The PANDA Penetrometer

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Micromechanics principle

- **Description of the grains :**
  - » Mineralogical nature of the medium
  - » Grain size distribution
  - » Particule shape
  - » Sensitivity to water (VBs, Atterberg)
- **State parameters**
  - » Water content
  - » Density
  - » Anisotropy
- **Global behaviour**

Practically

- Soil classification (GTR, AASHTO…)
- Water content
- Cone resistance (Panda)

•One can find out the main mechanical properties

•If the classification is sharp enough

+

•If a well documented database is available (correlations)

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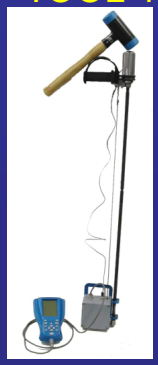
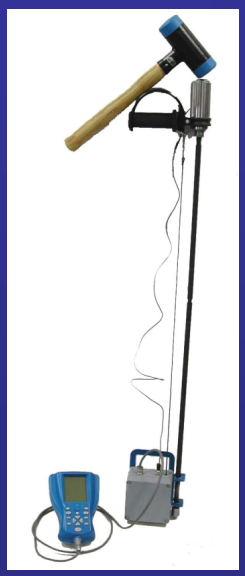
TOOL 1



The PANDA

TOOL 2

Geoendoscopy



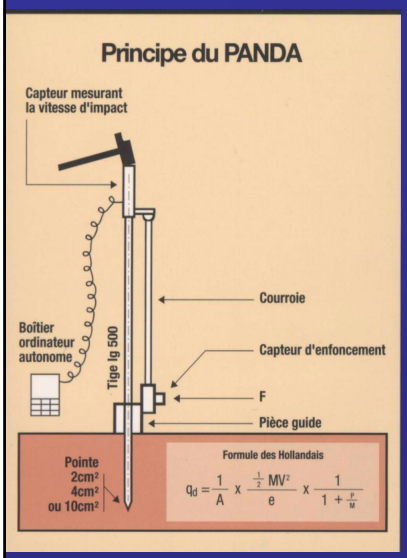
What is the PANDA?

The PANDA is an innovative tool using variable energy.

Principle:

- ✓ To drive into the soil a cone at the extremity of rods
- ✓ Measures:
  - Impact Energy
  - Penetration
- ✓ Records:
  - Dynamic Cone Resistance
  - Depth

PANDA

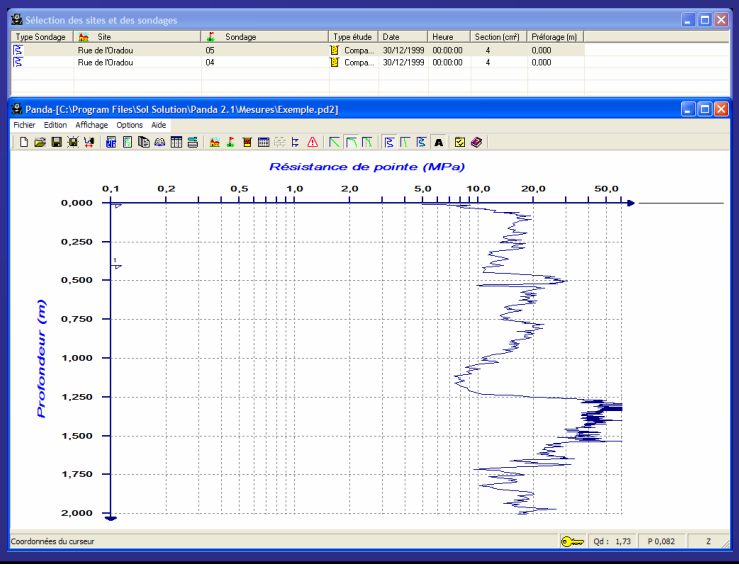


Limits:- 7 m for depth

- Grain size: 0/50 mm

- Resistance < 50 Mpa

PANDA Penetrogram



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Example of PANDA use

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LERMES

Example of PANDA use

Université Blaise Pascal

Experimental validation of the signal

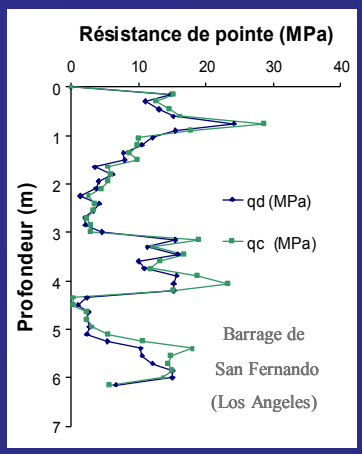
Comparison with other types of penetrometers

Comparison with dynamic penetrometers [Escandre][Gourvès] :

$$0{,}95 \leq \frac{q_{d\ PANDA}}{q_d} \leq 1{,}05$$

Comparison with static cone penetrometers [Escandre][Lepetit][Vachon] :

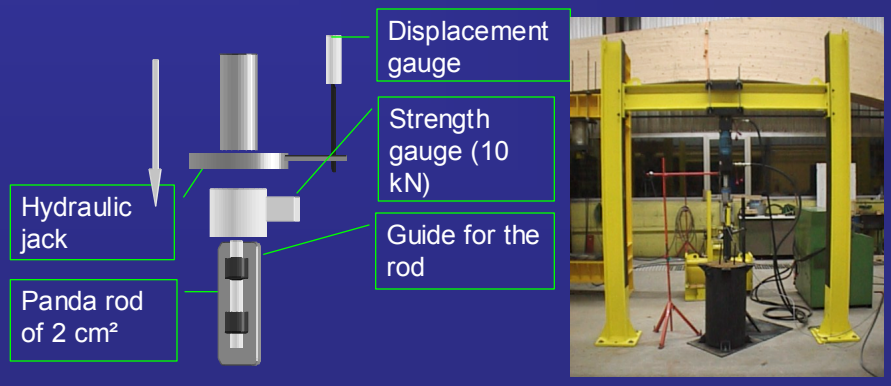
$$0{,}85 \leq \frac{q_{d\ PANDA}}{q_c} \leq 1{,}1$$



