Selected aspects of teaching geo-engineering sciences at the Faculty of Civil Engineering, Warsaw University of Technology

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ABSTRACT: Geo-engineering sciences is a major component of civil engineering courses at the Faculty of Civil Engineering, Warsaw University of Technology. This paper presents the integration of subjects related to geo-engineering subjects, its purposes and format of the procedures used to teach it. Some examples of good teaching practice are presented.

1 INTRODUCTION

Geo-engineering sciences (with encompasses soil and rock mechanics, engineering geology, foundation design, ground engineering methods, underground constructions, etc.) is a major component of all civil engineering courses. Teaching Geotechnical Engineering to future civil engineers is somewhat different from teaching other disciplines. In fact, geotechnical engineers have to deal always with different materials, mostly with high degree of heterogeneity and sometimes with soils characteristics and groundwater conditions varying along time.

In order to enable the students to relate the basic topics they have learned in the soil mechanics disciplines with real geotechnical works, it is necessary to confront them with somewhat easy, but real cases and to help them solving these problems. The faculty members who better fulfil this task are teachers with long professional practice.

This paper presents the integration of the subjects related to geo-engineering sciences of the course in civil engineering degree at the Faculty of Civil Engineering Warsaw University of Technology, its purposes and format of the procedures used to teach it. Afterwards it is emphasized the teachers experience as well as the students feedback.

2 GEOTECHNICAL SUBJECTS IN CIVIL ENGINEERING STUDIES

2.1 *B.Sc. level – 1st degree*

Study programme at the Faculty of Civil Engineering, Warsaw University of Technology is 4+2 model for B.Sc. and M.Sc. degree. One can find geotechnical subjects on both levels. The subjects are related and connected to a number of other subjects. On the 1st study level there are the following geotechnical and related subjects:

Engineering geology – sem. 4
- Related subjects:
  - Chemistry – sem. 1
  - Building materials I – sem. 2
  - Building materials II – sem. 3

Soil mechanics – sem. 5
- Related subjects:
  - Engineering geology – sem. 4
  - Strength of materials II – sem. 4
  - Structural mechanics I – sem. 5

Geotechnical engineering – sem. 6
- Related subjects:
  - Strength of materials II – sem. 4
  - Structural mechanics I and II – sem. 5,6

Underground constructions I – sem. 7
- Related subjects:
  - Strength of materials II – sem. 4
  - Structural mechanics I and II – sem. 5,6
  - Soil mechanics – sem. 5
  - Geotechnical engineering – sem. 6
  - Concrete structures I and II – sem. 5,6

The programme of four geotechnical subjects is a base for further study on the 2nd degree of studies. Usually we have about 150 students (per year) on fourth year of studies and only 1-3 from them do the diploma work in the field of geotechnical subjects. They prefer other areas on construction, management and communication engineering. Why ? The possible reason is that deep studies of the geotechnical subjects are too difficult for them.

Typical is a conflict between geotechnical subjects and mechanics. In "Strength of materials", "Structural mechanics" it is not possible to teach nonlinear mechanics, which is necessary for geotechnical subjects.
Detailed programme of geotechnical subjects on the 1st degree of studies is the following:

Engineering geology
Geological sciences.
Engineering geology aims, geological processes and their partition.
Internal geological processes and their phenomena.
External geological processes, general characteristics, weathering of the rocks.
Engineering-geological conditions on the weathered debris covers.
Karst and its results.
Glaciers activity and their deposits.
Engineering-geological conditions on the areas of glacial deposits.
Spatial arrangement of the rocks (tectonics).
Engineering-geological conditions due to tectonics.
Rivers activity. River erosion: its types and results.
Influence on engineering-geological conditions.
River transport types. River accumulation and the engineering-geological conditions on its areas.
Precipitation waters activity (ablation), the factors influencing its intensity. Engineering-geological characteristics of its deposits.
Wind activity. Engineering-geological characteristics of the aeolian deposits (sands and losses).
Destructive activity of the seas and lakes (abrasion).
The overgrowing of the lakes.
Engineering-geological conditions on the areas of the lake and swampy accumulation.
The landslides partition and characteristics of the individual types.
Engineering-geological examinations on the areas treated by the landslides.
Essential engineering-geological features of rocks (soils).
Essential information concerning the groundwater.
Types of groundwater table. The kinds and types of groundwater. The saturated and unsaturated zones.
Essential principles of groundwater flow. Darcy's principle.
Presentation of groundwater table on the maps.
Physical and chemical features of the groundwater.
Depression cone. Piping and clogging processes.

Important part of teaching engineering geology are laboratories, where the students can see and test the geological materials.

