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Geosynthetics: drainage and waterproofing functions

BGS : Drainage en grondwaterbeheersing met geokunsstoffen / Drainage et gestion des eaux souterraines au moyen de géomatériaux

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1. GEOMBRANE – Waterproofing
2. Drainage with geosynthetics

”All geomembranes are punched – all geotextiles are clogged”

Why not to use geomembrane for geotextiles application and geotextiles for waterproofing »

May be, the reason it linked with a correct use of the product ?

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GEOSYNTRHETICS ⊃ GEOMEMBRANE & GEOTEXTILES
Function GEOMEMBANES > < Function<u>S</u> GEOTEXTILES

- ”All geomembranes are punched – all geotextiles are clogged”
- Why not to use geomembrane for geotextiles application and geotextiles for waterproofing »

- May be, the reason is linked with a correct use of the product : DESIGN & EXECUTION!

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Geomembrane - Waterproofing

The function of a geomembrane is exclusively waterproofing

Some basic rules

- ➢ About the design :
  - ➢ Function = waterproofing > < stabilization ➔ limit the strength & deformation

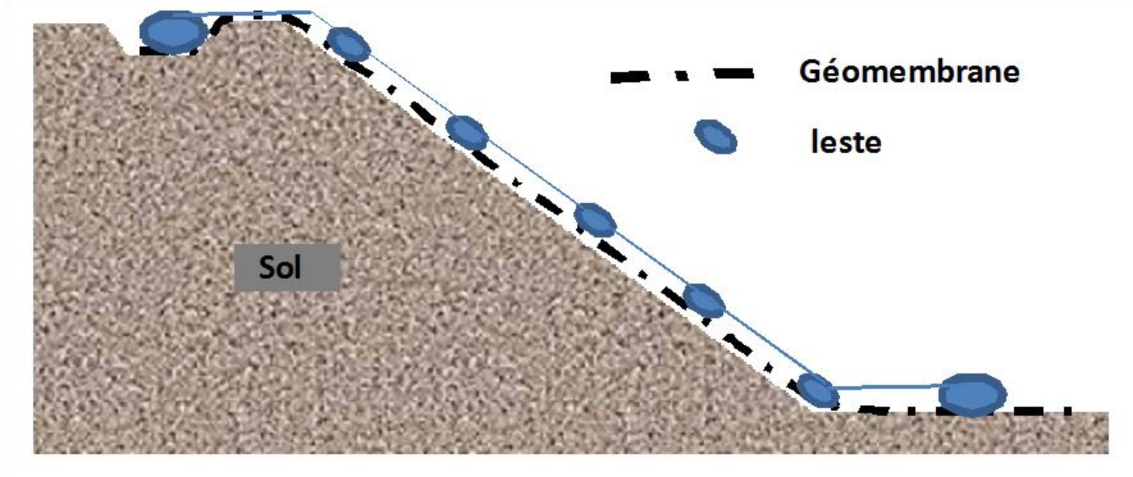
- ❑ The bottom, capping must have enough bearing capacity
- ❑ The slope must be stabilized
- ❑ Avoid pressure of water/ gas under the geomenbrane
- ❑ In case of settlement or temperature effect , limit the deformation (HDPE +/-5%)




The function of a geomembrane is exclusively waterproofing

Some basic rules

- About the design :
  - Design on slope :
  - Designing the anchorage against :
    - Mainly wind effect :



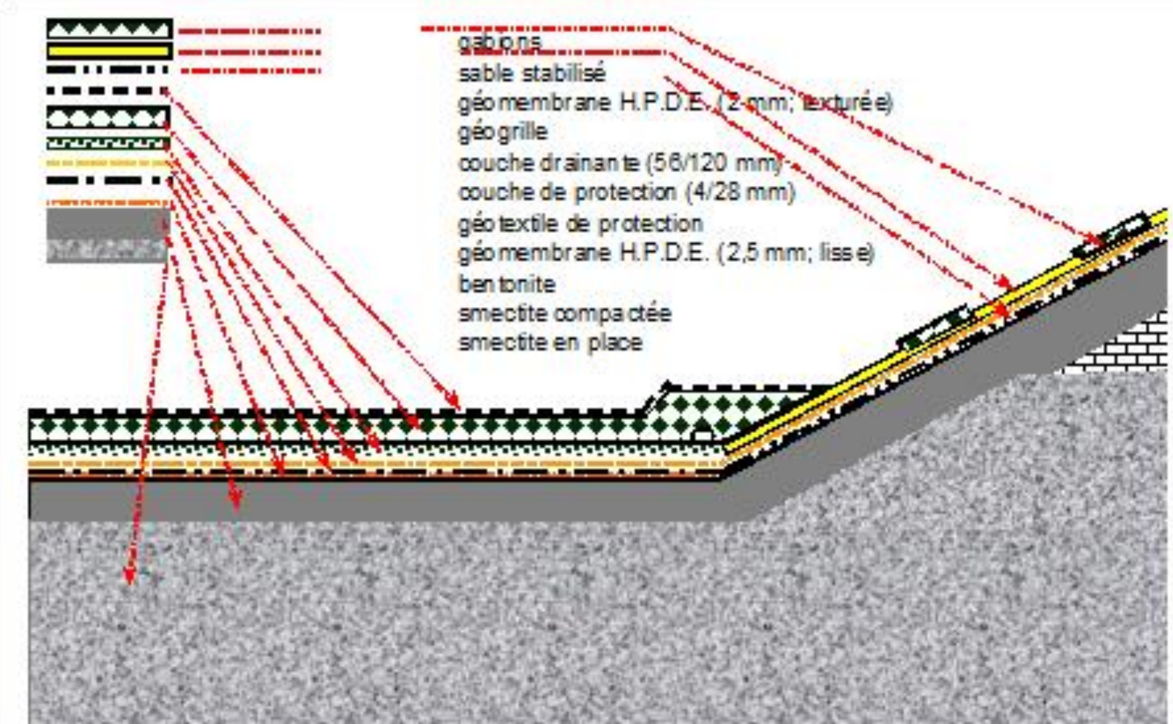
Type de géomembrane	Densité de la géomembrane $\rho_{géom}$ [T/m³]	Epaisseur de la géomembrane $t_{géom}$ [mm]	Masse par unité de surface $\mu_{géom}$ [kg/m²]	Vitesse minimale de soulèvement à z = 200 m [km/h]
P.V.C.	1,25	0,5	0,625	11
		1,0	1,25	15,8
H.D.P.E.	0,94	1,0	0,94	13,7
		1,5	1,41	16,8
		2,0	1,88	19,4
		2,5	2,35	21,7
Bitume	variable	3	3,5	26,5
		5	6	34,7

