TUNNELING STUDIES IN THE FACULTY OF CIVIL ENGINEERING AT THE BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS (BME)

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1 Introduction

In my lecture I would like to present tunnelling studies in the Faculty of Civil Engineering at the Budapest University of Technology and Economics (BME). I would mostly use my own memories and information, unfortunately it won't be possible to give an entire discourse.I sincerely hope, that those who won't be able to follow the lecture, and those who would think I should have talked about other things or references in detail, will excuse me. I am going to briefly present the past of tunneling studies, its present a bit more in detail and I am going to highlight some important points about its future as well. Scientific student association activities, diploma writingactivities and doctoral studies are going to be mentioned as well.

2 The past

As I have already mentioned in the introduction, I am going to use merely my own memories. They do not include Károly Széchy, who has not only become a well-know representative of the art of theoretical and practical tunneling studies for the academical circles but also all around the world. No technical book in tunnelling can be ever published without mentioning his grandiose *The art of tunneling* in the bibliography. Unfortunately, he passed away before I got to the University.

Károly Széchy, Géza Petrasovits, Miklós Müller

After his death, Géza Petrasovits took over teaching the course entitled Classical Subterranean structures (two lectures and two seminars).He obtained his theoretical qualifications during his studies in the Soviet Union and got technical experience during the metroline constructions of Budapest which took place during the fifties. We used his notes, and after he retired, he and co-authors György Fazekas and Frigyes Kovácsházy have produced an excellent book entitled *Constructing and Implementing urban subterranean structures*, a book we still use in education today. Unfortunately, this author trio is not amongst us today either anymore.

My seminar teacher, Miklós Müllerwas the next one to take over teaching the course, he gave the seminars with János Lőrincz and myself. During the reorganization of Education (Építő 2000), the course entitled Subterranean structures (studied by all students studying structures) has become part of Geotechnics, which itself has become a track.With six lectures and two seminars per week, it took 40 percent of the fourteen-week semester, complementing the topics of terranean statics, soil dynamics and international designing methods.

3 The present

3.1 BSc programme

With the introduction of the three-year programme tunnelling studies have been divided into two sections. Today the seventh and eight semesters include the subjects which are part of the eight-semester long study and which have to be completed after the general civil engineering programme (Soilmechanics, Earthworks, Groundwork).

3.1.1 Subterranean structures, deep groundwork

During the Structure-civil engineering track, at two thirds of the semester,

- in the sixth semester,
- three hours of lecture and one hour of seminar per week can be attended and,
- the above-mentioned subject can be studied for 4 credit points.

This means more or less 150 students. Since, by this time many of the students have not followed the curriculum, the subject is lectured in every semester. At first, Miklós Müller was the lecturer of the Subterranean structures part of the subject, from spring 2011 I am going to take over his work. The schedule is adjusted to the seminar assignments, which are not always specifically about tunnelling:

- pier piling,
- securing the excavation pit with diaphragm wall.

The second assignment is included in the category of subterranean structures, thus theoretical studies had to precede the seminar.

On the one hand, the topic is too wide compared to the available amount of time, on the other hand only a small part of students will deal with this topic more deeply in professional life, so we primarily want to give a general overview of tunnels. The lectures deal with the following topics:

- load and usage of wallwork in tunnels constructed using open and closed method;
- vehicular, public utility and metro tunnels;
- closed method construction.

Whenever it is possible, site visits are also included in the training, in this matter we are very thankful to the Vásárhelyi Pál dormitory. On TV channels dealing with natural science and while "surfing" on the internet we can find several films, out of which the following ones were screened during this year's spring term:

