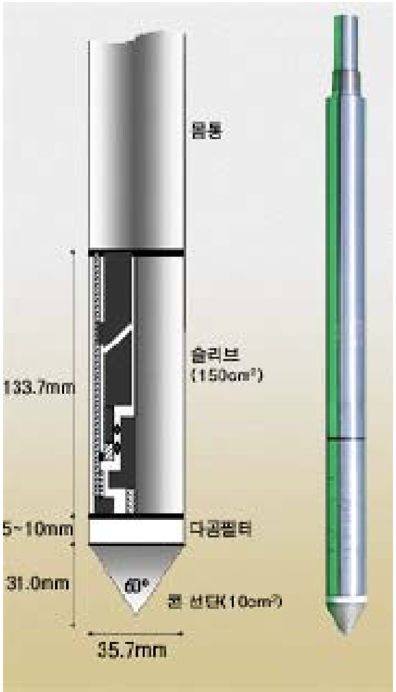
3.3 Cone Penetration Test (CPT)

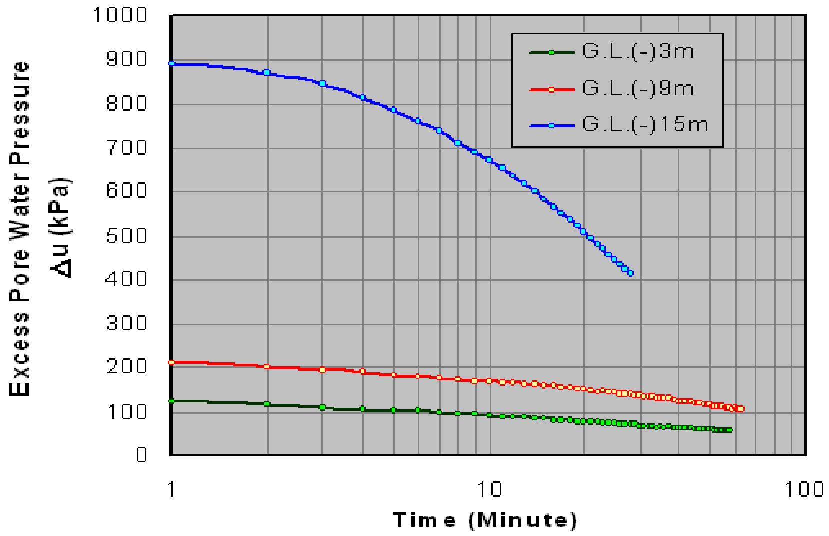
(1) General



The CPT is carried out by pushing a 60°cone with a face area of 10 cm^2 into the ground at a constant speed (2±0.5cm/s), whilst measuring the force to do so. The shear force on a 150 cm^2 'friction sleeve' and pore pressure are then also measured.

- Type of cone
  - Piezocone
  - Environmental cone
  - Seismic cone
  - Visual cone

- Dissipation test with piezocone
  In clays, the horizontal coefficient of consolidation Cv can be determined by stopping the cone, and measuring pore pressure dissipation as a function of time.



