

Geotechnical Engineering



<http://www.okm-engineering.com/geotec.htm>



<http://cee.illinois.edu/geotech>

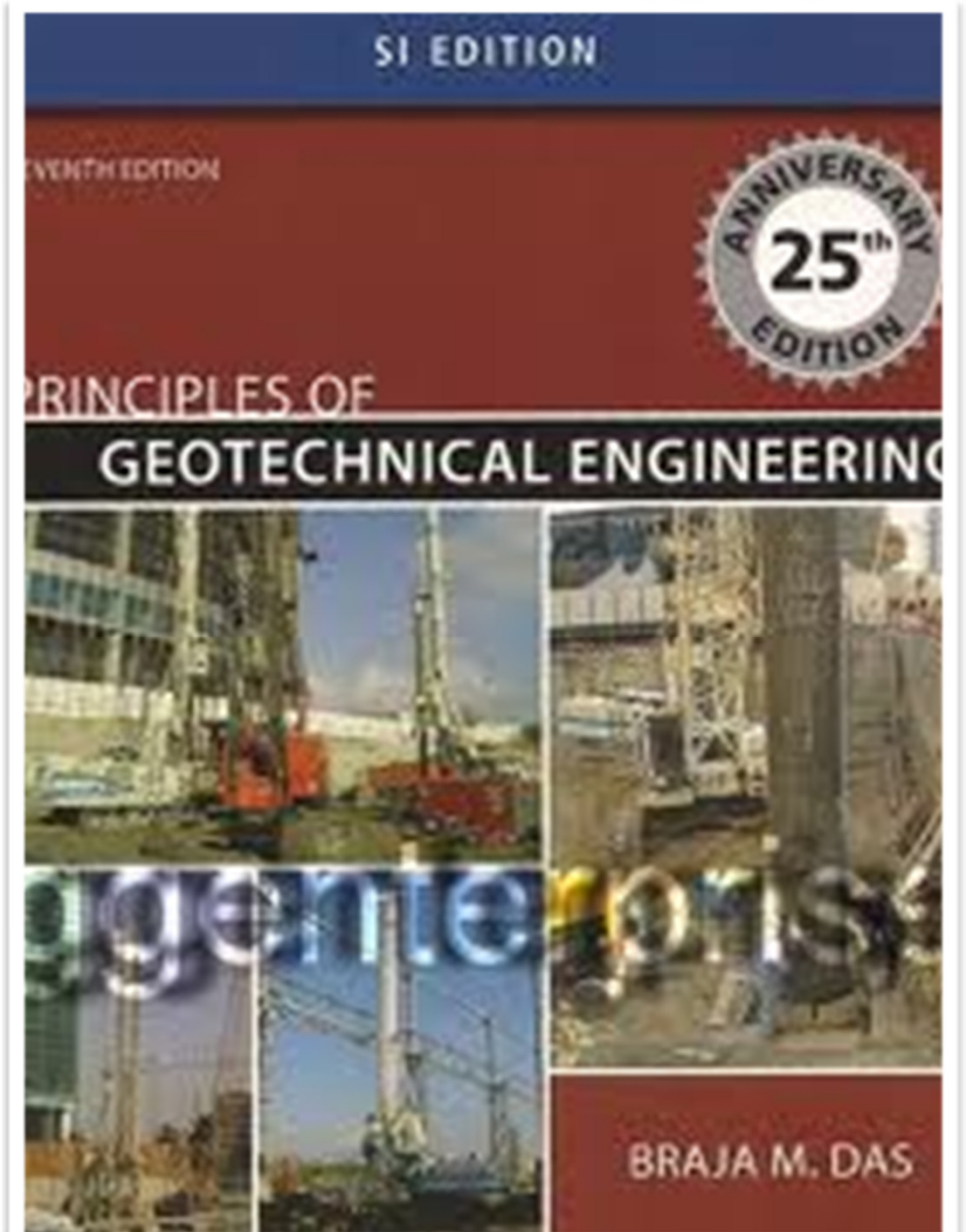


<http://thekesselgroup.com/construction-materials-testing/>

Unit Introduction

Text: Das, 2010. Principles of Geotechnical Engineering (**SI edition**)

- 1 lecture/week + tutorial as needed.
- 3 assignments due as indicated online.
- Technical problem-based tutorials online.
- Compulsory intensive school.
- Two-hour end-trimester exam.



