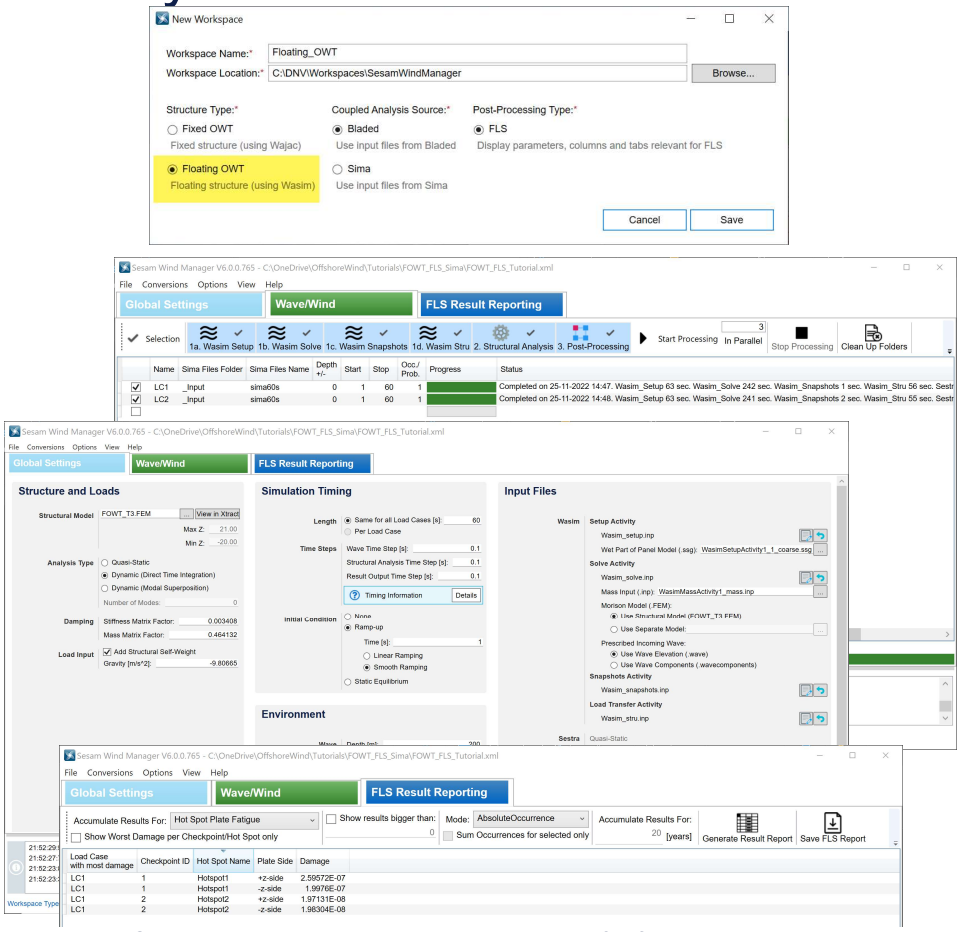




It is now much easier to handle the data flow from coupled analysis through to the structural analysis of the floater (the hull)

New floating wind workflow for fatigue analysis

- The new release of Sesam Wind Manager (version 6.0) supports a workflow for floating offshore wind, including the import of data from coupled analysis, hydrodynamic load reconstruction, structural analysis and fatigue post-processing
  - Finite element model and Morison model are made in GeniE, and fatigue input is defined in GeniE (see next slide)
  - Wet part of panel model and mass input are obtained from HydroD
  - Coupled analysis results are obtained from Sima or Bladed
  - After load reconstruction in Wasim and structural analysis in Sestra, fatigue post-processing is done in Sesam Core (see next slide)
  - Analysis can be run locally or in the cloud
  - Fatigue results are automatically accumulated
- Sesam Wind Manager has different views for fixed and floating foundation workflows, which makes it easier to set up your analysis workflow data

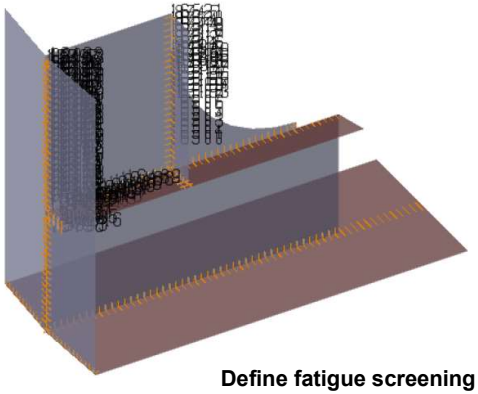


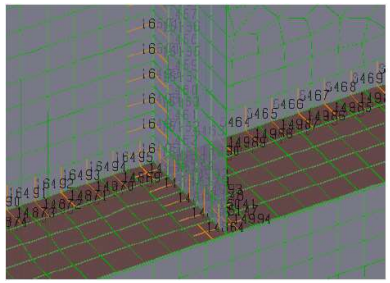
Sesam Wind Manager now provides support for floating wind fatigue analysis

The emerging releases will significantly reduce the analysis time, allow for much larger models and supporting the latest edition of DNV-RP-C203

