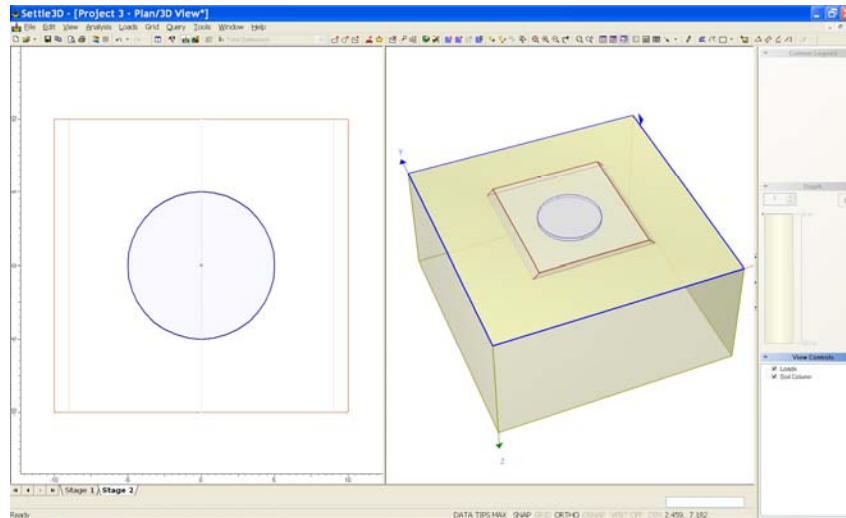
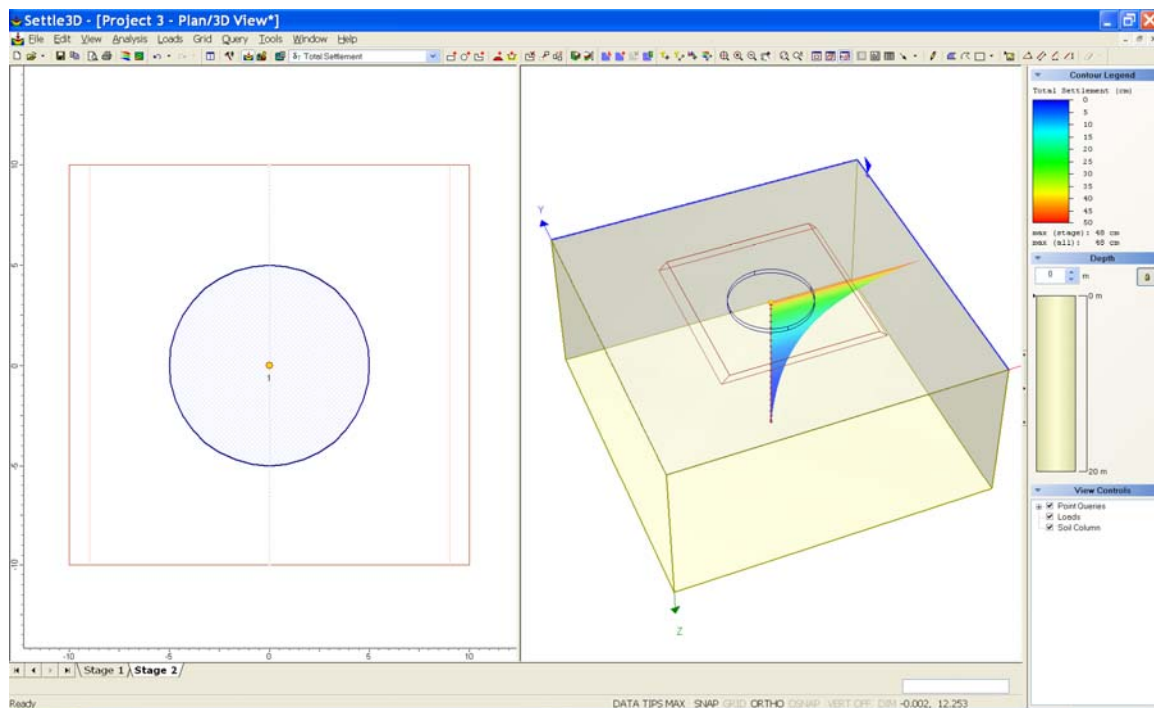


