

CEE 658 – Earth Pressures
_____ 20__

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Office hours: _____

Textbook: None. Reading assignments will be provided and **must** be completed before coming to class.

Grading:

Homework	30%
Term Project	35% (_____ – Presentation and Report due)
Mid-term exam	<u>35%</u> (_____)
Total	<u>100%</u>

Homework: Homework assignments are due 1 week from the assigned date unless otherwise noted. **A cover memorandum summarizing the pertinent points of the assignment must be attached to all homework assignments.** See [memorandum format - Search \(bing.com\)](#) for an example of a memorandum format.

CEE 658 – Earth Pressures**Week Topic****A **Wall Types****

1 Introduction and Classification of Retaining Structures

B **Earth Pressure Theories**

1 – 3 Active, Passive and At-rest Lateral Earth Pressures (Rankine, Coulomb and Log Spiral Theories)

Equivalent Fluid Pressures

4 Earth Pressures due to Surface Loads

5 Compaction-induced Earth Pressures

C **Statically Determinate Walls**

6 Retaining Walls (Geotechnical Aspects of Design of Gravity and Cantilever Walls)

7 - 8 Cantilever Sheet Pile Walls (Free-earth Support) and Anchored Bulkheads

D **Statically Indeterminate Walls**

9 – 13 Design of Braced Excavations (Empirical Method, Beam-on-elastic Foundation Method, Numerical Method)

E **Bracing**

14 Design of Anchor Blocks and Grouted Anchors

14 Difference between Ground Anchors and Soil Nails

F **Seismic**

15 Seismic-Induced Earth Pressures on Retaining Walls

G **Student Presentations**

16 Term Project Presentations

Selected References

General Textbooks

1. Clayton, C.R.I., Woods, R.I., Bond, A.J. and Milititsky, J. (2014). *Earth Pressure and Earth-Retaining Structures*. 3rd Edition, CRC Press, London, 613 pp.
2. Clough, G.W. and Duncan, J.M. (1991). *Earth Pressures: Chapter 6 in Foundation Engineering Handbook*. 2nd Edition, Edited by H.Y. Fang, Van Nostrand Reinhold, New York, NY, 223-235.
3. Terzaghi, K. (1943). *Theoretical Soil Mechanics*. John Wiley and Sons, Inc. New York, 510 pp.
4. Terzaghi, K., Peck, R.B. and Mesri, G. (1996). *Soil Mechanics in Engineering Practice*. 3rd Edition. John Wiley and Sons, Inc. New York, 549 pp.
5. Tschebotarioff, G.P. (1973). *Foundations, Retaining and Earth Structures*. McGraw-Hill, New York, 642 pp.
6. Huntington, W.C. (2013). *Earth Pressures and Retaining Walls*. Literary Licensing, LLC, Whitefish, MT.
7. Hettler, A. and Kurrer, K.-E. (2019). *Earth Pressure*. Wiley Online.

Sheet Pile Walls

1. United States Steel. (1975). *Steel Sheet Piling Design Manual*. USS. 81 pp.

Ground Anchored Walls

General References

1. Ou, C.-Y. (2006). *Deep excavation – Theory and practice*. Taylor and Francis. 532 pp.
2. Sabatini, P.J., Pass, D.G. and Bachus, R.C. (1999). *Geotechnical engineering circular No. 4, Ground anchors and anchored systems*. Report No. FHWA-IF-99-015.
3. Weatherby, D.E. (1998). *Design manual for permanent ground anchors*. FHWA Publication No. FHWA-RD-97-130.

4. Long, J.H., Weatherby, D.E. and Cording, E.J. (1998). *Summary report of research on permanent ground anchor walls, Vol. I: Current practice and limiting equilibrium analyses*. FHWA Publication No. FHWA-RD-98-065.
5. Weatherby, D.E. Chung, M., Kim, N.-K., and Briaud, J.-L. (1998). *Summary report of research on permanent ground anchor walls, Vol. II: Full-scale wall tests and a soil-structure interaction model*. FHWA Publication No. FHWA-RD-98-066.
6. Mueller, C.G., Long, J.H., Weatherby, D.E., Cording, E.J., Powers III, W.F. and Briaud, J.-L. (1998). *Summary report of research on permanent ground anchor walls, Vol. III: Model-scale wall tests and ground anchor tests*. FHWA Publication No. FHWA-RD-98-067.
7. Weatherby, D.E. (1998). *Summary report of research on permanent ground anchor walls, Vol. IV: Conclusions and recommendations*. FHWA Publication No. FHWA-RD-98-065

