PRESSUREMETER TEST

Study case: Rhone Valley – Power Plant

Presentation for SBGIMR / BVGIRM

CHOOSE EXPERTS, FIND

PARTNERS

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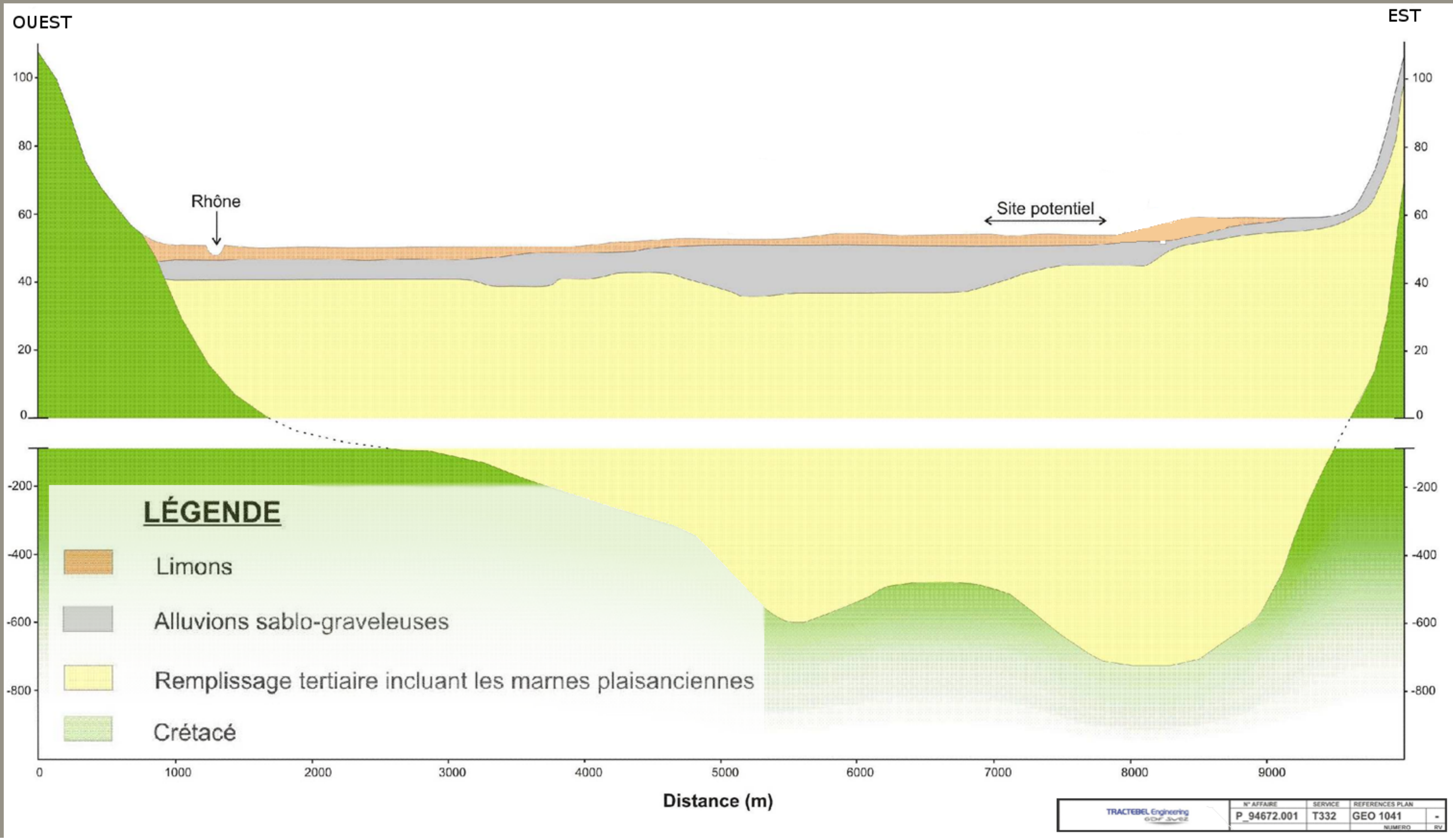
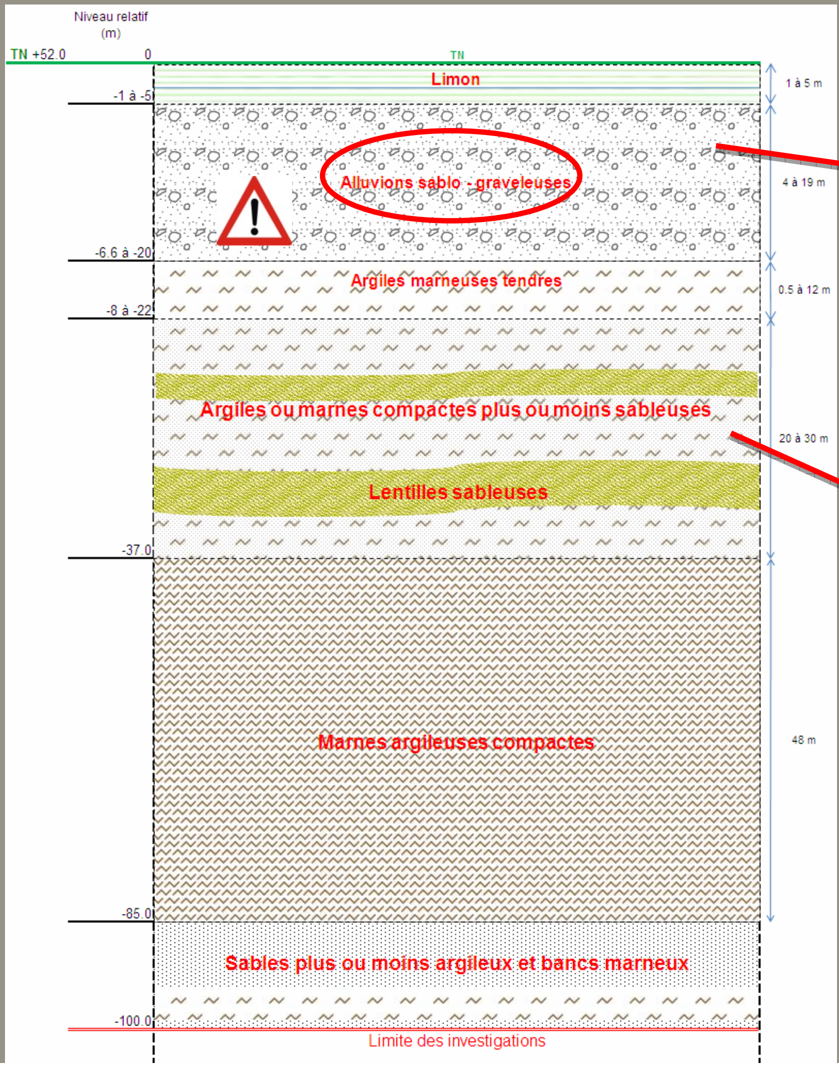
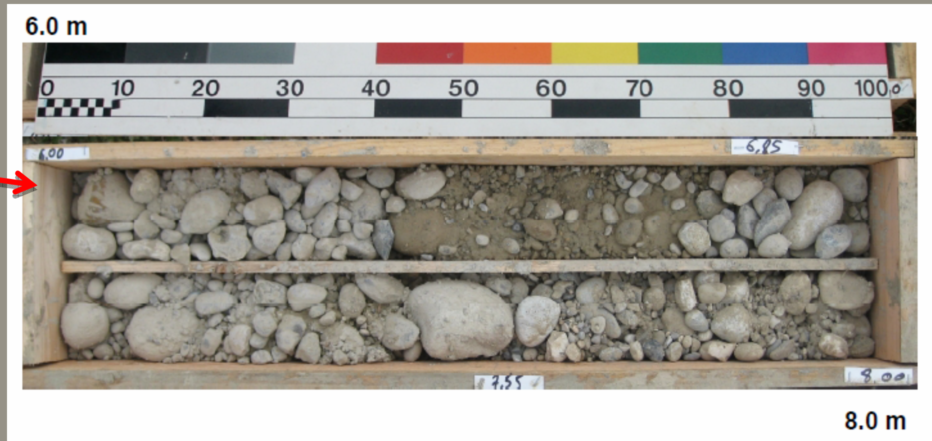
RHONE VALLEY POWER PLANT LAYOUT

