Role of Research Infrastructures in Seismic Rehabilitation

STABILITY CONTROL OF RAFTED PILE FOUNDATION AGAINST SOIL LIQUEFACTION

THE UNIVERSITY OF TOKYO

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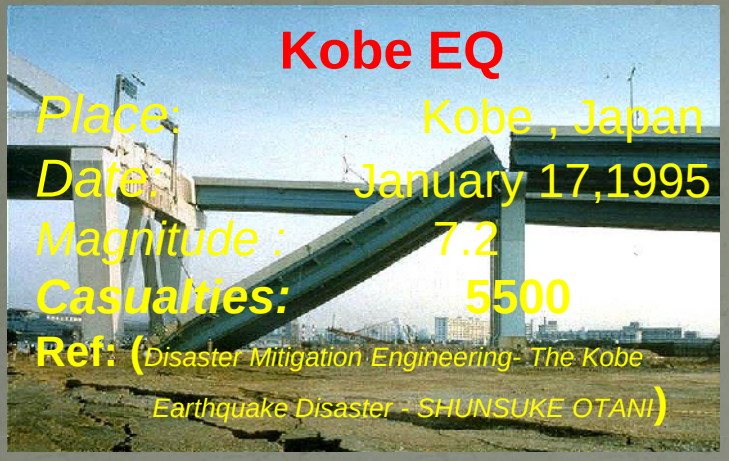
OUTLINE

- **RC & SOIL Models and Verifications**
- **Effect of using Steel Sheet Pile Wall**
- **Conclusions**

Past EQs soil liquefaction

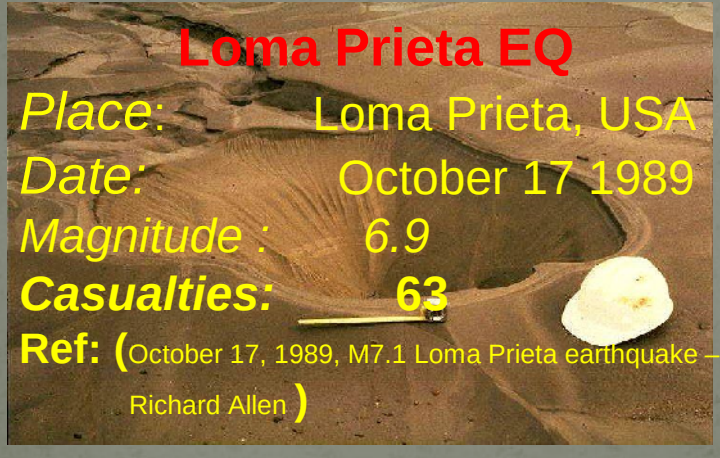


Kobe EQ

Place: Kobe , Japan
Date: January 17,1995
Magnitude : 7.2
Casualties: **5500**
Ref: (*Disaster Mitigation Engineering- The Kobe Earthquake Disaster - SHUNSUKE OTANI***)**

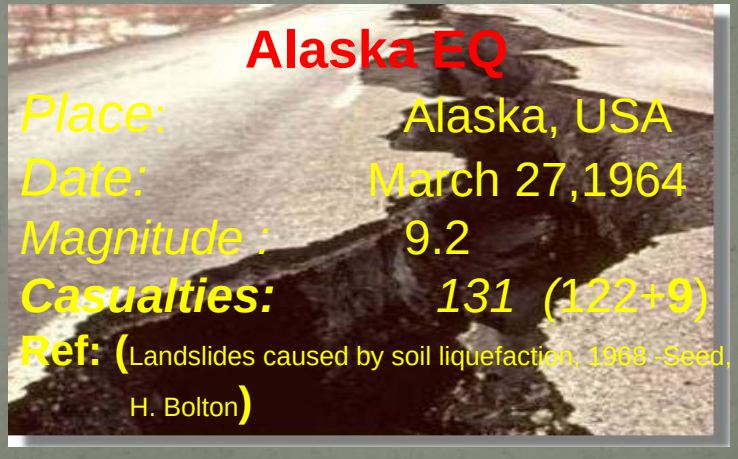
Niigata EQ

Place: Niigata, Japan
Date: June 16,1964
Magnitude : 7.5
Casualties: **28**
Ref: (*General report on the Niigata earthquake of 1964, 1968 - Kawasumi-Hirosi* **)**



Loma Prieta EQ

Place: Loma Prieta, USA
Date: October 17 1989
Magnitude : 6.9
Casualties: **63**
Ref: (October 17, 1989, M7.1 Loma Prieta earthquake – Richard Allen **)**



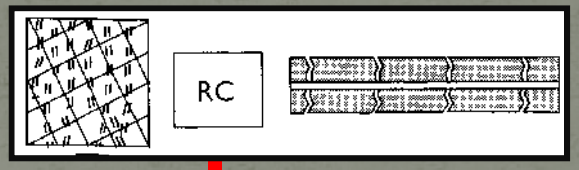
Alaska EQ

Place: Alaska, USA
Date: March 27,1964
Magnitude : 9.2
Casualties: *131 (122+***9***)*
Ref: (Landslides caused by soil liquefaction, 1968 -Seed, H. Bolton**)**