Unit Materials

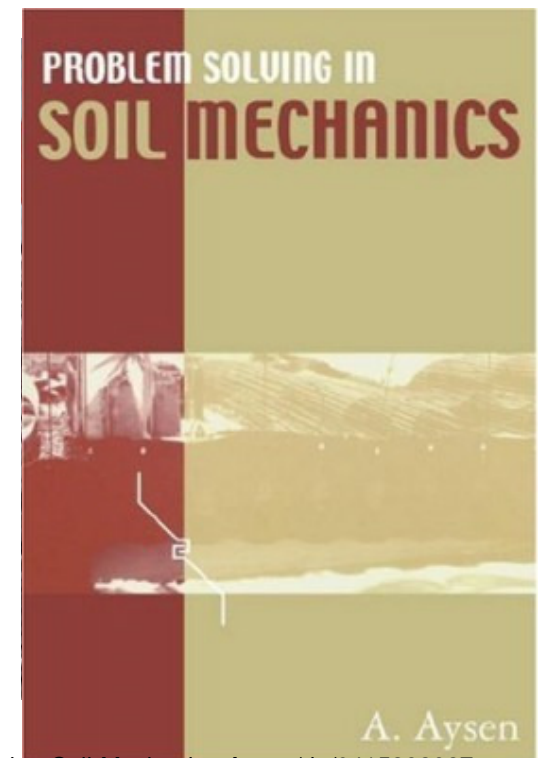
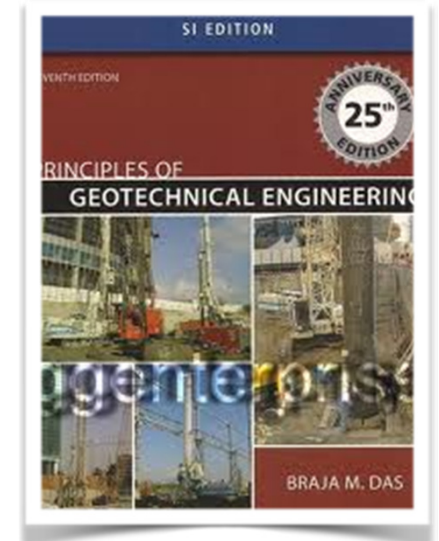
The unit follows the text fairly closely so you will need to buy this from the bookshop.

The lectures, available online through Moodle, are a cut-down version of the text. Don't rely on the PowerPoint! Buy the text and come to lectures.

Assignments will be based on problems given in the text, often illustrated by examples in the text.

Excel spreadsheet solutions and method summaries will be provided as we proceed.

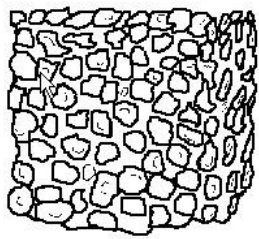
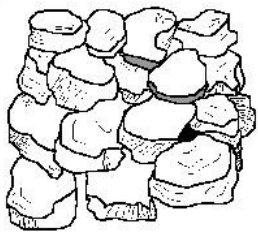
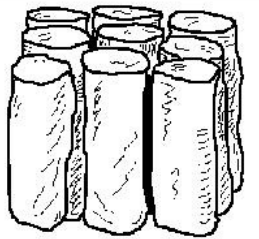
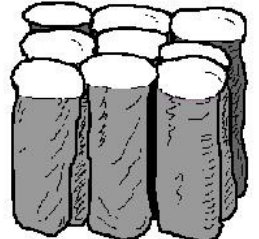
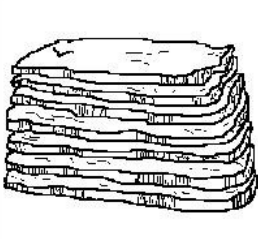
Geotechnical engineering is a very broad field! Build your knowledge by reading other texts in Dixson library.

