An experimental full-scale hydraulic earthen structure in lime-treated soil

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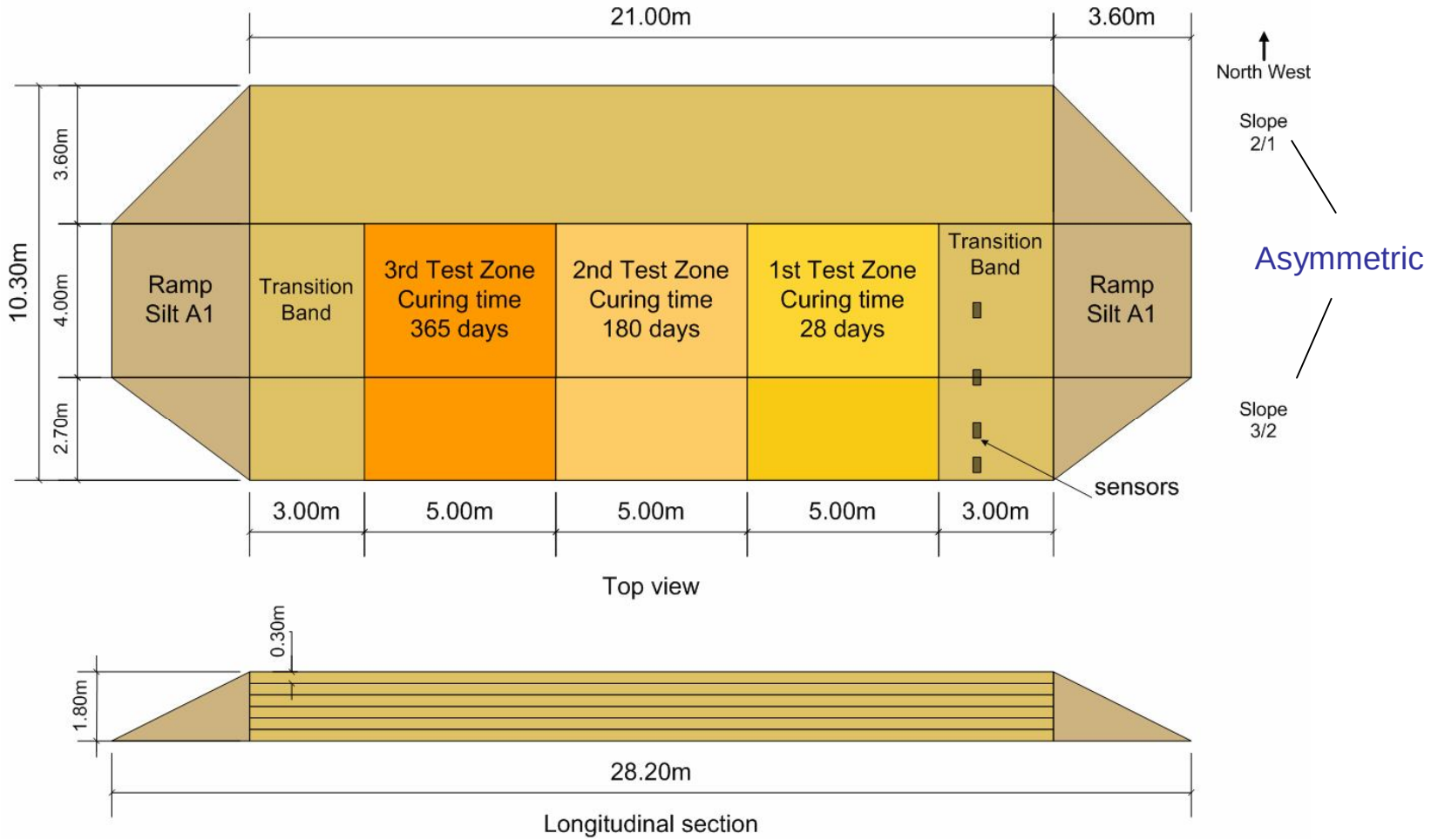
Présent pour l'avenir

Ressources, territoires et habitats
Énergie et climat
Développement durable
Prévention des risques
Infrastructures, transports et mer

