CT4350	Numerical soil mechanics	4

Instructor	**Frans Molenkamp**
Education Period	3rd Education Period
Exam Period	3rd Exam Period
Course Language	English
Course Contents	The aim of this teaching module is to clarify the process behind the composition of industrial finite element software. Starting from the differential field equations, boundary and possibly initial conditions the corresponding integral equation for finite element analyses are composed using a.o. Galerkin's method. These integral equations are implemented in numerical code and the resulting output of that code is interpreted using computer graphics. These processes are considered in details for four types of geomechanics problems. Finally the industrial finite element packages Plaxis and Diana are discussed. Rather than remaining black boxes, in this way the capabilities and limitations of industrial software become better appreciated. The following five topics are taught: Introduction of programming in Fortran95. Formulation and programming in Fortran95 by means of Finite Elements of the following 4 topics: Foundations on elastic bedding. The distributions of the settlement of the foundation and the bending and shear forces in the foundation are derived. This formulation is also considered for lateral soil-pile interaction. Plane deformation and failure of elasto-plastic solid with Mohr-Coulomb failure criterion. The plastic failure criterion is satisfied by means of a visco-plastic numerical iteration scheme. The factor of safety is estimated on the basis of a series of analyses with reduced strength parameters. The finite element analysis is compared to the classical slope stability analysis using slip circles. Ground water flows through embankment, involving both a free surface and a seepage surface. Consolidation of elastic 1-dimensional and plane-strain compression with drainage at the upper surface due to ramp type of loading on the upper surface. The accuracy of the numerical solution is demonstrated, both by comparing to analytical solutions and by considering numerical solutions with both spatial and temporal refinements. The same problems are also analyzed by means of the industrial finite element package Plaxis. To assess the student's performance reports are requested on five assignments, concerning: Hands-on Fortran95 Beam on elastic foundation Slope stability Groundwater flow Consolidation
Study Goals	The students develop an insight in the way geomechanical and numerical aspects are combined in order to achieve numerical predictions of the behaviour of geomechanical structures both by F.E. code and industrial F.E. software.
Education Method	lectures case study exercise instruction
Course Relations	CT4350 uses CT4352 CT4350 uses CT4360 CT4350 uses CT5142
Literature and Study Materials	syllabus: Available at the first lecture. obligatory lecturenote(s)/textbook(s): Lecture notes by prof.dr.ir. A. Verruijt on Numerical Geomechanics Available at BookShop Civil Engineering. Course book by I.M. Smith, D.V. Griffiths, "Programming the finite element method", 3rd edition, John Wiley & Sons (1998), ISBN: 0-471-96543-X available at: VSSD, Poortlandplein 6 te Delft
Assessment	Assignments: 5