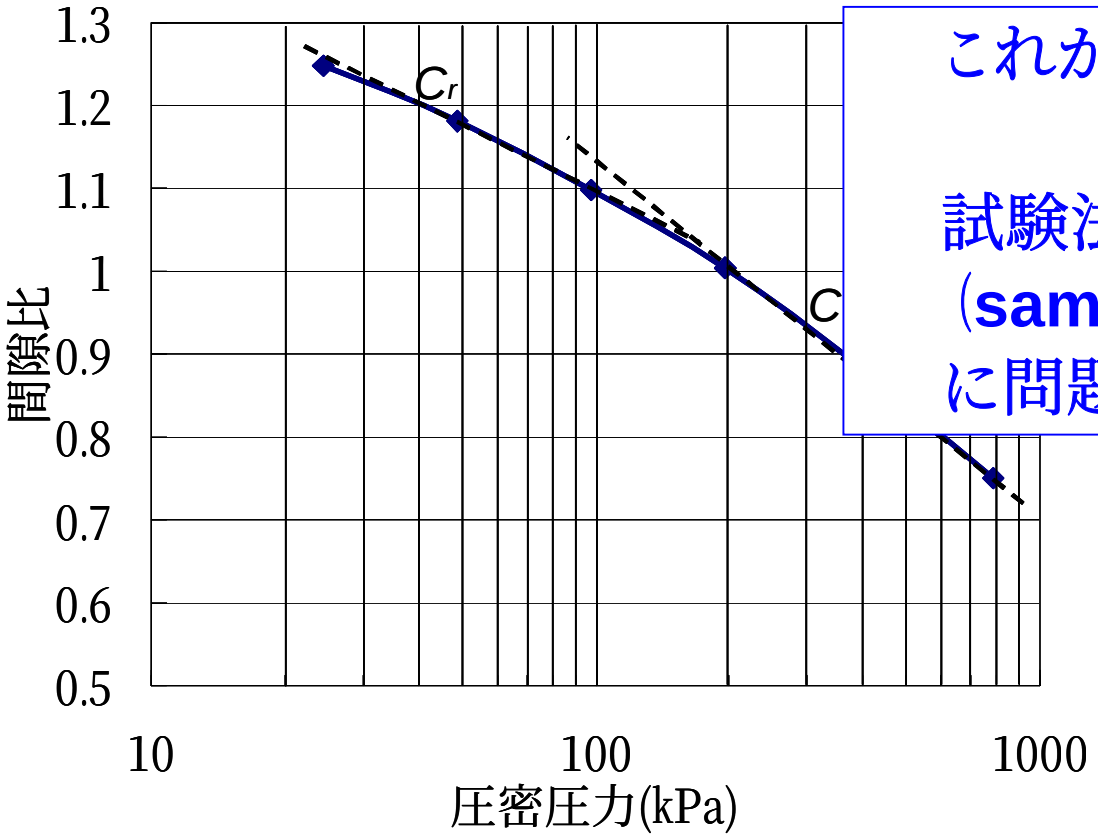
COLLABORATIVE RESEARCH ON CHARACTERIZATION OF SOFT CLAY IN VIETNAM

Jiro Takemura
Tokyo Institute of Technology, (Formerly AIT,)
Yoichi Watabe , Masanori Tanaka
Port and Airport Research Institute, Yokosuka, Japan
Bui Tan Man
Ho Chi Minh City University of Technology, (Former AIT Graduate student)
Le Thu Hanh &, Pham Huy Giao
Asian Institute of Technology, Pathumthani, Thailand
Dang Cong Thuan
Transport Engineering Design Incorporated, Hanoi, Vietnam
Truong Huu Hung
Union of Survey Companies, Hanoi, Vietnam

20th Dec 2003

ベトナムの地盤調査報告書でよく見られる粘土のe-logpの形状



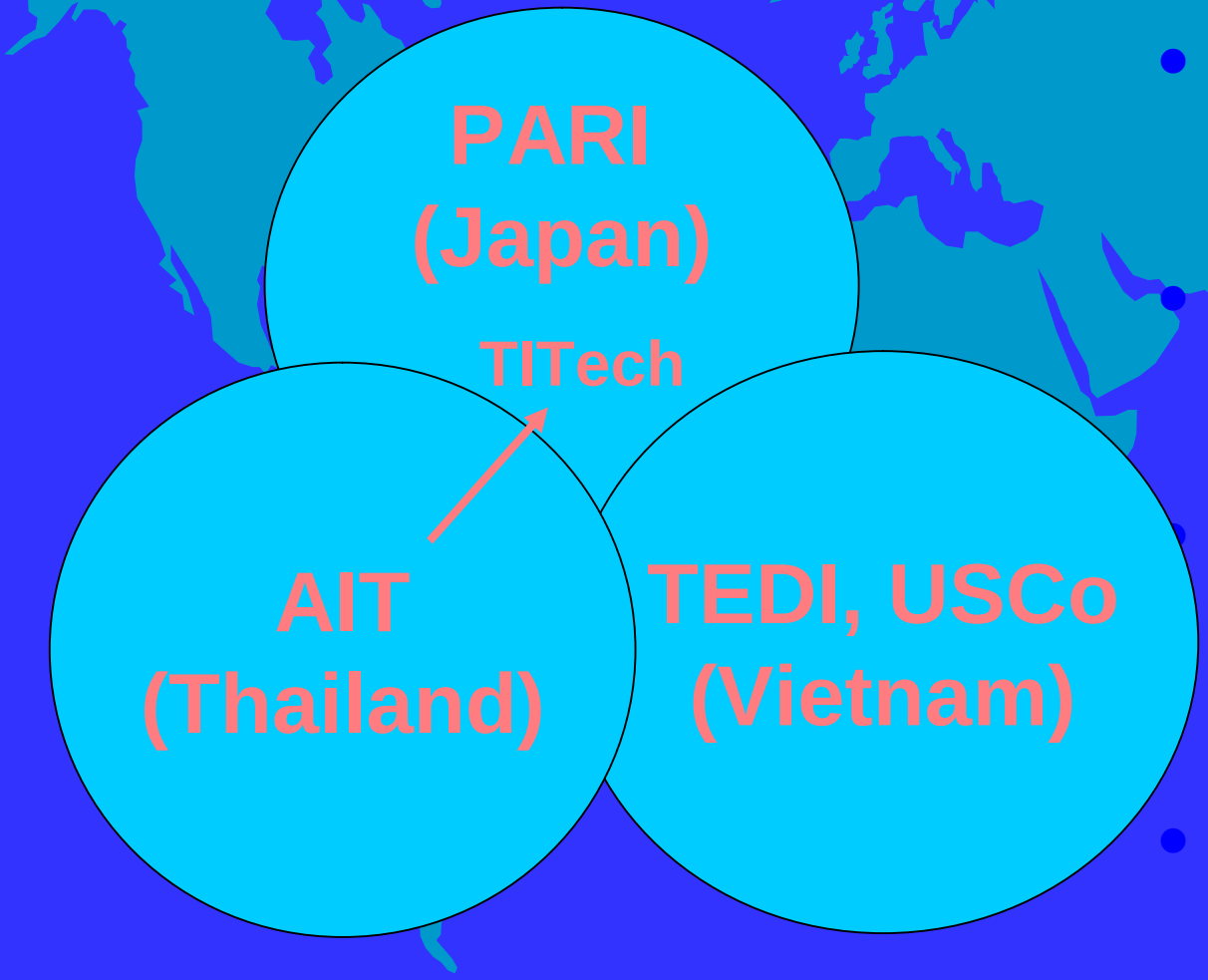
これが本当の特性か？

試験法
（sampling,室内試験）
に問題があるのか?

ベトナムの軟弱粘土の強度の一例

c=1.35tf/m²、ϕ=5.4°

Collaboration research program



- **PARI**: Port and Airport Research Institute
- **AIT**: Asian Institute of Technology
- **TEDI**:Ttransportations Engineering Design Incorporation
- **USCo**: Union of Survey Companies

Objective of the project

- To study the applicability of sampling and laboratory techniques commonly used in Vietnam and Japan for characterizing soft clay.

- To study the applicability of various field tests for characterizing in-situ soil conditions.