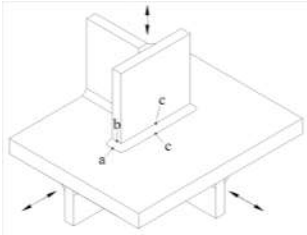
New floating wind workflow for fatigue analysis

- Sesam Core performs time domain fatigue analysis on plates. It includes two types of fatigue analysis: screening checks and detailed hotspot fatigue checks.
- Supporting hot spot stress method for proportional loading, as well as multidirectional fatigue analysis for non-proportional loading.
- Sesam Core offers new post-processing functionality together with Sestra, offering significant speed and storage improvements
- Screening check to identify most damaged areas
  - Screening areas are defined in GeniE
- Hotspot check to perform detailed hotspot fatigue check according to DNV-RP-C203
  - This is to be performed on fine meshes
  - Hotspot fatigue model data is defined in GeniE:
    - Location, weld normal line, hotspot type
    - SN-curve setup (unidirectional and/or multi-directional)
    - Stress extrapolation method (see DNV-RP-C203 section 4.3.4.1)
    - Detail category (see DNV-RP-C203 table A.3)
- Sesam Core is now in preview testing by users and will become a commercial product in 2023





Define fatigue screening locations in GeniE



Hotspot type

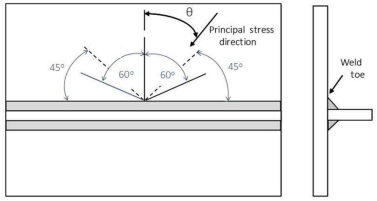
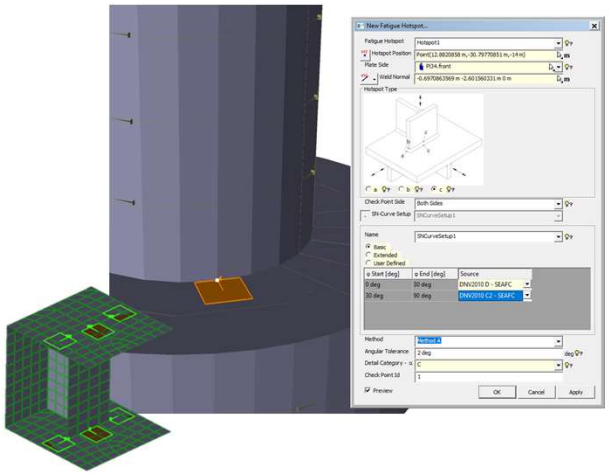


Figure F-29 Illustration of sectors to be analysed for crack along the weld toe and transverse to the weld

Multi-directional damage (DNV-RP-C203)



Define fatigue hotspot locations in GeniE

You may use turbine concept models in case you don't have the full details of the turbine

Turbine Concept Models for integrated load analysis

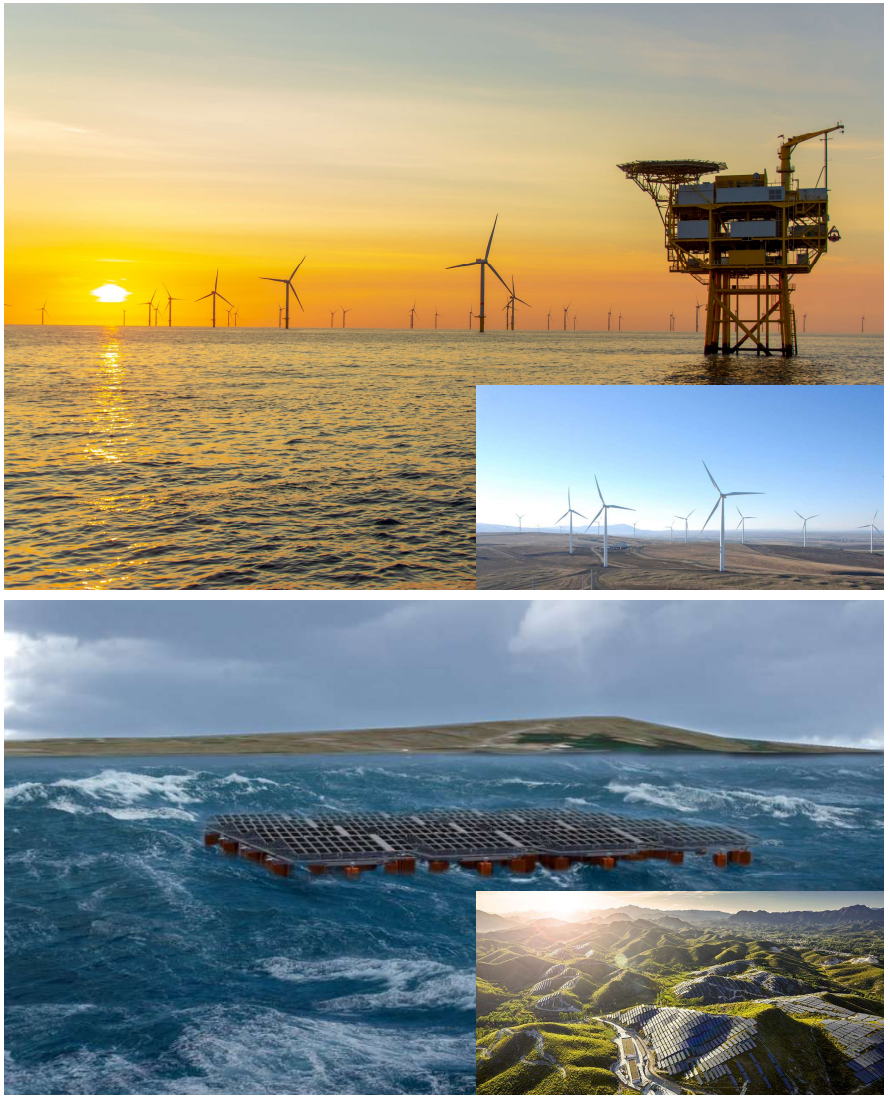
- Represents existing/coming offshore turbines
  - Based on public information and experience
  - DNV Turbine Engineering
    - Define the turbine in Bladed
    - Design and (re)tune the control system
- Non-turbine OEM stakeholders can perform integrated loads analysis for:
  - Foundation design initialization
  - Sensitivity studies
  - Additional structural design loops (outside of turbine OEM)
  - Learning process of turbine foundation design
- If desired, DNV can run representative models, acting as turbine OEM
- The Turbine Concept Models can be purchased from DNV

