



GEOTECHNICAL ENGINEERING

Hydrogeological engineering MSc.

2023/24 II. semester

COMMUNICATION FILE OF THE COURSE

University of Miskolc
Faculty of Earth and Environmental Science and Engineering
Institute of Water and Environmental Management

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1. Course description, Responsible Instructor, Number of lectures and seminars, Credits

<p>Course Title: Geotechnical engineering</p> <p>Instructor: Dr. Tamás KÁNTOR associate professor</p>	<p>Code: MFKHT720025</p> <p>Responsible department/institute: Department of Hydrogeology and Engineering Geology / Institute of Water resource and Environmental Management</p> <p>Type of course: Compulsory</p>
<p>Position in curriculum (which semester): 2nd</p>	<p>Pre-requisites (if any): -</p>
<p>No. of contact hours per week (lecture + seminar): 2+1</p>	<p>Type of Assessment (examination/ practical mark / other): exam</p>
<p>Credits:4</p>	<p>Course: full time</p>
<p>Course Description: The students will be familiar with the basic concepts of geotechnical engineering, with the principles of designing and with the construction methods of different buildings and objects.</p> <p>The short curriculum of the subject: The subject follows the geotechnical tasks of the construction works, starting from the planning of the geotechnical preparatory activity through the model calculations to the technical supervision. The course introduces the student to the process of geotechnical design, the related standard environment and its application. The presentation of failure and serviceability limit states and the design methods defined by EC7 are part of the course. During the semester, the students' task is to perform design tasks for STR, GEO, EGQ, HYD and UPL limit states. Technological and design questions and types of flat slabs, as well as their dimensioning for subsidence and ground breaking, will be introduced during the course. Students can learn about the basics of stability tests for their natural and artificial copper. In addition to deep foundation technologies, the aim of the course is to introduce planning tasks.</p>	
<p>Compatencies to evolve: Knowledge: T3 – Thorough understanding of the concepts and principles of engineering geology and civil engineering and their processes. T6 – Knows basic requirements of environmental protection, quality control, consumer protection, product liability, equal access approach, occupational health and safety, technical and economic legislation and engineering ethics. T7 – Have knowledge of a wide range of problem-solving techniques for research or academic work. T8 - Have general and specialist management skills to manage complex design work. Ability: K2 – Ability to process information from the knowledge frontiers of professional experience of the discipline, ability of problemsolving, and interpreting hydrogeological issues. K4 – Ability to effectively apply water production techniques and knowledge of modern well construction technologies. K7 – Prepared to identify and solve geotechnical problems. K8 – Able to solve mining and pit dewatering problems at a high level K10 – Prepared to effectively apply relevant national and European professional, environmental and conservation legislation K12 – Ability to work in compliance with EU legislation, to cooperate with foreign partners to solve the tasks required by the EU Water Framework Directive K13 – The ability to independently participate in and manage research, development and expertise in the field of hydrogeology K14 – Ability to lead and participate in complex design work and project management in water management and water supply K15 - Ability to solve complex problems in a flexible way through creative problem solving, to work in a team, to think and cooperate effectively with representatives of other disciplines (e.g. environment, quality, consumer protection, human health, construction, etc.) Attitude: A1 – Open-minded and receptive, active in learning about professional and technological methodological developments in the fields of geosciences and environmental engineering, and in solving geological problems from an engineering perspective A2 – Open and sensitive to problems and sustainability issues related to the environment and its elements A3 – Have the motivation to work in a changing</p>	

work, geographical and cultural contexts A4 – Deep commitment and professional solidarity A5 – It is committed to lifelong learning, diversity and values A6 – Respect and act in accordance with the ethical principles and written rules of work and professional culture, and be able to adhere to them when managing small teams A7 – Adhere to and comply with health and safety, environmental protection, quality assurance and control requirements.

A8 – Characterised by intuition, consistency and a willingness to learn.

A9 – In addition to his technical and engineering background, he also has an interest in science.

Autonomy and responsibility: F1 – Act independently and proactively to solve professional problems.

