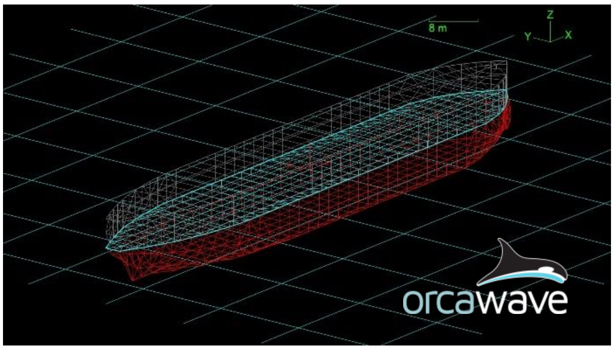
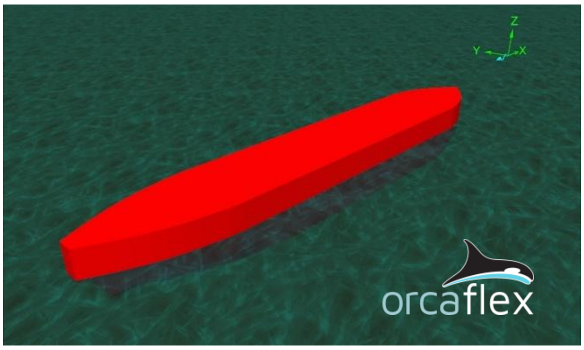
L01 Default vessel

Introduction

In this example we use OrcaWave, the diffraction and radiation solver included with OrcaFlex since version 11.0, to re-create the hydrodynamic data set used by the OrcaFlex default vessel. This is the vessel type data that you see when you first add a new vessel to an OrcaFlex model. It was generated for us in a 3rd party diffraction tool, many years ago, but we have recreated it here to demonstrate the use of OrcaWave and the import & subsequent use of the data in OrcaFlex.

Note: OrcaWave has been extensively validated against WAMIT. For full details, please refer to the validation study which is available for download from the Orcina website.





OrcaWave diffraction analysis

OrcaWave data files have the file extension *.owd* and the results files *.owr*. In this example we will interrogate a diffraction model and observe the dependency of certain diffraction results on a range of model parameters.

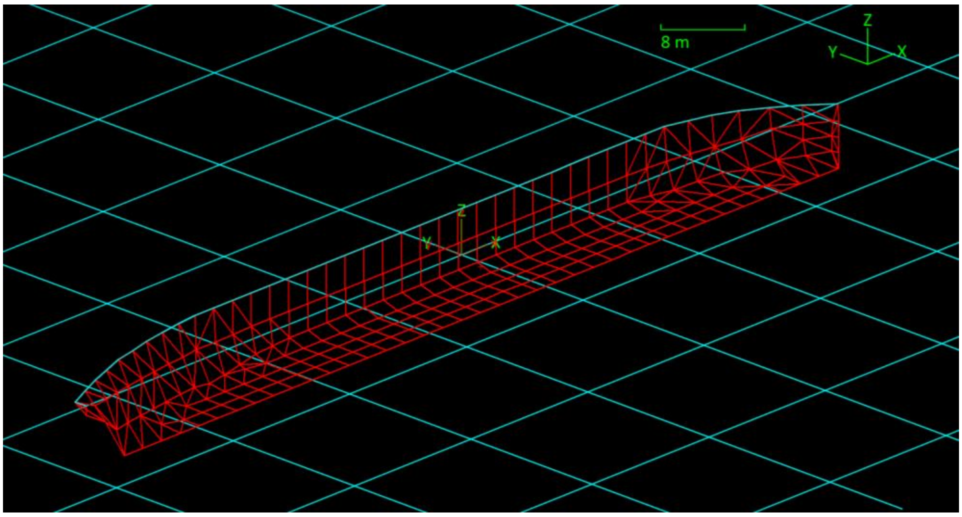
Open the file *L01 Default vessel.owr.* The OrcaWave user interface is very simple and consists of several pages into which the data to be used in the diffraction calculation are input.

Mesh

The starting point for doing a diffraction analysis is to generate a suitable mesh of the vessel's hull form. OrcaWave does not currently include a mesh generation or editing tool, therefore a suitable meshing tool is needed to generate a mesh file.

OrcaWave accepts various mesh formats, including WAMIT .gdf, AQWA .dat and Hydrostar .hst. For a full list, please see the Mesh file formats page of the OrcaWave help. In this example we have used Rhino to generate and edit meshes in the WAMIT .gdf format, but other tools are available.

In this case we have the mesh available from the original diffraction analysis and we use this as the starting point. To improve the efficiency of the diffraction analysis, the mesh makes use of half-symmetry along the global xz-plane. The mesh is truncated at the free surface:

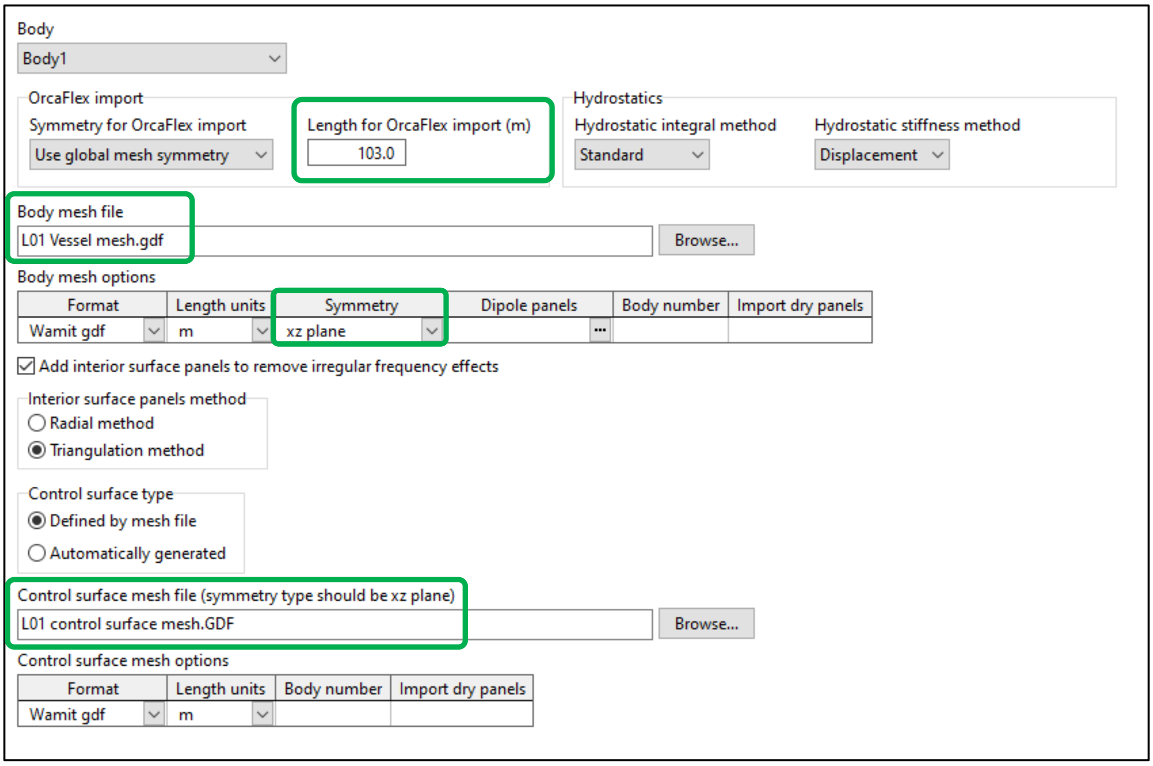


The mesh in its original format contains 216 panels. The speed of the calculation and the accuracy of the results are heavily dependent on the size of the panels and how well the mesh describes the true form of the body (similar to the number of segments used to model an OrcaFlex line). Therefore, mesh sensitivity studies are usually performed to establish the optimum mesh density.

