Application of Higher-Order Elements for Coupled Analysis in Geomechanics

Mina Kardani*, Majidreza Nazem[*] and John P. Carter[*]

[*] ARC Centre of Excellence for Geotechnical Science and Engineering (CGSE)
the University of Newcastle
University Drive, Callaghan, NSW 2308, Australia
e-mail: mina.kardani@newcastle.edu.au, web page: http://www.newcastle.edu.au/cgse

ABSTRACT

In this paper high-order triangular elements are implemented in the framework of the Arbitrary Lagrangian-Eulerian method for the analysis of large strain consolidation problems in geomechanics. The theory of consolidation, as well as details of the high-order elements, including cubic (10-noded), quartic (15-noded), quantic (21-noded) and sextic (28-noded) elements are discussed. The accuracy and the efficiency of high-order elements in the analysis of consolidation problems are demonstrated by conducting a small deformation analysis of the soil under a strip footing as well as a large deformation analysis of a vertical cut subjected to a surcharge loading.

Based on the numerical results, it is shown that high-order elements not only improve the accuracy of the solution but can also significantly decrease the required computational time. It is also demonstrated that assuming identical order for displacement shape functions and the pore water pressure shape functions does not affect the stability of the time-marching analysis of consolidation nor the accuracy of the numerical predictions.