CHARTING THE PATH
TOWARD
THE FUTURE
6 INTERNATIONAL CONFERENCE
Geotechnical Engineering **Education**

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Geosynthetics in the Classroom: Educating Future Engineers and Their Instructors

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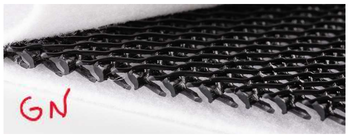
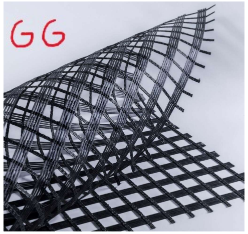
Why Geosynthetics in Undergraduate Education?

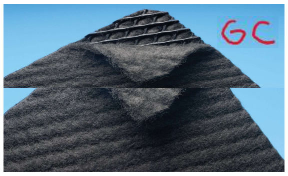
- Geosynthetics are ubiquitous in geotechnical engineering
  - They contribute to nearly every subfield in geotechnical engineering
- Professional training may eventually cover the use of geosynthetics
  - Yet, the fundamentals of geosynthetics belong earlier in the educational process
- The proposal is to teach geosynthetics in the introductory geotechnical course, alongside the first exposure to soils
  - This can be achieved by framing geosynthetics in a broader family of “geomaterials”
- Teaching geosynthetics can help students better understand the functional role of soils
  - It also provides insight into the role of geomaterials in the built environment

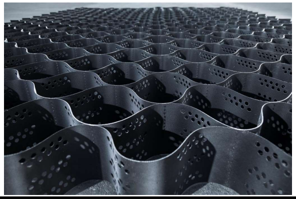
Geosynthetic Types

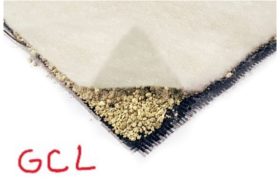
- Geotextiles
- Geogrids
- Geomembranes
- Geonets
- Geocomposites
- Geocells
- Geosynthetic clay liners
- Erosion control products
- Many others:
  - Geofibers
  - Geofoam
  - Geopipes
  - Interlayers

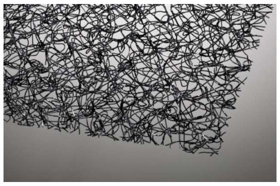






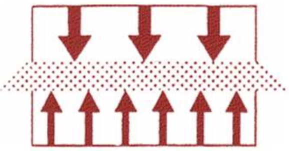


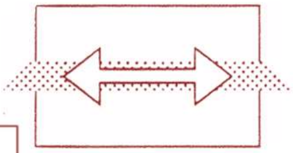


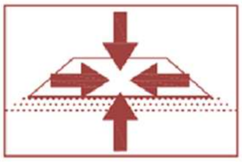


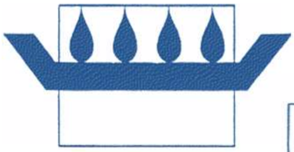
Geosynthetic Functions

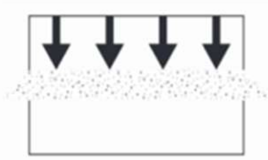
- **Separation**
- **Reinforcement**
- **Stiffening**
  (a.k.a Stabilization)
- **Filtration**
- **Barrier**
- **Drainage**
- **Protection**









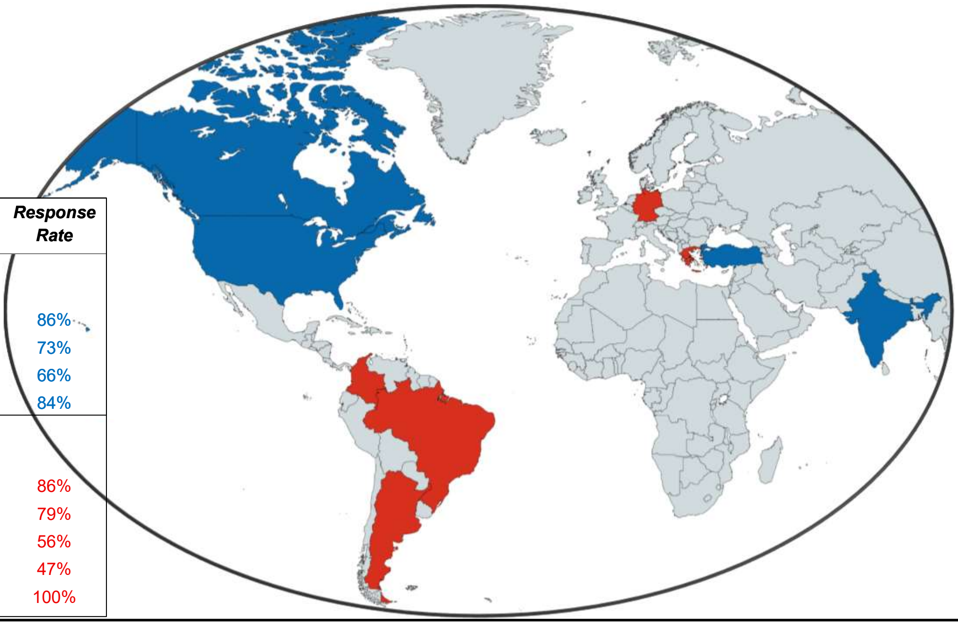


An International Survey on Geotechnical Education

- A survey was conducted among civil engineering faculty at universities in nine countries
  - Its goal was to assess how geosynthetics are taught at the undergraduate level
- A total of 466 civil engineering programs were identified
  - Very high response rate (about 73%)
  - Only one faculty member from each identified academic institution was contacted to complete the survey
- The majority of the participating institutions (86%) offer Ph.D. programs
- The analyses presented here focus on:
  1. The geotechnical engineering courses within the civil engineering programs
     - Required versus elective course offerings
  2. Coverage of geosynthetics in the geotechnical courses
     - Coverage in required versus elective geotechnical courses

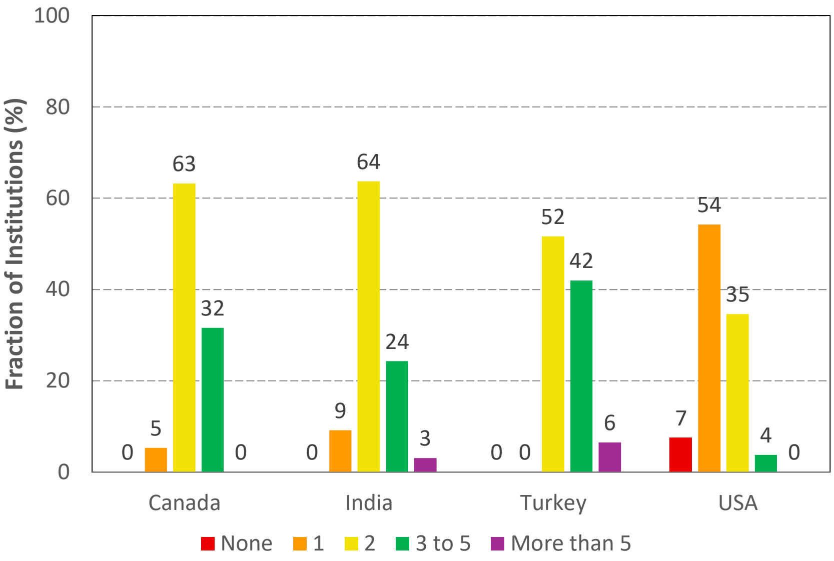
Participating Institutions

Country	# Programs Identified	Response Rate
4-Year Programs:		
Canada	22	86%
India	49	73%
Turkey	97	66%
USA	129	84%
5-Year Programs:		
Argentina	22	86%
Brazil	56	79%
Colombia	25	56%
Germany	59	47%
Greece	7	100%