Objectives

- Proving the feasibility of the specific lime treatment and placement procedure at an industrial scale
- Correlating the laboratory observations on lime-treated soil properties at a real scale
- Evaluating the benefits of lime treatment compared to natural soil (mechanical and hydraulic behavior)

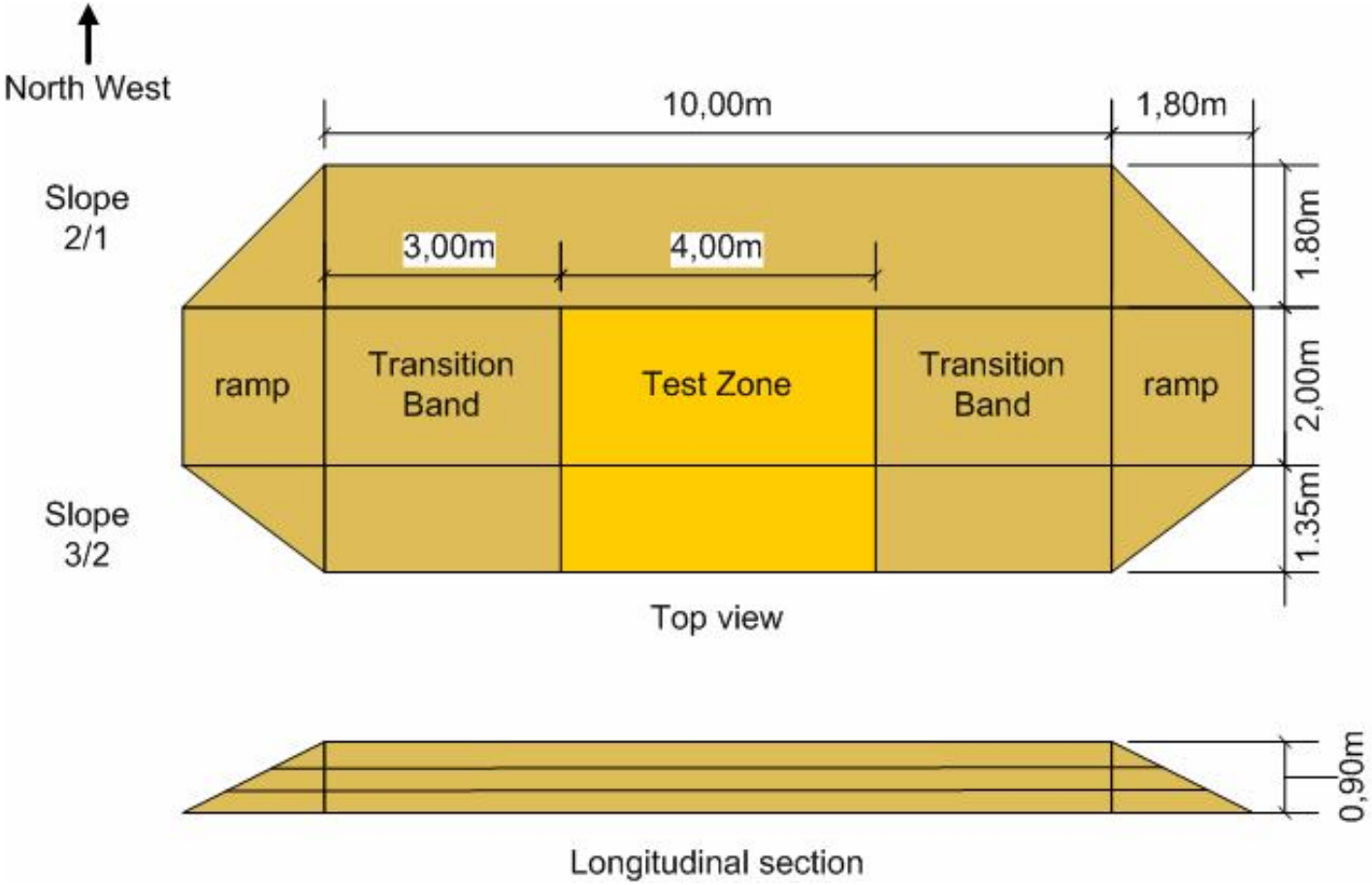
Experimental dike with lime-treated soil



