



# Research plans/activities from SJTU to ECN

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9 Jan. 2014

# 1 Research activities at SJTU



**Conference organized:** Specialized workshop “Time-dependent Stress-strain Behavior of Geomaterials” within ISMODEL2012, Beijing, China, 15 to 16 Oct 2012.



## Creep of Geomaterials

**Workshop D:** *Time-dependent Stress-strain Behavior of Geomaterials*

*J.H. Yin, Z.Y. Yin, T.M. Bodas Freitas*

**Special issue organized:**

(1) “Time-dependent Stress-strain Behavior of Geomaterials” in *International Journal of Geomechanics ASCE* (2014)

(2) “Time Effects on the Behavior of Soils” in *Geotechnical Engineering—Journal of SEAGS-AGSSEA* (2015)

*Geotechnical Engineering – Journal of SEAGS-AGSSEA*

**Welcome !!!**

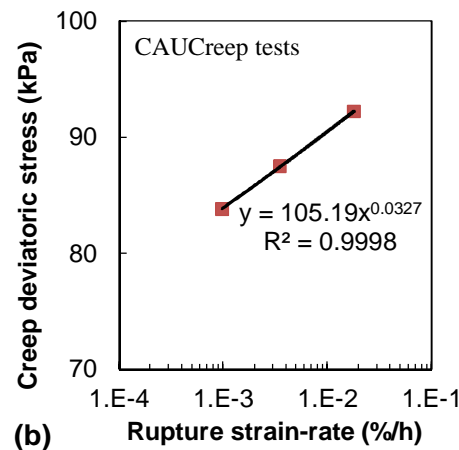
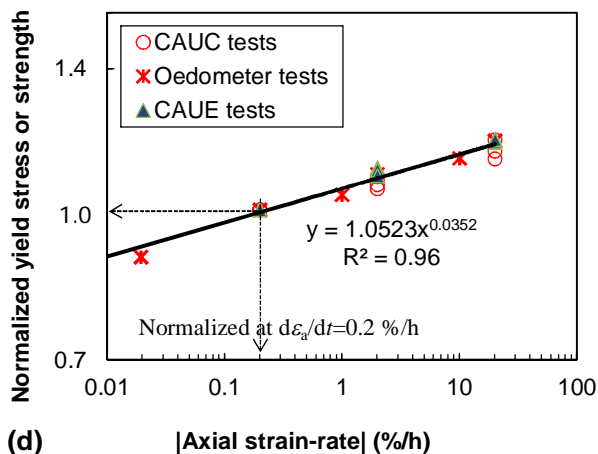
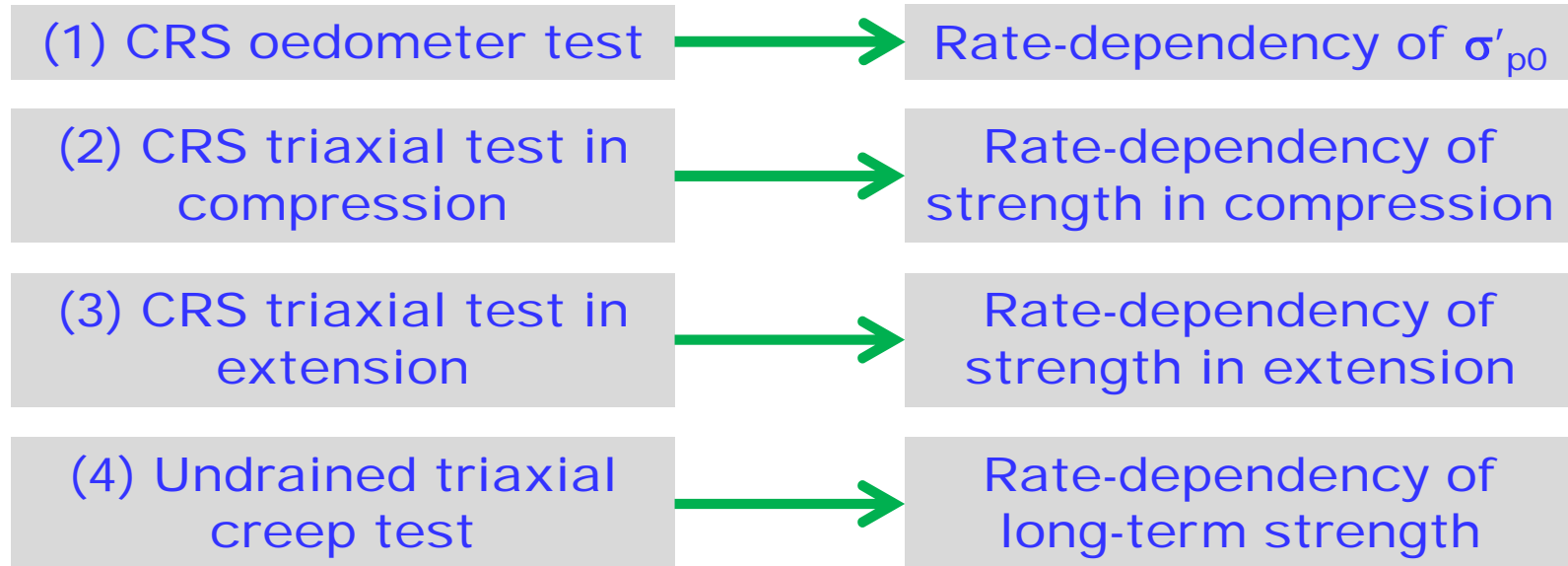
**Special Issue on**