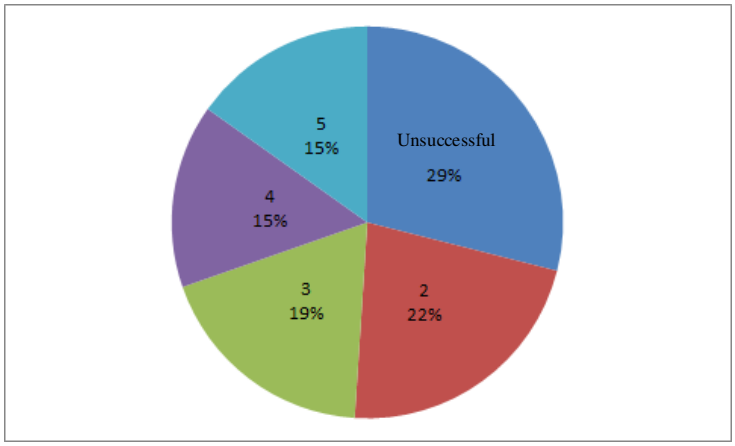
- The Boston superconstruction;
- Lefortovo (security camera recordings on accident possibilities);
- Big, bigger, the biggest: the London tube.

On the one hand, these films let us see such details that aren’t visible even at the most well guided site visits, and on the other hand the whole process can be followed from the first conceptions (which can be a hundred years old), to the first challenges met during the operation, which can be seriously instructive.

We decided with József Farkas, teacher and lecturer of the Deep groudwork part, not to keep any list of names during the course. This predetermines attendance, which also depends on the following factors:

- The course is compulsory even for those who intend to follow their studies in building construction;
- As I have mentioned above, by this time many of the students do not follow the curriculum as prescribed, which means several times they need to choose between two courses;
- Many of the students have jobs in their sixth semester, thus they only attend the courses that are the most necessary for them.

Unfortunately, this is also reflected in the results. Their unsuccessfullness is mostly due to the fact they could not deal with the simple numerical problems and in a wider sense, they felt it difficult to adjust their minds from the once practiced static problems to geotechnical problems. Assessment is done on the basis of two drawing exercises and two tests (the second one in our topic).



Subterranean structures and deep groundwork – results of spring term 2012

3.1.2 Tunneling

Geotechnics track,

- During the seventh, namely the panultimate, pre-diploma semester,
- two hours of lecture and one hour of seminar per week can be attended and,
- the above-mentioned subject can be studied for 3 credit points.

For this course, the amount of students is considerably lower; they were no more than 43 last fall. Based on and extending the learning material (Subterranean structures) of the previous semester, we deal with the following topics:

- load and usage,
- traditional and finite element calculations,
- preparatory works,
- tunnel types
  - vehicular tunnels,
  - metro,
  - urbantunnels,
- wallworks in tunnels, coatings,
- construction methods,
- monitoring.

Yet again, we try to enlarge the students' knowledge by screening films and organizing site visits. Last years' films:

- Let us understand: Tunnels
- SMART tunnel
- Grubbing (digging)
- Big, bigger, the biggest: Tunnels

Whenever the opportunity presented itself, we invited guest speakers to the lectures.. Some examples:

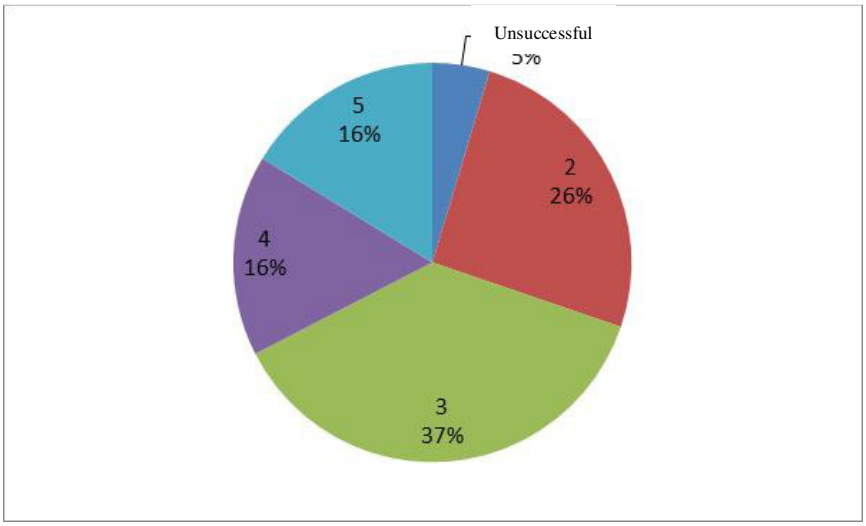
- Eszter KálmánHorváth, DBR MetroProject management (Tunnel monitoring);
- Gusztáv Klados, DBR Metro Project management (Riskmanagementduring bigtunnel constructions);
- Csaba Pethő, UVATERV (The construction of the Kálvin square metro stop)

We publish the lectures of the Hungarian Tunnelling Association, and we award attendance with extra points for the subject and for the Master programme as well.