Reliable soil characterization methods

Program of the Study(1)

- Sampling and laboratory tests -

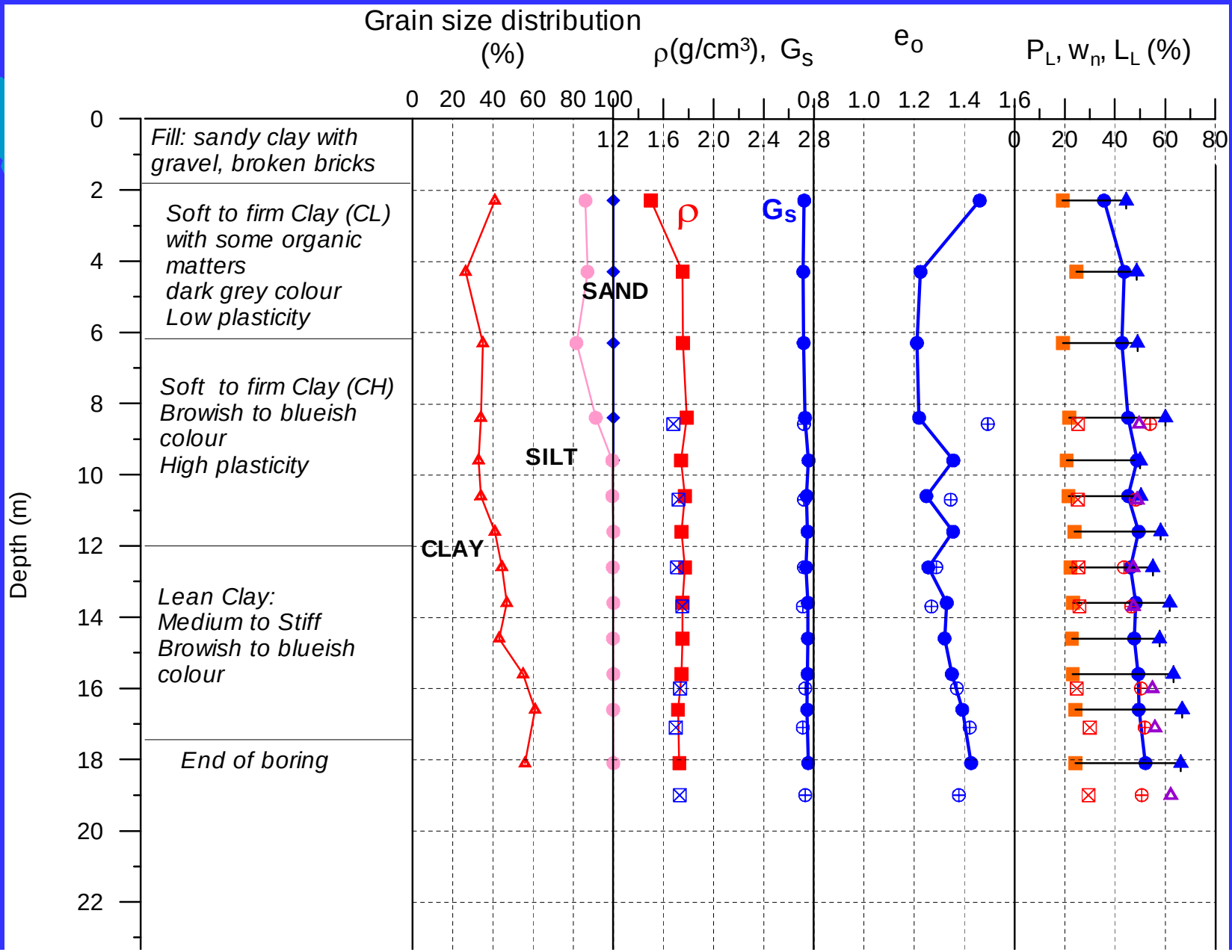
- ✓ **Evaluating sample quality by using two kind of samplers**
  - ✓ **Shelby sampler**, commonly used in Vietnam
  - ✓ **Japan fixed piston sampler**, commonly used in JPN
- ✓ **Obtaining compressibility and consolidation properties by**
  - ✓ Conventional Oedometer test at Vietnam and Japan
  - ✓ Constant rate of strain (CRS) test at Japan
- ✓ **Obtaining shear strength parameters by lab tests**
  - ✓ Triaxial consolidation undrained compression CIU
  - ✓ Consolidated constant volume direct shear box DSB
  - ✓ Unconfined compression UC
  - ✓ Quick direct shear DS

Location of Investigation Site

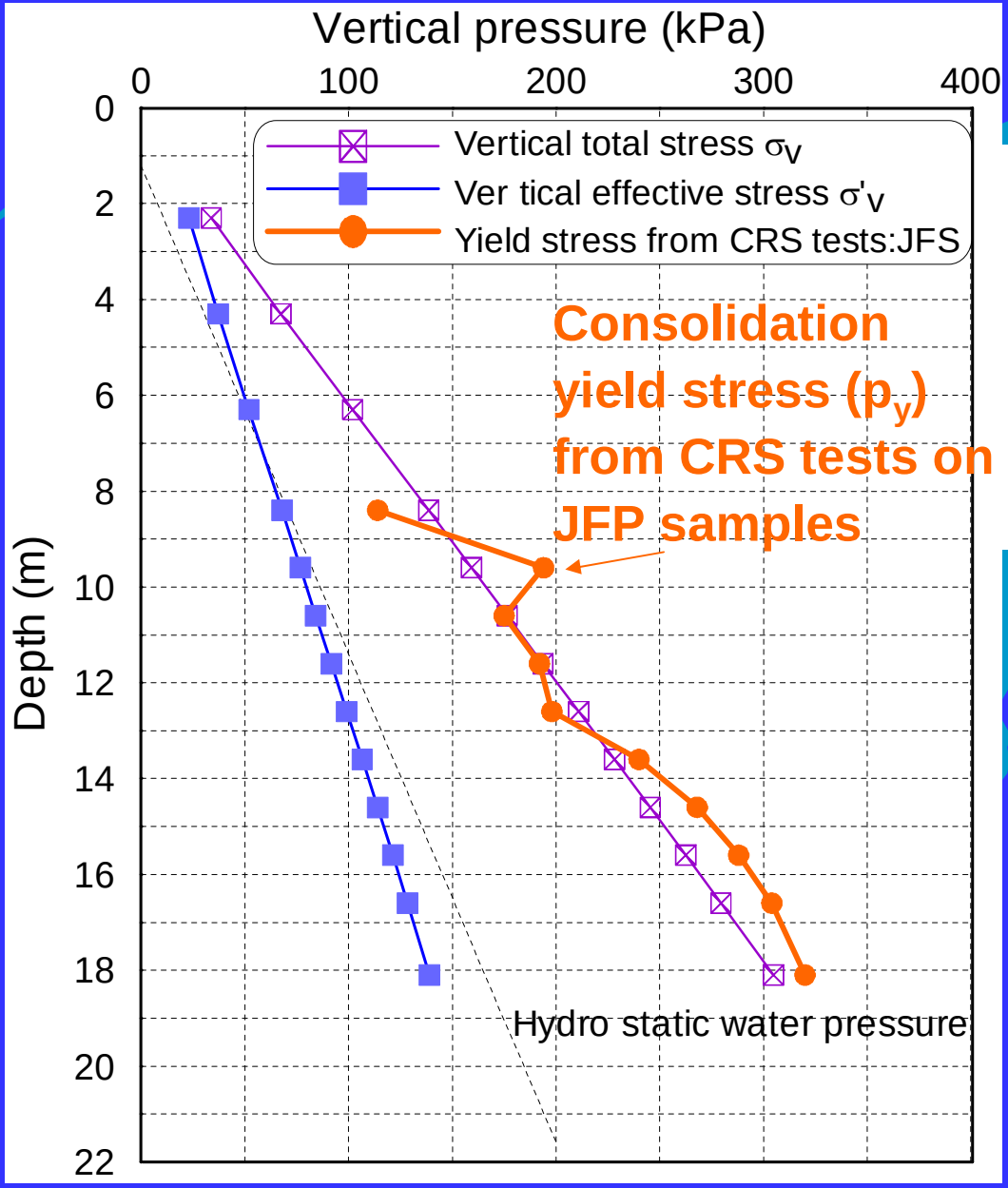
HAI PHONG CITY

Site at Technical School of
HP Cement manufacturer

Soil profiles and physical properties



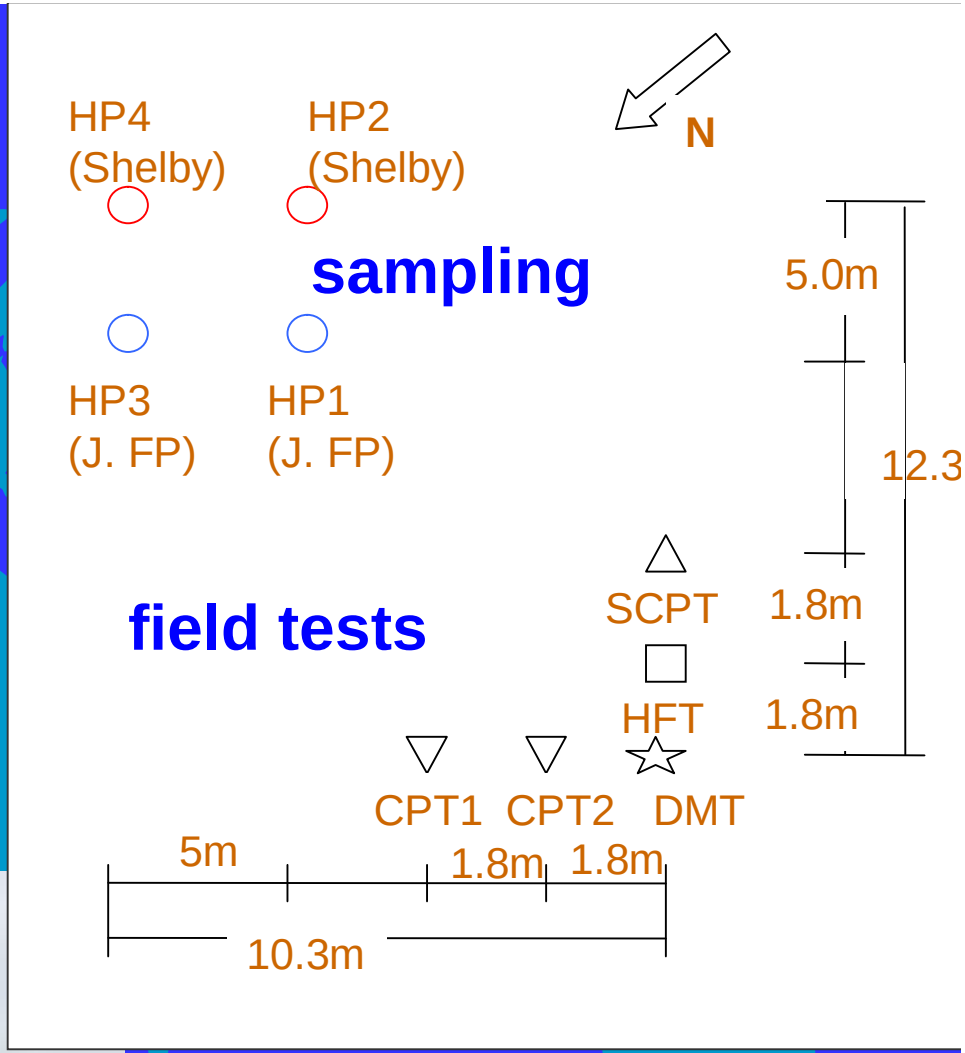
Variation of vertical stresses and yield stress ratio