F2 – Have a responsible attitude towards the environment.

F3 – Takes decisions independently and in consultation with other disciplines (mainly legal, economic, energy and environmental), for which it takes responsibility.

F4 – In decisions, takes into account the principles and application of environmental protection, quality, consumer protection, product liability, equal access, health and safety at work, technical, economic and legal regulation and engineering ethics.

F5 – Committed to sustainable natural resource management practices.

F6 – He/she is responsible claims in expert opinions, professional judgements and for the work carried out under his/her supervision.

Assessment and grading:

Students will be assessed with using the following elements.

Reports: 20 %

Midterm exam 30 %

Exam 50 %

Total 100%

Grading scale:

% value	Grade
85 -100%	5 (excellent)
75 – 84%	4 (good)
65 - 74%	3 (satisfactory)
50 - 64%	2 (pass)
0 - 49%	1 (failed)

Compulsory or recommended literature resources:

- J.A. Knappett, R.F. Craig: Craig’s soil mechanics, Eight edition, Spon Press, London 2012.
- Atkinson, J.: The Mechanics of Soils and Foundations. Taylor and Francis, London, 2007.
- Braja M. D.: Advanced soil mechanics, Spon Press, 2008
- Aysen A.: Soil mechanics, Basic concepts and engineering applications, Taylor&Francis, 2002.
- Charles W. W. Ng., Menzies B.: Advanced unsaturated soil mechanics and engineering, Spon Press, 2007.
- Jiang M., Liu F., Bolton M.: Geomechanics and geotechnics: from micro to macro, Taylor and Francis 2010.
- Orr T. L. L., Farrell E. R.: Geotechnical design to EUROCODE 7, Springer-Verlag, London 1999.
- I. Vaníček, M. Vaníček: Earth Structures. Springer, ISBN: 978-1-4020-3963-8, 2008. pp. 497-606

2. Topics of the subject (by hours)

Geotechnical engineering.
Topics of the subject (Plan of the semester)
Spring semester
Hydrogeological engineering MSc, 2. semester

Date	Topic of lecture and seminar
2024.02.15.	Introduction (requirements, thematic, time schedule, Geotechnical Engineering)
2024.02.22.	Stress fields in soil, earth pressures (geostatic earth pressure; Rankine's earth pressure theory; earth pressures as a function of wall movement) (HW)
2024.02.29.	Basics of geotechnical design (general characterization of EuroCode; limit states; design methods; characteristic value; design value; partial safety factor)
2024.03.07.	Shallow foundations (types of shallow foundations; design process of shallow foundations; settlement of shallow foundations; bearing capacity of shallow foundations)
2024.03.14.	Practice – Calculation
2024.03.21.	Deep foundations (types of deep foundations; deep foundation technologies)
2024.03.24.	Break
2024.04.04.	Break
2024.04.11.	Stability of self-supporting soil masses (types of slope movements; factors influencing stability; stability testing methods)
2024.04.18.	Practice – Calculation
2024.04.25.	Retaining structures (types of retaining structures; design of retaining structures; stresses around retaining structures)
2024.05.02.	Practice – Calculation
2024.05.09.	Midterm exam 1 st chance
2024.05.16.	Midterm exam 2 nd chance

