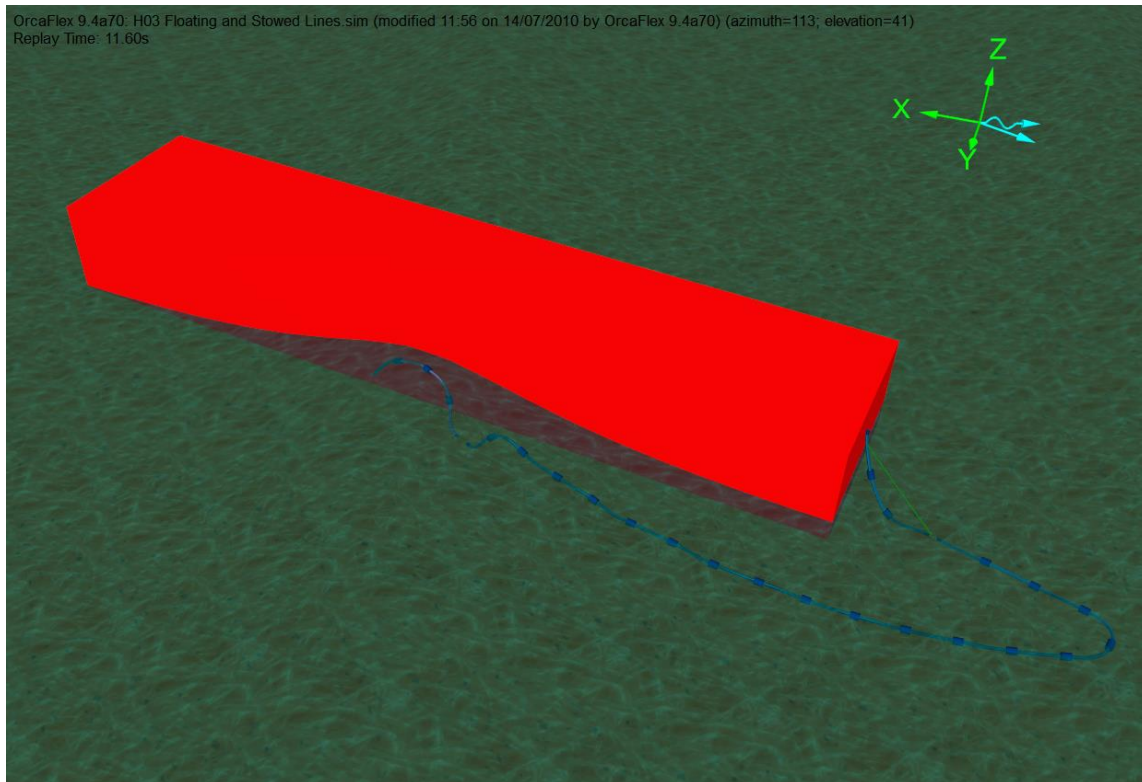


H03 Floating and stowed lines



Introduction

A floating hose, attached to the stern of an FSU (Floating Storage Unit), is stowed by curling it around and attaching the free end to the vessel side. Interaction with the vessel sides needs to be considered. The hose end is released, and during the analysis, the protective chain at the stern of the FSU breaks.

Building the model

The vessel hull is modelled as an elastic solid shape (called *Hull*) which is connected to the vessel itself (*FSU*) and provides boundary surfaces so that clashing between the hull and the hose can be considered. Note that the complex loads due to turbulence and water trapped between the vessel side and the approaching hose are not considered, and there is no shielding from the vessel hull included in the model (although this could be included using *sea state RAOs* if required – see OrcaFlex help for further details). The hull is modelled as a simple rectangular block attached to the vessel.

One end of the hose is attached to the stern of the vessel and the other to the port side, near the bow. It is modelled as a single line with the chain clamp and the Mid-line Connector (MBC) set up as line properties.