In this case we only intend to replicate the original diffraction analysis results. It should be noted that our original vessel mesh has coarse resolution by modern standards, but this example is not a meshing study, and we benefit from the fast calculation time that a coarse mesh provides. We therefore only make a few minor improvements to the mesh as we work through the analysis.

Defining a body

The *bodies* page is where we import the mesh file. Whilst OrcaWave can perform multibody analysis, we are only considering a single body here, so only one body is specified.



The *length for OrcaFlex import* is set to 103m, the length of the default vessel. This property is not used by OrcaWave, but it can be set here for convenience so that the *vessel type length* is automatically set upon import to OrcaFlex.

The *body mesh file* specifies the name of the file that contains the vessel mesh. As we are making use of half-symmetry in the mesh file, the *symmetry* data item needs to be set accordingly (*xz plane*).

The *control surface mesh file* specifies the name of the file that contains a control surface mesh. This will be used in the quadratic load calculation, but we will discuss this in more detail later in this example.

Body inertia

Moving to the *inertia* page, the vessel's *centre of mass*, *mass* and *moment of inertia tensor* are specified. The values considered here have been copied directly from the default OrcaFlex vessel. We are specifying the inertia using a matrix (for a general body). In OrcaFlex, the inertia matrix is defined about the centre of mass**,** therefore the corresponding *inertia origin* has been selected in OrcaWave.

Calculation & output settings

On the *calculation & output* page, we choose the type of solve that we want to carry out. As we are re-creating the data used in the OrcaFlex default vessel, it's worth listing the diffraction results that it contains, and that we therefore want OrcaWave to generate:

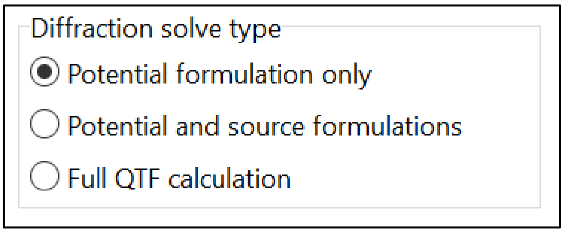
- Displacement RAOs
- Load RAOs
- Wave drift QTFs (Newman's approximation)
- Hydrostatic stiffness matrix
- Added mass and damping matrices.

In addition to calculating this data, OrcaWave can calculate full QTFs, sea state RAOs (disturbance data) and multibody data, but these types of data are not covered in this example. Other damping data is also specified and will be discussed later in this example.

The default OrcaFlex vessel also contains data for wind and current loading; note that this data is not generated in a diffraction tool. Further details about the vessel current and wind loading models can be found in the OrcaFlex help (Modelling, data and results | Vessels | Vessel types | Current and wind loads).

The *diffraction solve type* determines the extent of the diffraction calculation and the results that can be reported. Note the hydrostatic results are available on the *mesh details* page before the diffraction analysis is initiated. They are unaffected by the selection of *diffraction solve type*.

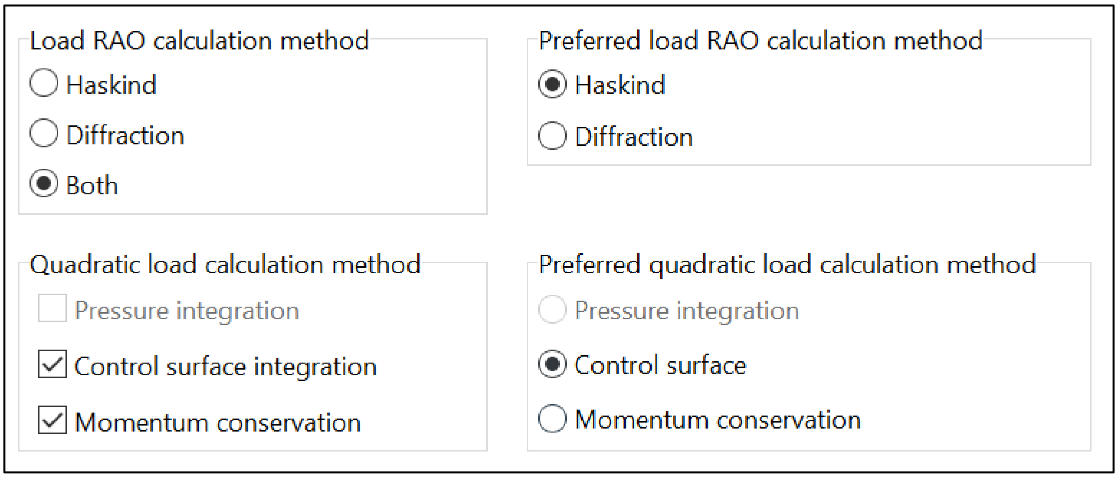
There are three options when nominating a *diffraction solve type*. As you move downward from one solve type to the next, the diffraction calculation becomes more extensive. The memory demand increases and so does the run time. Therefore, it is advisable to choose a solve type which is capable of reporting the results you are interested in, anything more is wasted effort.



Diffraction solve type	OrcaWave results
Potential formulation only	• Load RAOs • Added mass & damping • Displacement RAOs • Sea state RAOs • Mean drift loads (via control surface and momentum conservation methods) • Panel pressures • Fluid pressures • Fluid velocities
Potential and source formulations	• As above • Mean drift loads (via pressure integration method) • Panel velocities
Full QTF calculation	• As above • Full QTFs (sum and difference frequency)

In this example, we require first order wave effects. Furthermore, we require mean drift loads that will be used to model wave drift loads in OrcaFlex via Newmans approximation. All three diffraction solve types are capable of reporting these properties. We will use the 'potential formulation only' solve type since it demands the smallest amount of memory.

OrcaWave then offers some additional calculation choices:



Firstly, we have a choice of *load RAO calculation method*, either 'Haskind' or 'Diffraction'. The two methods are mathematically equivalent, and both methods can be implemented with no additional computational cost. With this considered, we will use the default option of 'Both'. This means that two sets of load RAOs will be available for import into OrcaFlex. Checking for agreement between the load RAOs calculated by the 'Haskind' and the 'Diffraction' methods is a useful quality check of the load RAO results. Conveniently, visual inspection and comparison of the load RAO results calculated under each method can be undertaken on the *graphs* page using the *calculation method* radio buttons.

The *preferred load RAO calculation method* is used to nominate the data set to be used when importing load RAOs into OrcaFlex. You can change this preference at the time of import if you use the OrcaFlex vessel type import wizard. Realistically, if the quality of the mesh is satisfactory, both data sets will be very similar. Note that the preferred choice also dictates the load RAO data used in the calculation of displacement RAOs.

The user is also able to nominate one or more quadratic load calculation methods. There are three quadratic load calculation methods i.e. 'pressure integration', 'control surface integration' and 'momentum conservation'. Each method is mathematically equivalent. If all methods are left unchecked, the quadratic load calculation will be neglected. In this example we are interested in calculating mean drift loads, which are an example of a quadratic load. Quadratic loads also represent part of the full QTF result.

In the example files, the option to use pressure integration is unavailable. This option will become available when using a *diffraction solve type* of 'potential and source formulations' or 'full QTF calculation'. We have chosen to tick both remaining options here. Comparing the loads calculated using each method can help verify whether the mesh quality is sufficient to return an accurate result for a given analysis. The momentum conservation method is only capable of calculating loads in surge, sway and yaw DOFs. We require mean drift loads in all 6 DOFs, so the control surface method dataset has been nominated for use when importing data into OrcaFlex. For more information on the effectiveness of the different quadratic load calculation methods, please see the technical note OrcaWave – working with meshes.