Experimental validation of the signal

Comparison qd / qc in a calibration chamber :

Experimental device



Experimental validation of the signal

Comparison qd / qc in a calibration chamber :

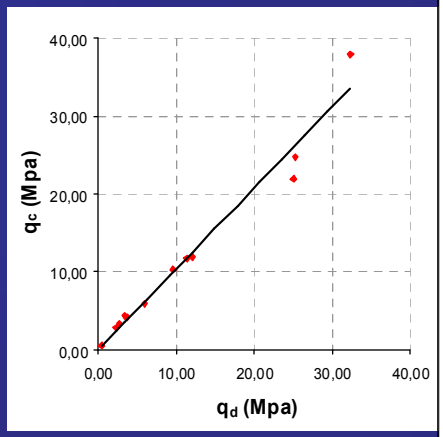
2 cm² cone

Static test : 2 cm/s

Dynamic test : PANDA

Tested soils : silt, sand, gravel

$$0{,}85 \leq \frac{q_{d\ PANDA}}{q_c} \leq 1{,}1$$

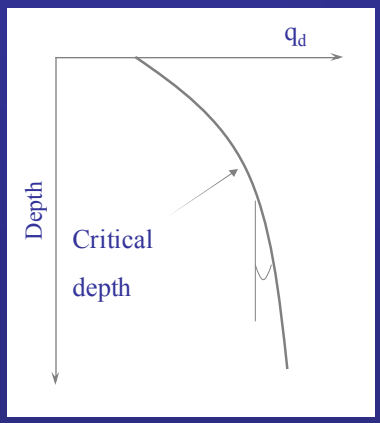


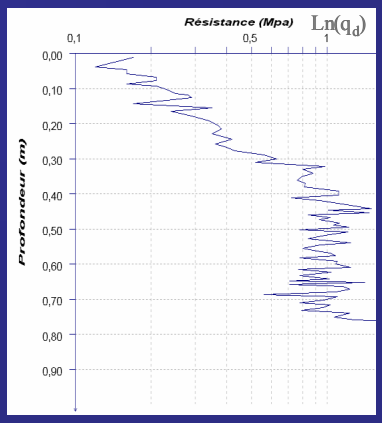
Dynamic resistance $q_d \approx$ Static resistance q_c

Experimental validation of the signal

Caracteristics of the signal

Penetrogram in an homogeneous medium [Cassan][Lorin] :





Experimental validation of the signal

Caracteristics of the signal

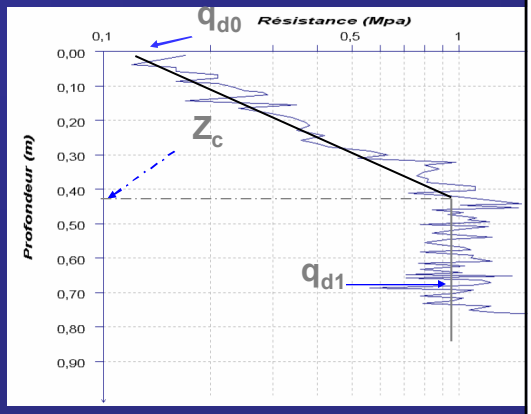
Penetrogram in an homogeneous medium might be schematised by :

3 parameters [Quibel] :

q_{d0} : cone resistance at the surface

z_c : critical depth

q_{d1} : cone resistance in depth



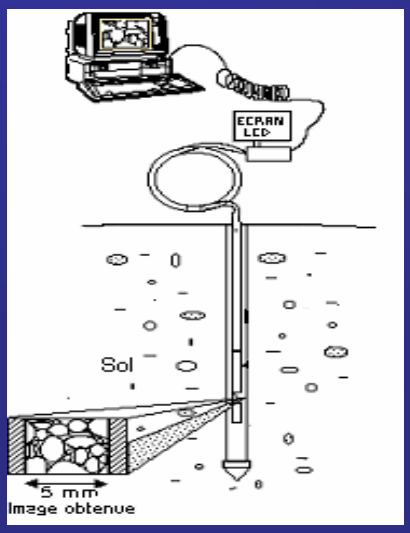
Experimental validation of the signal

Caracteristics of the PANDA signal

- $q_{d\ PANDA}$ reproductible
- $q_{d\ PANDA}$ equivalent to q_d for other dynamic penetrometers
- $q_{d\ PANDA}$ equivalent to q_c
- $q_{d\ PANDA}$ stable

TOOL 2

GEOENDOSCOPY



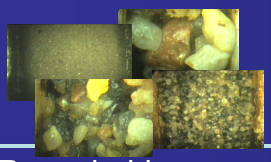
Allier sand

Silt

TOOLS

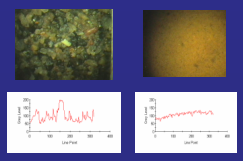
GEOENDOSCOPY

Use of image processing tools to describe quantitatively relevant properties from a mechanical point of view

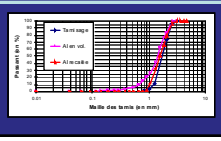


Recorded images

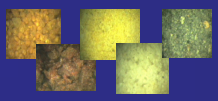
Texture analysis



Grain size distribution



Coloremetric analysis



Angularity

Diagnosis of works in use : main sewer

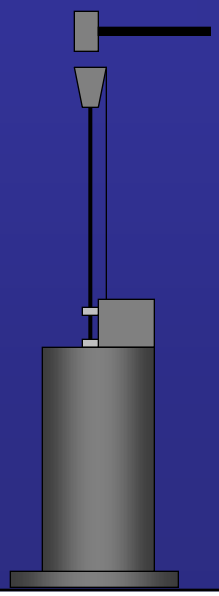
Objectives : - Diagnosis of the structure (fracture index)
- Diagnosis of soil-structure interaction (contact)
- Diagnosis of the surrounding material

