ABSTRACT: This report presents information compiled by the authors, with input from the wider geotechnical community, on geotechnical engineering education and practice in Greece. Geotechnical engineering education is offered as part of the undergraduate curriculum of all five Civil Engineering Departments in Greece, which also have postgraduate programs leading to specialization and doctoral degrees. Geotechnical engineers typically have a postgraduate specialization degree and practice either in small- to medium-size geotechnical consulting firms or in larger Civil Engineering construction and consulting companies. A license from the Ministry of Environment, Planning and Public Works is required for acquiring public consulting or construction contracts.

1. INTRODUCTION

The information on geotechnical engineering education in this report is based on previous surveys (Atmatzidis and Anagnostopoulos, 2000; Atmatzidis, 2001), the results of which were updated with current descriptions of curricula posted at the departmental web pages (see references) and complemented with personal interviews conducted by the authors. After a brief introduction on the five Civil Engineering departments in Greece and the basic features of undergraduate and postgraduate studies, the report describes the geotechnical component of undergraduate and postgraduate degree programs, before providing an overview and examples of geotechnical practice.

Engineering education in Greece is offered by the National Technical University of Athens (NTUA), the Aristotle University of Thessaloniki (AUTH), the University of Patras (UP), the Democritus University of Thrace (DUTH) and the University of Thessaly (UT). All undergraduate engineering education programs have a duration of five years (ten academic semesters) and the degree awarded is called "Diploma". There is a Department of Civil Engineering at each of these Universities.

To obtain the "Diploma in Civil Engineering", all students follow a pro-program of studies that consists of required or compulsory courses (about 75% of the total) and elective or optional courses (about 25% of the total). The undergraduate program also includes the preparation of a diploma thesis, which is equivalent to up to one semester full-time registration. At some departments (e.g., NTUA), the 10th semester is fully dedicated to thesis work, whereas at others, students enroll in a limited number of optional courses in the final semester [e.g., at AUTH students enroll in four (4) courses].

All Universities offering undergraduate education in Civil Engineering operate postgraduate education programs. The degrees awarded are called "Postgraduate Specialization Diploma", which may be construed as being at the level of a Master of Science (MSc) degree, and "Doctoral Diploma", which may be construed as a Doctor of Philosophy (PhD) or Doctor of Science degree. All Departments of Civil Engineering have postgraduate education programs leading to specialization as well as Doctoral degrees.

In order to practice engineering in Greece, a license is required, which is obtained after oral
examinations administered by committees appointed by the Technical Chamber of Greece. Graduates from Universities abroad are allowed to enter these examinations after their degrees have been verified by a special service of the Ministry of Education. This license allows the engineers to work either as employees of the public or private sector or as engineers in private projects (consulting or construction). However, another license, from the Ministry of Environment, Planning and Public Works, is required for acquiring public consulting or construction contracts.

2. GEOTECHNICAL EDUCATION

2.1 Undergraduate Education

The curricula of the five Departments of Civil Engineering include both required and elective courses in geotechnical engineering. The number of required courses is either four (4) or five (5), as shown on Table 1. The most common titles of required courses are: Soil Mechanics (which is usually offered as a two-semester sequence), Foundation Engineering, and Geology for Civil Engineers (which is considered of special interest due to the complex geological formations encountered in Greece). Table 1 also includes the hours taught per week for each required course (during a 13-week long semester).

The basic required courses on Soil Mechanics are supplemented by laboratory work, either in the form of demonstrations or with simple experiments-exercises conducted by the students. These include the determination of grain size distribution, Atterberg limits, coefficient of permeability by constant and falling head methods and compaction curves from standard and modified Proctor tests. Other typical tests include consolidation, unconfined compression, direct shear and triaxial testing for undrained and drained conditions. Demonstrations are preferred when the number of students is very large compared to available equipment and/or when the nature of the laboratory test requires significant time (such as a complete consolidation test or a drained triaxial test on fine-grained soil). Since the use of small-scale physical modeling in geotechnical instruction has attracted the interest of the international geotechnical community (e.g., Bucher, 2000), including efforts at developing virtual testing software (Budhu, 2000), developments or at least discussions can be expected in the domain of laboratory instruction.

All Civil Engineering undergraduate students form their own program of studies by selecting the required number of elective courses among a relatively large number of offered courses. Each student is required to concentrate his/her options in a certain field of Civil Engineering, such as structural analysis and design, highway and transportation engineering, hydraulic engineering, geotechnical engineering, environmental engineering, or in a combination of the aforementioned fields. The first six (seven at AUTH and UP) semesters are common for all students. During the remaining semesters, students enroll in increasingly fewer common courses, concentrating more and more on courses in their elected field of Civil Engineering. It should be noted that students are awarded a common degree in Civil Engineering, regardless of their elected emphasis.