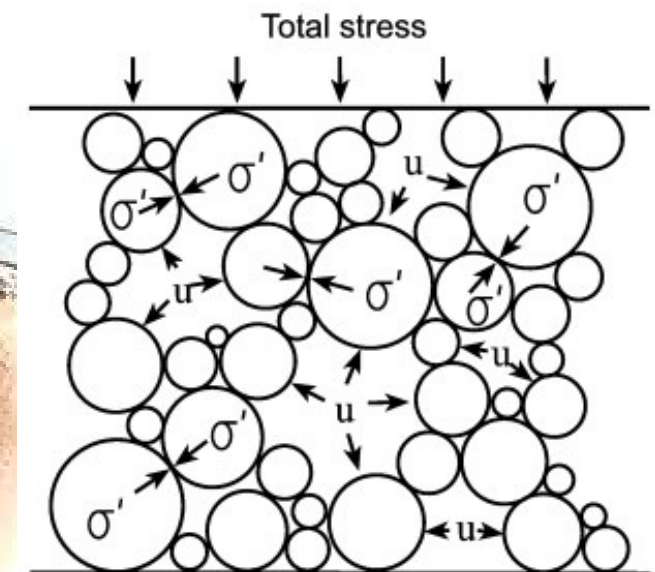
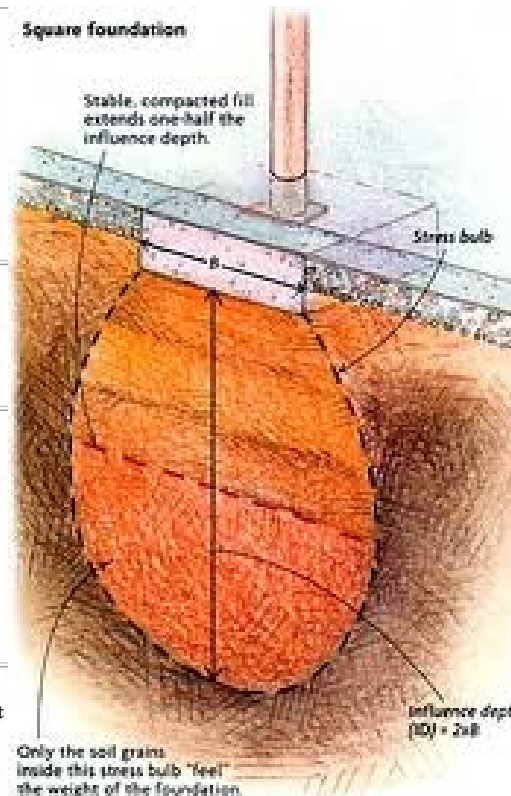


Geotechnology: Definitions

For engineering purposes, soil is defined as an uncemented aggregate of mineral grains and decayed organic matter with liquid and gas in the spaces between solid particles.

Soil mechanics is the branch of science that deals with the study of the physical properties of soil and the behaviour of soil masses subject to various types of forces.

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	Blocky: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	Prismatic: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	Platy: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil. Soil Science Society of America	Single Grained: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.



https://lh5.ggpht.com/6kqa8iskktQI__69rV1iw2yE0lidpPz8K1Fjp0loKkBaniv22mPB3-BoFT3pSzC17v3oBg=s95

Definitions continued

Geotechnical engineering is a subdiscipline of civil engineering that includes the application of the principles of soil mechanics and rock mechanics to the design of foundations, retaining structures and earth structures.

Soil science is an older discipline that includes soil chemistry, soil biology and soil physics. Soil physics combined with material science, groundwater hydrology and stress analysis is the basis of soil mechanics.



Historical Background

Geotechnical engineering is one of the world's oldest professions, based originally on millennia of accumulated experience in the success or failure of progressively larger structures.

The earliest civilisations are noted for massive and monolithic structures that at times and for different reasons challenged the ability of their designers to anticipate the behaviour of the soil foundations.