- Concepts ready off the shelf
  - 6MW 154
  - 7MW 154
  - 8MW 167
  - 9.5MW 164
  - 9.5MW 174
  - 10MW 178
  - 12MW 218
  - 14MW 222
  - 15MW 240
  - 16MW 240
  - 19MW 265
  - 20MW 252
  - 22MW 290



Layout modelling & energy production assessment

- New values during 2022
  - WindFarmer: Analyst on its way to replace WindFarmer v5.3 and delivering more functionality
  - SolarFarmer: Introducing 3D Energy Calculation API for Private Preview



Our focus is to provide a full wind farm development workflow in one package



Focus on your job with our workflow centred user interface

Full wind farm development workflow in one package

- Mapping, wind analysis, flow modelling, energy capture and uncertainties connected in a single calculation chain.
- Rapidly update your energy results as more wind data are received. Apply the updates to many wind farm design scenarios.
- Full traceability and repeatability reduces human errors and increases efficiency.



Be confident in your results with our continuous validation against wind farm measurements

Leading through innovation

- We add innovations derived from our research to increase the **accuracy** of WindFarmer: Analyst models.
- Validated blockage correction model
- Fully validated wake models
- Monte Carlo Net Energy approach offers greater accuracy for accessing project uncertainties.
- 15% revenue invested into R&D for new models. Coming this year, CFD.ML. Next, Stratified Ainslie wake model for power time series. Then, wind farm control strategy modelling.



Work faster and integrate your own tools through automation

Extend WindFarmer: Analyst

- Programmatically access all workbook data and WF:A functionality through scripting interface.
- Write repeatable workflows.
- Link WF:A to your own tools. Outputs and report to your templates.
- Customise the target of the layout optimizer to minimise cost of energy.
- Energy calculation available as web API to call calculation from your own python scripts.

Validated turbine interaction models for offshore wind farms

WindFarmer turbine interaction results are compared with 7GW and 4000 turbine years of offshore operational SCADA data from small & large North Sea farms turbines. WindFarmer's old and new models are assessed:

- DNV Machine Learning model based on CFD simulations
- DNV's Stratified Eddy Viscosity Model for wind farm control modelling
- WindFarmer Eddy Viscosity with large wind farm correction
- WindFarmer PARK with large wind farm correction



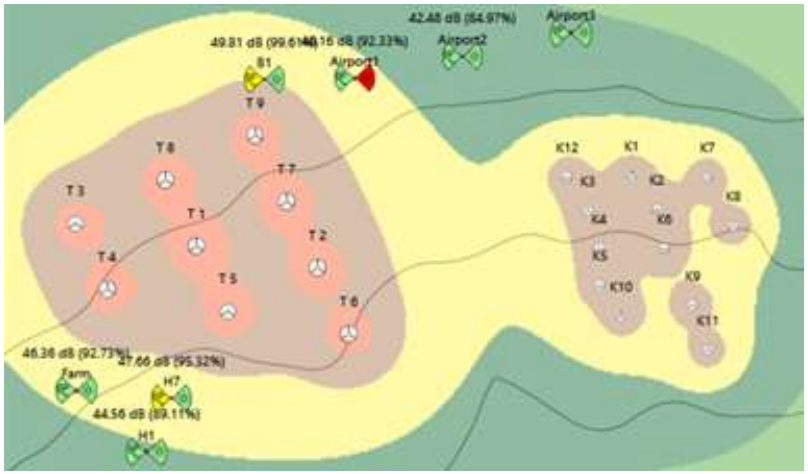


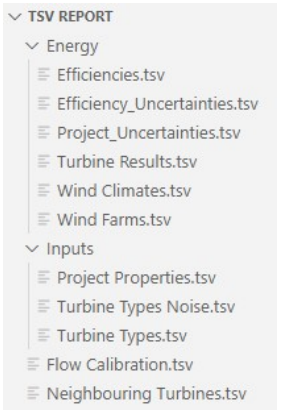
https://www.dnv.com/events/webinar-creating-the-next-generation-of-validated-turbine-interaction-models-for-offshore-wind-farms-226994