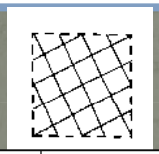
RC & Soil Models and verifications

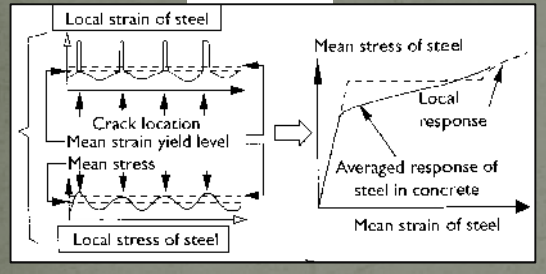
RC & Soil Models and verification

RC MODEL



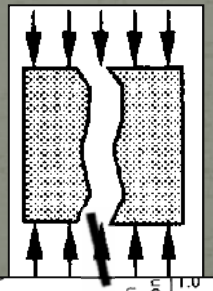
Reinforcement

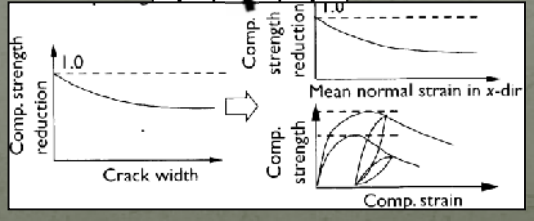




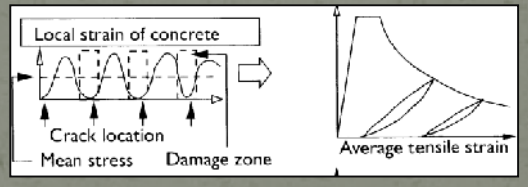
Cracked concrete

Compression model

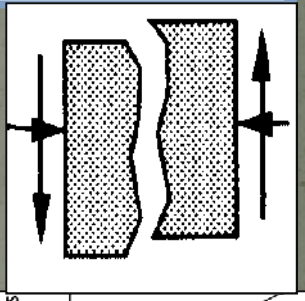


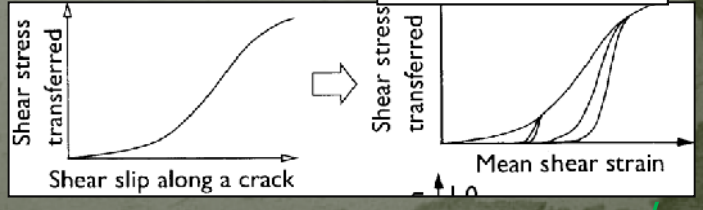


Tension model



Shear model



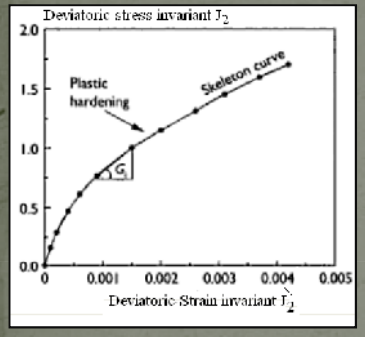


(Maekawa, 2003)

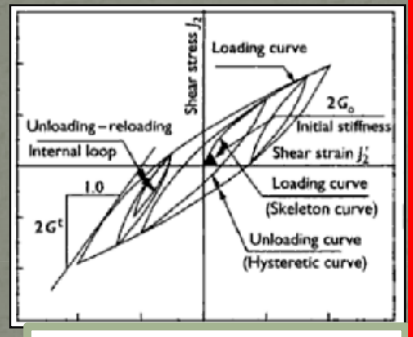
RC & Soil Models and verification

SOIL MODEL

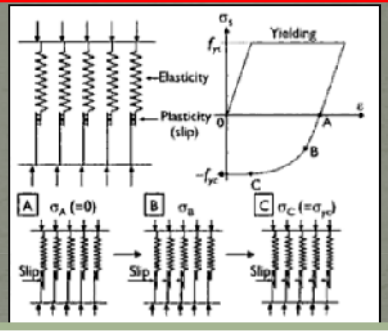
Multi-surface plasticity model

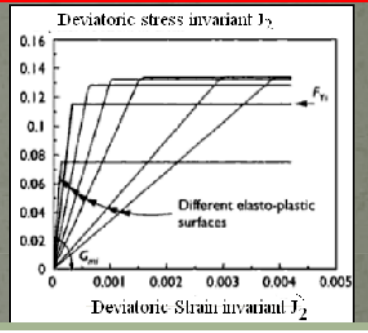


(Maekawa, 2003)

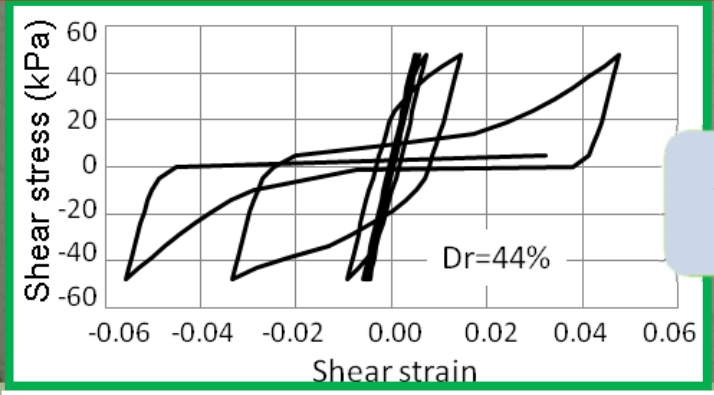


Masing's rule For The hysteresis curves





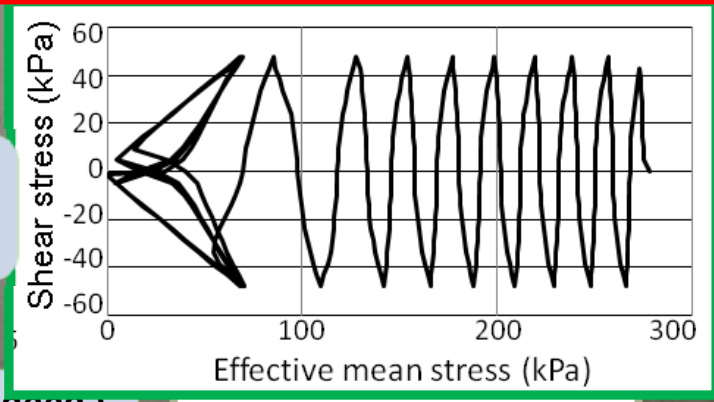
Soils is idealized as an assembly of finite number of elasto-perfectly plastic elements connected in a parallel pattern



Undrained stress-strain behaviour of loose sand

Soil simulation Okhovat (2010)

(Towhata, 2008)