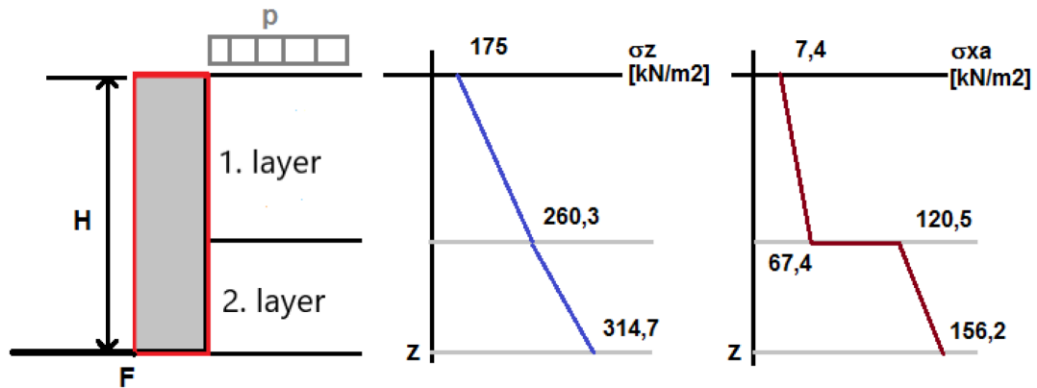
3) Sample of a mid-term exam

GEOTECHNICAL ENGINEERING
MID-TERM EXAM
2018-05-07

1. Calculate the results of following examples!

- Geostatic pressure, if $\rho = 1,983 \text{ g/cm}^3$, $h = 4,7 \text{ m}$
 $\sigma_z = 93,2 \text{ kN/m}^2$
- Passive earth pressure, if $\sigma_z = 188 \text{ kN/m}^2$, $\varphi = 25,7^\circ$, $c = 18 \text{ kPa}$
 $\sigma_{xp} = 533,2 \text{ kN/m}^2$
- Compression module, if $\Delta\varepsilon = 8,3 \%$, $\Delta\sigma_z = 213 \text{ kPa}$
 $E = 2,56 \text{ MPa}$
- Earth pressure at rest, if $\varphi = 27^\circ$, $c = 18 \text{ kPa}$, $\sigma'_z = 145 \text{ kN/m}^2$, $\sigma'_{z, \max} = 287 \text{ kN/m}^2$
 $\sigma_{x0} = 111,6 \text{ kN/m}^2$
- K_0 , K_a and K_p , if $\varphi = 31,1^\circ$
 $K_0 = 0,483$
 $K_a = 0,319$
 $K_p = 3,137$
- Pressure under the point foundation, if $B = 2,4 \text{ m}$, $L = 2,7 \text{ m}$, $F = 2\,954\,880 \text{ N}$
 $\sigma_{z0} = 456 \text{ kN/m}^2$
- Effect of external stress, if $p = 456 \text{ kN/m}^2$, $\sigma_z / p = 0,757$
 $\sigma_{z1} = 345,2 \text{ kN/m}^2$
- Strain in X direction, if $\sigma_z = 677 \text{ kPa}$, $\sigma_x = 415 \text{ kPa}$, $\sigma_y = 369 \text{ kPa}$, $E = 3,8 \text{ MPa}$, $\nu = 0,31$
 $\varepsilon_x = 2,39 \%$ (= 0,0239)

4. Define the active earth pressure distribution next to the retaining structure and the resulting force of active earth pressure and its acting depth!

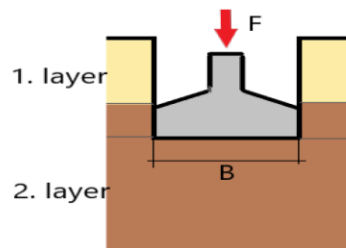


$z_e = 4,81\text{ m}$ ($z_1 = 2,15\text{ m}; z_2 = 2,85\text{ m}; z_3 = 5,65\text{ m}; z_4 = 6,1\text{ m}$)
 $F_e = 534,5\text{ kN}$ ($F_1 = 31,9\text{ kN}; F_2 = 129,1\text{ kN}; F_3 = 325,4\text{ kN}; F_4 = 48,2\text{ kN}$)

