Introduction to the use of GCLS

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What is a Geosynthetic Clay Liner?

Geosynthetic Clay Liners are manufactured Hydraulic/gas barriers consisting of clay bonded to a layer or layers of geosynthetics. They are relatively thin (5 to 7 mm when dry)

Geosynthetic Clay Liners

Other Names:

- **Prefabricated Bentonite Blankets**
- **Bentonite Blankets, Mats, or Panels**
- **Clay Blankets, Mats, or Panels**

Geosynthetic Clay Liners (GCLs) was selected in 1991 and stuck because:

Suggests that GCLs are part of the larger geosynthetic family.

Suggests that GCLs are another type of clay (i.e, an alternative to CCL).

Captures the essence of the material (i.e., Geosynthetic & Clay).

In 1962 Volclay panels were invented and introduced for underground water proof in applications (e.g., basements of commercial buildings)

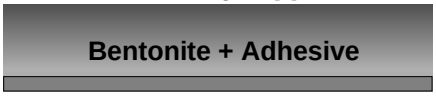
Volclay panels consist of sheets of corrugated cardboard with the flutes filled with granular sodium bentonite

Types of Geosynthetic Clay Liners

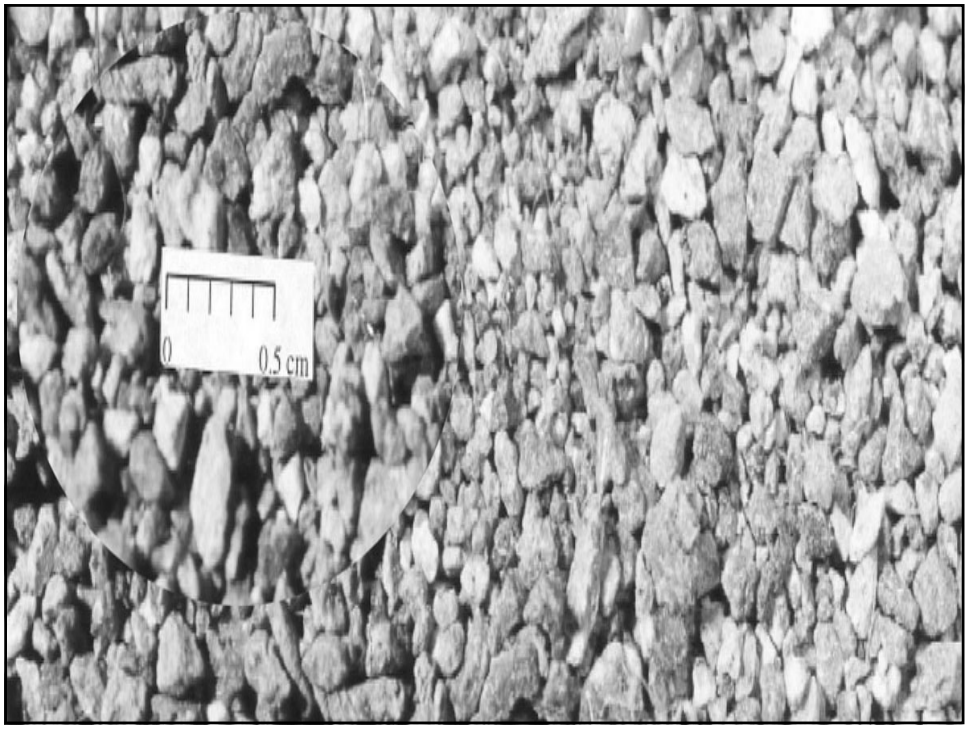
(a) Adhesive bound bentonite to upper and lower GTX

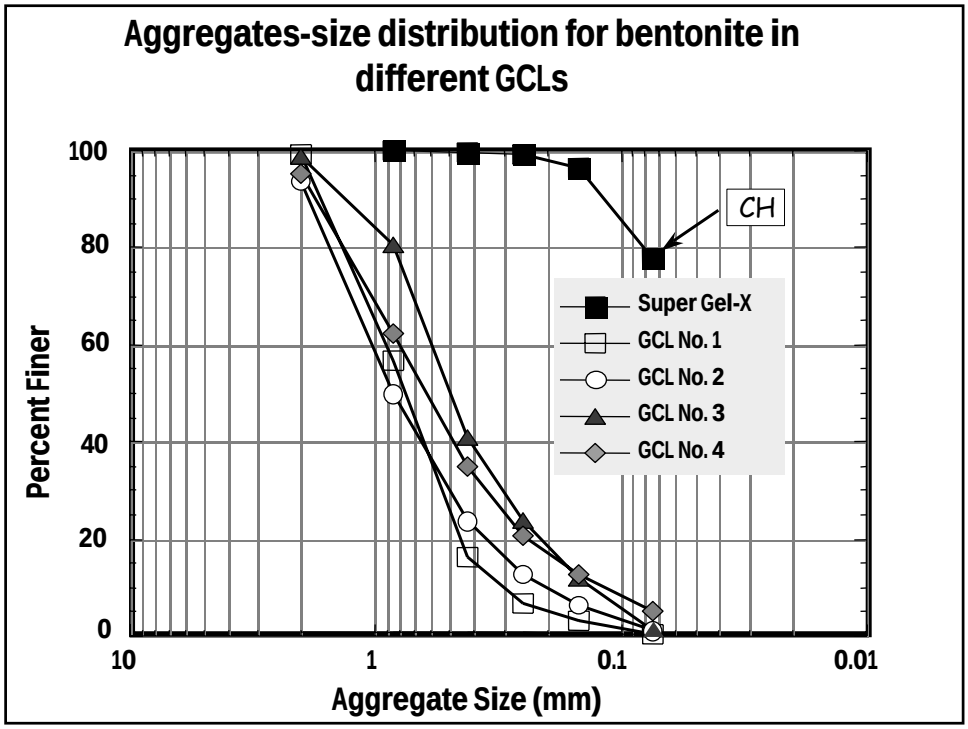
(b) Stitch bonded bentonite between upper and lower GTX