<http://www.ancientegypt.co.uk/pyramids/home.html>



http://en.wikipedia.org/wiki/Hanging_Gardens_of_Babylon

Historical Background continued

Ancient Greek and classical Roman civilisations were the first to develop isolated pad footings and strip-and-raft foundations for building structures. Earthquake and war were common causes of active structural failure in those times but there is little evidence of foundation failure.

In contrast, classical Chinese civilisation constructed thousands of pagodas on silt and soft clay layers. In many cases the foundation pressure exceeded the load-bearing capacity of the soil, with extensive structural damage.



<http://academic.reed.edu/humanities/110tech/parthenon.html>



<http://www.ancientbagan.com/bagan-monuments.htm>

Middle Ages and Renaissance

Although structural engineering was largely forgotten during the dark ages, a period of castle building founded on the classical techniques of pad and raft foundations was largely successful until the advent of cannon warfare.

In the Renaissance, more elaborate structures were conceived and constructed with varying degrees of success. The Leaning Tower of Pisa is founded on a soft clay layer at about 11 m and has a long and peculiar history of tilting in different directions.



http://en.wikipedia.org/wiki/Doune_Castle



http://en.wikipedia.org/wiki/Leaning_Tower_of_Pisa

Pisa



18th Century to the Present

Starting in the early part of the 18th century, engineers and scientists began to address the properties and behaviour of soil in a more systematic way.

This time-span can be divided into five distinct periods:

- 1700 to 1776: basic earth pressure theories.
- 1776 to 1856: soil friction and cohesion: slope stability.
- 1856 to 1910: permeability, compaction and stress distributions.
- 1910 to 1927: plasticity, shear stress and consolidation.
- 1927 to the present: industrial geotechnology and geosynthetics.

The Austrian engineer Karl Terzaghi is known as the "father" of modern soil mechanics. Beginning in 1927 he organised and consolidated the empirical and theoretical content of soil mechanics, and almost single-handedly created the institutions that led to the profession of geotechnical engineering.

Geotechnical Engineering after 1927



Karl Terzaghi 1883 - 1963

http://en.wikipedia.org/wiki/Karl_von_Terzaghi

Terzaghi's professorships at Vienna and Harvard Universities became the nucleus for civil engineers interested in the new discipline of soil mechanics. With Arthur Casagrande, also at Harvard, Terzaghi organized a series of conferences over 25 years that laid the foundations of geotechnical engineering.



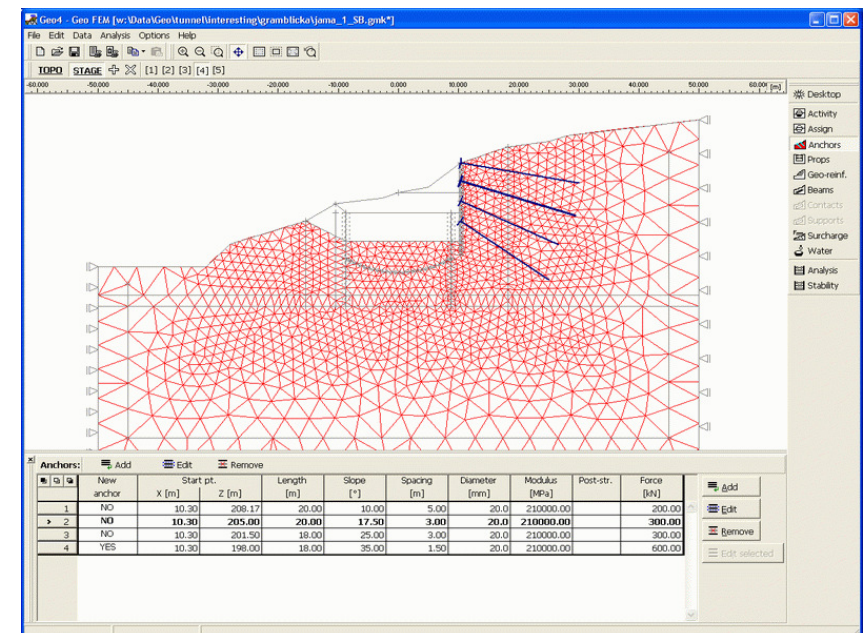
Arthur Casagrande
1902 - 1981

http://en.wikipedia.org/wiki/Arthur_Casagrande

Geotechnical Engineering after 1927

Geotechnical engineering has developed enormously since 1927. A short list of topics developed in that time would include:

