The TzLiq1 Material

uniaxialMaterial TzLiq1 matTag? tzType? tult? z50? c? solidElem1? solidElem2?

The above command constructs a uniaxial t-z material that incorporates liquefaction effects. This t-z material is used with a zeroLength element to connect a pile (beam-column element) to a 2-D plane-strain FE mesh. The t-z material obtains the average mean effective stress (which decreases with increasing excess pore pressure) from two specified soil elements. Currently, the implementation requires that the specified soil elements consist of FluidSolidPorousMaterials in FourNodeQuad elements.

The arguments matTag, tzType, tult, z50, and c are the same as for the uniaxial material TzSimple1. See the documentation for TzSimple1 for input parameter descriptions. The arguments solidElem1 and solidElem2 are the eleTag (element numbers) for the two solid elements from which TzLiq1 will obtain mean effective stresses and excess pore pressures.

To model the effects of liquefaction with TzLiq1, it is necessary to use the material stage updating command:

updateMaterialStage –material matNum –stage sNum

where the argument matNum is the material number (for TzLiq1) and the argument sNum is the desired stage (valid values are 0 & 1). With sNum=0, the TzLiq1 behavior will be independent of any pore pressure in the specified solidElem's. When updateMaterialStage first sets sNum=1, TzLiq1 will obtain the average mean effective stress in the two solidElem's and treat it as the initial consolidation stress prior to undrained loading. Thereafter, the behavior of TzLiq1 will depend on the mean effective stress (and hence excess pore pressures) in the solidElem's. The default value of sNum is 0 (i.e., sNum=0 if updateMaterialStage is not called). Note that the updateMaterialStage command is used with some soil material models, and that sNum=0 generally corresponds to the application of gravity loads (e.g., elastic behavior with no excess pore pressure development) and sNum=1 generally corresponds to undrained loading (e.g., plastic behavior with excess pore pressures development).

The analysis for gravity loading cannot use the "algorithm Linear" command because the relevant soil materials do not currently work properly with this command. Instead, the "algorithm Newton" or some other option must be used.

TzLiq1 inherits TzSimple1 and modifies its response based on the mean effective stresses (and hence excess pore pressures) in the specified solid soil elements. The logic and implementation are the same as for how PyLiq1 inherits and modifies PySimple1. Therefore, the reader is referred to the documentation of PyLiq1 for details.