Simplify planning assessments with wind farm noise & turbine operational modes

- Noise
  - Map your wind farm's acoustic emissions
  - ISO 9613 compliant
  - Account for complex terrain
  - Include noise @ location constraints in your project design

- Turbine operational modes
  - Make full use of sophisticated turbine operational modes. Now reported in an intuitive hierarchical structure

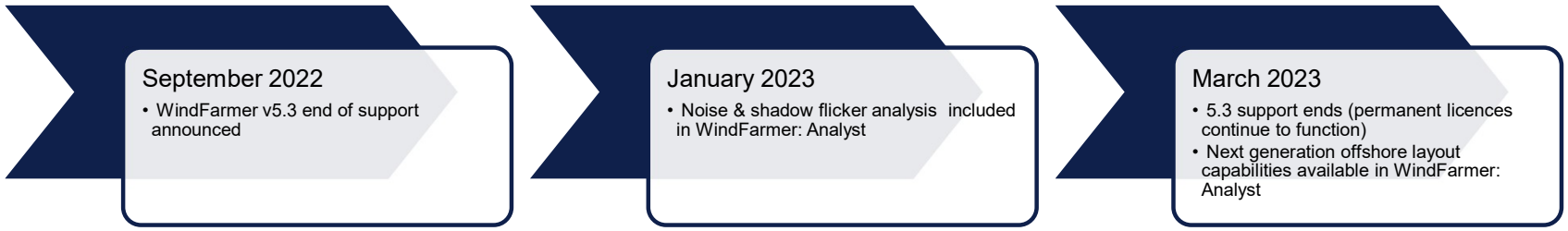




Please see the user guide and calculation reference for more details

WindFarmer: Analyst supersedes legacy WindFarmer v5.3

- Make the easy transition to the latest version of WindFarmer to get dependability, plus new and exciting tools.
  - **Validated models and methodologies:** Globally our engineers at DNV use the latest version of WindFarmer for all DNV's bankable energy assessments. We want to ensure you have the best software we have available for designing your wind farms
  - **Minimise the risk:** DNV is continually investing in our methods and models to ensure the best accuracy. WindFarmer's new wake models and blockage effect calculations continues to help you minimize the risk in your wind farm design
  - **Efficiency comes as standard:** Find what you need quickly and make tasks easier with the latest version of WindFarmer's extensive automation capabilities and intuitive workflow driven UI from raw time series to wakes, blockage and P90 Net energy



Layout modelling and energy production assessment for wind

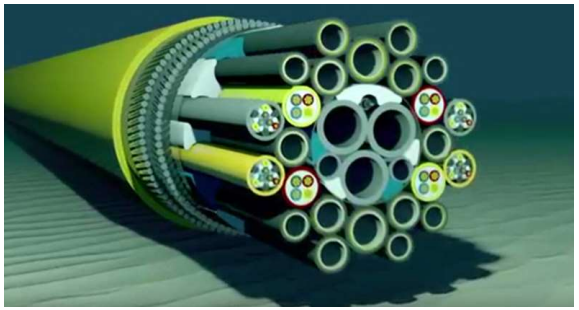
- WindFarmer: Analyst 1.3.6
  - Private preview noise beta - contact us if you are interested in joining.
  - Turbine Types.tsv only outputs turbine types and modes used in energy calculations.
  - TSV Reports now has sub-directories.
  - Operational Modes.tsv from the intermediate results of the power time series calculation now shows the air density.
- WindFarmer: Analyst 1.3.5
  - New TurbOPark wake model from Ørsted
  - Up to 4x faster power time series calculation
  - Bat curtailment long term hub height wind speed time series prediction script
  - Wind Resource Grid (WRG) import script to assist you in performing mastless energy assessments.
  - Ideal yield calculation in scripting
- WindFarmer: Analyst 1.3.4
  - Temperature curtailment rule support
  - Power time series input wind speeds defined for every initiation mast.
  - New Turbine interaction settings task. Wake calculation settings that are shared between the power time series and the annual energy production calculations have been combined in a separate task.
  - Export waked wind speeds, operational modes and other intermediate results when running the power time series calculation.
  - Realistic power time series calculation progress reporting and a cancellation option.
  - Set up multi-mode, multi-air density turbine types faster by importing .trbx files to add data to existing turbine types.
  - Configure the normal mode for a turbine type
- WindFarmer: Analyst 1.3.3
  - Import measurement sites from other workbooks
  - WAsP from wind atlas supported for WAsP 12 and 11
  - Projection system setting from EPSG codes
  - New energy calculation out of BETA