4. Click on the tab for Stage 2. Go to **Loads > Add Circular Load**. Leave all default values. Ensure that the installation stage is Stage 2. Click OK to close the dialog.
5. You now need to enter the location for the centre of the circular load. Enter 0, 0 and hit enter. The model for Stage 2 should now look like this:

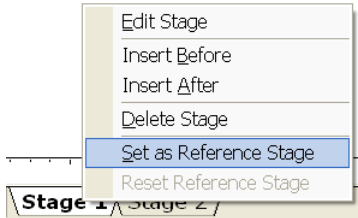


6. Go to **Query > Add Query Point**. Leave the Number of Vertical Points as Automatic. Click OK to close the dialog. Now place the query point in the centre of the circular load by clicking on the centre point. You should now see the settlement at that point as shown.



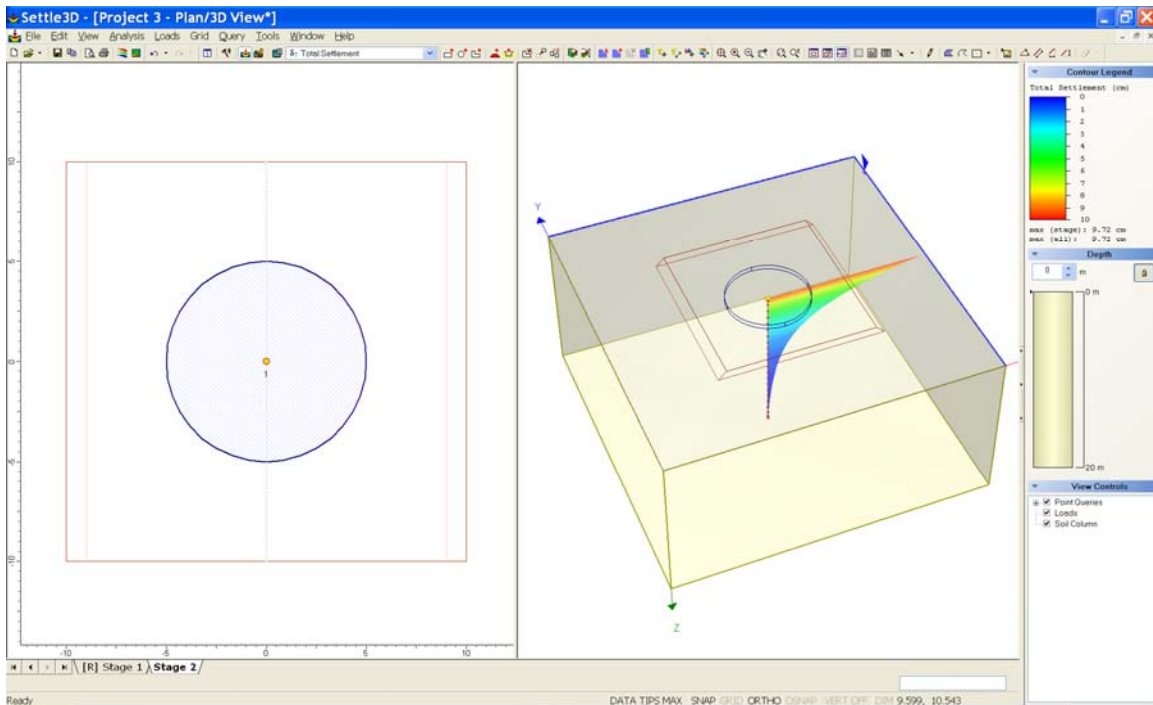
The maximum settlement in Stage 1 (only the embankment) is **38.3 cm**. The maximum settlement in Stage 2 is **48 cm**. This includes the effect of the embankment plus the storage tank. If we want to see the effects of the storage tank only, then we need to set a reference stage.