**Time Effects on the Behavior of Soils**

by Guest Editors: Zhen-Yu YIN (Mainland China) and Jian-Hua YIN (Hong Kong, China)

# 1 Research activities at SJTU

## Topic 1: Uniqueness of rate-dependency (Wenzhou clay)



Yin Z-Y, Yin JH,  
Huang HW. *Marine  
Georesources &  
Geotechnology*,  
[DOI:10.1080/1064  
119X.2013.797060](https://doi.org/10.1080/1064119X.2013.797060).



# 1 Research activities at SJTU

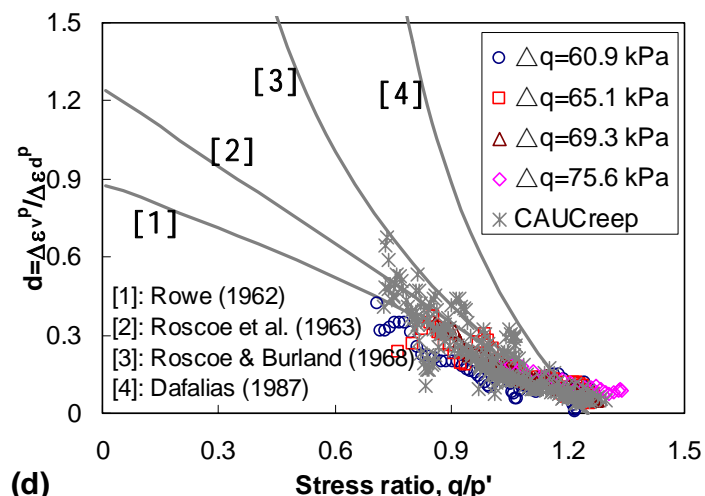
## Topic 2: Stress-dilatancy during undrained creep (Wenzhou clay)

$$\frac{d\varepsilon_v^p}{d\varepsilon_d^p} = \begin{cases} \frac{9(M-\eta)}{3M-2M\eta+9} & \text{Rowe (1962)} \\ M - \frac{q}{p} & \text{Roscoe et al (1963)} \\ \frac{M^2 - \eta^2}{2\eta} & \text{Roscoe \& Burland (1968)} \\ \Rightarrow \frac{M^2 - \eta^2}{2(\eta - \alpha)} & \text{Dafalias (1987)...} \end{cases}$$

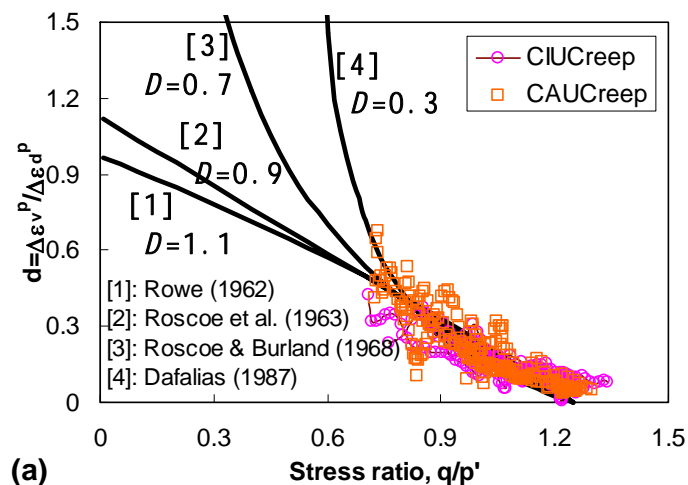
$$\frac{d\varepsilon_v^p}{d\varepsilon_d^p} = f(M, \eta) \Rightarrow \frac{d\varepsilon_v^p}{d\varepsilon_d^p} = D \cdot f(M, \eta) \Rightarrow$$