Layout modelling and energy production assessment for PV

- SolarFarmer 1.0.234
  - Desktop application updates
    - Import layout and exclusion regions from Google Earth files (Docs)
    - Calculate exclusion regions from slopes (Docs)
    - Improved exclusion region support (Docs)
    - Added support for version 5.2 of PVGIS API download (Docs)
    - Thin-film modules with trackers now supported in local calculation.tsv from the intermediate results of the power time series calculation now shows the air density
  - API and website updates
    - Added support for shading objects in 3D API
    - Added support for POA-only solar resource data in API
- SolarFarmer 1.0.229
  - Desktop application updates
    - Scripting enhancements
    - Specify Site Layout tool improvements
  - API and website updates
    - Security updates
    - Calculation improvements
    - New endpoints (ModelChainAsync and TerminateModelChainAsync)
    - Website improvements (filter and paginate the runs page)
- SolarFarmer 1.0.223
  - Desktop application updates
    - Support for 6x11 silicon module specifications (both full and half-cell modules)
    - Allow user to choose to store inputs and outputs online
    - Provide system attributes file from cloud calculations
- 3D Energy Calculation API now available for Private Preview
  - We have released 3D API yield calculation including run time speed up, runs with fixed-tilt or trackers, and bifacial (albeit using the 2D algorithm for the backside)
  - The 3D API is available on a Private Preview basis to existing customers who want to road test the API whilst we continue to work on API management and scalability. Note that there are a few caveats; not all features are immediately available in this first pre-view release
  - Whilst in Private Preview the 3D API is available at no additional charge, although we are currently limiting maximum project size to 50MW and we are running on a relatively small cloud cluster – which means that you may experience resource contention at busy times
  - Full scale up of the API infrastructure is happening over the next couple of months, but if you want to get ahead and you are willing to help us with road testing then please request access by clicking this link: **Register for 3D API private preview**

Offshore pipelines & cables

- New values during 2022
  - DNV-ST-F101 was revised in 2021 and replaces DNVGL-OS-F101. The tool DNV-ST-F101 Code Compliance supports the latest revision of the code
  - Lateral stability of pipelines based on dynamic analysis is supported in the new tool PILSS. It supports the latest DNV-RP-F109 revision from May 2021

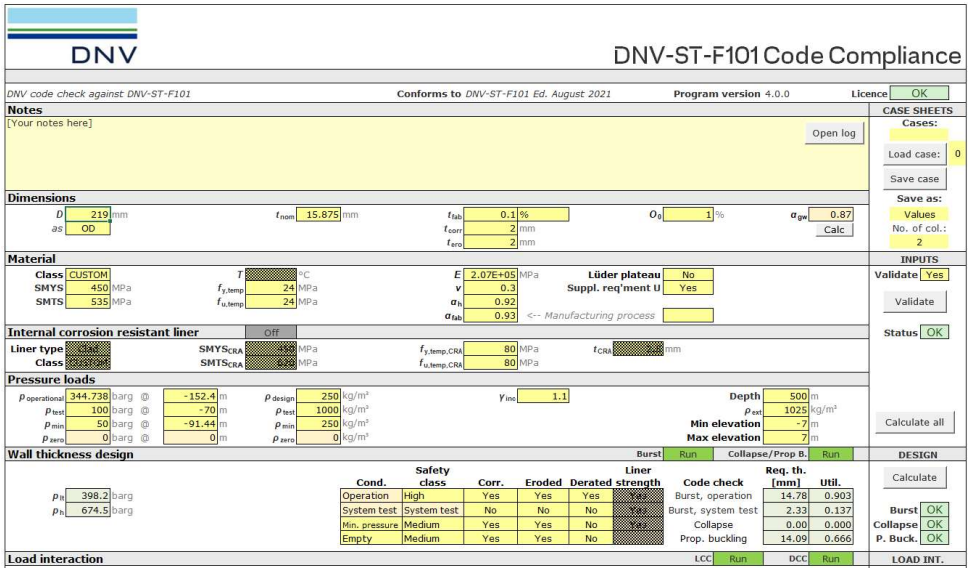






Offshore pipelines and cables - headlines

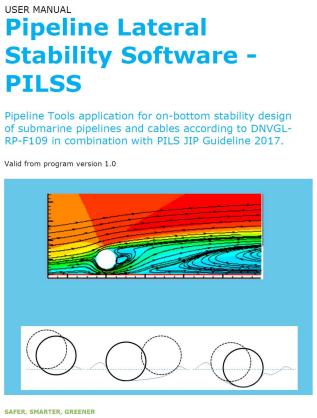
- Compliance with DNV ST-F101 revision August 2021
  - Renamed to "DNV-ST-F101 Code Compliance“
    - Previously this tool was called DNVGL-OS-F101
  - Program code migrated to the .Net platform
  - Excel 64-bit compatible
  - Code checks for lined/clad pipes according to latest edition of standard
  - Import data from previous versions 3.1 through 3.4 of DNVGL-OS-F101



PILSS help engineers to reduce conservatism in the design of offshore cables, umbilicals and pipelines by providing efficient and user-friendly dynamic on-bottom stability assessments in accordance with DNV-RP-F109 (rev. 2021)

PILSS - Pipeline Lateral Stability analysis

- Software for time domain dynamic lateral stability analyses of cables, umbilicals and pipelines according to DNV-RP-F109 (May 2021) in combination with PILS JIP Guideline 2017
- Extends the functionality of StableLines from static to **dynamic**
  - **StableLines: Deepwater – static**
  - **PILSS: Shallow water – dynamic**
- MS Excel user interface
  - Excel 64-bit compatible
  - Possibility to use Fortran DLL calculation engine directly through its API





