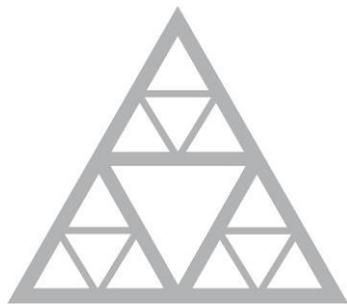




# Recherches sur pieux géothermiques à l'Ecole des Ponts ParisTech

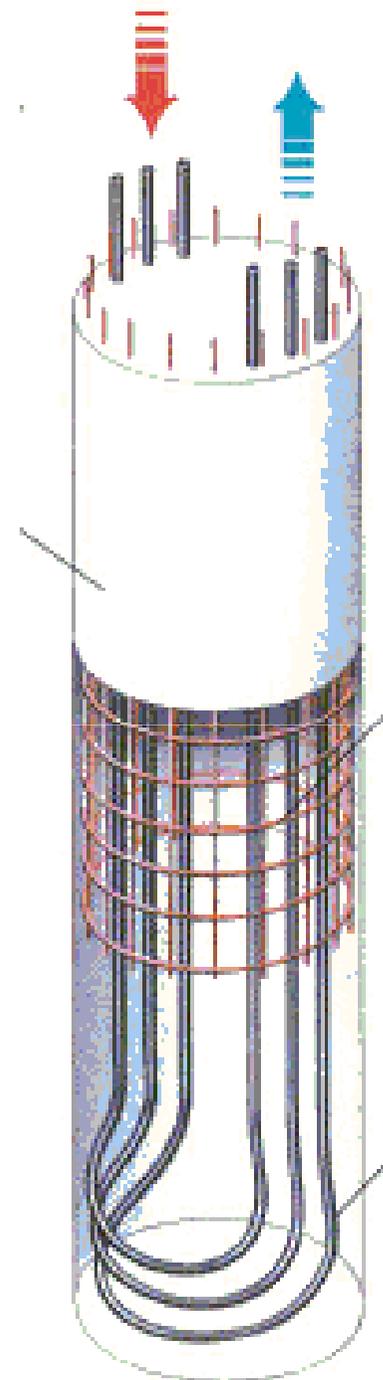
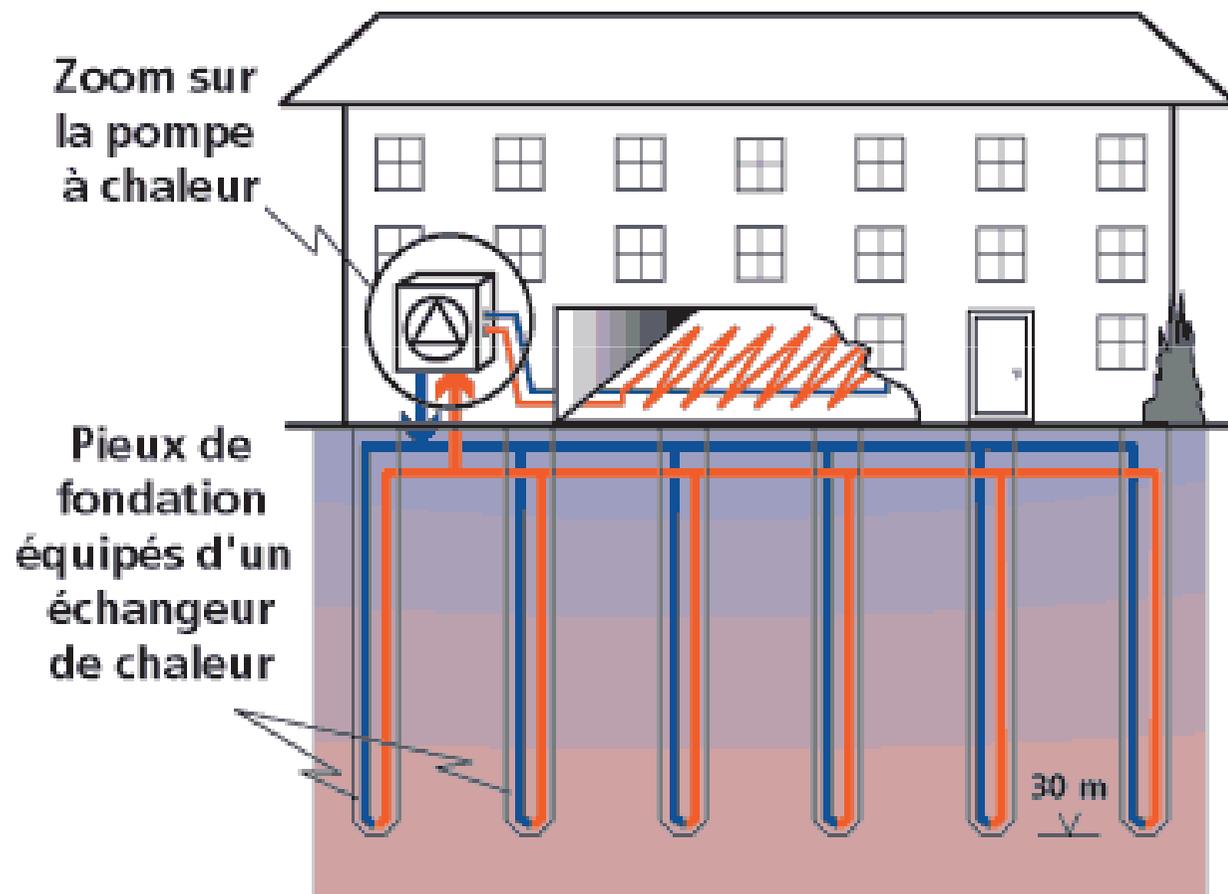
**A. M. Tang, J.-M. Pereira, G. Hassen**  
*Laboratoire Navier (ENPC/CNRS/IFSTTAR)*



