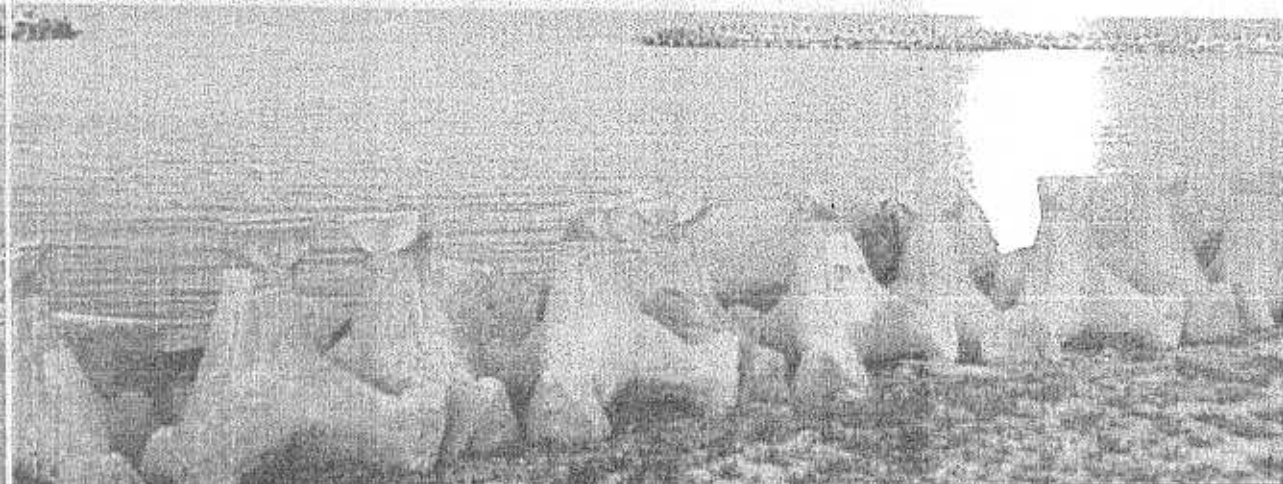


EDUCATION AND TRAINING IN GEO-ENGINEERING SCIENCES

**Soil Mechanics, Geotechnical Engineering,
Engineering Geology and Rock Mechanics**

Iacint Manoliu & Nicoleta Radulescu – editors



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A BALKEMA BOOK

Engineering geology at University Complutense of Madrid: 30 years of postgraduate courses

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ABSTRACT: Engineering geology and geological engineering has been taught at the University Complutense of Madrid during the last 30 years throughout a postgraduate course from 1979 to 1989 and a MSc course from 1990 to present time (2008). Over 250 students have been awarded with the MSc degree in geological engineering. A detail description of the educational system is presented, consisting in a two years long course which includes fundamentals of geo-engineering disciplines: engineering geology, soil mechanics and rock mechanics, along with applied engineering geology and geotechnics. A well balanced programme of teaching and training including field and practical work and 3 months of practice in consulting or construction companies is shown. Presentation of a thesis and examinations are requested to obtain the MSc degree. Experience during this long period of education and training, academic achievements and insertion on professional practice are presented.

1 INTRODUCTION

The Complutense University of Madrid (UCM), one of the oldest universities in Europe and the biggest of Spain, holds a Faculty of Geological Sciences which at present time offers two degrees, one in Geology ("Licentiate" in Geological Sciences) and other in Geological Engineering (Geological Engineer), both lasting five years, although in the immediate future it will be reduced to 4 years due to Bologna Declaration.

The first postgraduate course in engineering geology in Spain was organized in UCM in 1980. This was an introductory course, which provided an introduction to soil and rock mechanics, site investigations and applied engineering geology to civil engineering. This course expanded over 140 hours, including theoretical and practical lectures. The number of students ranged from 15 and 20 per year and most of them came from a geological background. After 10 editions, this postgraduate course was transformed in 1990 into an MSc degree in Geological Engineering, lasting two academic years. Nine editions of this MSc have been carried out until 2008.