The final setting to mention on the *calculation & output* page is the choice of *linear solver method*. The direct solver is often faster for smaller meshes, but the iterative solver is often faster for larger meshes. A secondary factor that affects performance is the *number of wave headings* (specified on the *environment* page). The direct solver can solve for multiple headings without performing much extra work beyond what is needed for a single heading. However, for iterative solvers the total work is proportional to the number of headings.

It is possible that memory consumption, instead of calculation time, will be the limiting factor in the production of OrcaWave output. Diffraction calculations require the solution of matrices whose dimensions are directly related to the number of panels in the calculation mesh. As a result, a refined mesh can demand a large quantity of your computer memory during calculation. You should ensure that the OrcaWave thread count – which can be set from the *tools* menu – is low enough that the analysis will not demand more memory than is available. To help inform your choice, OrcaWave presents the estimated memory consumption *per thread* on the *validation* page.

Full details of all the calculation choices, and of the remaining data items on this page, can be found in the OrcaWave help (Data | Calculation and output).

Setting up the environment

On the *environment* page we define the water depth and the wave periods & headings that we want to include. The original default vessel data was calculated using 400m water depth, therefore we have opted to consider the same here.

For interest, we also ran the analysis with 100m water depth (the default OrcaFlex water depth). The influence this parameter has on the results is discussed later in this document, in the 'Comparison of results – 1st order' section.

The 24 wave periods and 9 wave headings listed on the *environment* page are the periods and headings that were considered in the original analysis.

Constraints

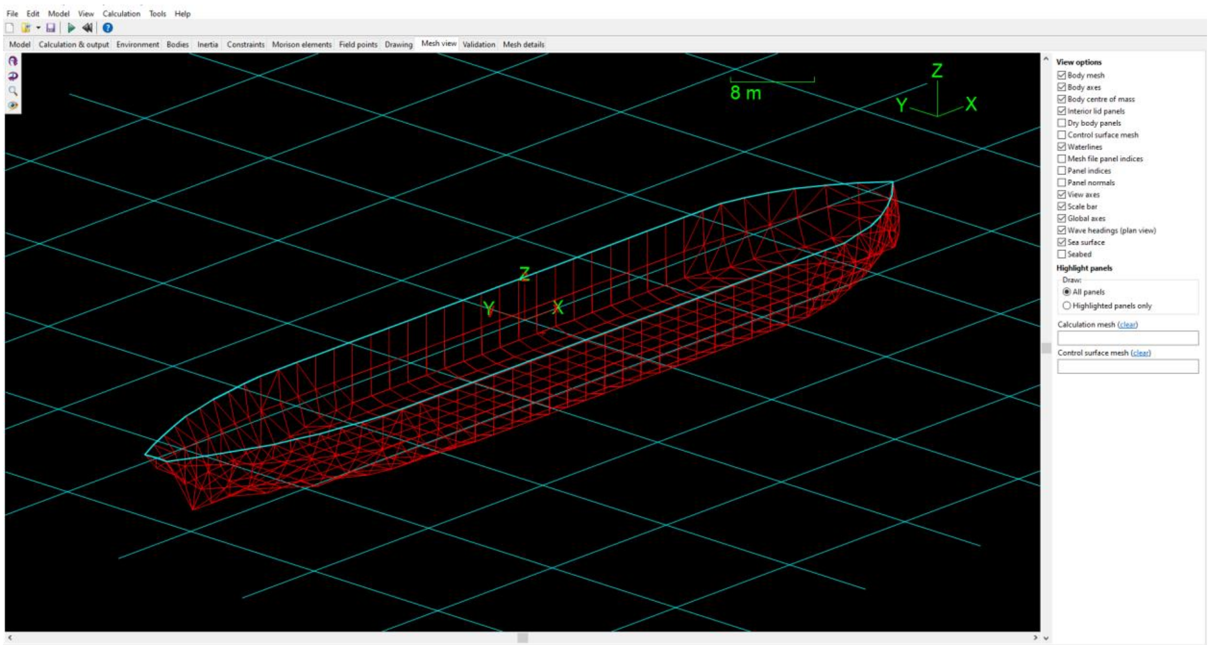
The *constraints* page provides the means to apply external stiffness and damping matrices. The *external stiffness matrix* could, for example, be used to represent the stiffness of a mooring system if you were generating displacement RAOs for the vessel in its moored condition.

The *external damping matrix* can be used to apply additional sources of damping to the body. In this case you will see that we have applied additional roll damping. This is discussed in the 'Comparison of results – 1st order' section.

Mesh validation

To demonstrate the mesh validation tools, we are going to first study the original mesh. To do this, reset the model (*F12*), and then on the *calculation & output* page untick the *divide non-planar panels* box. Also, on the *bodies* page untick the *add interior surface panels…* box.

Then click on the *mesh view* tab. You will see an OrcaFlex style view of the mesh or meshes. The view can be zoomed, panned and rotated in the same way as with an OrcaFlex view. In the list of *view options* down the right-hand side, make sure that the *body mesh* and *waterlines* boxes are ticked, but the *dry body panels* and *control surface mesh* are not ticked. You will now see the vessel's mesh with the waterline highlighted in blue:



Next, click on the *validation* page. OrcaWave performs a validation of the mesh or meshes, and in this case two warnings are reported.

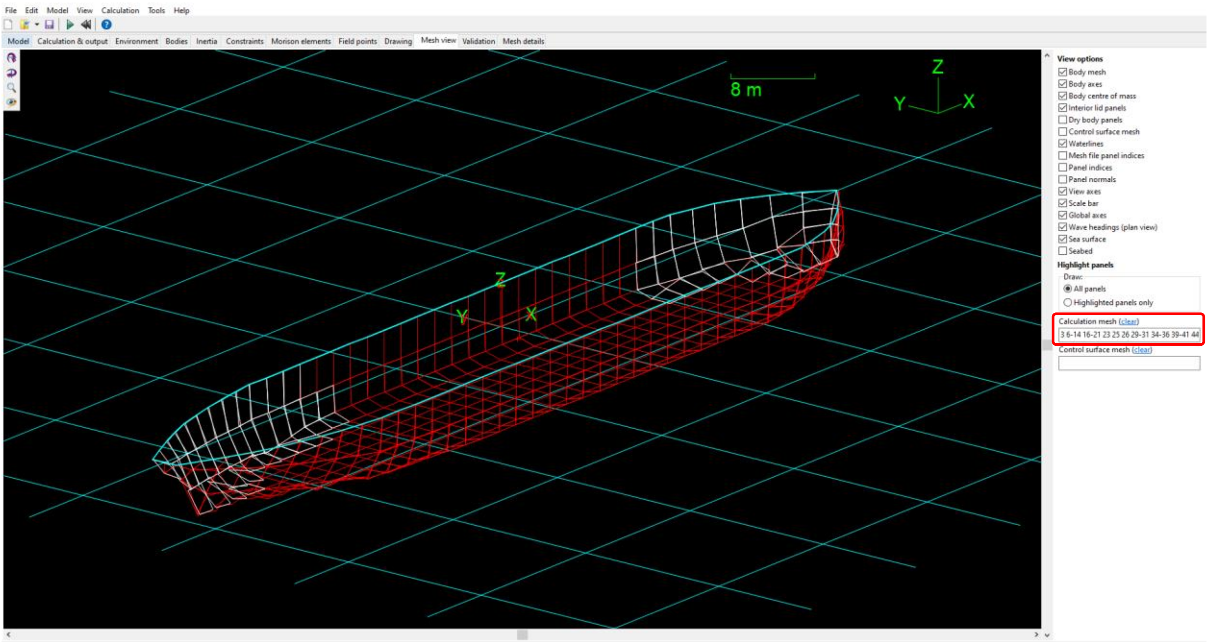
Specifically, these warnings refer to the following issues:

a) Several panels in the mesh are non-planar.
b) Irregular frequency effects are expected from the *Body1* mesh.