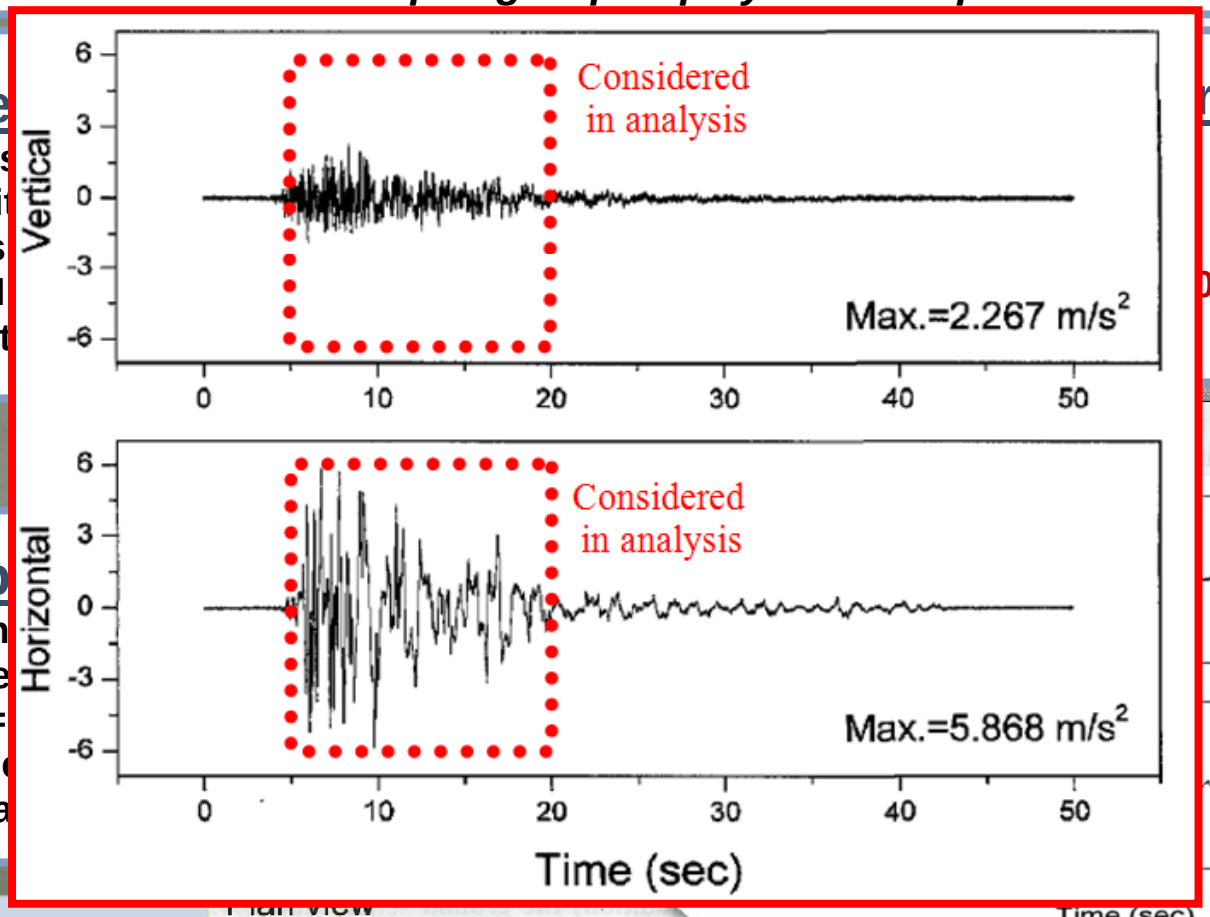


Stress path of loose soil

RC & Soil Models and verification

EXP VERIFICATION

Large scale experiment ***was conducted by*** ***Ramin Motamad & Towhata***
(March 2006 at NIED).
Behaviour of pile group + quay wall + liquefaction

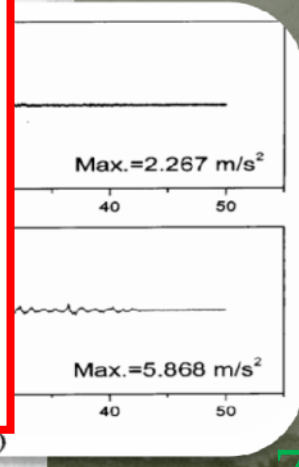


Soil Prope
- Albany silica s
- Specific gravit
- Relative Dens
- Friction angel
- Initial shear st

rties

m^2
m^4
^{11} N/m^2

Pile Prop
- Hollow cylin
- Outer diame
- Thickness =
- Modulus of
- Poisson's ra



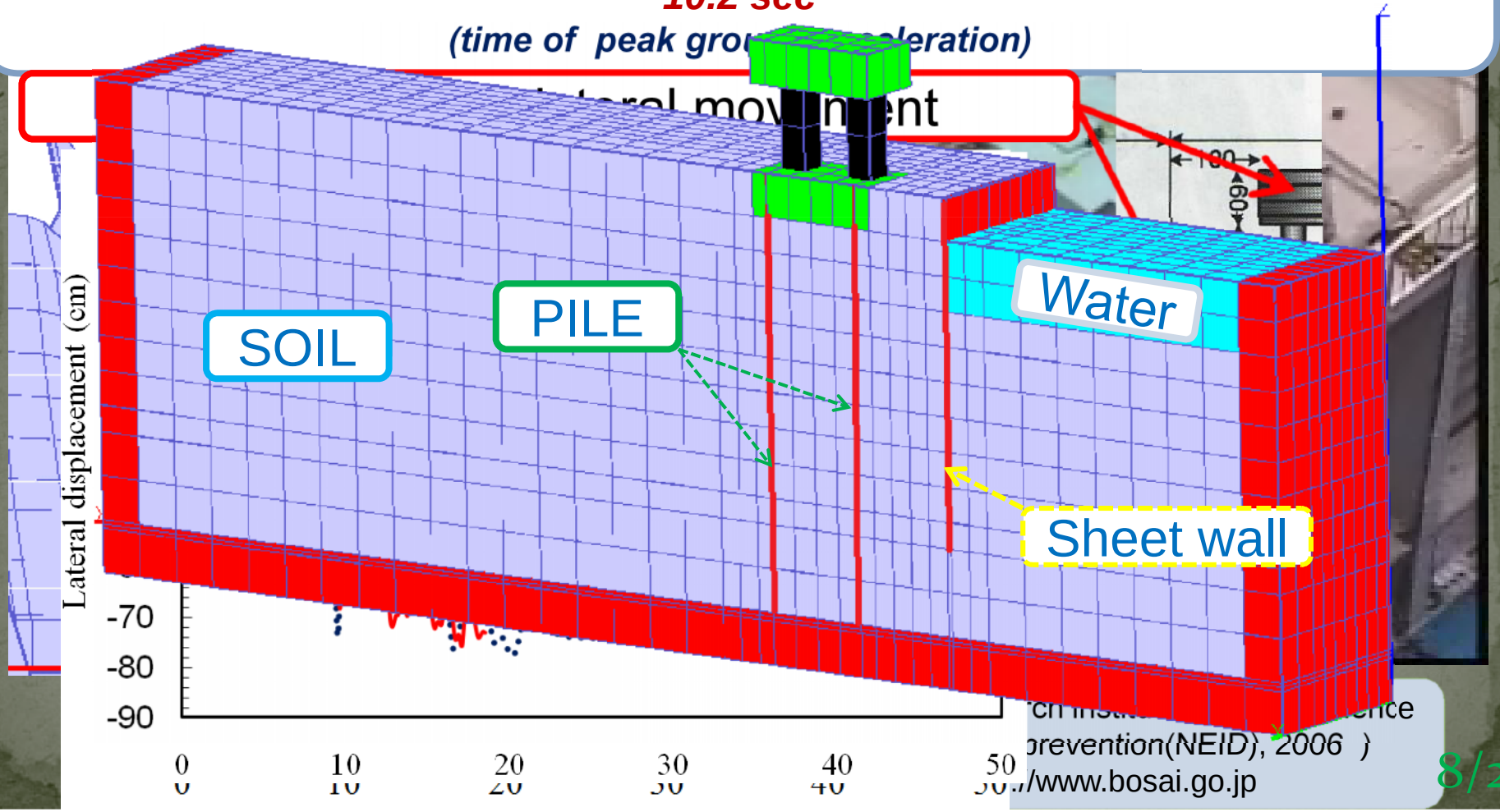
(Motamad &Towhata, 2006)