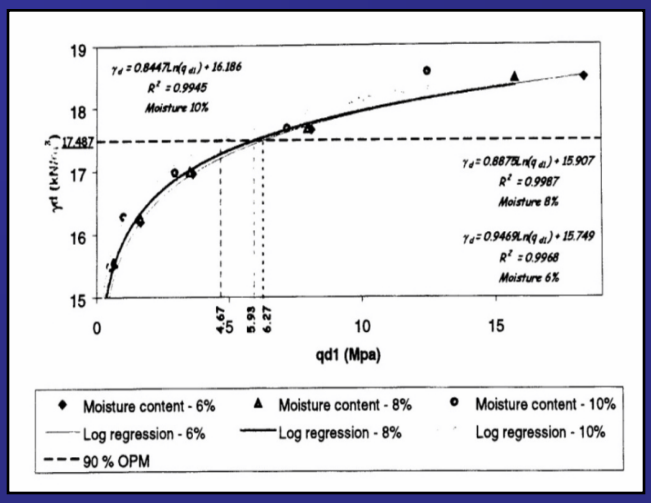
Panda Tests

Geoendoscopic tests

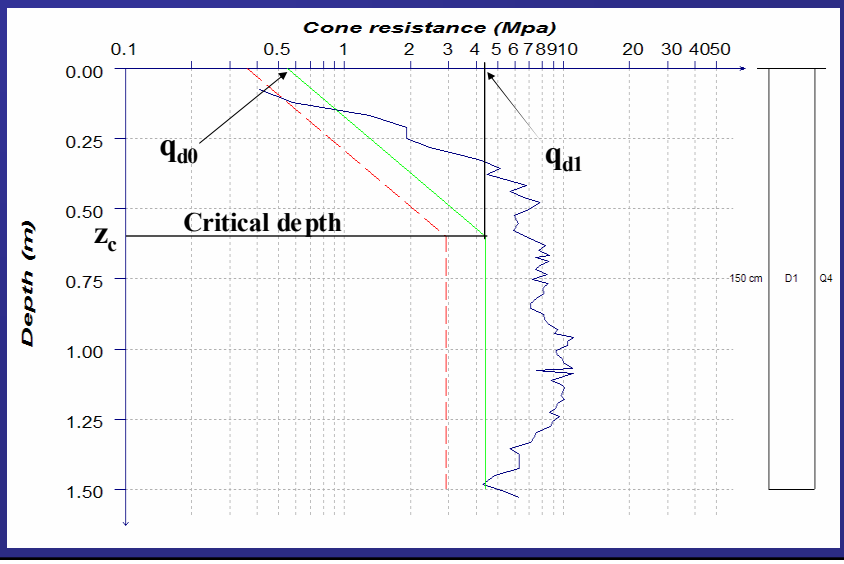
Figure 3. Mould and hydraulic press (Chaigneau, 2001)