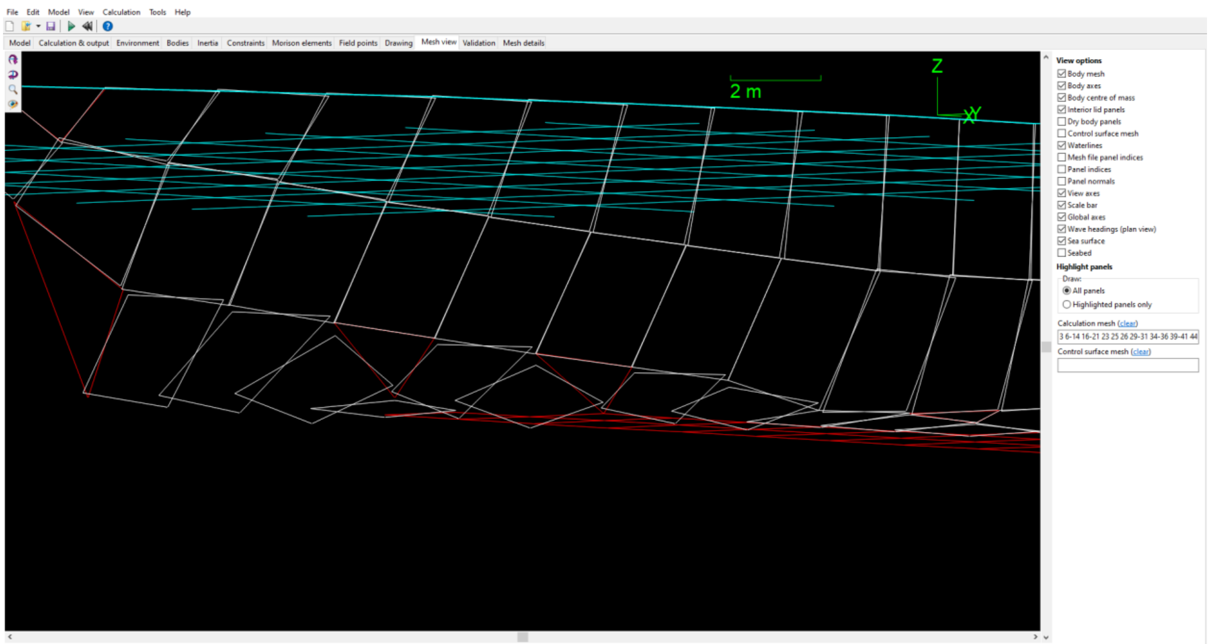
These are common warnings, so it is worth explaining each one.

Firstly, warning (a) relates to the condition that all body panels must be planar i.e. each panel must have all its vertices lying on a single plane. Triangular panels, with only 3 vertices, are naturally planar, however quadrilateral panels may not be. If the vertices that make up a panel in the mesh file are non-planar then OrcaWave will project them onto a common plane. In other words, OrcaWave will manipulate the coordinates of the panel vertices to force them to be planar.

Warning (a) is informing us that this has occurred, and a list of the affected panels is given on the *validation* page. To see which panels the numbers refer to, click the *show in mesh view* option. The affected panels are then highlighted:



If you zoom in on these panels, you will see that gaps and overlaps now exist as a consequence of forcing the mesh panels to be planar:



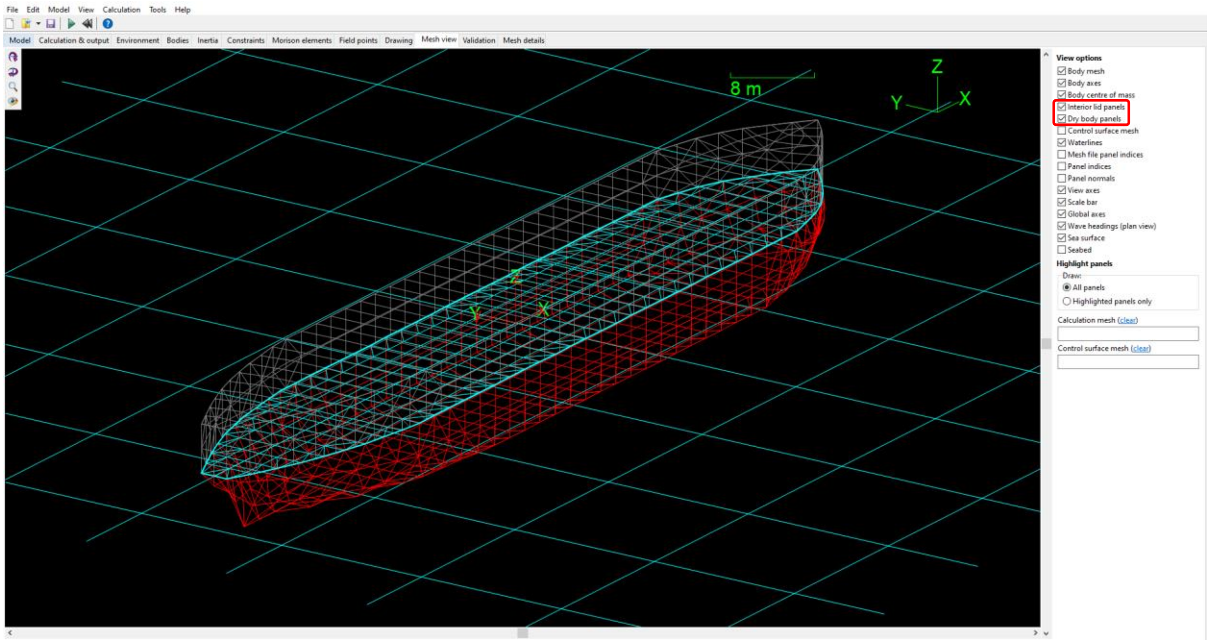
It is possible that movement of the vertices in this way will have a negligible effect on the results. However, these ill effects can be avoided by splitting each non-planar quadrilateral panel into two triangular panels. This obviously increases the number of panels in the mesh, and therefore the calculation time. So, it might be beneficial to run some sensitivity checks to assess the influence of non-planar panels compared to additional panels, focusing on both result accuracy and computation time.

In this example the run time is very quick, so we have triangulated the non-planar panels to create a modified mesh. This can either be done in the original meshing tool (e.g. Rhino) *or* you can rely on OrcaWave to do this for you by ticking the *divide non-planar panels* box on the *calculation & output* page. Tick this box and look at the mesh view again to see the effect on the panels (note you will have to click on *clear* in the *highlight panels* section to remove the previously highlighted panels).

Warning (b) tells us that there is a risk of irregular frequency effects occurring. Details of how these effects arise are given on the Theory | Irregular frequencies page of the OrcaWave help. The key thing to note here is that they can cause erroneous results if not accounted for correctly. The recommended method for removing irregular frequency effects in OrcaWave is to supply mesh panels that cover the interior free surface. These panels can be included in your mesh file, or you can ask OrcaWave to add these panels to your mesh automatically, by ticking the *add interior surface panels…* box on the *bodies* page.

Asking OrcaWave to mesh the free surface *might* lead to mesh quality issues e.g. panels with high aspect ratio if the body waterline has very short segments. So, adding the free surface mesh to your body mesh file gives you more control over the quality of this mesh. However, in this case, OrcaWave meshes the free surface well, using the 'triangulation method' available on the *bodies* page.

Tick the relevant box (*add interior surface panels…*) and then go back to the *mesh view* page. Check that the *interior lid panels* box is ticked in the list of *view options*, and you should see the interior surface panels drawn in blue. On the *validation* page OrcaWave now reports no warnings.



If the *dry body panels* box is also ticked on the *mesh view* page, you will see that we have included some panels above the water line. These have been added for visualisation purposes only; when imported into OrcaFlex the mesh file can be used to add graphics to the vessel, so showing the extents of the hull above the surface is useful. Note that the panels above the free surface will not be used in the OrcaWave calculation i.e. OrcaWave automatically detects that they are above the free surface, so inclusion of these panels in the mesh file will not affect analysis run time.