(c) Needle punched bentonite through upper and lower GTX

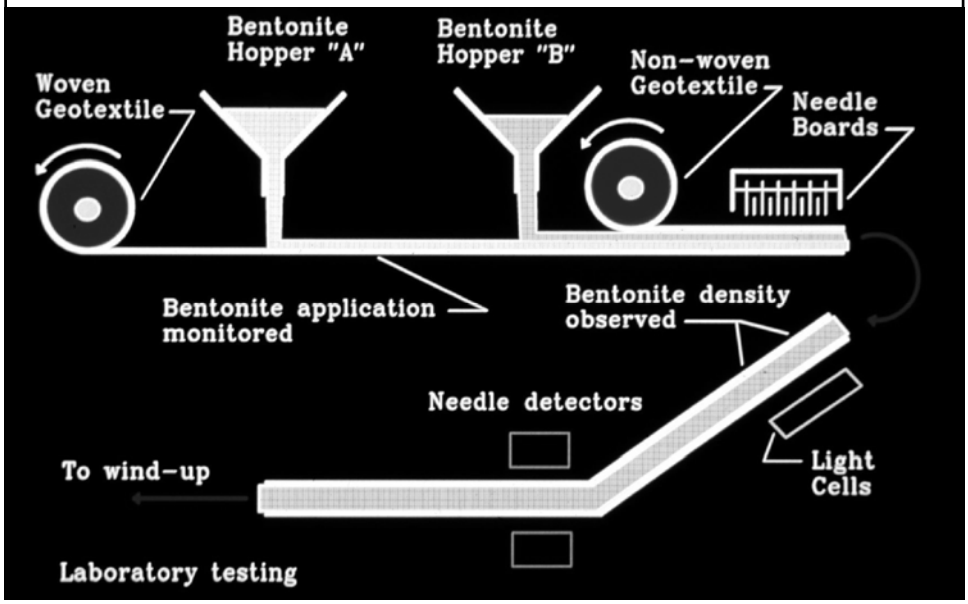


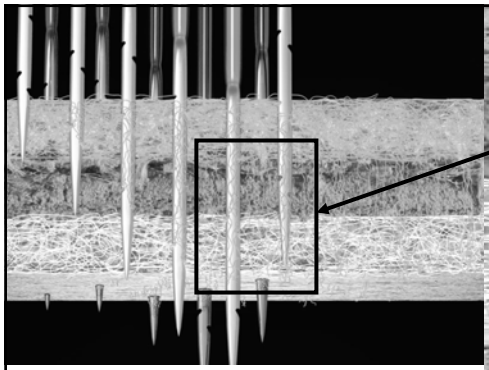
(d) Adhesive bound bentonite to a geomembrane

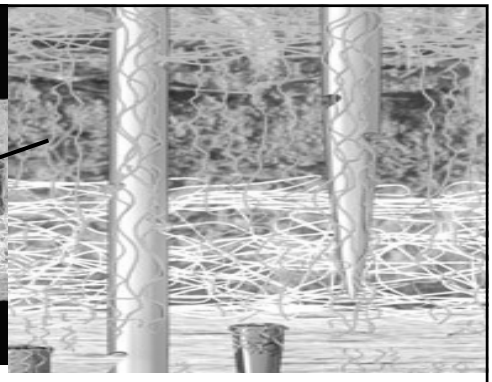

0
0.5 cm


Aggregates-size distribution for bentonite in different GCLs
Percent Finer
100
80
60
40
20
0
10
1
0.1
0.01
Aggregate Size (mm)
CH
Super Gel-X
GCL No. 1
GCL No. 2
GCL No. 3
GCL No. 4