The function of a geomembrane is exclusively waterproofing

About the design on slope

- ❑ Designing the anchorage against :
  - ❑ Friction effect : (with a correct design, this effect is limited)
- ❑ Designing to limit the tensile stress in the geomembrane :

friction angle under side > upper side / sliding geotextile / counter mass at the bottom



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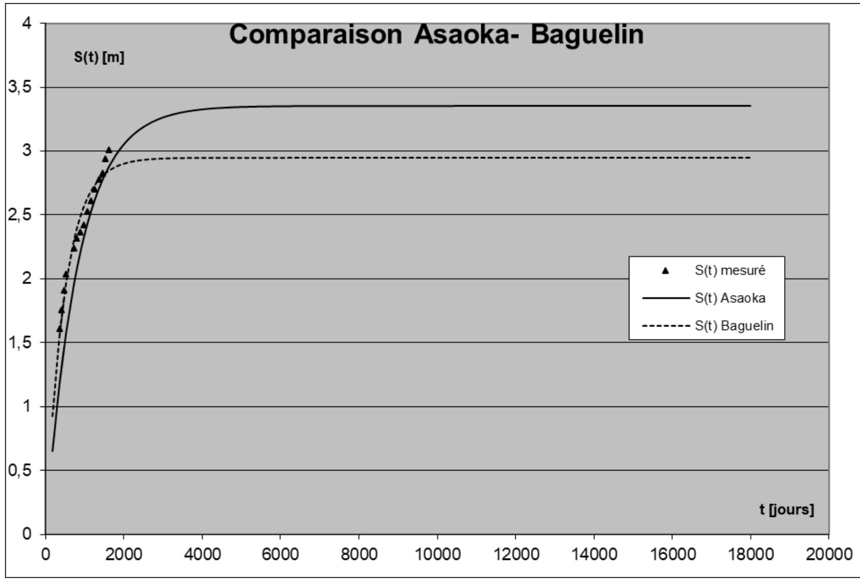
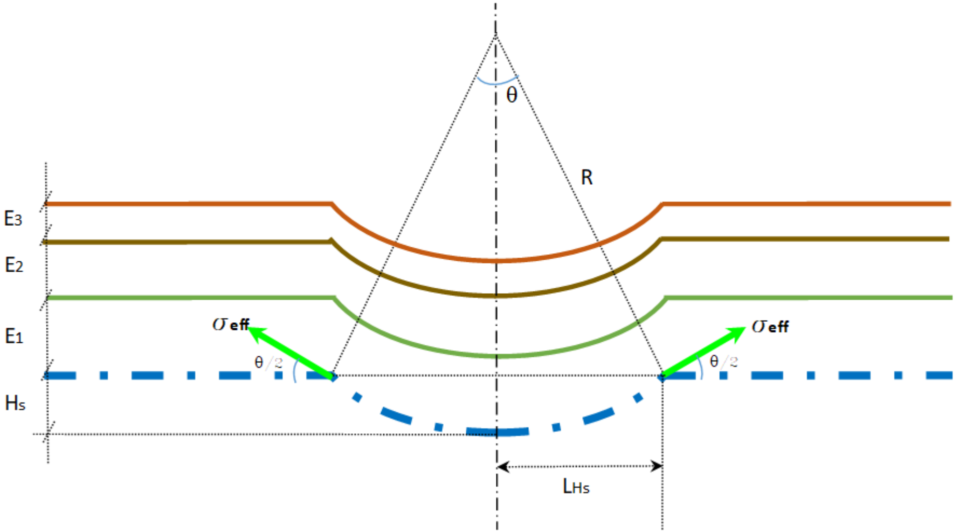
The function of a geomembrane is exclusively waterproofing

About the design on the bottom or for capping

- ❑ Designing to prevent effect of the deformation :
  - ❑ Capping : Limit the deformation in case of settlement ?
  - ➔ Put the geomembrane when settlement are limited



  - ❑ Bottom : use system in case of possible cavities



The function of a geomembrane is exclusively waterproofing

Some basic rules

- About the execution : *Point of attention: Wind effect, temperature, humidity, protection*
  - ❑ Wind effect : don’t place geomembrane when wind velocity is high
  - ❑ Protection :The support must be clear of any punching element ➔ geotextile to protect