Calibration Curves

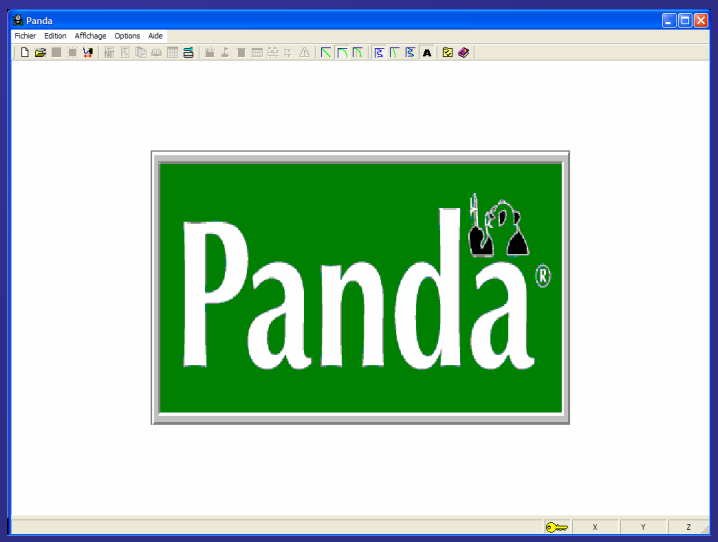




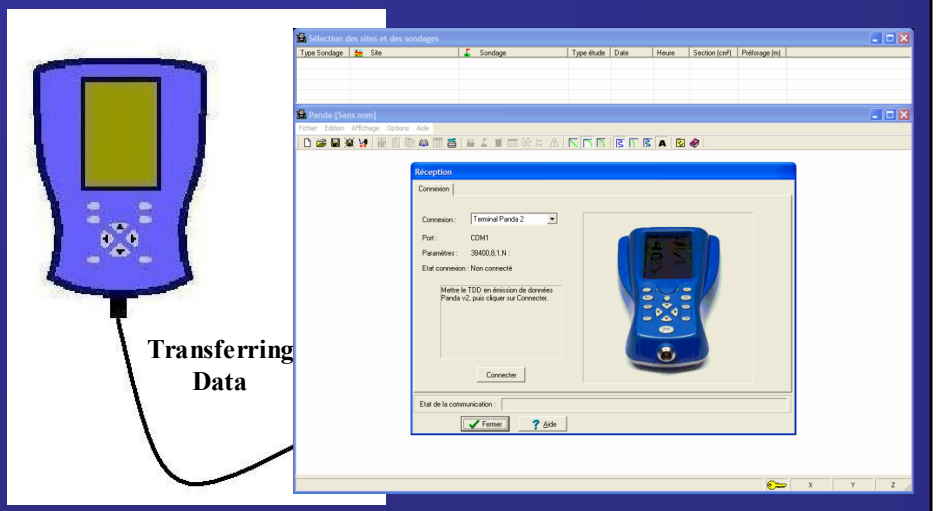
Reference curves



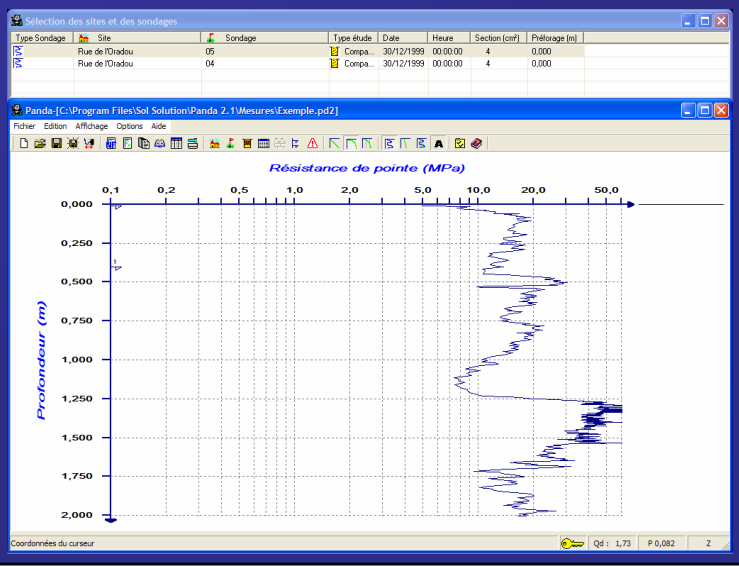
The PANDA Software



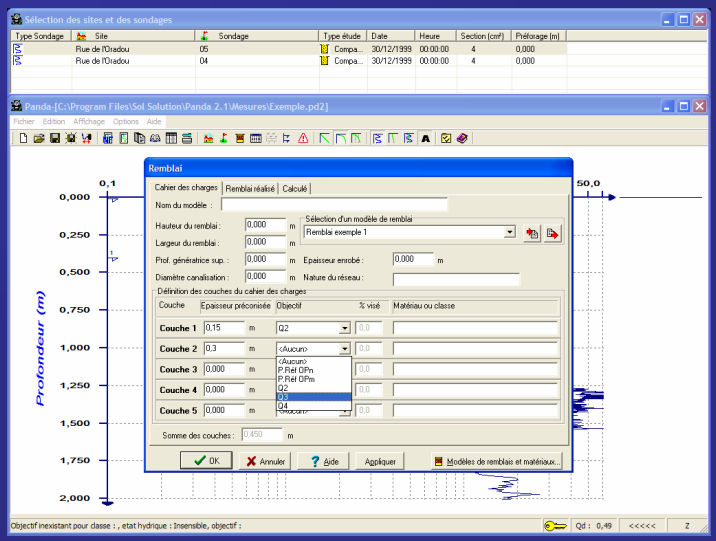
Data Processing



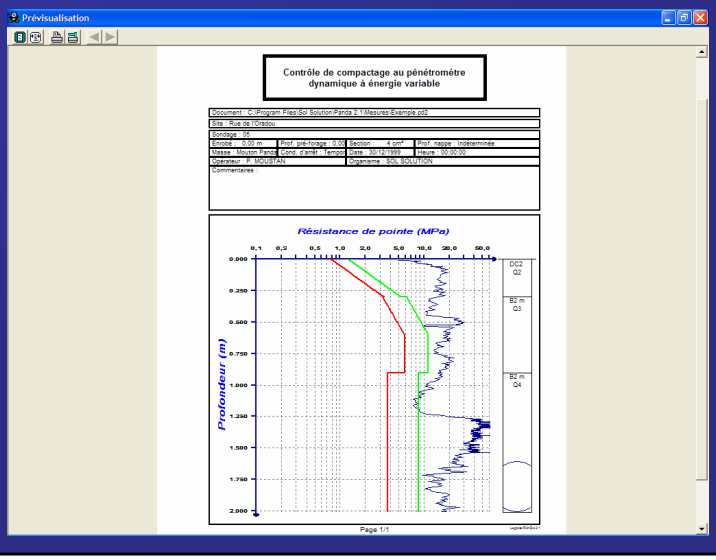
PANDA Penetrogram



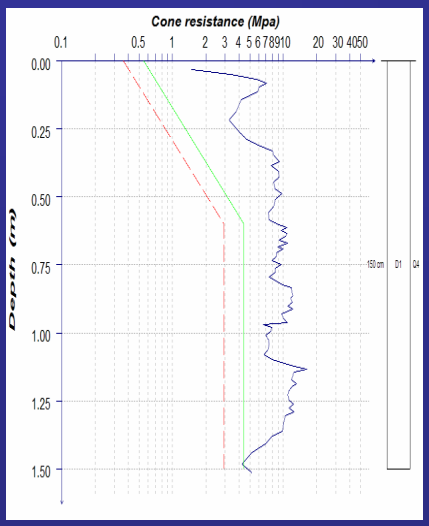
Definition of the Backfill

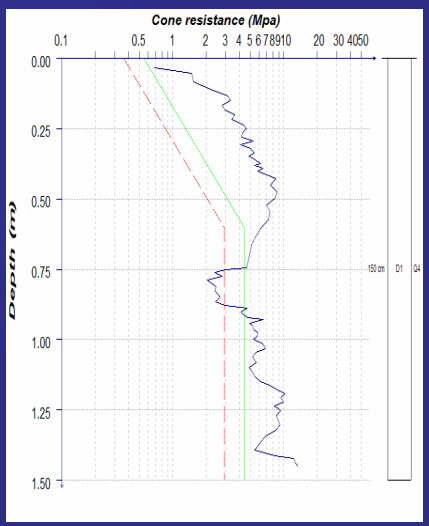


Final Print Out



Urban Utility Center Assessment (NYC)