Age of clay:
20,000 - 40,000 years

Lightly over consolidation
OCR ~ 2

Plan Layout of Field Tests and Sampling Boreholes



Laboratory test results

Various kind of tests which can be done in three labs. (PARI, TEDI, USCo)

- **Tests commonly conducted, but following their own procedure**
  - ✓**Consolidation test（IL oedometer test)**
  - ✓**Unconfined compression tests (UC)**

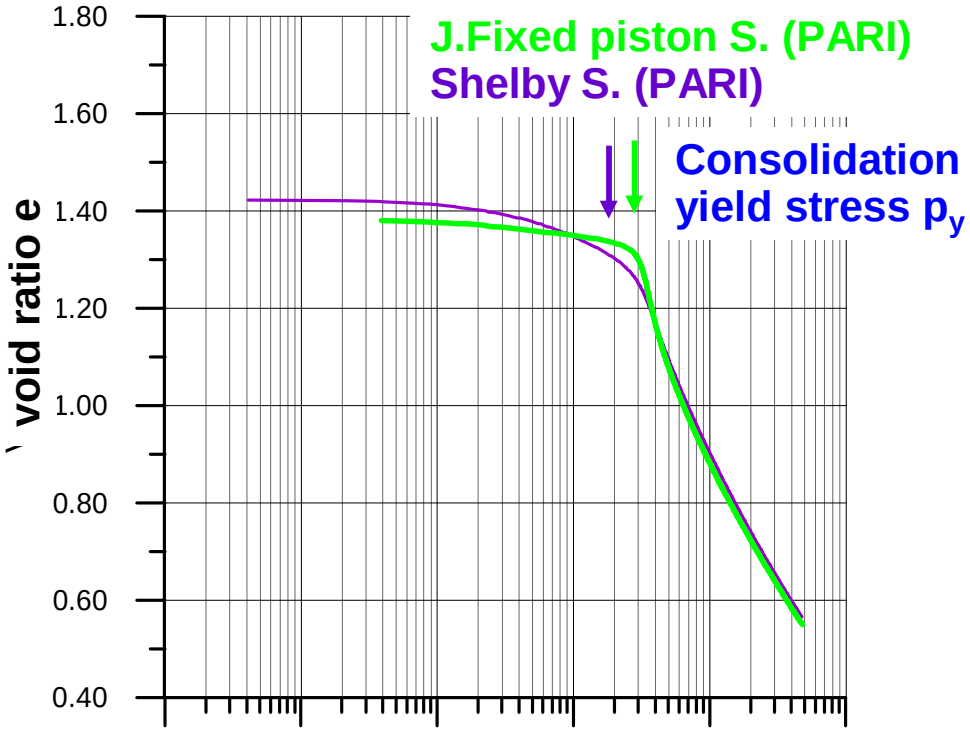
- **The other tests,**

  Constant Rate of Strain consolidation (CRS)

