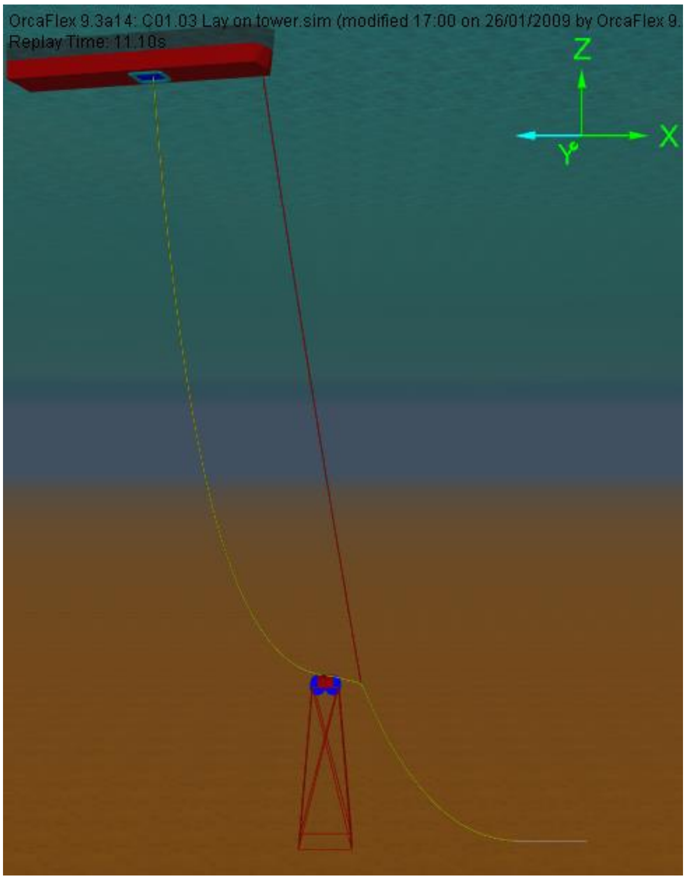
D03 Lay on tower

Introduction



This is an example of installing a riser over a subsea tower in 300m water. The riser is being paid out from the moonpool of the installation vessel, and is supported from an auxiliary winch at the bow of the ship. There is a clamp about 14m above the attachment point of the winch, which has to be placed in the centre of the support tower.

This example shows:

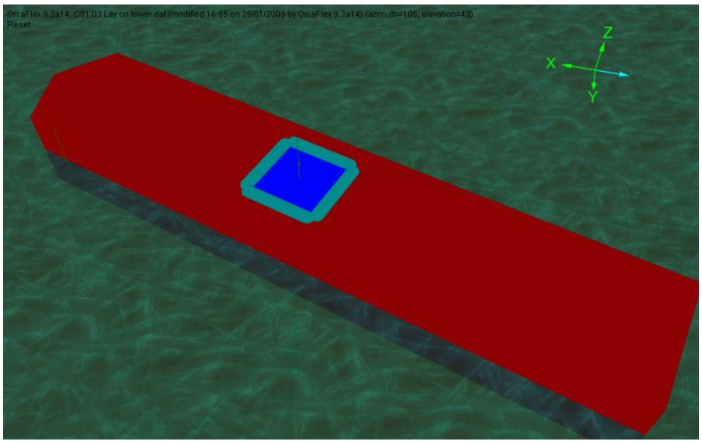
- Guiding a line into position using shapes.
- Friction between lines and shapes.
- Clearance checks with moonpool edges.
- Getting physical and hydrodynamic properties for a winch wire
- Shielding the length inside the moonpool from direct wave and current loading.

The installation will take place very slowly and only in calm weather, so a series of static snapshots would be sufficient. However it is simple and convenient to run the analysis dynamically and the replay gives a valuable view of the operation.

You need to view the model browser in the *view by groups* mode.

Building the model

Look at the *Vessel Structure* group.



The vessel has a shape attached representing the inside of the moonpool, *Moonpool Shielding*. It is blue in the view here.

The shape type is *trapped water* so any nodes within the shape will have the wave and current load algorithms turned off. This represents shielding from direct wave and current loading.

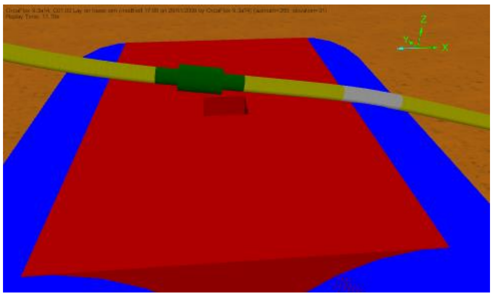
When the nodes leave the confines of the shape these forces are turned back on again.

Note this is not the same as setting drag and added mass to zero. The line will be moving in the moonpool water and so relative flow will not be zero. This means drag and added mass on the line will not be zero.

The boundaries of the moonpool edge are marked by single segment lines in *Moonpool Top* and *Moonpool Bottom*. These lines have negligible physical and hydrodynamic properties but have a contact radius of 1m (contact diameter 2m). Each is positioned with centreline 1m from the moonpool edge so the line outer edge is at the boundary. Clearance information can then be obtained between the flowline and the moonpool. The boundaries are pale blue in the view above.