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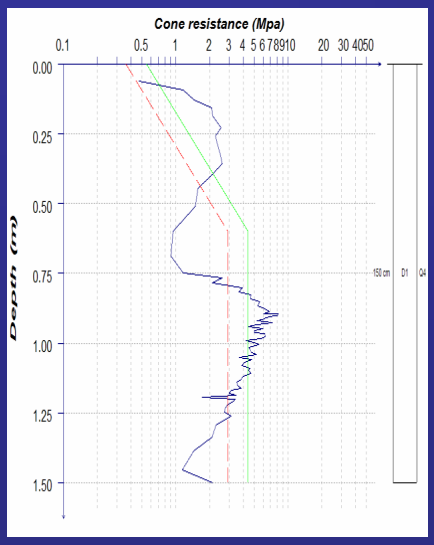
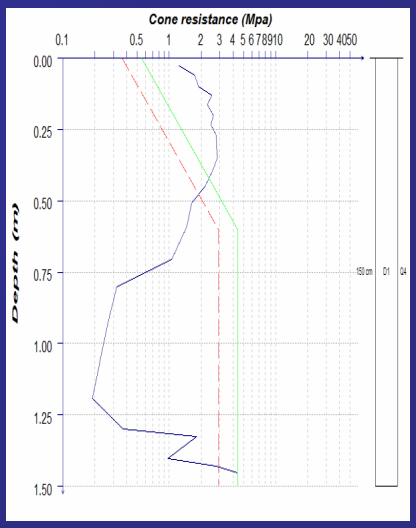
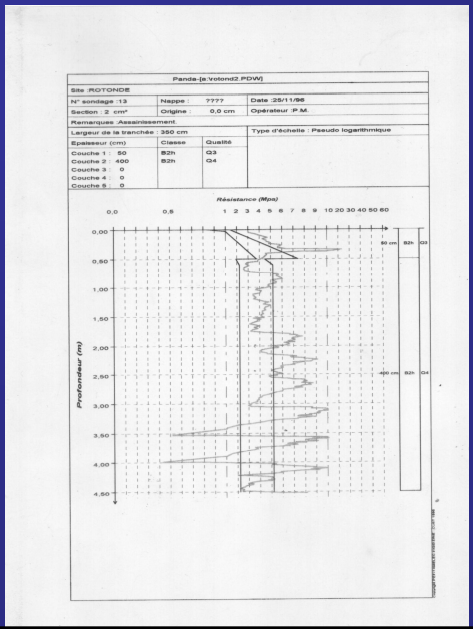
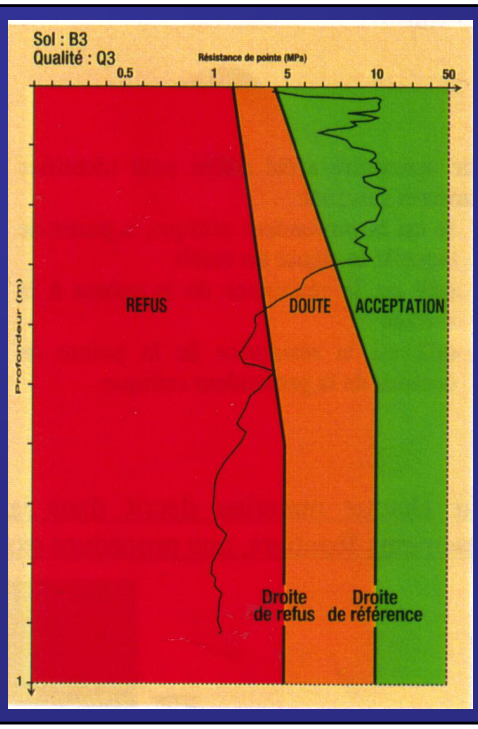




Sample



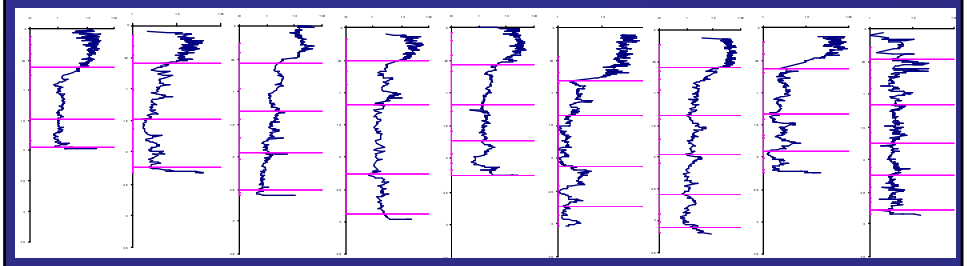


Caracterization of the backfills (La Pardieu - 63)

Purpose :

- **to find out the mechanical structure of the backfill,**
- **to caracterize the materials,**
- **to control the compaction**

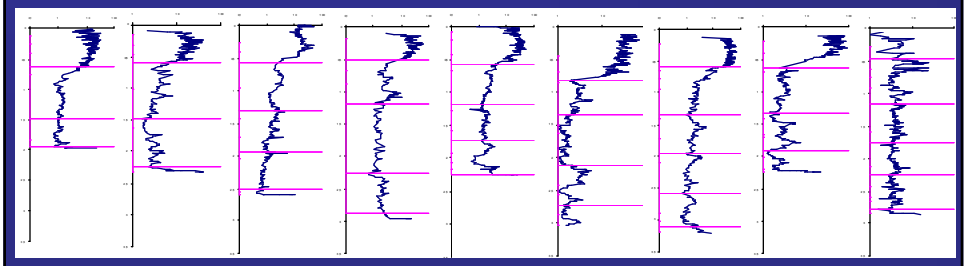
Stratigraphy from penetrograms



Caracterization of the backfills (La Pardieu - 63)