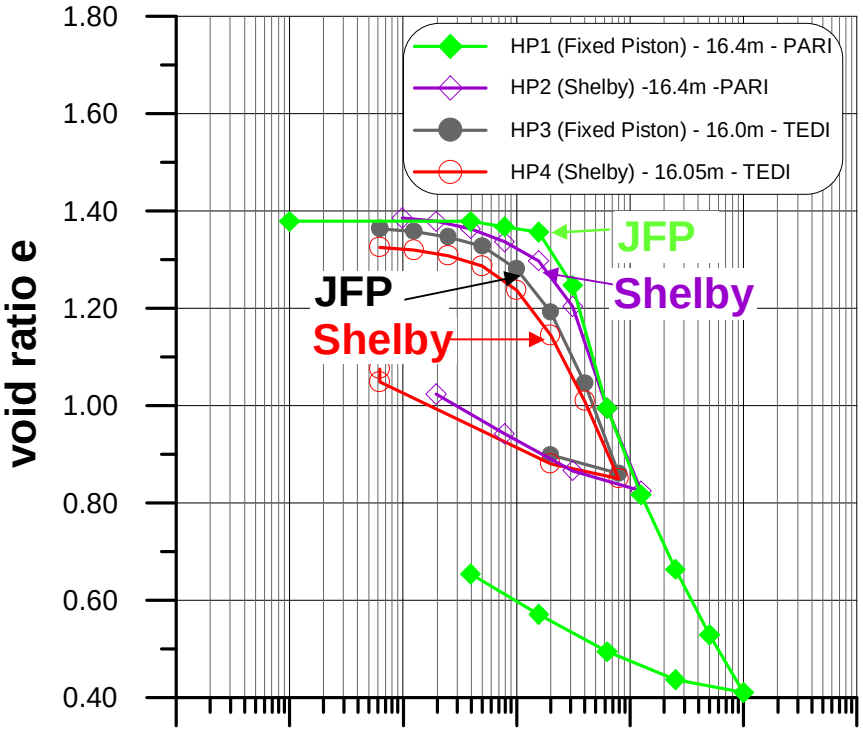
  CIU, $CK_0UC\&E$, CVDS, QDS

Comparison betw. JFP S and Shelby S

CRS: Constant rate of strain test



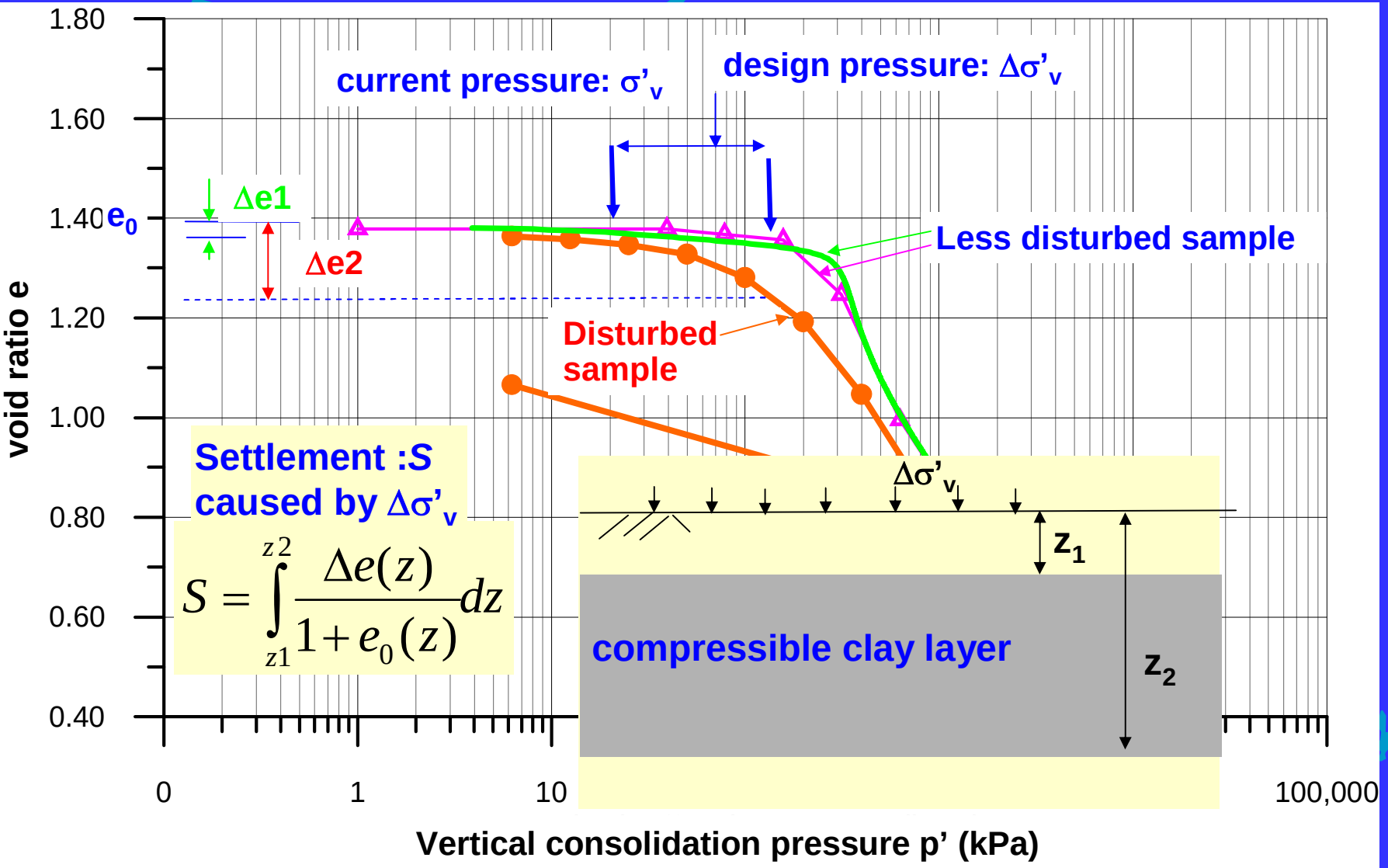
oedometer: standard consolidation test



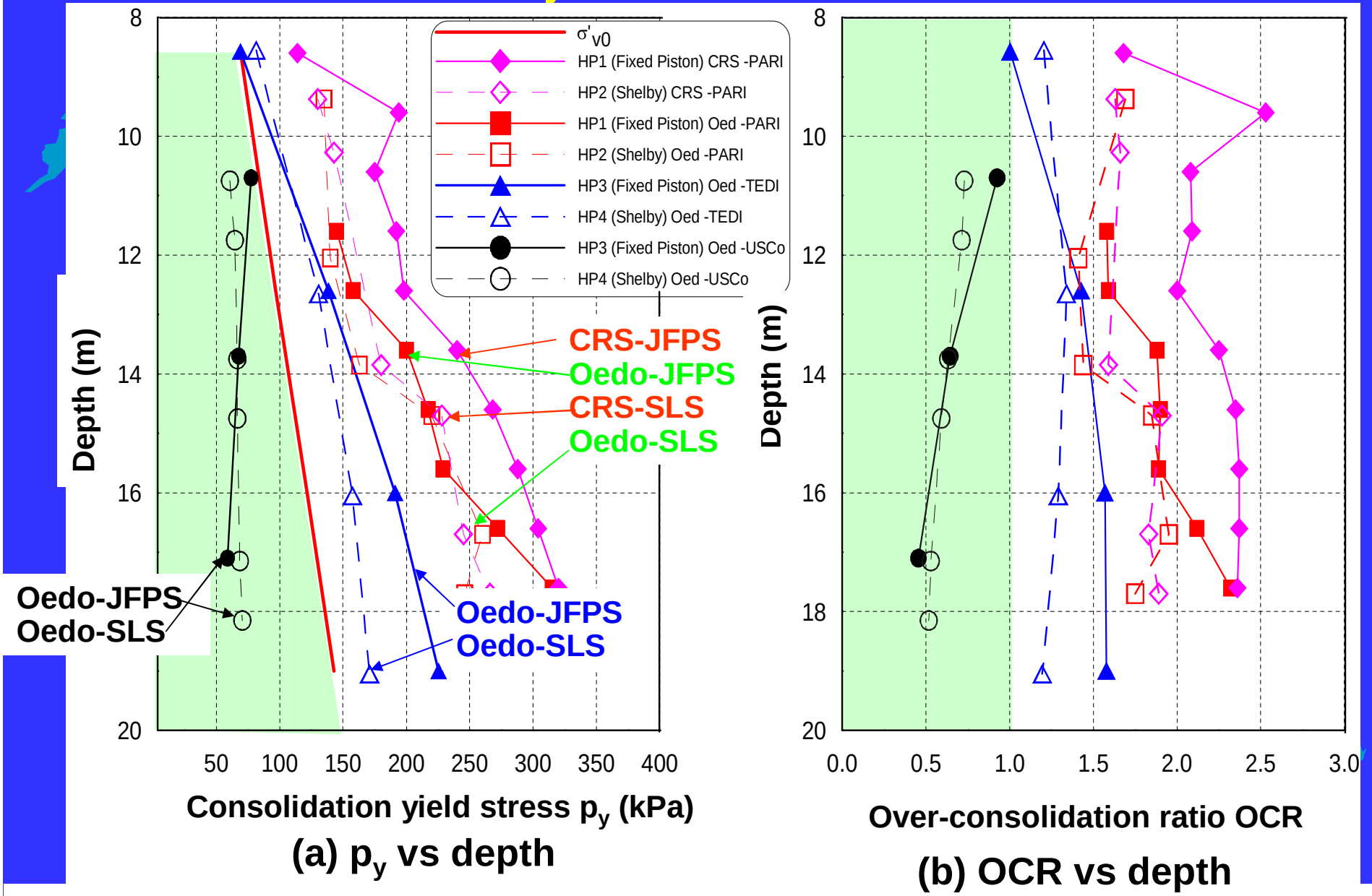
- **Difference betw. JFP S and Shelby S in both CRS and Oedo.**
  <u>Clear sharp bend</u> and p_y: JFP S > Shelby S
  → **"less disturbed and good sample quality"**
- **At pressure well over p_v, difference is not significant**
- **<u>Difference betw. different lab.</u>**
  → **Disturbance caused by other process than sampling**

