ISP7.PRESSIO 2015

PMT NET LIMIT PRESSURE pl* AND PRECONSOLIDATION PRESSURE σ'p

Jean-Claude GRESS
ECOLE NATIONALE DES TRAVAUX PUBLICS DE L'ETAT
VAULX EN VELIN FRANCE
HYDROGEOTECHNIQUE TECHNICAL ADVISER

30/04/2015 – 01/05/2015
HAMMAMET - TUNISIE

GEOTECHNICAL ENGINEERS WHEN THEY WANT TO BE RELEVANT FOR THE ASSESSMENT OF SOIL SETTLEMENT HAVE :

- **TO KNOW IF SOIL IS SATURATED OR NOT**

- **FOR SATURATED SOILS AND SOILS HAVING A SIGNIFICANT CONTENT OF FINES, TO KNOW FOR EACH LAYER**

- INITIAL VOID INDEX VALUE	e_c
- COMPRESSION INDEX	C_c
- SWELLING INDEX	C_s
- PRECONSOLIDATION PRESSURE	$\sigma'p$
- CREEP INDEX	C_α

HAVING A LOOK A AN OEDOMETER GRAPH

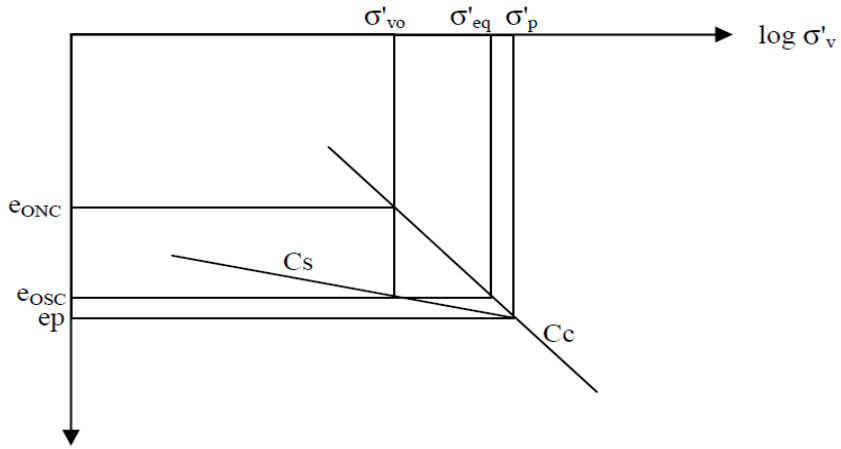

Fig. 1

WE CAN MAKE APPEAR EQUIVALENT STRESS VALUE σ'eq.

WE WRITE Cc VALUE IN THREE MANNERS AND Cs IN ONE AS :

$$Cc = \frac{e_{ONC} - e_p}{\log \frac{\sigma'_p}{\sigma'_{vo}}} = \frac{e_{OSC} - e_p}{\log \frac{\sigma'_p}{\sigma'_{eq}}} = \frac{e_{ONC} - e_{OSC}}{\log \frac{\sigma'_{eq}}{\sigma'_{vo}}} \qquad (1)$$

$$C_S = \frac{e_p - e_{OSC}}{\log \frac{\sigma'_p}{\sigma'_{vo}}} \qquad (2)$$

AND THEN

$$C_C - C_S = \frac{e_{ONC} - e_{OSC}}{\log \frac{\sigma'_p}{\sigma'_{vo}}} \qquad (3)$$

AND COMPARING (3) AND SECOND PART OF (1) :

$$\log \frac{\sigma'_{eq}}{\sigma'_{vo}} = \frac{Cc - Cs}{Cc} \log \frac{\sigma'_p}{\sigma'_{vo}} \qquad (4)$$

OR

$$\sigma'_{eq} = \sigma'_{vo} \left(\frac{\sigma'_p}{\sigma'_{vo}} \right)^{\frac{Cc-Cs}{Cc}} \qquad (5)$$