5 DYNAMIC LATERAL STABILITY ANALYSES

5.1 Introduction

The purpose of lateral on-bottom stability design is to ensure that the lateral displacement of pipelines or cables resting on the seabed does not exceed a predefined limit $y_{allowable}$. In some cases, for instance if there is a risk of collision with surrounding infrastructure, absolute static stability ($y_{allowable} = 0$) or very strict maximum allowable displacement limits are required, while in other cases the pipeline or cable may be allowed to move under the influence of the most severe waves in a design sea state. The latter approach may offer a significant reduction in weight requirements, but also increases the complexity of the lateral stability design analyses.

In order to allow for pipe or cable movement during a design storm, the design must be based on dynamic lateral stability analyses, simulating both the build-up of pipe penetration $z_p(t)$ into the soil and the lateral pipe displacement $y(t)$ in time domain, see Figure 5-1. The main objective of a dynamic lateral stability analysis is thus to calculate the lateral displacement of a pipeline subjected to hydrodynamic loads F_Y and F_Z from a given combination of waves and current during a design sea state.

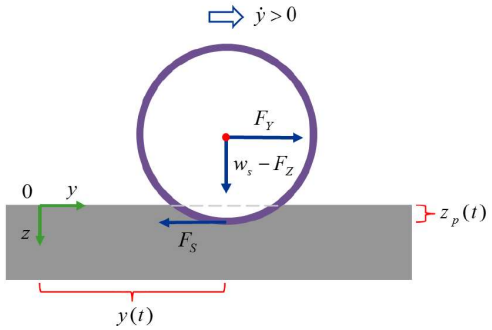


Figure 5-1 Definition and positive direction of displacement $y(t)$, penetration $z_p(t)$ and external forces per unit length acting on the pipe or cable cross-section.

Source: PILS JIP Guideline 2017

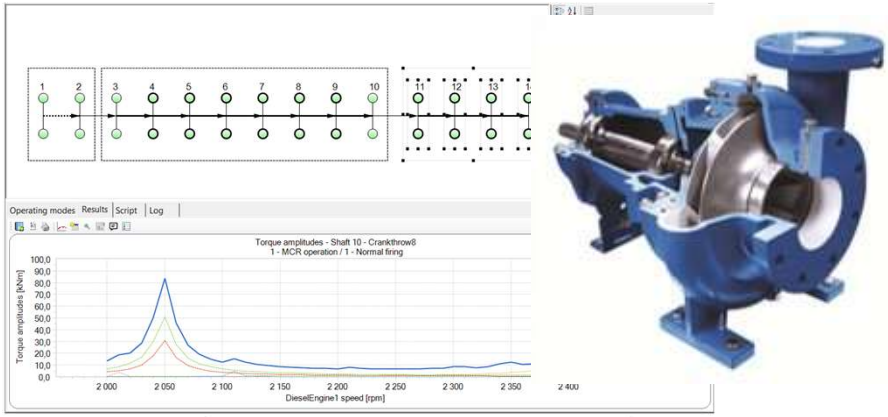
Propulsion design and analysis

- New values during 2022
  - Nauticus Torsional Vibration Calculation
    - New elements of centrifugal pump and reciprocating pump
    - New option to set the limitation of mean indicated pressure (MIP) for cylinders in a diesel engine
  - Nauticus Gear Rating
    - Calculation of scuffing load capacity according to ISO6336-20 Flash temperature method is now supported for both cylindrical gears and bevel gears
  - Ice-extension function
    - Supports the DAV (Double acting vessels) notation requirements for ice extension calculation
  - Nauticus Machinery Workflow Manager
    - Improve the efficiency of loading data from the portable local database

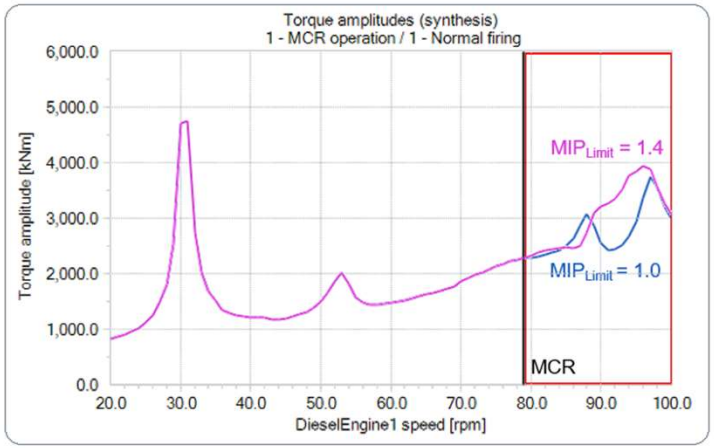


Torsional vibration

- New elements of centrifugal pump and reciprocating pump
  - Users can now simulate different types of pumping working process. Especially for the reciprocating pump, the excitation can be considered in each pump cylinder with correction of phase angles. Thus, more reliable results will be achieved for the model with pump elements



