

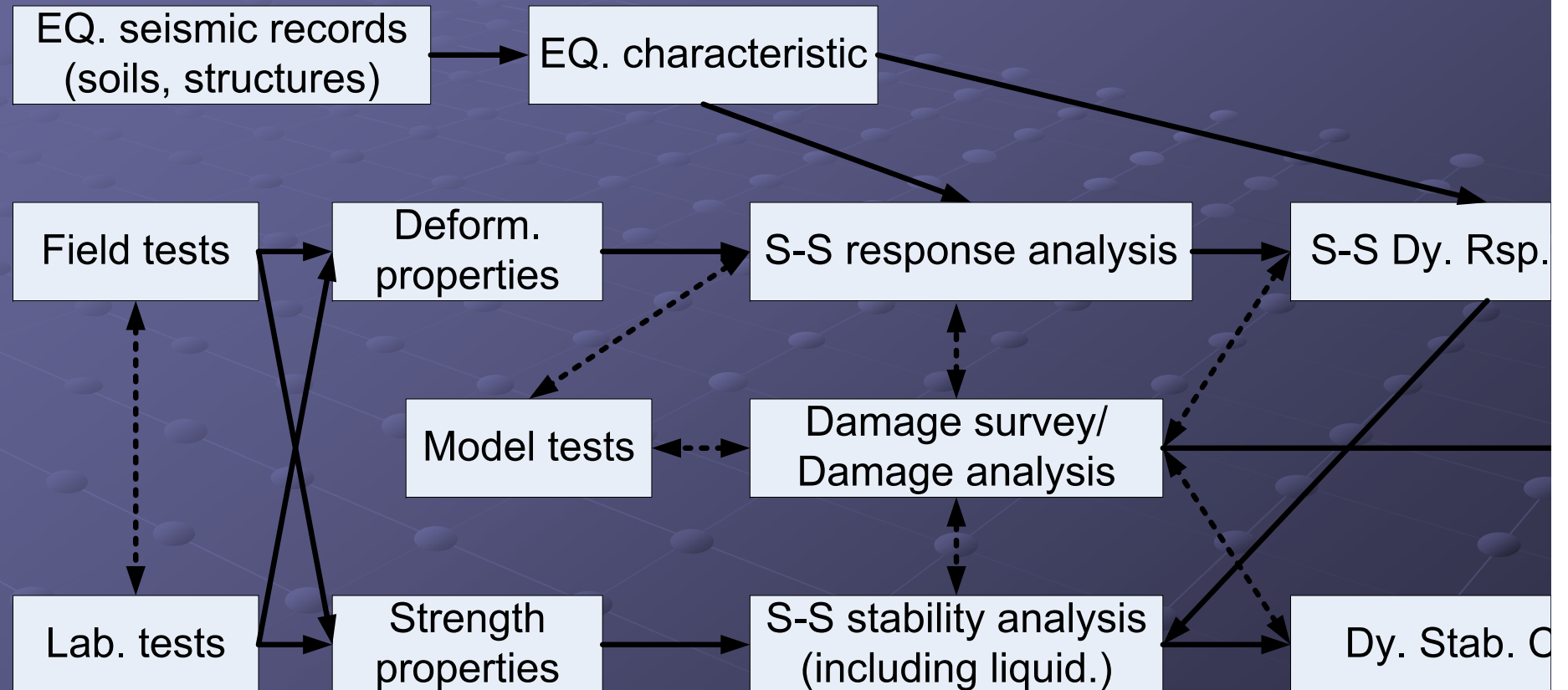
# พฤติกรรมทางพลศาสตร์ของดิน

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6 มิถุนายน 2551

# กระบวนการในการวิเคราะห์ผลกระทบต่อแผ่นดินไหว





# ผลตอบสนองต่อแรงพลวัตแยกตามประเภทของดิน

แรงพลวัตแบบวัฏจักร  
(cyclic, dynamic)