During the seminar, the students have to prepare the general blueprint of one section of a scutal built and circularly sectioned tunnel (under Dávid Turi's supervision for the time being), using the traditional method of loadings and static sizing and calculating the sagging of finite elements (utilizing the prototype of the Plaxis programme). The students may write a paper using advised and owned ideas, so they can improve their final marks. Last year's essays are as follows:

- The Gibraltar tunnel
- The Athens metro construction
- Tunnels containing hazardous and radioactive waste
- Elaboration of professional films

Results (based on two tests, one drawing exercise and one exam) are considerably better, thanks to the more specialized, more profession-oriented students.



Tunnelling – results of fall term 2011

3.2 MSc programme

Unfortunately, in the MSc programme, the is no tunnelling–related subject per say. To my eyes, the above-mentioned subject entitled Tunnelling should have its place in it.Within the Structural engineering MSc programme, the students can attend lectures on tunnels within the Trussing (holding) and geotechnical engineer and also within the Geological engineer tracks.

Unfortuately, we cannot set up BSc leveled pre-schooling requirements, thus students attending the subjects called during this MSc, did not study Tunnelling at all.

- Geotechnical case studies

  Can be attended in the first semester, in two hours of lectures per week, valued for 3 credit points; one third of the material is about tunnels, the lecturer is Professor Müller. Topics are as follows:

  - Sizing metro tunnels,
  - Damage and reconstruction of vehicular and railway tunnels.

- Lectured by myself: geotechnical numerical methods.

  In the second semester, 1 hour lecture and 1 hour seminar per week, for 3 credit points. Students in small groups have to resolve problems that of which some concern static examination of tunnels with finite element 2 and 3d methods. This year's spring semester conatained the following tunnel-related problems:

  - New Austrian Technique tunnels, wallwork usage;
  - Shear strength conditions of endwall stabilityin case of undergrade crossingsforged through under levees
  - Sizing of levees (closing of stulms)

4 Scientific student associations (SSA), diploma and doctorial activity

In the last few decades, only a few SSA dissertations dealing with tunneling were submitted at the Department of General and Higher Geodesy, the Department of Construction Materials and Engineering Geology and the Department of Geotechnics of the Faculty of Civil Engineering. This topic is not especially popular, not even amongst the students taking part in the doctoral programme. The last one to achieve all the requirements and to defend their doctoral degree was Eszter Kálmán Horváth with her dissertation entitled *Tunnelling in the clay of Kiscell*. In the doctoral programme, it is also Miklós Müller who is responsible for the „tunnelling part".

Final dissertations dealing with actual Hungarian tunnelling problems are published and successfully defended every year, both at the end of the BSc and the MSc programmes. The topics of the last few years are as follows:

- Metro line 4, tunnels and stops
- M6 Highway (Bátaszék, Geresd, Baranya, Véménd)
- The National Radioactive Waste Disposal at Bátaapáti
- Urban tunnels

We assign these exercises and problems with the help of tunnelling and tunnel designing companies, thus the students who successfully submit their dissertations are in posession of a solid and sound knowledge when leaving the University.During the final examination in the field of geotechnics they can get the following questions:

- Static examination of tunnels;
- Structural solutions for tunneling works;
- Tunneling methods.

5 The future

The future of tunnelling studies is, fittingly to the topic, actually in the dark. We need to find the person or people who will continue Professor Müller's and my work on a long term

basis.We definitely need a person on „the inside”, but there was no volunteer for it yet. It is not likely to work with an external part-timer, due to the required amount of work and the academic compensation system the transit between education, designing and construction are merely one-way, subsequently not pointing towards the University. It is possible that the person resolving this issue will arrive from another department or another university, but one thing is sure: this person will not posess Professor Széchy's, Professor Petrasovits's or Professor Müller's experience.