Typical e- log*p* relations

from the sample collected by fixed piston sampler



Profile of p_y and OCR with depth

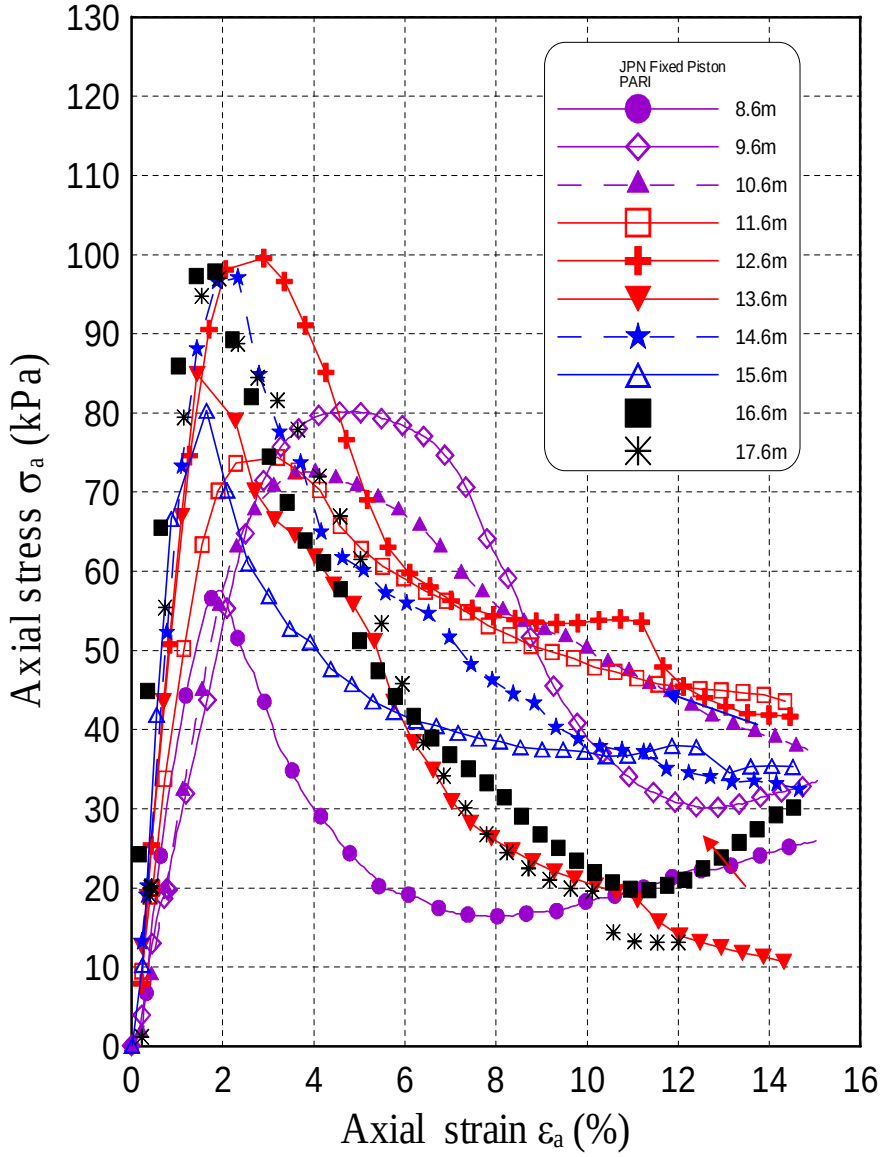


(a) p_y vs depth

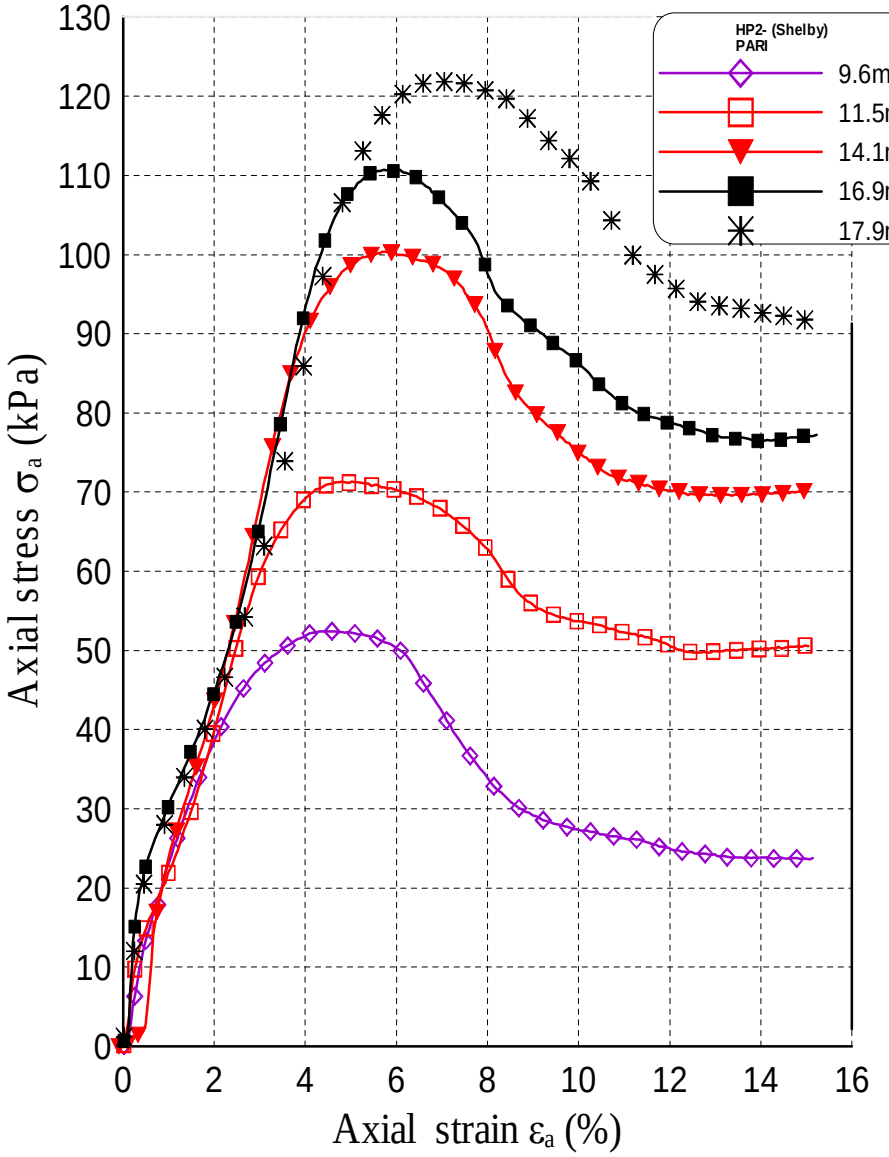
(b) OCR vs depth

P_y:JFP S > Shelby S; CRS> Oed.; more difference betw. Labs.

Unconfined compression tests

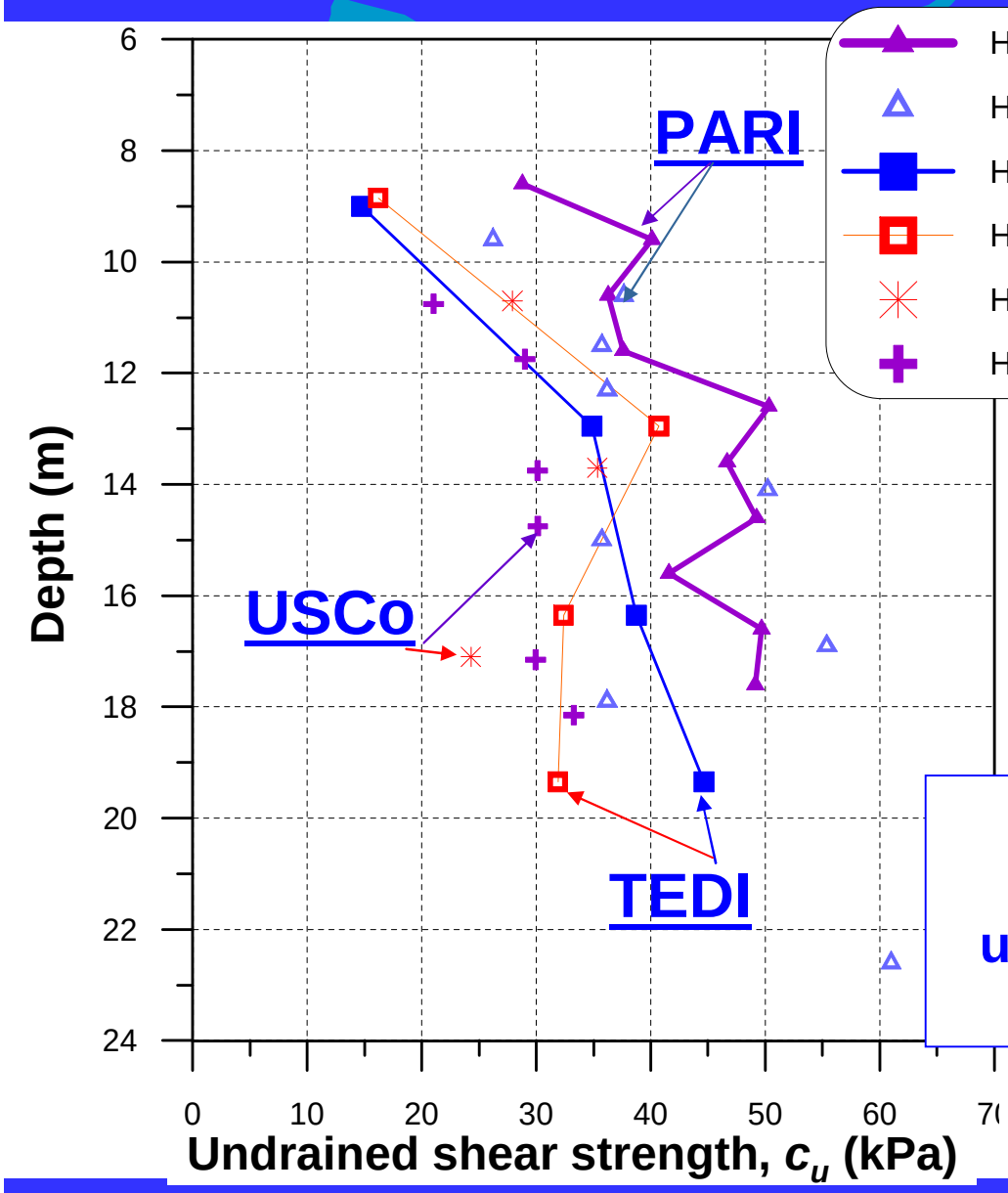


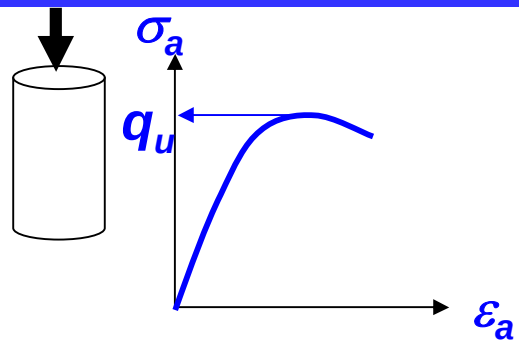
Stress-strain (JFP S)



Stress-strain (Shelby S)

Unconfined Compression Test Results on strength q_u

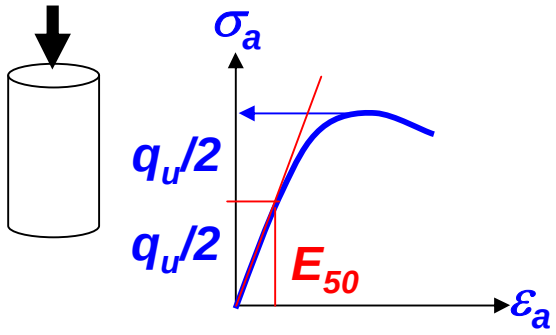




- Some difference betw. Labs.
- No clear difference betw. JFP and Shelby samples

Effect of disturbance caused by sampling on undrained shear strength, $c_u = q_u/2$
not so significant