FOR Cs ≈ 0,2 Cc, WE WILL OBTAIN A PRODUCT, WE MEET VERY OFTEN IN SOIL MECHANICS :

$$\sigma'_{eq} = \sigma'_{vo}{}^{0,2} \, \sigma'_P{}^{0,8} \qquad (6)$$

INTEREST OF CPTu PROFILE

MAYNE (2009) PROPOSED IN ALEXANDRY CONGRESS A VERY INTERESTING RELATION BETWEEN $\sigma'p$ AND $q_T - \sigma_v$:

$$\sigma'_p = 0{,}33\ (q_T - \sigma_v)^m \quad \text{in kPa} \qquad (7)$$

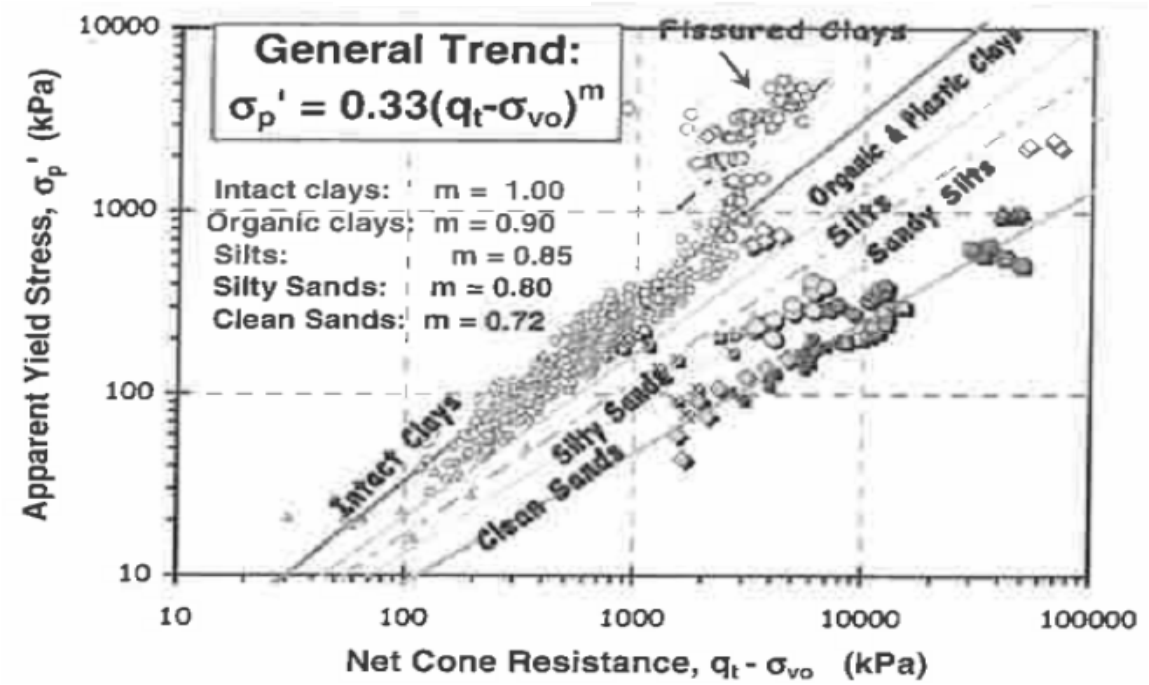

Fig. 2

WE HAVE PROPOSED TO SLIGHTLY MODIFY THIS RELATION AS :

$$\sigma'^{0,25}_{vo}\ \sigma'_p = (q_T - \sigma_v)^m \text{ en kPa} \qquad (8)$$