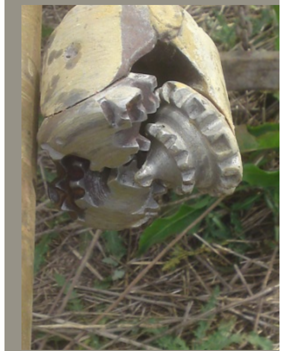
RHONE VALLEY GEOLOGICAL CONTEXT



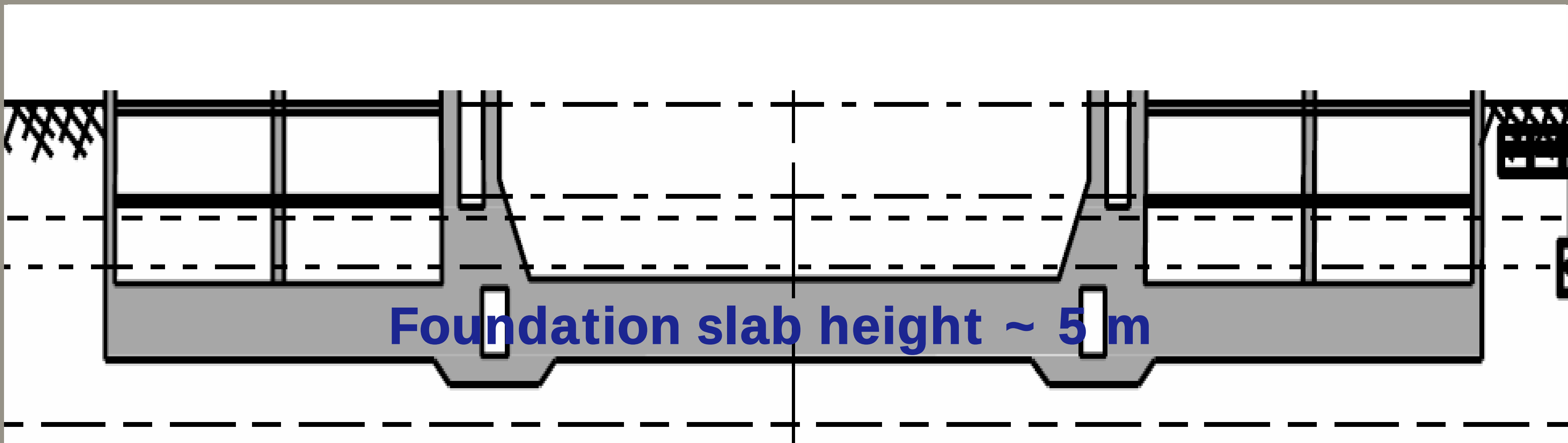
SITE GEOLOGICAL DESCRIPTION







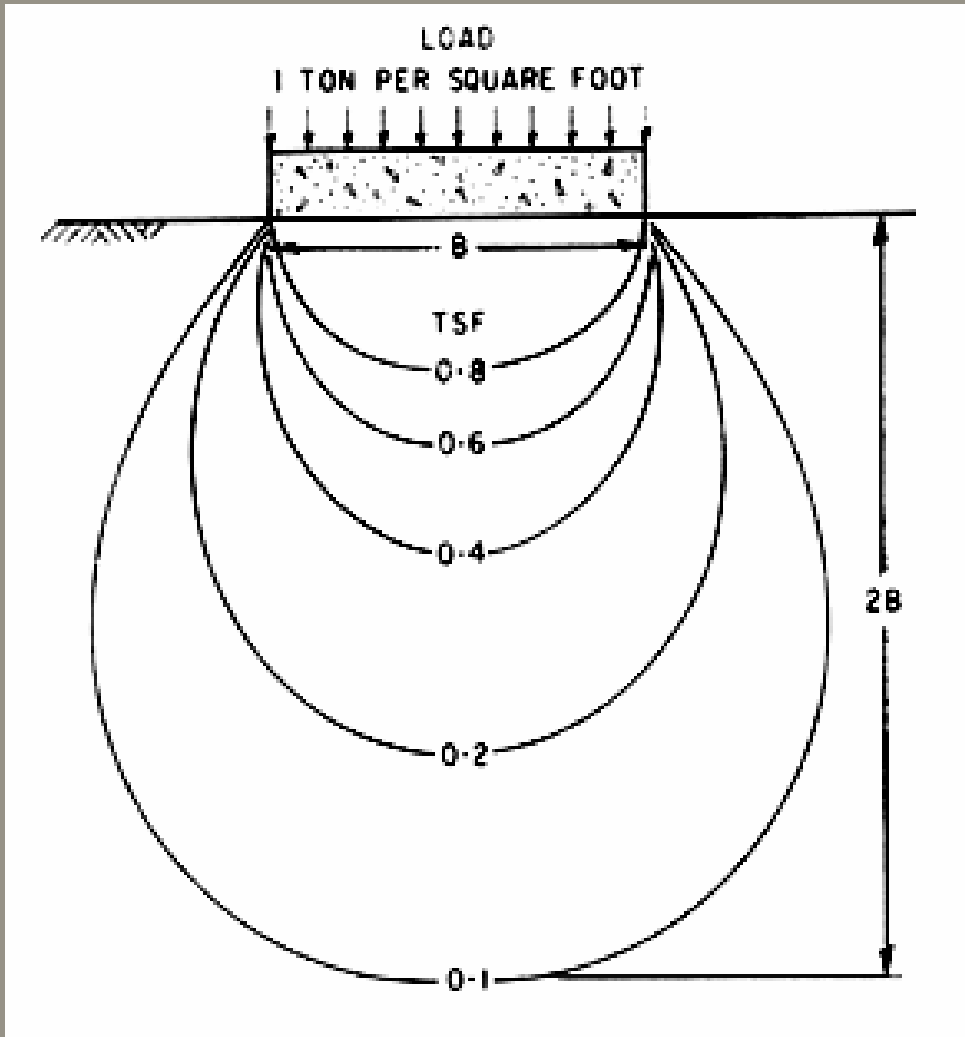
POWER PLANT FOUNDATION LAYOUT



Foundation slab diameter ~ 65 m
3300 m²

REQUIRED SOIL INVESTIGATION DEPTH

Superficial foundation



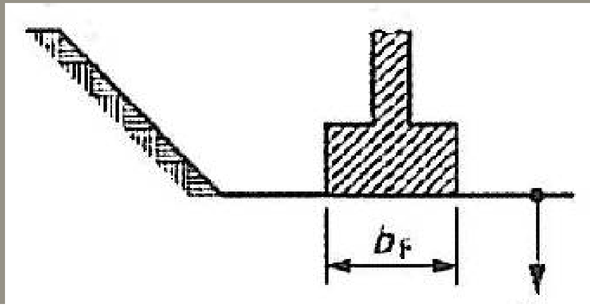
RECOMMENDATIONS FOR THE SPACING AND DEPTH OF INVESTIGATIONS BASED ON E.C. 7

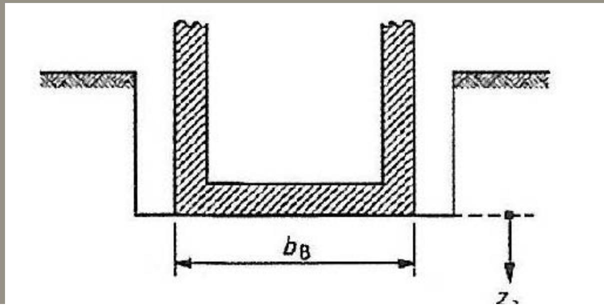