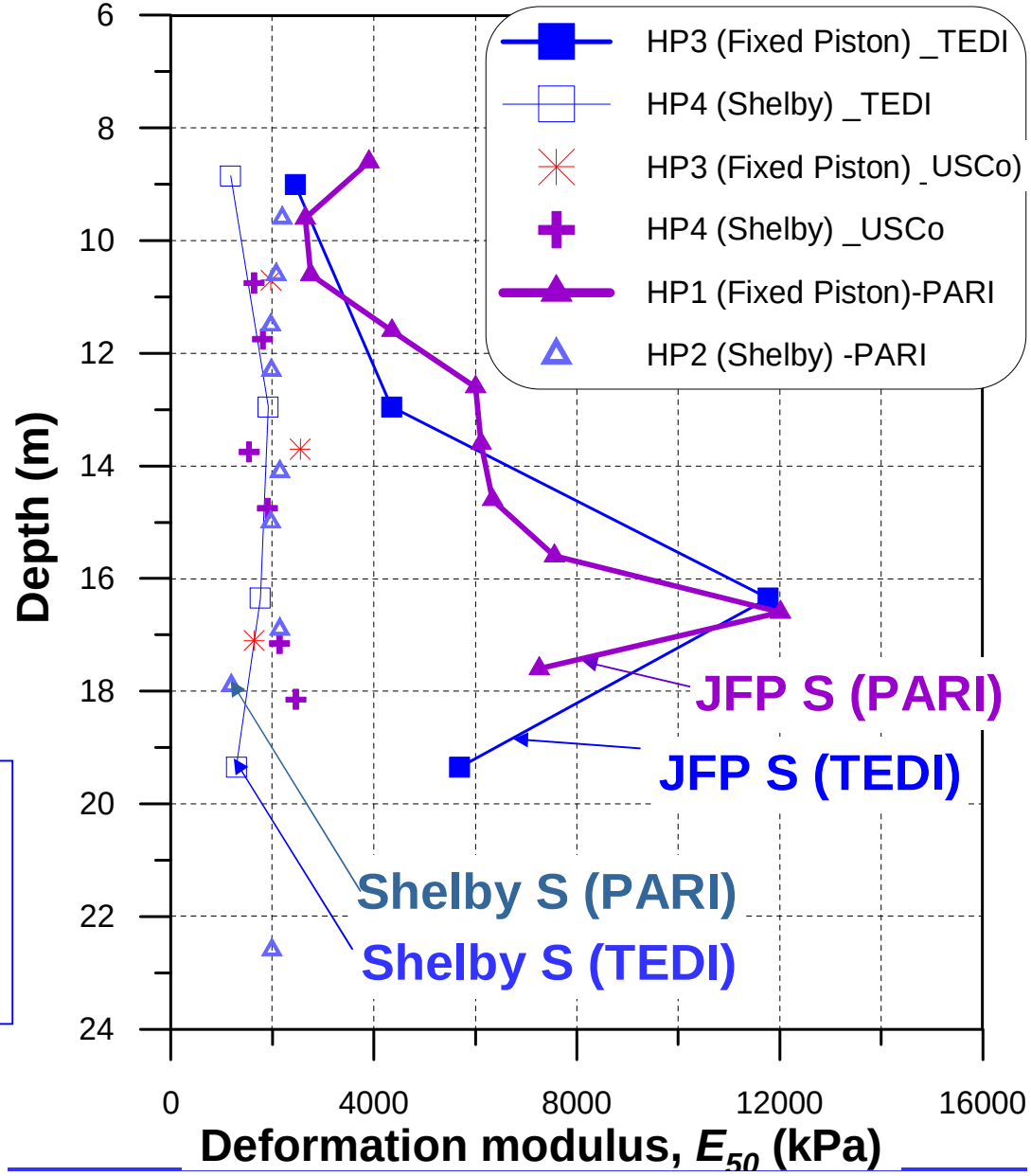
Unconfined Compression Test Result on deformation modulus E_{50}



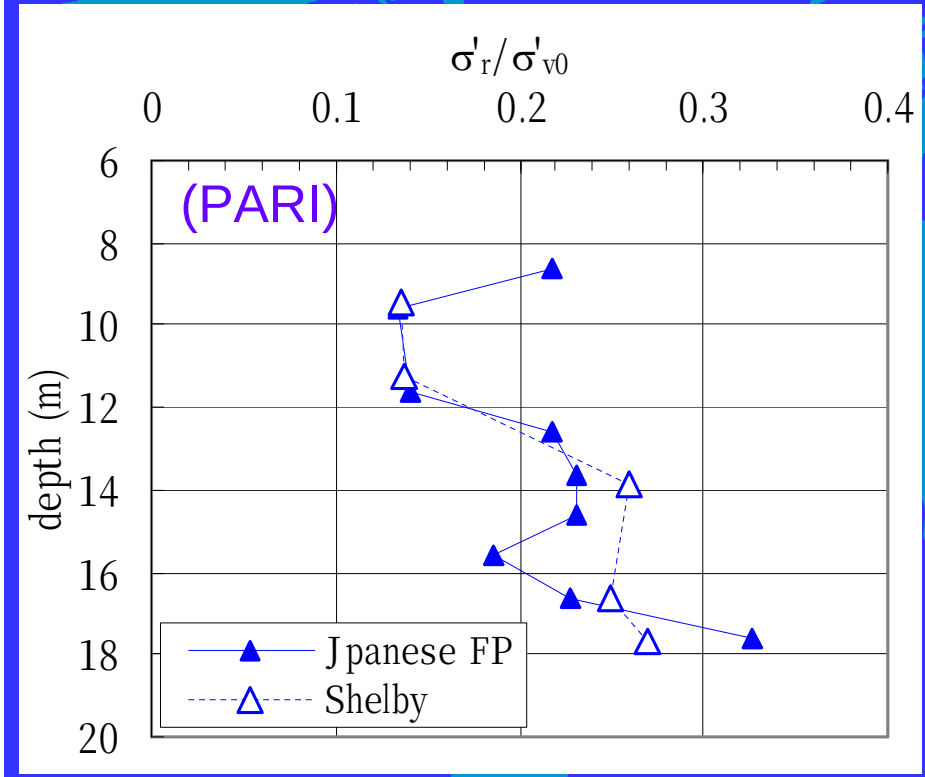
- Some difference betw. laboratories.

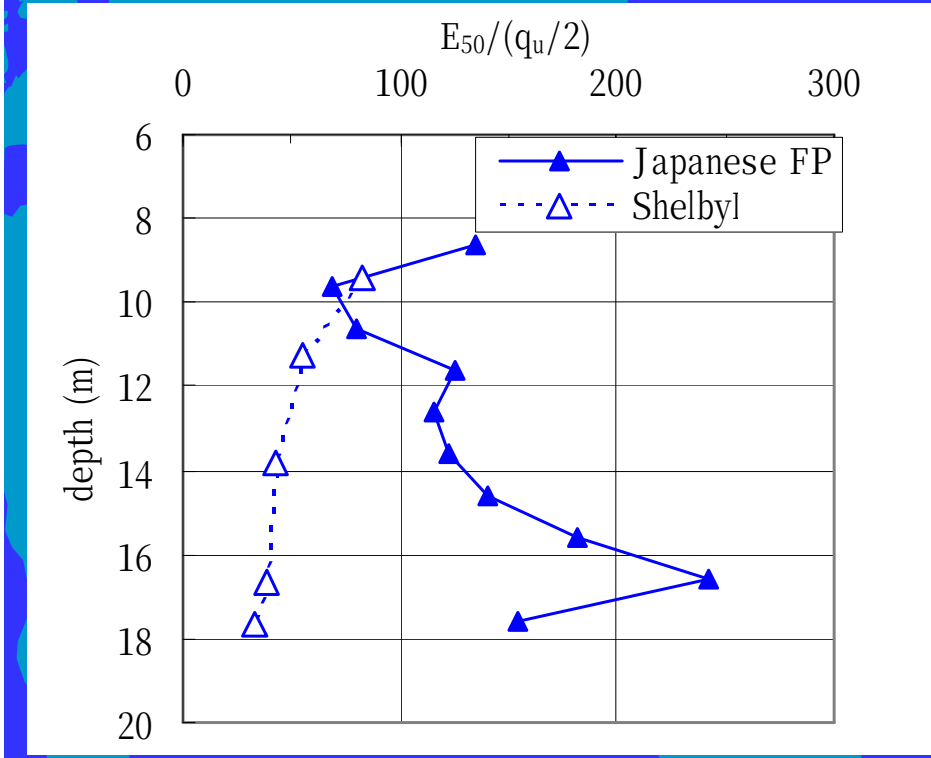
- Clear difference betw. JFP S and Shelby S