Needle punched Manufacturing Process



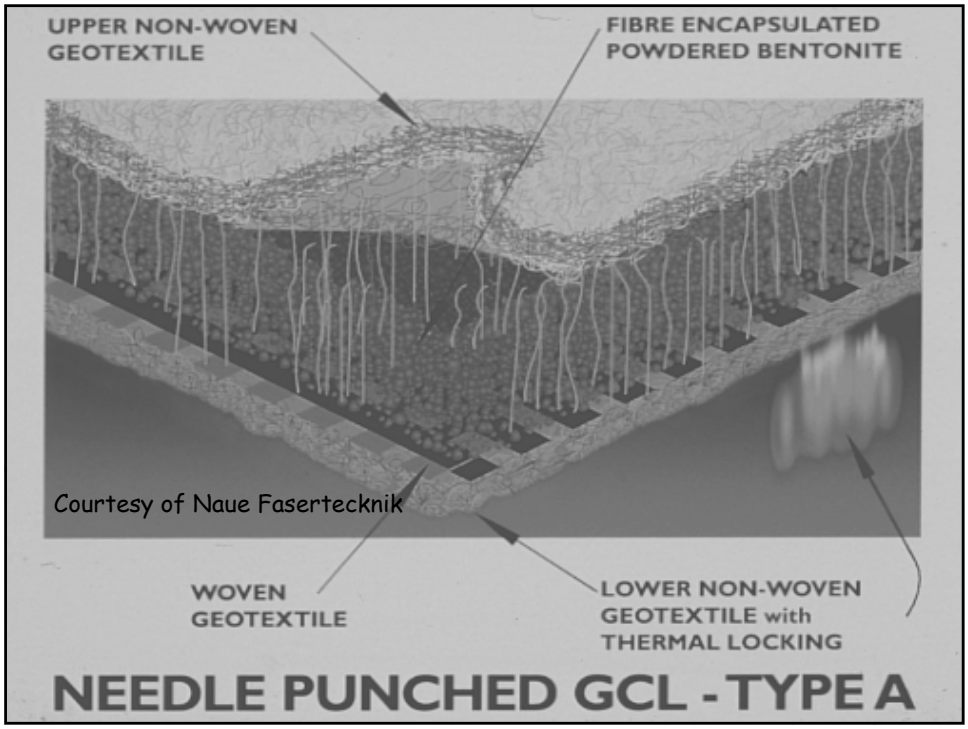




Approx. 2.5 million needle-punched fibres per m^2 create an unique GCL with several important advantages.

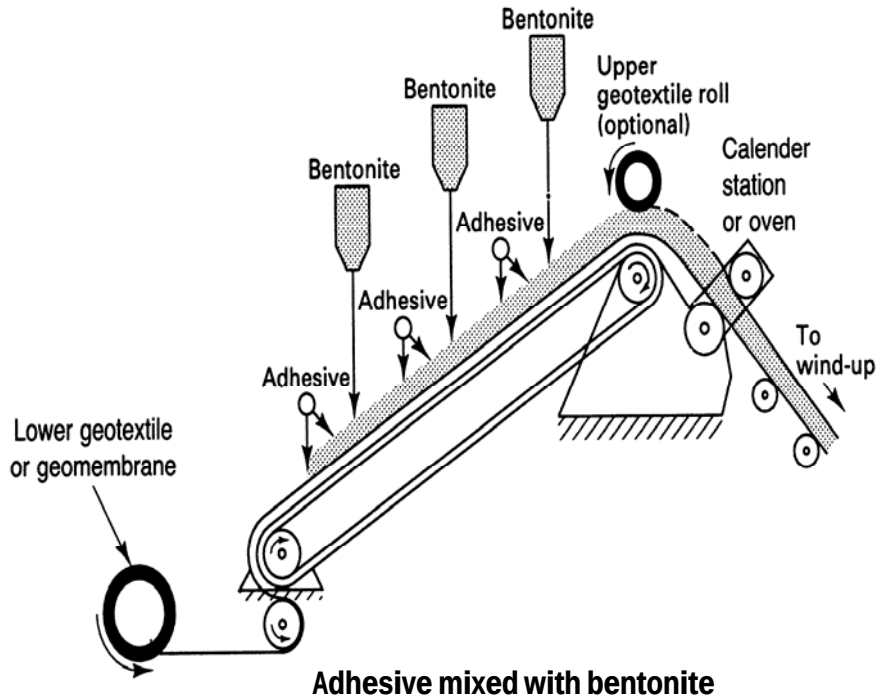
Benefits of Needle punching

- **Higher internal shear strength**
  - Higher factor of safety
  - Allows steeper slopes or higher shear loads
  - Not the "weakest link" in a multi-layer system
- **Better mass per area consistency**
  - Fewer thick and thin spots
  - Uniform hydraulic performance
  - Minimal edge loss during handling/installation
- **Better resistance to unconfined hydration**
  - Resists swelling pressure of bentonite



Benefits of fibre penetration or thermal treatment

- **Larger displacement capability**
  - **More shear movement can occur before maximum strength level is achieved**
- **Higher post-peak strength**
  - **More strength at large displacement**
  - **Improved FOS in "residual" conditions**



