CE 5390 Special Topics: GEOTECHNICS OF LANDFILL DESIGN
CRN: 16785, 16813, 16887, 16888
Fall 2022

Instructor: Vivek Tandon, x-6924, vivek@utep.edu **Office:** **A**-220
Class Time: MW 3:00 to 4:20 PM **Class Room: CRBL301**

Office Hours: Students are always welcome

Textbook: Qian, X., Koerner, R.M., Gray, D.H., (2002) Geotechnical Aspects of Landfill Design and Construction, Prentice-Hall, NJ. (This book is reserved in the Library)

Reference: Oweis, I.S., and Khera, R.P (1998) *Geotechnology of Waste Management*, 2nd Edition, PWS Publishing Co., Boston, MA, 472pp. (Main Reference for Course)

Koerner, R.M., *Designing with Geosynthetics*, 4th Ed. Prentice-Hall, Englewood Cliffs, NJ, 1998, 761 pp. (Chps 5 "geomembranes" and 6 "GCLs are specific to landfills)

Daniel DE (Ed.) (1993) *Geotechnical Practice for Waste Disposal*, Chapman and Hall, London. 683 pp. (Chapters 5 thru 12 are specifically for new landfills)

COURSE OBJECTIVES

This course will focus on geotechnical aspects in the analysis, design, and construction of new waste containment facilities (landfills). The disposal of waste generated by people and industrial processes is an essential issue in our society. In the U.S. alone, we produce more than 8 billion tons of waste annually. If this waste is not managed safely and reliably, then human health and the environment are at risk. Landfills are one of the most commonly used means for waste disposal. There are approximately 5,000 municipal waste and 250 hazardous waste landfills in the U.S.

Both technical and practical issues related to the design of landfills will be explored. We will rely primarily on lectures and laboratory work (mainly YouTube videos) to develop your understanding of these issues. However, we do not intend to throw information at you. You will be expected to read and think about material outside of class and actively participate. These discussions will enhance the learning process (and make it more interesting). While we don't expect you to be an expert landfill designer at the end of the semester, you should have a solid understanding of the geotechnical issues involved in landfill design and be well on your way to becoming an expert if so desired.

TEXTS

We will make extensive reference to the texts noted above (Oweis & Khera 1998, Qian et al. 2002, Koerner 1998, and Daniel 1993). There are several other texts which deal fully or partially with the topic of landfills. I will refer to these texts from time to time throughout the class.

COURSE PREREQUISITES

The course is designed so that a substantial background in geotechnical engineering is **not** required; when necessary, we will review some basic geotechnical engineering principles. Environmental engineers, geologists, soil scientists, and others with engineering, geosciences, or scientific backgrounds are welcome.

READINGS

Articles from the literature will be assigned throughout the semester. These articles have technical and/or historical significance to the current state of landfill design. The assigned articles will be made available for copying. You are expected to read these articles critically, prepare a 1-page synopsis of the key points and be prepared to discuss them in class. A list of references that may help understand and evaluate these articles will be distributed in class.

HOMEWORK

On occasion, homework problems will be assigned. Some of your solutions will be collected and graded; however, the solutions to all of the problems will be posted to grade them yourself.

GRADING (some revisions may be necessary, and I will report them at the first class meeting if needed)

Your grade in this course will be determined as follows:

Component	%
Homework and Synopses	20
Group Project(s)	20
Quizzes	20
Virtual Laborator Work	15
Final Project	25
	100

Topics Covered in
CE 5390 Geotechnics of Landfill Design

1. Introduction to Landfills (2-3)

   A. Overview of course topics/course administration
   B. What are landfills?
   C. History of landfills
   D. Overview of how they regulated/constructed
   E. Overview of types and uses of geosynthetics in landfills

2. Siting/Permitting (2-3)

3. Conceptual Design Considerations (parts of a landfill and why we do what we do) (3-4)

   A. Concepts and Procedures
   B. Liner design - functions
   C. Cells
   D. Caps
   E. Anchor trenches
   F. Slope stability considerations
   G. Gas generation
   H. Leachate
   I. Settlement
   J. Piggybacking

4. Liner Design (5-6)

A. Compacted clay
   (1) Factors affecting hydraulic conductivity
   (2) Clod vs. particle orientation
   (3) Keys to low hydraulic conductivity
   (4) Water content-density criteria
   (5) Recommended procedures for determining acceptable zone
   (6) Influence of overburden stress
   (7) Bonding of lifts
   (8) Thickness
   (9) Desiccation
B. Geomembranes
   (1) Types
   (2) Manufacturing
   (3) Handling
   (4) Seaming
   (5) Testing
C. Leachate Collection System
D. Bentonite
   (1) Mineralogy
   (2) Double layer principles
   (3) Sodium vs. calcium bentonite
   (4) Tests for bentonite quality
   (5) Effect of bentonite addition on k
   (6) Determining the amount of bentonite to add
   (7) Assessing the amount of bentonite in an admixed liner

E. Geosynthetic Clay Liners

   (1) Types and history
   (2) Hydraulic conductivity and compatibility
   (3) Shear strength
   (4) Installation and field testing
   (5) Equivalency

5. Leakage Detection Design (1-2)

6. Slope Stability; Foundation and Waste Settlement (4-6)

A. Slope Stability
B. Importance of calculating settlements
C. Foundation settlement
D. Waste settlement

7. Construction (incl. field geosynthetics testing) (4-6)

A. Compacted soil liners
   (Equipment, preprocessing of soil, soil moisture control, clod processing, compaction, test pad)
B. Geomembrane
   (shipping, placement, seaming, field testing)
C. Leachate collection system
   (materials – soils vs. geosynthetics, handling, placement)
D. Waste placement and filling operations
   (select lift, daily cover, intermediate cover, compaction)
E. Cover system

(materials, placement, field testing)
F. Gas collection system
G. Leachate recirculation system
H. Maintenance
(of leachate collection systems, of cover)

8. Operation (3-4)

A. Collection and Processing
B. Waste placement
C. Disease vector control
D. Environmental monitoring
E. Bioreactors
F. Other operational aspects (finances, employees, logistics, etc.)

9. Seismic Stability (1-2)

A. Description of earthquake-induced slope instability
B. Basics of seismic analysis (earthquakes, attenuation, frequencies, duration)
C. Simplified displacement analysis of base and liner

10. Final Cover (3-4)

A. Components and cover systems
B. Water balance
(Emphasis on the HELP model)
C. Slope stability
(relying on section 6A but emphasizing the role of interfaces, adequate drainage, settlement, and erosion)
D. Alternative designs and materials
(Asphalt Barriers, Capillary barrier, Leachate recirculation, Bioreactors – note bioreactors covered in section 7 and section 8)
(Erosion control materials (note the importance to the cover but covered in-depth in section 11), Geofoam, Sprayed on barriers, Shredded tires, Papermill sludge)
E. Construction Quality Control

11. Erosion control (3-4)

A. Introduction to the erosion control problem - legal aspects
B. Causes of erosion in landfills
C. Erosion evaluation techniques
D. Erosion control measures

12. Evaluation after construction (1-2)

13. Case Histories (3)