ด

Stability analysis/  
Liquifaction

Response analysis/  
Lateral flow

ด

Stability analysis/  
Slope stability,  
Stab. of Seawall

Response analysis/  
Signal amplification

# คุณสมบัติของดินที่เกี่ยวกับแรงกระทำทางพลศาสตร์

## ● Cyclic

- จำนวนรอบของการสั่น
- ช่วงกว้างของการสั่น

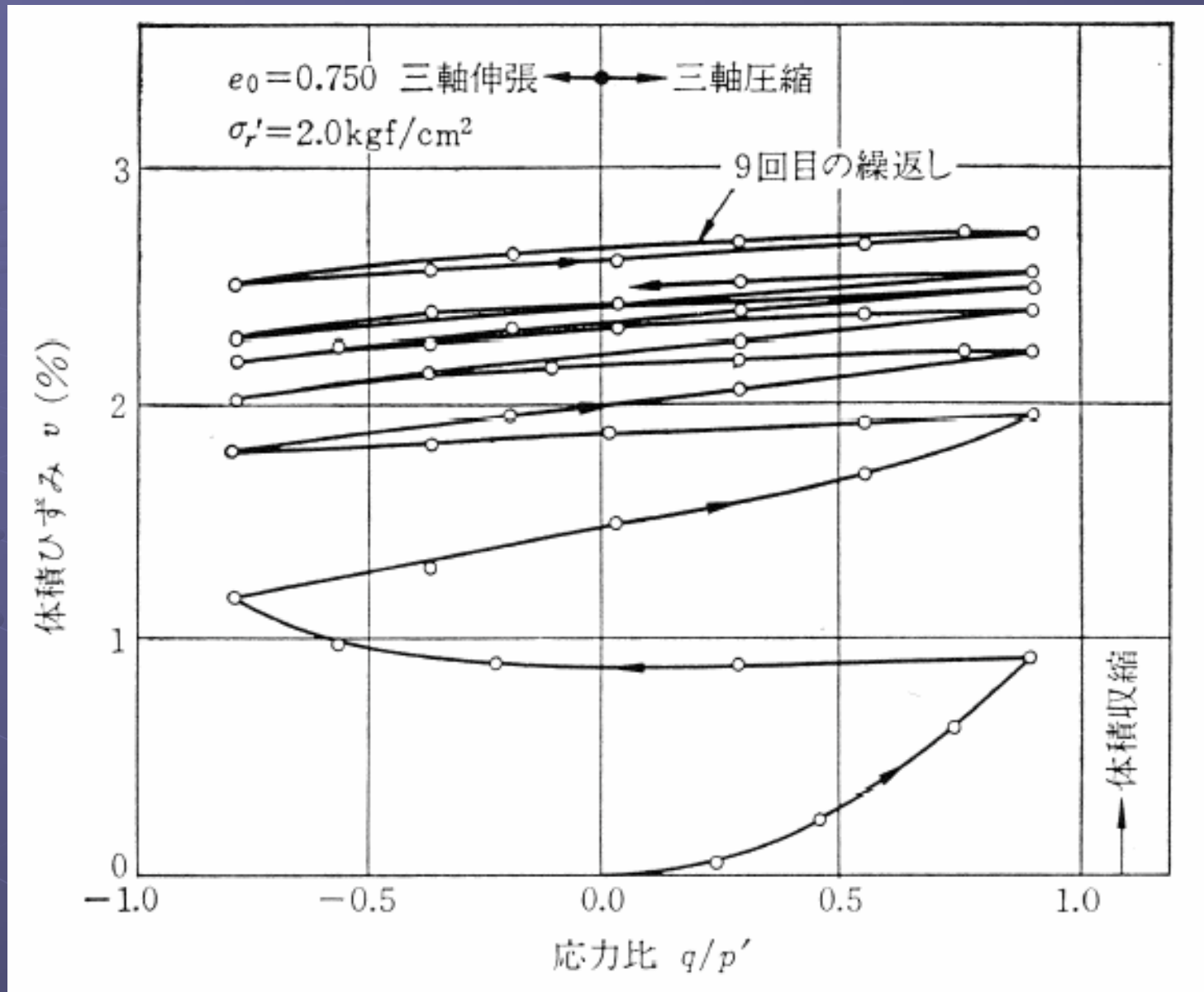
Cyclic load test in triaxial

$T \in [10, 100]$  sec

## ● Time dependency

- ความเร็ว - ช้าของแรงกระทำ
- ดินเหนียวมีผลตอบสนอง > ดินทราย

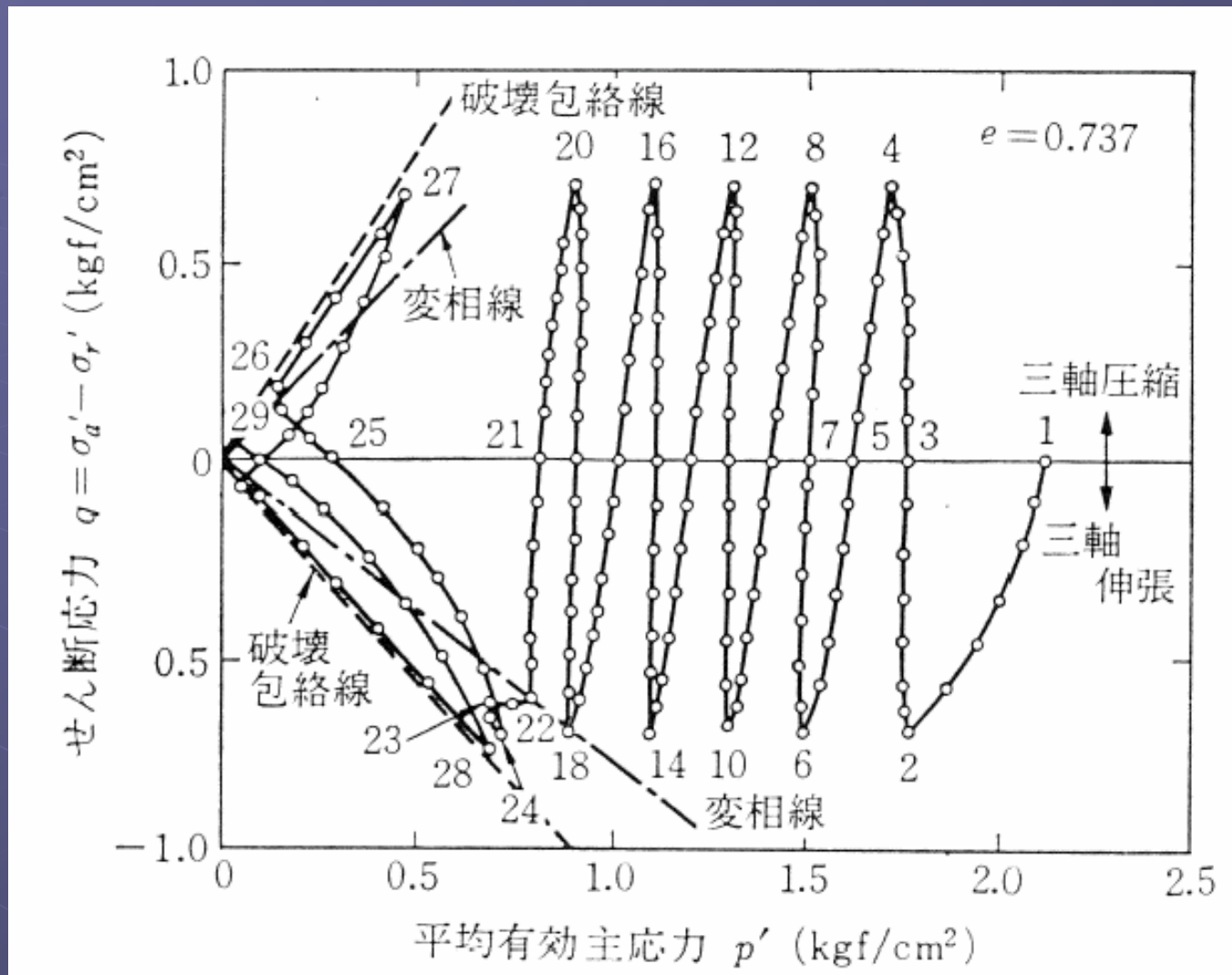
volume change



$q/p'$

drained

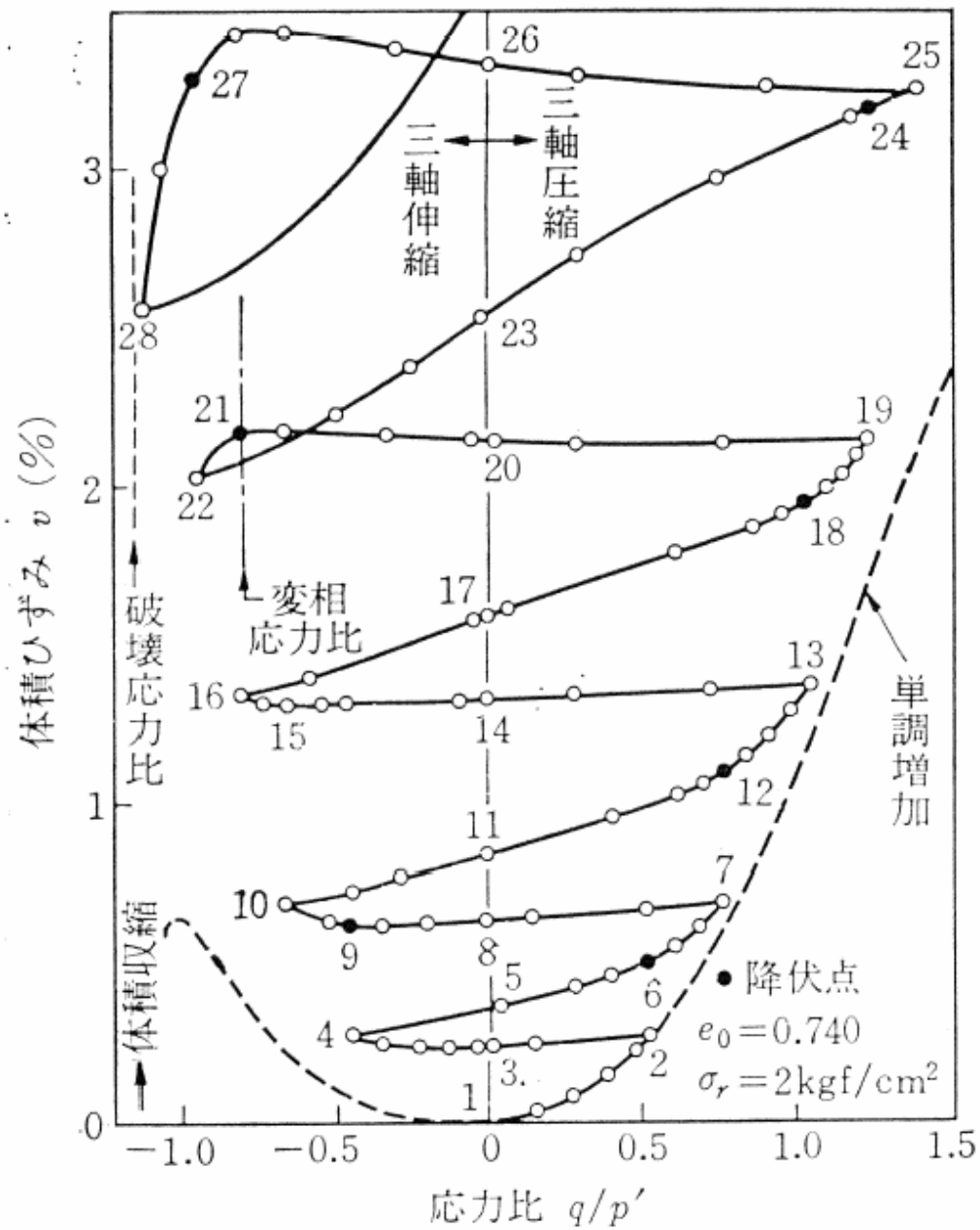