Specific characteristics of the treated soil with 2.5% quicklime :

γ_d = 17.3 kN/m^3 at w_{OMC} = 17.8 %

Dike with natural untreated soil



Specific characteristics of the natural soil :

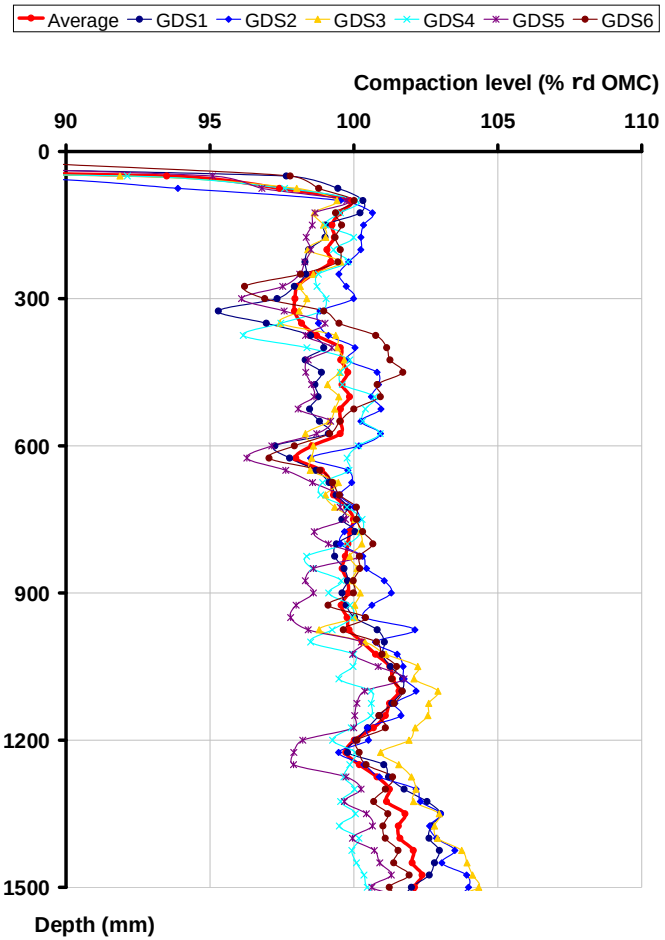
γ_d = 18.2 kN/m^3 at w_{OMC} = 14.5 %

Experimental dikes construction
Sept. 2011 – CER (Rouen / France)

Construction steps - Movie

Compaction control

- **High homogeneity level of the lime-treated material**
  - Water content
    - average = **19.4 %** (OMC + 1.6 %)
    - st dev = **0.7 %** (118 measurements)
  - Dry density (Variable-depth point gammadensitometer)
    - **96.7 % $\rho_{d\ OMC}$**
    - objective was ≥ 95 % $\rho_{d\ OMC}$
    - Top layer : **98.5 % $\rho_{d\ OMC}$**
    - st dev = **1.1 %** (42 measurements)

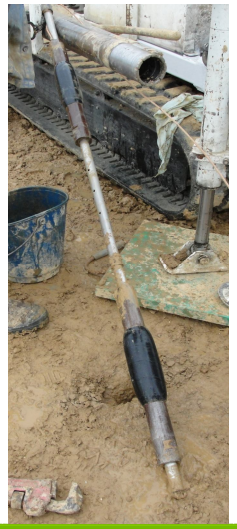


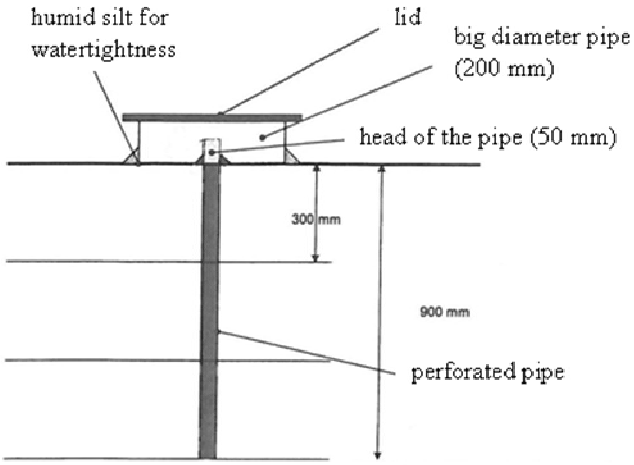
Compaction level recalculated from volumic weight measurements (gamma probe)