Adhesive mixed with bentonite

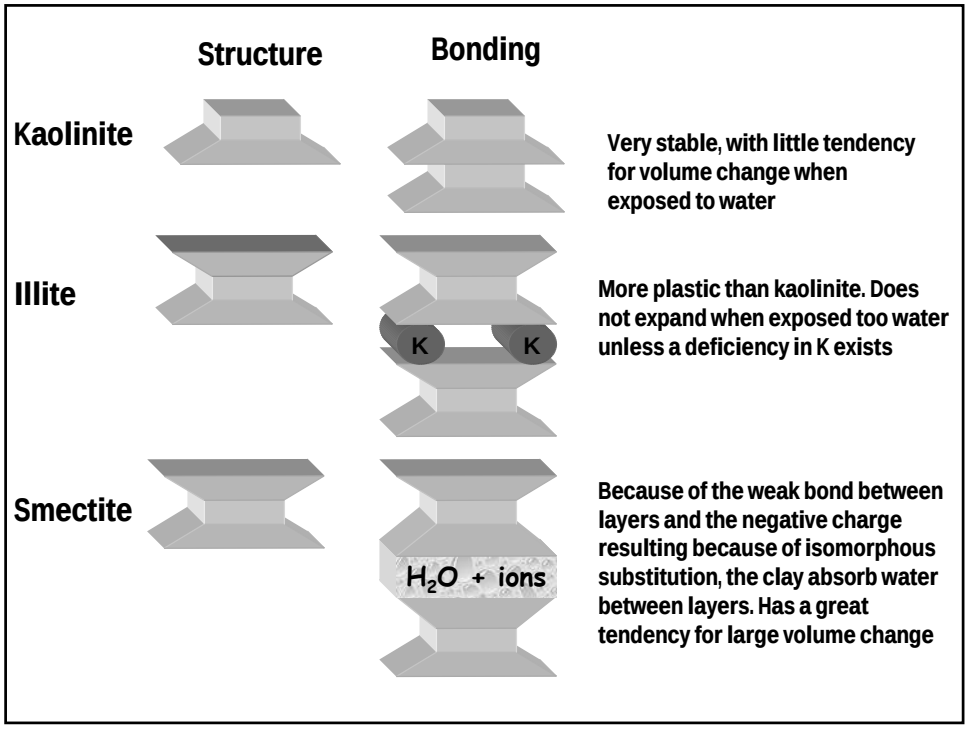
Bentonites

Vary considerably in properties due to variations in depositional environment and weathering process.

Most bentonites are sodium or calcium bentonites:

- ✓ **Volcanic ash that was deposited in marine environments during cretaceous period generally weathered to form sodium (Na^+) bentonite.**
- ✓ **Volcanic ash that was deposited in the tertiary period fell mostly in fresh water environments and weathered to form calcium (Ca^{2+}) bentonite**

- ✓**Purity of bentonite varies from about 60% montmorillonite to 90 % montmorillonite (Other minerals include quartz, feldspar, calcite, and gypsum).**
- ✓ **Degree of crushing and pulverisation of bentonite is variable; bentonite granules have different physical characteristics than more finely ground bentonite powder.**
- ✓ **Chemicals (particularly polymers) can be added to bentonite ("peptise" the bentonite)**



Sodium versus Calcium Bentonite

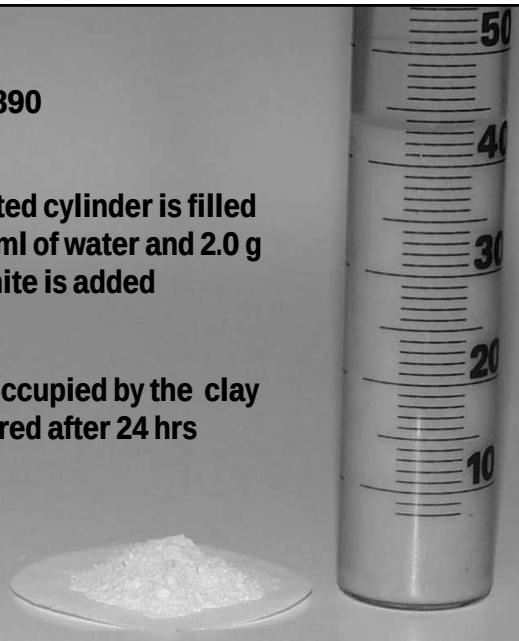
- ✓ Interlayer spacing for Ca++ bentonite is 10 to 20 A; interlayer spacing for Na+ can theoretically go to infinity but is probably inthe range of 20 to 4,000 A.

- ✓ Due to greater water absorbing capacity in the interlayer zone, Na^+ bentonites tend to have higher water contents, greater shrink-swell potential, and lower hydraulic conductivity