# Shear stress



$p'$

undrained

volume change



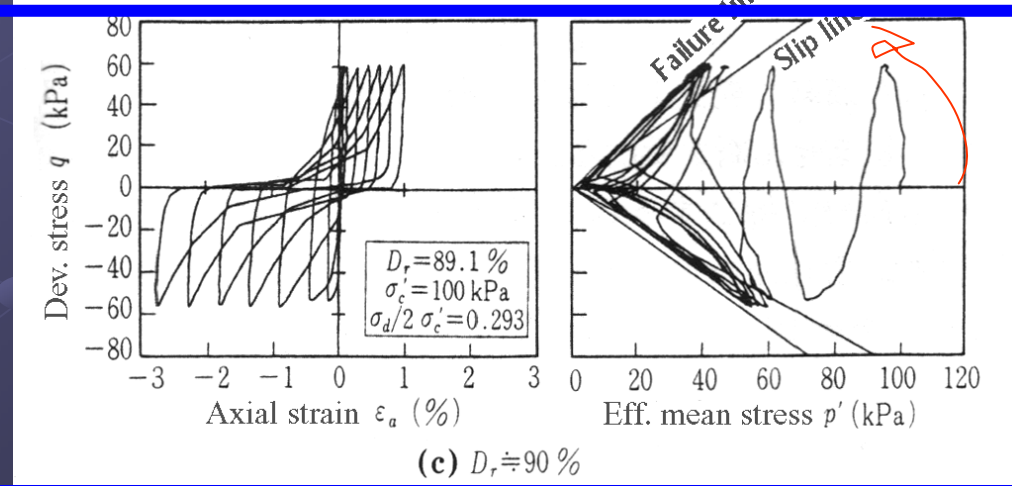
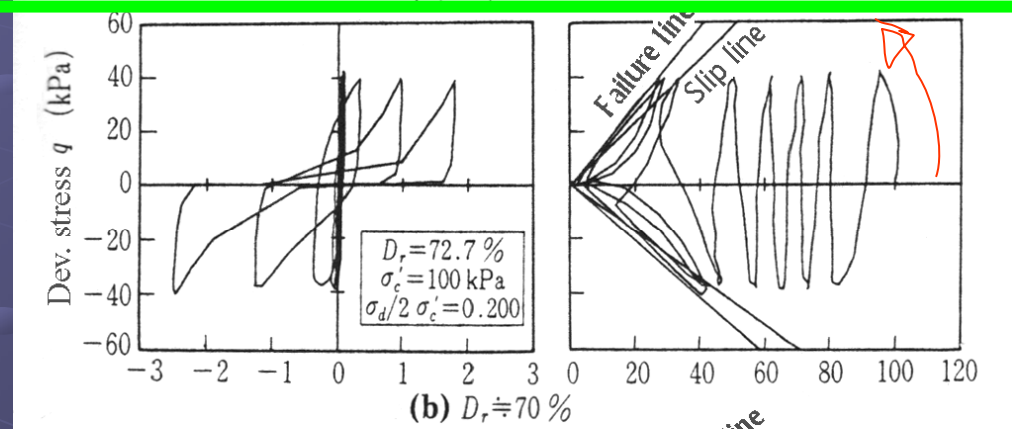
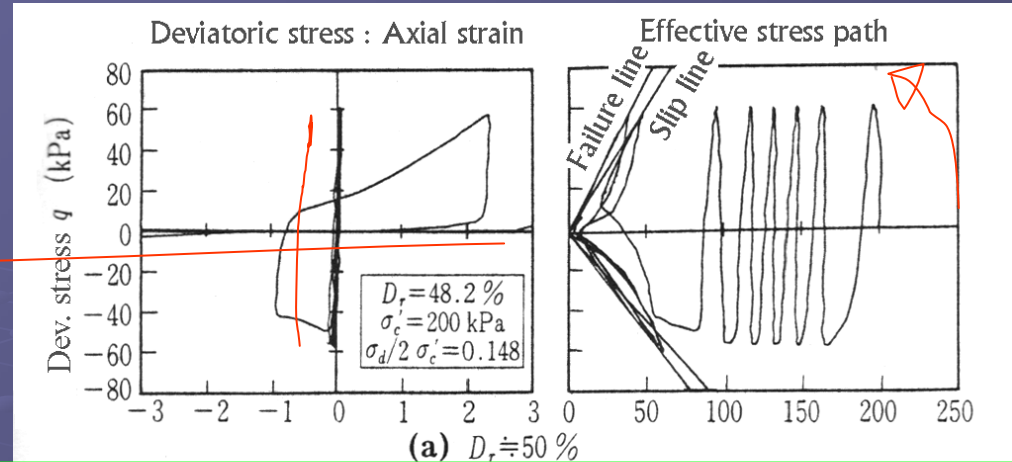
$q/p'$

drained + q varied



# พฤติกรรมของทราย ที่มีต่อ แรงแบบวัฏจักร

- Loose sand -> Excessive strain
- Medium sand -> Gradually increased
- Dense sand -> more stable

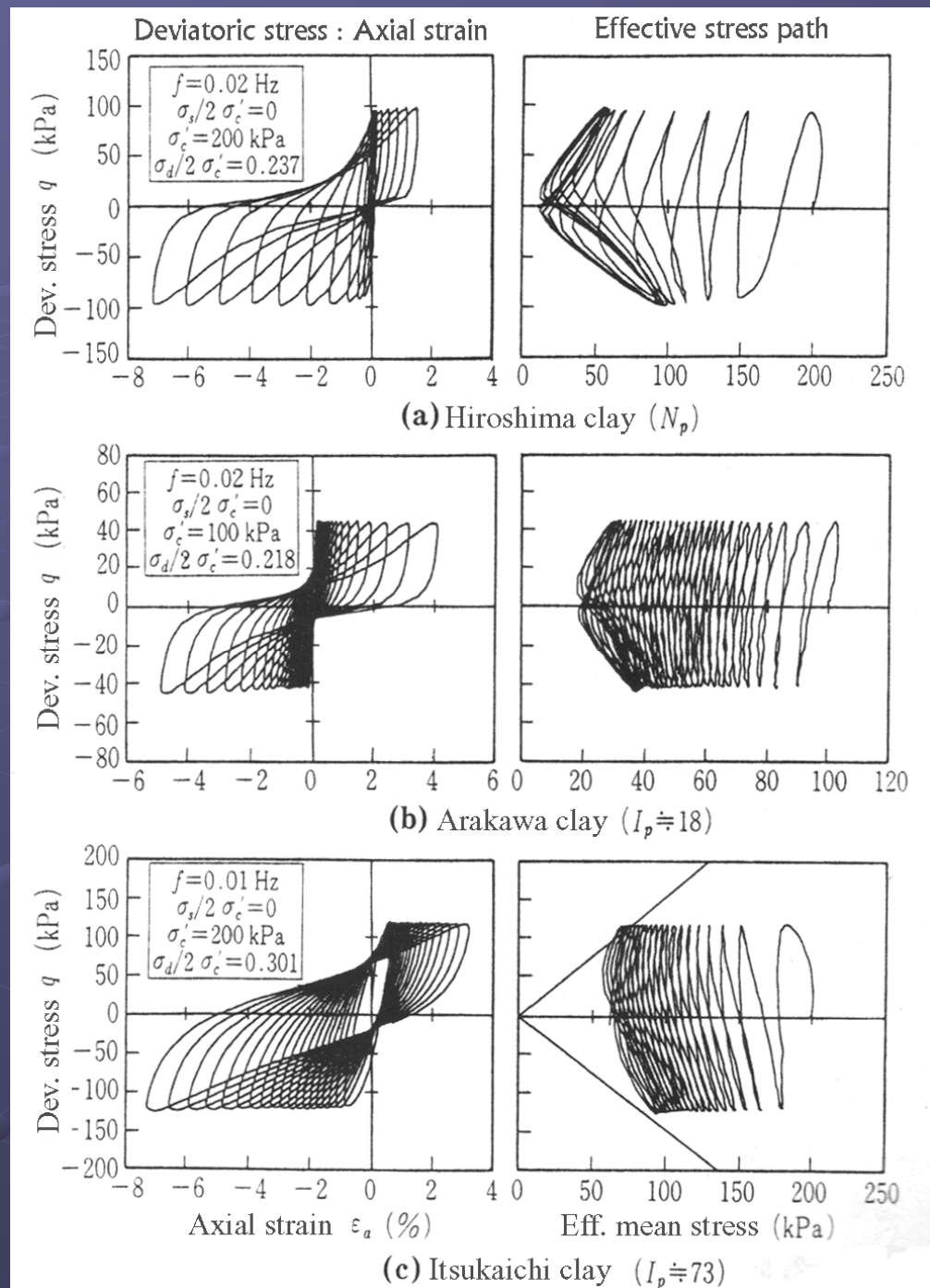


# พฤติกรรมของดินเหนียว

ที่มีต่อ

แรงแบบวัฏจักร

- NP Clay -> degraded quickly
- Low Plasticity -> Improved durability
- High Plasticity -> Higher resistance