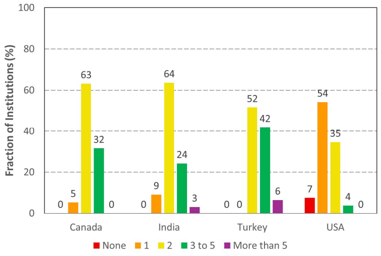
Mandatory Undergraduate Geotech Courses

4-Year Programs

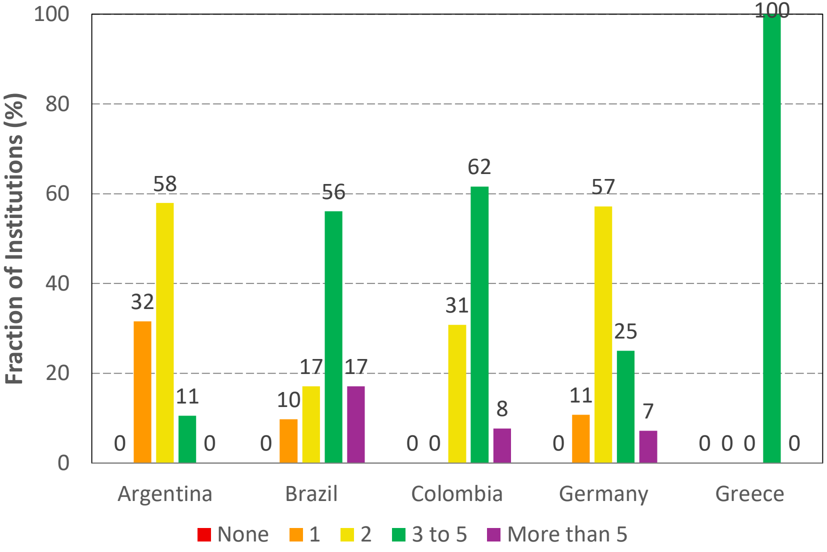


Mandatory Undergraduate Geotech Courses

4-Year Programs:



5-Year Programs:

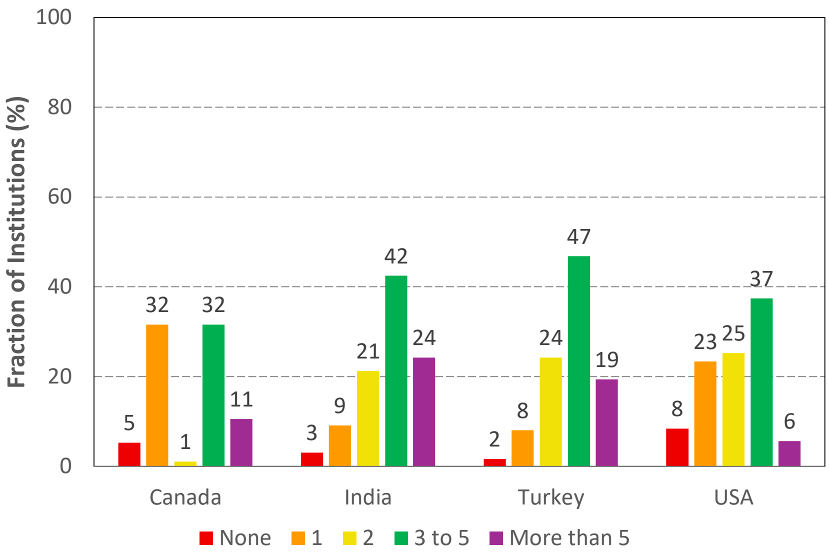


Mandatory Undergraduate Geotech Courses

- Predictable yet clear pattern: Programs with longer durations tend to include more mandatory geotechnical courses
  - Some 4-year programs even lack a single mandatory Geotech course!
- The gap in geotechnical coverage may warrant a call to action to reduce adverse educational impacts
  - Geotech education should adapt to the global trend of shortening civil engineering programs
- While this shift may be irreversible, its effects must be evaluated carefully
  - Certain topics must remain in all civil engineering programs, regardless of length
- The argument that students can specialize later through graduate studies does not address key issues
  - Specialization typically happens after students' educational paths and professional identities have already begun to form
  - Topics like geosynthetics are increasingly important across various civil engineering fields, making them relevant to all practicing civil engineers, not just those who decide to specialize

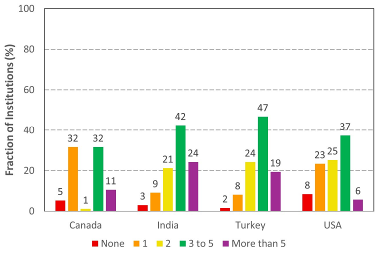
Elective Undergraduate Geotech Courses

4-Year Programs

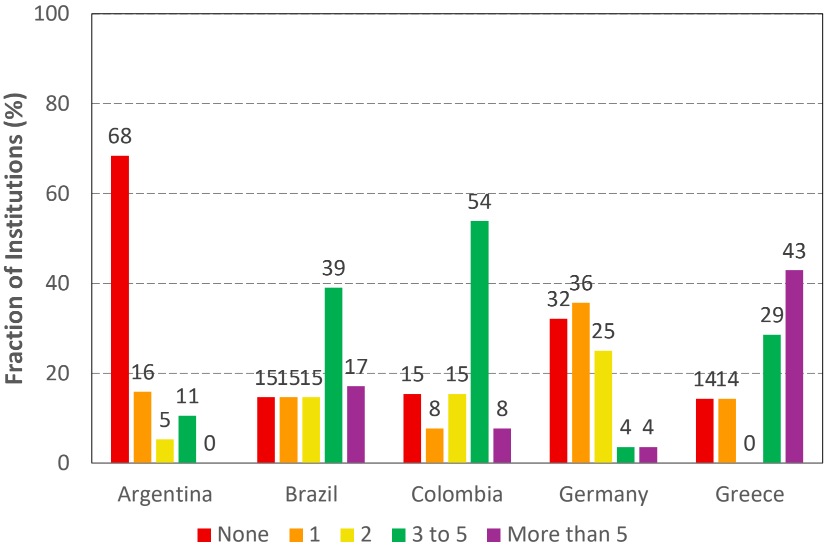


Elective Undergraduate Geotech Courses

4-Year Programs:



5-Year Programs:



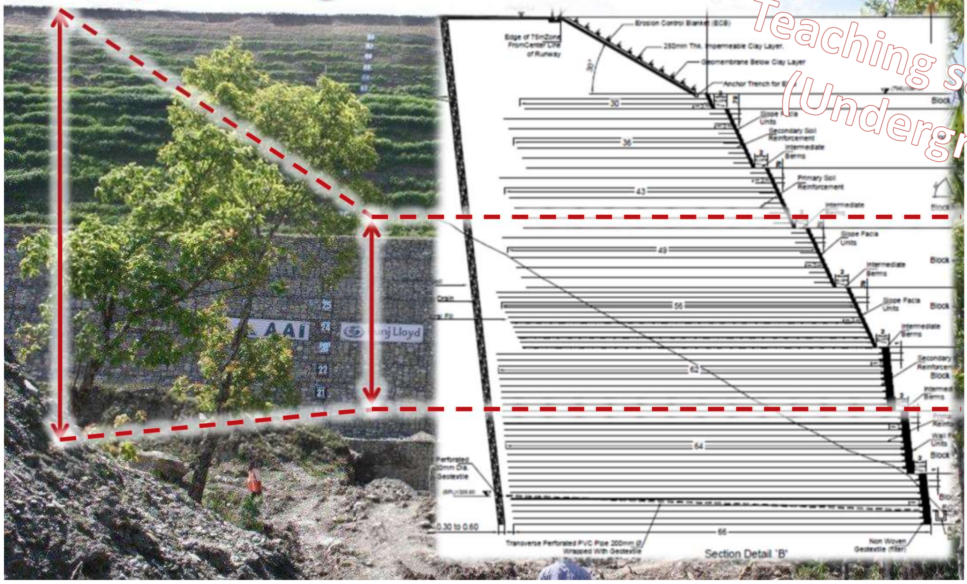
Elective Undergraduate Geotech Courses

- In the 4-year group, most (but not all) institutions report offering at least one elective Geotech course
  - For instance, in the United States, 69% offer at least two elective Geotech courses, and 44% at least three
  - The distribution of elective geotechnical courses is fairly similar among the 4-year programs, with about half of the programs in each country offering at least three elective Geotech courses
- The 5-year group shows a quite diverse picture regarding elective Geotech courses:
  - In some cases, the number of electives is smaller than in the 4-year group:
    - Argentina: 68% of civil engineering programs in Argentina offer no elective Geotech courses
    - Germany: 32% of programs offer no elective Geotech courses, and 36% offer only one
    - This might suggest weaker support for geotechnical depth in five-year programs, although this interpretation would be inaccurate without considering the number of mandatory courses
  - In some other cases, the number of electives is healthy, complementing a healthy number of mandatory courses:
    - Brazil and Colombia: 55% and 62% of programs offering at least 3 Geotech electives
    - Greece: 43% of the programs offer over 5 Geotech electives

The Need to Teach Geosynthetics

- Geosynthetics have become essential in modern civil engineering
  - They are used in a wide range of infrastructure projects
  - Have been included in national and international design standards (e.g., AASHTO, ISO, CEN)
- Unlike natural soils, geosynthetics are engineered materials with tightly controlled properties
  - This makes them ideal to help students understand material selection, specification, and performance-based design
- Use of geosynthetics leads to comparatively more sustainable design alternatives
  - They allow for thinner pavement layers, more efficient earth structures, and reduced volume of natural aggregates
  - They enhance durability and extend service life, leading to more resilient and sustainable infrastructure
- Their incorporation into the curriculum is both feasible and scalable
  - A meaningful introduction to geosynthetics can be achieved in just one class session within an introductory geotechnical engineering course

Today... MSE Wall at Sikkim Airport



Courtesy: Edoardo Zannoni

Today... Austin, Texas, USA

Teaching sample (Undergrad)

The Challenges of Teaching Geosynthetics

- Curriculum limitations constitute a significant obstacle:
    - As technical knowledge needed by students keeps growing, undergraduate programs struggle to cover more material within a set number of hours
    - Dropping new topics, like geosynthetics, is an easy way out despite their well-established role in engineering
- Faculty readiness is a significant barrier
    - Many Geotech professors were not introduced to geosynthetics during their own education
    - As a result, they may lack confidence and instructional resources to teach geosynthetics effectively
- The significant breadth of geosynthetics poses a didactic challenge
    - Covering geosynthetics requires going over a wide variety of material types, each with different functions, properties, and applications
- These challenges underscore the need for a teaching approach that is strategic
    - Again → a brief yet well-thought-out exposure can ensure that all students graduate with at least a basic exposure to geosynthetics

The Appeal of Teaching Geosynthetics

- The appeal of teaching geosynthetics extends beyond their technical relevance—it also lies in their ability to inspire thoughtful, creative, and well-rounded engineering professionals
  - Using geosynthetics often requires innovative thinking, adaptable solutions, and interdisciplinary integration
  - Introducing students to the ingenuity of geotechnical projects involving geosynthetics early in their education can be highly motivating
- The breadth of geosynthetic types, functions, and applications—also identified as a challenge—provides the appeal for developing tailored solutions to engineering problems
  - Evaluating trade-offs involving performance, cost, constructability, and sustainability helps students learn to make informed, context-aware decisions
- Teaching geosynthetics provides an opportunity to refresh the curriculum with content that is both modern and engaging

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Ingenuity in Geosynthetic Design for Unsaturated Soil Barriers

Where?

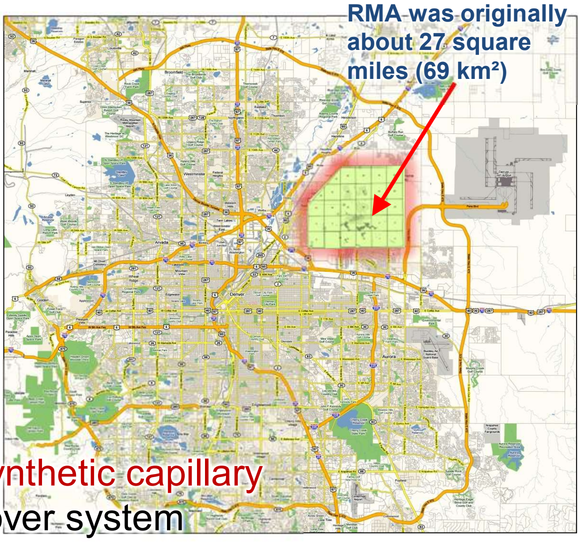
Rocky Mountain Arsenal, Denver, Colorado, USA

What?

Establish the largest urban wildlife refuge in a highly contaminated site

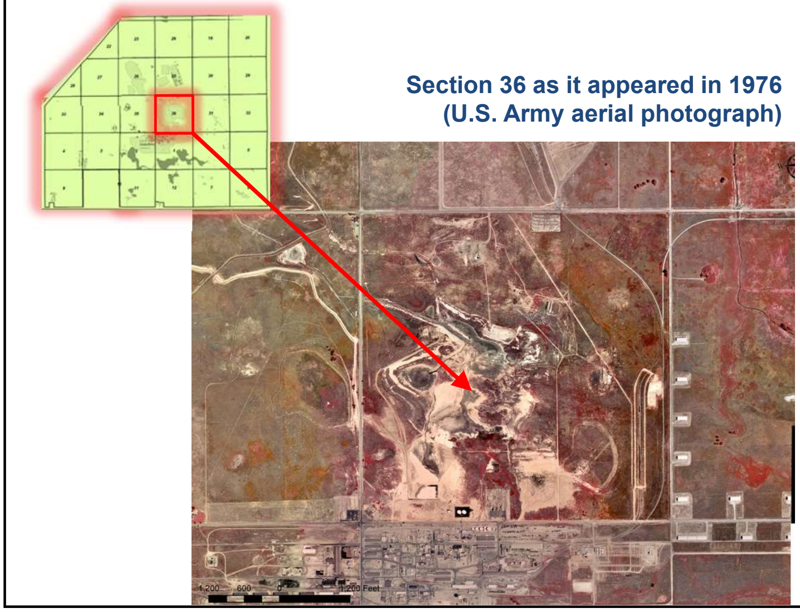
How?

Designing and constructing a geosynthetic capillary barrier within an unsaturated soil cover system



RMA was originally about 27 square miles (69 km²)

“The Most Contaminated Square Mile on Earth”

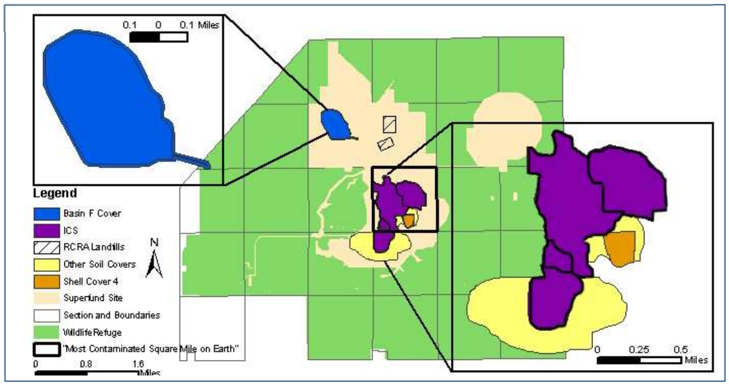


Section 36 as it appeared in 1976
(U.S. Army aerial photograph)

Sarin bomblet showing relative size
(USFWS photograph)