Wang L-Z, Yin Z-Y. *ASCE Int J Geomech*,  
doi: 10.1061/(ASCE)GM.1943-5622.0000271.



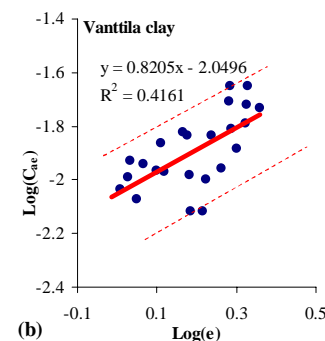
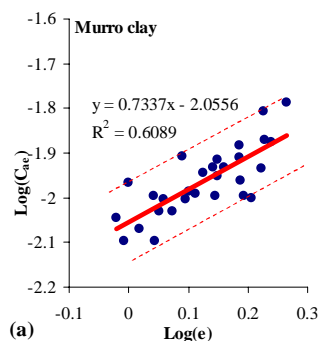
(d)



(a)

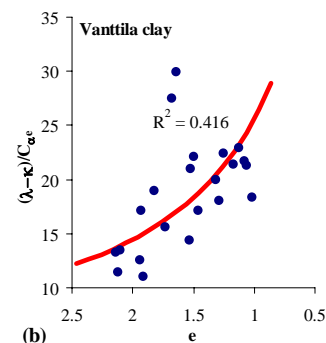
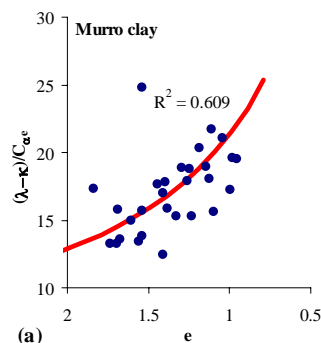
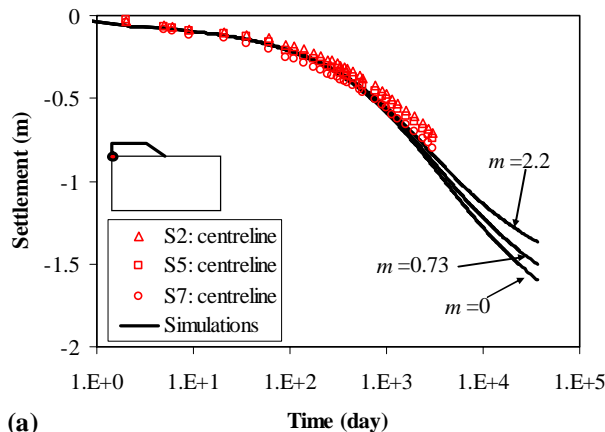
## Topic 3: Nonlinear creep simulation

(1) Nonlinear  $C_{ae}$ : 
$$C_{ae} = C_{aef} \left( \frac{e}{e_f} \right)^m$$



(2) Nonlinear index  $\beta$ : 
$$\dot{\varepsilon}_{ij}^{vp} = \frac{C_{aei}}{(1+e_0)\tau} \frac{(M_c^2 - \alpha_{K0}^2)}{(M_c^2 - \eta_{K0}^2)} \left( \frac{p_m^d}{p_m^r} \right)^\beta \frac{\partial f_d}{\partial \sigma'_{ij}}$$
 with 
$$\beta = \frac{\lambda_i - \kappa}{C_{aef}} \left( \frac{e_f}{e} \right)^m$$