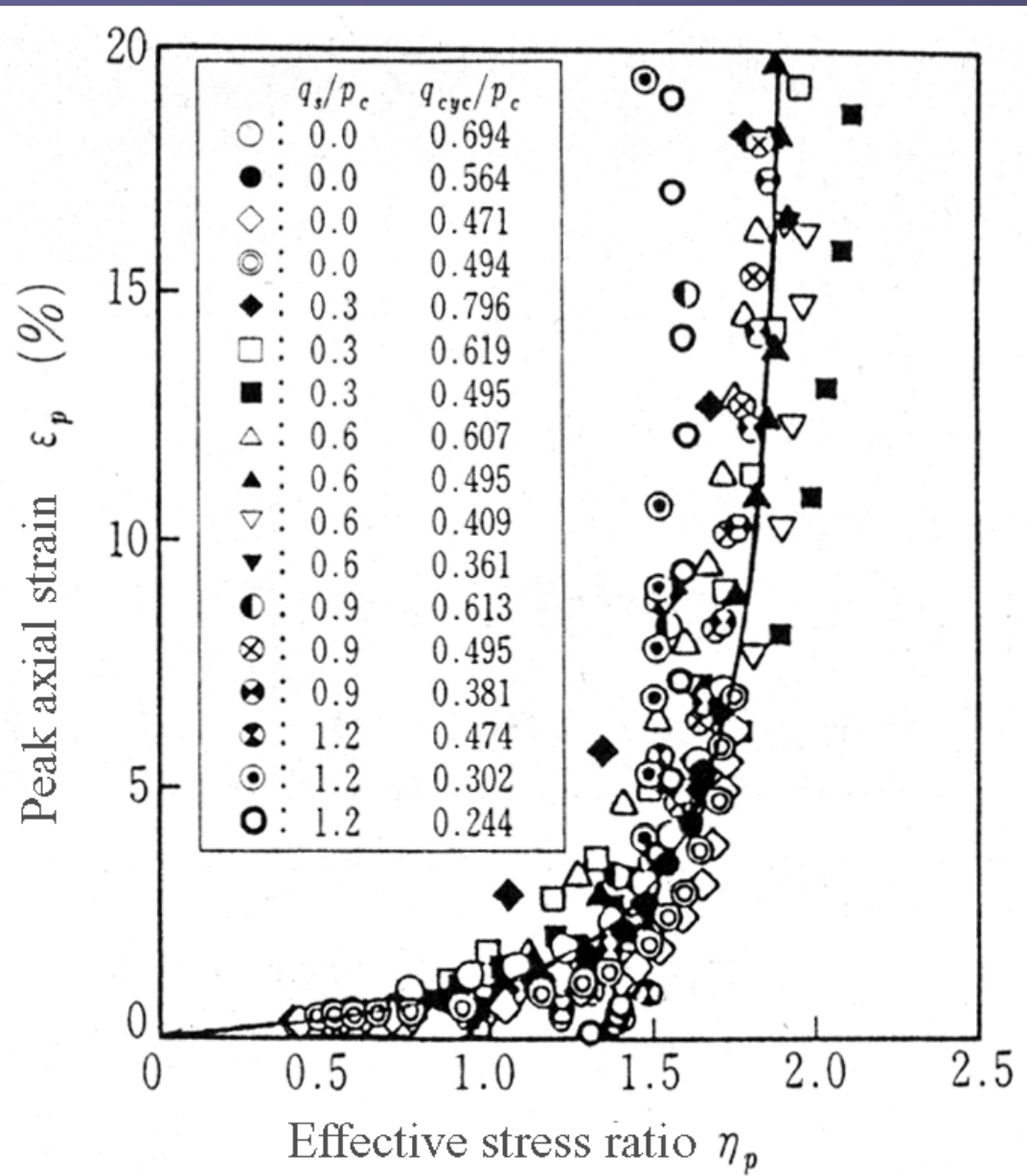
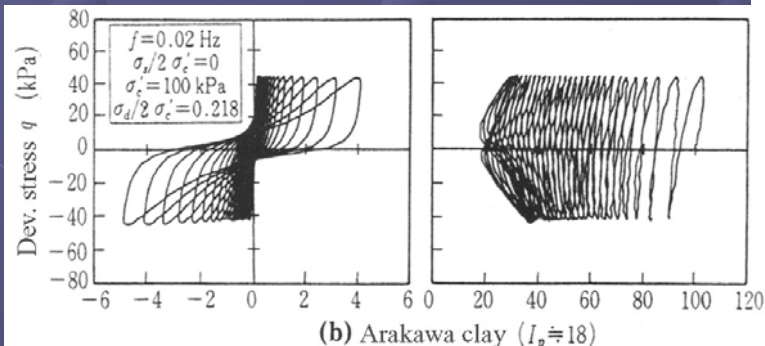
# Cyclic shear behavior of a NC clay

$$n_p = \frac{q}{p'}$$

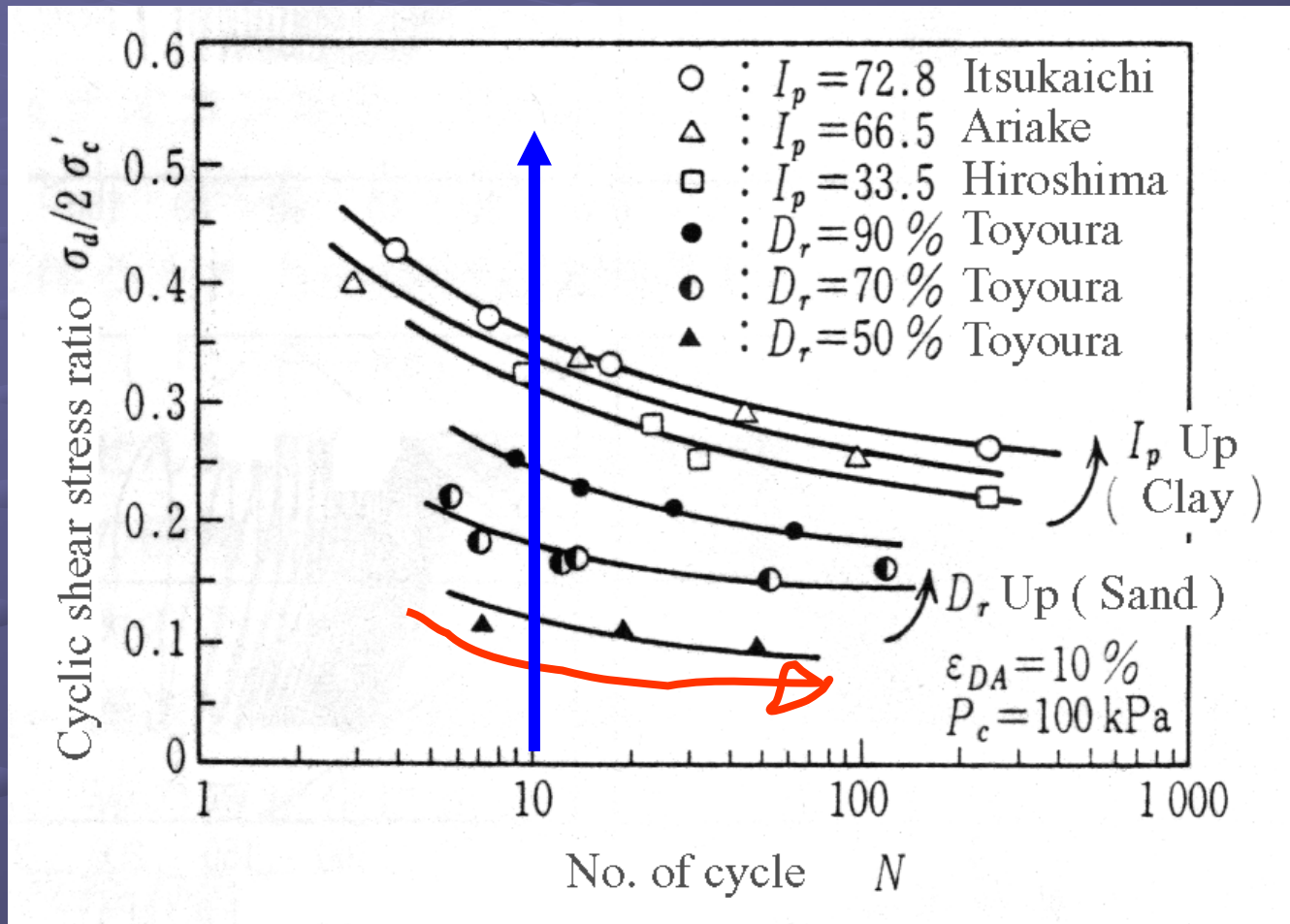
$$n_p \uparrow \Rightarrow p' \downarrow$$