**École des Ponts**  
ParisTech

*Journée technique CFMS, 25 janvier 2012*

# Pieux géothermiques





# Plan de la présentation

1. Pieux expérimentaux Descartes+  
*(en collaboration avec IFSTTAR)*
2. Premiers résultats en modèle réduit  
*(Projet ANR PINRJ)*



# 1. Pieux expérimentaux Descartes+

## ○ Contexte

- Projet de recherche financé par l'ENPC (A.M. Tang, J.M. Pereira)
- Opération de Recherche IFSTTAR 11W103 « Géothermie »
- Projet ANR GECKO (S. Burlon - IFSTTAR)
  - Post-doc de Fabien Szymkiewicz
- Thèse de doctorat (demande de financement IFSTTAR)



# Bâtiment Descartes+



PROJET DESCARTES +  
Ecole Nationale des Ponts et Chaussées



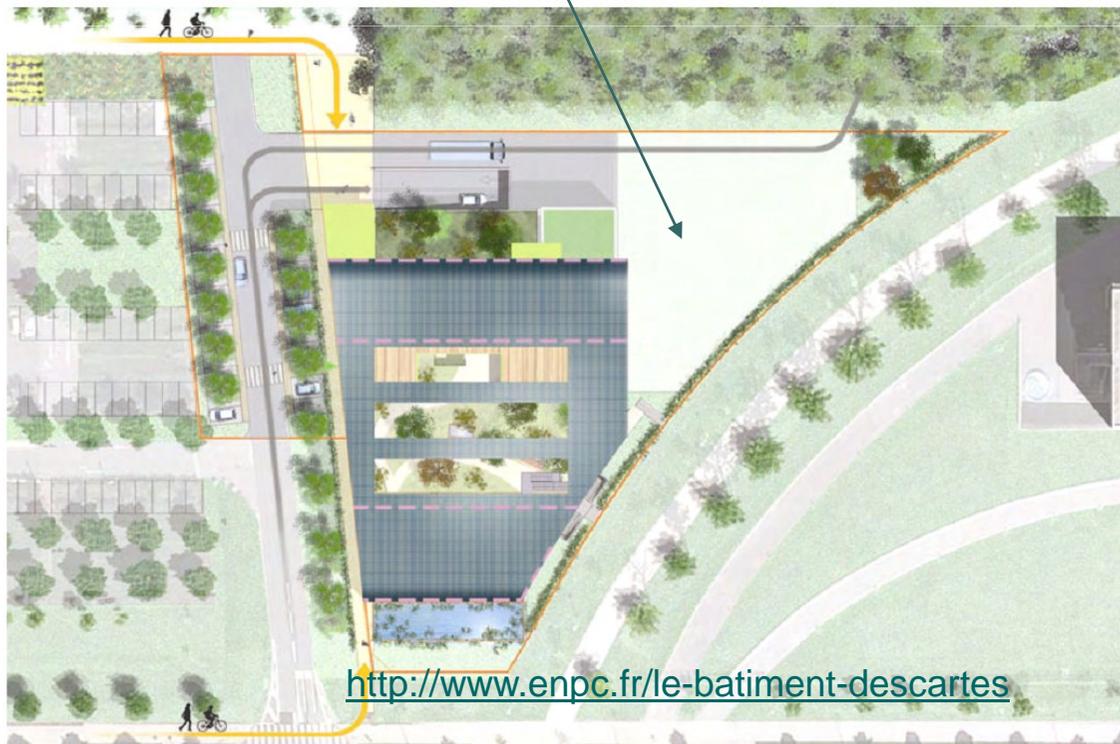
NOTICE EXPLICATIVE

Atelier Thierry Roche & Associés  
ARCHITECTES - URBANISTES



le 13 août 2009

Aire d'expérimentations



# Pieux expérimentaux Descartes+

The screenshot displays the Descartes+ web application interface. At the top, a blue header contains the logo "DESCARTES +" and the tagline "Suivi de la construction du bâtiment". Below the header are navigation buttons for "PROJET", "PHOTOS", and "TIME-LAPSE". A sidebar on the left includes a "Résolution" dropdown, a calendar for "Janvier 2012", a "VERSUS" comparison tool with date pickers, a thumbnail image, and a set of social media icons. The main content area shows a large photograph of a construction site. In the foreground, a yellow excavator is positioned near a concrete pile being drilled by a tall machine. The site is enclosed by a green safety fence. In the background, a modern building with a glass facade and a forested area are visible under a clear sky. A timestamp "20/11/10 12:00" is located in the top right corner of the image area.