Presently, four institutions (NTUA, AUTH, DUTH and UT) have developed a “specialization” in geotechnical engineering as part of their undergraduate curriculum. The existence of a formal “specialization” ensures that there is a structured program of courses that allows the student to become exposed to several subfields of geotechnical engineering (although, as previously mentioned the awarded degree does not reflect the choice of “specialization”). At UP, the Civil Engineering Department offers a combined Hydraulics-Geotechnical-Geodesy specialization, which includes five (5) geotechnical courses. Beyond the courses that are compulsory for all students, the minimum number of courses required for specialization in geotechnical engineering is sixteen (16) at AUTH, ten (10) at DUTH and UT, and four (4) at NTUA. Table 2 contrasts the numbers of required geotechnical courses for all students to those of the additional minimum requirements for the geotechnical specialization. The minimum requirement of geotechnical courses is smaller at NTUA, compared to the other universities, because NTUA’s geotechnical specialization is flexible, allowing combinations with other fields. Some titles of courses leading to specialization in geotechnical engineering are: Advanced Soil Mechanics, Foundations and Earth Retaining Structures, Soil Mechanics Laboratory, Soil Dynamics, Rock Mechanics, Environmental Geotechnics, Computational Geotechnics, Soil - Structure Interaction, Flow through Porous Media,
Tunnels and Underground Works and Earth Dams.

Table 1. Required geotechnical courses at Civil Engineering Departments in Greece

<table>
<thead>
<tr>
<th>Course name</th>
<th>NTUA</th>
<th>AUTH</th>
<th>UP</th>
<th>DUTH</th>
<th>UT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Mechanics</td>
<td>2/4, 4</td>
<td>2/(5+1)</td>
<td>4, 2/(5+2)</td>
<td>5</td>
<td>1/(5+1)</td>
</tr>
<tr>
<td>Geotechnical Engineering (Foundations, Geotechnical Structures)</td>
<td>1/5</td>
<td>1/5</td>
<td>1/4</td>
<td>1/5</td>
<td>1/4</td>
</tr>
<tr>
<td>Geology for Civil Engineers</td>
<td>1/4</td>
<td>1/5</td>
<td>1/(2+2)</td>
<td>1/3</td>
<td>–</td>
</tr>
<tr>
<td>Engineering Geology</td>
<td>1/3</td>
<td>–</td>
<td>–</td>
<td>1/4</td>
<td>1/4</td>
</tr>
<tr>
<td>Total number of required geotechnical courses</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

\(^a\) (lecture hours + lab hours)

Table 2. Requirements for geotechnical courses at Civil Engineering Departments in Greece

<table>
<thead>
<tr>
<th>Required courses for all students</th>
<th>Additional required courses (minimum) for students electing the geotechnical specialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTUA 5</td>
<td>4(^a)</td>
</tr>
<tr>
<td>AUTH 4</td>
<td>16</td>
</tr>
<tr>
<td>UP 4</td>
<td>N/A(^b)</td>
</tr>
<tr>
<td>DUTH 4</td>
<td>10</td>
</tr>
<tr>
<td>UT 4</td>
<td>10</td>
</tr>
</tbody>
</table>

Notes: \(^a\) The geotechnical specialization at NTUA allows combinations with other fields
\(^b\) N/A = non applicable (there is no separate geotechnical specialization at UP but students may take up to five geotechnical courses)

Textbooks and other educational materials are distributed to the students free of charge. Textbooks are all written in Greek and authored by members of the faculty. Recommendations are made periodically to the University Libraries to purchase other books and bibliography, mainly written in English, for use by students who wish to expand their reading material. Students also undertake term projects in few courses, for which they need to consult the international literature (typically in English) and Internet resources.

At the undergraduate level and for required courses, the use of computer codes to support laboratory and design work is rather limited. The instructors have prepared some available simple design codes. At some courses (e.g., Computational Geotechnics at NTUA), students use in course assignments publicly available educational software (e.g., http://www.uwe.ac.uk/geocal/) or student editions of professional software (e.g., http://geo-slope.com/products/student.aspx). Although significant efforts have been directed internationally to the development of geotechnical software suitable for educational uses (Jaska et al., 2000), exchanges among instructors of experiences from their in-class use has lagged behind and to the authors' opinion should be encouraged.

Students typically elect to complete their geotechnical specialization by undertaking a diploma thesis on some geotechnical topic. Diploma theses form an integral part of the undergraduate curriculum and require significant effort and dedication from both students and supervisors. The purpose of the thesis is to offer the opportunity to the student to work for the first time on an extended problem and exercise some initiative. At the same time, the student develops a breadth of knowledge and a deeper understanding in the particular topic studied (e.g., deep foundations, seismic design of piers, landfills). Some indicative contents for diploma thesis work include the following: (a) conducting series of geotechnical tests, presenting the results and often exploring possible correlations, (b) performing parametric studies based on numerical simulations using commercially available finite difference or finite element codes, (c) providing the full design of a
realistic geotechnical structure, such as a complex retaining wall. Many of these diploma theses are effectively at the level of a Master’s thesis, as attested by the fact that the findings of several of them are published in national and international conferences and journals.