Spacing

- For high-rise & industrial structures : grid pattern with points at 15 m to 40 m distance;
- For special structures (e.g. machinery foundations, etc) : 2 to 6 investigation points per foundation.

Depth

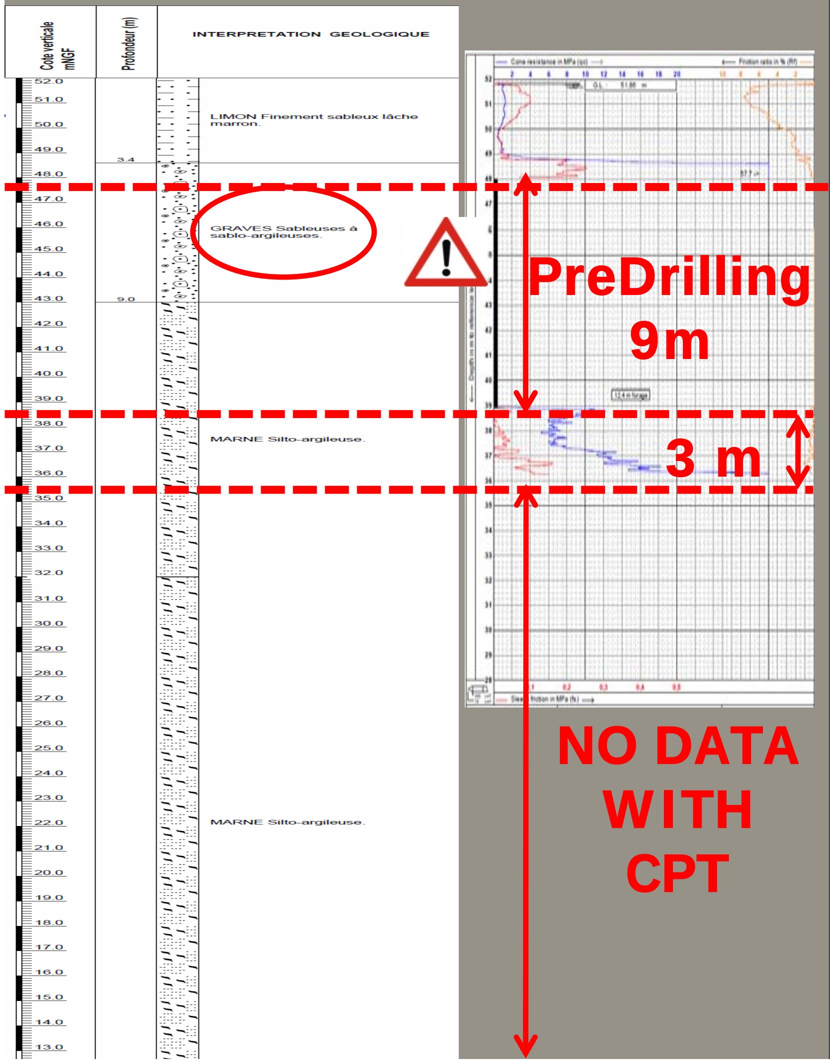
- For high-rise structures : investigation depth ≥ 3*bf ;
- For raft foundations with several foundation elements whose effects in deeper strata are superimposed on each other : investigation depth ≥ 1.5*bB.