# Pieux expérimentaux Descartes+

The screenshot displays the Descartes+ web application interface. At the top, a blue header contains the logo "DESCARTES +" and the subtitle "Suivi de la construction du bâtiment". Below the header are navigation buttons for "PROJET", "PHOTOS", and "TIME-LAPSE". A sidebar on the left includes a "Résolution" dropdown, a calendar for "Janvier 2012", a "VERSUS" comparison tool with two time slots (20/11/10 12:00 and 14/09/10 12:00), a small video player, and social media icons. The main content area shows a large aerial photograph of a construction site. In the foreground, a drilling rig is positioned on a dirt area. In the background, a modern building with a glass facade is under construction, surrounded by trees and a parking lot. A timestamp "23/11/10 12:00" is visible in the top right corner of the image area.

# Pieux expérimentaux Descartes+

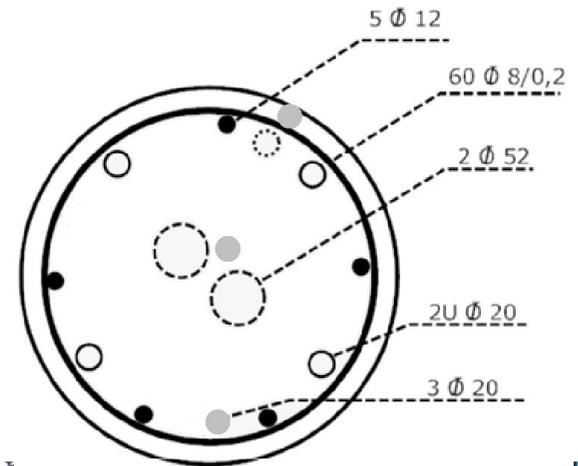
The image displays a screenshot of the Descartes+ web application interface. The main content area shows a wide-angle photograph of a construction site. In the foreground, a yellow crane with "FAL INDUSTRIE" written on its boom is positioned on a truck. The site features a large, shallow, light-colored pond or excavation area. In the background, a modern building with a glass facade is under construction, surrounded by trees and a clear sky. The interface includes a top navigation bar with the text "DESCARTES + Suivi de la construction du bâtiment" and buttons for "PROJET", "PHOTOS", and "TIME-LAPSE". A sidebar on the left contains a calendar for January 2012, a "VERSUS" comparison tool, and a small thumbnail of the construction site. The bottom of the sidebar has icons for email, download, star, and help. The top right corner of the main image area shows a resolution dropdown set to "23/11/10 13:00".

# Pieux expérimentaux Descartes+

The image displays a screenshot of the Descartes+ web application interface. The interface is divided into several sections:

- Header:** A blue banner with the text "DESCARTES + Suivi de la construction du bâtiment" and navigation buttons for "PROJET", "PHOTOS", and "TIME-LAPSE".
- Left Sidebar:** A vertical navigation panel containing:
  - A "Résolution" dropdown menu.
  - A calendar for "Janvier 2012" with days of the week (L, M, M, J, V, S, D) and dates (01-31).
  - A "VERSUS" comparison tool with date ranges: "13/01/12 12:00" and "14/03/10 12:00".
  - A small thumbnail image of the construction site.
  - A set of social media and utility icons (email, download, star, help).
- Main Content Area:** A large photograph of a construction site. It shows a multi-story concrete building under construction, two tall yellow cranes, and various construction materials and equipment on the ground. The background includes a parking lot and some trees.
- Top Right:** A small status bar showing the date and time "13/01/12 12:00" and a refresh icon.