Soil mechanics
Soil and Rock identification.
Soil classification (incl. geotechnical categories).
Nature, physical and mechanical properties of soil.
Ground water – appearance and phenomenon connected with it.
Bearing capacity of soils and foundations.
Limit states.
Stress distribution in the subsoil (total and effective stresses).
Theory of consolidations.
Soil settlements.
Laboratory tests:
– macroscopic analysis,
– soil moisture analysis;
– sieve test;
– hydrometer analysis;
– bulk density analysis, particle density analysis;
– consistency limits test; LS (w_s) – shrinkage limit, PS (w_p) – plastic limit, LL (w_L) – liquid limit - Casagrande apparatus;
– density index calculation;
– permeability calculation, active capillarity calculation, passive capillarity calculation;
– OMC optimum moisture content calculation – Proctor compaction device;
– modulus of primary compressibility indication, modulus of secondary compressibility indication - oedometer test;
– shear strength indication: direct shear apparatus – shear test box, tri-axial apparatus.

Geotechnical engineering
Definition, models and types of foundations.
Limit state.
Partial safety factors (Eurocode 7).
Shallow foundations (including design).
Deep foundations – piles: technics, design.
Dewatering of excavations – design.
Deep excavations – sheet piles walls, piles walls.
Retaining structures.
Slope stability.
Earth pressure acting on retaining structures.
Structures-subsoil interaction.

Underground constructions
Lectures:
Classification of tunnels (traffic and transportation tunnels).
Preliminary studies – economic analyses, geological survey and site investigations.
Factors influencing the location of the tunnel.
Analysis of loads on tunnels and underground constructions.
Design of tunnel sections.
Roads tunnels ventilation.

Lighting and noise control in tunnels.
Shield and TBM tunnelling.

Practice:

Classification of tunnel's method constructions.
Tunnelling in solid rock.
New Austrian Tunnelling Method.
Tunnelling in soft ground and under water table level.
Cut and cover method.
Method of constructions of deep excavations - diaphragm wall, berliner wall.
Calculations of deep excavation's wall.

2.2 *M.Sc. level – 2nd cycle*

During the studies on the M.Sc. level the students can choose the speciality named "Bridges and underground constructions", whete they can study geotechnical subjects: Underground constructions II and Numerical methods in geotechnical engineering. The studies are much more advanced then on the 1st level. The best proof for that are the examples of diploma works presented below.

APPENDIX

Examples of good practice – diploma works

Title: Slope protection for enlargement of the commercial centre "Wzgorze" in Gdynia
Student: Marcin Giers
Tutor: prof. A. Siemińska-Lewandowska

Figure 1. About the investment.

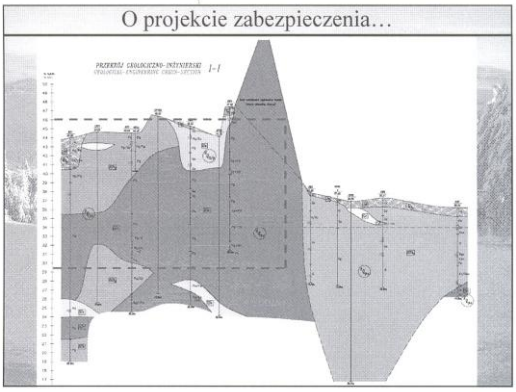

Figure 2. Project of the slope protection.

Figure 3. Existing palisade.

Title: Application of the theory of a wash away class in the FE simulation of the tunnel building
Student: Paweł Sysik
Tutor: prof. A. Siemińska-Lewandowska

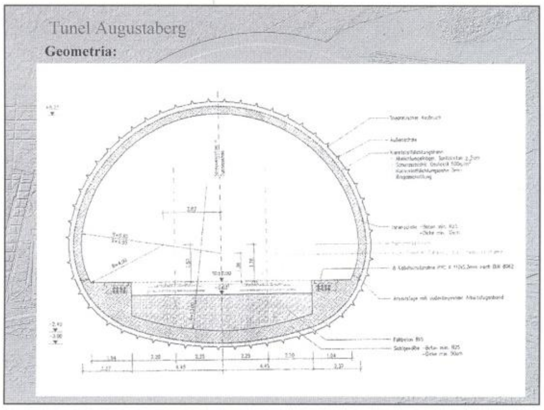

Figure 4. Tunnel in Augustaberg – cross-section.