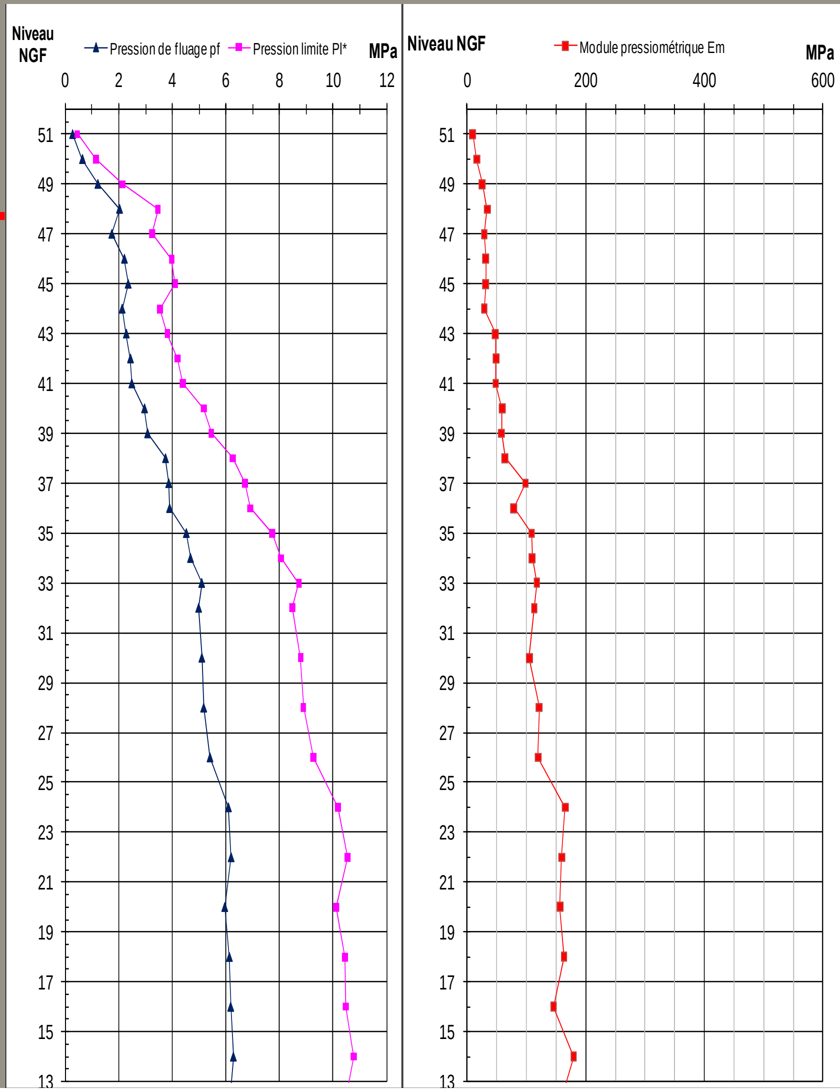


GEOTECHNICAL SOIL INVESTIGATION

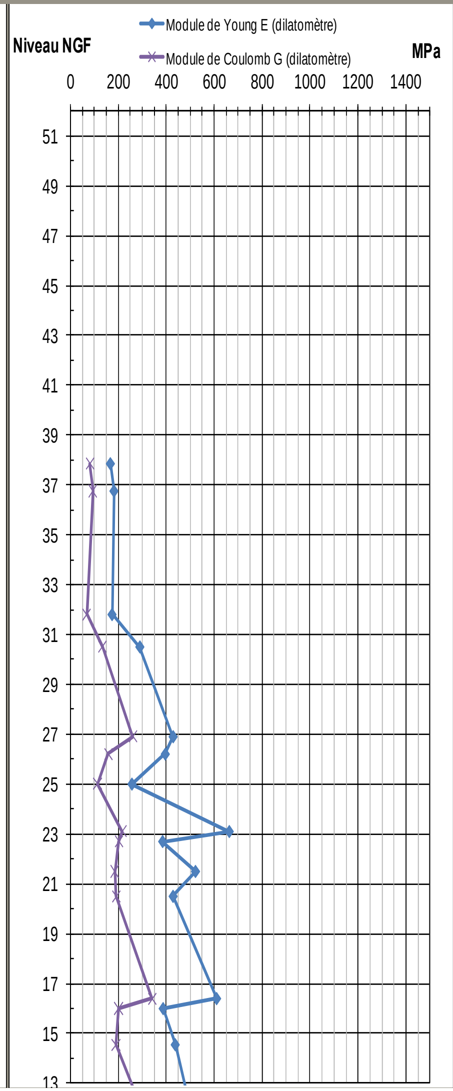
CPT



PRESSIOMETER



DILATOMETER



FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (1)