# Pieux expérimentaux Descartes+

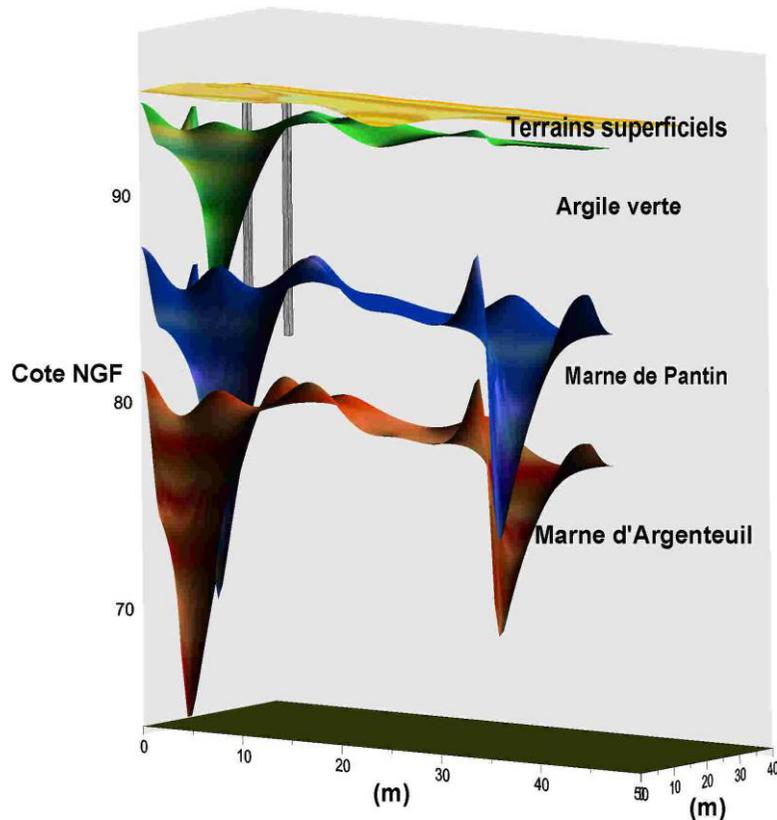


Dimensions des pieux : D = 40 cm; L = 12 m

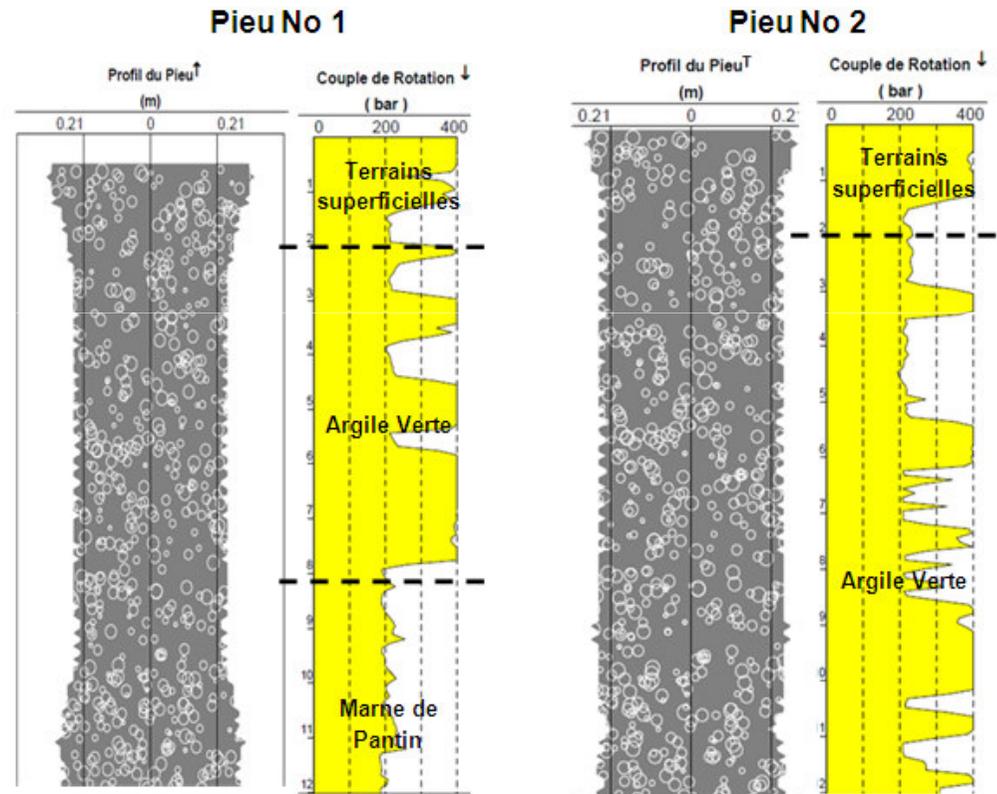




# Pieux expérimentaux Descartes+



Profil géologique

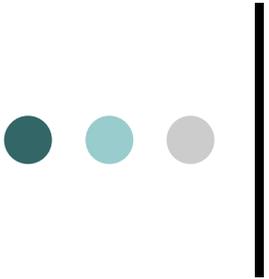


Paramètres de forage



# Pieux expérimentaux Descartes+

- Résumé
  - Deux pieux expérimentaux géothermiques
  - Instrumentation : T°, déformation axiale
- Travaux prévus :
  - Essais de chargement statique des pieux
  - Sollicitations thermo-mécaniques
  - Campagne d'identification du site
  - Modélisation numérique
  - ...

