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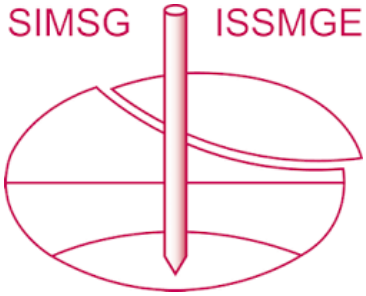

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Education, training and learning in geo-sciences for civil engineering

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ABSTRACT: The qualification level of a graduate in Civil Engineering is associated with vocational competences which involve the application of knowledge in an extended area of professional activity. Geosciences are the very core of effective interaction between constructions, community development and urban planning. Modeling in Soil Mechanics and design in Foundation Engineering has reached the point of being performed as a rigid mechanism of routine calculations and thus, judgment errors led to inappropriate solutions for infrastructure works. Geology, Geotechnical and Foundation Engineering should work together in both education and training of undergraduates in Civil Engineering in order to solve proper idealization of the real site conditions when deciding design solutions.

1 INTRODUCTION

The last two decades of economical and social developments in Romania re-designed the educational strategies at all levels, university included.

In 2005 a major change was made in the higher education system by adopting a system essentially based on three cycle degrees, bachelor, master and doctorate. In Civil Engineering the 1st cycle with a duration of 4 years for bachelor-level studies, the 2nd cycle of 1.5 years for master-level studies and the 3rd cycle of 3 years to obtain the doctorate degree.

The 1st cycle – undergraduate level in Civil Engineering at the Technical University "Gh. Asachi" Iasi, Romania is organized in two stages with a total of 240 ECTS:

- the first two years with a curricula common for all specializations consisting in general engineering subjects;
- the following two years with a curricula designed for each specialization: Civil, Industrial and Agricultural Constructions; Railways, Roads and Bridges; Urban Development.

The teaching is offered in both maternal language and English for the specialization in Civil, Industrial and Agricultural Constructions.

There are students that at the beginning of the 3rd year of education decide for a part-time or full-time employment; our faculty board designed a specialization based on evening courses with the same number of ECTS (240) and 5 years duration.

The 1st cycle is graduated based on a license examination to obtain the bachelor degree that represents a certification to access the labour market and a break-point to enroll into the 2nd cycle.

The specific competences a student in Civil Engineer is expected to develop are the followings:

- an ability to identify, formulate and solve common civil engineering problems,
- an understanding of the elements of project and construction management of common civil engineering works;
- a recognition of the need for, and the ability to engage in life-long learning,
- an ability to use techniques, skills and modern engineering tools, including IT, necessary for engineering practice,
- an understanding of professional and ethical responsibility of civil engineers.

Geotechnical Engineering is a compulsory course that is developed with a different content for each specialization, with a total number 56 contact hours and represents the basic concepts and engineering tools to solve common problems in this field. Curricula consist also of a compulsory course in Foundation Engineering with 70 contact hours. Elective courses in the field of Geotechnical Engineering are designed to provide an intermediate level of understanding and solving problems.

2 GEOTECHNICAL ENGINEERING EDUCATION

Since the course Geotechnical Engineering is followed by the course of Foundation Engineering, the first one is more theoretical oriented with laboratory works focused on the basic properties of soils obtained from laboratory tests on soil samples.

The applied knowledge in Geotechnical Engineering is involved more in the project works as applications in Foundation Engineering.

Although the course is intended to offer the basic knowledge as concepts, models, theories and practice in the field of Geotechnics, its content is comprehensive in all aspects of soil behavior:

- Elements regarding the formation of rocks
- Composition and characterization of soils
- Hydro-geological conditions and elements of soil hydraulics
- Compressibility of soils
- Stress state in soil masses
- Settlement of constructions
- Shear strength of soils
- Man-made and natural slope stability
- Active and passive earth pressure of soils
- Calculus of the foundation soil

The course is delivered in the 3rd academic year where students are almost in the middle of their university studies and they expect to receive very structured information where their contribution is only to memorize and adopt the technicalities of solving problems as for calculus oriented subjects. They are used with the term "lecturing" as teaching so that they expect to have solutions delivered as the course object for any potential problem to come.