WITH FOR 0 – 400 µ SOILS :

$$m \neq \frac{W_L + 0,14}{W_L + 0,233} \qquad (9)$$

W_L LIQUIDITY LIMIT

AND FOR COARSE SOILS :

$$m \neq \frac{VB_{OD} + 4,5}{VB_{OD} + 6} \qquad (10)$$

VB_{OD} BLUE METYLENE VALUE OF TOTAL SOIL

D SMALLER DIAMETER OF THE BIGGER STONES

FOR PMT Tests, WE HAVE SHOWN (2012) THAT WE HAD :

$$pl^* \# (q_T - \sigma_v)^{0,8} \text{ en kPa} \qquad \textbf{IN Kpa} \qquad (11)$$

pl* = NET LIMIT PRESSURE

$q_T - \sigma_v$ = CONE RESISTANCE CORRECTED FOR PORE PRESSURE EFFECTS MINUS IN SITU TOTAL VERTICAL STRESS

WE CAN THEN WRITE THAT :

$$\sigma'^{0,25}_{vo}\ \sigma'_p = pl^{*\ 1,25m} \qquad \textbf{IN Kpa} \qquad (12)$$

AND THEN

$$\sigma'_{eq} = \sigma'^{0,2}_{vo}\ \sigma'^{0,8}_{p} = pl^{*\ m} \text{ en kPa} \qquad \textbf{IN Kpa} \qquad (13)$$

OF COURSE A VERY INTERESTING RELATION FOR SATURATED SOILS BUT BE AWARE THAT m VARIES QUICKLY

WE HAVE SHOWN (2012) THAT WE HAD :

