Discretisation of Spar Buoys in OrcaFlex

We are often asked why there is a need to introduce the apparent complexity of having multiple cylinders stacked on top of each other when working with 6D Spar Buoys in OrcaFlex. This can be particularly difficult to understand when the diameters of those cylinders are the same.

The reason we recommend discretising spar buoys is to improve the modelling of buoyancy, as will be explained in this document.

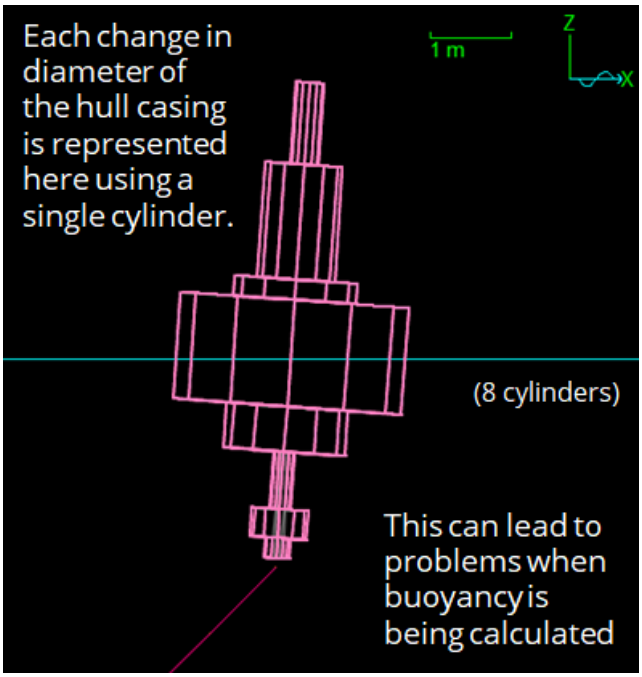

Figure 1: Each diameter modelled with a single cylinder

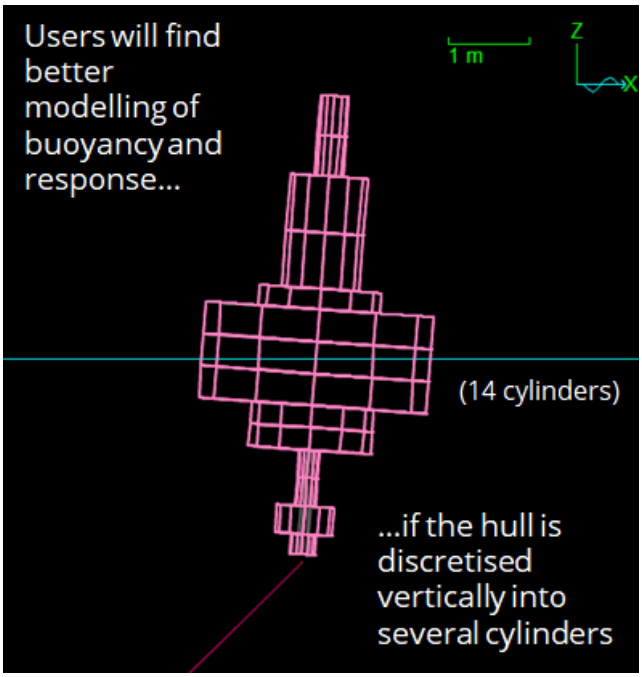

Figure 2: Each diameter discretised into multiple cylinders

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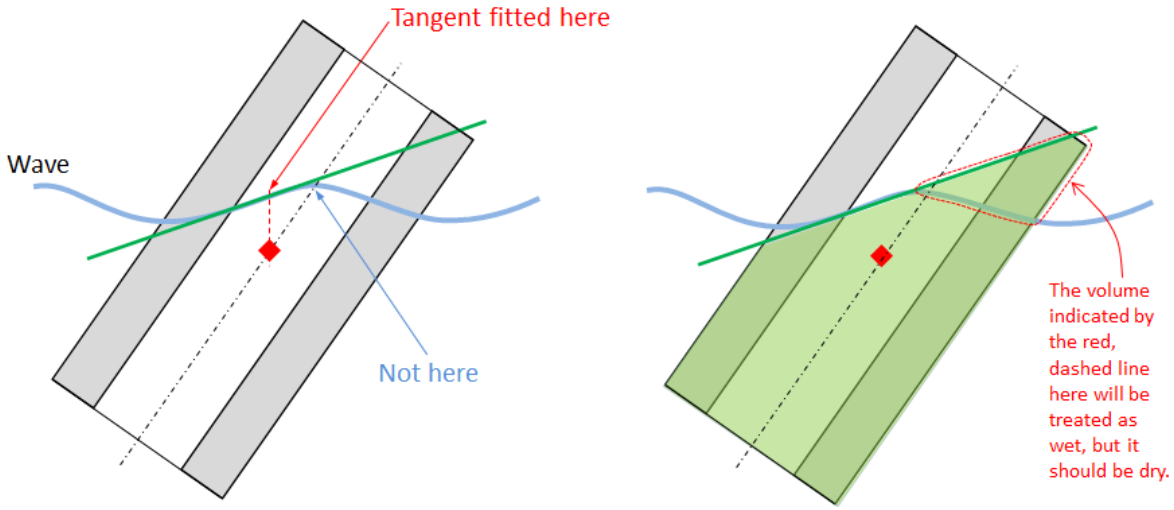
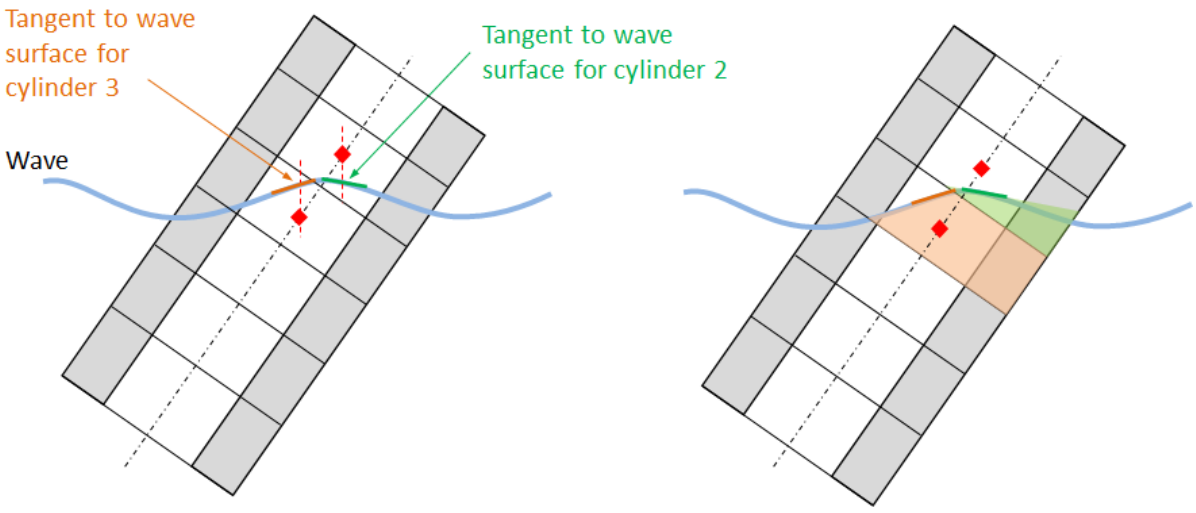
Taking the simplest case of a buoy with a constant diameter, if it is inclined and the OrcaFlex model uses only one cylinder, the OrcaFlex solver looks for the wave slope above/below the centroid of the cylinder. It then fits a tangent to the wave surface, directly above/below the centroid (marked as follows in the image below: ♦).



As a result, all of the green-shaded region (in the right-hand image) will be treated as wet. Clearly, that includes some volume of the buoy which is actually dry. Hence the calculation of buoyancy and where it acts would not be accurate in this case.

If the buoy was made from a stack of cylinders, keeping the same overall height (note that the OrcaFlex convention is that cylinder no. 1 is at the top of the stack), for any cylinder, a tangent to the wave surface is fitted directly above (or below) the centroid of that cylinder. This shows that for two of the cylinders:



The two shaded regions on the right show the proportion of each cylinder which is treated as being wet. OrcaFlex calculates the buoyancy, and where it acts for each individual cylinder, then resolves all contributions over the whole buoy. Hence, the calculation of buoyancy is more accurate, and this is why it can be beneficial to discretising a spar buoy.