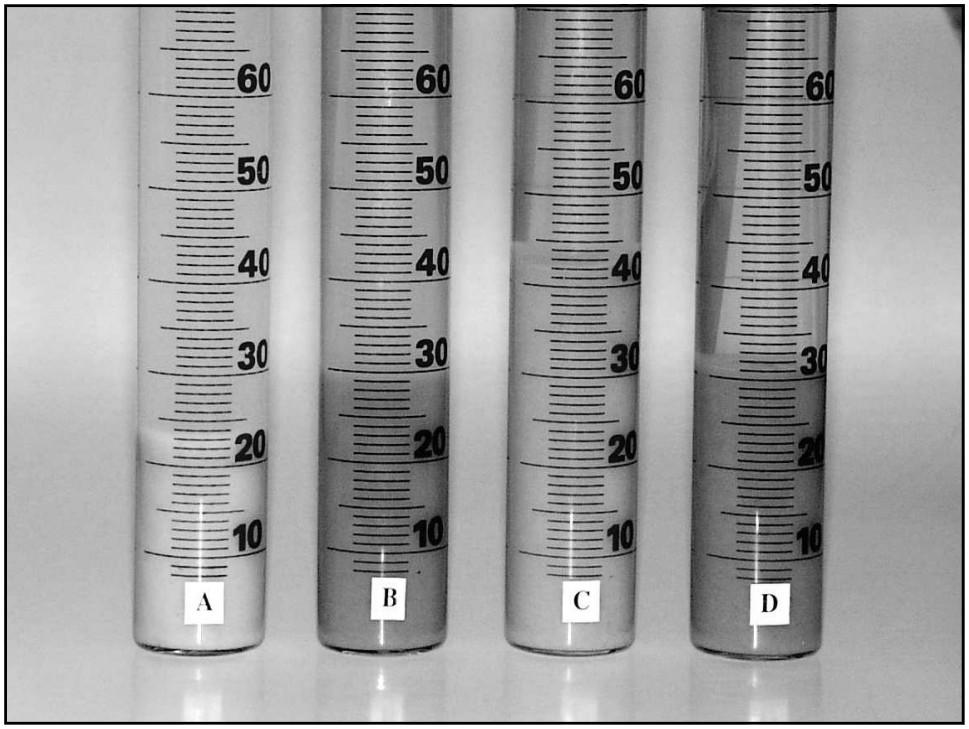
ASTM D5890

A graduated cylinder is filled with 100 ml of water and 2.0 g of bentonite is added

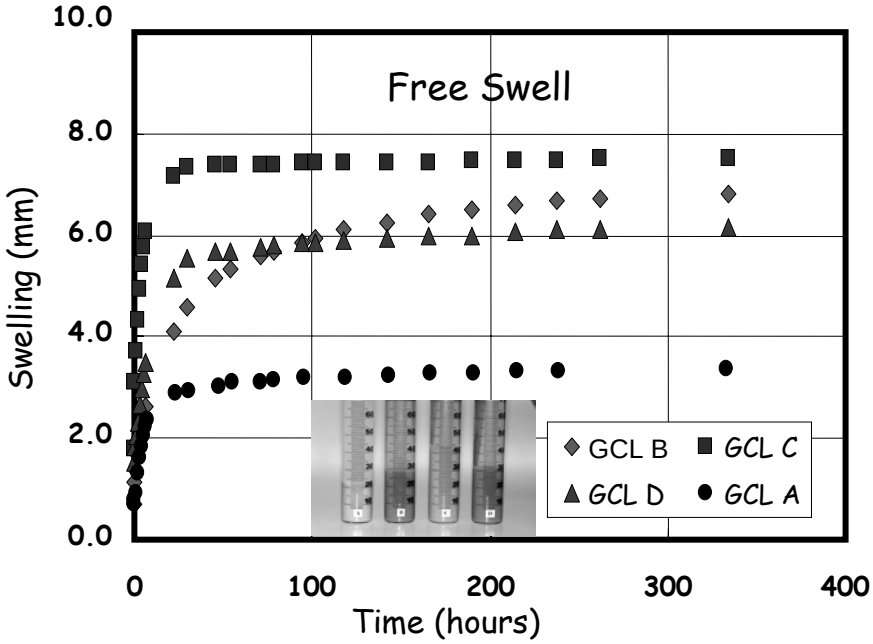
Volume occupied by the clay is measured after 24 hrs



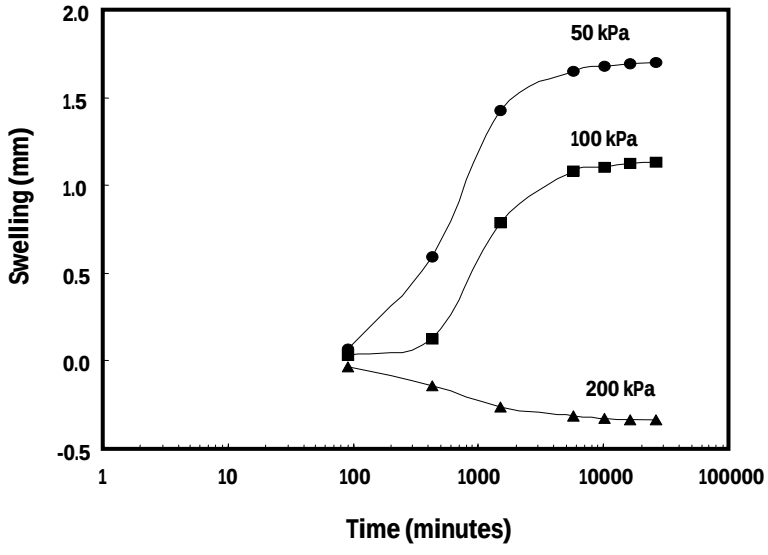
A minimum swell index value of 25 ml is recommended

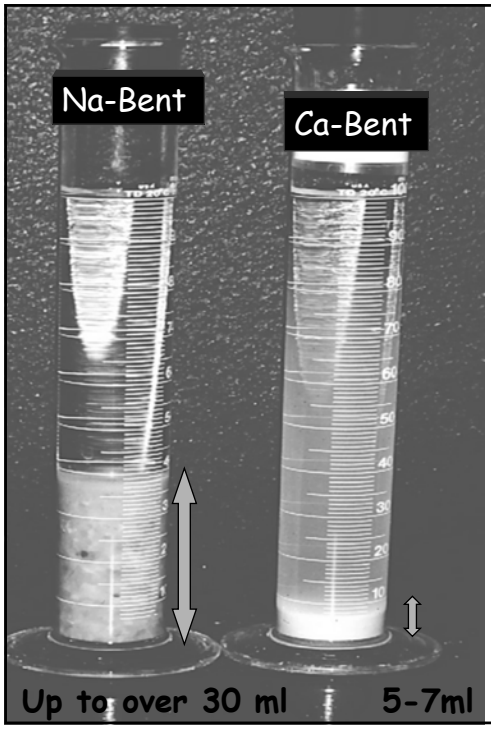


Swell Tests



Swell Tests





Swelling capacity depends on type of bentonite.