$$Cu \# (pl^*)^{0,7} \text{ in kPa} \qquad (14)$$

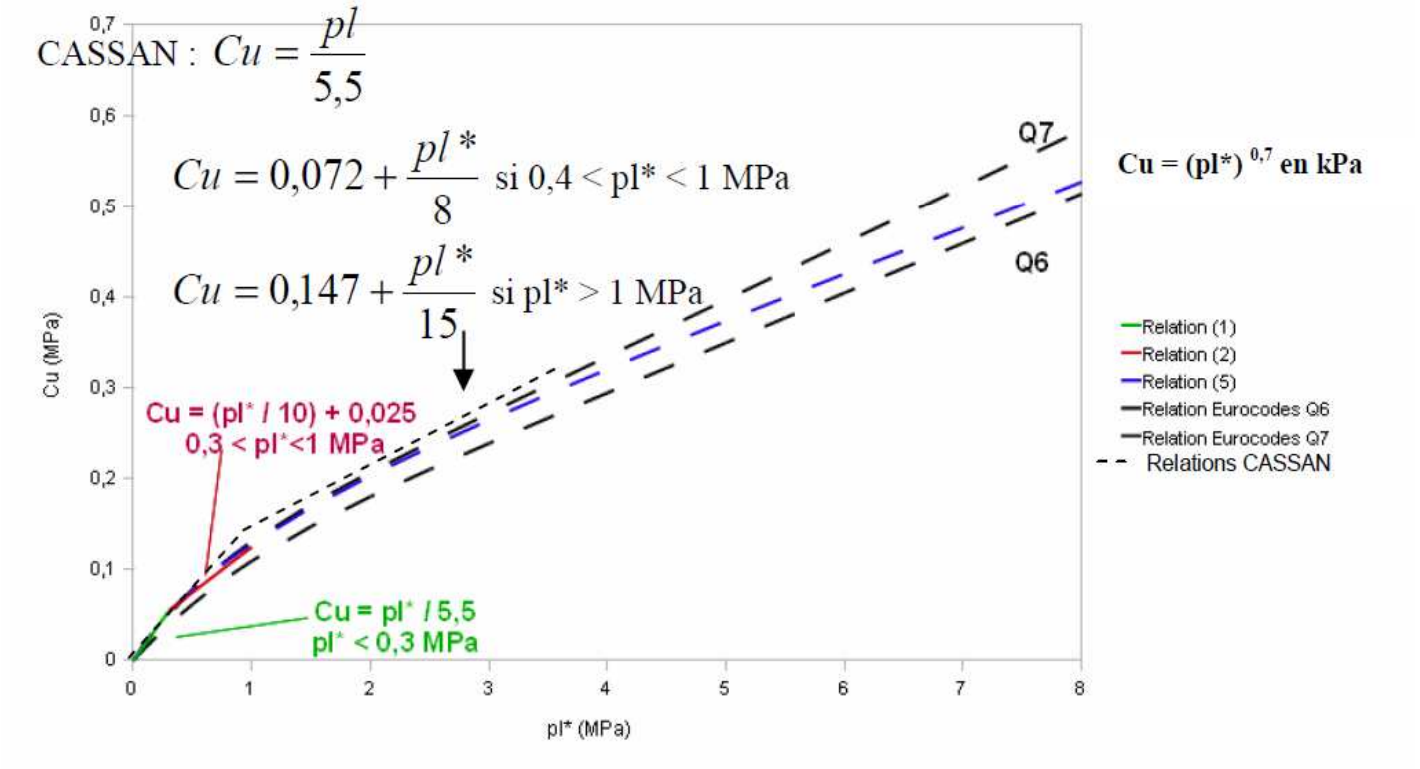

Fig. 3

WE CAN THEN WRITE

$$Cu = [\sigma'_{vo}{}^{0,2} \ \sigma'_{p}{}^{0,8}]^{0,7/m} \text{ in kPa} \qquad (15)$$

INTERESTING TO COMPARE WITH THAT WELL KNOWN OF JAMIOKOLWSKI :

$$Cu = \lambda cu \ \sigma'_{vo}{}^{0,2} \ \sigma'_{p}{}^{0,8} \qquad (16)$$

IT WILL BE ALWAYS IMPORTANT TO HAVE A PARALLEL PROFILE OF SOIL PHYSICAL IDENTIFICATION PARAMETERS AS :

DENSITY, WATER RETENTION CONTENT, LIQUIDITY LIMIT, BLUE METHYLENE VALUE, GRANULOMETRY AND SO ON.

WE HAVE SHOWN (2012), THAT WE HAD :

$$\log \sigma'p = 5{,}25 - 0{,}25 \log \sigma'_{vo} - 4\frac{W_{SC} - 0{,}075}{W_L - 0{,}075} \quad \text{en kPa} \qquad (17)$$

WITH : $$W_{SC} = \left(\frac{1}{\gamma d} - \frac{1}{\gamma s}\right) \times \gamma w \qquad (18)$$

IT IS ANOTHER INTERESTING WAY TO HAVE AN IDEA OF THE EXPECTED VALUE OF σ'p AND IT'S VARIATION WITH DEPTH.

FOR UNSATURATED SOILS :

- **WE WILL HAVE TO KNOW THE VARIATION OF SUCTION WITH WATER CONTENT (FILTER PAPER METHOD OR ARYA AND PARIS METHOD FOR EXAMPLE)**
- **USE FREDLUND FORMULAE :**

$$\tau_{ff} = C' + (\sigma_v - u_a)\, tg\emptyset' + (u_a - u_w)\, tg\, \emptyset d \quad)$$

$$\tau_{ff} = \tau_{ff\ SAT} + s\, tg\, \phi d$$

- **USE FOR EXAMPLE OBERG AND SALFOURS RELATION :**

$$tg\, \emptyset d \# S\, tg\, \emptyset' \qquad (23)$$

S LEVEL OF SATURATION ∅ LONGTERM ANGLE OF FRICTION

TO MAKE CORRECTIONS ON pl* OR $q_T - \sigma_v$ VALUES

CONCLUSION :

PMT TESTS, HAVING NO DIFFICULTY TO PERFORM THEM AT THE DESIRED DEPTH, DOUBLED WITH A SOIL IDENTIFICATION PROFILE,

APPEAR TO BE GOOD TOOLS TO CHARACTERIZE THE EVOLUTION WITH DEPTH OF PRECONSOLIDATION PRESSURE VALUES,

WHICH KNOWLEDGE WE NEED FOR SETTLEMENT ASSESSMENT.

THANK YOU

FOR YOUR ATTENTION