

## ***COST GABI \ Working group 4 : Thermoactive geostructures design***

### **Benchmark n°1 : Modelling Energy Piles**

The experimental site is located in the north of France, near Dunkirk. The average annual outside temperature in Dunkirk is 11.3°C.

The soil is mainly made of poorly graded clean sand, which is covered by a layer of silts about 2.7 m thick. The depth of water table is 1.6 m and the average temperature of the soil is around 14°C.

The case study deals with cast flight auger (CFA) piles with a 0.52 m diameter and a 12.0 m length.

The concrete compressive strength is 42 MPa. The reinforced cage is made of 5 steel rods with a 20 mm diameter (see Figures 1a and 1b). The installation parameters are joined in annex.

Two U-loops were installed in each pile (see Figure 1a).

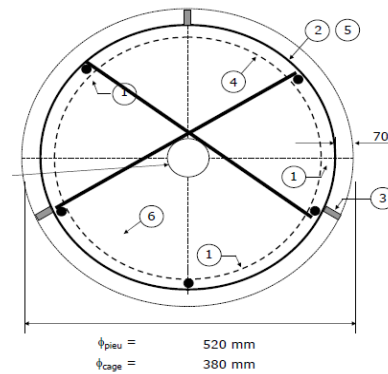


Figure 1a et 1b

The main properties have been measured until a 15 meters depth and are given on Table 1.

- volumetric weight  $\gamma$ ,
- mechanical properties :
  - shearing resistance measured with a shear-box apparatus on undisturbed samples,
  - CPT and PMT results are given in annex (the different in-situ-tests results are reported in Annex)

Table 1 : Ground model

	Thickness (m)	$\gamma$ (kN.m-3)	$\varphi'$ (kPa)	$c'$ (kPa)
Silt	2,7	19,0	-	-
Poorly graded sand	> 13	19,5	31	2

A static load test with maintained load steps (each of one hour duration) has been performed on a first CFA pile and the significant results are given in Figure 2 and Table 2.

