

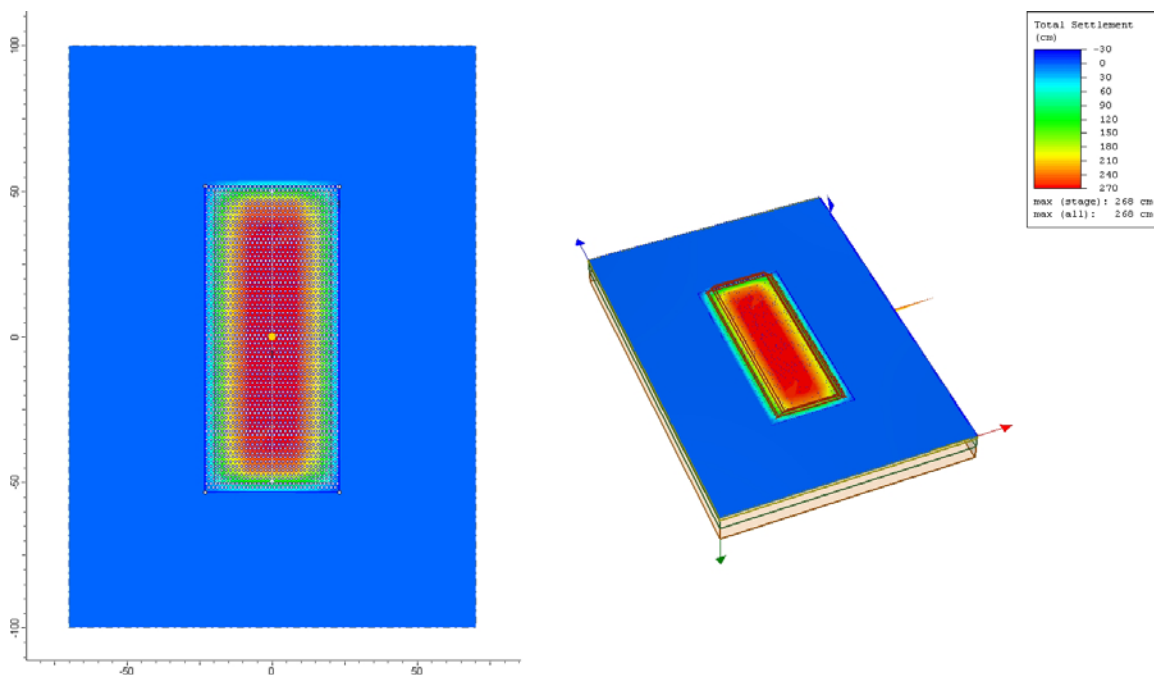


## Developer's Tip: Buoyancy Effects in *Settle*<sup>3D</sup>

The latest update to *Settle*<sup>3D</sup> adds the ability to account for buoyancy effects. As soil layers and embankments settle below the water table, the loading stress will decrease due to buoyancy. If these buoyancy effects are not taken into account, then the settlement will be overestimated. This article demonstrates how to account for buoyancy in *Settle*<sup>3D</sup>.

First make sure that you update your *Settle*<sup>3D</sup> program to the latest version (version 1.005 at the time of writing). You can do this easily by going to the **Help** menu and selecting **Check for Settle**<sup>3D</sup> **Updates** from the **Product Updates** submenu. Also, if you haven't turned on the automatic update notification feature, then please do so by selecting the **Check for Updates Automatically** option in the same menu. It is important to keep the program updated since Rocscience releases bug fixes and feature improvements on a regular basis.

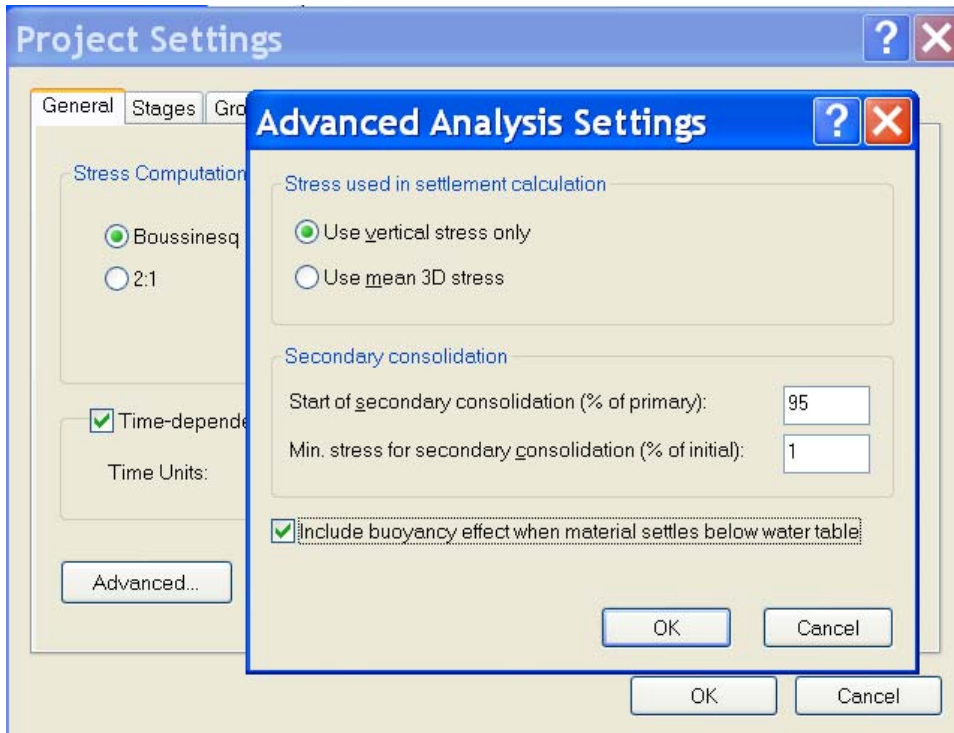
For this demonstration we will use the model from Tutorial 04. Run the *Settle*<sup>3D</sup> program and open the **Tutorial 04** file by going to the **File > Recent Folders > Tutorials Folder** menu option. Plot the Total Settlement by choosing Total Settlement from the drop-down menu in the toolbar at the top. For Stage 7 (400 days), your model should look like this:




Note that the maximum settlement (shown under the legend in the sidebar) is equal to 268 cm.

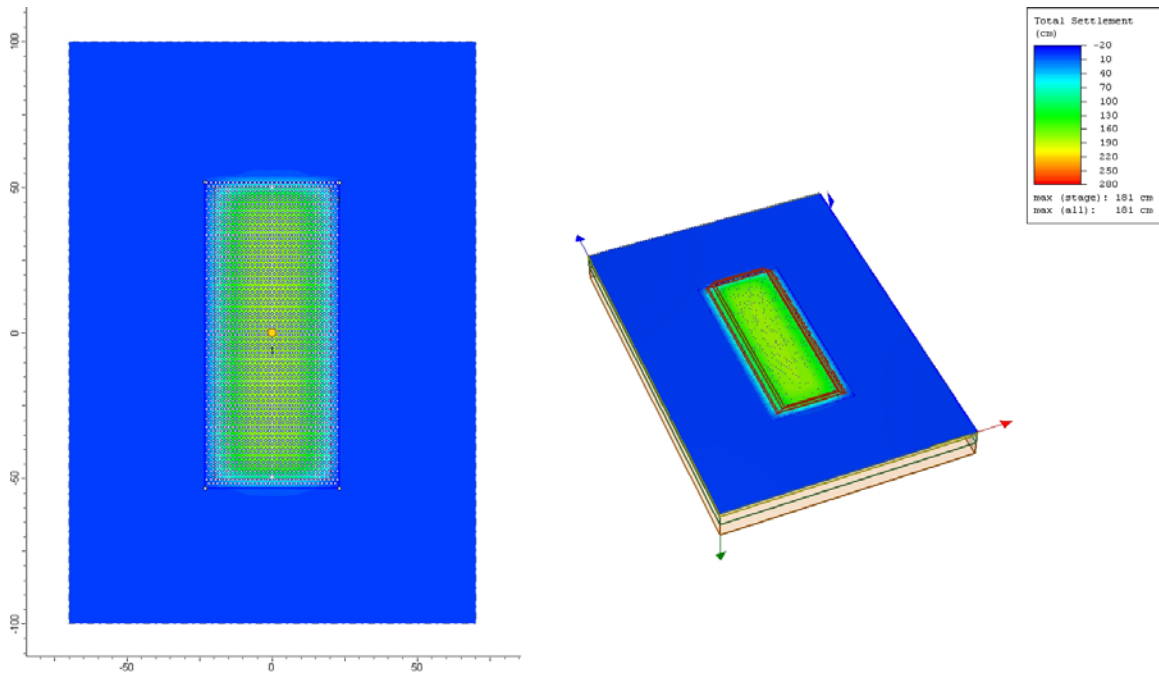
In this example, the water table is at the surface (depth = 0 m). We would therefore expect that as the embankment settles, upward buoyancy forces will act on the embankment reducing the load. By default, these buoyancy forces are not accounted for in *Settle<sup>3D</sup>*.

To account for the buoyancy effect, Go to **Project Settings** and click on the **Advanced** button. Check the box next to ‘Include buoyancy effect ...’ as shown.



Click OK to close the Advanced Analysis dialog and click OK to close the Project Settings dialog. Now click the compute button  in the toolbar to recompute the settlement contours.

Your computer will take several seconds to perform the calculations. The model for Stage 7 (400 days) should now look like the model on the following page:



You can see that the maximum settlement is now 181 cm – a decrease of approximately 30%. Clearly, the buoyancy effect has reduced the amount of calculated settlement, however there are several things to keep in mind when applying the buoyancy correction in *Settle<sup>3D</sup>*:

- The buoyancy effect is calculated as if the changes in displacement are infinite in extent. In general this will not be the case. This procedure therefore generally overcorrects for the buoyancy effect. For loads with small lateral extent you should be aware that the calculated buoyancy effect will be too large and that the settlement will be too small.
- In a time-dependent analysis, the buoyancy effect should increase gradually as settlement occurs with time. In *Settle<sup>3D</sup>*, the buoyancy effect is only calculated at the end of each stage, therefore small inaccuracies will result. To improve the accuracy of the time-dependent results, you could include more stages in the analysis.
- The water table can never be higher than the current ground surface elevation (except for the case of embankment loads, see below). This means that a water table at the surface will actually move downwards as settlement occurs to maintain the water table at the top of the soil.
- For embankment loads, if the embankment settles below the water table, the water table will extend into the embankment material. If the embankment settles completely below the water table, the water table cannot be higher than the top surface of the embankment.

This concludes this developer's tip on the new buoyancy correction feature in *Settle<sup>3D</sup>*