The function of a geomembrane is exclusively waterproofing

- About the execution : *Point of attention: Wind effect, temperature & humidity, protection*
  - Temperature and humidity have to be acceptable ➔ dilatation effect & welding issue
    - Temperature > 5°
    - Play attention to differential temperature
    - Support must be dry
    - Necessity of testing of the possibility of welding (+ resistance)

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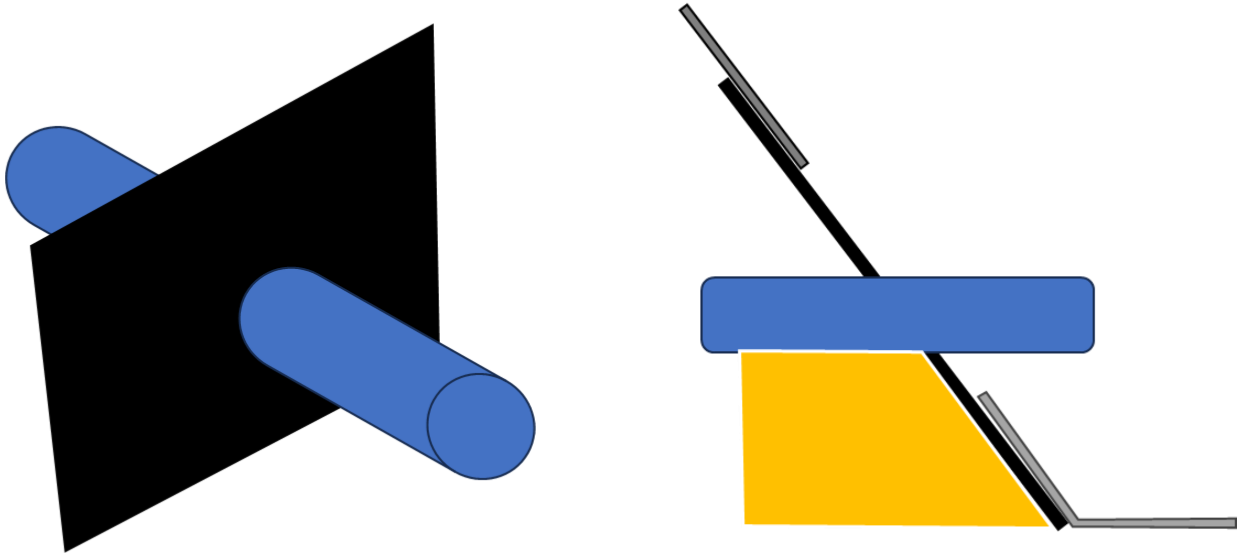
The function of a geomembrane is exclusively waterproofing