Sodium bentonite (swell 10-15 times vol.)

Calcium bentonite (swell 2-4 times vol.)

Sodium activated bentonite (sodium carbonate)

Comparison of Atterberg Limits

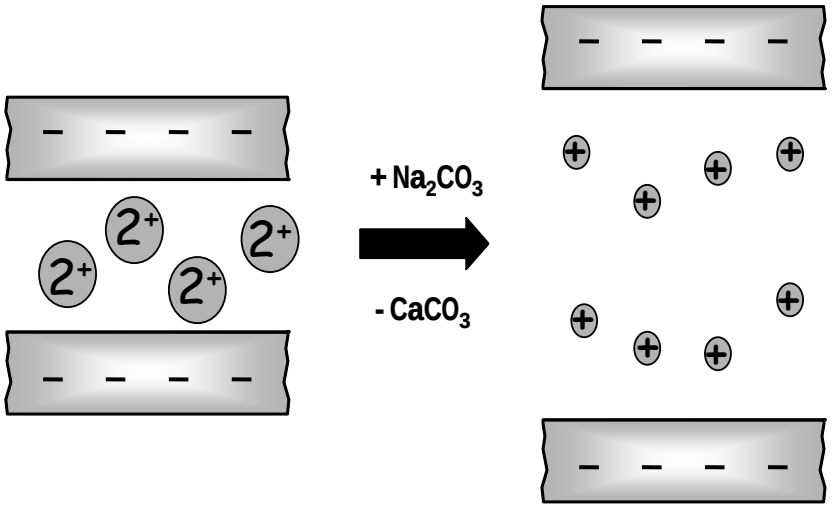
	LL (%)		PI (%)	
Investigators	Na^+	Ca^{++}	Na^+	Ca^{++}
Grim (1948)	700	124	603	52
Mesri & Olson (1970)	880	200	-	167
Eykholt (1988)	590	123	553	85
Gleason (1993)	603	124	567	98

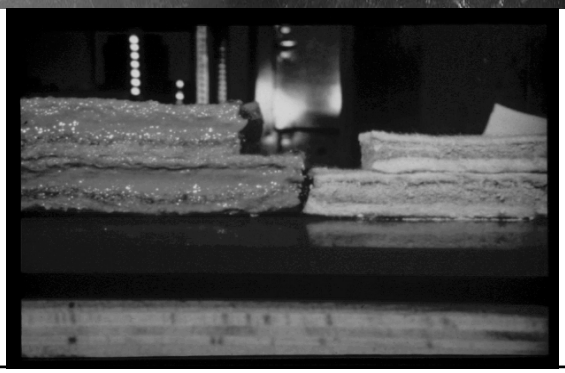
LL= Water content of the soil when the soil is at the boundary between liquid & plastic state.

PL= Water content of the soil when the soil is at the boundary between plastic and solid state