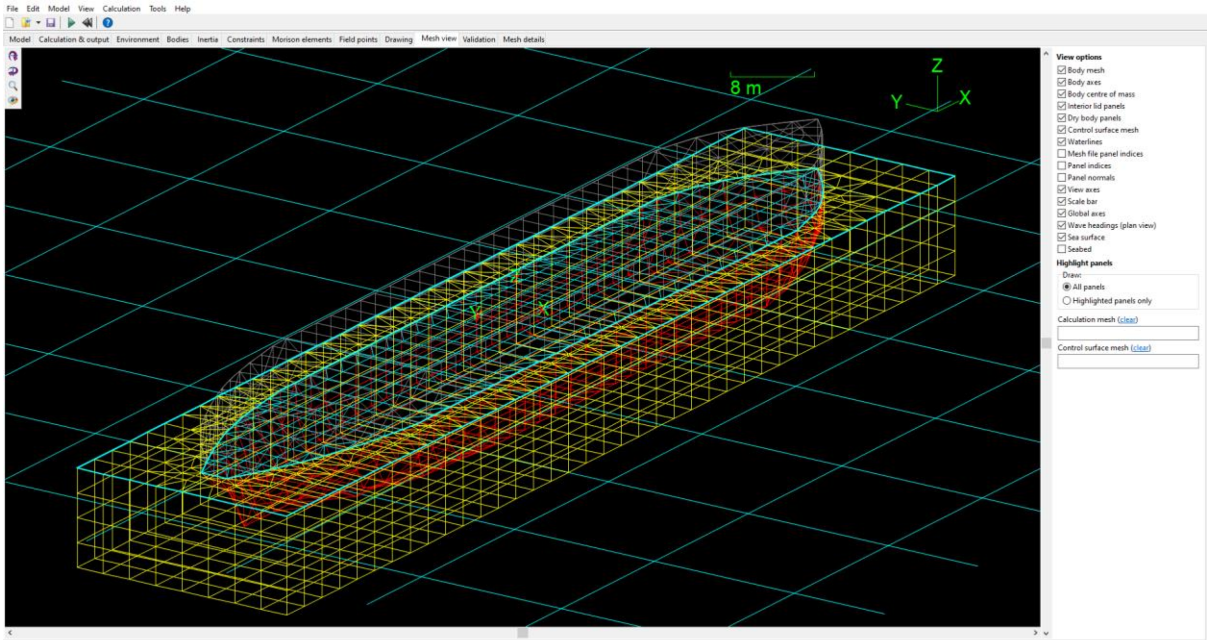
The changes made to remove non-planar panels and irregular frequency effects have increased the mesh from 216 to 940 panels. However, the run time is in the order of ~1 minute so the penalty for having this improved mesh is not too onerous.

Note that a more detailed mesh validation check is possible, by ticking the *perform validation of panel arrangement* box on the *calculation & output* page. This performs some further checks (e.g. overlaps and gaps between panels) but the checks can take longer to perform. This option is often used when first importing a mesh and turned off for later work once the mesh quality is satisfactory.

Control surface mesh

Finally, we need to specify a control surface mesh. This is needed because we have opted to calculate the quadratic load using the *control surface integration* method as well as the *momentum conservation* method. The latter does not need an additional mesh, but here we are going to compare results from the two methods. The control surface mesh has again been created in Rhino. This mesh needs to surround the body, have the same symmetry as the body mesh, and (for a partially submerged body) can include the free surface between the control surface and the body waterline. Failure to mesh the free surface will limit the calculation of mean drift loads to surge, sway and yaw.

The control surface mesh has already been added to this model, so on the *mesh view* page, ticking the *control surface mesh* box will show the control surface in yellow:



You can examine this mesh by ticking / unticking the relevant boxes and manipulating the view.

Note that one further check, which is always worth making, is to check the direction of the *panel normals*. Ticking this box in the *view options* list displays the direction of the *interior* surface of each panel. Generally, the panel normals should point *into* the hull so if any panel normals are pointing in the wrong direction, then you must return to the meshing tool to correct this.

Summary

This concludes the set up for our OrcaWave analysis. To summarise, we have specified:

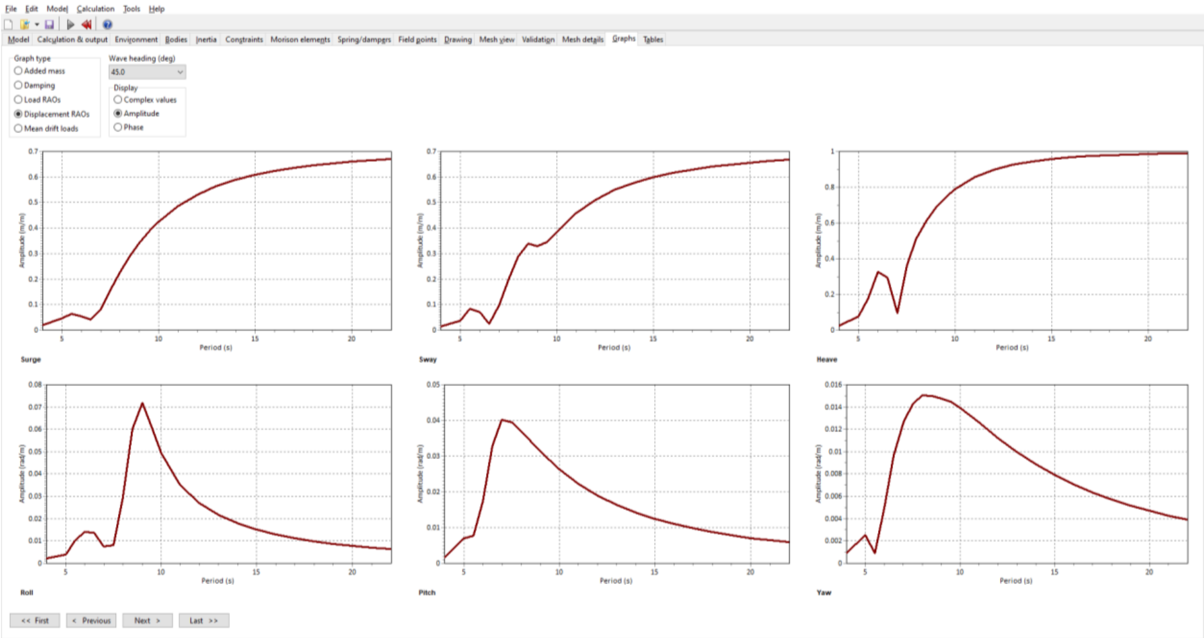
- the diffraction calculation methods,
- the applied environment values of water depth, wave heading and wave period,
- the analysed body via its inertia and mesh description, and
- additional interior surface and control surface meshes.

We have also reviewed the OrcaWave validation of these inputs and, now that we are happy with the mesh quality, we can calculate & view the OrcaWave results.

Viewing the results

Re-open the *L01 Default vessel.owr* file, which contains the results of the OrcaWave analysis. The results are presented across two pages: *graphs* and *tables*.

The graphs should be recognisable to anyone familiar with the OrcaFlex *check RAOs* plots produced from the *vessel type* data form in OrcaFlex. The tables provide the full set of results, spread across several pages, in tabular form. These results can be exported in spreadsheet format, however as we will be using them in OrcaFlex, there is no need to do this because OrcaFlex recognises the *.owr* file.