Note that line clashing does not need to be turned on to get clearance results. The clashing algorithm significantly slows the run so should only be turned on for re-runs of selected cases where clearance was zero or negative (which indicates that one line is inside the other). For most analyses, contact is undesirable and so clearance results are sufficient to indicate if system change is required. Clash checking is used if information about the energy involved in the contact is required, of if behaviour post-contact needs to be assessed.

Now look at the *Winches and Flowline* group.



The flowline is split into two lines connected either side of the clamp, see *Flowline*. They have encastré connections to the clamp (infinite connection stiffness).

More refinement of segment length is applied in the region of the tower so the lines can better follow the curve of the arch.

The clamp is modelled as a 6D spar buoy, *clamp buoy*, with small diameters at the ends and a larger one in the middle. Rotation about the local x and y axis are restrained by the flowline connections and reaction from the arch.

The buoy is prevented from spinning about its local z-axis by the fact that torsion is included on the flowlines. In this case, modelling torsion is necessary because we are connecting the auxiliary winch wire to the flowline at a point that is offset from the line's axis. However if we didn't include torsion on the flowlines then there would be nothing to prevent the clamp buoy from spinning, which could prevent the static calculation from converging. In this situation, offsetting the centre of mass of the buoy slightly will help to prevent the buoy from rotating, by providing a unique static solution.

The buoy contact area is 3.6m^2. Contact occurs between buoy vertices and shape surfaces. You need to change the buoy drawing settings to *draw square cylinders* and the view to wireframe if you want to see them. There are 24 vertices in total so each represents an area of 3.6/24 = 0.15m^2.

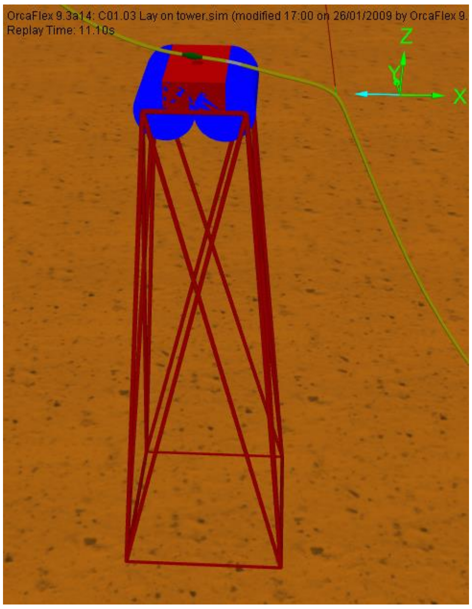
When the clamp is being slid into place, only four vertices will be in contact, those for the larger diameter. This means a contact area of 0.6m^2. When dropped in place there will be eight vertices in contact (for the smaller diameter cylinders) so 1.2m^2. The exact values are not critical in this application but it shows the principle.

Both flowline lengths and the clamp buoy interact with the arch shapes. This reaction includes friction. Take a look at the *friction coefficients* page in the model browser for settings.

The installation operation here is performed using two winches, a main and an auxiliary.

The main winch represents the main riser handling winch in the moonpool of the lay vessel; It is attached to the flowline end A (the top end) and paid out to lower the flowline slightly. Because the winch wire is short and remains in air, the stiffness and length of the winch object are sufficient properties to model its response.

The auxiliary winch is at the stern of the vessel and its purpose is to lift the riser into position. It is much longer than the main winch, with most of the length submerged. See the structure in the *Clamp Control Winch* group.



The mass, displacement and hydrodynamic loading on this wire could be significant for the overall system behaviour. Therefore most of the winch wire length has been modelled as a line, *Aux Winch Wire*. The winch object itself, *Aux Winch*, has only sufficient length to allow pay in without ending up with zero length.

The *Aux Winch Wire* is attached directly to the *Lower Flowline*.

The tower arrangement is shown in the *Tower Structure* group. It uses a dummy vessel, *Tower*, as a common axis system and all calculations are set as *None*. The vessel also provides the graphics for the tower legs. The arch and hole for the clamp are produced by elastic solid type shapes with contact stiffness so they generate a reaction force.

The winches are active in different stages to enable the required order. The stages are as listed below and finish with an 8sec settle:

Stage	Main Winch		Auxilliary Winch	
	Payout	Rate	Payout	Rate
-8s to 0s	0m	~	-5m	-0.625m/s
0s to 16s	5m	0.3125m/s	0m	~
16s to 32s	5m	0.3125m/s	0m	~
32s to 48s	0m	~	-4m	-0.25m/s
48s to 64s	0m	~	0m	~

Stage 0, the wave build-up stage, can be used as a normal stage here as no waves are applied.

Results

Open the workspace *D03 Curvature and contact.wrk*. Watch the animation for the whole simulation. Note how the clamp drops into its slot.

The right hand plots show curvature about the local y axis (curving in the vertical plane) for the upper and lower flowline lengths. The left hand graph shows clearance of the upper flowline from the moonpool edges.

Run the replay and note how the curvature changes close to the arch. Also note how the minimum clearance (clear water) varies along the arc length as the line is paid out and moved.