2.2 Graduate Education

Engineering Schools at Greek Universities have developed a number of departmental, interdepartmental and interinstitutional postgraduate education programs leading to a “Postgraduate Specialization Diploma” in various fields of Civil Engineering. A program leading to specialization in geotechnical engineering has been developed only at UP. In addition, NTUA offers a program that provides indirectly advanced education in geotechnical engineering. Specific programs leading to specialization in geotechnical engineering have not yet been developed at the other Civil Engineering Departments, while currently one such program is under development at DUTH, with plans to start in academic year 2007-2008.

The “Postgraduate Specialization Diploma in Geotechnical Engineering” offered by the Department of Civil Engineering at the University of Patras (UP) accepts a limited number of students each year (5 to 6), who are required to register for eight (8) geotechnical engineering courses and present a research thesis on a geotechnical engineering topic. Examples of courses offered in this program are: Advanced Soil Mechanics, Deep Foundations and Retaining Structures, Soil Dynamics, Geotechnical Earthquake Engineering, Engineering Seismology, Numerical Methods in Geomechanics, Advanced Rock Mechanics, Designing with Geosynthetics, Flow through Porous Media, Ground Investigation and Geotechnical Instrumentation.

Another opportunity to obtain advanced geotechnical engineering education is offered through an interdepartmental program at the National Technical University of Athens (NTUA), which awards a “Postgraduate Specialization Diploma on the Design and Construction of Underground Works”. A postgraduate student may obtain a strong background in areas of geotechnical engineering by registering for as many as eight (8) geotechnical engineering courses, out of a total of sixteen (16) required, and may complete a thesis on a geotechnical engineering topic. Examples of courses offered in this program are: Ground Investigation and Geotechnical Instrumentation, Geotechnical Earthquake Engineering, Engineering Geology for Underground Works, Design of Underground Works, Numerical Methods of Analysis of Underground Works, Near-surface Tunneling & Ground Settlements, Tunnel Portals & Slope Stability.

At the Aristotle University of Thessaloniki (AUTH), courses on various geotechnical issues are offered in the existing four interdepartmental and interdivisional postgraduate educational programs. More specifically, in one of these programs, AUTH offers postgraduate studies in the field of geotechnical engineering under the framework of the “Postgraduate Specialization Diploma in Seismic Design of Engineering Structures”. The following courses are offered: Principles of Seismology, Engineering Seismology, Soil Dynamics, Geotechnical Earthquake Engineering, Vulnerability Assessment and Risk Management of Lifeline Systems and Infrastructures.

The University of Thessaly (UT) offers a “Postgraduate Specialization Diploma in Applied Mechanics and Simulation of Systems”, which includes six (6) courses and a dissertation. Coursework includes Mathematics, Mechanics, Fluid Mechanics and two (2) geotechnical courses: Advanced Soil Mechanics and Soil-Structure Interaction.

All five Departments of Civil Engineering operate programs leading to a “Doctoral Diploma in Civil Engineering". Students with a first degree in Civil Engineering are required to take anywhere from six (6) to fourteen (14) postgraduate courses and credits are given for postgraduate courses taken at the “specialization” or the MSc level. The major component of the requirements for the “Doctoral Diploma” is the successful completion of a doctoral dissertation. Each geotechnical division awards on the average two to three doctoral degrees each year.

3. GEOTECHNICAL PRACTICE

Engineers graduating from the five Civil Engineering Departments in Greece obtain their license to practice after passing an oral exam administered by committees set up by the Technical Chamber of Greece. These committees consist of three members, with significant experience in the disciplines...
requested by the exam participants to be examined.

Graduate engineers from Universities abroad are allowed to enter these examinations after their degrees have been verified and their parity to the Greek Civil Engineering Department degrees has been examined by a special service of the Ministry of Education.

There is no other requirement from the State for a practicing engineer working on privately financed projects. However, for an individual engineer or an engineering company to bid for a public project, either for design or for construction, they need to demonstrate a certain level of prior experience with similar projects of comparable scale and complexity. This certification of experience is managed in Greece through a system of "professional degrees or certificates" ("ptychia" in Greek) either for design—consulting or for construction. A licensed engineer can apply for the lowest level (A) of professional certificate, 3 years after graduation for the construction certificate and 4 years after graduation for the design—consulting certificate. The design—consulting certificate is awarded for at most two fields of Civil Engineering (e.g., geotechnical, hydraulics, transportation, marine works, structural etc.), while the construction certificate is awarded for at most four fields of Civil Engineering (e.g., hydraulics, road works, buildings, marine works, geotechnical etc.).