RC & Soil Models and verification

VERIFICATION

Flexure failure at the piles heads and buckling at middle of piles were occurred and caused tilting of footing toward the quay wall at the time of 10.2 sec

(time of peak gro… …leration)



…prevention(NEID), 2006)

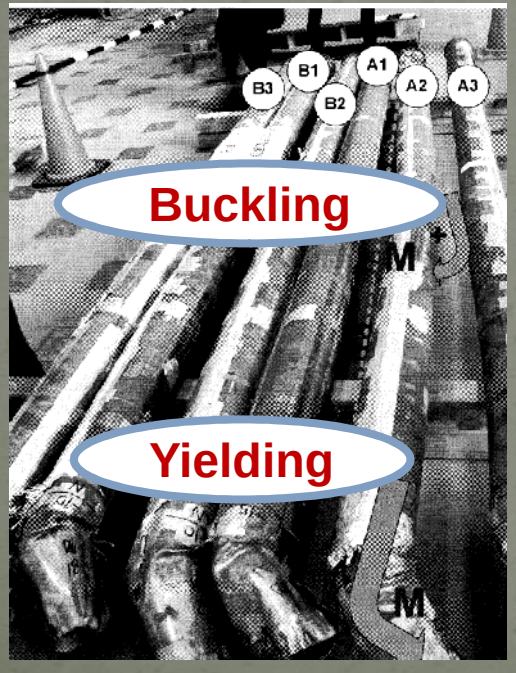
…//www.bosai.go.jp

RC & Soil Models and verification

VERIFICATION

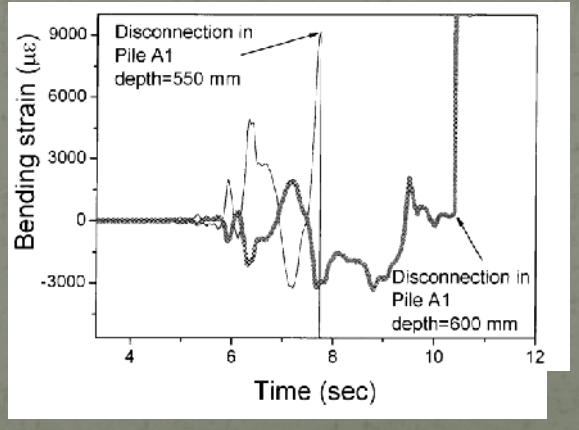
Flexure failure at the piles heads and buckling at middle of piles were occurred and caused tilting of footing toward the quay wall at the time of 10.2 sec
(time of peak ground acceleration)

Piles failure mode : Yielding at heads + Buckling at middle

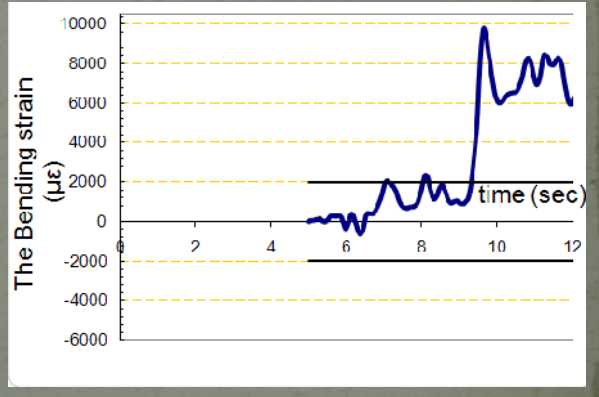


Bending strain profile

Experiment



Analysis

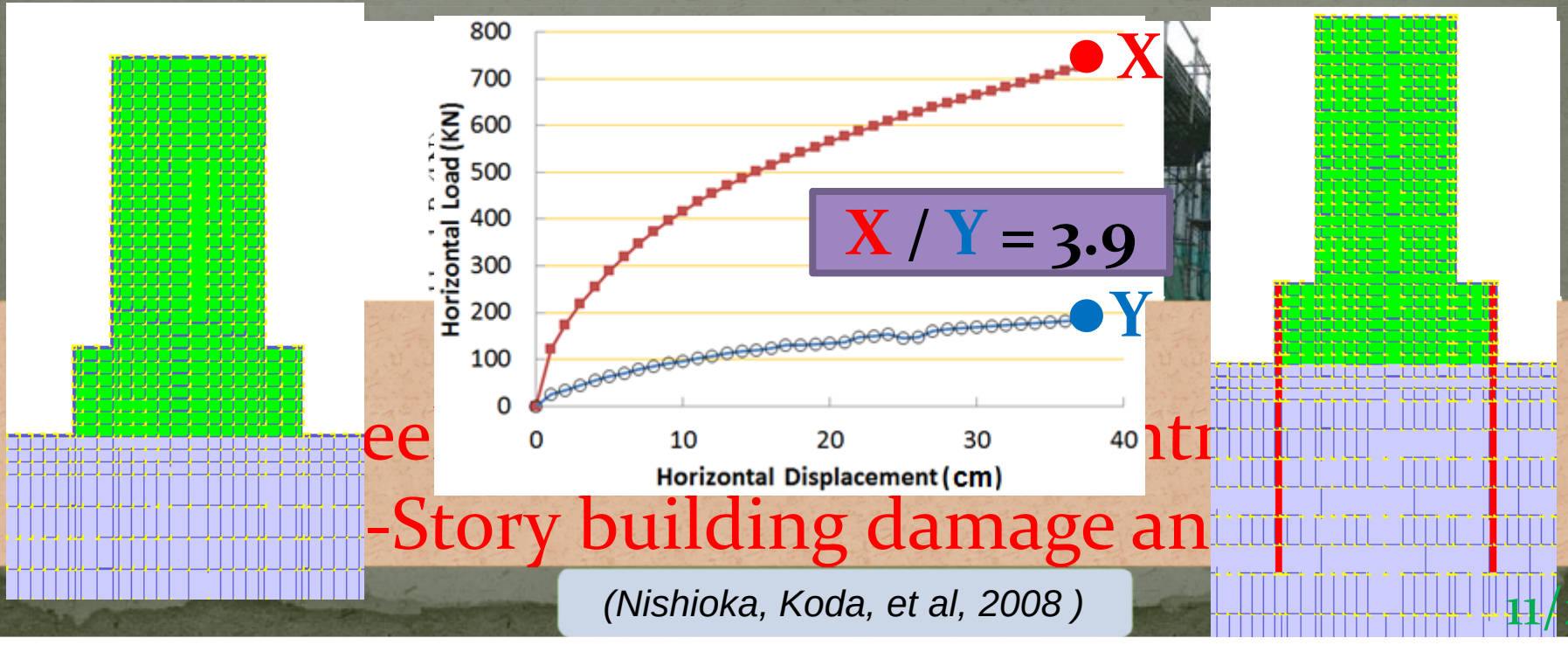


Stability Control using Steel Sheet Pile Wall

Steel sheet pile wall

How is the effect of using sheet pile (SPW) wall to protect multi-story buildings against earthquakes with and without pile foundation.