$$p' \rightarrow \text{constant}$$

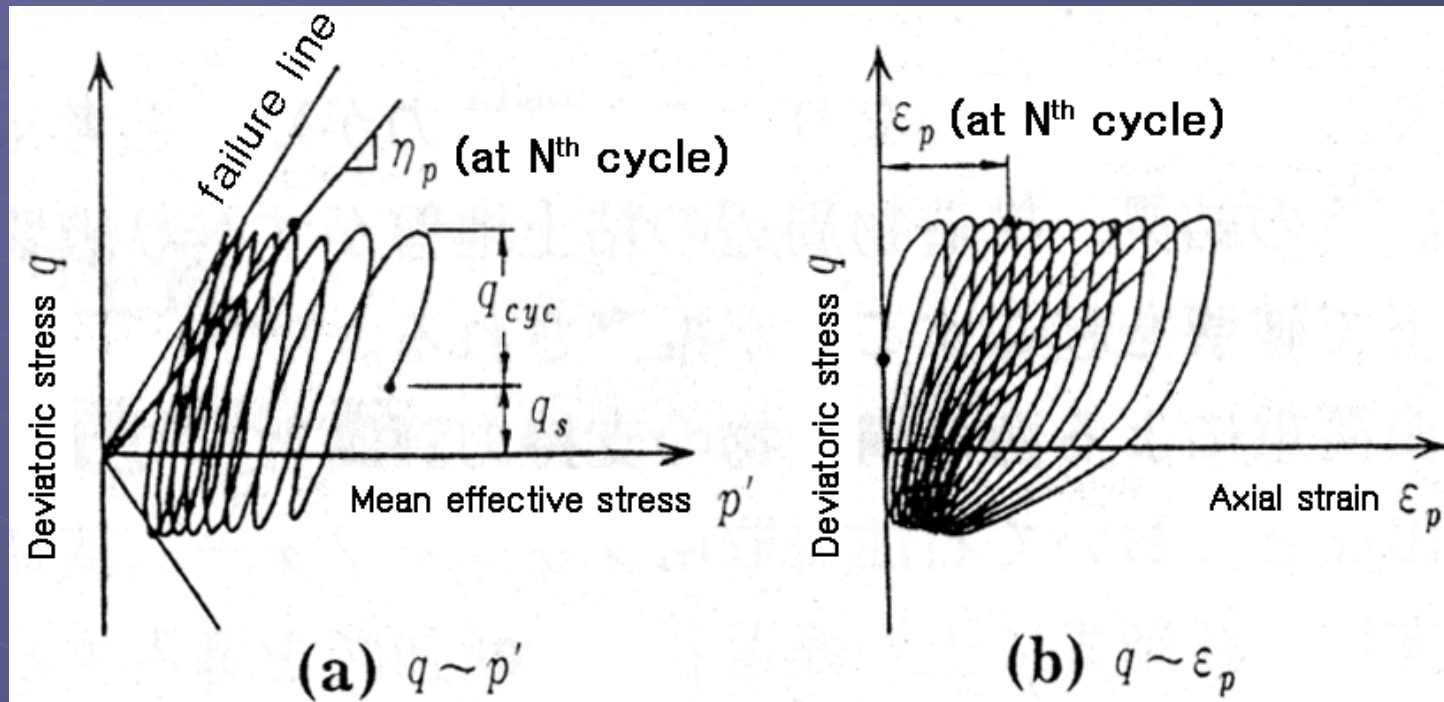
$$\varepsilon_a \rightarrow \infty$$



# Comparison among sands and clays



# Effect of Initial shear stress



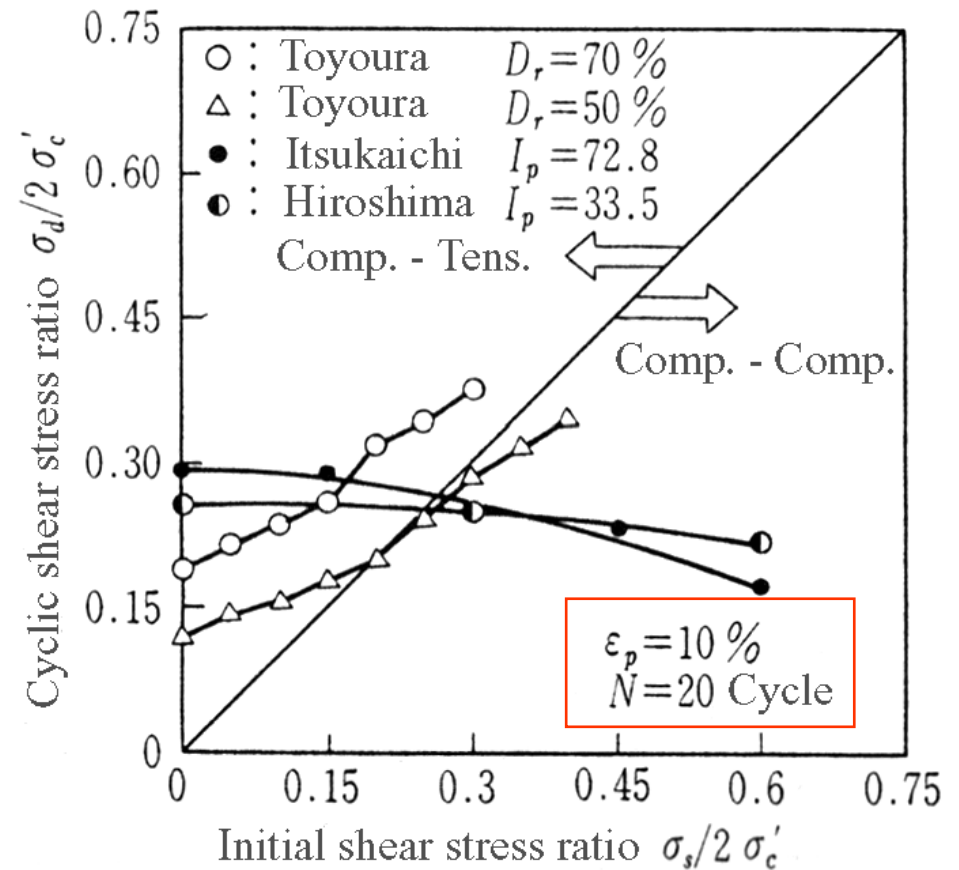
if  $q_s \geq q_{cyc} \Rightarrow$  one-side undulation

if  $q_s = 0 \Rightarrow$  symmetry, two-side undulation

# Effect of Initial shear stress (2)

*sand* :  $\sigma_s \uparrow \Rightarrow$  *Strength*  $\uparrow$

*clay* :  $\sigma_s \uparrow \Rightarrow$  *Strength*  $\downarrow$



# Effect of loading frequency (speed)

*Fast*

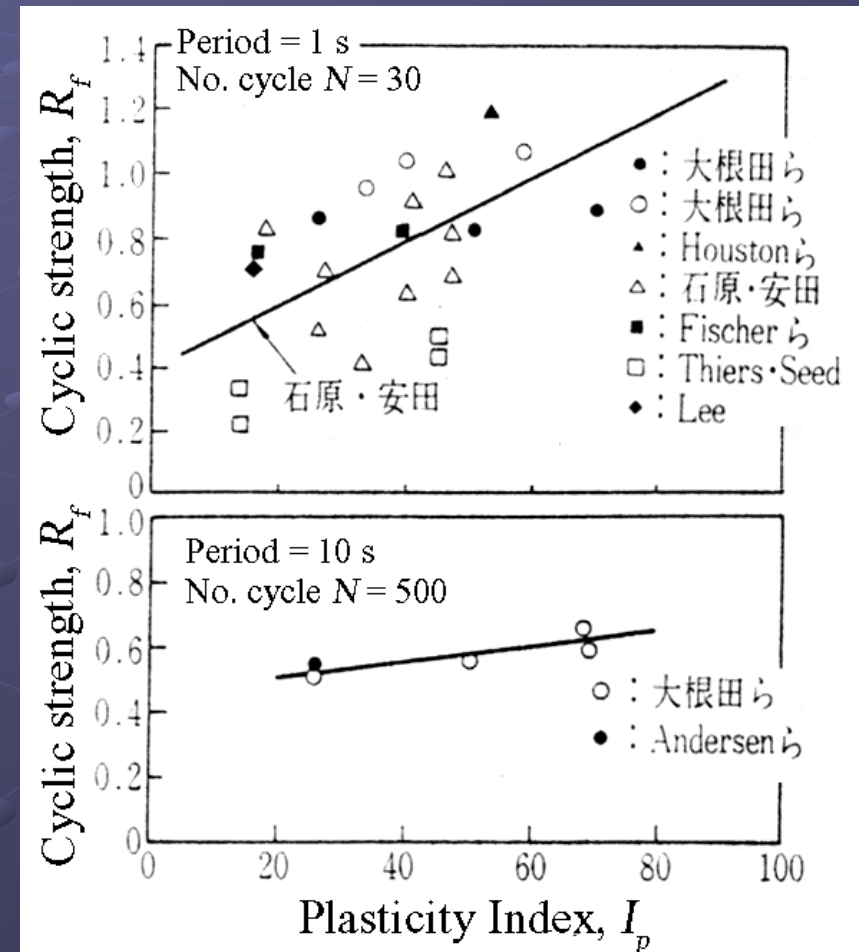


*Range of shear stress → large*

*Slow*



*Range of shear stress → small*



*for  $\varepsilon_a = 5\%$*

# Failure types

## ● Sand

- Liquefaction
- Cyclic mobility

## ● Clay

- Shear failure

## ● Failure induced by soil

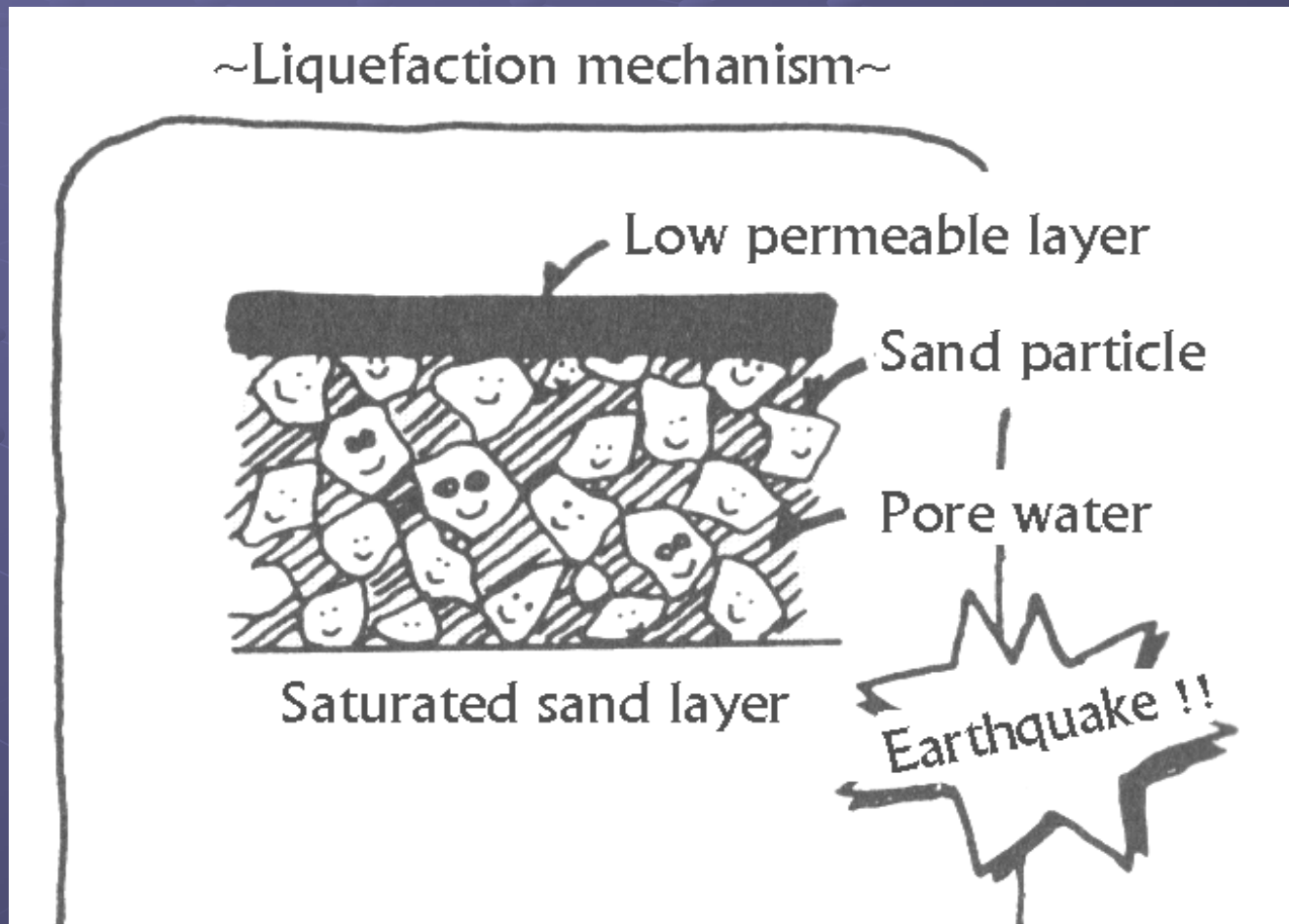
- Lateral pressure, Lateral spreading
- Signal magnification
- Uplift pressure