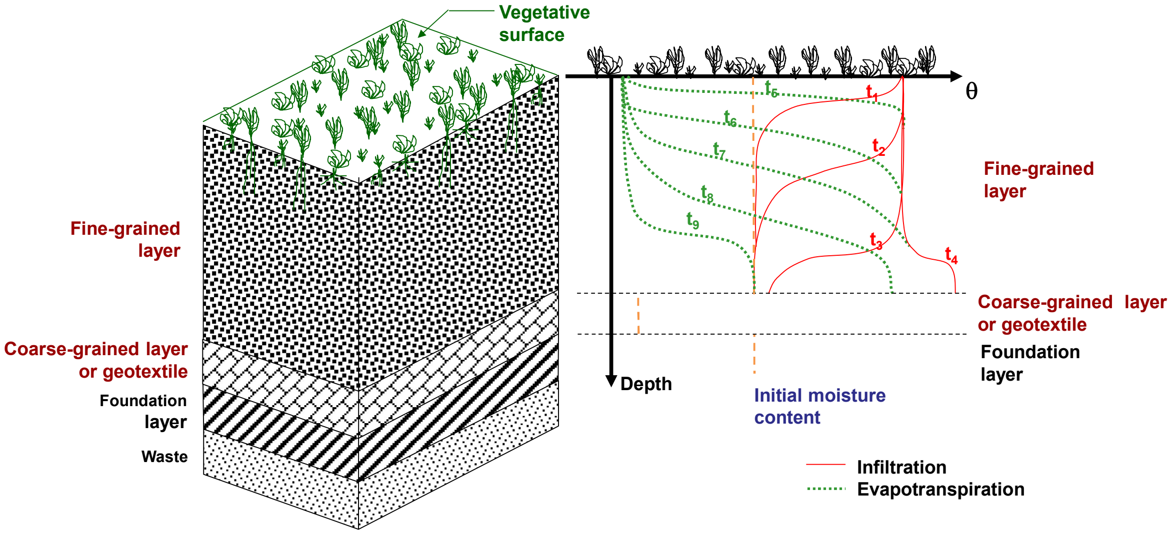
Sarin bomblet recovered from a debris
pile at the RMA (U.S. Army photograph)

Rocky Mountain Arsenal



- Hazardous waste:
  - Disposed in landfills (34 ha) that include both double and triple liners, leachate collection systems, leak-detection systems, and multi-layer covers
- Contaminated soils and demolished structures:
  - Consolidated in-situ below “unsaturated soil” covers (183 ha) – no liners

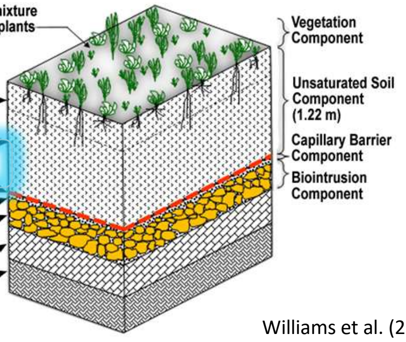
Capillary Break Cover



Zornberg and McCartney (2007)

Final Cover Design

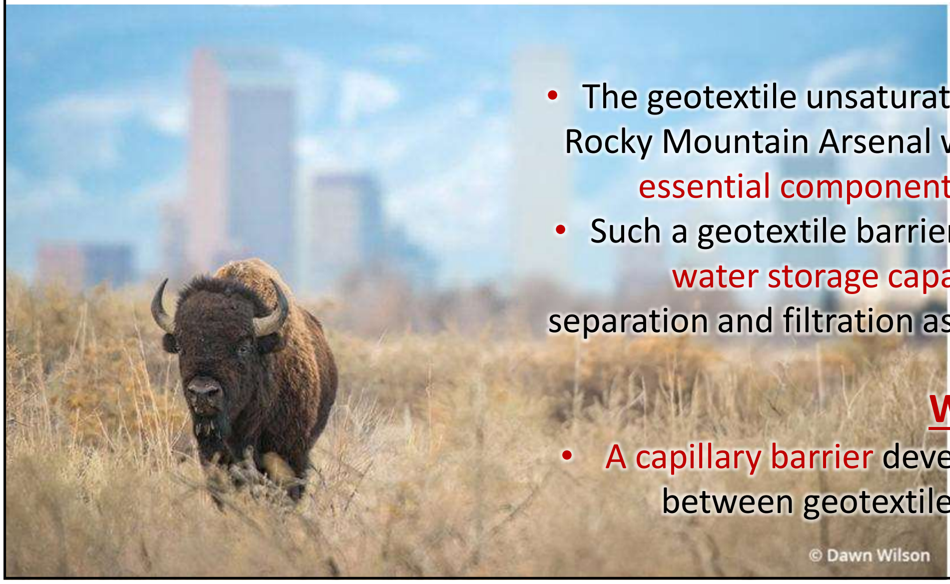
EPA field oversight photograph



The cover was redesigned by incorporating a permanent capillary barrier

Williams et al. (2011)

Ingenuity on Geosynthetic Design for Unsaturated Soil Barriers


© Dawn Wilson

Significance:

- The geotextile unsaturated soil barrier at the Rocky Mountain Arsenal was recognized as an essential component of the cover system
- Such a geotextile barrier provides additional water storage capacity (with geotextile separation and filtration as additional benefits)

Why does it work?

- A capillary barrier develops at the interface between geotextiles and overlying fine-grained soils

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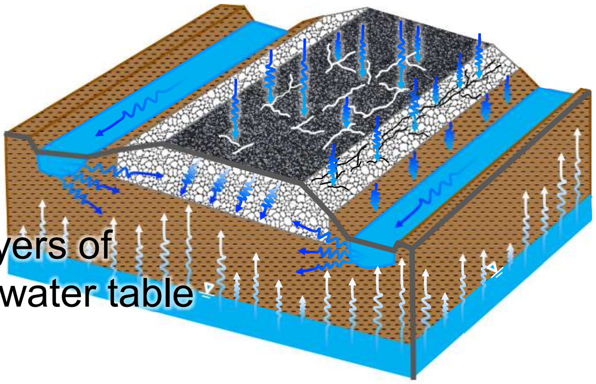
Ingenuity in Geosynthetic Design for Unsaturated Soils Drains

Source: Zornberg et al. (2016)



Where?

Daniel Boon Bridge, St. Louis, Missouri, USA

What?

Reduce moisture in structural layers of pavement at locations with high water table

How?

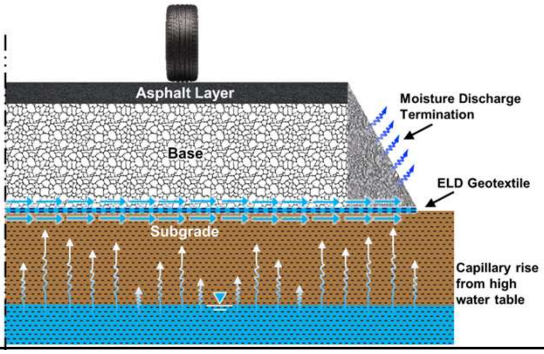
Adopt a geosynthetic with enhanced lateral drainage that promotes “wicking” of moisture from soil layers

Daniel Boone Bridge

- **Reconstruction of Daniel Boone Bridge**
  - In Interstate 64
  - Two original bridges:
    - 1935 bridge deteriorated beyond repair
    - 1980's bridge could not meet demand
- **The challenge: Stringent drainage requirements**
  - Site with a **high water table**
  - Good drainage needed for **approaching roadways** to minimize pavement distress

Daniel Boone Bridge

- Adopted final design involved a **"wicking geotextile"** for internal drainage
- Moisture migrating upward from high water table is drained laterally



Source: Zornberg et al. (2017)