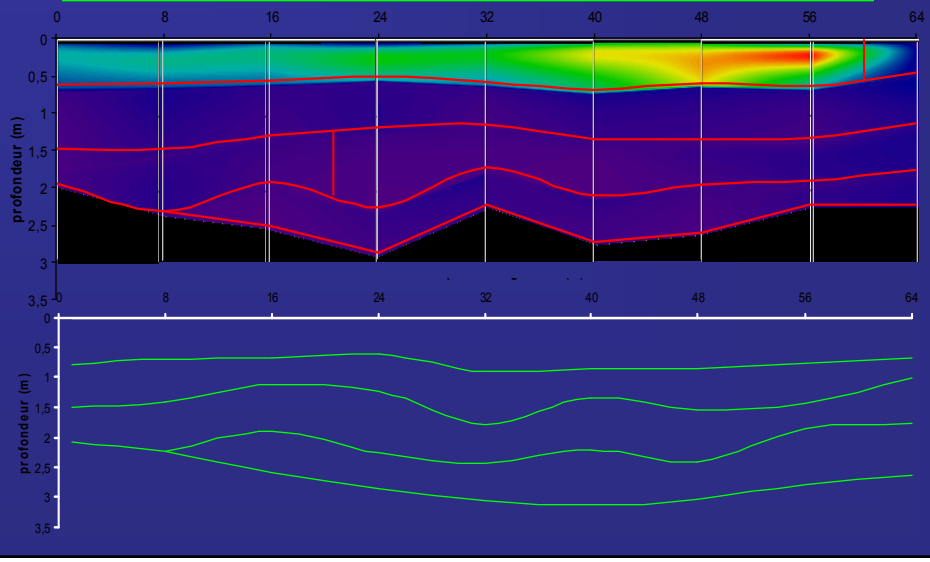
Purpose :
- to find out the mechanical structure of the trench,
- To caracterize the materials
- To control the compaction

Stratigraphy from penetrograms



Caracterization of the backfills (La Pardieu - 63)

Comparison with reality



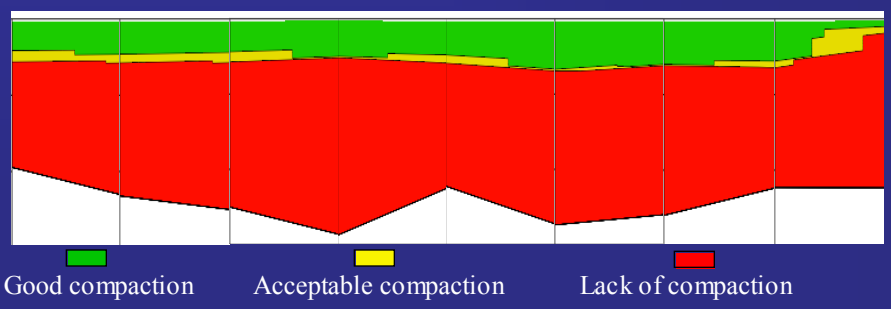
Caracterization of the backfills (La Pardieu - 63)

Coupling with the database

In situ soil knowledge

Using the relation γ_d / q_d from the database

Compaction control



Investigation for aeronautic roadways

by coupling geophysical and geotechnical tests

Initial questions

Structure of the roadway:

- depth, compliance with the specifications

Evolution of the subbase :