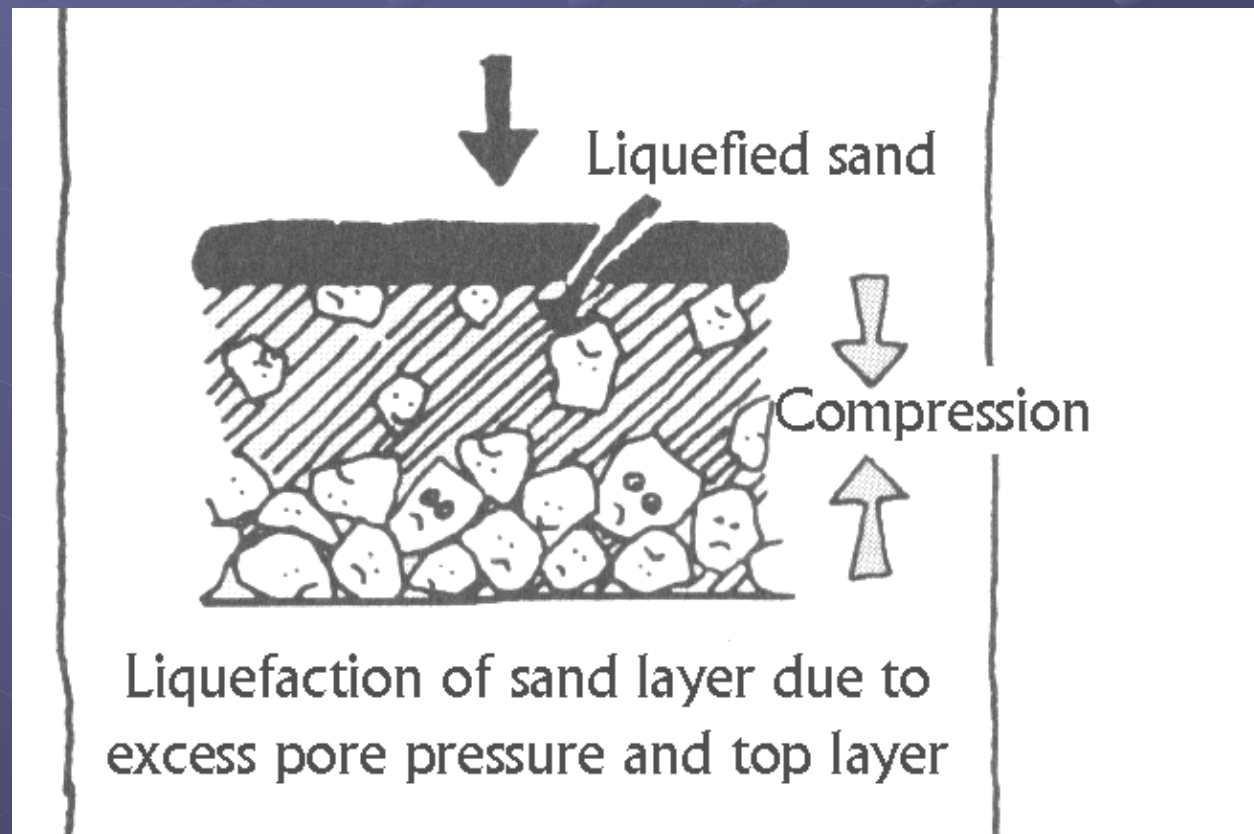
# Volume contraction of sand layer



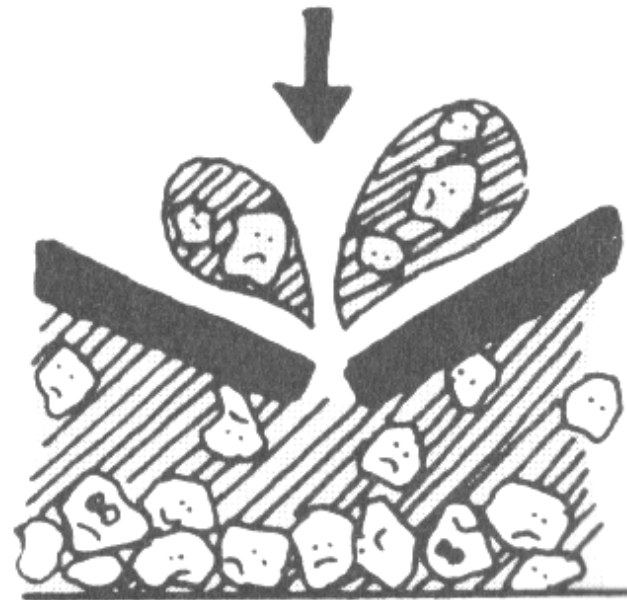
# Liquefaction Mechanism



# Liquefaction Mechanism



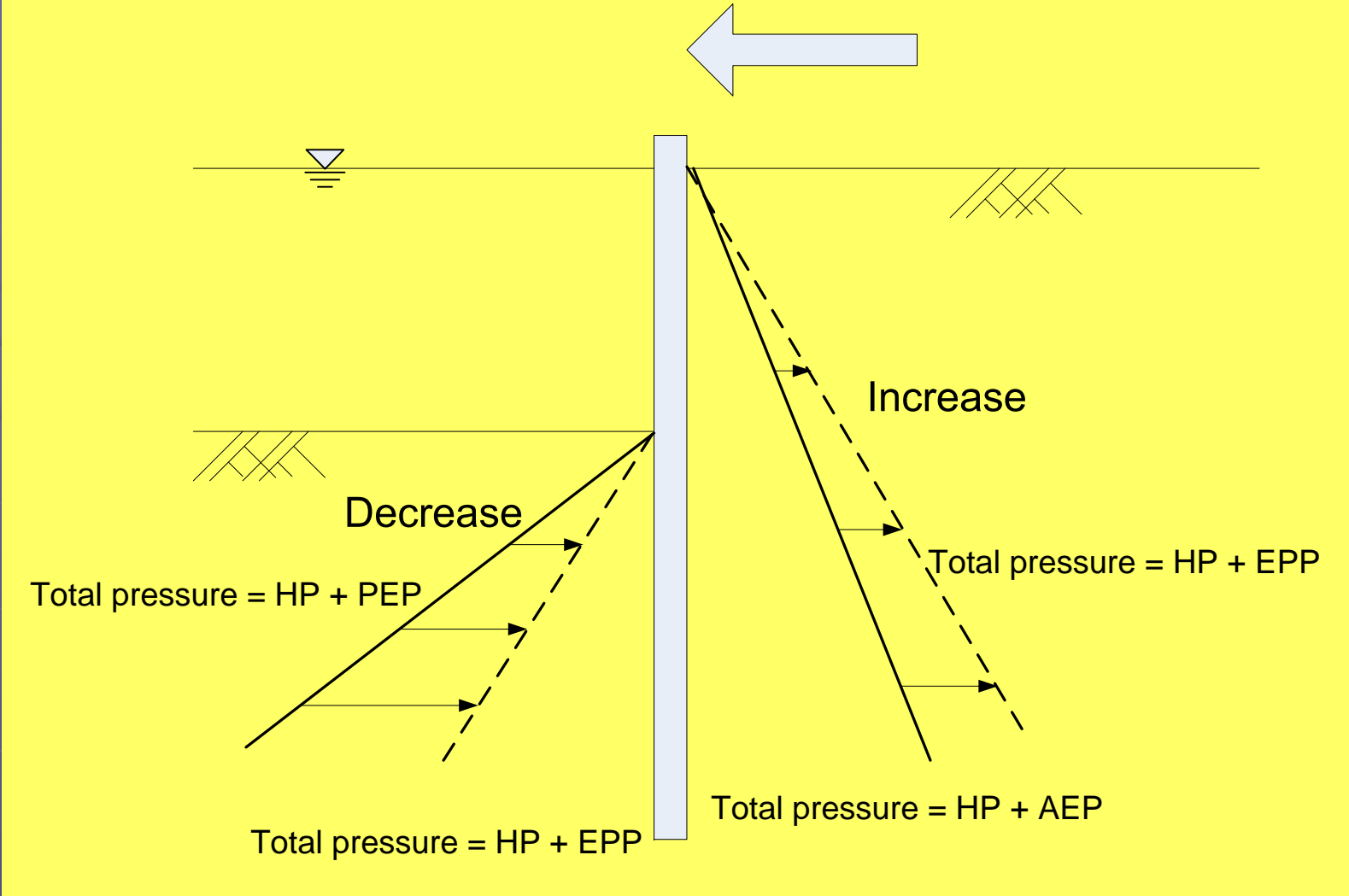
# Liquefaction Mechanism



Breakage of top layer,  
outflow of liquefied sand and  
ground subsidence

# Liquefaction failure





# Liquefaction failure



# Liquefaction failure





# Liquefaction failure



# Liquefaction failure



# Liquefaction failure



# Liquefaction



# Liquefaction



# Failure types

## ● Sand

- Liquefaction
- **Cyclic mobility**

## ● Clay

- **Cyclic shear failure**

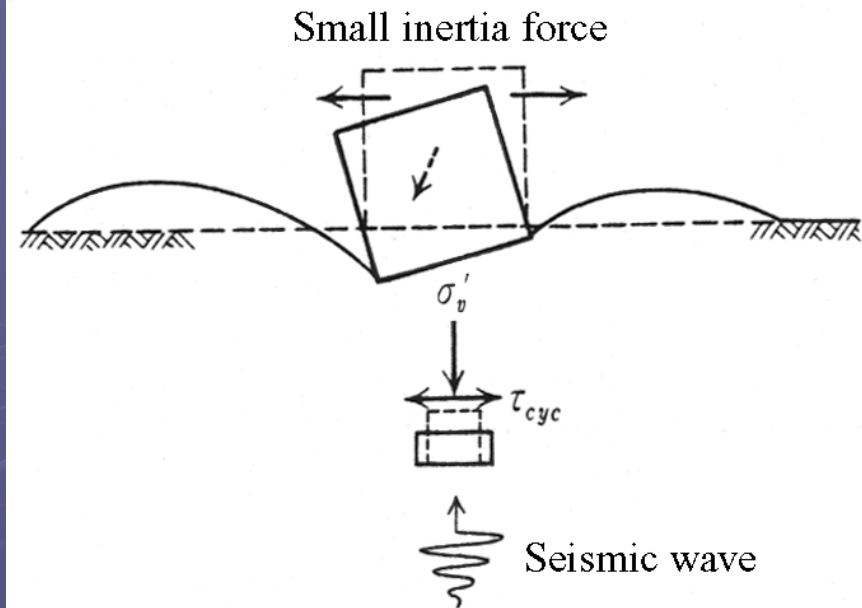
## ● Failure induced by soil

- Lateral pressure, Lateral spreading