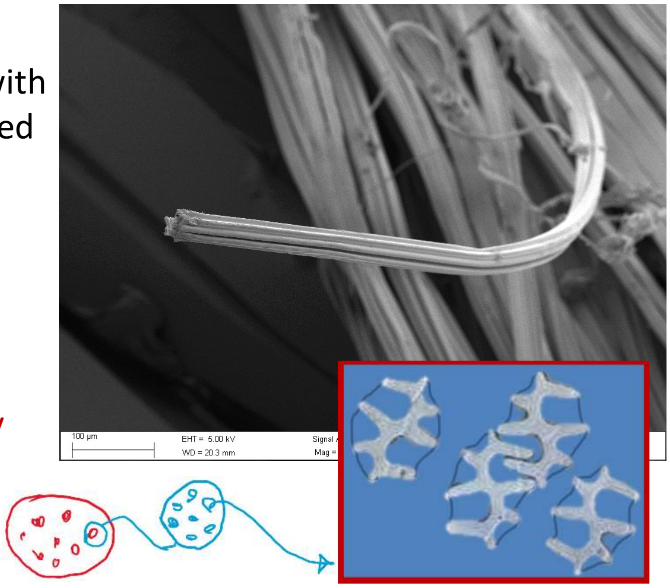
Ingenuity on Geosynthetic Design for Unsaturated Soil Drains

Significance:

- The adoption of geosynthetics with enhanced lateral drainage avoided the need to use costly granular materials
- No pavement distress has been observed since construction

Why does it work?

- The suction-driven flow capacity was quantified and proved adequate to decrease the moisture in relevant layers

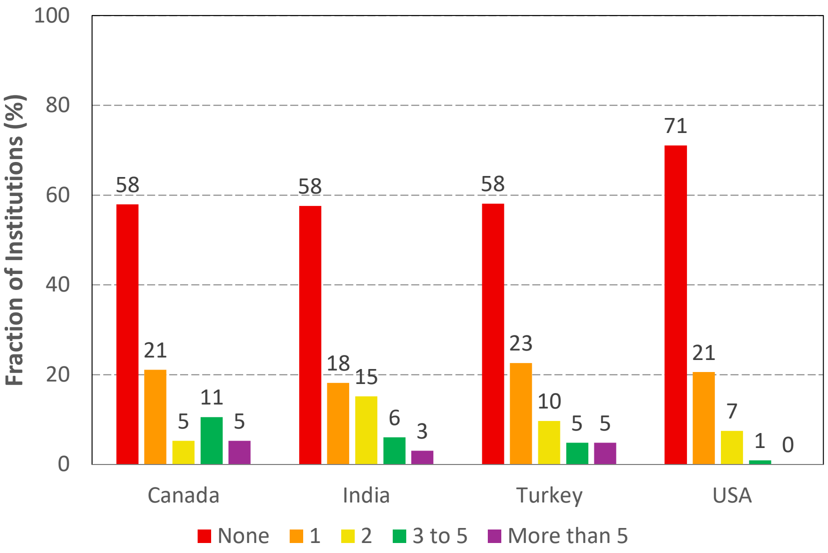


Geosynthetics to Strengthen Geotechnical Understanding

- Teaching geosynthetics helps improve students' understanding of fundamental geotechnical concepts
  - A primary feature of geosynthetics with strong teaching advantages is that their functions are clearly defined, offering simple ways to illustrate key design objectives for geotechnical projects
- For example:
  - Geosynthetics offer opportunities to review and apply concepts related to flow through porous media when examining the filtration and drainage functions of geosynthetics
  - Reinforcement mechanisms provide a tangible way to revisit the shear strength of soils and the effects of confining stresses

Geosynthetics in Mandatory Undergraduate Courses

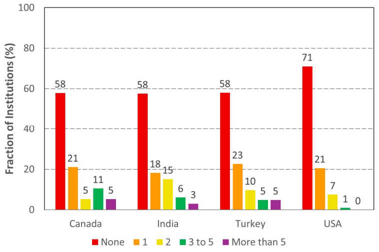
4-Year Programs

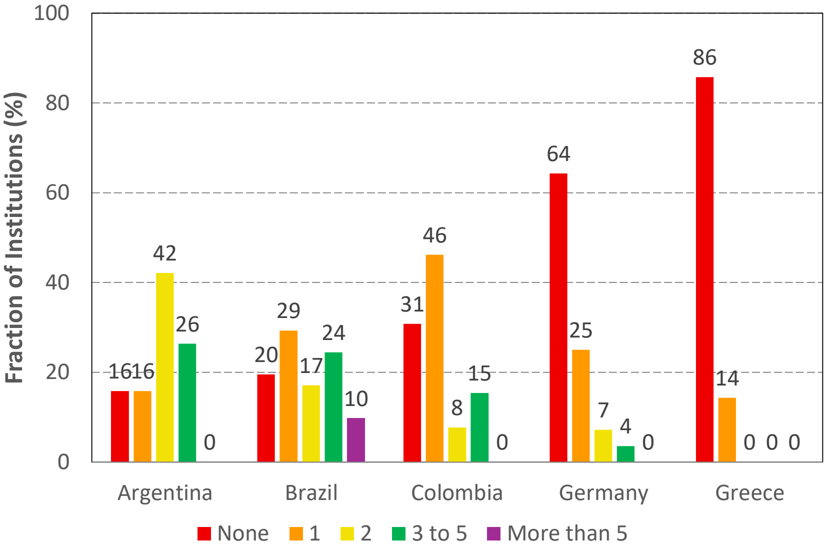


Geosynthetics in Mandatory Undergraduate Courses

5-Year Programs:

4-Year Programs:



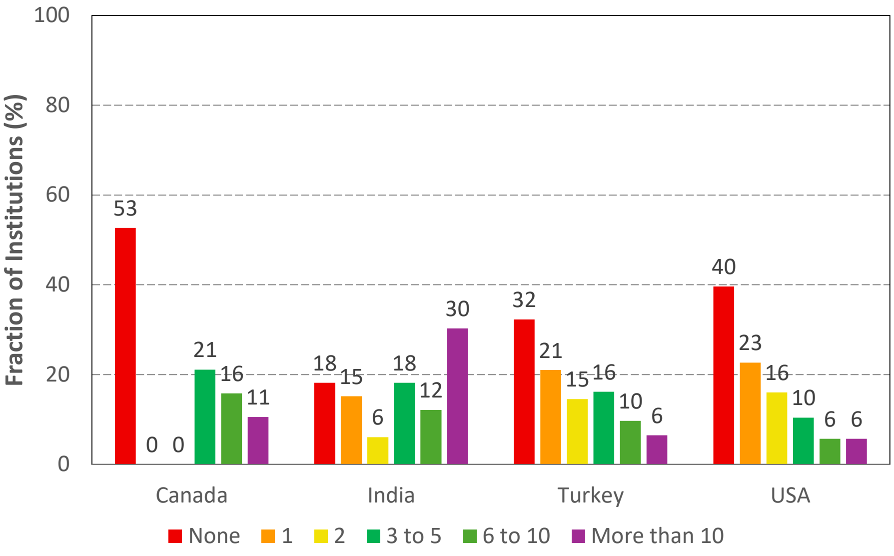


Geosynthetics in Mandatory Undergraduate Courses

- The coverage of geosynthetics in mandatory undergraduate Geotech courses varies significantly
- In the 4-year programs group, coverage is minimal:
  - The U.S. stands out as the country with the lowest level of coverage, with geosynthetics not being included in any mandatory course in 71% of the institutions
  - The coverage of geosynthetics in mandatory courses is quite consistent in the rest of the 4-year programs, but not significantly better: Geosynthetics are not covered in any mandatory course in 58% of institutions
- In the 5-year programs group, coverage displays a diverse pattern:
  - Brazil: 51% of the institutions include at least 2 hours
  - Argentina: 42% of the programs include at least 2 hours
  - Germany and Greece, despite their healthy number of mandatory Geotech offerings, exhibit the lowest coverage: 64% of German institutions and 86% of Greek institutions report no coverage of geosynthetics in mandatory Geotech courses
- The comparison between 4- and 5-year programs reveals that program length is not a dependable predictor of geosynthetics coverage in required geotechnical courses