## (3) FEA for Murro embankment

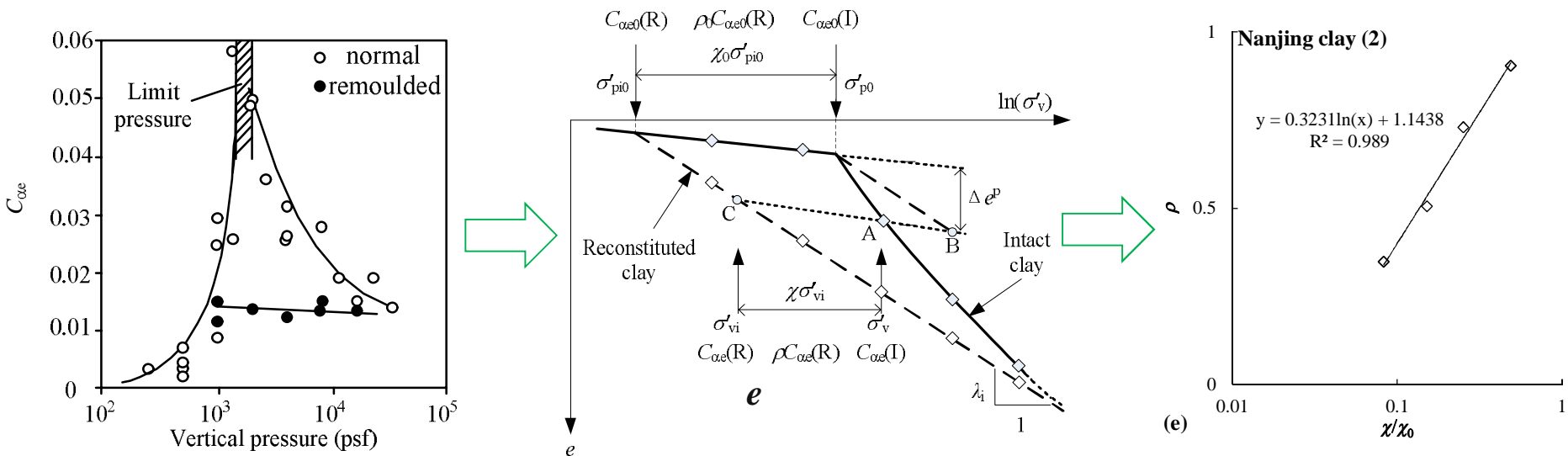


Yin Z-Y, Xu Q, Yu C. *ASCE Int J Geomech*,  
doi: 10.1061/(ASCE)GM.1943-5622.0000271.



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## Topic 4: Non-linearity of one-dimensional creep



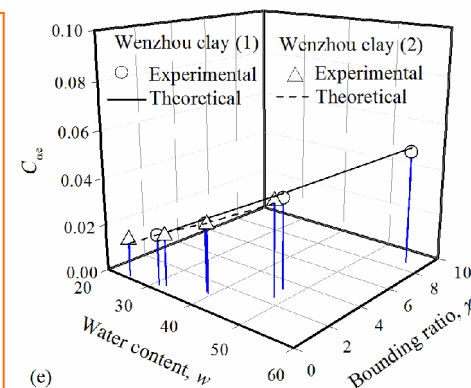
$$C_{ae} = \left( n \log \left( \frac{\chi}{\chi_0} \right) + \rho_0 + 1 \right) C_{aef} \left( \frac{e}{e_f} \right)^m$$

$$C_{aeL} = 0.0007 w_L - 0.0223$$

$$m = 0.7872 - 0.0369 w_L + 0.0619 I_P; n = 2.4630 - 0.0585 w_L + 0.0532 I_P$$

$$\frac{\rho_0}{\chi_0} = 2.34 \exp(-0.047 w_L); I_P = 0.8381 \omega_L - 16.438$$