OrcaFlex dynamic analysis

Import to OrcaFlex

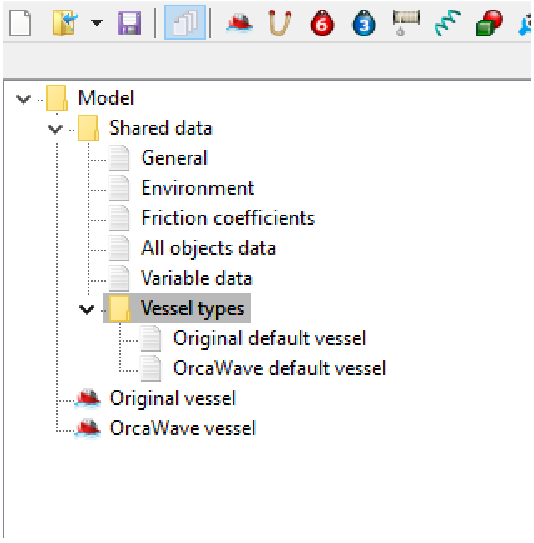
There are two ways to import the vessel diffraction data to OrcaFlex. If you are starting a brand-new model, you can simply open the OrcaWave *.owr* file in OrcaFlex, either by dragging and dropping it into an OrcaFlex window, or via the *file | open* menu command. This method will create a new model with a vessel object and vessel type data populated with the OrcaWave diffraction results.

The water depth used in the OrcaWave analysis will be applied in the OrcaFlex model provided it is not set to infinity. There are a number of other parameters that are also conveniently set when using this method. Please see the [Modelling, data and results | Vessels | Importing hydrodynamic data | OrcaWave]() page of the OrcaFlex help for further details.

The second method of importing vessel data is via the *import...* button on the *vessel type* data form. This is the option you would use to import hydrodynamic data generated by any other diffraction tool. We will demonstrate this method here.

Switching to OrcaFlex now, open the model *L01 Default vessel.sim* included with this example. In this model we are comparing the original OrcaFlex default vessel with the 'new' vessel data generated by OrcaWave. We have therefore added two vessels to the model.

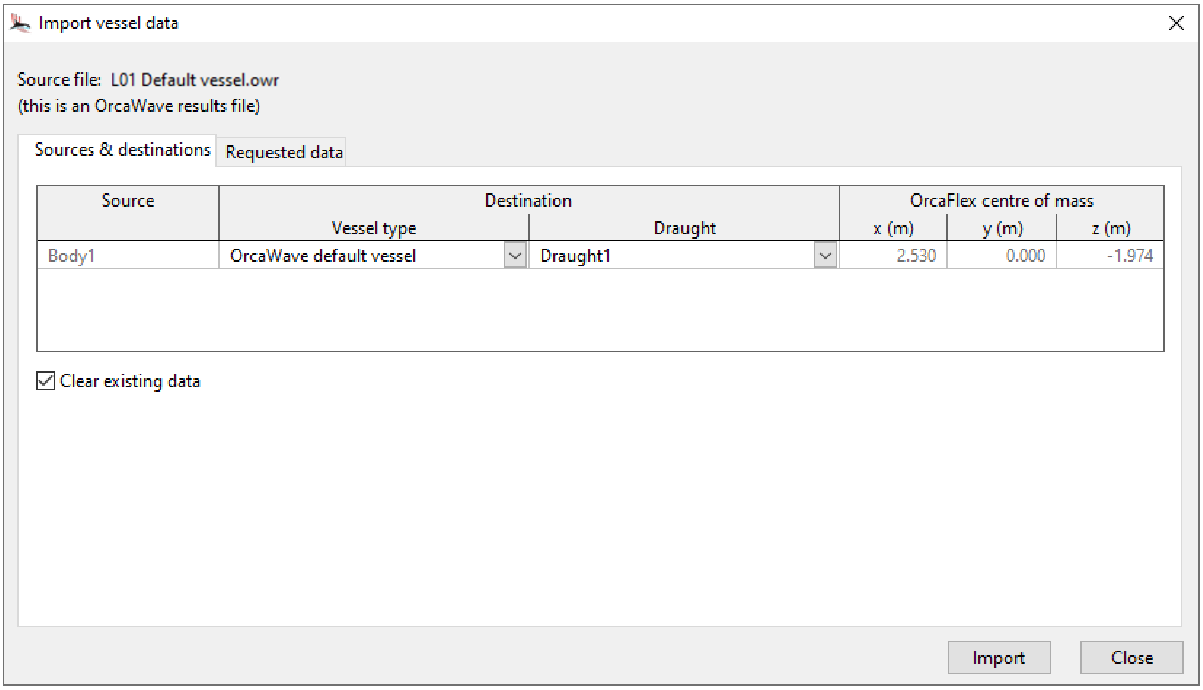
The *Original vessel*, which is currently hidden (press *Ctrl+H* on the object in the *model browser* to show it) is drawn with a green pen, and the *OrcaWave vessel*, is drawn with a red pen. Note that the OrcaWave vessel makes use of the panel mesh file that was used in the OrcaWave analysis. Hence, we have a much better representation of the vessel's geometry.



To see the import process, first reset the model (press *F12*). Then open the *OrcaWave default vessel* data form from the model browser. This is in the list of *vessel types*.

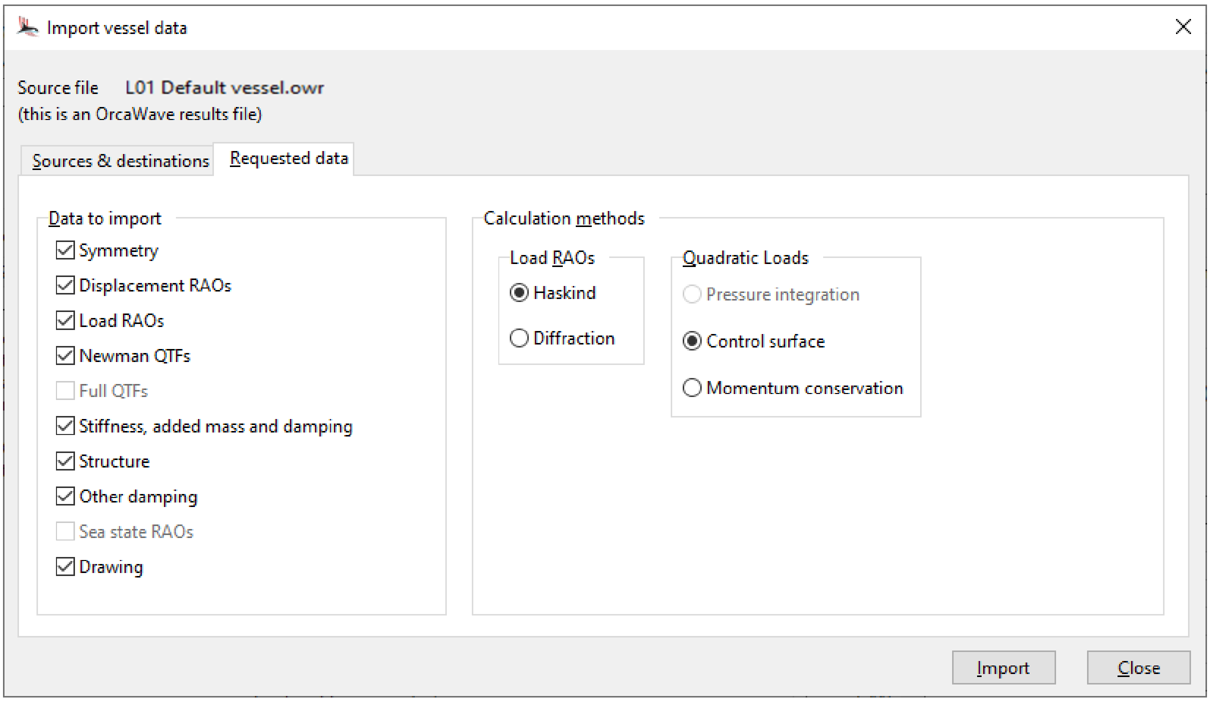
The *vessel type* data form contains the data that has been imported from OrcaWave already, however you can repeat the process by clicking the *Import...* button at the bottom of the data form and selecting the OrcaWave results file *L01 Default vessel.owr*.