PI=LL-PI a measure of the water holding capacity over its plastic range

Soda Activation





GENERAL APPLICATION OF GCLs

Uses of GCLs in landfill sites

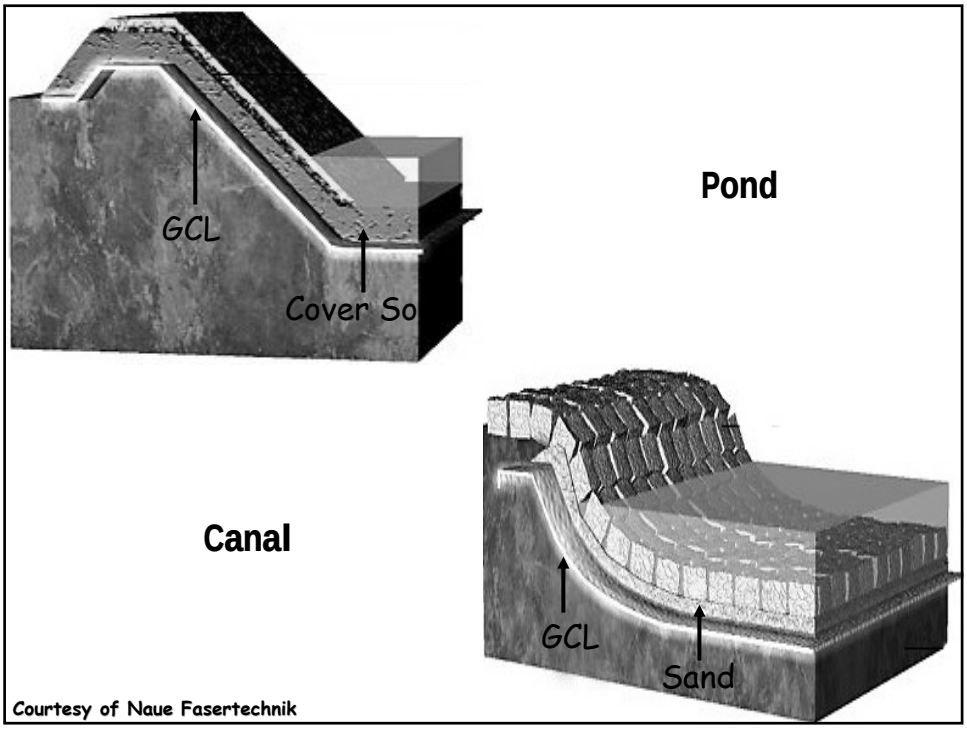
- A liner component

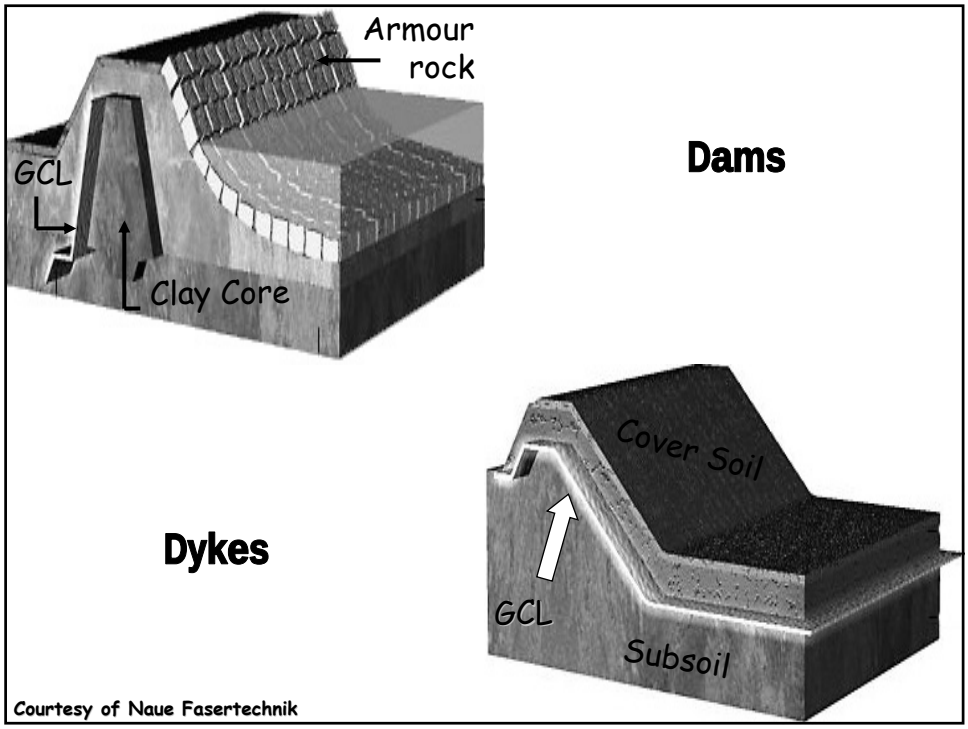
–> Hydraulic barrier

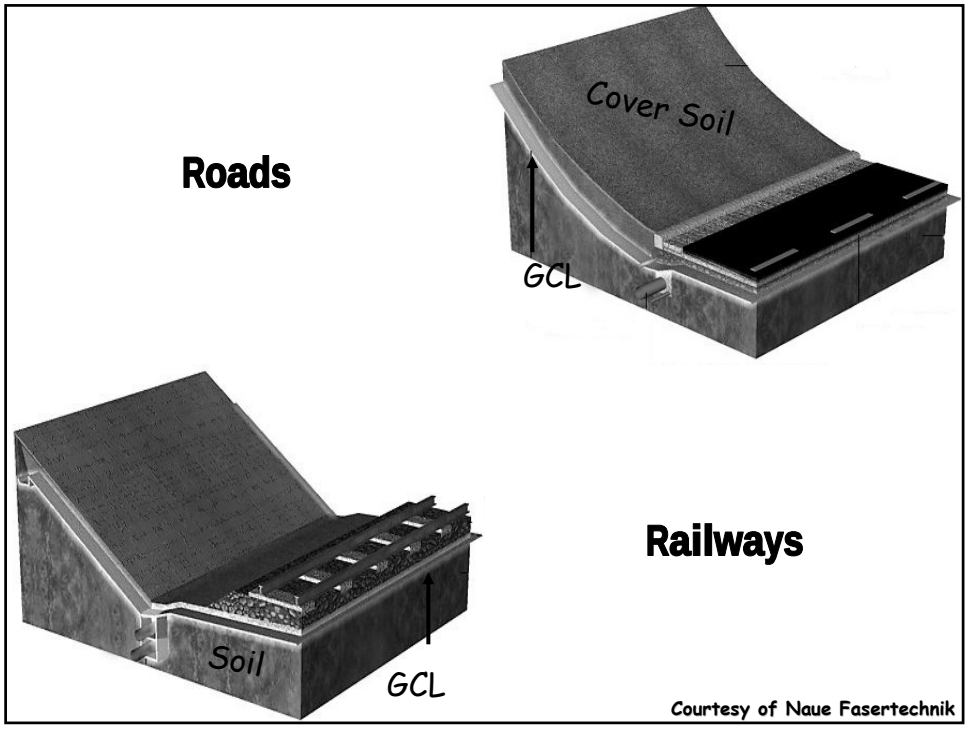
- A cover component

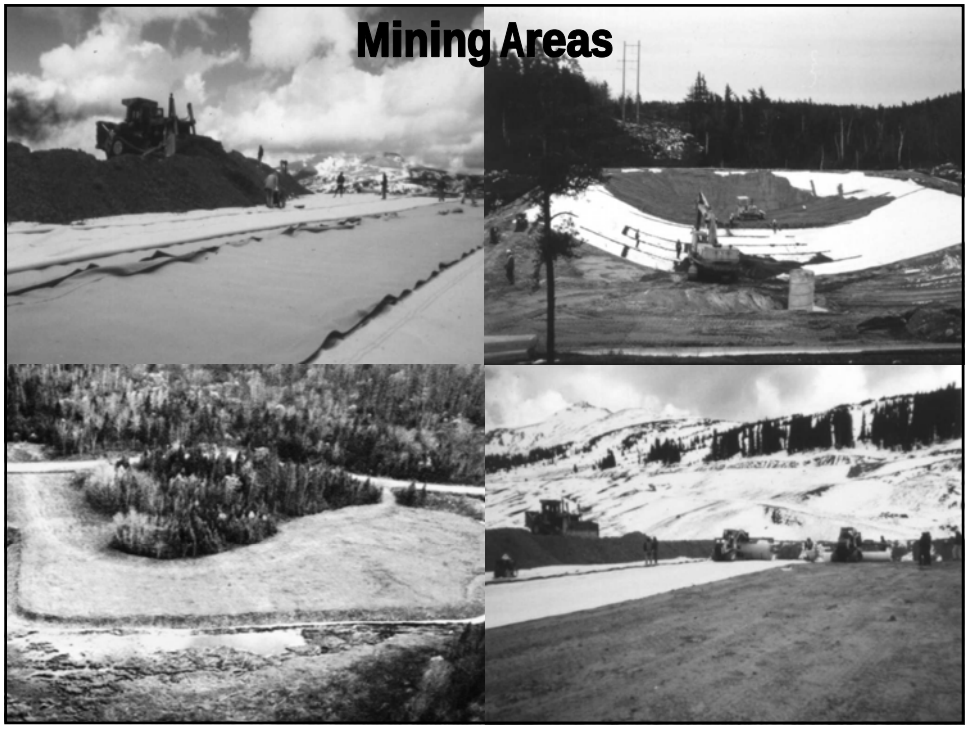