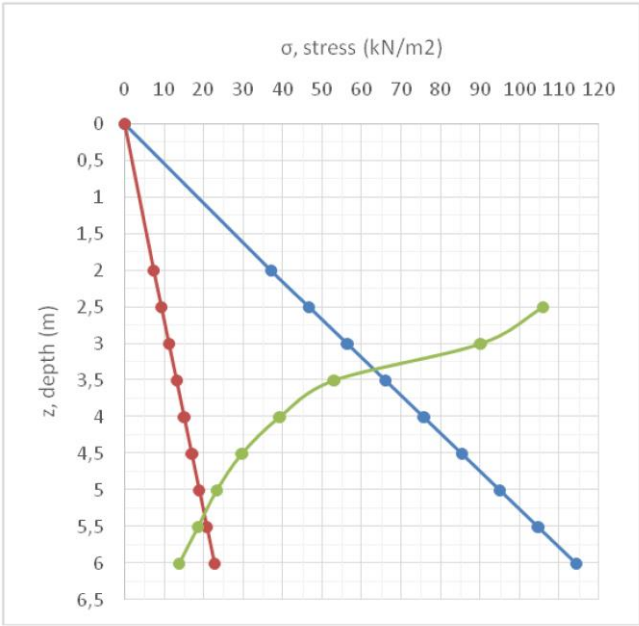
	soil type	h_i (m)	ρ_i (g/cm ³)	ϕ_i (°)	c_i (kN/m ²)
1. layer	clay	4,3	1,983	10	69
2. layer	silt	2,7	2,016	12	31
$p =$	175 kN/m ²				

5. Define the depth of limit of calculation (m_0) in the following situation!

- ρ_1 [g/cm³] = 1,850
- ρ_2 [g/cm³] = 1,930
- F [kN] = 610
- B [m] = 2,4
- L [m] = 2,4
- 1. layer = 0,0 - 2,0 m
- 2. layer = 2,0 - 6,0 m
- Found. level = 2,5 m



$Z_{\text{surf.}}$ [m]	$Z_{\text{Found.}}$ [m]	σ_{z0} [kPa]	$\sigma_{z0}/5$ [kPa]	z/B [-]	σ_z/p [-]	σ_{zi} [kPa]
0	-	0	0	-	-	-
2	-	37,00	7,40	-	-	-
2,5	0	46,65	9,33	-	-	105,9
3	0,25	56,30	11,26	0,10	0,85	90,0
3,5	0,75	65,95	13,19	0,31	0,50	53,0
4	1,25	75,60	15,12	0,52	0,37	39,2
4,5	1,75	85,25	17,05	0,73	0,28	29,7
5	2,25	94,90	18,98	0,94	0,22	23,3
5,5	2,75	104,55	20,91	1,15	0,18	18,5
6	3,25	114,20	22,84	1,35	0,13	13,8



The depth limit of calculation is $m_0 = 5,4$ m

4) Sample of an exam



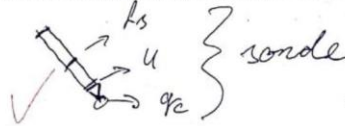
GEOTECHNICAL ENGINEERING
Exam
2018-06-19

32 / (5)

Answer shortly (10-15 sentences) the following questions! If possible, draw a diagram, or a curve for demonstration!

1. Describe the Geotechnical Categories (GC's), based on the EUROCODE 7! (examples, design requirements, design procedure)
2. Describe the passive earth pressures after Rankine's theory in case of cohesive soils ($c > 0, \Phi > 0$)
3. How do you use the method of Block when evaluating slope stability? What are the main forces around the soil wedge (draw them)?
4. Show me the CPT(u) test! (Parts of it, measured parameters, handling of its results, advantages vs. disadvantages)
5. When do we have to use Deep foundations? Show me on a draw the technological steps of the construction of a CFA pile!

4. CPT → cone penetration test



- it is a static, indirect, in-situ measurement
- in this method, we have to press a standard cone into the soil with a relatively thin metal rod, and we measure the force for pressing down

- basic idea that we have to separate 3 parameters, there are
 $[u]$ - pore press by water; $[f_s]$ - skin friction; $[q_c]$ - resistivity of the top of cone

Advantage: easy to make it; relatively cheap; nowadays professions have a lot of experience for this method, so we can use it exactly; we can get several ~~inform~~ inform with this measure.
Disadv: we can't use it in hard soil (debris, magma, gravel..)