The *import vessel data* form then appears. Note that the *centre of mass* is reported here. OrcaFlex uses this information to deduce how the origins used by the diffraction tool relate to the origins used by OrcaFlex. Therefore, it is important that the *centre of mass* is set *before* the diffraction data is imported. This data is set on the *vessel type* data form, on the *structure* page. In this case, it has already been correctly set. The *clear existing data* check box allows you to delete all existing data from the chosen vessel type before importing the new data. Ticking this box ensures that you don't accidentally use any default vessel data in your analysis.



The *requested data* page gives you control over which data sets contained in the diffraction output file are imported into OrcaFlex. In this case we are choosing to import everything that is available (we did not calculate full QTFs or sea state RAOs, meaning these are greyed out). The calculation methods for *load RAOs* and *quadratic loads* are as per the 'preferred' settings we selected in the OrcaWave analysis, but these could be changed here if necessary.

To import the data, press the *import* button and check any warning messages that appear (in this case there are none).

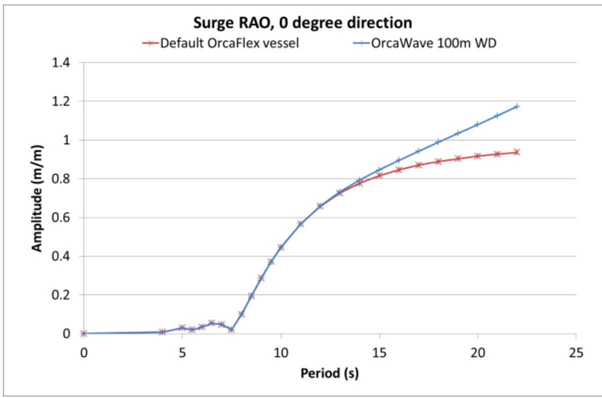


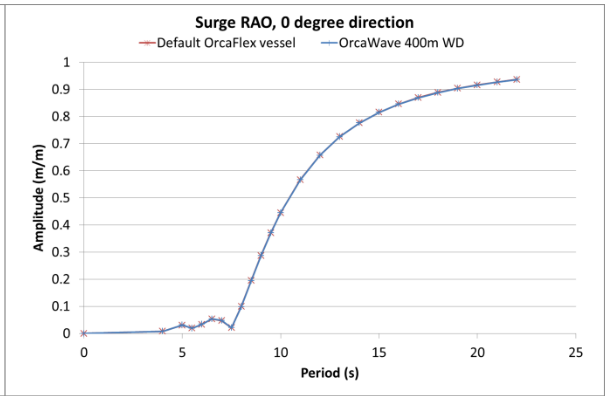
Comparison of results – 1st order

We ran several OrcaWave cases to check the influence of the various parameter settings.

To compare the 1st order results from OrcaWave with the data in the default OrcaFlex vessel we used the *report vessel response* option (see the Modelling, data and results | Vessels | Vessel response reports page of the OrcaFlex help for details). This allows us to report the displacement RAOs for specified points on the vessel, and for different wave directions. By checking these results, we will be comparing both the displacement RAO calculation and, because the displacement RAOs are derived from the load RAOs, hydrostatic properties, added mass and damping, it will check the other diffraction results too.

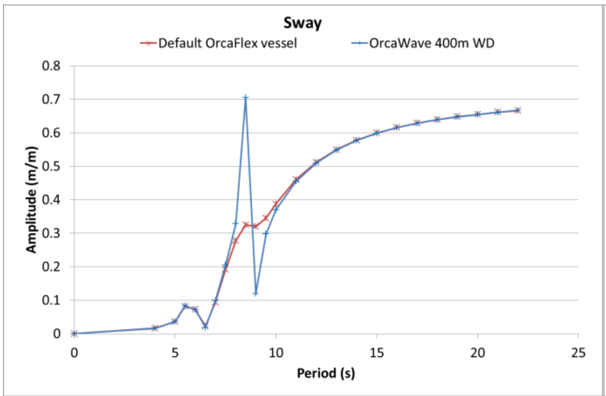
Firstly, we checked the influence of the water depth in the diffraction calculation. OrcaFlex has a default water depth of 100m, so we looked at the diffraction results with a water depth of 100m in OrcaWave, versus setting it to 400m. Below we have plotted the surge RAOs, for a 0-degree direction, at the vessel origin (for brevity we have chosen to only show the plots that display results of interest).

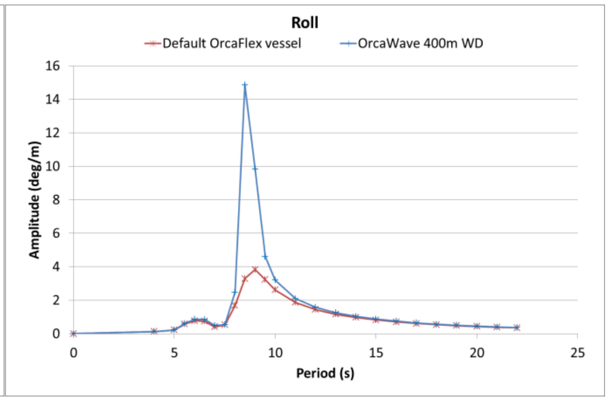




It is clear from the above left-hand plot that setting the water depth in OrcaWave to 100m has a significant influence on the surge results, at longer wave periods, when compared to the original default vessel data. Setting the water depth to 400m in the OrcaWave calculation produces excellent agreement, as shown in the right-hand plot. This demonstrates the importance of using the appropriate water depth in the diffraction calculation, particularly if you are considering a relatively shallow water application.

Next, we compare the plots for sway and roll, for the 45-degree direction, at the vessel origin. In the first two plots the OrcaWave calculation included no external damping so that we can show what a body motion resonance often looks like:



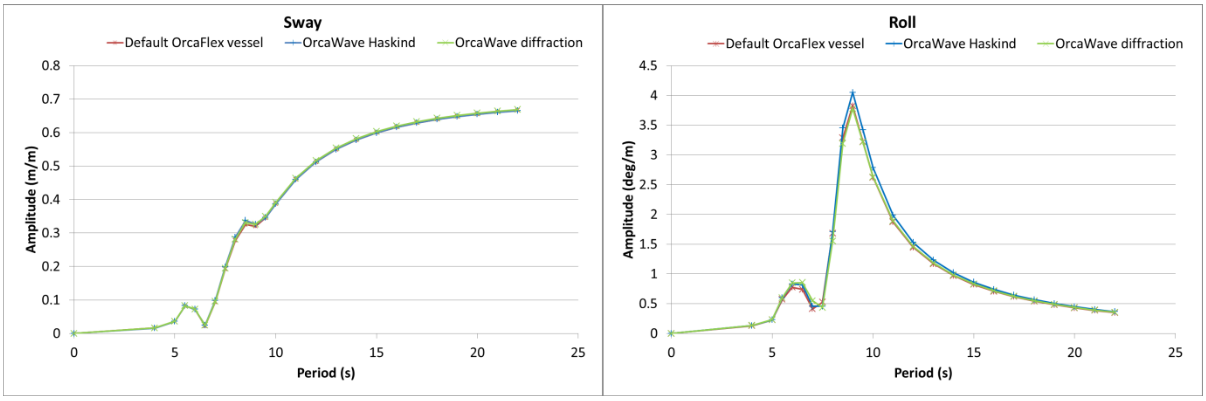


Here, we clearly have significant disagreement between the OrcaWave data and the existing default vessel data, at a period of around 8.5s. Upon closer examination of the data, the amplitude graphs have smooth variation in the added mass & damping, and in the load RAOs, through the 8.5s region. The spikes only occur in the displacement RAOs. This is classic behaviour for a body motion resonance, in this case a roll resonance. Potential theory typically overestimates this motion because it does not consider viscous damping. It is common practice to apply an external damping matrix to the body in the diffraction analysis to account for this.