- New option to set the limitation of mean indicated pressure (MIP) for cylinders in a diesel engine
  - MIP limit exists in diesel engines, but could be various for different types. With this option, users can set the MIP limit and expect more accurate results for the conditions when engine is running overloaded (speed beyond Maximum Continuous Rating MCR)



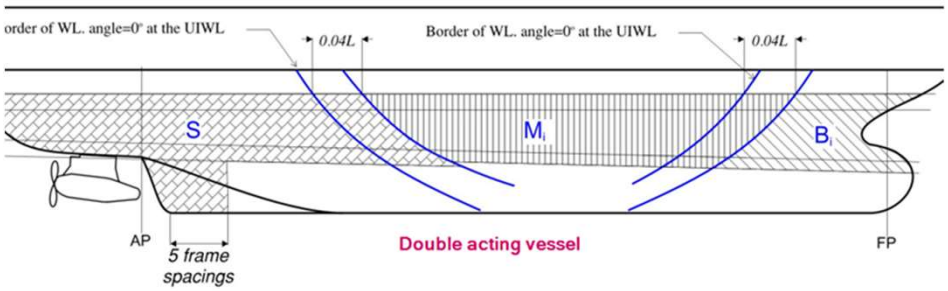
Support updated ISO and DNV standards for gear rating and ice extension calculation of double acting vessels

Gear Rating and Ice-extension modules

- Calculation of scuffing load capacity according to ISO6336-20 Flash temperature method is now supported for both cylindrical gears and bevel gears
  - The scuffing calculation in Gear Rating supports both the latest ISO flash temperature method and DNV class guideline method. By this release, Gear Rating users can use the tool for not only the marine reduction gear, but also the industrial gear referring to ISO standards

No.	Calculation standard	Rule based
1	DNV Standard	All calculations are based on DNV CG-0036, both for cylindrical gear and bevel gear. - Calculation of surface durability - Subsurface fatigue - Calculation of tooth bending strength - Calculation of scuffing load capacity
2	ISO Standard	The calculations are based on - Calculation of surface durability: ISO 6336-2 for cylindrical gear, ISO10300-2:2014 (method B1) for bevel gear - Calculation of tooth bending strength: ISO 6336-3 for cylindrical gear, ISO10300-3:2014 (method B1) for bevel gear - Calculation of scuffing load capacity: ISO 6336-20:2017 both for cylindrical gear and bevel gear, which is based on flash temperature method.
3	ISO Standard with DNV class	The surface durability and tooth bending strength calculations are based on the ISO 6336 standard method B for cylindrical gear and ISO 10300 standard method B1 for bevel gear. The required safety factors and material endurance limits are based on DNV Rules (RU-ship) Pt.4 Ch.4 Sec.2. The scuffing calculation is according to ISO 6336-20:2017 [Calculation of scuffing load capacity], which is based on flash temperature method.

- Supports the DAV (Double acting vessels) notation requirements for ice extension calculation
  - The DAV notation has special requirements in addition to the ice class strengthening. This new function supports the user to check such requirements for DAV notation effectively and efficiently.