Parameters

$[u]$ → difference between granular and cohesive soil

$[f_s/q_c]$ → layer boundaries, soil type

$[q_c]$ → main mechanical inform.; density (and ~~respected~~ ^{approx.} to cohesion) carrying capacity of pile

Parts: sonde (measur.); anemeter (for pressing); can be computer (for diagram)



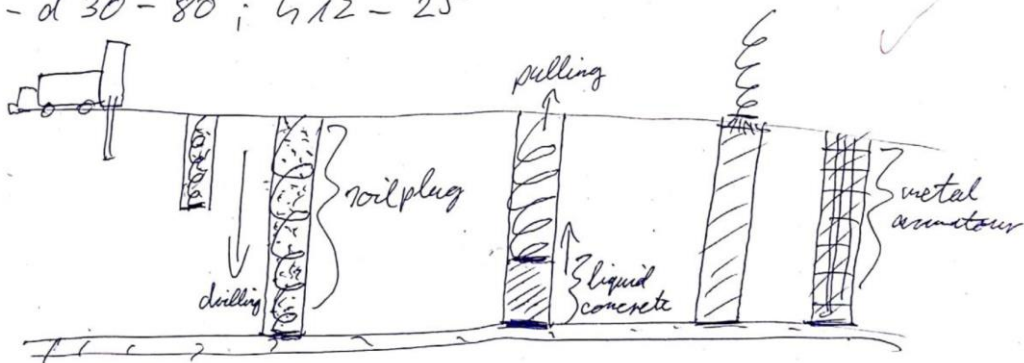
5. Deep foundation

When:

- if the stable, loadable layer is the deep for building or any geot. works
- if dewatering in shallow foundation have much more cost
- if slipping or ~~unstable~~ unfavorable sedimentation takes place in case of shallow f.
- if can be cavitation (for example bridge pile)
- if the deep found. is more economical than shallow

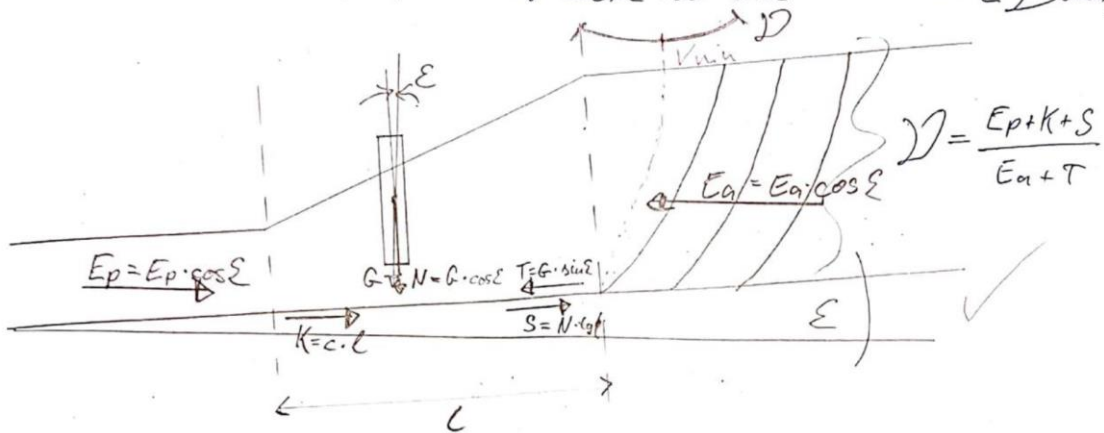
CFP pile

- we use a spiral shape drill
- the soil plug is retaining the wall of borehole
- the concrete added across the drilling rod
- the pressure (from added concrete) and pulling force displacing the soil plug
- ~~add~~ metal armature into the liquid concrete
- d 30 - 80 ; L 12 - 25