Limit base pressure q_{pu}

In our case study, the raft foundation is a shallow foundation:

According to fascicule 62 – titre V, the limit base stress is provided by the formula

$$Q_{pu} = k_p . p_{le}^*$$

where k_p is the bearing factor depending on soil nature (see table here below)

TYPE DE SOL	EXPRESSION DE k_p
Argiles et limons A, craies A	$0{,}8 \cdot \left[1 + 0{,}25 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Argiles et limons B	$0{,}8 \cdot \left[1 + 0{,}35 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Argiles C	$0{,}8 \cdot \left[1 + 0{,}50 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Sables A	$\left[1 + 0{,}35 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Sables et graves B	$\left[1 + 0{,}50 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Sables et graves C	$\left[1 + 0{,}80 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Craies B et C	$1{,}3 \cdot \left[1 + 0{,}27 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$
Marnes, marno-calcaires, roches altérées (***)	$\left[1 + 0{,}27 \cdot \left(0{,}6 + 0{,}4\frac{B}{L}\right)\frac{D_e}{B}\right]$

B, L : dimension of foundation

D : Depth of the foundation

$$D_e = \frac{1}{p^*_{le}} \int_0^D pl^*(z)\,dz$$

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (2)

$p*_{le}$: the soil equivalent net limit pressure under the foundation

•In the case of a shallow foundation established on homogeneous soil layers with a thickness of at least 1.5. B below the base of foundation:

$P*_{le}$ = pl* → Net limit pressure value prevailing at a thickness of 1.5 B

•In the case of a shallow foundation on no homogeneous soil layers between depths D and D +1.5 B :.

$$p*_{le} = \sqrt[n]{p*_{l1} \cdot p*_{l2} \cdots pl*_{n}}$$

→ Net limit pressure value in the layers located on D to D +1.5 B

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (3)

In order to calculate the bearing capacity of a shallow foundation, the limit values for the base Q_{pu} have to be multiplied by the following reducing factors, depending on the limit state considered:

	Serviceability Limit State (SLS)	Ultimate Limit State (ULS)
Base strength Q_{pu}	0.33	0.5

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (4)

The calculation of settlement by the pressuremeter method defined in French code (Fascicule 62 Titre V or DTU 13.12) is not applicable for of large dimensions of rafts. Settlement by the pressumerter method is limited to the soles of small sizes (3m x 3m).

For raft foundation, finite element model must be performed. In finite element model, Young modulus must be determinate.

In this studies case Ey is determinated by Dilatometer test and pressiometer test with correlation.

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (5)

Young modulus correlation with pressumeter test

The relationship usually used : $E_M = \alpha_M E_{oed}$

$$E_y = E_{oed} \frac{(1+\nu')(1-2\nu')}{(1-\nu')}$$

With ν', Poisson coefficient = 0.3

$$E_y = 0.74 \frac{E_M}{\alpha_M}$$

Selection of rheological coefficient of soil α_M:

Depth (m)	Lithology	Geotechnical behavior	α_M
14 - 20	Marls	Natural Rock	1/2
20 - 40	Sandy Marls	Normally consolidated Sand	1/3
40 - 80	Marls	Natural Rock	1/2
80 - 100	Sandy Marls	Normally consolidated Sand	1/3

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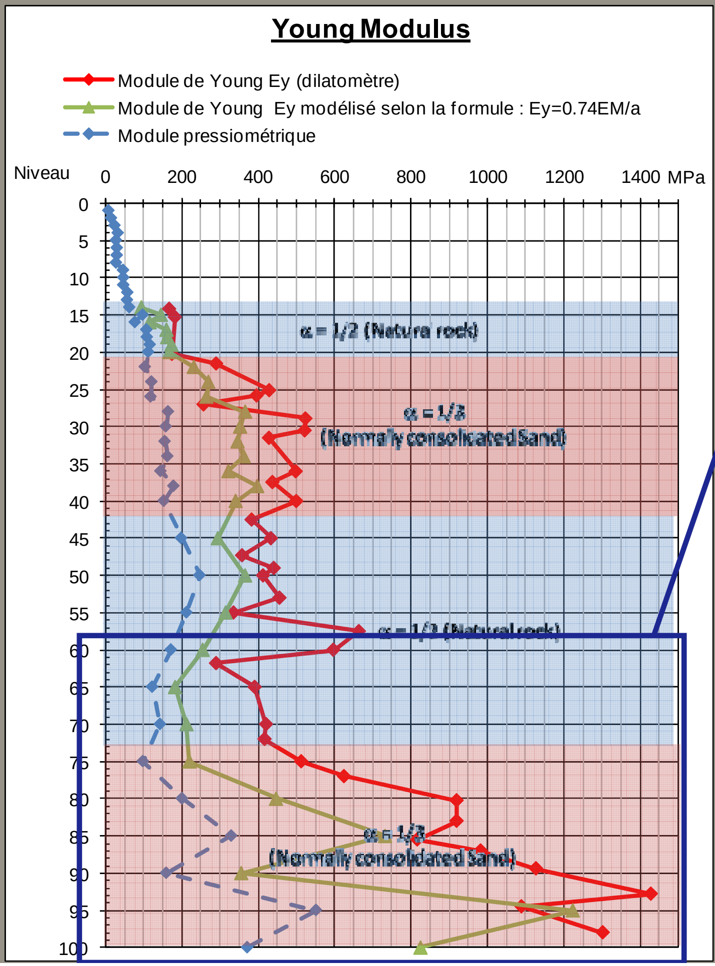
FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (6)