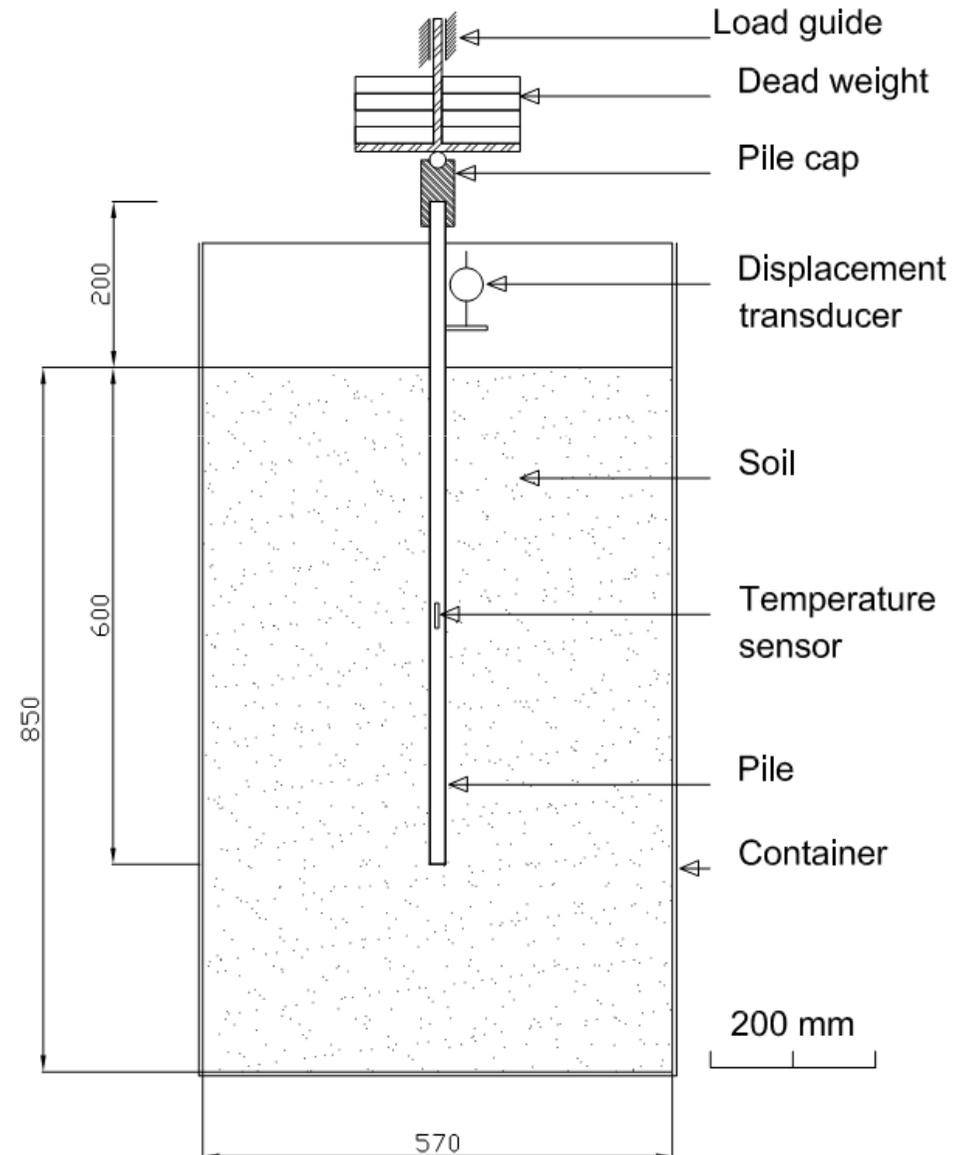
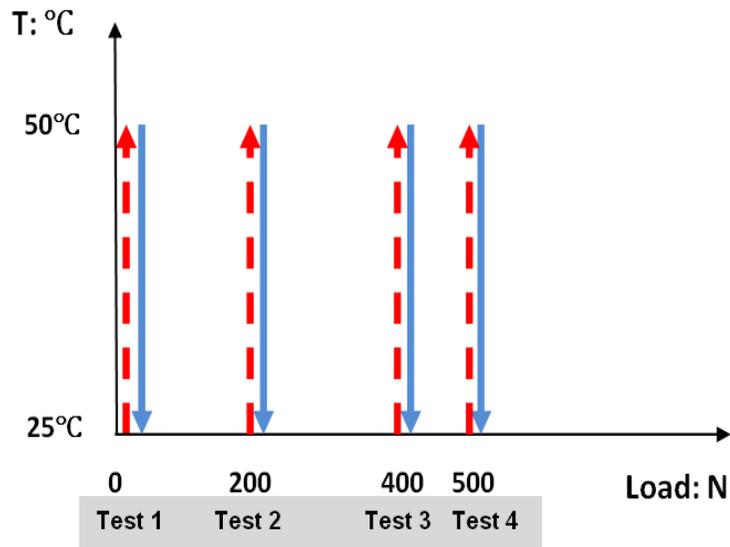