Right click on the tab for Stage 1. Select Set as Reference Stage as shown.



There should now be an [R] next to Stage 1 in the tab indicating that this is the reference stage. All data is now plotted relative to this stage. The settlement for this stage will now be 0.

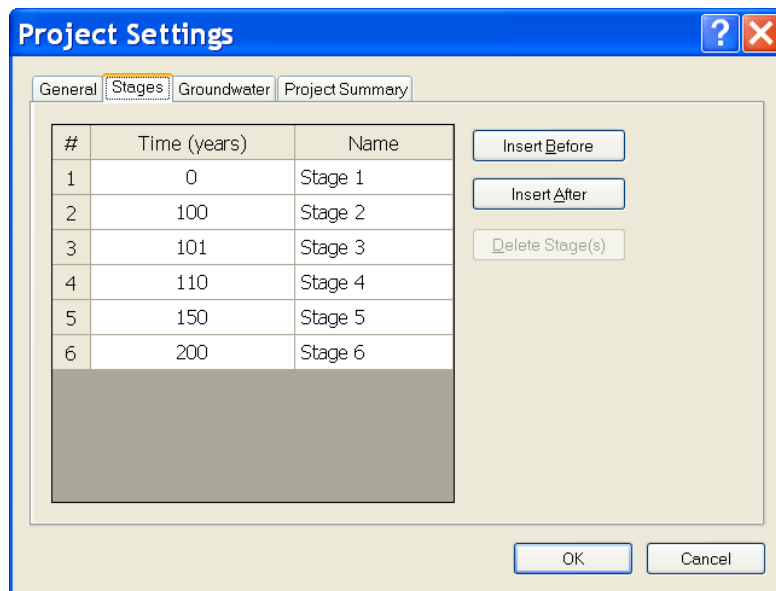
Click on the tab for Stage 2 and you will now see that the maximum settlement is only **9.72 cm**. This is the settlement in Stage 2 minus the settlement in Stage 1, or simply the settlement due to the storage tank alone, which is what we wanted.



Using the reference stage with time-dependent consolidation

Now we will re-run the example with time-dependent consolidation turned on so we can see the evolution of settlement with time.

1. Go to **Analysis > Project Settings**. Click on the General tab and click the box for time-dependent consolidation. Set the Time Units to years.
2. Click on the Stage tab. Set the time for Stage 2 to 100 years (to ensure full consolidation of the embankment load before applying the circular load). Now click 'Insert After' 4 times and fill in the Stage times as shown. In this way we can observe the evolution of settlement of the storage tank with time. Click OK to close the dialog.