- Signal magnification
- Uplift pressure

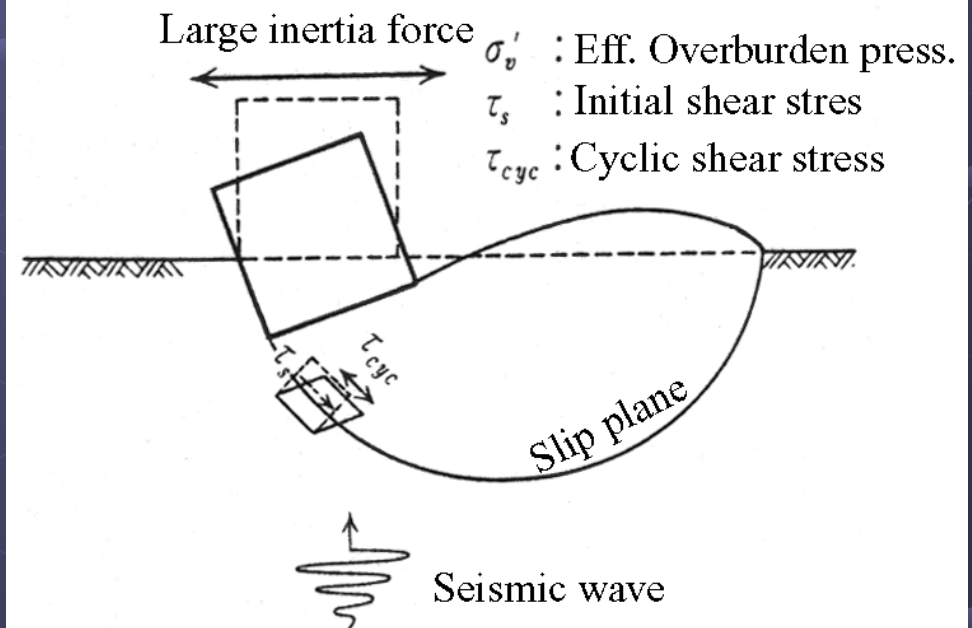
# Failure of sand VS Failure of clay

Sink  $\Rightarrow$

Slide  $\Rightarrow$



(a) Liquefaction of sandy ground



(b) Cyclic shear failure of clayey ground

# Failure types

## ● Sand

- Liquefaction
- Cyclic mobility

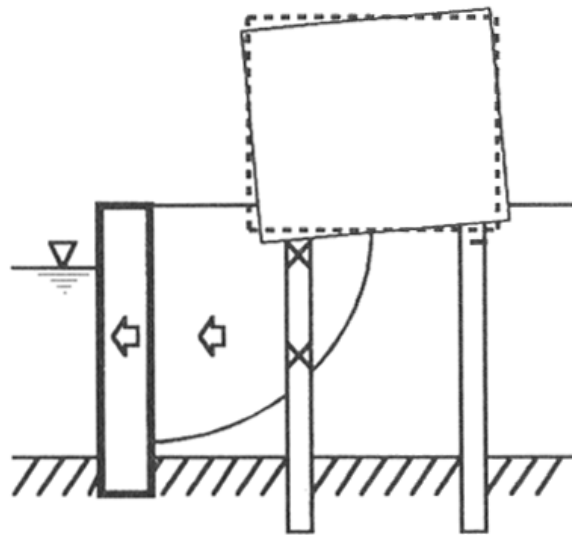
## ● Clay

- Cyclic shear failure

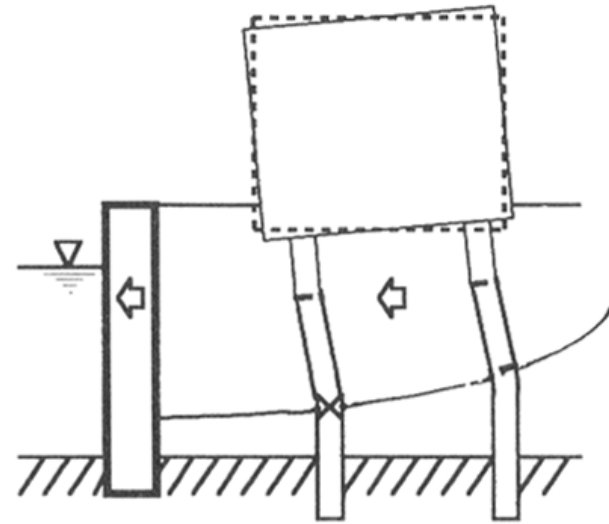
## ● Failure induced by soil

- Lateral pressure, Lateral spreading
- Signal magnification
- Uplift pressure

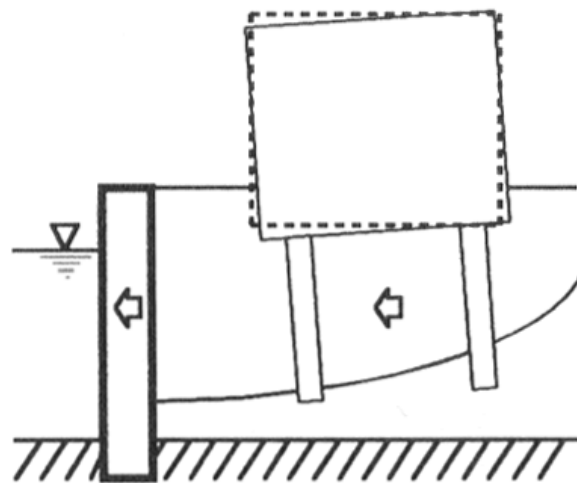




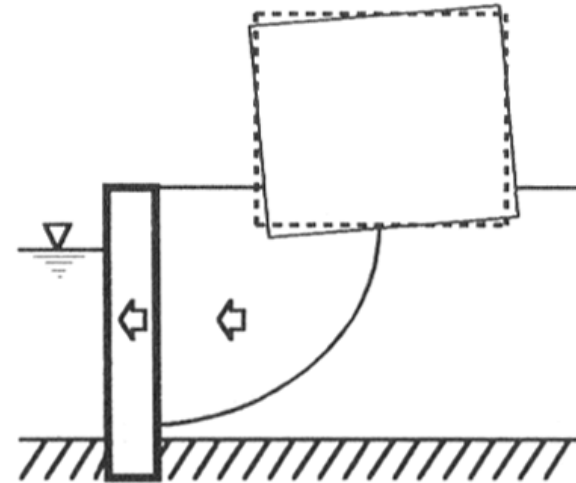
**(a) Failure of pile due to lateral spreading**