Nishioka, Koda, et al made a static loading experiments to show how good the permanent use SPW is with soft soil foundation. But , the application was for a single column foundation . So the effect on a full scale building is investigated under earthquake motion(PGA =0.5g , same soft liquefied soil properties mentioned before).



ee ntr

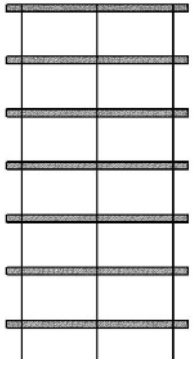
-Story building damage an

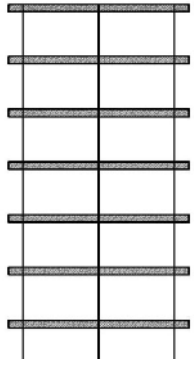
(Nishioka, Koda, et al, 2008)

Steel sheet pile wall

How is the effect of SPW to protect multi-story buildings against earthquakes with and without pile foundation.

No pile + No wall | **pile + No wall** | **No pile + wall** | **pile + wall**





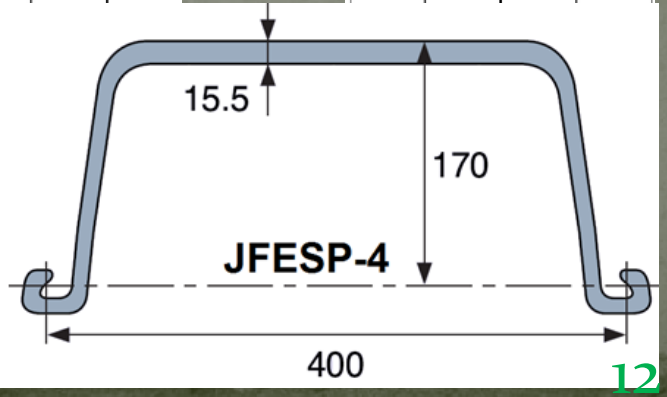
Sheet pile wall: JFESP-4

Piles : 0.5 % Rft (70cm*70 cm)

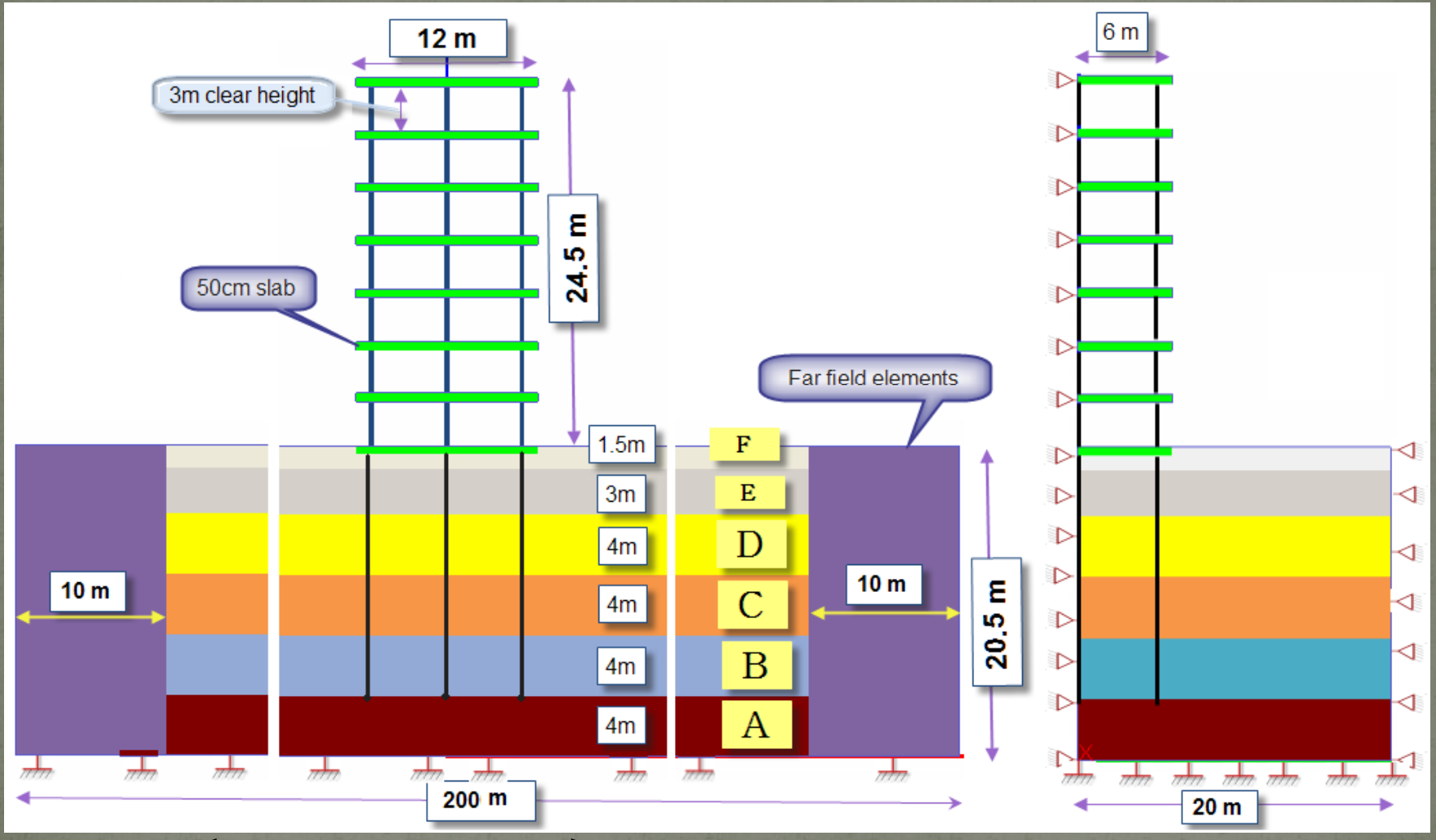
Soil properties: soft saturated sand

Earthquake : as shown before (PGA =0.5 g)

Properties per 1 m of Wall			
Sectional Area	Mass	Moment of Inertia	Section Modulus
242.5 cm2/m	190.0 kg/m	12090 cm4/m	1175 cm3/m