Young modulus correlation with pressumeter test



Significant difference between Young's modulus measured by the dilatometer tests and Young's modulus deducted by the pressuremeter tests :

- Limits of correlations ?

See article O. Combarieux in “Revue française de la géotechnique N° 114”:

« L’usage des modules de déformation en géotechnique »

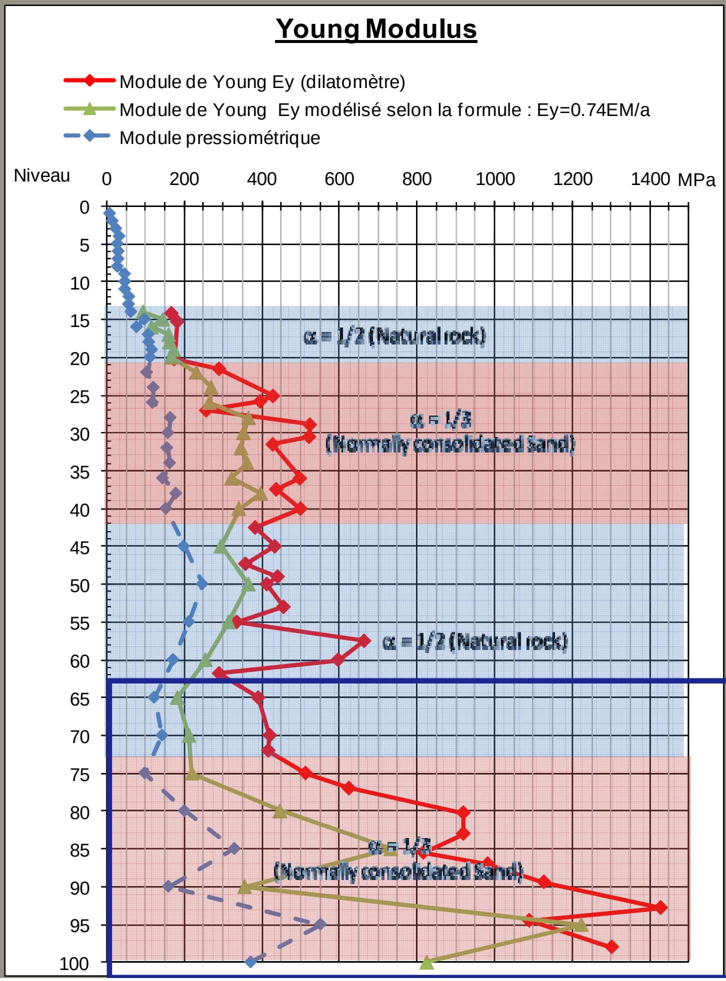
He defied for circular slab the following relationship