**(b) Failure of pile due to lateral spreading**



**(c) Differential settlement due to lateral spreading**



**(d) Differential settlement due to lateral spreading**

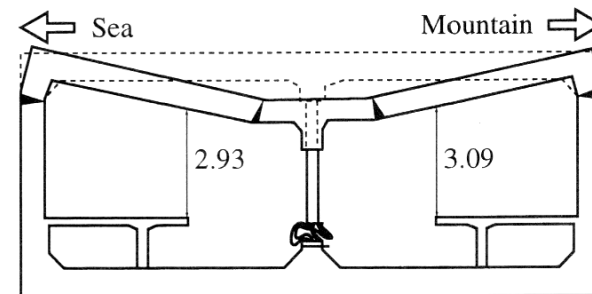
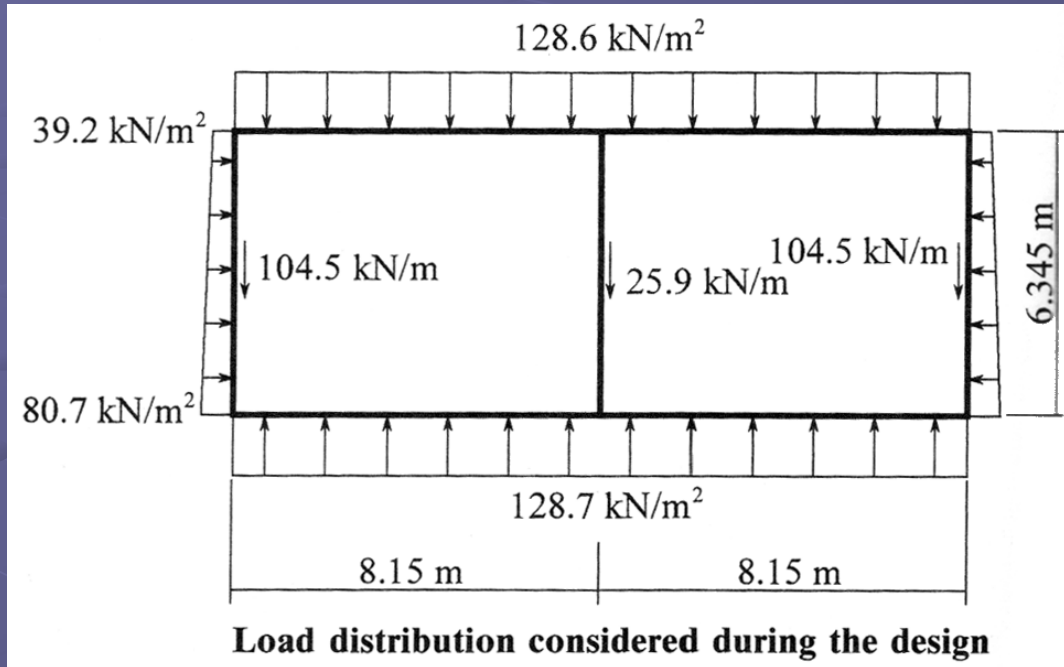
# Lateral flow (Earth pressure failure)



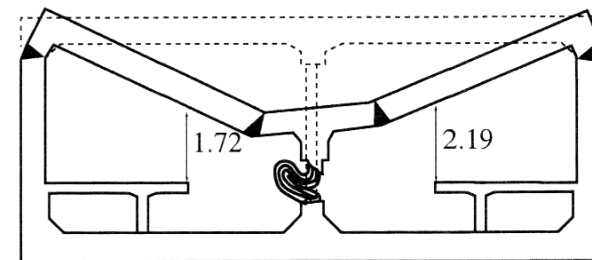
# Daikai station



# Daikai station (2)



(a) Column 2



(b) Column 10

# Failure types

## ● Sand

- Liquefaction
- Cyclic mobility

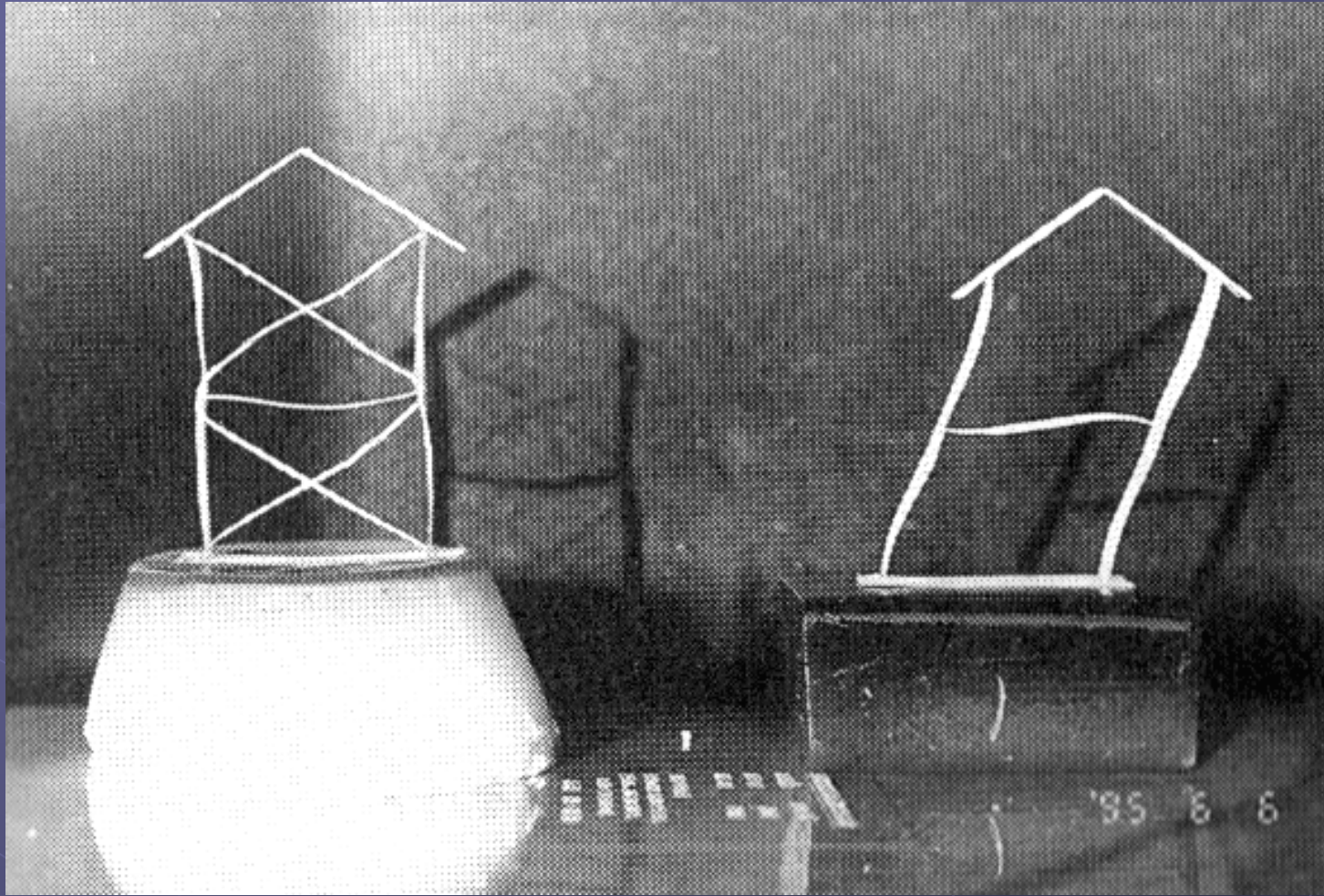
## ● Clay

- Cyclic shear failure

## ● Failure induced by soil

- Lateral pressure, Lateral spreading
- **Signal magnification**
- Uplift pressure

# Signal magnification of clay



# Top view of Kobe port



# Failure types

## ● Sand

- Liquefaction
- Cyclic mobility

## ● Clay

- Cyclic shear failure

## ● Failure induced by soil

- Lateral pressure, Lateral spreading
- Signal magnification
- Uplift pressure



# Uplift pressure