- aging, evolutive soils, settlements

Need of a general and comprehensive diagnosis

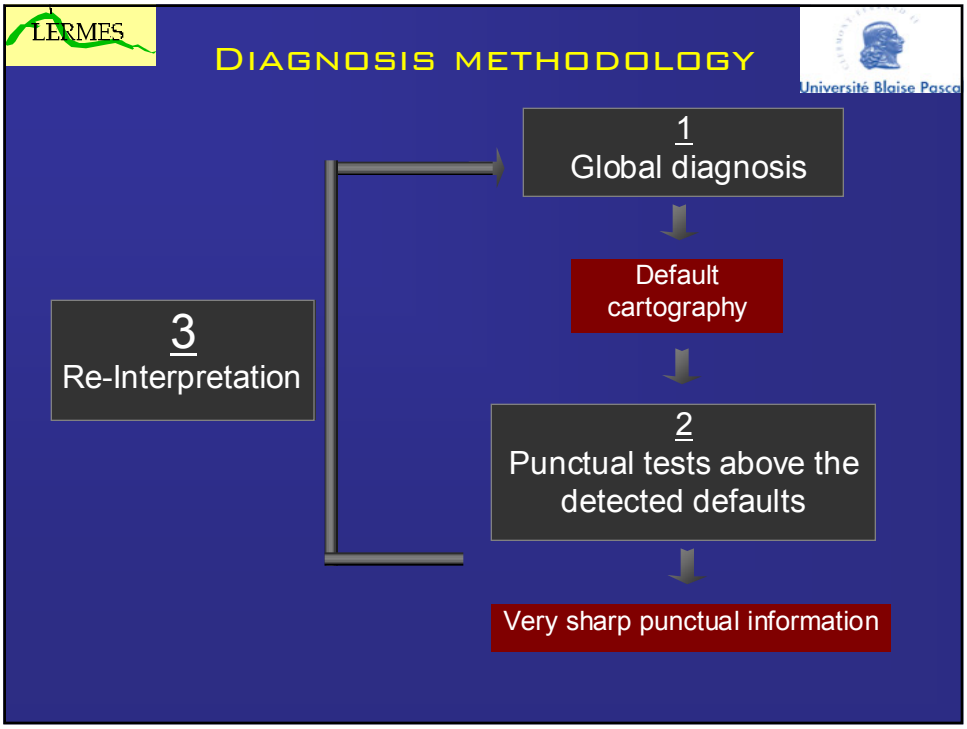
Constraints

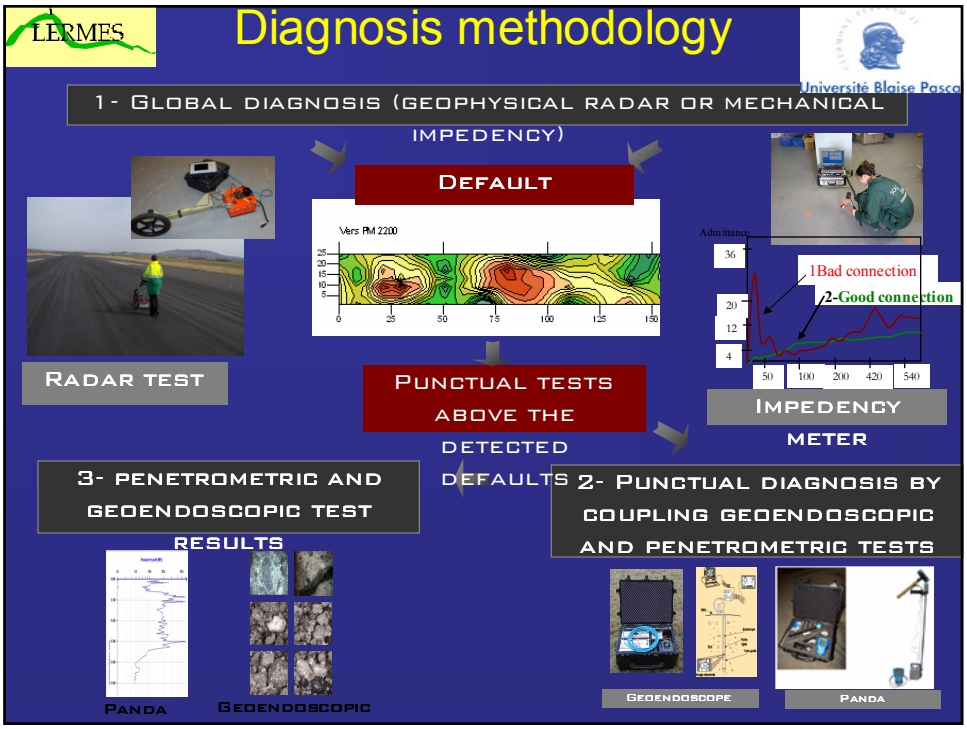
Constraints :

- large investigation surface
- limited intervention time

Solutions:

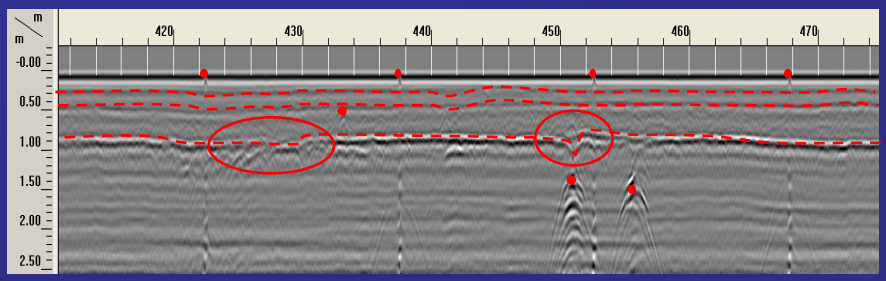
- money-saving auscultation methods
- non-destruvtive methods
- quick implementation suitable to trafic constraints


LERMES
Diagnosis methodology
Université Blaise Pascal
1
Global diagnosis
Default cartography
2
Punctual tests above the detected defaults
Very sharp punctual information
3
Re-Interpretation


LERMES
Diagnosis methodology
Université Blaise Pascal
1- Global diagnosis (geophysical radar or mechanical impedency)
Default
Vers PM 2200
Radar test
Punctual tests above the detected defaults
Admittance
1Bad connection
2-Good connection
Impedency meter
3- penetrometric and geoendoscopic test results
2- Punctual diagnosis by coupling geoendoscopic and penetrometric tests
Panda
Geoendoscopic
Geoendoscope
Panda