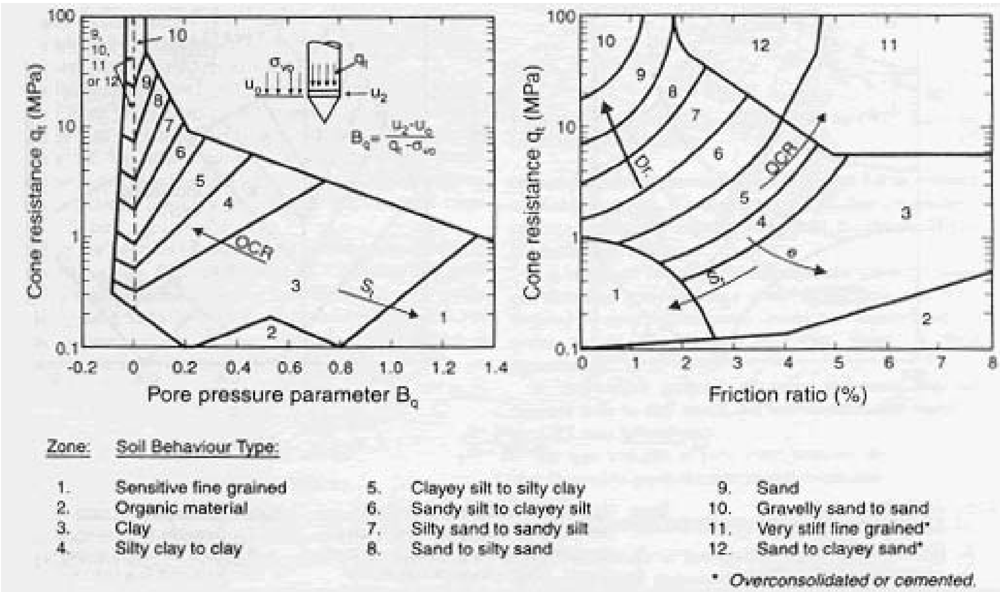
(2) Interpretation and use

i) soil classification

- Robertson and Campanella (1986)

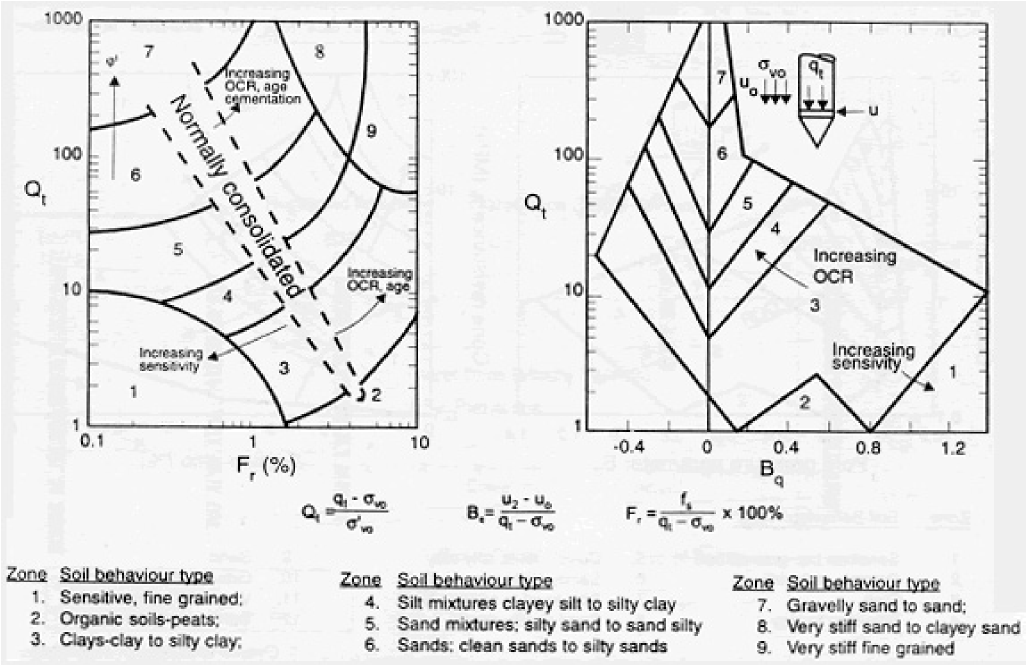
$$B_q = \frac{\Delta u}{q_t - \sigma_{vo}} \quad \text{vs} \quad q_t$$

$$F_r = \frac{f_s}{q_t - \sigma_{vo}} \quad \text{vs} \quad q_t$$



- Robertson (1990)

$$B_q \ \text{vs} \ Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \ , \ F_r \ \text{vs} \ Q_t$$



ii) Undrained strength

- Su is evaluated with cone factors (N_{kt}, N_{ke}, $N_{\Delta u}$)

- Schmertmann(1978), Lunne et al(1985) $s_u = \frac{q_T - \sigma_{v0}}{N_{kt}}$

- Senneset et al (1982), Campanella et al (1982) $s_u = \frac{q_T - u}{N_{ke}}$

- Lunne et al (1985) $s_u = \frac{\Delta u}{N_{\Delta u}}$

regions	The test to evaluate cone factor	Cone factor
England	CIUC	N_{kt} =12~20
Norway	FVT	N_{kt} =12~19
Italy	FVT	N_{kt} =8~16
	CK0UC	N_{kt} =8~10
Vancouver, Canada	FVT	N_{kt} =8~10
	SBPT	
Japan	UCT	N_{kt} =8~16
	FVT	N_{kt} =9~14
Taiwan	CIUC	N_{qu} =5.0~6.8
	CAUC	N_{qu} =6.0~7.2
Canada	FVT	N_{Du} =6.2~7.0