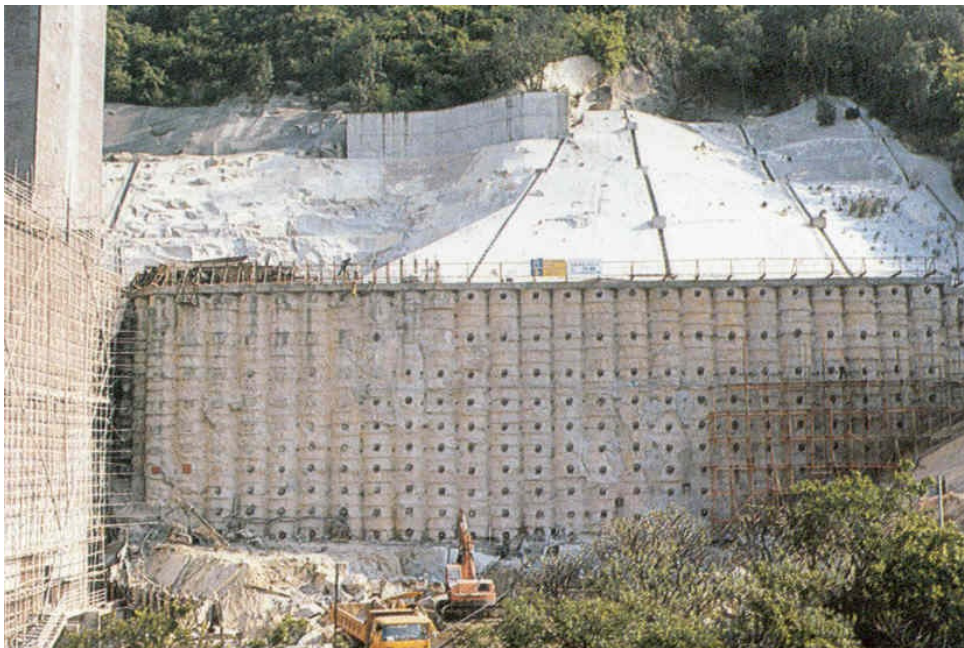
- Elastic theory and stress distributions
- Swelling of clays
- Earthquake stress and soil liquefaction
- Pore pressure and effective stress
- Finite difference and finite element methods
- Geotechnical instrumentation
- Geosynthetics and earth reinforcement
- Landslides and coastal engineering
- Pile foundations
- Computerised methods of analysis



Scope: Careers in Geotechnology

The scope of geotechnical engineering is enormous, with careers in civil or structural engineering, mining, environmental assessment and monitoring, and the currently emerging science of natural disaster geoengineering.

An entry level role in geotechnical engineering might involve site design, investigation, construction supervision and monitoring, earthworks, foundations, slope stability, and retaining structures for mining, landfill, road/rail infrastructure, commercial, recreational and residential projects.



http://en.wikipedia.org/wiki/Geotechnical_engineering



<http://www.engineering.unsw.edu.au/mining-engineering/>

Geotechnical Environmental Landfills

Geo-Environmental Engineering Pty Ltd (GEE) is a small geotechnical and environmental engineering consultant based in Southern Sydney.

Although small, GEE has a reputation for providing quality solutions for both small and large scale projects, and is dedicated to providing cost effective comprehensive service.