# ANR PINRJ (2011 – 2014)

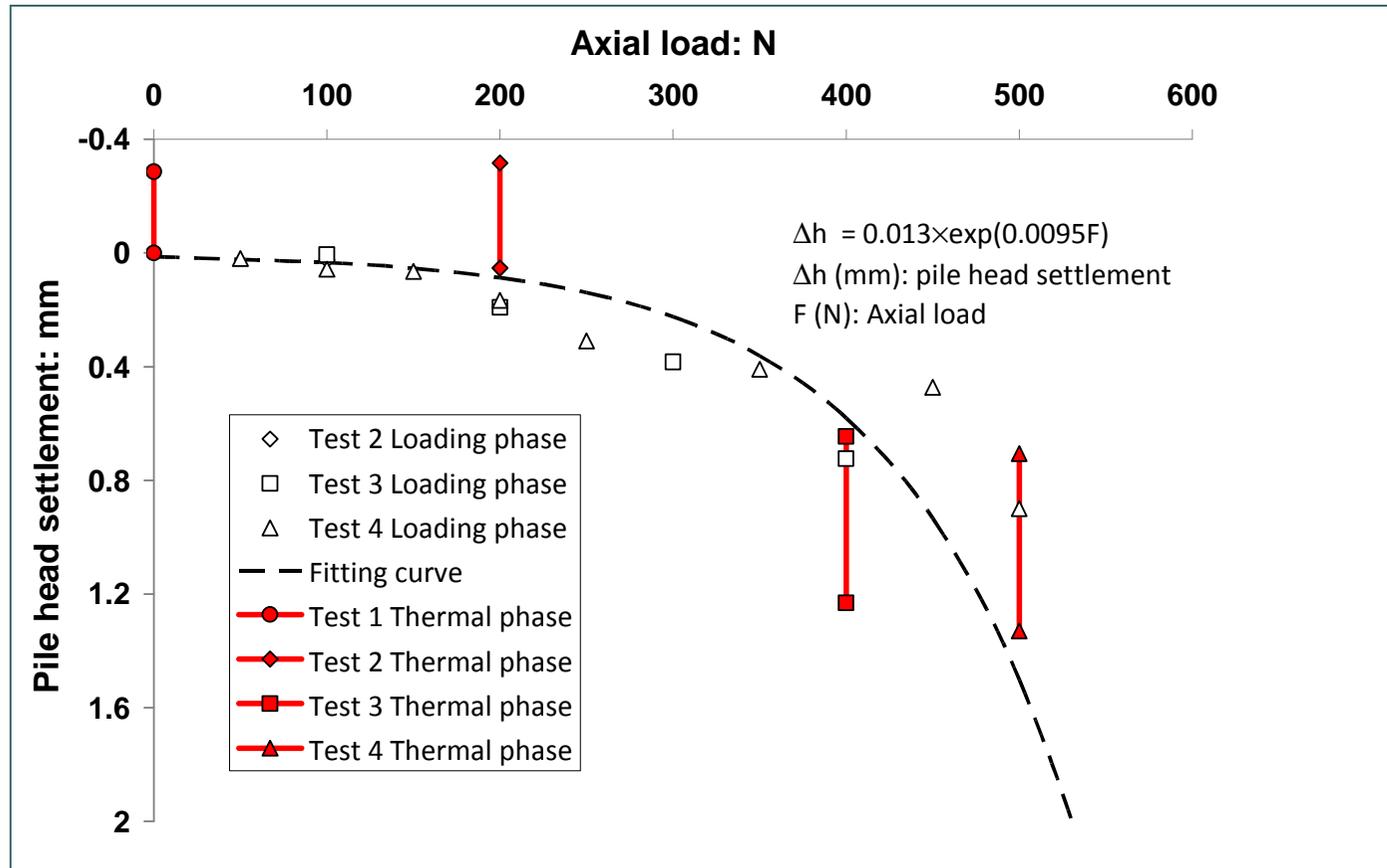
- Titre : Aspects géotechniques des pieux de fondation énergétiques
- Participants: A.M. Tang, J.M. Pereira, G. Hassen
- Thèse de doctorat de N. Yavari (démarrée en sept. 2011)
- Programme
  - Modélisation physique
  - Modélisation numérique d'un pieu isolé
  - Modélisation numérique d'un groupe de pieux
- Premiers résultats:

Kalantidou, A., Tang, A.M., Pereira, J.M., Hassen, G., (2012). Preliminary study on the mechanical behaviour of heat exchanger pile in physical model. *Géotechnique* (sous presse)