The MSc course is mainly addressed to geologists who are looking for a professional qualification in engineering geology or need to improve their engineering geological knowledge. It is also offered to civil or mining engineers who need to know the geological

applications to engineering and geotechnics, and the methods of analysis and resolution of geological related construction problems.

In the following sections a description of this MSc course is included. Further information can be obtained in: www.masteringenieriageologica.com/ or request to: master@geo.ucm.es.

2 MSc COURSE PROFILE

2.1 Objectives

The MSc on Geological Engineering is based on the principles of engineering geology and its methods to solve geological problems involved in the project, construction and operation of engineering works, and to prevent, mitigate and correct geological hazards.

The main objective of this course is to provide theoretical and practical training in geological engineering. Students who pass the course should be capable to solve the following issues:

- 1 Where to site a civil engineering facility or industrial plant being geological secure and economically feasible.
- 2 Where to project communication or transportation infrastructures to assure favourable geological conditions.

- 3 The geological and geotechnical conditions under which building foundations must be designed.
- 4 How to excavate a slope to be stable and economically feasible.
- 5 How to excavate a tunnel or underground facility to be stable.
- 6 Availability of geological materials to built dams, embankments, roads, etc.
- 7 Ground treatments to prevent or correct seepages, subsidence, settlements, landslides, etc.
- 8 Under what geological conditions and materials can be stored toxic, urban or radioactive wastes.
- 9 How to control or prevent geological hazards (earthquakes, landslides, etc.)
- 10 What geologic and geotechnical criteria must be taken into account in land use and urban planning and to mitigate environmental impacts.

2.2 Course activities

The MSc course has duration of 500 hours (50 credits), divided into two academic years, starting in October of an even year and ending in June of the next even year.

The first year is divided in two periods: 1) Theoretical learning on fundamentals and methods in engineering geology, practical learning on laboratory, course work and practical exercises; 2) Applications of engineering geology to foundations, slopes, tunnels and underground excavations, dams and geological hazards.

During the second year the following activities are developed:

- Training period in a company
- Field work
- Tutorials
- Master thesis
- Examinations.

2.3 Admission

Qualify applicants must fulfil the following requirements:

- A first degree in geology, earth sciences, civil or mining engineering
- No professional experience is required, although advisable
- Fluent Spanish and acceptable level of English language are required.

Maximum number of students admitted per course is 30.

2.4 Certificate award

To obtain the Master of Science degree in Geological Engineering from University Complutense of Madrid, it is required to pass examinations, to present a master

thesis, to keep a regular attendance and to carry out properly the course work.

2.5 Job opportunities

The main sources of employment for MSc graduates in geological engineering are consulting firms in geotechnics, civil engineering and contractor companies. More than 90% of the engineering geologists/geological engineers usually get a job before the MSc course ends. Several national agencies and technical institutions of Spain also offer opportunities for our postgraduates.

This MSc course is also recognized by UNESCO as Advanced Course in Earth Sciences and it is recommended in its international program.

3 STUDY PROGRAMME

3.1 Syllabus

- Soil mechanics. Soils in geological engineering. Geotechnical behaviour of problematic soils.
- Rock mechanics and geomechanical behaviour of rock masses.
- Hydrogeology applied to geological engineering.
- Methods in geological engineering and site investigations. Geotechnical mapping.
- Applied geological engineering.
- Construction materials and earth structures.
- Foundations.
- Reservoirs and dams.
- Slopes and surface excavations.
- Tunnels and underground excavations.
- Ground geotechnical treatments.
- Prevention and mitigation of geological hazards.
- Geological engineering in civil engineering projects.
- Case studies.
- Codes and legal regulations in geo-engineering.

3.2 Field work

During the course several field trips are organized. One-day visit to sites near Madrid are often carried out, and 5 days long trips to other regions of Spain and abroad are also carried out. Emphasis is focussed on civil engineering works under construction, e.g. tunnels, motorways, open pit and underground excavations, etc. Visits are also organized at consulting companies, laboratories and geotechnical contractors.

Field trips always raise a great interest and learning achievements. Some examples of technical visits have included Athens Metro, Lisbon Metro, "Vasco de Gama" bridge in Lisbon, high-speed railway system in northern Italy including the Bologna-Firenze line, Vaiont dam etc. Tunnels of Guadarrama (28 km long),

Pajares (30 km long) and Madrid Metro in Spain, are some examples of large infrastructures constructions visited.