Program versions released during 2022

- Bladed
- WindFarmer & SolarFarmer
- Sesam
- Nauticus Machinery



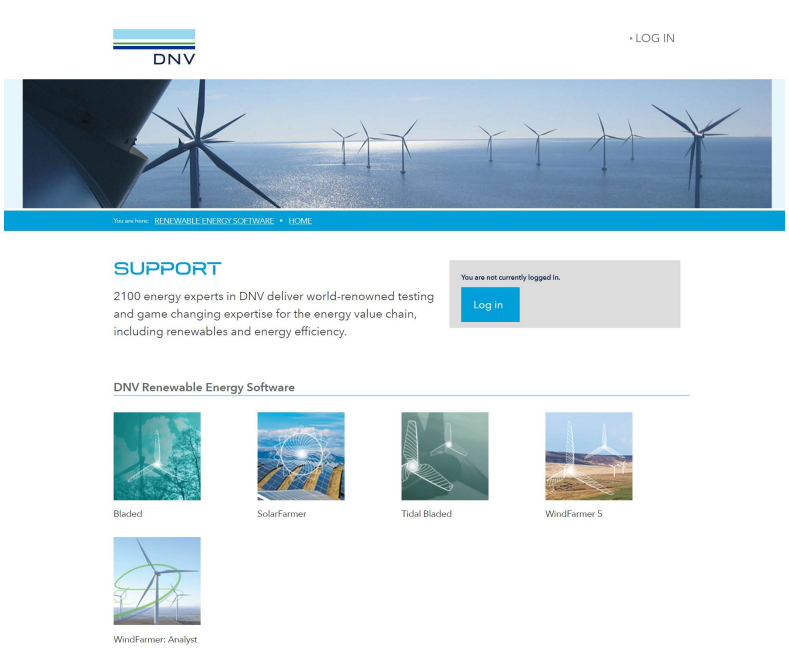
List of program releases during 2022

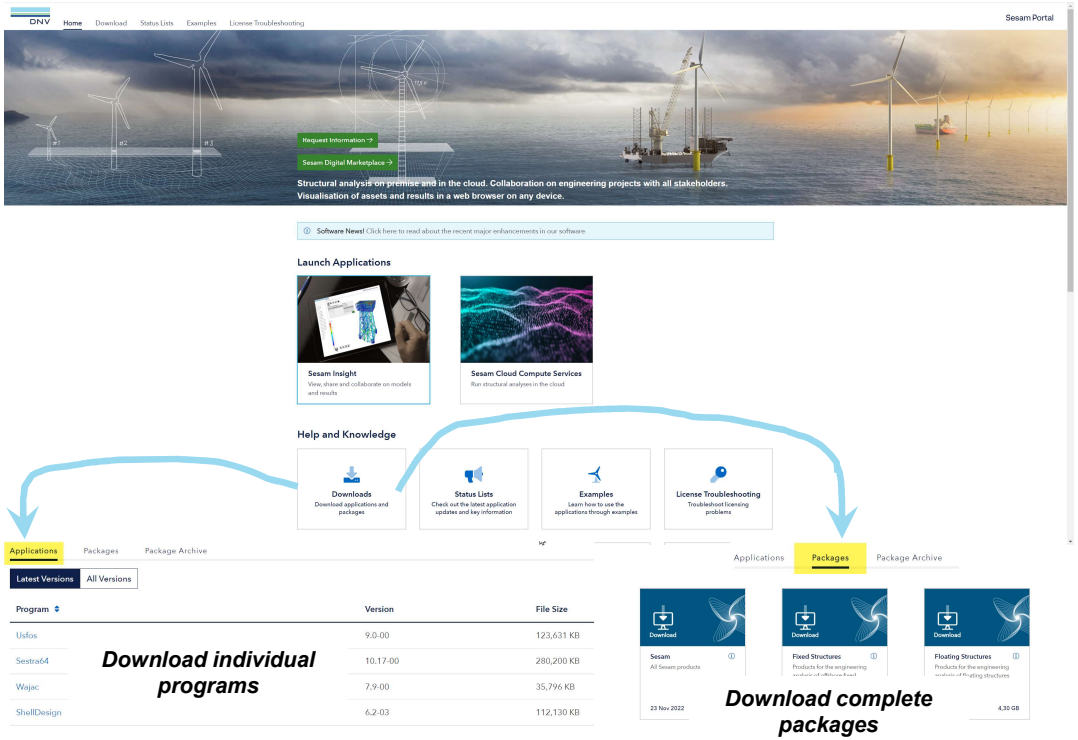
Program	Version	Release date
Bladed	4.13	11 Nov 2022
Bladed	4.12	11 Feb 2022
GeniE	8.4-06	7 Oct 2022
GeniE	8.3-04	10 Jan 2022
HydroD	6.1-02	7 Jul 2022
Nauticus Machinery	14.5-00	12 May 2022
Patran-Pre	2022.3	9 Dec 2022
Sesam Insight	2.3.0	26 Oct 2022
Sesam Insight	2.2.0	10 Aug 2022
Sesam Insight	2.1.0	30 May 2022
Sesam Insight	2.0.0	13 Apr 2022
Sesam Insight	1.12.0	22 Feb 2022
Sesam Manager	6.6-03	6 Oct 2022
Sesam Wind Manager	6.0-00	15 Dec 2022
Sesam Wind Manager	5.3-03	12 Sep 2022

Program	Version	Release date
Sestra	10.17-00	9 Nov 2022
Sestra	10.16-00	5 Apr 2022
ShellDesign	6.2-07	12 Dec 2022
Sima (Incl. Simo, Riflex)	4.4-03	17 Oct 2022
SolarFarmer	1.0.229	28 July 2022
SolarFarmer	1.0.225	23 May 2022
SolarFarmer	1.0.223	30 Mar 2022
Splice	8.0-01	28 Nov 2022
Splice	8.0-00	25 May 2022
ST-F101	4.0-01	11 Mar 2022
Stofat	4.1-02	7 Oct 2022
Usfos	9.0-00	17 Nov 2022
Wadam	10.2-02	28 Nov 2022
Wadam	10.1-03	13 May 2022
Wajac	7.9-00	7 Nov 2022

Program	Version	Release date
Wasim	6.5-08	13 Dec 2022
Wasim	6.4-08	12 Sep 2022
WindFarmer Analyst	1.3.6	15 Nov 2022
WindFarmer Analyst	1.3.5	23 Sep 2022
WindFarmer Analyst	1.3.4	26 Apr 2022
WindFarmer Analyst	1.3.3	30 Mar 2022

Download software and documentation





renewableenergysoftwareportal.dnv.com
to find the latest releases of Bladed, SolarFarmer and WindFarmer: Analyst

sesam.dnv.com
to find the latest releases of Sesam and Nauticus Machinery

Supported Windows systems

- WindFarmer: Analyst and SolarFarmer support Windows10
- Bladed 4.9 – 4.13 are supported on
  - All components on Windows10 64 bit
  - Calculation only on Ubuntu 18.04.3 LTS
- Sesam and Nauticus Machinery supports Windows 10
  - Programs released after 14 January 2020 have been tested on Windows 10
  - Programs released prior to 14 January 2020 have been tested on Windows 7/10

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