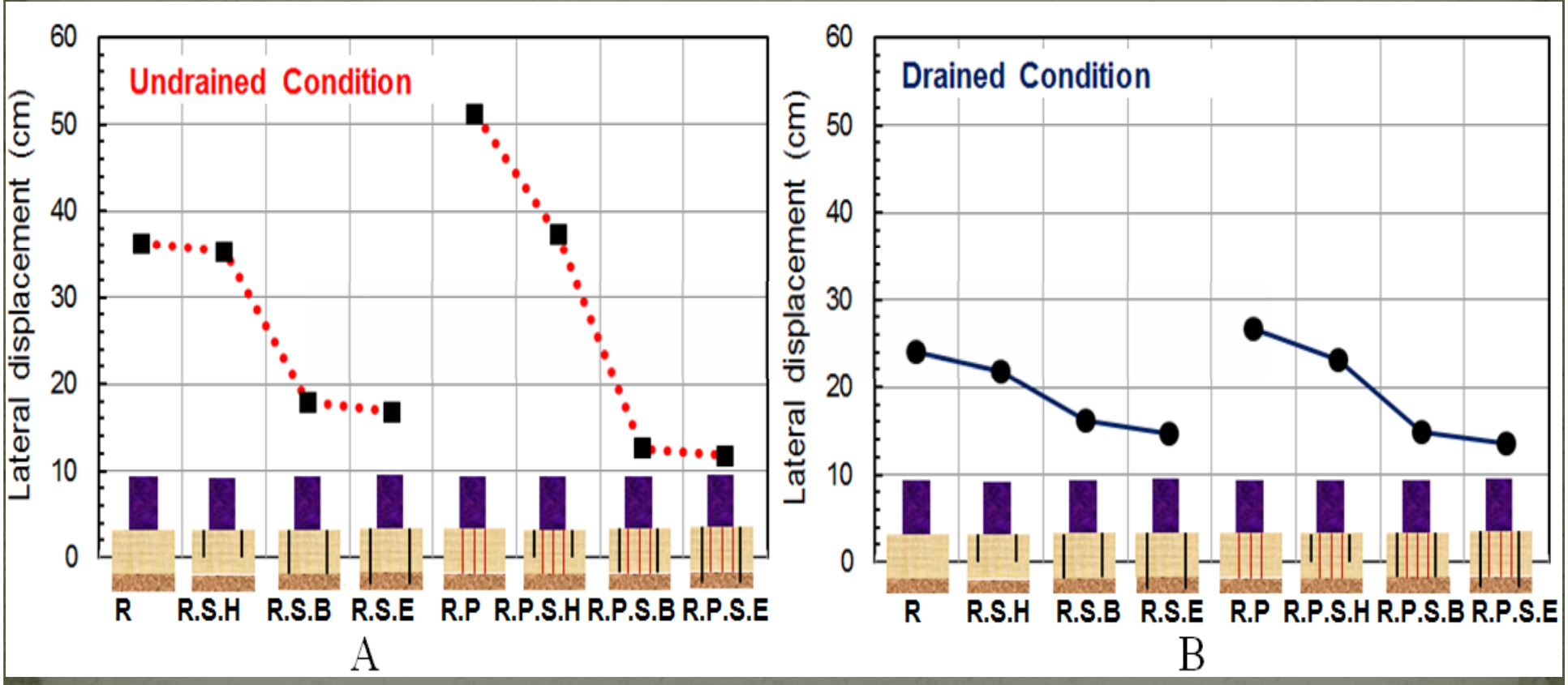


Steel sheet pile wall

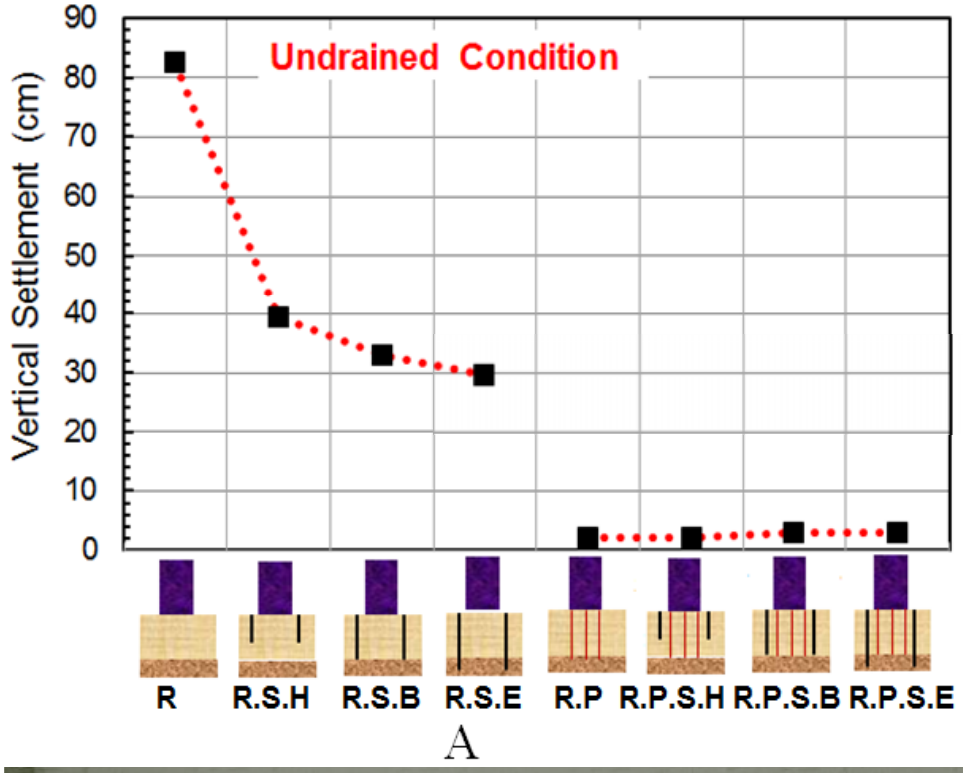


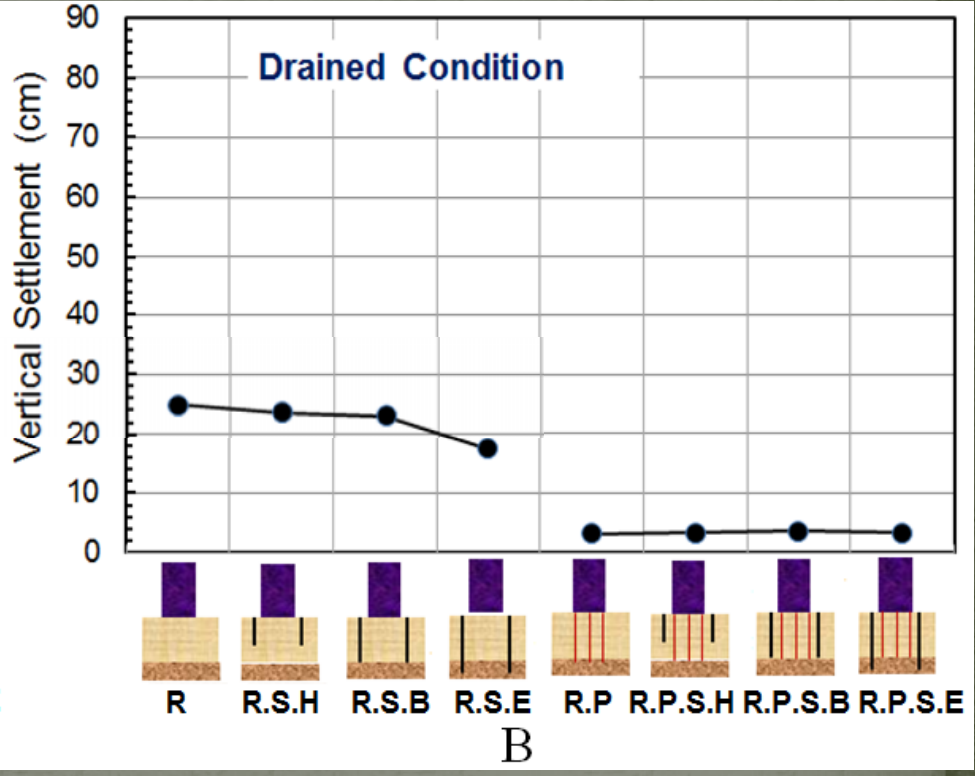
SHAKING DIRECTION

Steel sheet pile wall

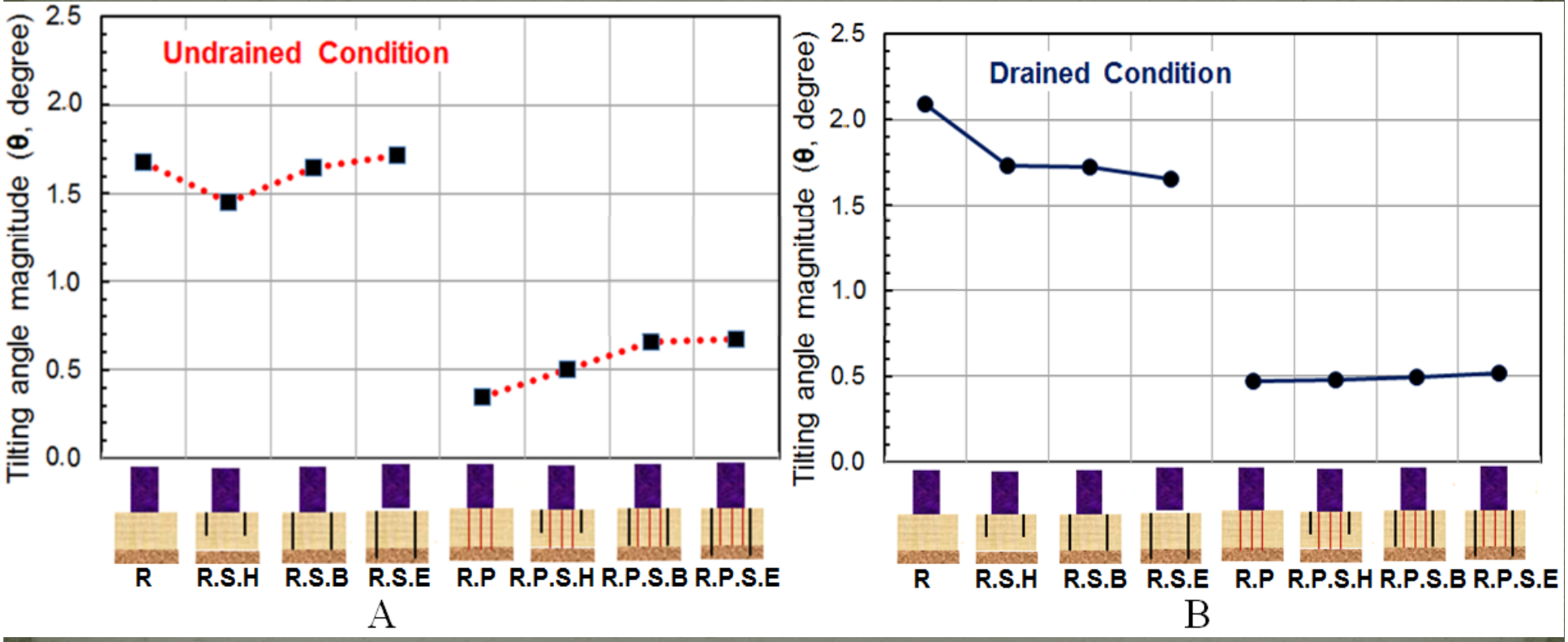


Steel sheet pile wall

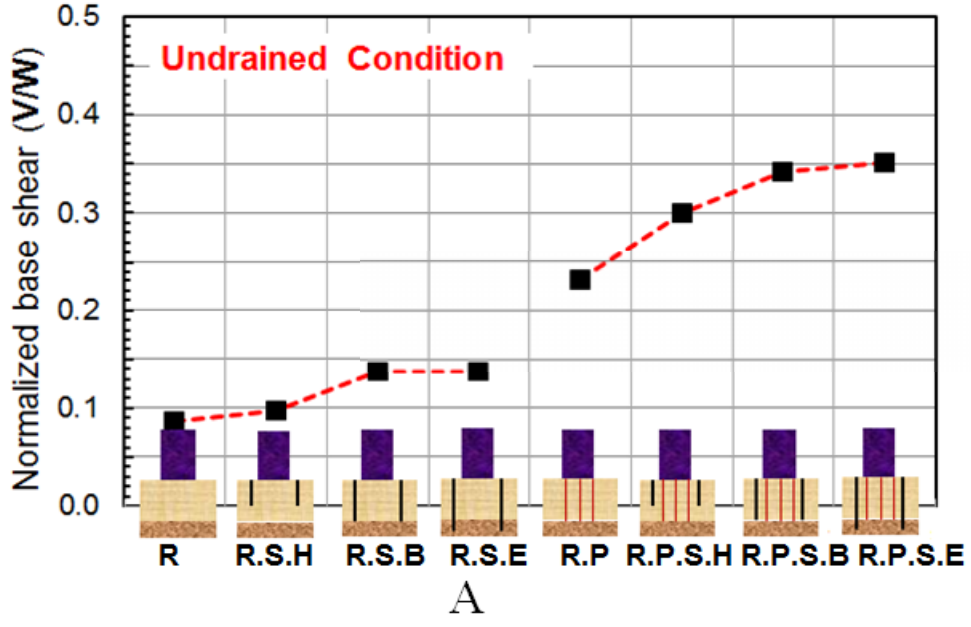




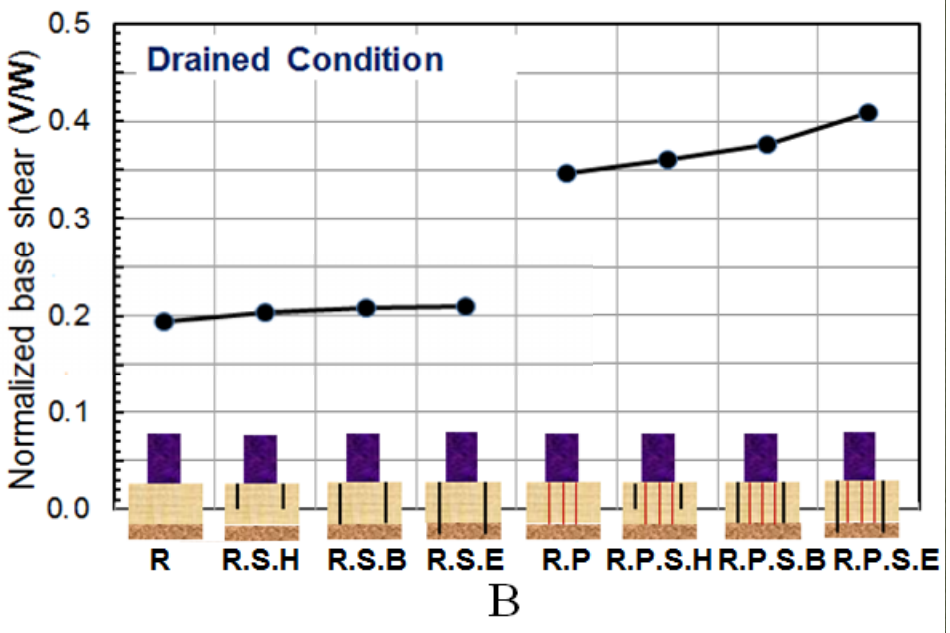