3.3 Training activities

Training is one of the most important aspects carried out during the course. Training is provided throughout the following activities:

- In-house practical work on case histories presented by experienced practitioners in geological and civil engineering; some of them former alumni from the MSc course. The students have to present reports including solutions and recommendations, which later on are discussed with the lecturers.
- Technical visits to engineering firms, contractors and projects under construction.
- A training period of three months in a company is compulsory for students without previous experience. Course staff organizes this training period with the help of professional associations.

UCM administrative staff provides to the students an insurance to cover accidents, and a contractual agreement between the student and the employer for this training period. Although in this agreement it is not stated any economical compensation, most companies provide a basic salary for the students.

3.4 Master thesis

One of the requirements to obtain the Master of Science degree is the successful completion of a thesis. The aim is to deepen on an important aspect of geological engineering.

The student should include a literature review, summary of the state of the art and application to a case history. Students must demonstrate their capacity for analysis and synthesis, good knowledge on the subject and sound scientific basis for technological development and practical applications. Emphasis is also given on the way of presentation, use of appropriate terminology and written style.

Thesis must be completed during the second year of the course.

4 RESEARCH AND PH.D.

Besides the MSc course, engineering geology at UCM also offers a full program on research leading to obtain the Ph.D. degree and the Certificate of Advances Studies.

The main research fields related with engineering geology include the following issues:

- Engineering geology and rock mechanics applied to tunnelling.

- *In situ* stress.
- Rock mass classifications.
- Engineering geology of volcanic soils and rocks.
- Earthquake hazard analysis.
- Landslides and slope stability.
- Socio-economic impacts of geological hazards.
- Geotechnical mapping.
- Properties of expansive and over-consolidated clays.

Detailed information on the research programme and the requirements for doctorate can be found in: www.ucm.es/info/geodina/docencia/ingenieriageologica and www.ucm.es/centros/webs/fgeo/

5 RESULTS

After 3 decades of teaching and training experience on engineering geology, some data and results can be shown, as representative of the situation, conditions and achievements under which the higher education on this field has been developed at UCM.

During the period 1990-2008 more than 250 post-graduated students have been awarded by the MSc degree. Average number of students per year has been 29, ranging from 17 to 36 under exceptional conditions.

Age distribution shows that more than 80% were under 30 years old. Most of the students (60%) did not had previous experience on engineering geology. 60% of the students were male. More than 90% came from Spain and the rest came from European and Latin American countries.

More than 80% of the students have successfully passed the examinations. MSc theses were evaluated by external examiners who have marked the thesis with an average of 7 points over 10. Many of the theses have been published in journals.

In relation with employment, it can be said that there is no unemployment among the UCM-MSc engineering geologists. Most of them got his/her first job before the end of the course.

A fluent communication between employers and course staff has been an important aspect for the course achievements, including career orientation. Good integration of UCM-engineering geologists within civil engineering companies, use of a common technical language and jointly cooperation between employers, civil engineers and engineering geologists have been key factors, not only for job opportunities, but also for the excellent acceptance in the engineering industry of the new professionals.

Different inquires among employers, students and practitioners during the last decade support these results.

ACKNOWLEDGEMENTS

MSc course on engineering geology at UCM has been a long and hard task kept on during almost 20 years. It has been possible thanks to the enthusiastic and volunteer cooperation of many colleagues and institutions, which have provide qualified and experienced lectures on many fields related with geo-engineering. It should be too long to list all of them, but some must be cited: Laboratorio de Geotecnia-CEDEX, Colegio Oficial de

Geólogos and Asociación de Ingeniería Geológica de España (AIGE).

Although this MSc course is carried out in Madrid, many colleagues from outside Spain have contributed very significantly, lecturing in Madrid and helping during the field trips in Italy, Portugal and Greece. We are very grateful to all of them, particularly to Prof. Ricardo Oliveira from Portugal, Dr. Michael de Freitas and Prof. Mike Rosenbaum from UK and Dr. Marino Trimboli from Italy.