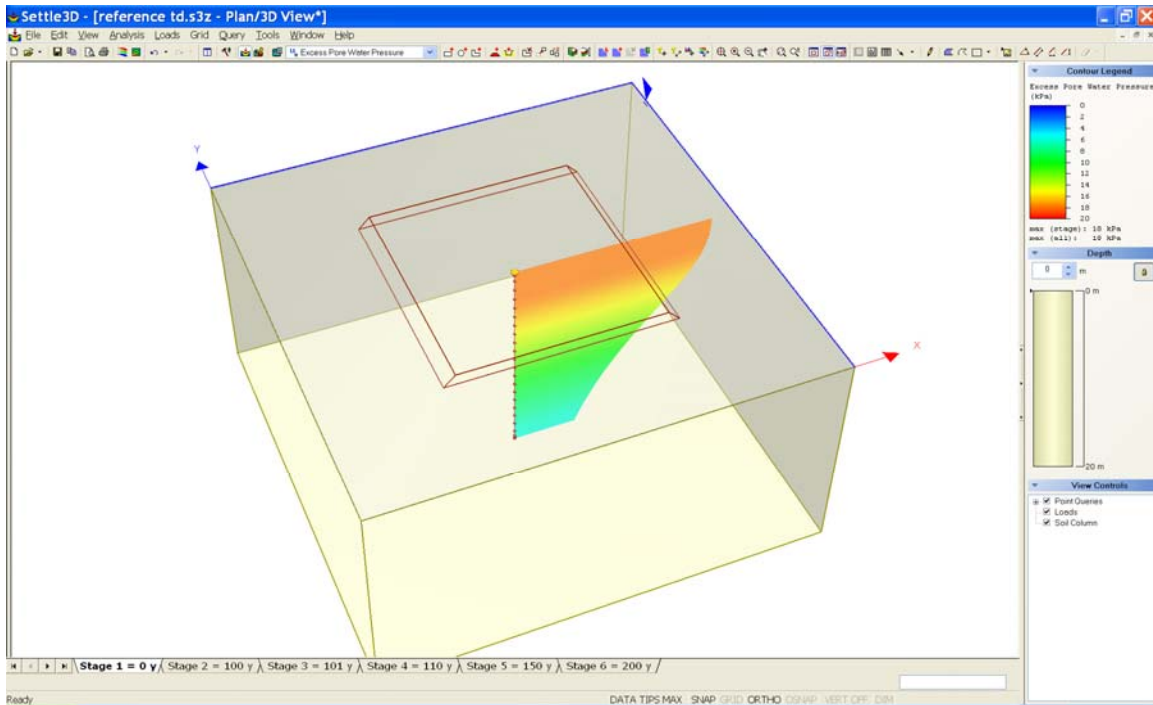


The problem

Stage 1 is still set as the reference stage and the storage tank is still added in Stage 2. Click through the tabs to observe the settlement at different times. You will see that the maximum settlement at Stage 6 (200 years) is **46.5 cm**. This is almost equal to the settlement of the embankment *plus* the storage tank observed in the non-time-dependent analysis. Yet we have set the reference stage to be stage 1 so we should only see the settlement due to the storage tank. So what is going on?

The solution

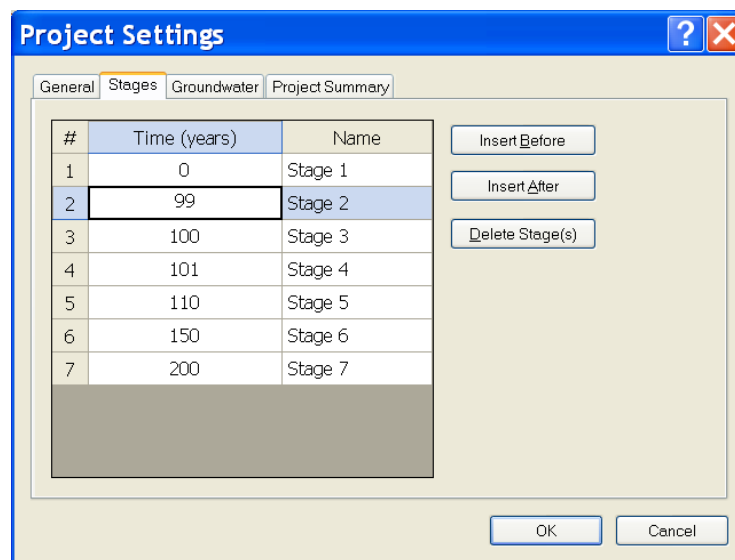
The problem is that when the embankment is added, the pore water takes most of the load. There is a big jump in excess pressure and almost no settlement. Right click on the tab for Stage 1 and choose Reset Reference Stage. This will 'unset' the reference stage. Now you can see that there is less than 1 cm of settlement in this stage. Change the plot to Excess Pore Pressure using the pull-down menu at the top. You can see a large jump in excess pore pressure as shown.



As you click through the stages, you will see the excess pore pressure dissipating.

