



PARAMETER DETERMINATION

An often reported obstacle that causes users to forego use of the Soft Soil Creep model is the determination of the stiffness parameters λ^* , κ^* , μ^* and the initial OCR, especially since the creep behaviour depends on all four parameters.

In principal all four parameters can be derived from a standard oedometer test, provided that the test has been performed for long enough after applying the load step. Preferably, the test results are plotted as the volumetric strain, ϵ_v , versus the natural logarithm of the mean effective stress, $\ln(p')$. The volumetric strain of an oedometer test sample can easily be calculated by dividing the settlement by the original sample height.

As usual, the graph of $\ln(p')$ vs. ϵ_v (Figure 1) will provide the κ^* and λ^* from the inclination of the settlement curve before and after the preconsolidation stress P_p . And the OCR can be calculated from this preconsolidation stress, if the mean stress level at the depth where the sample was taken from, is known.

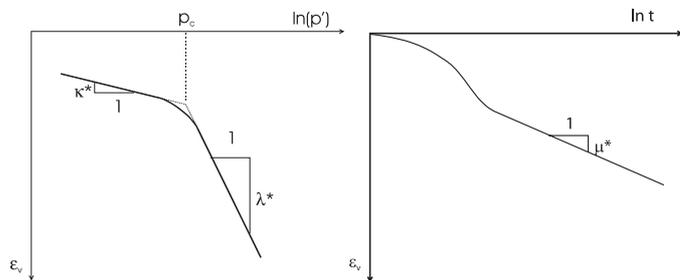


Figure 1: Graph of volumetric strain vs. natural logarithm of mean stress

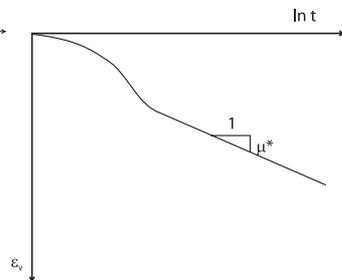


Figure 2: Graph of volumetric strain vs. natural logarithm of time

The difficult part is the determination of the modified creep modulus μ^* . In order to determine the μ^* , the oedometer results should be plotted as volumetric strain versus the natural logarithm of time, $\ln(t)$, see Figure 2. For a proper parameter determination the time period must be long enough so that the settlement curve plots as a straight line in this graph, i.e. after full consolidation.

When a load step is applied both consolidation and creep will occur simultaneously. At the start of the test the effect of consolidation on the settlement of the soil sample will usually be significant. However, for the determination of μ^* the consolidation rate should be low enough so that its contribution on the settlements is minor compared to the contribution of creep. If this state is reached the settlement curve will indeed become a straight line in the $\ln(t)$ vs. ϵ_v graph. Unfortunately it is quite common that an oedometer test is stopped rather quickly after the last load step has been applied. As a result, the consolidation has not completely finished and rate of consolidation is still significant. This consolidation rate is then added to the creep rate, resulting in an overestimation of creep and a too large μ^* parameter. This is a common origin of overestimating the creep behaviour, which results in larger settlements being predicted than actually occur.

Therefore, it is strongly recommended to check the correctness of the parameters by simulating the oedometer test in Plaxis and comparing the calculation results with the laboratory findings. In case the Plaxis simulation does not resemble the test results, check carefully which parameters should be changed.

The Plaxis Curves program can easily plot graphs of volumetric strain vs. mean stress or time if a stress point is selected before starting the calculation. First, if the graph of the logarithm of mean stress p' vs. volumetric strain ϵ_v does not match the original oedometer test results, adjust λ^* and κ^* in order to match the slopes of the settlement curve before and after the preconsolidation stress. Possibly also adjust the OCR to match the preconsolidation stress point, where the transition between reloading and virgin loading takes place. Secondly, if the graph of the logarithm of time vs. ϵ_v differs from the oedometer results the parameter μ^* has to be adjusted. Certainly, the creep rate also depends on the values of λ^* and κ^* , but changing these parameters will also affect the primary loading and unloading-reloading behaviour and thus seriously affect the results of the simulation.

Further take into account that these parameters cannot be varied unlimitedly. The ratio of the unloading/primary loading stiffness, λ^*/κ^* , cannot be smaller than 1 and should normally be between 2 and 10. Users should be very wary of values outside this range; for most practical cases the value of the λ^*/κ^* ratio falls within the range of 3 to 7.

Secondly there is the creep ratio, $(\lambda^* - \kappa^*) / \mu^*$, to consider. This ratio can have a wide range of values, normally between 5 and 25, where high values represent stiff soils with little creep and small values represent soft soils with a considerable amount of creep. For most practical cases the ratio falls within the range of 10 to 20, and if the creep ratio is over 25 one could reconsider the use of the creep model. For these relatively stiff soils creep is of minor importance and the Soft Soil model or even Hardening Soil model could be used instead.

CLOSING REMARKS

The Soft Soil model and the Soft Soil Creep model have a different default setting for the slope of the Critical State Line, the M-parameter. For the Soft Soil model the default value of the M-parameter is chosen such that the simulation of an oedometer test will give the most realistic results. The Soft Soil Creep model on the other hand chooses the M-parameter such that the simulation of an undrained triaxial test gives the best results. When calculations using the Soft Soil and the Soft Soil Creep model are compared, one has to manually alter the default value of the M-parameter in order to obtain similar results. This can be done by changing K_0^{nc} in the Advanced material properties window.

Although the parameter determination for the SSC model will sometimes be hindered by a practical lack of long-term oedometer measurements, it is often worthwhile to determine these parameters if possible. Although there remains a gap between accurately-modelling a oedometer test and making a prediction for a practical case the SSC model offers enough possibilities for the accurate prediction of long-term settlements of embankments on soft marine clays and peats.