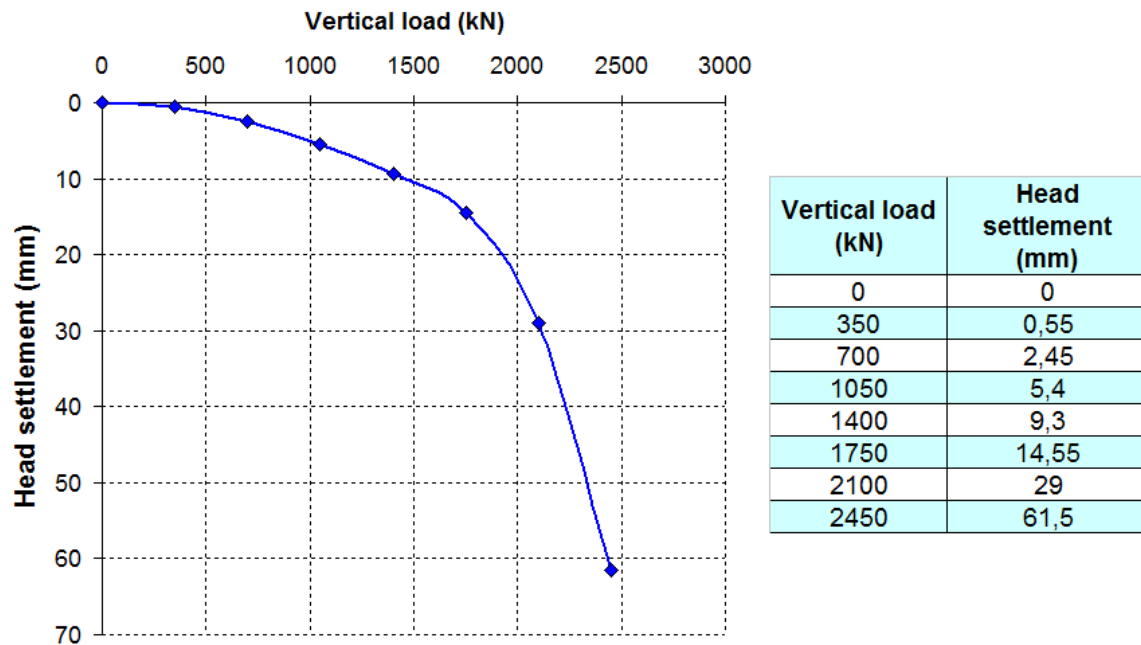


Figure 2 and Table 1

The thermal loading was applied on a second pile similar to the first one. A mechanical preloading equal to 900 kN was maintained during the whole test duration. The value of 900 kN was chosen, corresponding to the typical “working load” under French buildings. A thermal loading was then applied, through imposing the fluid’s average temperature ( $T_{in} - T_{out} = 3^{\circ}\text{C}$ ). It consisted in two weeks long phases, with the following temperature conditions :

- cooling phase : decrease in average temperature of  $12^{\circ}\text{C}$ ,
- heating phase : increase in average temperature of  $15^{\circ}\text{C}$ .

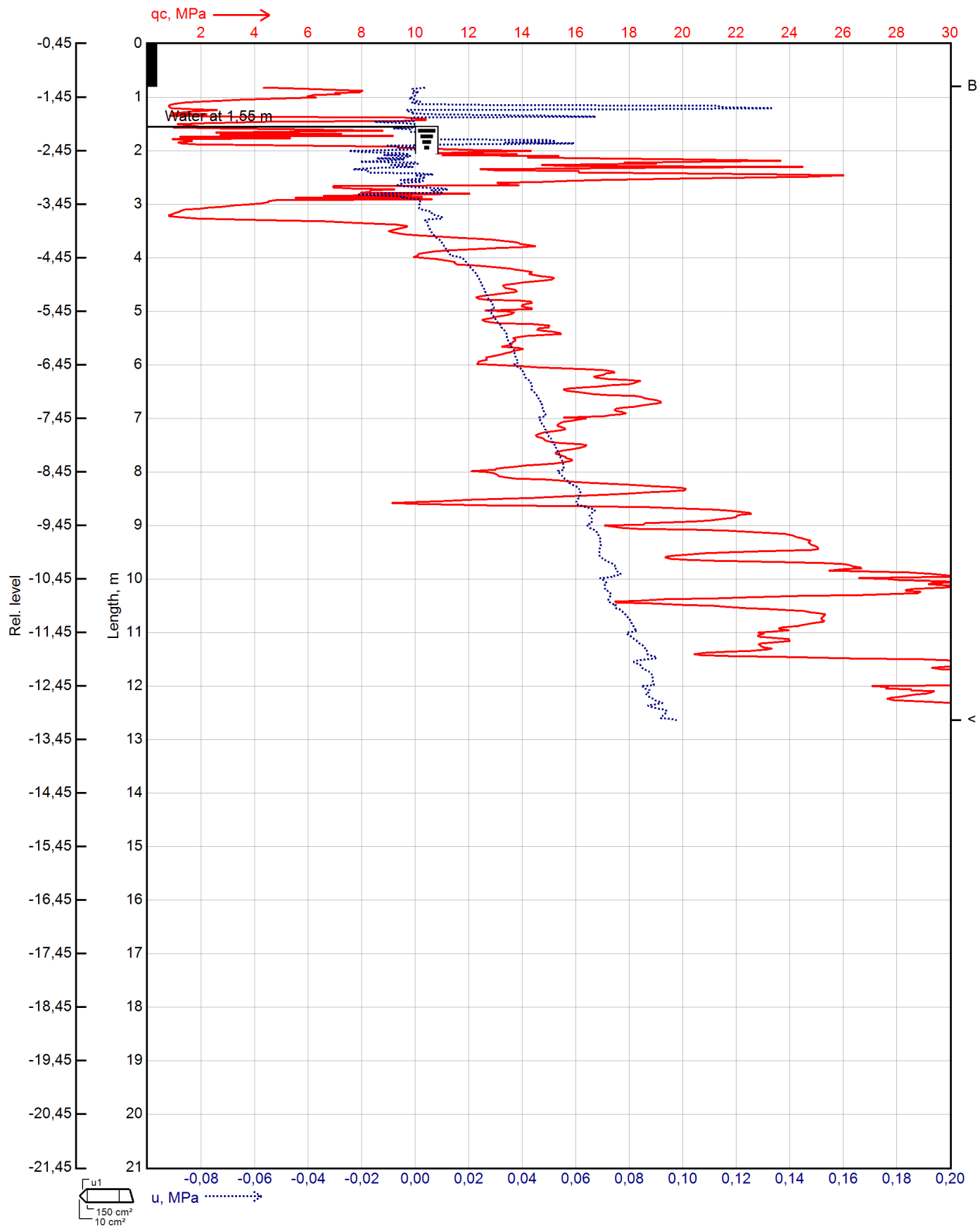
The benchmark will focus on the following output parameters :