Measurements - 28 days & 6 months after construction

- **Permeability**

	Untreated	***Lime-treated***	
		28 days	*180 days*
In situ : Lefranc or Nasberg (drilled holes)	3. 10^{-9} m/s	8.10^{-10} m/s 1. 10^{-9} m/s	4. 10^{-9} m/s
On cored specimens Triaxial tests (CD)	1. 10^{-9} m/s	10^{-9} to 10^{-8} m/s	In progress





Measurements - 28 days & 6 months after construction

- **Shear strength (triaxial tests)**

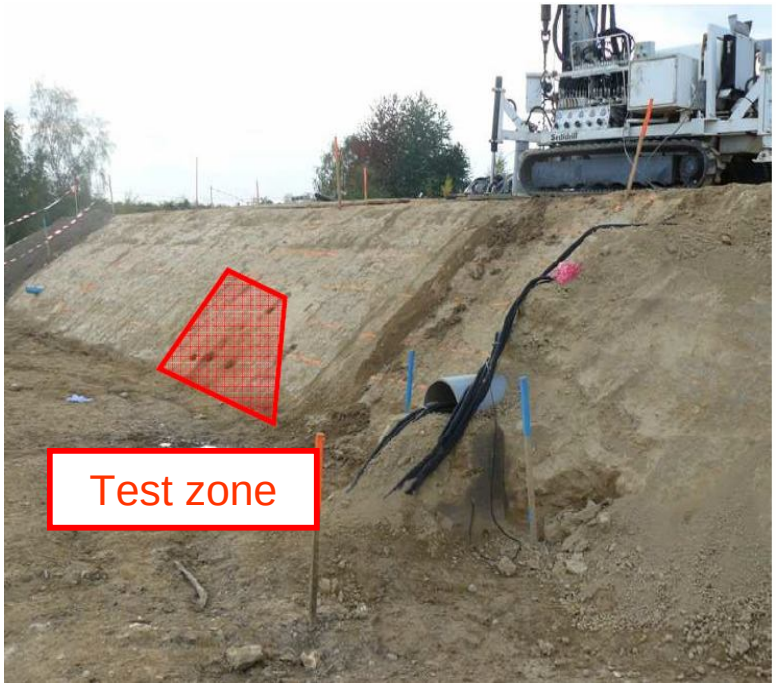
	Untreated	***Lime-treated***
c (kPa)	0 kPa (conventional)	61 kPa (CD, 75 days)
φ (°)	35 °	32 ° to 39 °

- **In situ pressuremeter and dilatometer tests**

	Untreated	***Lime-treated***	
		28 days	*180 days*
Pressuremeter :			
Limit pressure	0.25 MPa	3.77 MPa	4.23 MPa
Modulus	1.57 MPa	37.8 MPa	52.70 MPa
Dilatometer :			
Deformation modulus (G)	-	-	50 to 90 MPa
Young Cyclic Modulus (E)	-	-	400 to 480 MPa

Measurements - 28 days & 6 months after construction

- **Erosion test – Mobile Jets (in situ)**



Untreated soil (600 ml/min, 15 min)

Lime-treated (2000 ml/min, 5min)

$M_{600,lime\text{-}treated} = M_{600,untreated} / 25$

$M_{2000,lime\text{-}treated} = M_{600,untreated} / 12.5$

Conclusion

- The results of the measurements on the experimental lime-treated dike in comparison with the natural dike show:
  - feasibility of producing the lime-treated soil with a high level of homogeneity
  - increase of mechanical performance parameters
  - preservation of the low hydraulic permeability level
  - increase of erosion resistance

Thank you for your attention