- Cone factor are very site –specific.

iii) The horizontal coefficient of consolidation

- Based on dissipation test

Torstensson(1975, 1977)

$$c_h = \frac{R^2 \cdot T_{50}}{t_{50}}$$

Baligh & Levadoux(1980)

$$c_h = \frac{R^2 \cdot T}{t}$$

U (%)	A								B	C
	Spherical shape				Cylindrical shape					
	I_R=30	I_R=70	I_R=100	I_R=130	I_R=30	I_R=70	I_R=100	I_R=130		
40	0.18	0.26	0.34	0.40	0.74	1.14	1.48	1.78	3.0	0.142
50	0.29	0.44	0.58	0.69	1.47	2.19	2.90	3.55	5.6	0.245
60	0.46	0.73	0.98	1.17	2.49	3.83	5.36	6.63	10	0.439

A : Torstensson (1975), **B** : Baligh와 Levadoux (1986), **C** : Teh와 Houlsby (1991)

iv) Friction angle, ϕ in sandy soil

Robertson and Campanella (1983)

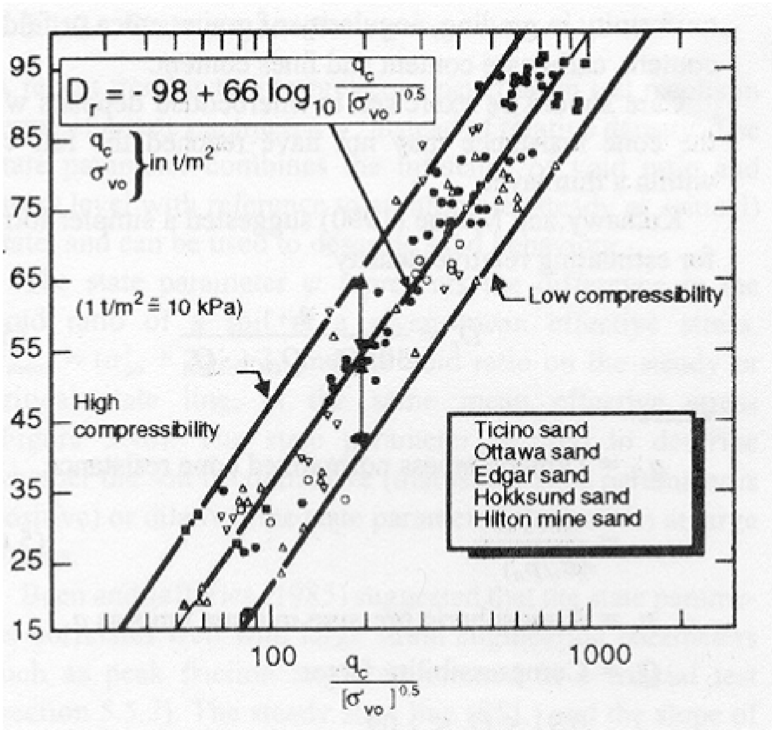
$$\phi = \tan^{-1}\left[0.1 + 0.38\log\left(\frac{q_c}{\sigma'_{v0}}\right)\right]$$

q_c/σ'_{v0}	Soil state	Friction angle (ø')
< 20	Very loose	< 30
20 ~ 40	Loose	30 ~ 35
40 ~ 120	Medium	35 ~ 40
120 ~ 200	Dense	40 ~ 45
> 200	Very dense	> 45

v) Dr in sandy soil

Jamiolkovski et al (1985)

$$D_r(\%) = 66\log\left(\frac{q_c}{\sqrt{\sigma'_{v0}}}\right) - 98$$



vi) Other usage

- OCR
- E_s
- Sensitivity
- Bearing capacity of foundation
- Liquefaction potential