

Bulletin: #121218-1
Date: December 18, 2012
Application: UniSettle 4.0

Subject: Calculation of time related settlement in UniSettle 4.0

Introduction

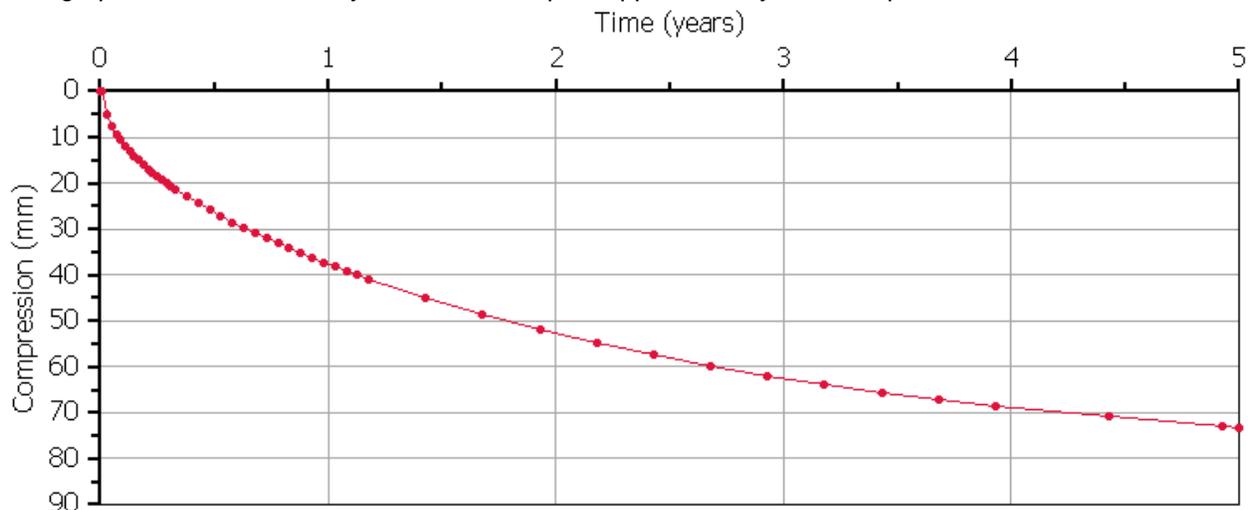
Starting with Release 4.0.0.30, we have corrected the manner in which UniSettle 4.0 applies overconsolidation and preconsolidation during multi-stage loading and unloading. This document clarifies how UniSettle calculates settlements in the event that unloading and reloading is incorporated in the analysis and also explains some limitations.

Calculation of Long Term Settlement

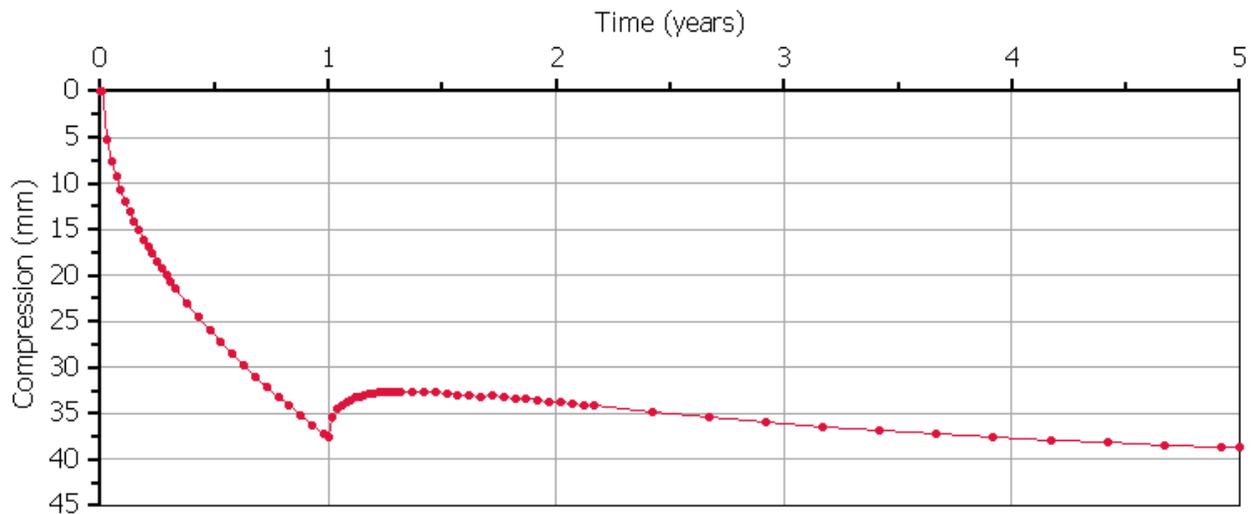
When calculating total settlement, UniSettle always assumes that 100% of the consolidation (and/or heave) caused by the various loads and excavations will take place. This concept may lead to some confusion when unloading occurs before 100% of the consolidation has developed. In practice, unloading before full consolidation is obtained will reduce or stop the consolidation process and result in some rebound. Unfortunately, calculating the exact effect of unloading depends on many factors, including the amount of consolidation already achieved, which also varies within a soil layer.