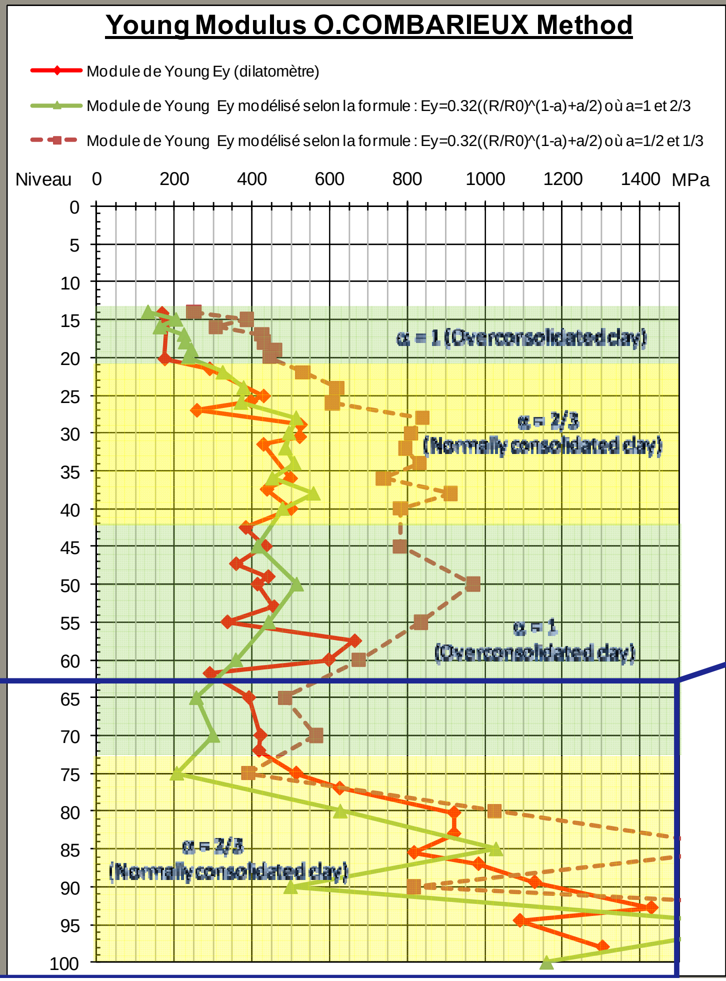
$$\frac{E_M}{E_Y} = 0.32\left(\left(\frac{R}{R_0}\right)^{\alpha-1} + \frac{\alpha}{2}\right)$$

Where :
R is the radius of the foundation = 32.5 m
R_0 = 0.3

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (7)

Young modulus correlation with pressumeter test





- Problematic of choice of rheological soil parameters α

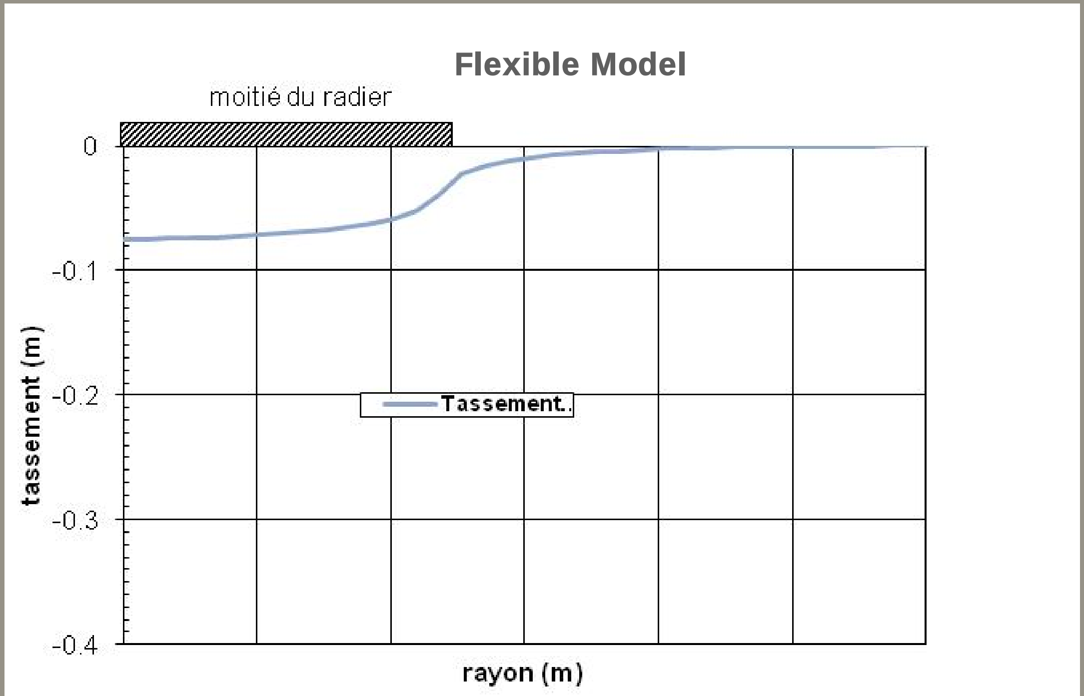
With the "O. Combarieux method" for the correlation the coefficient α=1 (behaviour of an over consolidated clay) α=2/3 (behaviour of a consolidated clay)

Same differences at great deep with this 2 method of correlation :

Limit of validity of the results of pressuremeter tests at great depth?

FOUNDATION DESIGN BASED ON PRESSUREMETER TEST (7)

Calculation of settlement with finite element model (SAP)



Estimation of settlement with load uniformly distributed over the raft of 6.3 Bar, is equal to 7.8 cm at the center of the raft

THANKS FOR YOUR ATTENTION.