In this case, we can see that the original vessel data accounts for some linear roll damping (applied as *other damping*), so the OrcaWave analysis was repeated with an *external damping matrix* applied. You can see this on the *constraints* page of the OrcaWave file (the same value appears in OrcaFlex on the *other damping* page of the *vessel type* data form). Note that OrcaWave is also able to calculate the roll damping as a percentage of critical, if the critical damping coefficient is known. Further details about this option can be found on the Constraints page of the OrcaWave help.

So far, all the OrcaWave results shown here have been calculated using the default *load RAO calculation method* i.e. the *Haskind* method. In the plots below we also include the results from the *Diffraction* method.

Applying the external damping has clearly had the desired effect, and both sets of OrcaWave displacement RAOs show good agreement with the original results, although it is noted that the *Diffraction* method appears to give slightly better agreement than the *Haskind* method, probably suggesting that *Diffraction* was the method that was used in the original analysis.



The above graphs show the amplitude of the generated RAOs, but we also need to check the phase. This can be achieved by plotting the data; however, you could instead run an OrcaFlex simulation in a regular wave so that you can visually compare the response.

If you have reset the OrcaFlex model, please re-open the simulation (*L01 Default vessel.sim*) and make sure the *Original vessel* is shown in the model view. Next, open the workspace file *L01 Default vessel phase check.wrk*. Run the replay to see how the two vessels respond to the default wave loading: *H* = 7m, *T* = 8s, with a Dean stream *wave type*. When viewing the simulation replay, you should be able to see that the pitching motion of the two vessels is slightly out of phase.

We investigated this issue by also running a diffraction analysis in WAMIT, which showed that the WAMIT results agreed with the OrcaWave results. It is possible that either the RAO origin or the RAO phase origin used by OrcaFlex for the original vessel data is not specified correctly. In any case, we are satisfied that the results generated by OrcaWave are correct.

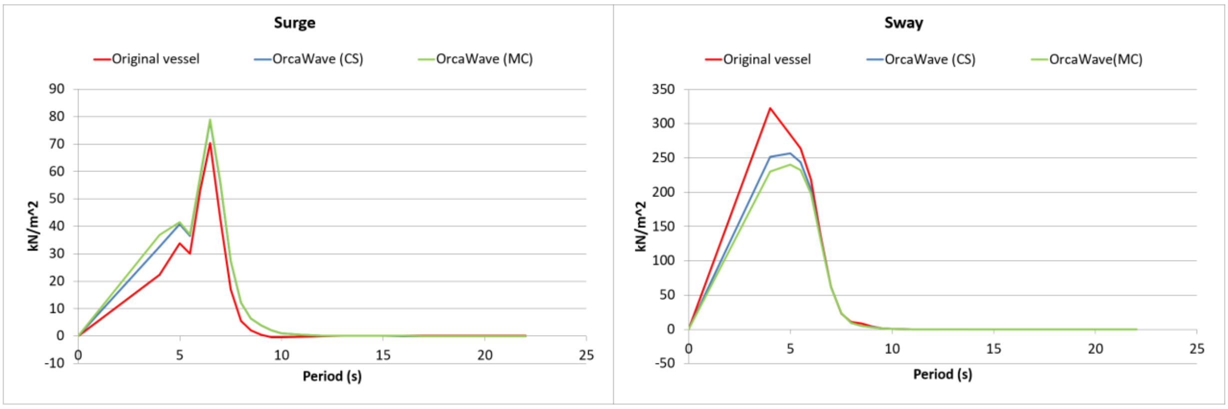
This comparison demonstrates agreement between results calculated in different diffraction packages. Whilst this is reassuring, it does not necessarily mean the results are correct. Furthermore, diffraction analysis is often undertaken in isolation where data for cross comparison is often not available. An effective way to prove the results of a diffraction analysis are appropriate, is to run a mesh sensitivity check. Typically, this will involve comparison of a number of key results under different wave conditions whilst systematically refining the body mesh. As the mesh panel size is reduced, the mesh becomes a better representation of the true hull form. Furthermore, when using a large number of small panels, OrcaWave is more effective at evaluating the loads induced by short waves, since wave loads are evaluated more regularly across the body. At some point, each OrcaWave result will converge to a consistent value. At this point the quality of the result will not improve, even with further mesh refinement. The subject of mesh convergence is covered in OrcaWave – working with meshes.

Comparison of results – 2nd order

We also generated wave drift loads in the form of Newman QTFs in the OrcaWave analysis. This was done using both the *control surface* and *momentum conservation* methods for comparison. The *control surface* method requires an additional mesh, the *momentum conservation* method is only capable of calculating loads in the 3 horizontal DOFs.

We also compared the results with the original vessel mean drift loads; however, it is noted that the data are reported about different origins (the original vessel wave drift QTF origin is located at the vessel type centre of mass, the OrcaWave results are reported about the vessel origin). Force QTF data can therefore be directly compared, but moments cannot. It is worth noting that the OrcaWave results can be reported relative to an origin of your choice, but this can only be achieved via the API; hence, allowing direct comparison of the different sets of results. This is beyond the scope of this example but further details about this can be found in the API help.

The plots below show the surge and sway results for the 45-degree wave direction, comparing the two OrcaWave methods with the original vessel results:

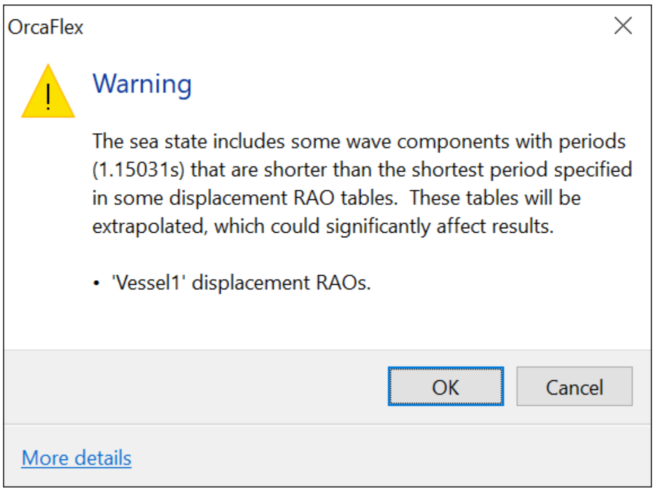


It is known that quadratic loads are often the slow to converge when performing a mesh convergence study and, in this case, it is likely that the mesh should be refined further to get better agreement between the methods. In this case we are restricted to using the original mesh which, while appropriate for RAO generation, is possibly too coarse for the quadratic load calculation. A detailed discussion on the effects of mesh refinement is offered in OrcaWave – working with meshes.

Setting the remaining data

Diffraction analysis is concerned with the calculation of wave induced loads. The default vessel type also has properties used to model wind and current loading. They have not been included here. For information on the wind and current loading model for vessels, see the OrcaFlex help.

OrcaFlex also requires the RAO and QTF data to span the range of frequencies involved in the simulation. The data imported from OrcaWave includes wave periods between 4 and 22 seconds. If the wave train modelled in OrcaFlex includes components outside of this range then OrcaFlex will make some assumptions about how the RAO and QTF data is applied to these components and will issue a warning, e.g.:



To avoid this warning, you can define data for periods of zero and infinity in your RAO and QTF tables, following guidance offered on the [Modelling, data and results | Vessels | Vessel types | RAOs]() page of the OrcaFlex help. We have taken this approach for this example model.

Finally, both the wire frame and the shaded image in OrcaFlex can also utilise the panel mesh. The mesh can be imported as panels at the same time as the diffraction data is imported. This panel data can be found on the *drawing* page of the *vessel type* data form. Switching to the shaded graphics mode (*Ctrl+G*) shows the hull form in the shaded view.