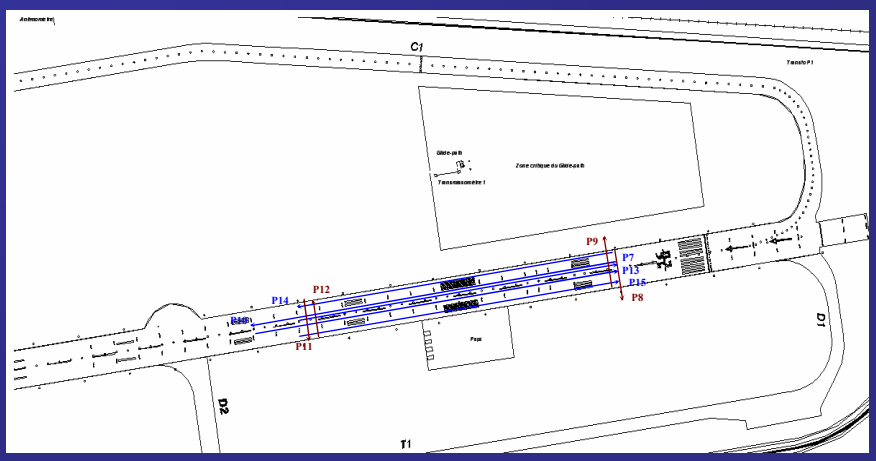
Roadway structure evaluation



Aulnat Airport (63,France

Roadway structure evaluation



0 m 45 m

Profils longitudinaux

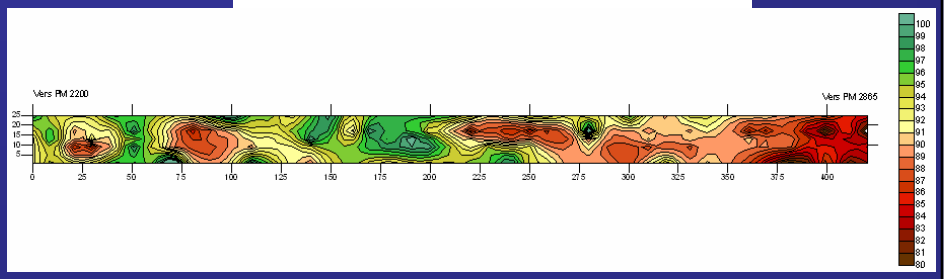
Profils transversaux

Aulnat Airport (63,France

Roadway structure evaluation

Default cartography

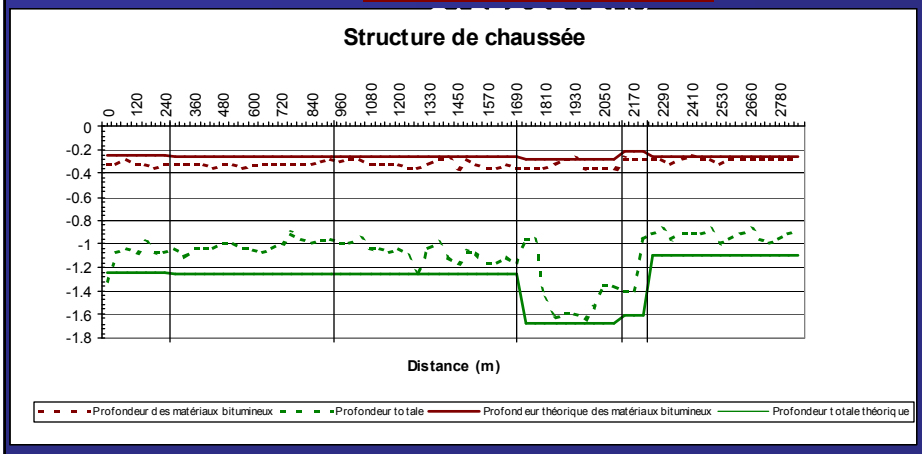
Depth of the interface between roadway and natural soil



Aulnat Airport (63,France

Roadway structure evaluation

Default

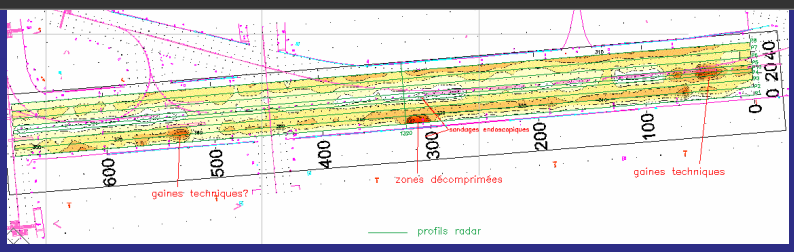


Aulnat Airport (63,France

Evolutive soils under roadway (gypsum)



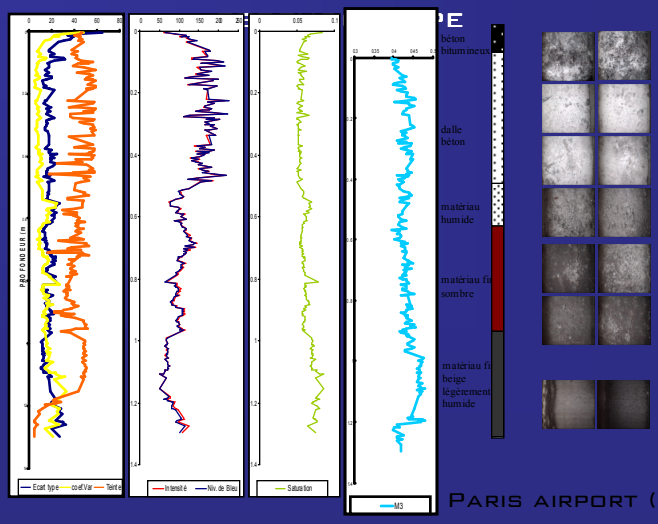
1- Global diagnosis through geological radar



Paris airport (75,France)

Evolutive soils under roadway (gypsum)

2- Punctual diagnosis with Panda and



Paris airport (75,France

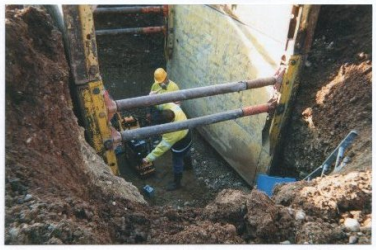
Conclusion

Implementation:

- Quasi non-destructive tests, quick, with light devices

- Full methodology allowing a diagnosis for wide, complex and strategic areas

ACCESSIBILITE DIFFICILE



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INTERIEUR DE CAVES

LERMES

Université Blaise Pasca

PANDA en moto au nord Cameroun a la saison des pluies

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PANDALP

LERMES

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SONDAGES SUR PENTES


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panda

LERMES

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PANDA en pirogue en foret equatoriale

LERMES

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SUPERMARCHE

LERMES

Université Blaise Pascal

Refuge des Cominges - CHAMONIX - MONT BLANC

LERMES

Université Blaise Pascal

TRAVAUX EN ZONE PORTUAIRE

Conclusions

- 1800 devices in 30 countries
  - French standard NF XP P 94-105
  - Remote areas
  - multiplication of simple and reliable tests
  - spatialization of the data.
- In the future :
  - To complete the database
  - To stick to international contexts
  - New applications (railways, mining residuals …)
  - Soil-structure interaction (underground works, pavings)