Steel sheet pile wall



Steel sheet pile wall

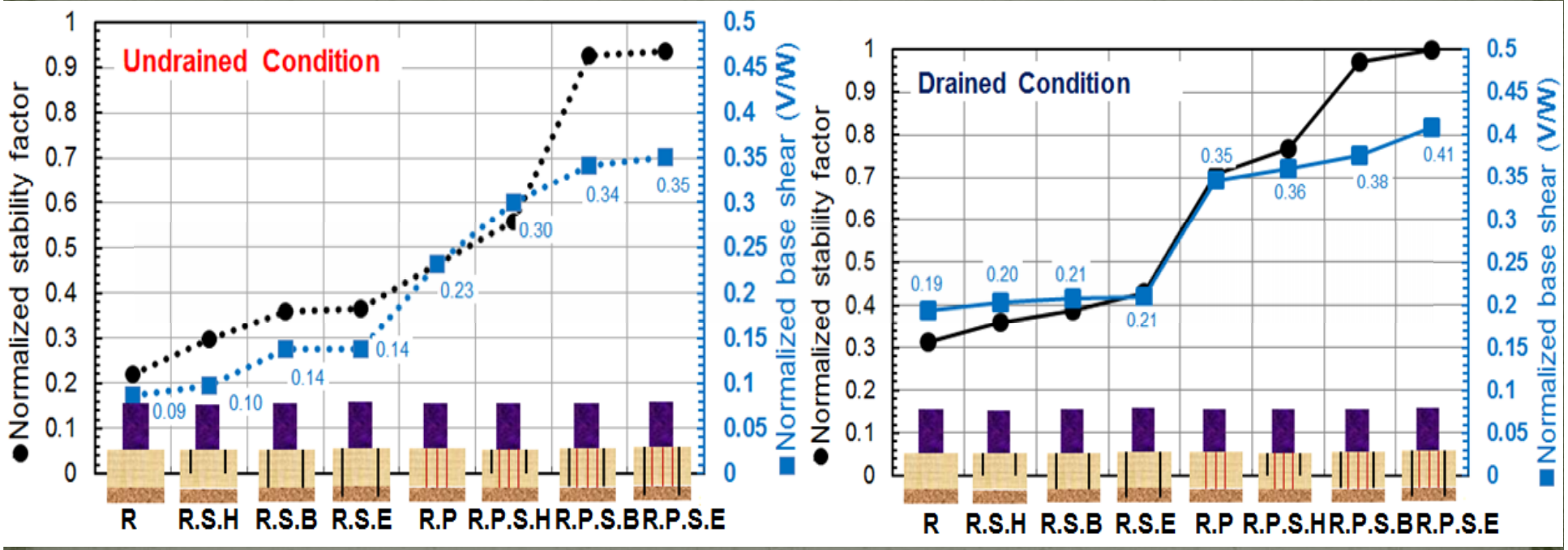


A



B

Steel sheet pile wall



Conclusions

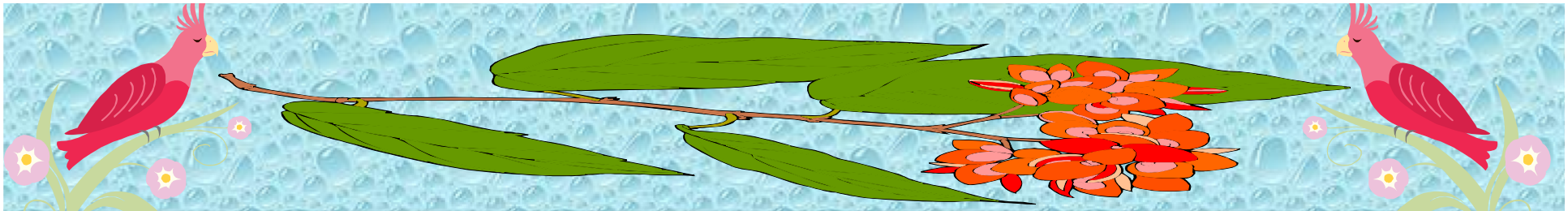
- Seismic performance of variant types of Foundations

- Using SSPW >>> >>> >>> Higher overall stability
  >>> >>> >>> Higher base shear

- Existing Buildings on liquefiable soil foundation

SSPW bearing on the non-liquefiable soil surface might be an optimum solution for strengthening the building against soil liquefaction.

- Raft with SSPW may be a good alternative for Pile foundation



Thanks for your attention

ご清聴ありがとうございました

شكرا لاهتمامكم