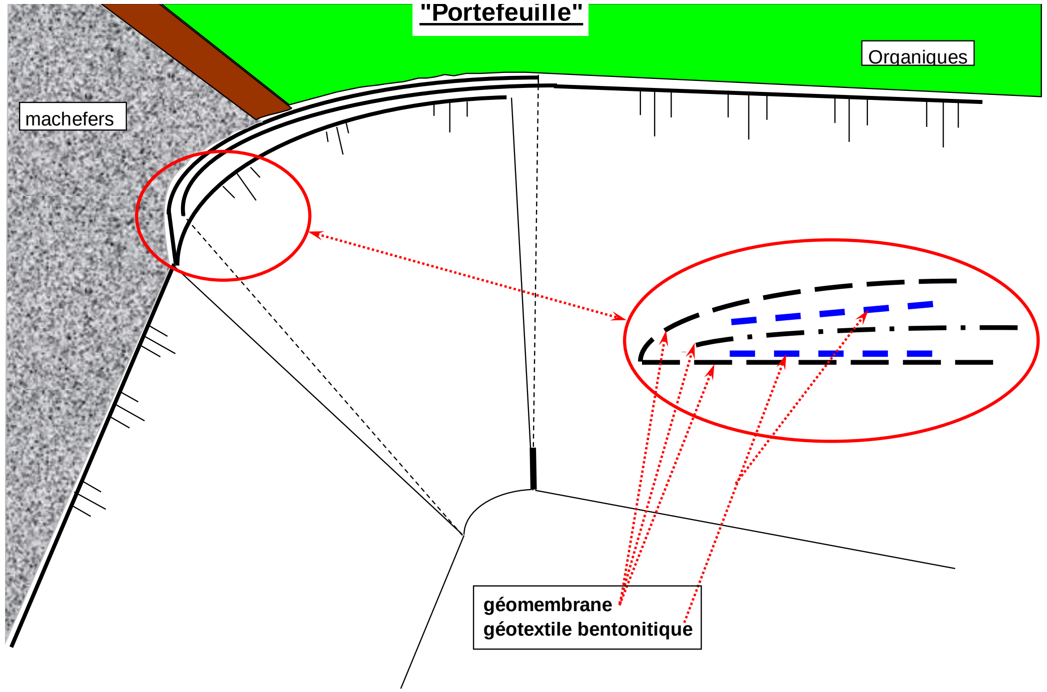
Some basic rules

➢ About the execution : *Points of attention:*

❑ pipe passage through geomembrane



❑ From rigid support to moving support: "Portefeuille" transition



Drainage with geosynthetics

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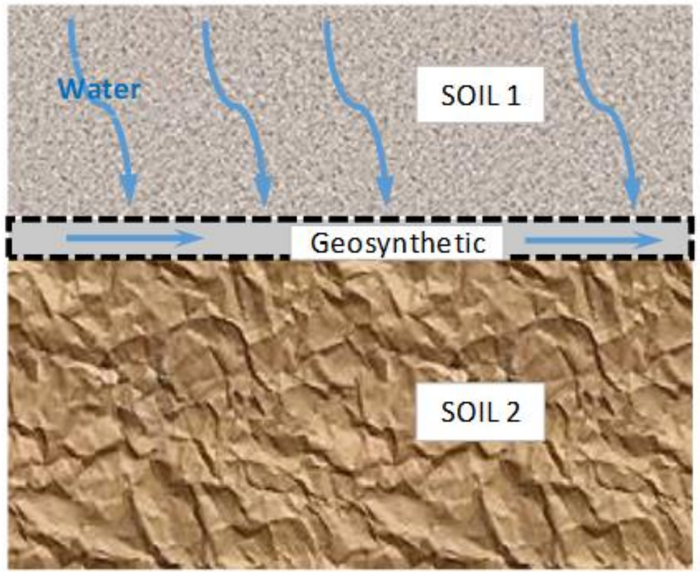
2 Mains systems when using of geotextiles for drainage function

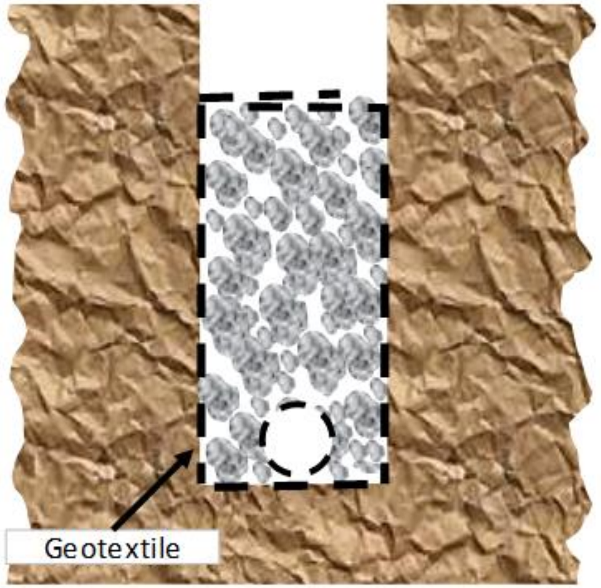
Geotextile as drainage & filtration system

➔ Permitivity / filtration - transmisivity



Geotextile as filtration function

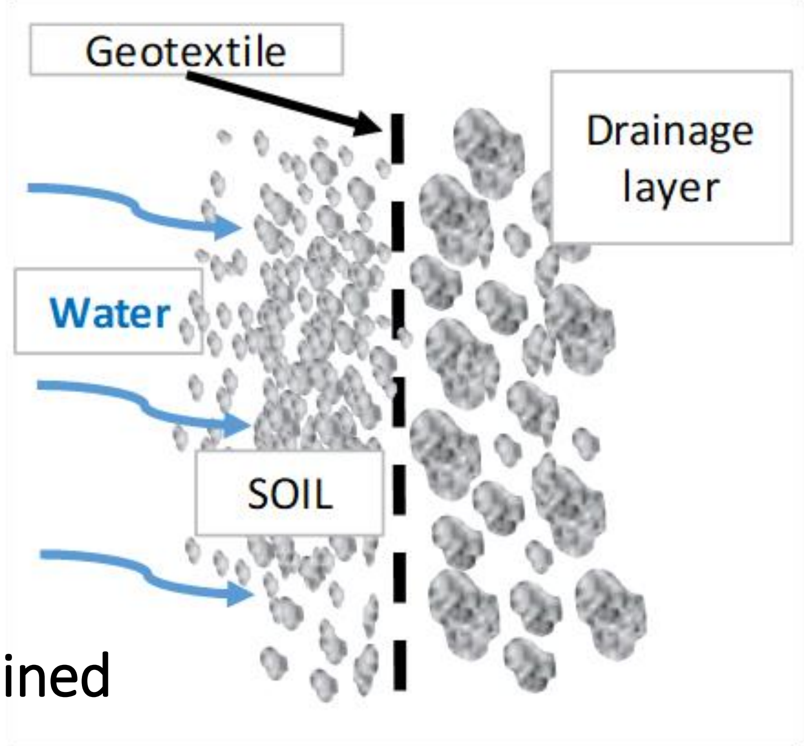
➔ Permitivity / filtration



Geotextile as filtration function

3 roles for the geotextile :

- ❑ Stabilization role: Hold the soil as a whole in place by stabilizing the particles constituting its skeleton;
- ❑ Role of water permeability: Maintain the free circulation of water throughout the life of the structure;
- ❑ Role of permeability to moving particles: Allow fine particles entrained to pass in order to prevent the clogging.