# Modèle réduit d'un pieu énergétique

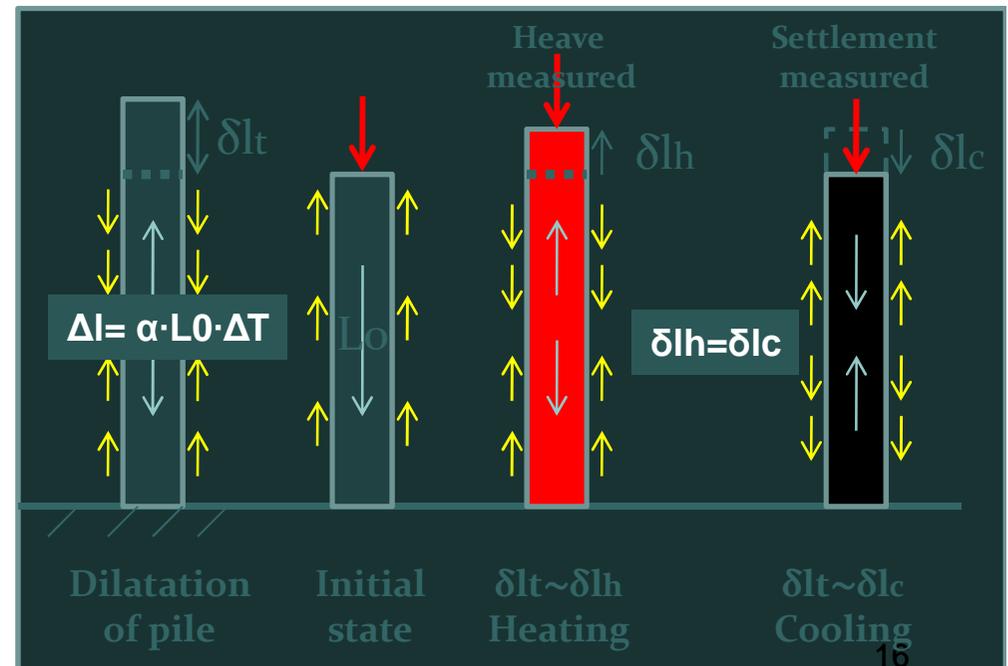
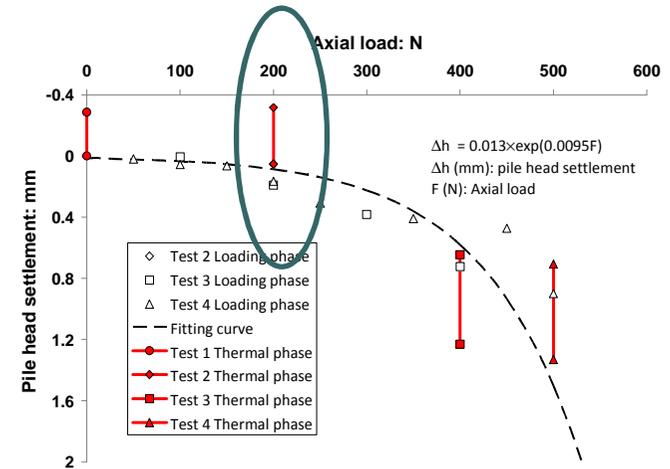
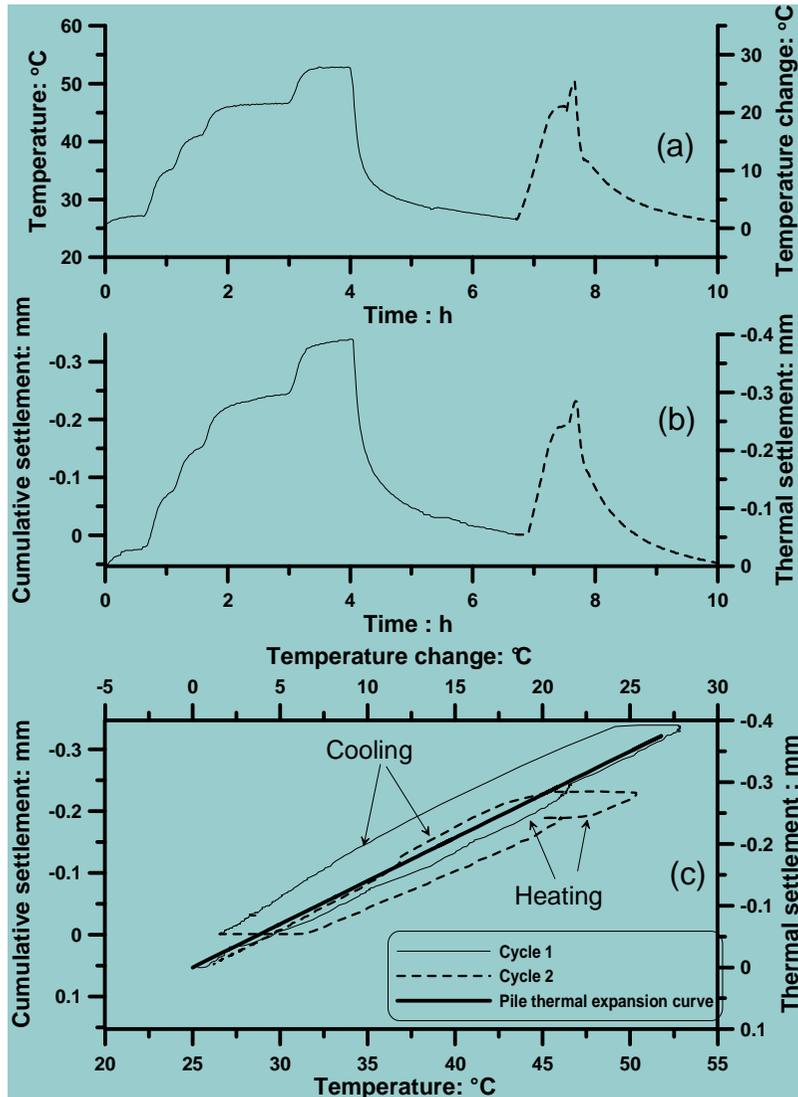