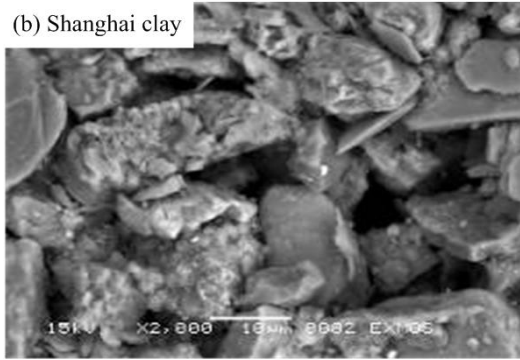
**Correlation with Atterberg limits**



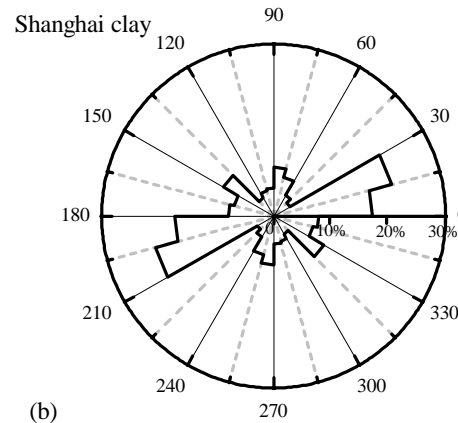
**Wenzhou clay**

# 1 Research activities at SJTU

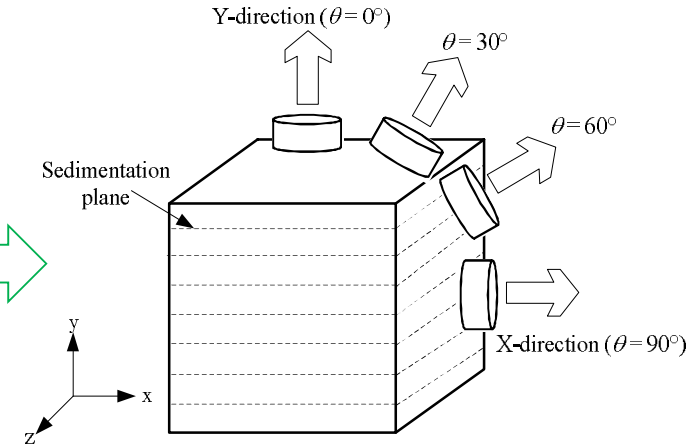
## Topic 5: Anisotropy of creep



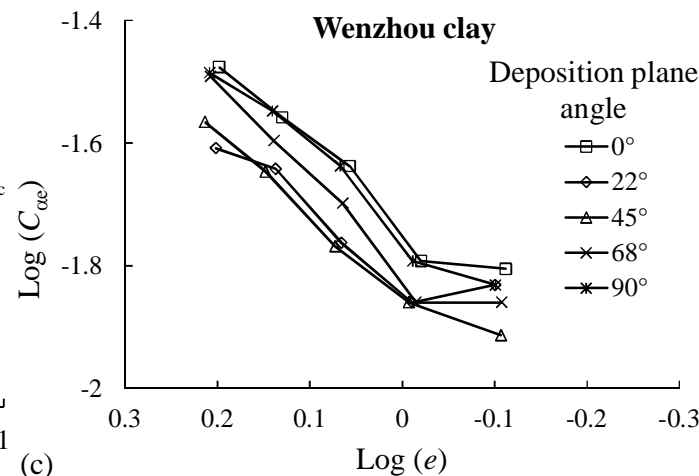
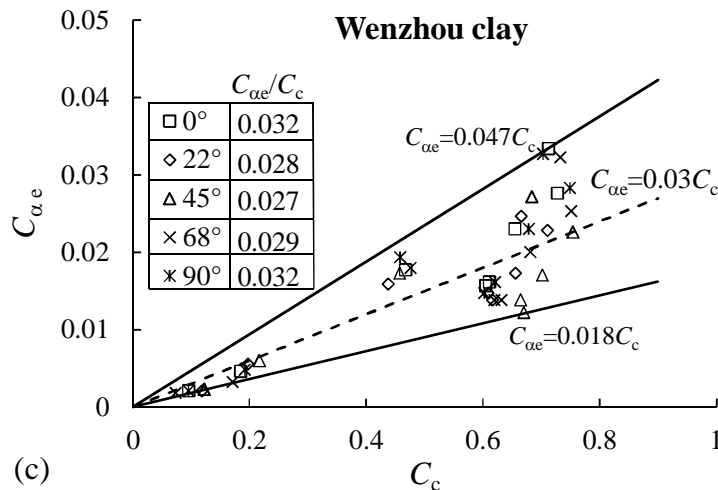
**SEM**