The filtration in short

- Filtration
  - Stabilization
    - Compact or consolided soil
      - continuous particle size
      - uniform particle size
      - Cohesive soil
    - Soil in suspension
      - passes suspended particles retaining the soil skeleton
      - Cake ➔hold back the fines particles/clogging
  - Water permeability
    - Limit the gradient at the surface of the geosynthetic
    - keep the permittivity :installation-filtration-clogging
    - keep the skeleton (let pass through small particles)
  - Permeability to moving particles
    - keep the skeleton (let pass through small particles) ➔ Prevent reducing filter permeability by clogging

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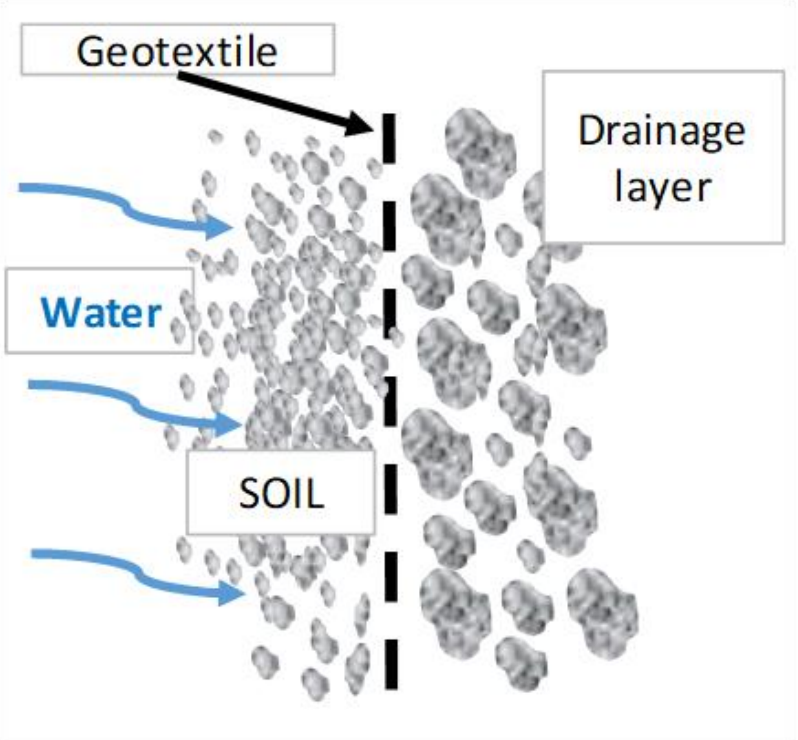
Designing the geotextile as filtration function



❑Permeability - permitivity criteria : $\psi \geq C.\ Ks$

permittivity $\perp$ Kn: Ψ = Kn/e [s-1]

➔Allowing water **to go through** the geotextile

❑Filtration criteria: Comparison between the opening of the filtration of the filter and the dimension of the largest particles likely of the cross the geotextile