GEOTECHNICAL

- Salinity
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- Acid Sulfate Soil
- Monitoring
- Septic /Effluent Disposal Assessment

ENVIRONMENTAL

- Soil & Groundwater
- Contamination Testing
- Waste Classifications
- Remediation Action Plans (RAPs)
- Remediation & Validation
- Environmental Management Plans (EMPs)
- Groundwater & Surface-Water Monitoring

LANDFILLS

- Construction Certification
- Monitoring (Dust, Noise, Water & Leachate)

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Career Highlights in Geotechnology

"The most interesting project I worked on was a railway embankment failure in Ireland in 2001. The embankment was founded on a peat bog and a failure through the embankment had propagated failure along the peat foundation. There was also a derailed locomotive still on the embankment! I was the first Geotechnical Engineer to assess the amazing failure features in the peat foundation and embankment. We reconstructed the embankment using polystyrene blocks." Roberta Lindbeck, URS Australia



http://en.wikipedia.org/wiki/2007_Peru_earthquake



<http://en.wikipedia.org/wiki/Levee>

Career Highlights in Geotechnology

"The most interesting project in my career was the Alexandria City Centre Project in Egypt conducted in 2000. This involved the use of Dynamic Replacement (driving of large diameter stone columns into the ground using a heavy drop weight) and Preloading (surcharging with fill) to improve 22 hectares of soft ground to support a Hypermarket the scale of a mini-city on reclaimed land." Patrick Wong, Coffey Geosciences



<http://buildingandconstructionreview.com.au/>



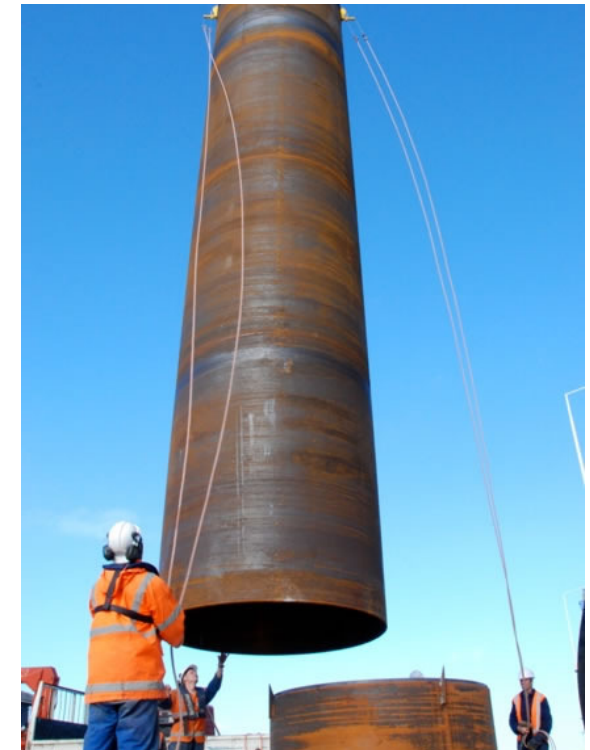
<http://www.vibromenard.co.uk/techniques/dynamic-replacement/>

Career Highlights in Geotechnology

"In 1995 I was the Resident Geotechnical Engineer for a US\$1 billion site reclamation project in Singapore. I was responsible for all ground improvement works, settlement monitoring and the construction of over three thousand concrete piles. This involved the reclamation of a 20-hectare area by placing sand to a depth of almost 8m over an 8m thick layer of very soft marine clays. The placement had to be very closely monitored using piezometers and strategically placed inclinometers to ensure that the rate of reclamation was consistent with strength gain of the marine muds to prevent failure." Dr Damika Wickremesinghe, Dames and Moore