Settlement vs Time

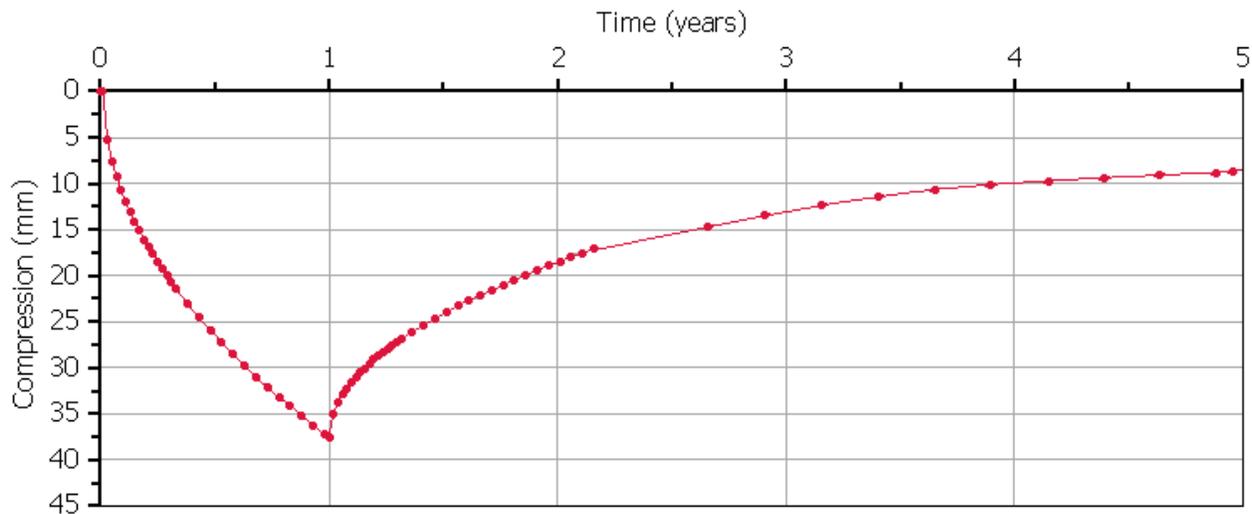
When partial or complete unloading is specified in UniSettle, combining the results of multiple UniSettle analyses may be required. The below graph shows the Settlement vs. Time as produced by UniSettle for a load applied early in a project. The total consolidation produced by the load is calculated as 80mm. The graph shows that at one year, one can expect approximately 38mm equal to 47% of consolidation.



When incorporating complete unloading of the same load at 1 year, the Settlement vs. Time graph produced by UniSettle is as per the following image. The graph shows some rebound followed by further consolidation for a total settlement of 41mm.



However, sound engineering judgment tells us that complete unloading at 1 year should stop the consolidation process and start producing rebound in accordance with the unloading modulus and as displayed in the graph below. This graph is a combination of two UniSettle calculations: The first calculation is the one-year settlement vs. time for the load. The second is a calculation of the rebound after full consolidation for the load has developed (change the consolidation coefficient to complete consolidation within, say 6 months; this will also recognize that heave occurs much faster than settlement). Add the calculated rebound curve (negative settlement) to the settlement at the one-year time.



Conclusion

When partial or complete unloading is involved, sound engineering judgment must always be applied, keeping in mind the limitations of any software and Terzaghi consolidation theory.