$$O_f < \lambda_r \, . \, d_x$$

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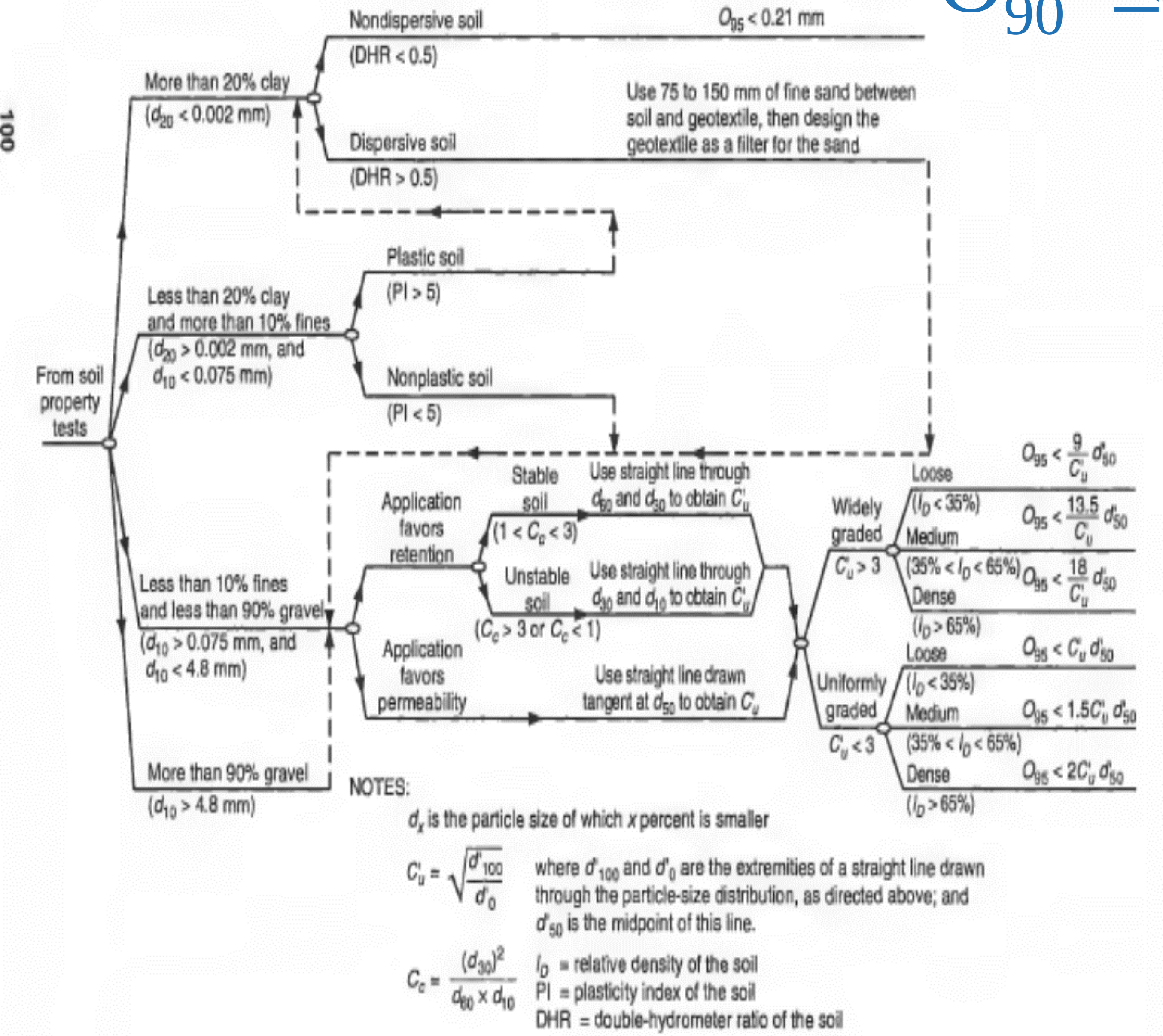
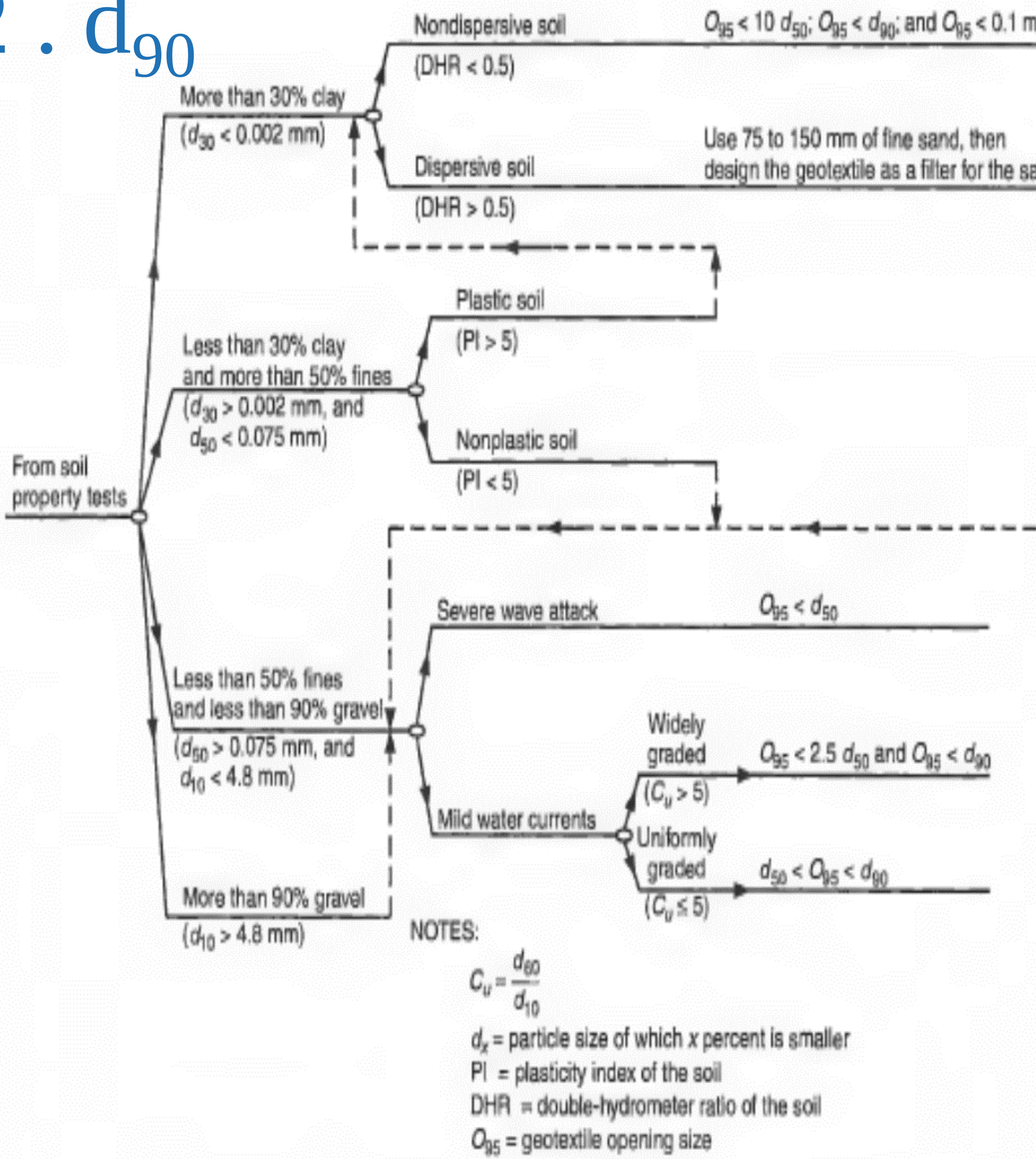
The filtration criteria

Belgium : (NBN 29001)

$$O_{90} \leq 2 \cdot d_{90}$$





Designing the geotextile as drainage function

- ❑ Permeability - permitivity criteria : $\psi \geq C.\ Ks$

permittivity ⊥ ‹n: Ψ = Kn/e [s-1]