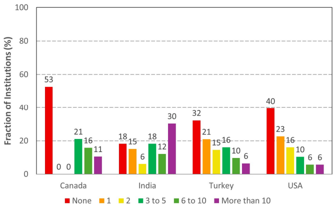
Geosynthetics in Elective Undergraduate Courses

4-Year Programs

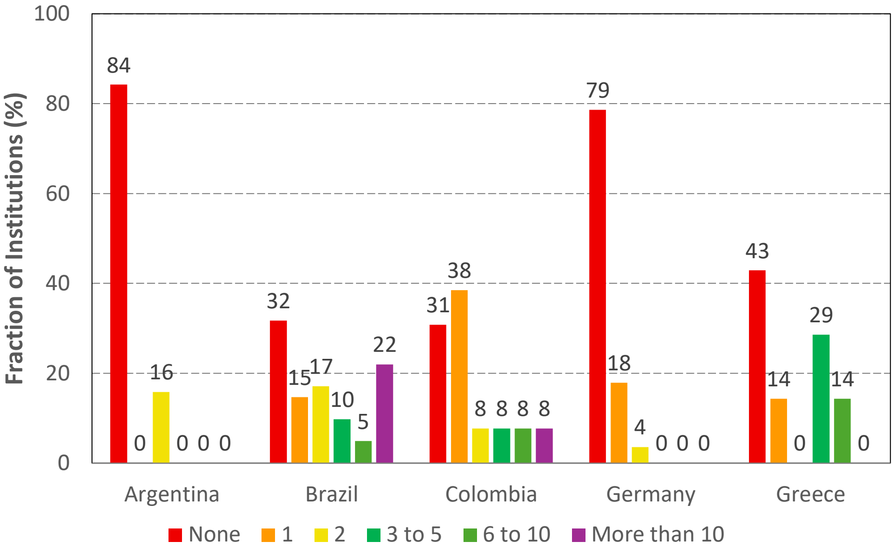


Geosynthetics in Elective Undergraduate Courses

4-Year Programs:



5-Year Programs:



Geosynthetics in Elective Undergraduate Courses

- While elective offerings allow for deeper exploration of specialized content, they do not guarantee exposure to geosynthetics
- In the 4-year programs group:
  - Canada and the U.S. stand out with a sizable number of programs that offer no geosynthetics coverage among the elective geotechnical courses (53% and 40%, respectively). Yet, a number of programs offer at least 6 hours of geosynthetics coverage among the elective geotechnical courses (27% and 12%, respectively)
  - India stands out among the countries in this group with the most extensive coverage of geosynthetics in elective courses: 60% of the institutions offer at least 3 hours of geosynthetics coverage
- In the 5-year programs group:
  - A staggering number of institutions do not offer any geosynthetics coverage in elective courses: 84% in Argentina, 79% in Germany, 43% in Greece, 32% in Brazil, and 31% in Colombia
  - On the positive side, Greece and Brazil have the highest percentages (43% and 37%, respectively) of institutions offering at least 3 hours of geosynthetics in their elective Geotech courses

IGS' Educate the Educator (EtE) Program

- To support university professors in bringing geosynthetics content into undergraduate civil engineering classrooms, the International Geosynthetics Society (IGS) launched an educational initiative
- The program facilitated in-depth discussions around technical content, instructional delivery, and the challenges of introducing new material into already crowded undergraduate curricula
- It also offered a valuable opportunity to assess how seasoned educators engage with emerging teaching content

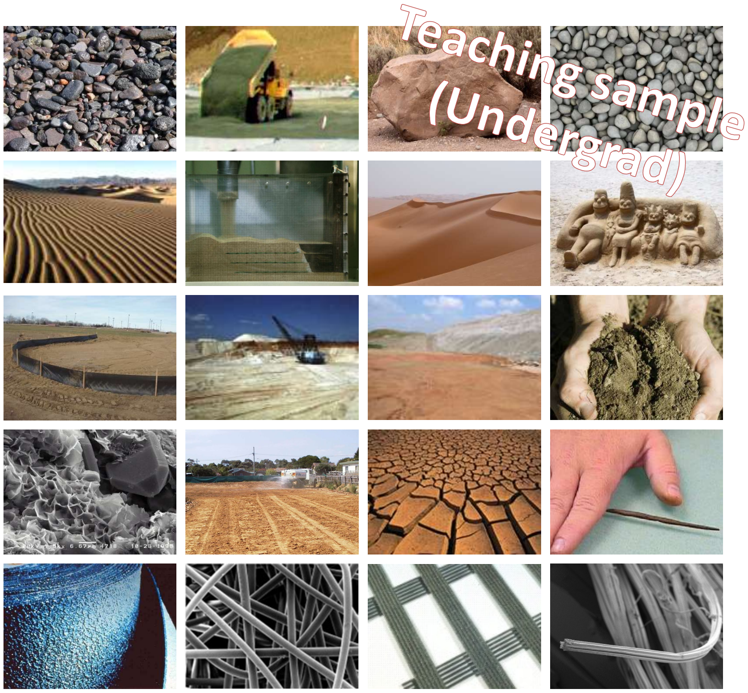
Geographic Distribution of EtE Programs

★ Completed EtE Events

✹ Planned EtE Events

Source:
Zornberg et al. (2017)

Educational Strategies to Introduce Geosynthetics to Undergraduate Students



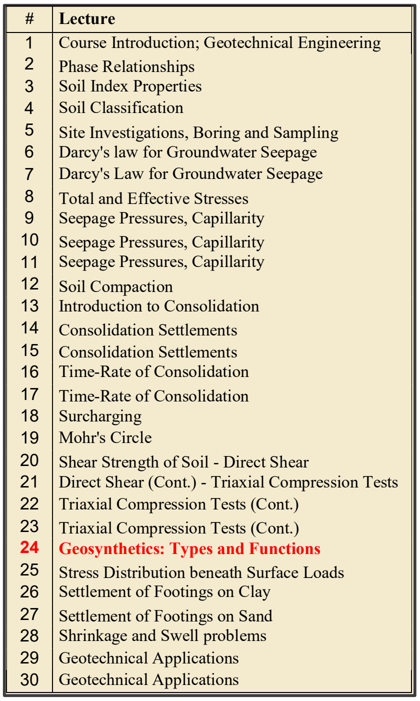
Focus of this lecture

Provide Early Exposure to Geosynthetics as a Core Geotechnical Material

- A key strategy promoted in this presentation is to introduce students to geosynthetics early (e.g., a mandatory, introductory geotechnical engineering course)
- The first geotechnical engineering course often functions as a "materials" course, introducing students to the engineering behavior of a key civil engineering material: soil
- Introducing geosynthetics early helps clarify the concept of "functions" in geotechnical materials, an idea central to performance-based design
  - Recognizing these functions (for both natural and synthetic geomaterials) gives students a framework for choosing material properties based on the intended use
- Even brief, well-placed exposure to foundational concepts can lead to long-term retention and understanding, especially when aligned with core learning principles that emphasize early activation of prior knowledge and relevance (Ambrose, 2020)

Teaching Samples (in Undergraduate Education)

- Example of implementation in a typical syllabus (UT-Austin)
- Clearly, providing the necessary breadth in a single hour of classroom teaching is challenging