Effect of sample disturbance on deformation modulus *very significant*



Effect of disturbance (1)
Residual effective stresses and $E_{50}/(q_u/2)$

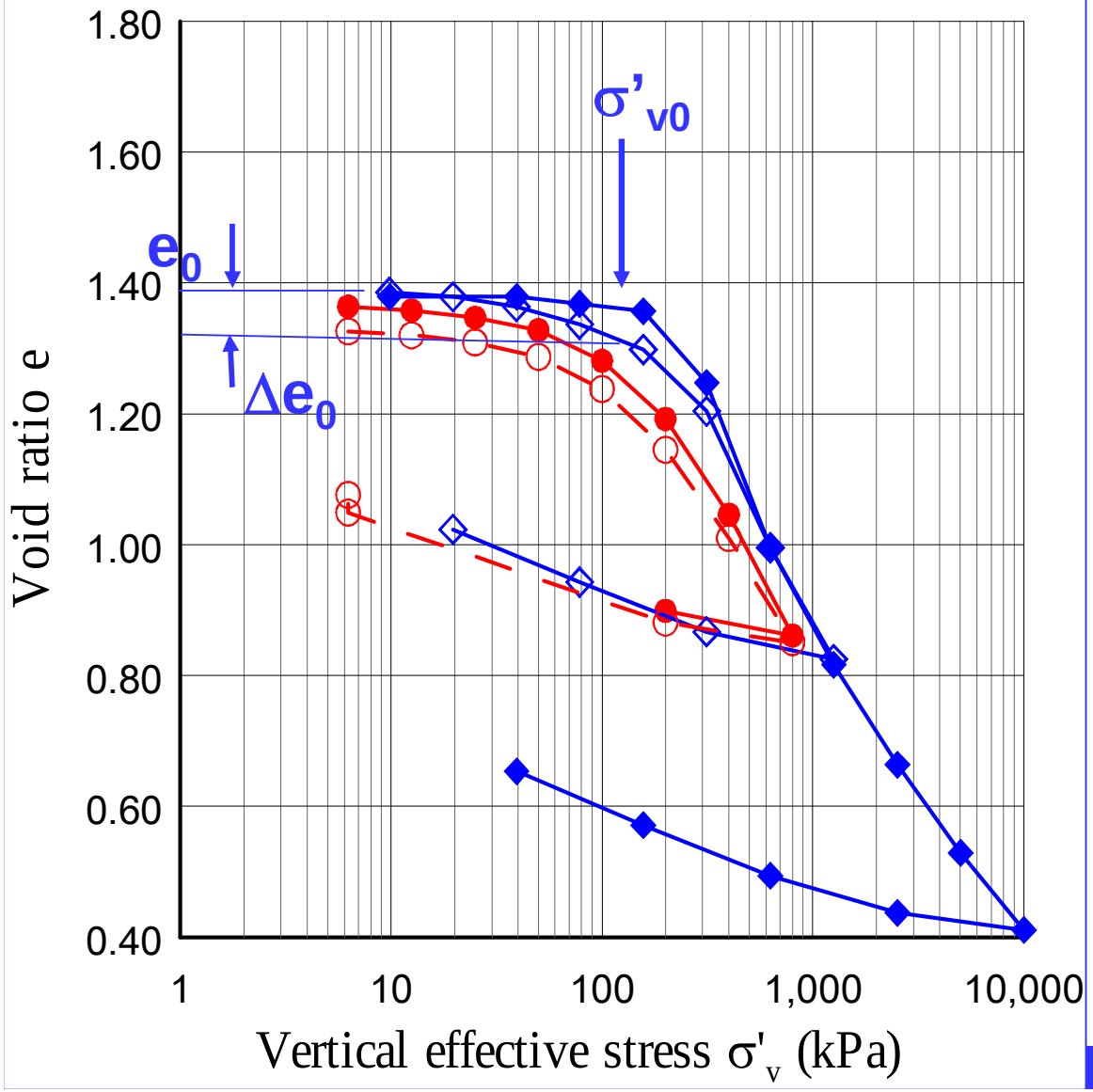




Residual effective stress in UC test samples evaluated from suction measurement.

$E_{50}/(q_u/2)$ in UC tests

Effect of disturbance (2)
Change of void ratio by recompression to in-situ effective vertical stress σ'_{v0}



Two indices

(1) $\dfrac{\Delta e}{e_0}$

Lunne et al. (1997)

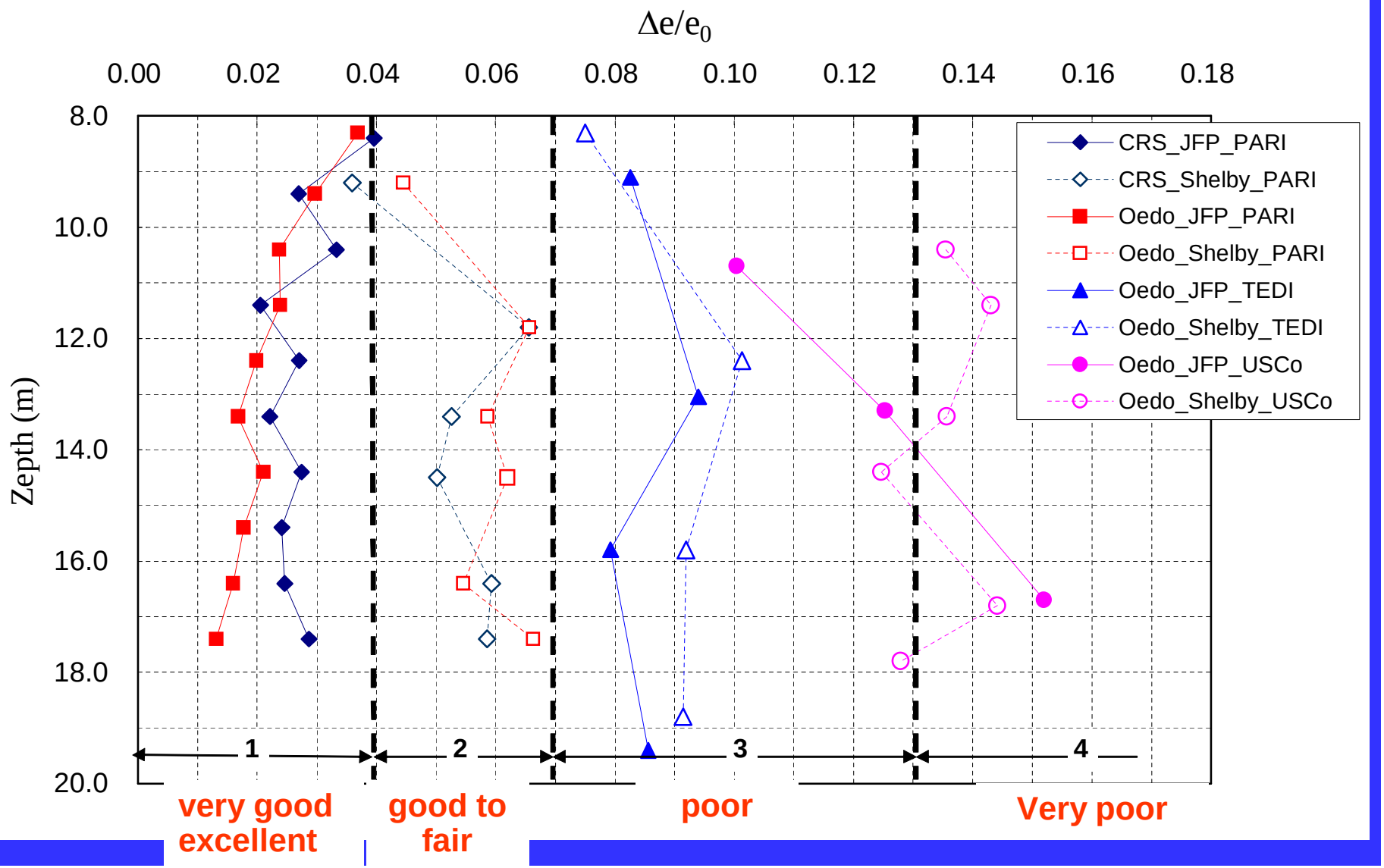
(2) $\varepsilon_v = \dfrac{\Delta e}{1+e_o}$

(Andersen and Kolstad, 1979)