➔Allowing water **to go through** the geotextile

- ❑ Filtration criteria: $O_{90} \leq 2\ .\ d_{90}$

- ❑Drainage : *Most of the case use as geocomposite:*

transmissivity // : θ: drainage in the plan: θ = Kp . e [m³/m/s]

$$\theta_{requ} = K_p\ .\ e \quad > f\ .\ Q$$

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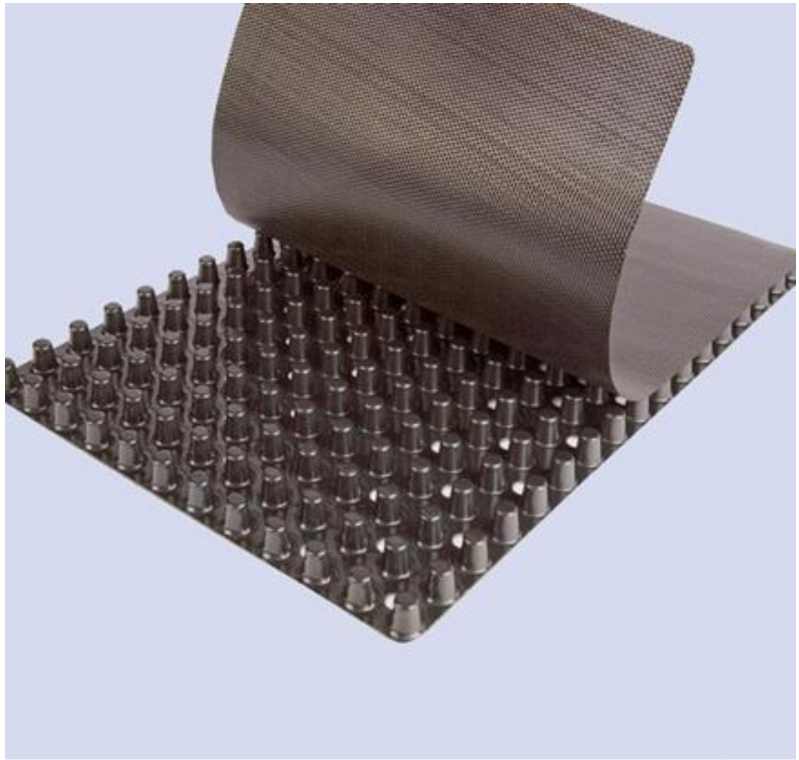
Designing the geotextile as drainage function

The available transmissivity depends on :

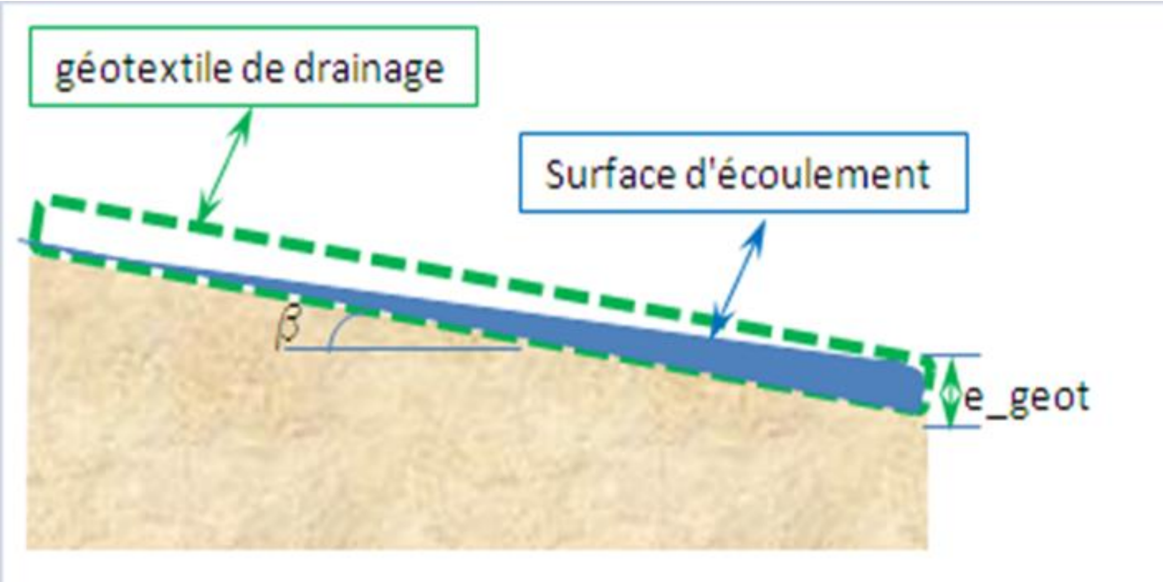
- ❑ The compressive stress applied
- ❑ The gradient
- ❑ The slope of the support
- ❑ The allowable hydraulic flow in the geosynthetic
- ❑ The long term behaviour of the geosynthetic