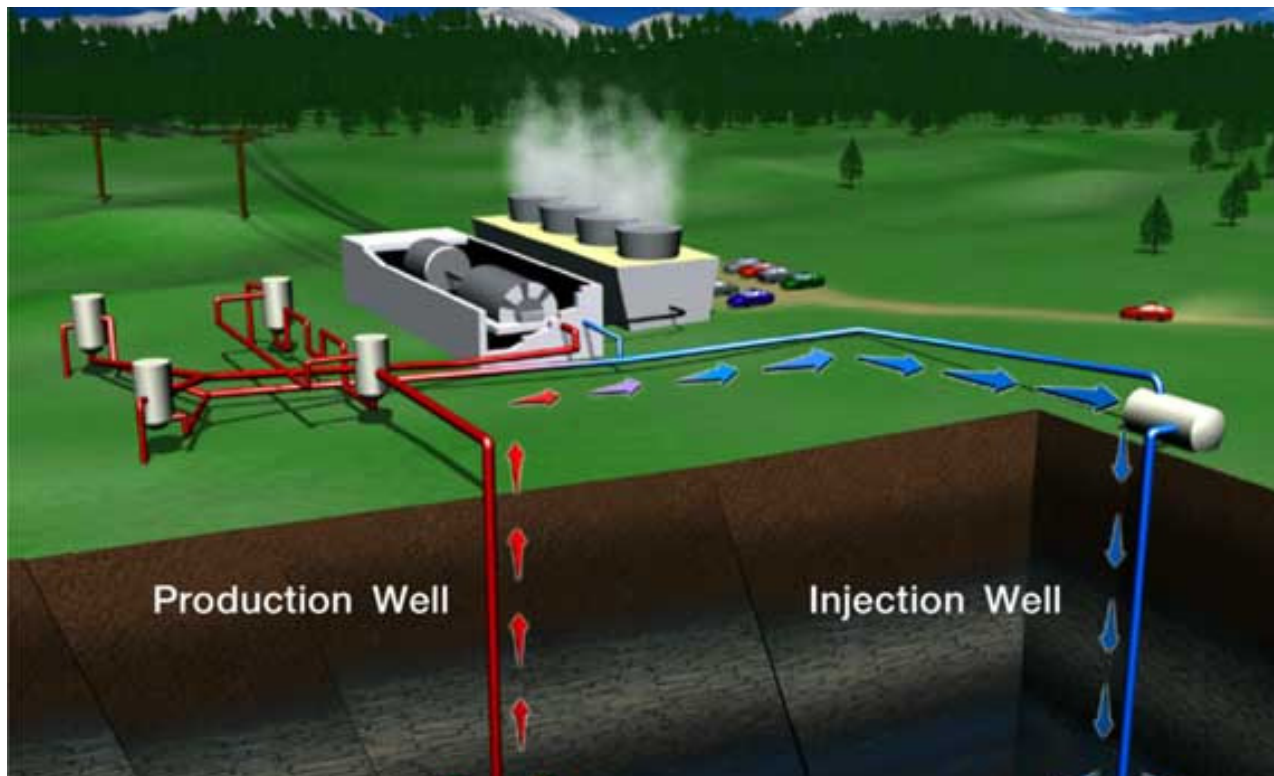
http://en.wikipedia.org/wiki/Environmental_remediation



http://en.wikipedia.org/wiki/Deep_foundation

Future Challenges in Geotechnology

"In many ways geotechnology is a mature field... Many serious problems have been solved. We know how to build strong foundations, safe dams, and stable roads and tunnels. We have a good understanding about the behaviour and protection of ground water, how to extract petroleum resources and develop a geothermal field. We understand quite a bit about the soil conditions that lead to liquefaction during an earthquake or make landslides likely.



Future Challenges

"If there is a major problem it is that the state of the practice worldwide does not match the state of the art. Even when the knowledge exists, economics or ignorance lead to harmful, suboptimal and dangerous practice. People still build trailer parks on floodplains"