What we need to do is add another stage just before the circular load is applied and use this as the reference stage. In this way, we allow the soil to consolidate from the embankment load and we will get the true settlement of the storage tank only.

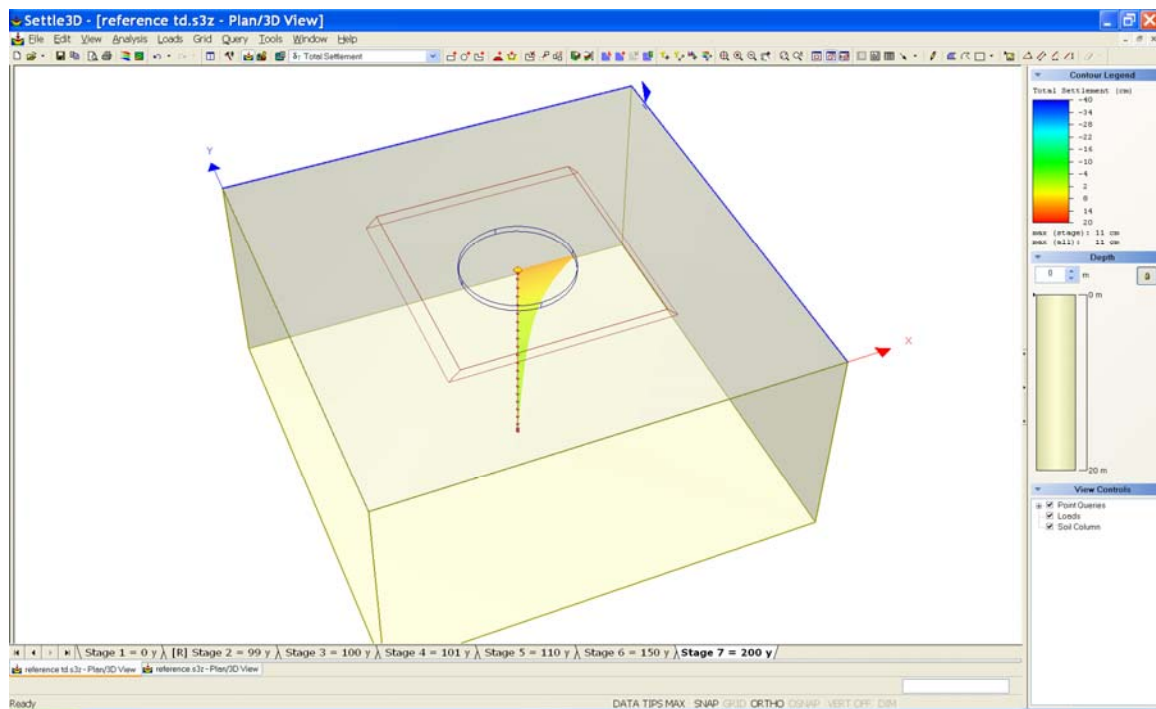
Go to **Analysis > Project Settings** and click on the Stages tab. Click on Stage 1 and hit the button for 'Insert After'. For the new Stage 2, set the time to 99 years.



Click OK to close the dialog.

Now click through the stages. You will see that the circular load is now being applied in Stage 3. You will also see that most of the excess pore pressure has dissipated in Stage 2 (99 years). If you change the plot back to Total Settlement, you will see a settlement of about 36.1 cm in Stage 2. This is close to the settlement of 38.3 cm due to the embankment alone that we observed in the non-time-dependent analysis.

Right click on the Stage 2 tab and choose Set as Reference Stage. Now if you click through Stages 3-7 you will see the evolution of settlement due to the storage tank alone. The settlement observed in Stage 7 (200 years) is **11 cm** – very close to the 9.72 cm observed in the non-time-dependent analysis. The reason that this settlement is slightly higher is that the soil was not fully consolidated at the time that the storage tank was added, therefore some settlement due to the embankment is included in the result.



This concludes this developer's tip on reference stages in *Settle^{3D}*.