Block method

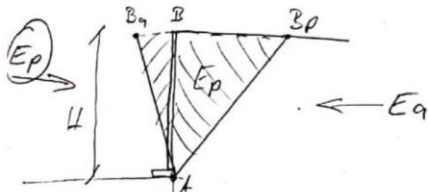
- we investigate a unit, what is separated 3 parts
- the upper (active E_a) and lower (E_p) is defined with forces, and we invest the equilibrium of the middle part
- after defining the forces, we searching for a slope stability factor, especially where is its minimum $[D]_{min}$



$$D = \frac{K + S + E_p}{T + E_a} = \frac{c \cdot l + N \tan \phi + E_p \cos \epsilon}{G \sin \epsilon + E_a \cdot \cos \epsilon} \quad \left. \right\} D_{min} ?$$

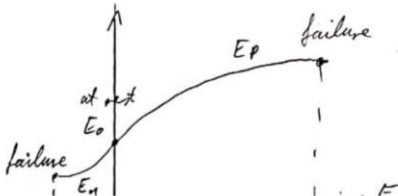
Passive earth pressure

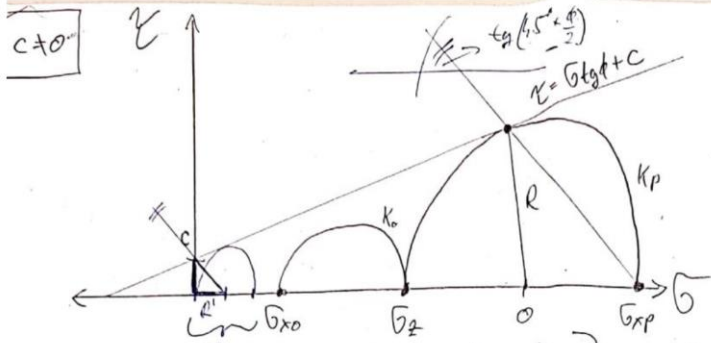
- passive e.p. acting, when a force pressing the wall to the background soil
- relatively high motion mobilising the passive earth p.
- it can be a useful, retaining force in geotechnical ^{retention} limits



$$E_a : E_o : E_p = 0.5 : 1 : 5$$

↓
relatively high displacing





$$\sigma_{xp} \rightarrow \sin \phi = \frac{R}{O} \rightarrow R = \frac{\sigma_{xp} - \sigma_z}{2}$$

$$\rightarrow O = \frac{\sigma_z + \sigma_{xp}}{2} \quad \left. \begin{array}{l} \sin \phi O = R \\ \sin \phi \sigma_z + \sin \phi \sigma_{xp} = \sigma_{xp} - \sigma_z \end{array} \right\}$$

$$\sigma_z + \sin \phi \sigma_z = \sigma_{xp} - \sin \phi \sigma_{xp}$$

$$\sigma_z (1 + \sin \phi) = \sigma_{xp} (1 - \sin \phi)$$

$$\left| \sigma_{xp} = \sigma_z \left(\frac{1 + \sin \phi}{1 - \sin \phi} \right) \right|$$

K_p

$$\tau_p \rightarrow \operatorname{tg} \left(45^\circ + \frac{\phi}{2} \right) = \frac{R'}{c}$$

$$c \cdot \operatorname{tg} \left(45^\circ + \frac{\phi}{2} \right) = R'$$

$$\tau_p = 2R$$

$$\left| 2c \operatorname{tg} \left(45^\circ + \frac{\phi}{2} \right) \right|$$

K_p

$$\sigma_{xp} = \sigma_z K_p + 2c \sqrt{K_p}$$

EC7 Geotech. categories: we define 3 cat

	①	②	③
Buildings	small buildings	usual build.	large b.
subsoil	favorable	usual	unfavorable
environment	without effect	normal eff.	spec. eff., have to deal
risk	∅	average	huge risk
test	routine	labor, field tests	special process
planning	routine planning	average p.	special planning
monitoring	simple	usual monitoring	special measure
deep found	∅	can be	special and new tech.
example	1-2 floors buildings; 250 kN load; 100 kN/m load; pit or ret. wall till 2 m	earthwork; ground anchoring; pit, retaining wall which greater than class ①	dewatering; landfill; very huge buildings

5. Others

During the exams using of mobile phone, smart devices, notes or copies of books are not acceptable. Violation of the examination order entails the suspension and completion of the writing of the exam.