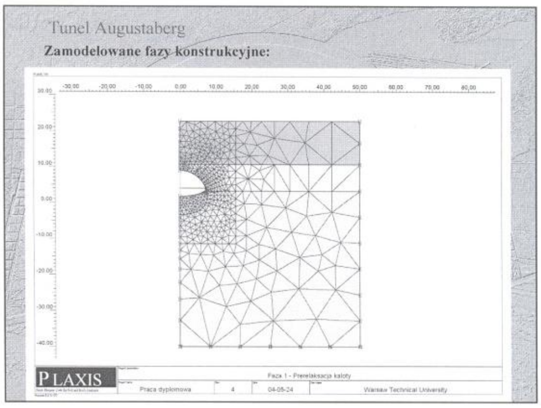

Figure 5. Finite element mesh – PLAXIS.

Title: Design of ground anchors with the use of European norms.
Student: Michał Markowski
Tutor: prof. A. Siemińska-Lewandowska

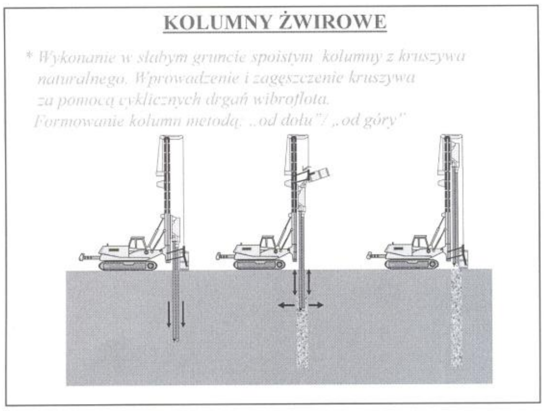

Figure 6. Gravel columns.

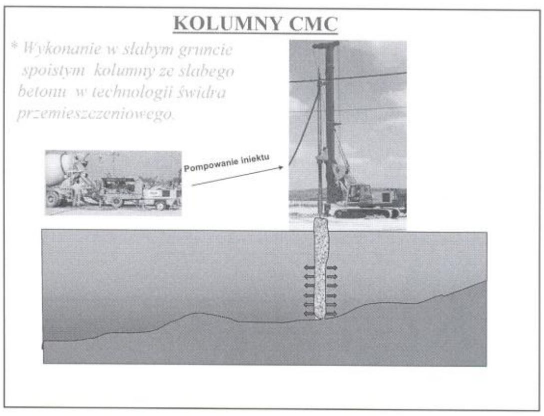

Figure 7. CMC columns.

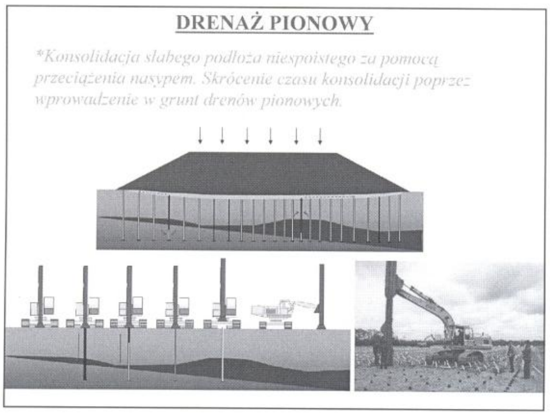

Figure 8. Vertical drainage.

Title: Project of the technological tunnel under the Wisła river in Warsaw.
Student: Izabela Kiernozek
Tutor: prof. A. Siemińska-Lewandowska

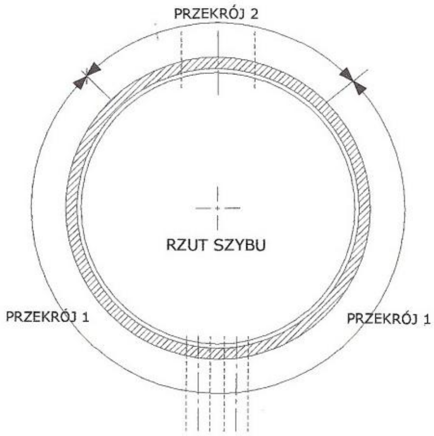

Figure 9. Cross-section of the tunnel.

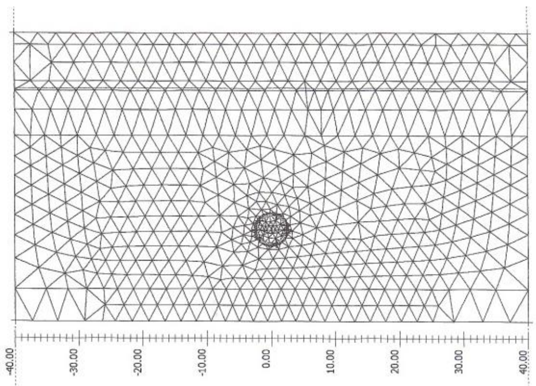

Figure 10. Finite element mesh