#	Lecture
1	Course Introduction; Geotechnical Engineering
2	Phase Relationships
3	Soil Index Properties
4	Soil Classification
5	Site Investigations, Boring and Sampling
6	Darcy's law for Groundwater Seepage
7	Darcy's Law for Groundwater Seepage
8	Total and Effective Stresses
9	Seepage Pressures, Capillarity
10	Seepage Pressures, Capillarity
11	Seepage Pressures, Capillarity
12	Soil Compaction
13	Introduction to Consolidation
14	Consolidation Settlements
15	Consolidation Settlements
16	Time-Rate of Consolidation
17	Time-Rate of Consolidation
18	Surcharging
19	Mohr's Circle
20	Shear Strength of Soil - Direct Shear
21	Direct Shear (Cont.) - Triaxial Compression Tests
22	Triaxial Compression Tests (Cont.)
23	Triaxial Compression Tests (Cont.)
24	**Geosynthetics: Types and Functions**
25	Stress Distribution beneath Surface Loads
26	Settlement of Footings on Clay
27	Settlement of Footings on Sand
28	Shrinkage and Swell problems
29	Geotechnical Applications
30	Geotechnical Applications

Emphasize the Role of Geomaterials as Essential "Construction" Materials

- By the end of the introductory Geotech course, students realize that soils, unlike materials such as concrete or steel, are not manufactured to uniform standards
- However, soil characterization goes beyond simply analyzing subsurface conditions to support structures → Soils and other geomaterials are frequently used as construction materials in civil engineering projects
  - Students may not fully appreciate how frequently geomaterials are selected, processed, and placed for construction purposes
- The teaching of geosynthetics offers a teaching entry point to highlight the role of geomaterials as construction materials
  - When students learn how geosynthetics are chosen for specific functions, they see similarities with how soils can be selected to meet performance goals
- Recognizing geomaterials as functional construction materials highlights that material selection is not just about classification or compliance, but about purpose, performance, and constructability
  - Geosynthetics then serve as educational tools that explain the construction role of geomaterials

Separation Function

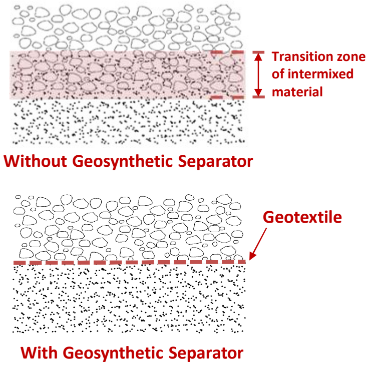
The geosynthetic, placed between two dissimilar materials, maintains them apart to keep their integrity and functionality.

Example: Geotextiles used to prevent base course materials from penetrating into an underlying soft subgrade, thus maintaining its design thickness.

Key properties:

- "Survivability" properties
  - Tear Strength
  - Grab Strength
  - Puncture Strength

⇨ AASHTO M288



Source: Zornberg & Christopher (2007)

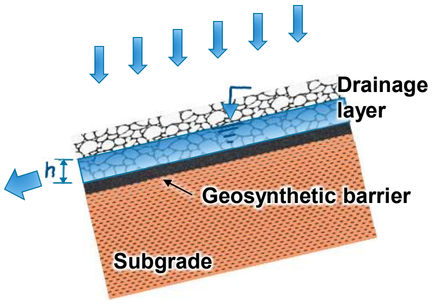
Barrier Function

The geosynthetic minimizes cross-plane flow, providing containment of liquids or gasses.

Example: Geomembranes used as barrier to downward migration of leachate at the base of a landfill.

Key properties:

- *For Geomembranes:*
  - Polymer type e.g. HDPE, PVC
  - Thickness t
  - Interface shear strength δ
- *For GCLs:*
  - Hydraulic conductivity k
  - Internal and interface shear strength ϕ, δ



Draw Parallels between Geosynthetics and Soil Mechanics Principles

- Core concepts in teaching geosynthetics closely resemble those of soils
- These parallels encourage a systems-level perspective on how different geomaterials interact in the built environment, a pedagogical approach grounded by evidence showing that connecting new teaching material to students' prior knowledge significantly enhances learning outcomes (Ambrose, 2020)
- Teaching geosynthetics offers unique opportunities to reinforce, expand, and unify traditional soil mechanics principles within a practical context
- In other words, geosynthetics are not just supplementary materials: they act as an effective lens for reinforcing essential geotechnical concepts clearly and powerfully

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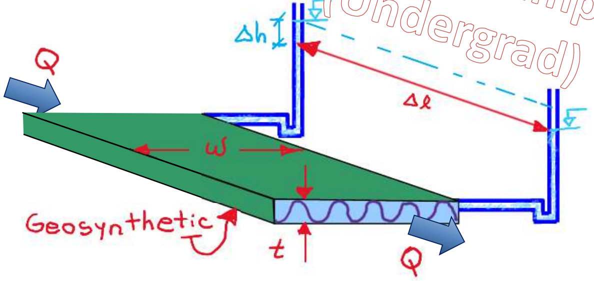
In-plane flow

Drainage Function

The geosynthetic allows liquid (or gas) flow within the plane of its structure.

Example: A geocomposite drainage layer used to convey liquids overlying a barrier in a waste containment facility.



Darcy's Law:

$$\theta = k_p . t$$

$$Q = k_p . \underbrace{\frac{\Delta h}{\Delta \ell}}_{i} . \underbrace{w . t}_{A}$$

$$\boxed{Q = \theta . i . w}$$

Key property:

- Transmissivity

$$\theta = k_p . t$$

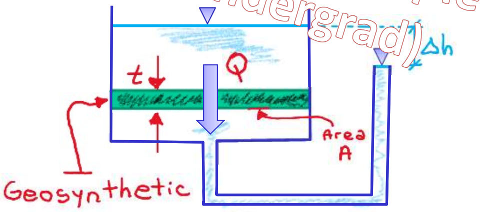
In-plane hydraulic conductivity

Geosynthetic thickness

Cross-plane flow

Filtration Function

The geosynthetic allows liquid flow across its plane while retaining fine soil particles on its upstream side.



Example: Geotextiles used to prevent soils from migrating into the aggregates in a road drainage system while maintaining adequate liquid flow.

Darcy's Law:

$$Q = k_n \cdot \underbrace{\frac{\Delta h}{t}}_{i} \cdot A \qquad \psi = k_n / t$$

$$\boxed{Q = \psi \cdot \Delta h \cdot A}$$

Key properties:

- Permittivity $\psi = \frac{k_n}{t}$

k_n: cross-plane hydraulic conductivity

t: Geosynthetic thickness

- Apparent Opening Size (AOS) O_{95}

Stiffening Function

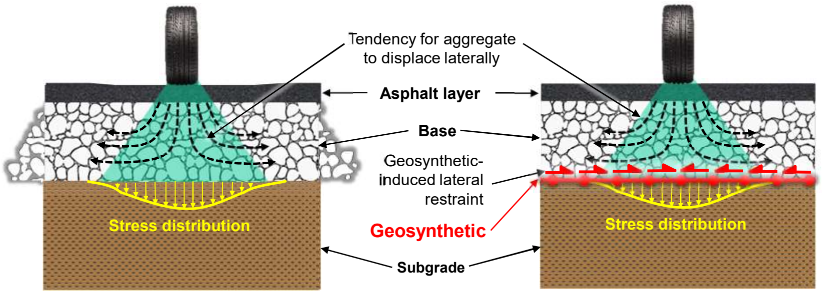
(a.k.a. Stabilization Function)

The geosynthetic develops tensile forces intended to control deformations in the soil-geosynthetic composite.

Example: A geosynthetic used to improve the mechanical properties of the unbound aggregate in a roadway.