The individual hoses making up the hose string are modelled using line sections to represent the different parts. These are steel flanges with and without floats, clamps and composite hose lengths. The segmentation is fine enough to capture curvature in the main hose but could be

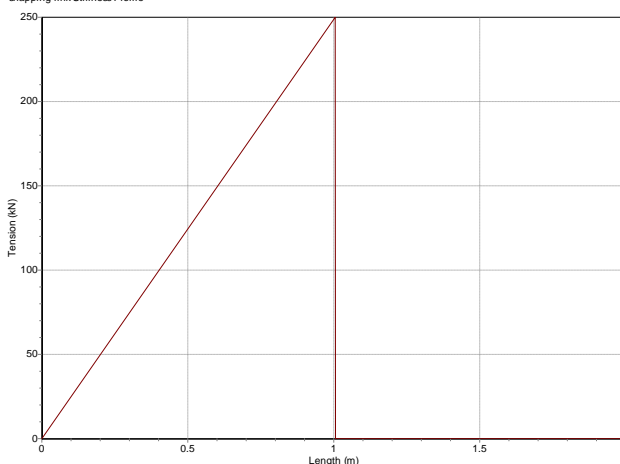
further refined local to the hose end connections if required. See [example H01](#) for how to model profiled reinforced hose.

As an alternative, the chain clamp and MBC could be modelled as 6D spar buoys and the hose length split into three sections to insert them. However this does mean modifications to prevent the buoys spinning on their local z axes, i.e. including torsion on the hose line. Using line properties to model these items avoids this issue.

The hose uses the *spline* option as the *step 1* statics method. This option is set on the *Hose* line data form. This setting allows us to start statics with the hose in an initial position that is away from the vessel hull. We also use *Mag.of Std. Error / Change* as the convergence control method, as this gives us control over the distance (using the *Mag. Of Std. Change* data item) that the line moves away from the spline during its search for a solution. This setting is on the *full statics convergence* page of the line data form.

The end of the hose initially attached to the side of the vessel is released at the start of stage 1 and drops into the water. As the hose swings away from the vessel under the influence of the waves and current, the load on the retaining chain at the stern increases. We model the chain breaking using a nonlinear link between the chain and the clamp. The link has the same stiffness as the chain. Because it is short the effect of it having no mass or displacement is negligible.

OrcaFlex 9.8c: H03 Floating and Stowed Lines.dat (modified 14:41 on 23/04/2015 by OrcaFlex 9.8c)
snapping link Stiffness Profile



The link has a linear increase in tension from 0kN at 0m to the required breaking tension of 250kN at 1m. Beyond 1m the tension drops to zero and so the link cannot resist further extension.

This means there is no “slack” state before the link breaks – this is not expected to make a significant difference to the results. The rest of the chain will go slack instead.

During the static search it is possible for the link to extend beyond the “break” point. To prevent this a parallel link “temp parallel” is added. This link takes the load during statics and then releases at stage

0.

During the simulation there are discrete events occurring through the run such as dropped hose ends, breaking lines, hose impacting the hull and the free ends lashing around. With an implicit time step integration scheme you need to make sure the time step is sufficiently small to follow these discrete responses accurately. You need to avoid it running with a high number of iterations per step as it struggles to follow the response, or with a step too large to capture higher frequency responses.

To be sure of obtaining accurate results for such an analysis it is simpler to use the explicit time step integration scheme, as shown in this example.

More information on the two-time step integration schemes can be found in the OrcaFlex help topic [Modelling, data and results | General data | Dynamics](#).

Results

The range graph of solid contact force (top graph) shows that the hose contacts the hull of the vessel. Looking at the time history of contact force at a point in the region where contact occurs (bottom graph) shows more detail of the contact loads.

Load workspace *H03 Floating and stowed lines - tension.wrk* from the workspace dropdown menu. Look at the time history of tension in the chain (top right) and the hose (bottom right) at the end connected to the stern of the vessel. The chain protects the hose by taking peaks of tension but the chain itself suffers snatch loading. After around 7.5 s the chain has broken and the hose takes the entire load itself.

Other results of interest include the hose curvature; which is quite high because it is moving on the surface of the waves. The precise behaviour of the hose curvature will vary dependent on the local conditions at the time of the release. This analysis will therefore yield results to characterise the release behaviour, but they should not be assumed to represent the maximum loads possible on the hose or the chain.