The course in Geotechnical Engineering is more difficult to cope with when trying to create a flowchart of solving situations. The course is opening the arena of engineering judgment over choices in infrastructure works that is challenging for students but at the same time requires a solid reading and understanding beyond the limited amount of time the course itself is providing in the curricula.

The change made in education as being nowadays student centered is forcing the student to become the active person he or she is not used to be and thus there is a certain difficulty to enroll in learning this course.

It is also a dangerous path when opening discussions over choices an engineer should consider because the limit between the technical benefit and the cost efficiency is blurred at this stage (economy of construction is a course in the 4th academic year) and money issue is strong for young people especially in countries where people still have to learn the solid path of a competitive market.

Many of these students have had especially for the summer time the experience of a part time job in the construction field and faced situations where the cost dictated over the technical solutions. They come in class with this experience and participate to discussions with the certitude that what they witnessed is good since it is already applied and nothing wrong happened.

In this respect, the local authorities in construction policy should become more responsible for the work quality of the companies performing both design and performance of infrastructure works.

Site visits are very important for the course of Geotechnical Engineering since infrastructure works are hidden for the public eye and the real dimensions of the problem are better perceived than from drawings only.

Since the 90's teachers from the university have been actively involved in providing consultancy work on site constructions. Many comments have been generated over the benefit of such activity for the university itself. Nevertheless, the experience such consultancy generated over the last 15 years for the teaching staff was displayed over the teaching approach and the enthusiasm of presenting case studies where they have been actively and successfully involved. Also, site visits have been easily organized and field trips in remote locations of industrial works.

One of the great challenge in teaching Geotechnical Engineering at present is to maintain confidence in predicting soil behavior when so much empiricism is involved, connecting dangerously some of the time the reality with some available theories. The outcome may be that students can loose confidence in the scientific aspect of Geotechnics and consider that oversize in respect to dimensions can counteract the lack of the geotechnical investigation of the site.

It is often recognized that mathematics is ruling the rigor in engineering and is blindly applied to Geotechnics as well. As the rigor of observation of physical and mechanical phenomena is not trusted to develop the required logic in solving a problem, even general practitioners tend to consider this field of knowledge as governed by numbers, linking routine investigations with design codes.

Many books have been published lately for the students and graduates as well in the field of Geosciences (Geology Engineering, Geotechnical Engineering, Foundation Engineering and other field related subjects). The most searched for are the ones in Foundation Engineering because they suppose to present "recipes" to solve daily problems on the construction site. Books with examples to compute particular values to predict soil behavior at some stage of construction development are considered as "laws" to follow.

The engineer graduating the Geotechnical Engineering course is more interested on "how to do" disregarding the "why's" involved in the problem. Methods became more important than concepts because of the pressure created by the deadline of the work and thus experience is only acquired in numbers involved. It is considered best to repeat concepts from various perspectives and/or to link soil mechanics concepts with those the students meet in everyday life.

In Romania, developments and new strategies are taking place in industry, constructions included, agriculture, health, education, law and finance. Changes occur sometime in expected ways and education is trying to accommodate the rate of change in economy so that the graduates fit the labor market demands at present.

Geotechnical engineers are in great demand nowadays but few of the graduates are devoted interest towards Geotechnical Engineering. Local companies for site investigation, design and performance of infrastructure works are slowly developing since the initial investment in logistic is difficult to cope with and the public opinion is still not granting this field the importance it deserves to ensure the safety of constructions.

As in any other field, the value of knowledge in Geotechnical Engineering should be determined by the quality assessment. When discussing on the topic of what quality means, the arguments reveal that there is a gap between the academic perception and the one of the practitioners and mostly between creativity measured in depth or in width. One of the competences a graduate should possess according to questionnaires addressed to employers is to take decision in solving any situation at the site and thus to be creative. In order to reduce the gap in perceiving the quality of knowledge the student/graduate has to be aware first of the harmony existing between relevant scientific and social issues at stake.

3 EUROPEAN COOPERATION IN GEOTECHNICAL ENGINEERING EDUCATION

Since the 90's, the European mobility of both students and teaching staff increased in number but also in the multiple cooperation programs that have been created to experience and overcome educational and social differences between countries.