# Courbe de chargement statique du pieu

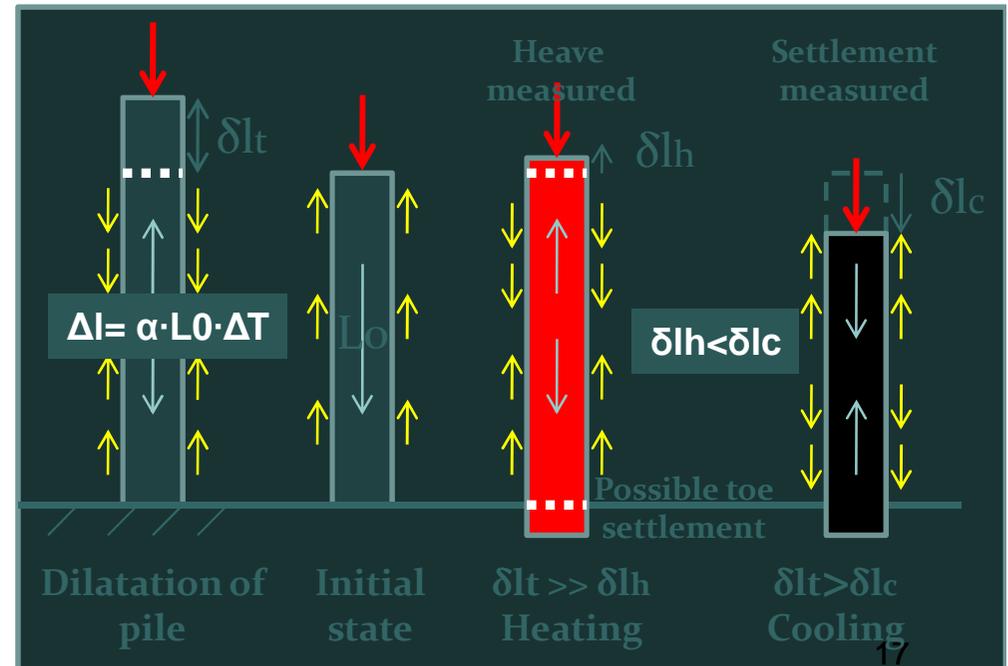
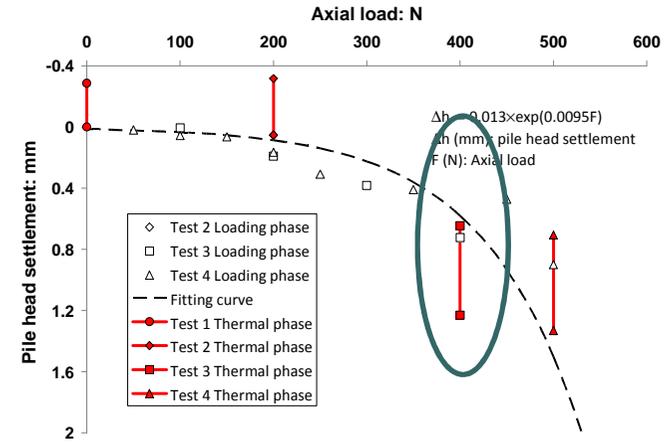
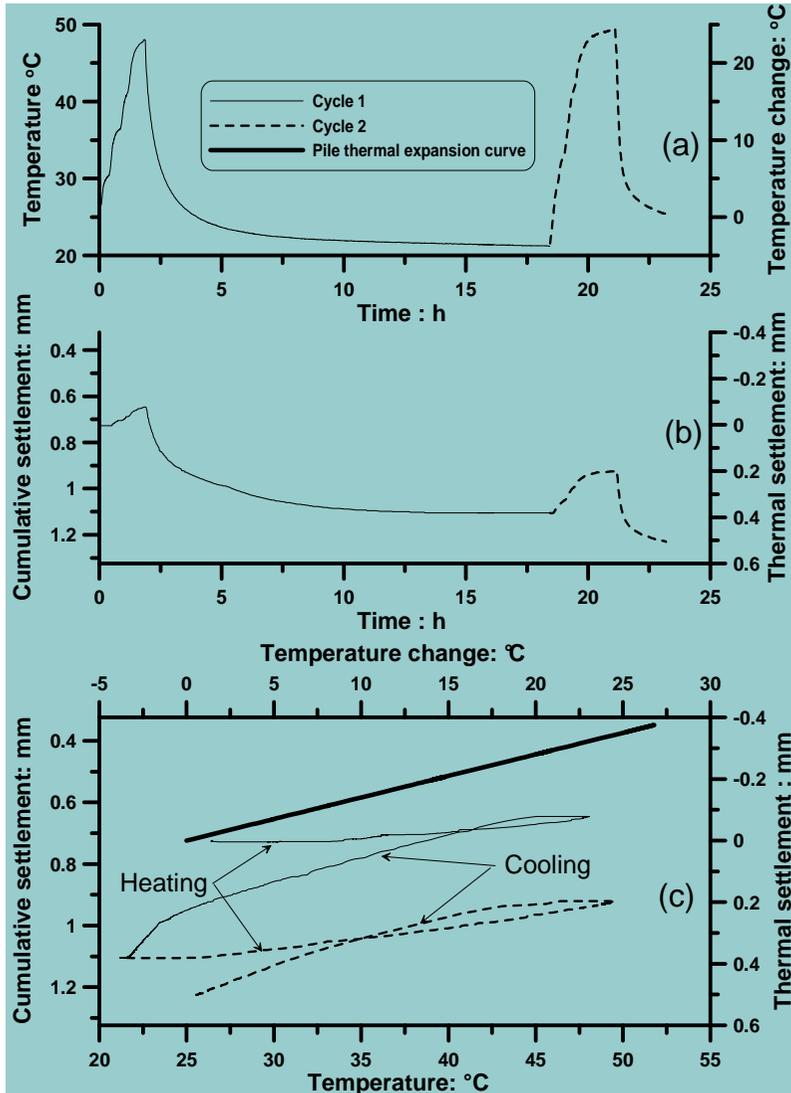




# Cycles T° sous faible charge



# Cycles T° sous forte charge





# Premières conclusions

- Essai en modèle réduit d'un pieu énergétique, cycles thermiques sous charge constante
- Comportement thermo-élastique du pieu sous charge  $< 40\%$  de charge limite
- Tassement irréversible après cycles thermiques sous charge  $> 40\%$  de charge limite
- Effets couplés température-fluage?