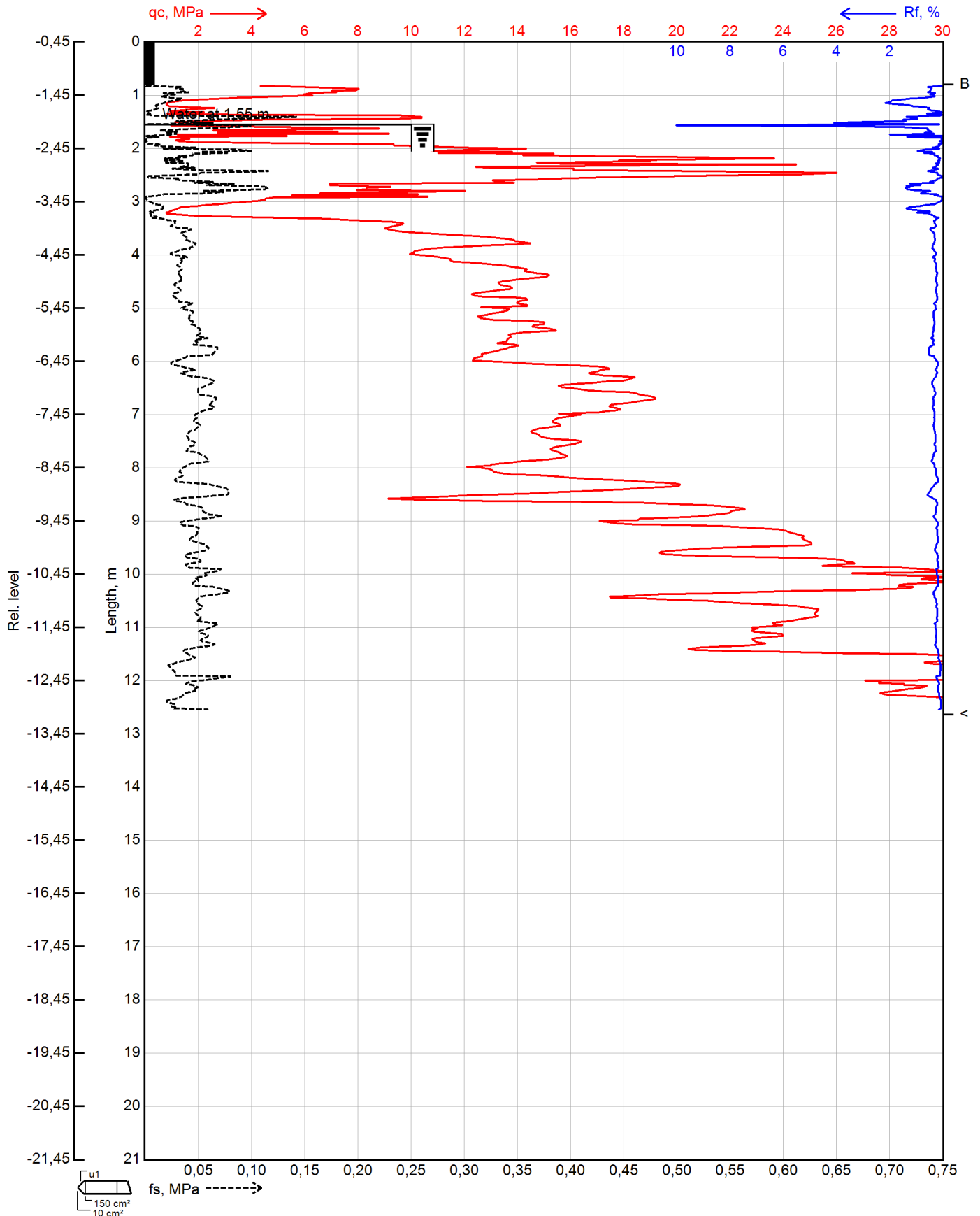
- head settlement,
- internal stresses or forces,
- mobilised shaft friction and base resistance.