There are five levels of the professional certificate for design—consulting. The second (B) and the third (C) level are awarded to an individual engineer 8 or 12 years, respectively, after his graduation and having certain amount of experience in the particular field. The first level certificate corresponds to one design—consulting unit, while the second and the third are equivalent to two and three units, respectively. The fourth (D) and the fifth (E) levels of the professional certificate are awarded only to companies with certain number of engineers with professional certificates. For the fourth level, seven design—consulting units are required, including at least one engineer of the third level. For the fifth level, 12 design—consulting units are required, including at least one engineer of the third level and one engineer of the second level.

For the construction certificates there are four levels for the individual engineers and seven levels for the engineering companies, each one formed by a certain number of professionally certified engineers.

Geotechnical design—consulting in Greece consists of geotechnical investigations and evaluation of their results, design of foundations, retaining structures, dams, tunnels and of any other geotechnical structure. The design—consulting professional certificates for geotechnical projects are awarded mainly to civil engineers and secondly to mining engineers and, recently, to geologists. There are also few engineers from other specialties, who hold professional certificates for geotechnical projects.

There is a big dispute for the award of geotechnical professional certificates to geologists, which has been imposed after a presidential decree. The Technical Chamber of Greece and all the Engineers Associations strongly opposed it. This is due to the fact that the geologists (even the greatest majority of the engineering geologists from Universities abroad) have knowledge only of site investigations and no knowledge of engineering design, which forms the greatest part of the geotechnical practice in Greece. The Engineers Associations have appealed to the High Court on the basis of lack of the required knowledge and are awaiting resolution of this dispute.

University professors are not allowed to hold a professional certificate either for design—consulting or for construction. Hence, it is not possible for them to acquire design—consulting projects directly from the public sector. However, they are allowed to work through the individual designers—consultants or through the engineering design—consulting companies.

Table 3 shows the individual engineers and geologists with professional certificates for design—consulting in geotechnical projects. Out of the total number of 810, 278 belong to the 99 engineering companies offering design—consulting services in geotechnical projects. Table 4 shows the engineering companies with professional certificates for design—consulting in geotechnical projects.

Table 3. Engineers and Geologists with Professional Certificate for Design—Consulting in Geotechnical Projects

<table>
<thead>
<tr>
<th>SPECIALTY</th>
<th>LEVEL A</th>
<th>LEVEL B</th>
<th>LEVEL C</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil</td>
<td>252</td>
<td>89</td>
<td>148</td>
<td>489</td>
</tr>
</tbody>
</table>
Participation in biddings for design – consulting geotechnical projects is allowed to the different levels of professional certification depending on the project budget. So, a company with Level E certification cannot participate in a bidding for a project with low budget and, similarly, an individual engineer or a company with Level A certification are not allowed to participate in biddings for projects with high budget.

Table 4. Engineering Companies with Professional Certificate for Design – Consulting in Geotechnical Projects

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27</td>
<td>12</td>
<td>25</td>
<td>7</td>
<td>28</td>
</tr>
</tbody>
</table>

During the last decade, many big infrastructure projects were constructed in Greece, providing geotechnical engineers with unique challenges and valuable experience. This fact is reflected in the sharp increase of the number of papers submitted in the last two Hellenic geotechnical conferences, particularly in the current one (see Fig. 1), as well as in the number of papers submitted by non academic geotechnical engineers (see Fig. 2).

4. CLOSING COMMENTS

Geotechnical engineers in Greece form a relatively close-knit community, which has the opportunity to meet as a group and discuss geotechnical practice and research issues in the events organized by the Hellenic Society of Soil Mechanics and Foundation Engineering, which include a Hellenic Geotechnical Conference every four years, and by the Geotechnical Committee of the Technical Chamber of Greece. Although geotechnical practice issues and examples are of interest to all, that is faculty members, contractors and consultants, issues of geotechnical engineering education are discussed mostly among academicians. The authors of this report, representing both industry and academia, express the wish that the wider geotechnical community engage actively in discussions on geotechnical engineering education.

Acknowledgements: The authors thank Professor S. Tsotsos from AUTH, Assistant Professor I. Markou from DUTH and Associate Professor P. Dakoulas from UT for their prompt response and input on their respective Departments.

REFERENCES


Department of Civil Engineering at NTUA:

Department of Civil Engineering at AUTH:
http://www.civil.auth.gr/eng/

Department of Civil Engineering at UP:
http://www.civil.upatras.gr/Ekpedeysh_gr/UGGen_Info_en.htm

Department of Civil Engineering at DUTH:

Department of Civil Engineering at UT:
http://www.civ.uth.gr/indexenglish.html