Stability of Excavation

1. Bjerrum, L. and Eide, O. (1956). Stability of strutted excavations in clays. *Geotechnique*. London, U.K., January, 32-47.
2. Henkel, D.J. (1971). The calculation of earth pressures in open cuts in soft clays. *The Arup Journal*, Vol. 6, No. 4, 14-15.
1. O'Rourke, T.D. (1992). Base stability and ground movement prediction for excavations in soft clay. *Proc., ICE Conference on Retaining Structure*, Thomas Telford Ltd., London, U.K., 657-687.

Analysis of Walls

1. Borin, D.L. (2000). *WALLAP Anchored and Cantilevered Retaining Wall Analysis Program: User's Manual (Version 5)*. Geosolve, London
2. Briaud, J.L. and Kim, N.K. (1998). Beam-column method for tieback walls. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE, (124)1, 67-79.
3. Clough, G.W. and O'Rourke, T.D. (1990). Construction induced movements of insitu walls. *ASCE Proceedings, Design and Performance of Earth Retaining Structures*, Cornell University, Ithaca, New York, Geotechnical Special Publication No. 25, 439-470.

4. Clough, G.W., Smith, E.M. and Sweeney, B.P. (1989). Movement control of excavation support systems by iterative design. *ASCE Procs., Foundation Engineering: Current Principles and Practices*, Evanston, Illinois, 869-864.
5. Dawkins, W.P. (1994). *User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)*. Instruction Report ITL-94-6, U.S. Army Corp of Engineers, Waterways Experiment Station, Vicksburg, MS.
6. Goldberg, D.T., Jaworski, W.E. and Gordon, M.D. (1976). *Lateral Support Systems and Underpinning: Vol. 1 Design and Construction*. Federal Highway Administration Report No. FHWA RD-75-128, April, 312 pp.
7. Peck, R.B. (1969). Deep excavations and tunneling in soft ground. *Proceedings of the 7th International Conference on Soil Mechanics and Foundation Engineering*, Mexico City, Mexico, State-of-the-Art Volume, 225-281
8. Terzaghi, K. (1955). Evaluation of coefficients of subgrade reaction. *Geotechnique*, London, U.K., December, 297-326.
9. Xanthakos, P.P. (1994). *Slurry Walls as Structural Systems*. 2nd Edition, McGraw-Hill, Inc.

Soil Nail Walls

1. Byrne, R.J., Cotton, D., Porterfield, J. Wolschlag, C. and Ueblacker, G. (1996). *Manual for design & construction monitoring of soil nail walls*. FHWA Publication No. FHWA-SA-96-069.

Seismic Analysis of Retaining Walls

1. Anderson, D.G., Martin, G.R., Lam, I.P. and Wang, J.N. (2008). Seismic analysis and design of retaining walls, buried structures, slopes and embankments. NCHRP Report 611. [References | Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments | The National Academies Press](#)

Review Questions

1. What are the various Atterberg limits and what are their physical significances?
2. What is relative density? How is it estimated?
3. What are pressure, elevation and total heads? How are they estimated?
4. What are equipotential and flow lines?
5. What is effective stress? How is it estimated?
6. What is overconsolidation ratio?
7. Define the pole or the origin of planes.
8. What is the difference between axi-symmetric and plane strain loading?
9. What are the shear strength parameters of soil, what failure criteria are they derived from and how are these parameters estimated?
10. Is the shear strength of soil unique? If not, what does it depend on?
11. Describe when you would use total stress analysis.
12. Describe when you would use effective stress analysis.
13. What are the two stages in a triaxial test?
14. List the different types of triaxial tests and describe how they differ?
15. Which types of triaxial tests are associated with total stress analysis and which types are associated with effective stress analysis?
16. What is the difference between peak and residual strengths?
17. What is dilation? What soils tend to dilate? What soils tend to compress?
18. What is the significance of Skempton's \bar{A}_f ?
19. What test is required to obtain the unconfined compressive strength and how is the unconfined compressive strength related to the undrained shear strength?
20. What is stress path and why is it important?