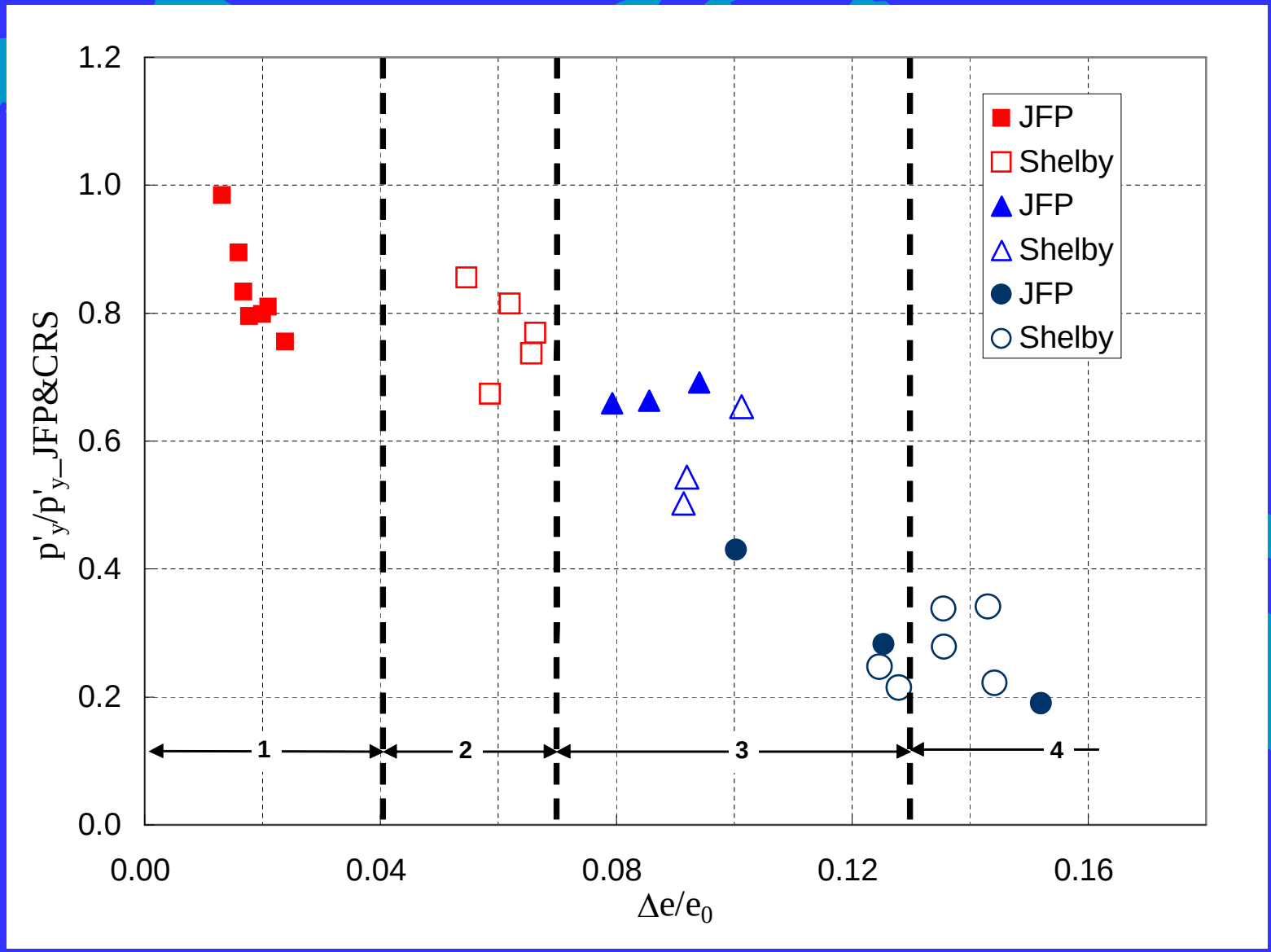
Factors affecting these Indices:

- **Disturbance;**
- **OCR;**
- **Depth.**

Effect of disturbance (2)
Change of void ratio by recompression to in-situ effective vertical stress σ'_{v0}



Effect of disturbance (2)
Relationship between $p_y/p_{yJFP\&CRS}$ and $\Delta e/e_0$



Conclusions

- In the oedometer test of the Shelby samples, larger compression was obtained than the JFP samples at the vertical stresses less than the yield stress, indicating higher disturbance in the former than the latter. However, the effects of sampling disturbance due to the difference of sampling method do not appear at the stress well over the yield stress.
- Differences in oedometer test results were observed not only between the two sampling methods but also between the different laboratories. The difference of the latter is sometimes more significant than the former. Beside the sampling process there should be some reasons which causes significant disturbance in the sample in the processes from the sampling to the lab testing. Further study is required to answer the question.

Conclusions (Cont.)

- In unconfined compression tests, difference between the two sampling methods can be more significantly seen in deformation modulus than strength, i.e., higher stiffness in the JFP samples than the Shelby tube samples.
- Change of void ratio by recompression to in-situ effective stress, $\Delta e/e_0$, can be a good indicator of sample quality.
- In-situ testing methods have large potential for the determination of in-situ properties with the combination of laboratory tests. In order to use in-situ testing in rational and more reliable way, further accumulation of the data on their application to various soils is highly recommended.

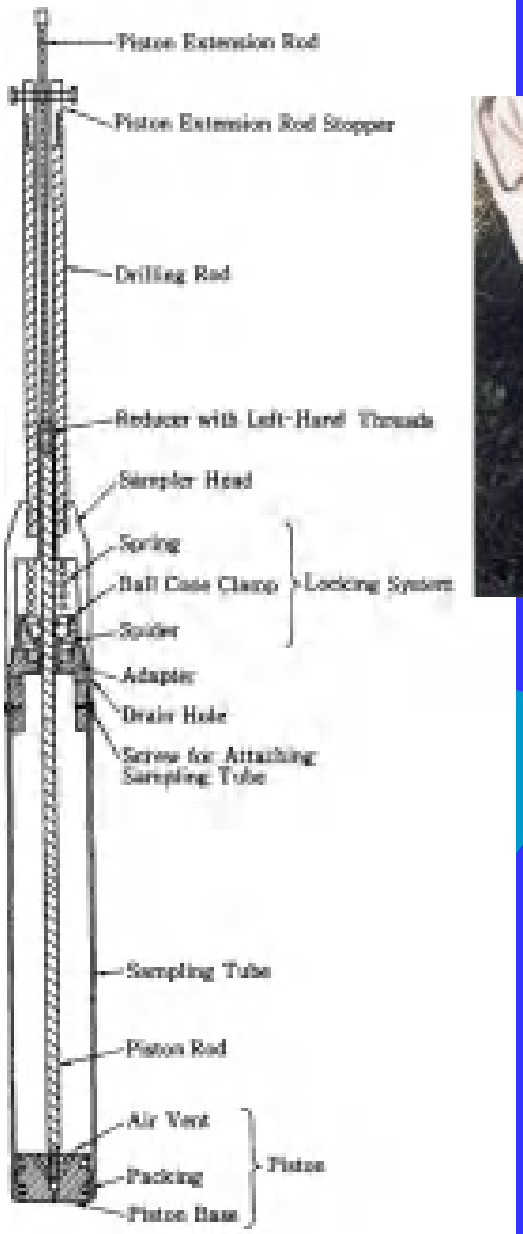
Field investigation
Undisturbed soil sampling

- Two kind of sampler were used
  - Shelby Sampler
  - JPN Fixed Piston Sampler

Main dimensions of Shelby and JPN fixed piston sampler

Sampler	Inside Diameter (mm)	Length (mm)	Thickness (mm)	Area ratio (%)	Piston
JPN	75	1000	1.5	7.5	Fixed Piston
Shelby	72	800	1.65	8.6	No

Undisturbed soil sampling- JPN Fixed Piston Sampler (Extension rod type)



Rotary Core Tube

t=1.50mm
D=75mm
L=1,000mm

Fixed Piston sampler

Undisturbed soil sampling- Shelby Sampler

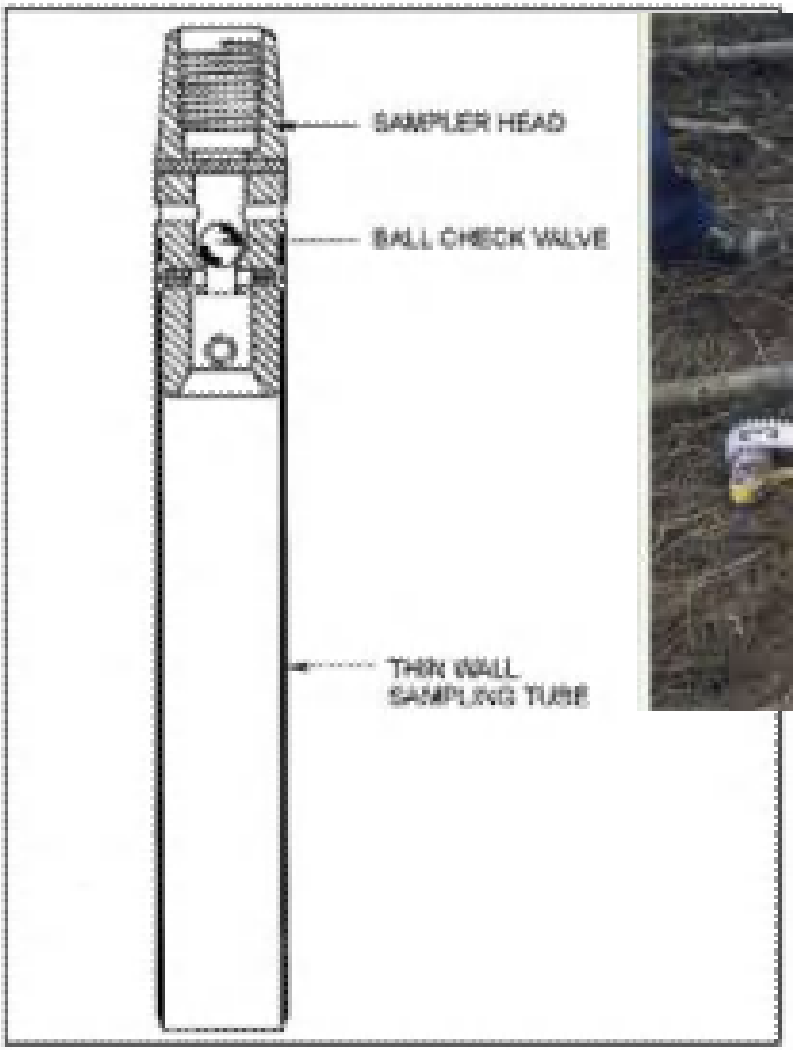


Figure 8-1. Schematic drawing of an open-tube sampler

t=1.65mm
D=72mm
L=800mm