



Geophysical estimation of the damage induced by an observatory digging in a limestone heterogeneous vadose zone **Beauce aquifer (France)**

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EMRP1.2 Advances in rock physics and petrophysics across the scales: integrating modes, laboratory experiments and field studies

Context: study site, project and damage problematic



Overall of the O-ZNS project:

- Setting: agricultural site
- O-ZNS platform: Observatory of the Non-Saturated Zone (Vadose Zone)
- Observation well: 20 m-depth, 4 m-diameter
- Geological context: continental limestones - Objectives:
 - Observe the mass and heat transfert,
 - Image the field cracking,
 - Develop new geophysical tools

Fig. 1: Study site located in an agricultural area at Villamblain (France)

This study:

- describe and model the soil layers from lab testing

and direct observations

- quantify the induced damage in the host rock

Soil characterization

Laboratory testing (based on 3 reference wells, SC1, SC2, SC3 (Fig. 1)): - Geophysical and geomechanical measurements of : density, Vp, Vs, permeability, porosity, Young's modulus

	$\rho_{s}(Mg/m^{3})$	V _P (m/s)	V _s (m/s)	k(cm/day)	n (cm ³ /cm ³)	E (MPa)
0	2 3	1500 2500 3500 4500 5500	1500 2500 3500 4500 5500	0 0,05 0,1 0,15	0 0,1 0,2 0,3 0,4 0,5 0,6	0 20 40 60 80 100
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5		•		••••	•	
	• •	•••	•	•	•	
10	•	• • •	•••			
15	•••	•••	• • •	•		
20	•	• • •	•		•	
25	 SC1 SC2 SC3 		For 	the Young's modu dynamic modulus static triaxial meas	lus: inferred from velocities urement	(at high frequencies)
Mechanical tests for strength determination and Mohr-Coulomb criterion description.						

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Numerical model



Global strains (step by step of digging)

















=> Strength and geophysical parameters are well defined in the first three layers => In the deepest layer (15-20 m) there is a large discrepancy due to important fracturation

=> An average value will be considered for the numerical model to account for an intermediate state of strength and

fracturation

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- => Without retaining wall: collapse after 6 m of digging
- => Maximal displacement of 12,9 mm (on the surface)
- => Strain is localized at the surface and do not go beyond 4 m radius (thus 2 m after the well)
- => Focusing on the shear strain: they vanish beyond 1,5 m after the well

Conclusion and Outlooks

Imput numerical model geometry



- 0 1 m: silty-clayed soil
- 7 m: karstified limestone
- 7 8 m: marly clay sand
- 8 25 m: micritic limestone
- 25 26 m: micritic limestone with silex of high strength
- Laboratory tests highlited 4 soil layers with a last one really heterogeneous due to high fracturation - The geotechnical Plaxis[®] software is used to model the induced strain and damage in the host rock - 2m after the well damage vanishes (1,5m for the shear strain)

Outlooks

- The effect of the water table variation will be investigated to model the time evolution - It is expected a finer resolution of the deepest hetrogeneous soil layer through a developed experimental campain including geophysical, geomechanical and hydrolic tests

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