In a second step (without experimental results), the same calculations can be performed for different head rigidity conditions :

- fixed head pile (infinite vertical rigidity),
- vertical rigidity of 100 MN/m.

In a third step, which checks will you perform to design this pile (900 kN is supposed to be the quasi-permanent SLS load)?





# Sondage : PR01

Client : IFSTTAR

Type : PRESSIOMETRE

Etude : IFSTTAR OR Géothermie 2012  
Site expérimental de Coudekerque

X : 602485

Date : 17/10/2012

Y : 368171

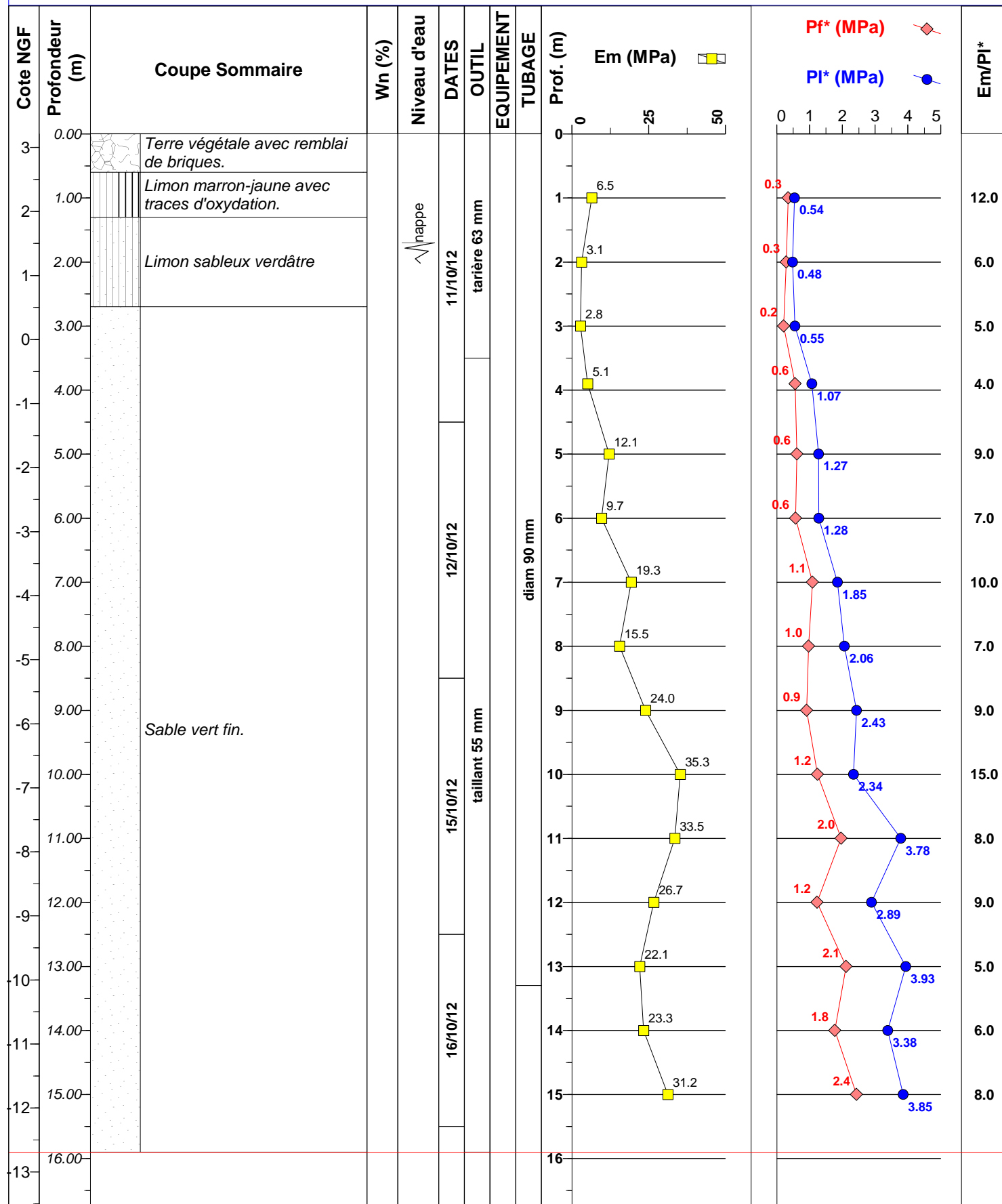
Début : 0,00

Z : 3,21 m

Fin : 15,90

Remarque :

Echelle : 1 / 80

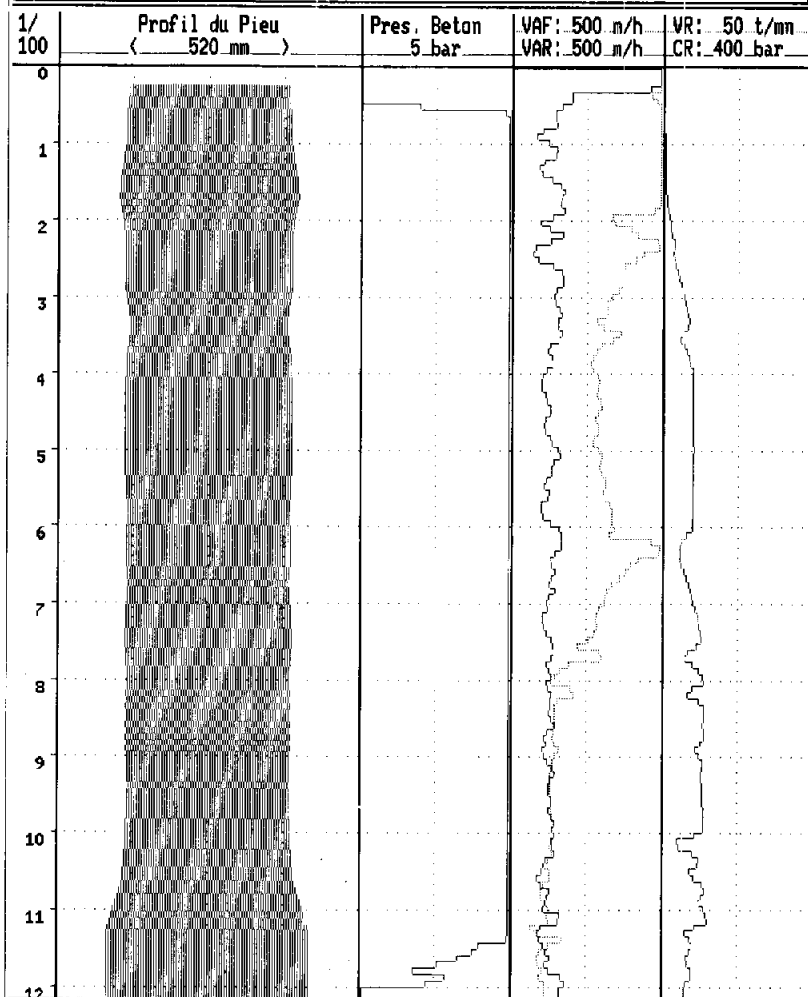


# COUDEKERQUE

Pieu : 05

Contrat: 22805

Date	: 05/07/13	Diamètre tarière	: 0.520 m
Heure	: 09h05	Profondeur Pieu	: 12.20 m
Bétonnage	: 09h25	Volume Béton	: 3.39 m3
Fin Pieu	: 09h34	Surconsommation	: 34 %
		Inclinaison X;Y	: -9.9; -9.9°



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