Key properties:

- Geosynthetic stiffness
- Soil-geosynthetic interaction
- Confined stiffness of the soil-geosynthetic composite



Without geosynthetic stabilization

With geosynthetic stabilization

Source:
Zornberg (2017)

Highlight the Two-Dimensional Nature of Most Geosynthetics

- A distinguishing characteristic of most geosynthetics is their two-dimensional shape
  - Unlike natural soils, which are usually described based on their volumetric properties, geosynthetics are often so thin that their thickness is included within other parameters
  - This difference affects how material properties are defined and measured
- Explicitly teaching the two-dimensional nature of geosynthetics avoids that differences in terminology obscure the fact that fundamental engineering principles behind the behavior of soils and geosynthetics are the same
  - Emphasizing adaptations in relevant properties promotes a better understanding of how the geometry of geomaterials can influence material characterization

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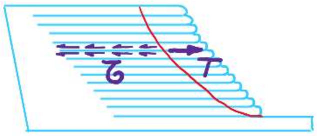
Reinforcement Function

The geosynthetic develops tensile forces intended to maintain or improve the stability of the soil-geosynthetic composite.

Example: Geosynthetics used to increase the margin of safety of a steep earth slope.



Key properties:

- Ultimate tensile strength T_{ult}
- Interface shear strength δ, P_r
- Reduction factors:
  - Creep RF_{CR}
  - Installation damage RF_{ID}
  - Durability RF_D

$$\overbrace{\frac{F}{w \cdot t}}^{\sigma} = E \cdot \varepsilon$$

T

$J = E \cdot t$

$$\boxed{T = J \cdot \varepsilon}$$

Revisit the Geosyntehtic “Materials” Concepts in Later “Application” Courses

- Instruction on geosynthetics may occur in elective courses, usually focused on geotechnical design applications
  - This practice should continue
  - The proposed approach does not replace the vital role of elective, application-oriented courses in reinforcing geosynthetics concepts
- This sequencing provides a significant pedagogical benefit
  - Instructors teaching application-oriented topics in geotechnical design won't need to pause to introduce the types, properties, and functions of geosynthetics from the beginning
- Revisiting geosynthetics in upper-level geotechnical courses aligns with the cognitive framework highlighted in learning research, where spaced repetition and revisiting concepts in varied contexts enhance mastery and long-term transferability (Ambrose, 2020)

Conclusions and Final Remarks

- An international survey was developed, implemented, and analyzed
  - With a response rate of 73% from 466 identified civil engineering programs, the survey provides a representative overview of how geotechnical education is organized in undergraduate programs
- Mandatory geotechnical courses among the 4-year programs:
  - Over 90% of the institutions in Canada, India, and Turkey offer at least two mandatory Geotech courses
  - Only 39% of the institutions in the U.S. require at least two mandatory courses, with 7% requiring no mandatory Geotech course at all
- Mandatory geotechnical courses among the 5-year programs:
  - At least two mandatory Geotech courses are offered in over 68% of the institutions
  - Discrepancies are observed with the number of institutions offering at least three mandatory Geotech courses, which represent 100%, 73%, 69%, 32%, and 10% of Greek, Brazilian, Colombian, German, and Argentine institutions, respectively.
- Coverage of geosynthetics in mandatory courses among the 4-year programs:
  - It is quite deficient: 71% of institutions in the U.S. and 58% of the institutions in Canada, India, and Turkey do not cover geosynthetics in any mandatory course
- Coverage of geosynthetics in mandatory courses among the 5-year programs:
  - It is quite diverse: The fraction of institutions not covering geosynthetics in any mandatory course corresponds to 16%, 20%, 31%, 64% and 86% of institutions in Argentina, Brazil, Colombia, Germany, and Greece, respectively

Conclusions and Final Remarks (Cont.)

- Introducing geosynthetics in the first geotechnical engineering course is expected to ensure that all students, including those not pursuing geotechnical electives, receive foundational exposure to geosynthetics
- Introducing geosynthetics early in the curriculum capitalizes on the concept of “functions” in geomaterials, serving as a teaching entry point to help students understand their roles and guide property selection based on their use
- The teaching of geosynthetics highlights the role of geomaterials as construction materials, helping students appreciate how frequently geomaterials are selected, processed, and placed to construct the built environment
- Parallels drawn between geosynthetics and soil mechanics principles result in unique opportunities to reinforce, expand, and unify core geotechnical concepts
- Highlighting the two-dimensional nature of geosynthetics helps ensure that differences in terminology do not prevent the fundamental principles from being understood
- Revisiting geosynthetics in application-focused courses later in the curriculum, after having provided early exposure, enables deeper engagement with design instead of needing remedial instruction on material fundamentals

The Power Behind Learning Geosynthetics

“Understanding how geosynthetics work together with soils helps me understand better how soils work"

Prof. Marina Pantazidou
National Technical University of Athens
Chair, TC306 - ISSMGE Technical Committee on Geotechnical Education
Chair, Fifth Intl. Conf. on Geotechnical Engineering Education

“What started as technology transfer from geotechnical engineering to geosynthetics engineering ended as technology transfer from geosynthetics engineering to geotechnical engineering”

Dr. J.P. Giroud
Founding father of the IGS
53rd Terzaghi Lecturer

Sources:
Pantazidou (2023)
Giroud (2008)

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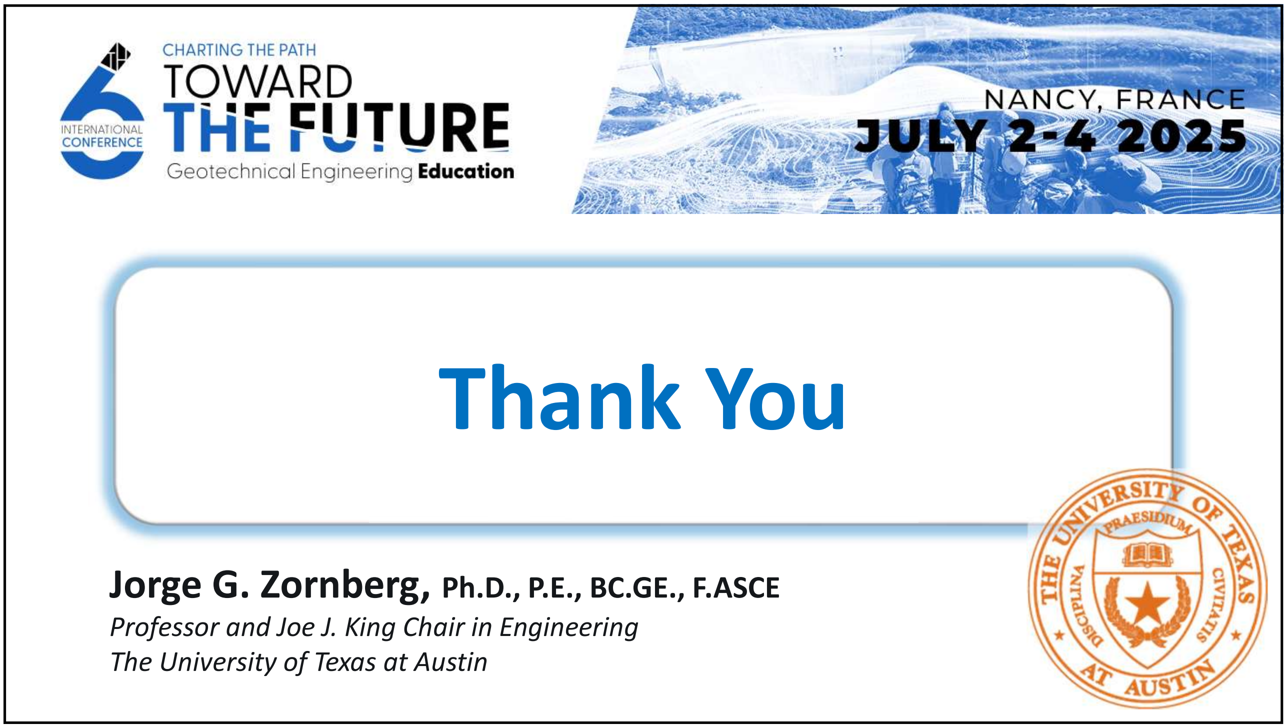

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Thank You

Jorge G. Zornberg, **Ph.D., P.E., BC.GE., F.ASCE**

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