–> Hydraulic barrier

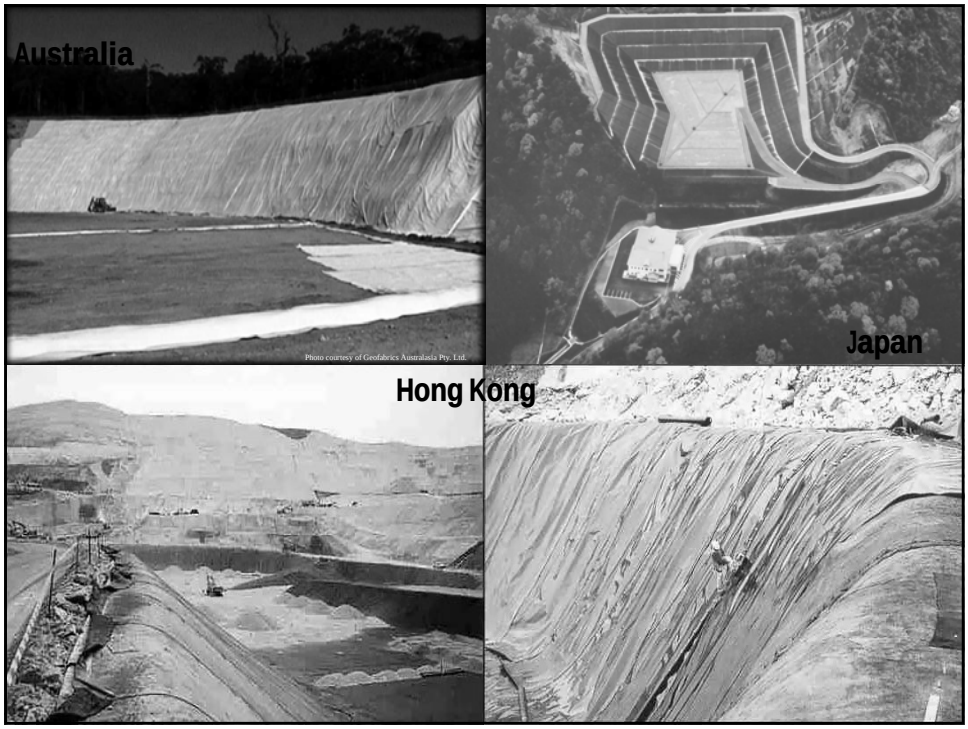
–> Gas barrier




Armour rock
GCL
Clay Core
Dams
Cover Soil
GCL
Subsoil
Dykes
Courtesy of Naue Fasertechnik


Roads
Cover Soil
GCL
Railways
Soil
GCL
Courtesy of Naue Fasertechnik


Mining Areas


Australia
Photo courtesy of Geofabrics Australasia Pty. Ltd.
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