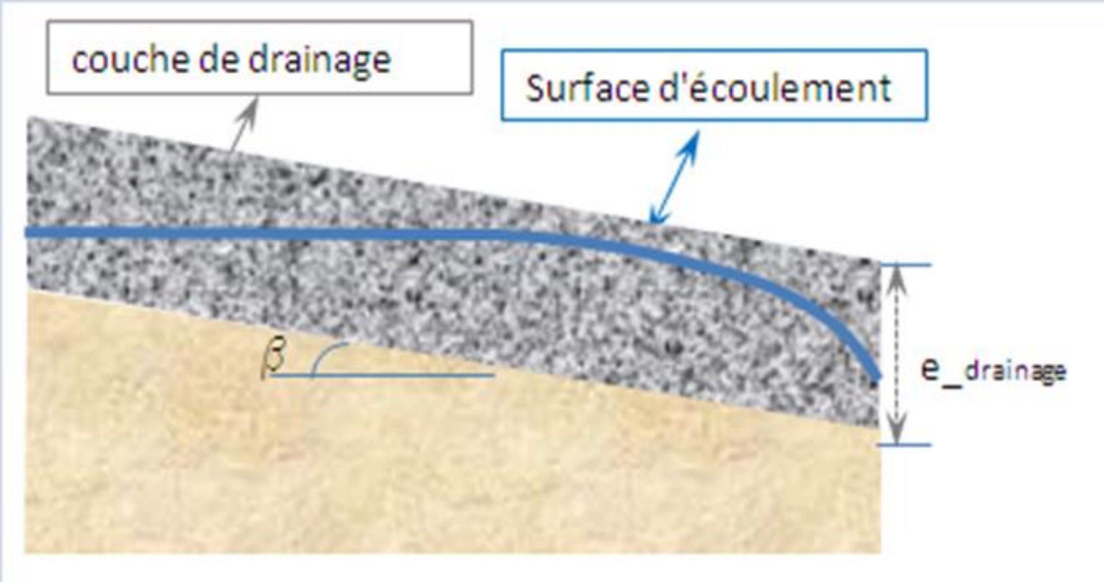


Designing the geotextile as drainage function

Points of attention about geosynthetic transmissivity :

1) Giroud : $\theta_{corrigée} = E \cdot \Theta_{requ}$ $E \approx \frac{1}{0{,}88}\left[1 + \left(\frac{e}{0{,}88 \cdot L}\right) \cdot \left(\frac{\cos\beta}{\tan\beta}\right)\right]$

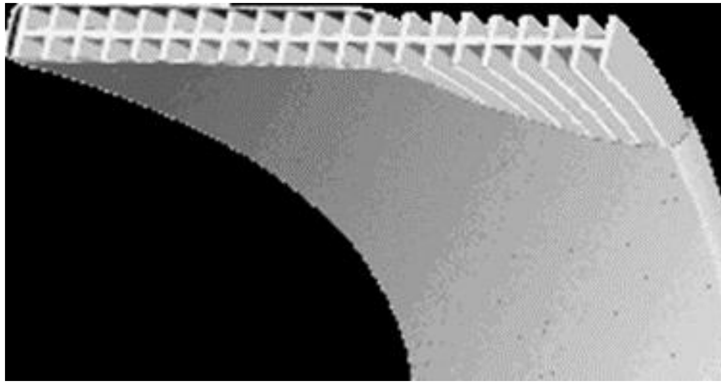




2) Effect of the compressive stress

Designing the geotextile as drainage function

Other systems : *Most of the case use as geocomposite:*



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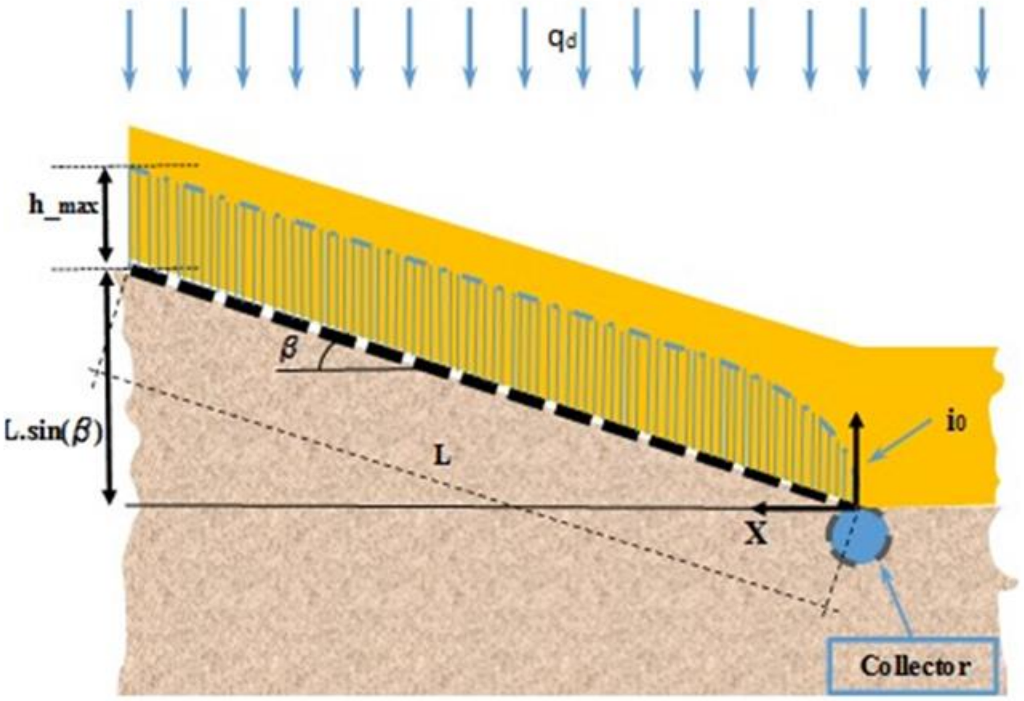
Designing the geotextile as drainage function

Other systems : *Water in the geosynthetic and the upper layer:*

$$q(\sigma_n, i_0, \text{long terme}) = q(\sigma_n, i_0) / (\alpha \,.\, F) \geq q_d \, L \cos(\beta)$$

α : coefficient de réduction de débit dû au colmatage interne (1 – 2.5)

F : coefficient de réduction d'épaisseur NF EN ISO 25619-1



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