- US Board on Earth Sciences and Resources, 2006



http://en.wikipedia.org/wiki/Soil_liquefaction

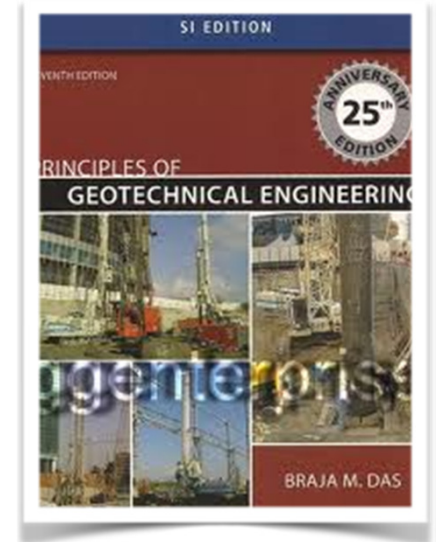


<http://www.bbc.co.uk/news/uk-england-london-24702806>

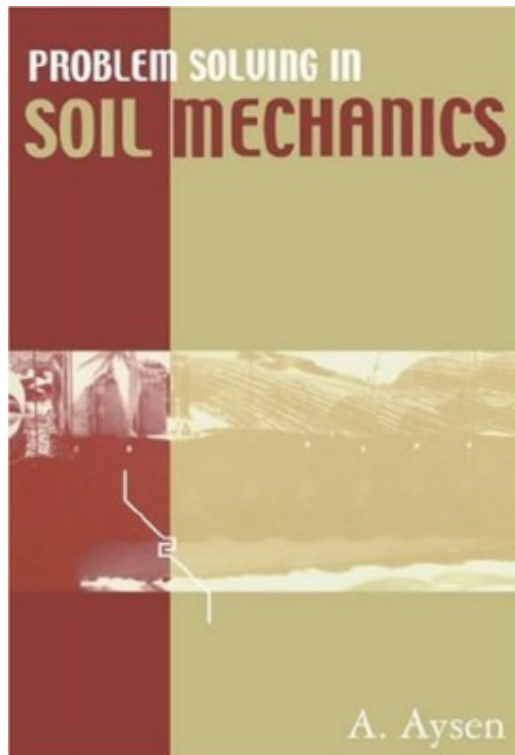
Reading

Chapter 1 Das

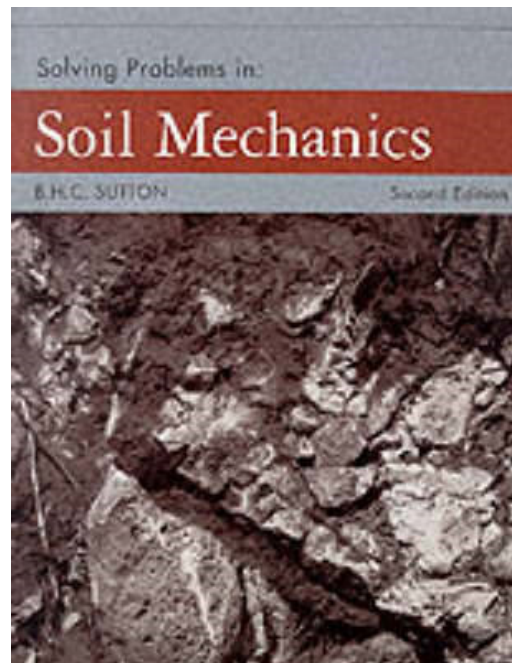
Internet research keywords: soil science, geotechnical engineering, soil failure



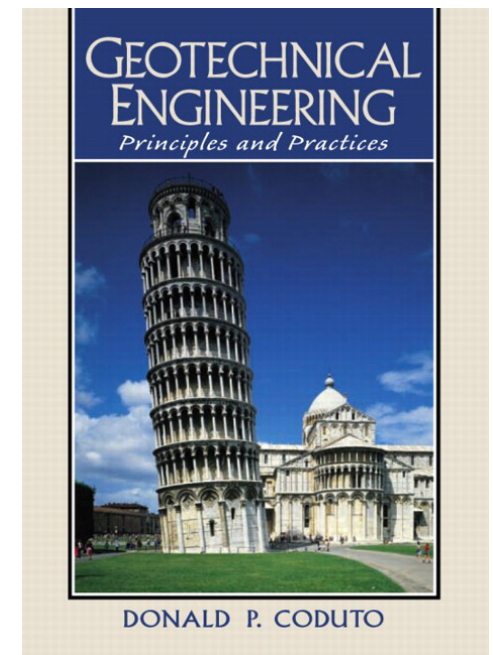
<http://www.bookdepository.com/Solving-Problems-Soil-Mechanics-BHC-Sutton/9780582089716>



<http://www.ebay.com/ctg/Problem-Solving-Soil-Mechanics-A-Aysen-2004-Paperback-/52853454>



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<http://www.tower.com/foundation-design-principles-practices-donald-p-coduto-hardcover/wapi/100501083>