The Tempus JEP 2776 initiated by the Technical University of Civil Engineering from Bucharest, under the supervision of Professor Iacint Manoliu created the first professional European cooperation in the field of Geotechnical Engineering.

Seminars and training stages for the teaching staff created opportunities for professional development for all persons involved and individual agreements of future cooperation that reflected afterwards in Erasmus/Socrates partnerships.

Students had opportunities to develop their diploma work in universities where Geotechnical Engineering is high ranked among the core subjects in Civil Engineering, to broaden their horizon and have the satisfaction of being adopted by another society.

All Romanian Faculties of Civil Engineering developed educational programs taught in foreign languages: English, French or German. They have offered the possibility for in-coming students to study subjects of Civil Engineering as in any other country in Europe.

The European dimension of education in Civil Engineering has been enhanced by the beginning of the Bologna process together with the initiation by professor Manoliu of the European Civil Engineering Education and Training program (EUCEET) where the Faculty of Civil Engineering from the Technical University "Gh. Asachi" of Iasi is one of the partners.

It is still difficult to harmonize and therefore to acknowledge diploma from different universities across Europe but there are institutions at work to facilitate the cross-border mobility of experienced engineers.

One step further is created by multinational companies in the field of Geotechnical and Foundation Engineering that opened representative offices in Romania, contracted infrastructure works and employed national labor force, engineers included to manage field projects in various locations all over the country. Many of them have been delegated to manage projects over-seas and by this, their diploma and experience have been acknowledged at the international level.

One of the benefits when working in such companies is the experience of continuous learning as the first step of a lifelong learning process. The short term courses organized by the companies to train its employees with the latest concepts, software or equipments involved in their daily activities are beneficial for all the persons involved, teachers included, since interaction with practitioners are creating for themselves some stage of lifelong learning process and also to adapt courses for undergraduates to a different perspective demanded by the labor market.

4 EXPECTATIONS AND TRENDS

Computers opened the possibility to develop new didactical methods. Geotechnical knowledge can be transferred to students via computers as it happens in many other aspects of life. The question is to what extent the human factor is playing an important role?

In Romania, ICT (Information and Communication Technology) is not uniformly involved in education. In universities computer is present and it became a routine equipment to access information but also to perform tasks during classes or home assignments.

Geotechnical Engineering is still using ICT to provide mainly learning material that is entirely the responsibility of the teacher. The teacher is becoming more a coach, to train the student in having the basic knowledge on the subject of interest. Along with changes in teaching approach the evaluation

should change as well. This is also related to the competences the education program has to provide in a graduate of that particular course so the responsibility of the teacher lies actually in assessing in such a way that competences are confirmed.

Although it seems difficult to implement Computer Based Instruction (CBI) in Geotechnical Engineering, Professor Sharma proved in his paper (Sharma, 2000) that it is possible and provided enough reasons to pursue this issue.

Research on education trends is clearly indicating that the development of education is orientated more and more on web-based delivery rather than CD modules. Until this trend will be a must in education, traditional techniques will be slowly turned into more interactive tools, where motivated students can find enough interest for learning and competing in groups rather than try as individuals to learn the content of the subject involved.

5 CONCLUSIONS

Geotechnical Engineering is a very challenging profession due to the fact that there is no "100% safety" and it always involves a calculated risk over the construction works. The competences of a graduate refer to understand not only the technicalities of the profession but also economical and political relationships, to have social skills and to be fully aware of the consequences his/her engineering decisions may induce for environment.

The responsibility for the effectiveness of the knowledge in this field is shared by the professor for the teaching and assessing part, the university to provide the logistic the course needs, the students for the learning process, and by the stakeholders when setting demands over the competences required for the graduate.

The infrastructure for the teaching activities is set on a development path regarding the laboratory equipments and facilities, bibliography available in libraries, computers to perform tutorials and access information.

Computer based instruction for the undergraduate level should be an alternative to other teaching techniques since there are still limitations apart from the benefits involved. The lifelong learning process on the other hand is more related to the computer era since involves access to resources available on the internet. Also the communication is important for professionals that join associations to share experience, exchange information and facilitate solutions to problems and in this respect little can be done without the help of computers and internet.

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