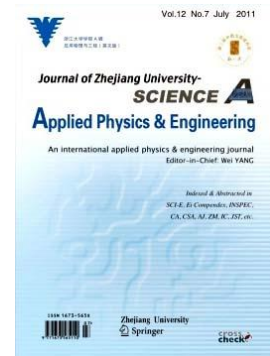
**Clay Particle orientation**



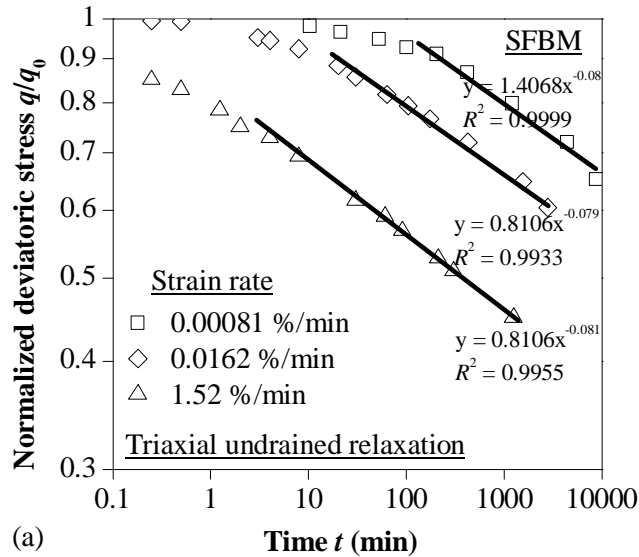
**Oedometer creep test**



Zhu, Jin, Yin et al. J ZUS-A, 2013 14(11):767-777.



## Topic 6: Stress relaxation coefficient and formulation



(a)

$$R_\alpha = -\frac{\Delta \ln \sigma'_v}{\Delta \ln t}$$



### EVP Model

$$\frac{\kappa}{1+e_0} \frac{\dot{\sigma}'_v}{\sigma'_v} = -\dot{\epsilon}^r_v \frac{\lambda - \kappa}{\lambda} \left( \frac{\sigma'_v}{\sigma_{pi}^r \exp\left(\frac{1+e_0}{\lambda - \kappa} \epsilon^{vp}\right)} \right)^\beta$$

Yin & Wang 2012

### Relaxation formulation

$$\sigma'_v = \left( -\dot{\epsilon}^r_v \frac{(1+e_0)(\lambda - \kappa)}{\lambda \cdot \kappa} \left( \frac{1}{\sigma_p^r \cdot \sigma_{vi}^{\frac{\kappa}{\lambda - \kappa}}} \right)^\beta \left( -\frac{\lambda\beta}{\lambda - \kappa} \right) t + \sigma_{vi}^{\frac{\lambda\beta}{\lambda - \kappa}} \right)^{\frac{\lambda - \kappa}{\lambda\beta}}$$

### Differential

$$-\frac{\partial \ln \sigma'_v}{\partial \ln t} = R_\alpha = \frac{\lambda - \kappa}{\lambda} \frac{1}{\beta} = \frac{C_{\alpha e}}{\lambda} \text{ or } \frac{C_\alpha}{C_c}$$

Yin Z-Y, Zhu QY, Yin JH, Ni Q. *Geotechnique letters*, 2014, accepted.



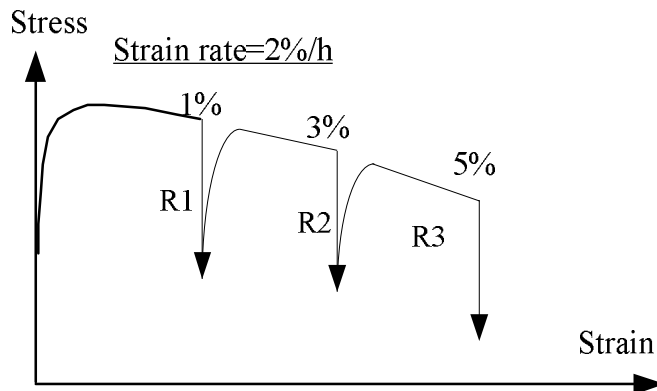
# 1 Research activities at SJTU

## Topic 7: Time-dependent behavior of Shanghai clay

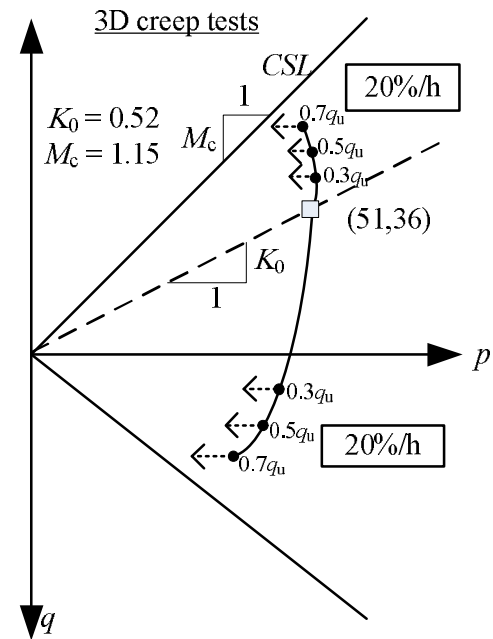
### Hollow Cylinder Apparatus



### Multi-stage relaxation test (compression and extension)



### Undrained creep test (compression and extension)



**Anticipation:**

**Fully understanding of the time-dependent behavior of Shanghai clay**

# 2 Research plans at ECN



## Research group in Geotechnical Engineering:

Pierre-Yves Hicher, *Professor*

Zhen-Yu Yin, *Associate professor (HDR)*

Christophe Dano, *Associate professor*

Yvon Riou, *Associate professor*



## Equipment:

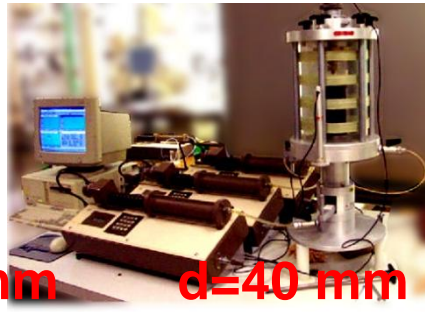
### Triaxial-statics



d=1m

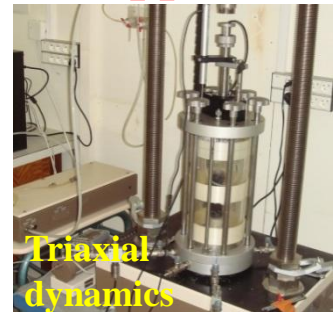


d=100mm

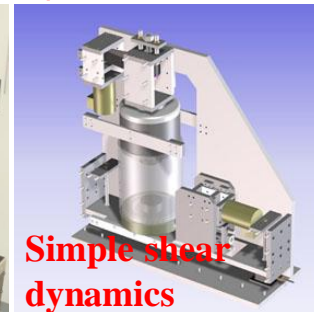


d=40 mm

### Apparatus-dynamics



Triaxial dynamics



Simple shear dynamics

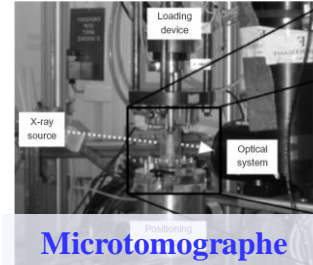
### Microstructure



MEB



MIP

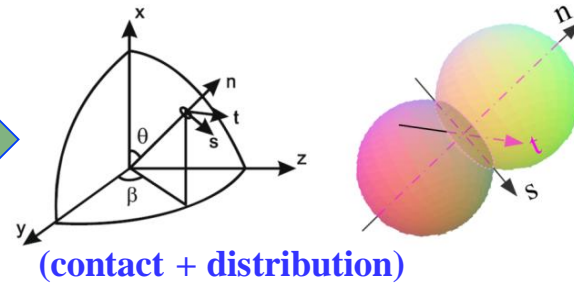
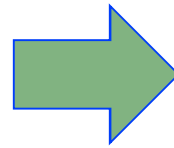
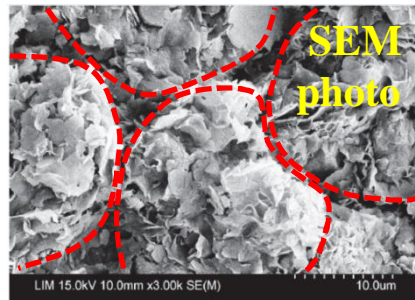


Microtomographe

## 2 Research plans at ECN



**Step 1:** Multiscale modeling of creep and cyclic behaviors



**Step 2:** Identifying parameters by genetic method

**Parameters from *MICRO* to *MACRO***

**Step 3:** Multiscale modeling platform for application

**Based on PLAXIS? ABAQUS?  
LS-Dyna? FLAC3D? ...**

**Need to become partner, PLEASE!!!**

Thank you very much  
for your attention!

