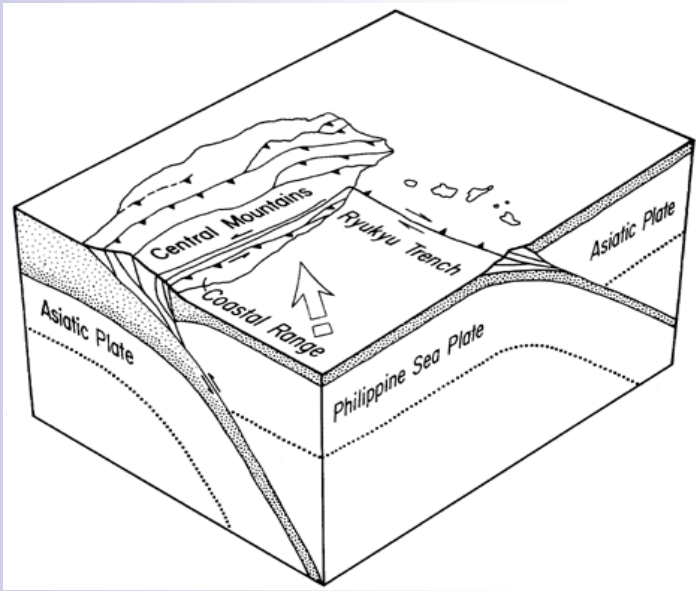
Introduction of National Center for Research on Earthquake Engineering (NCREE)

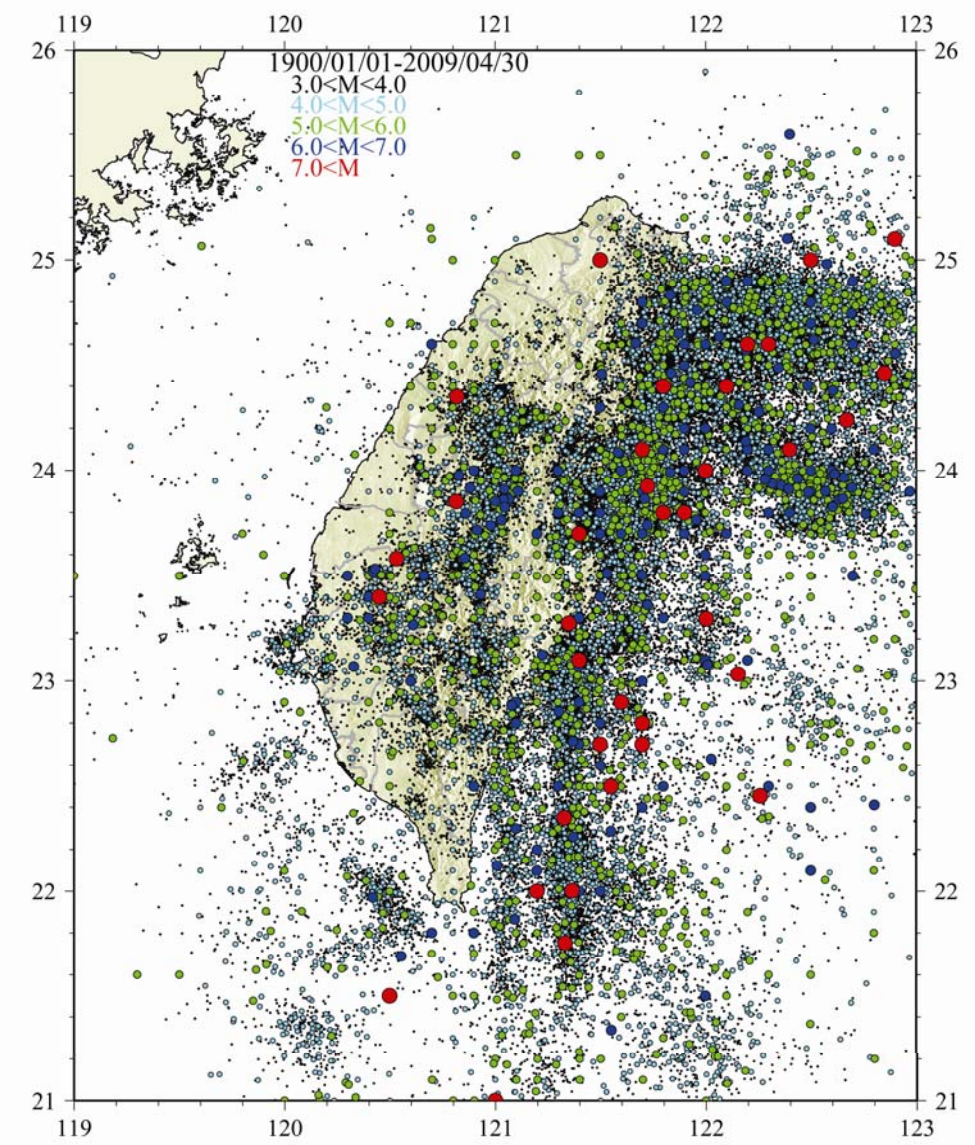
Prof. Kuo-Chun Chang
Director, NCREE
Professor, National Taiwan University, Taipei, Taiwan

December 6, 2010

Seismicity in Taiwan (1900-2009)



Tectonics of Taiwan



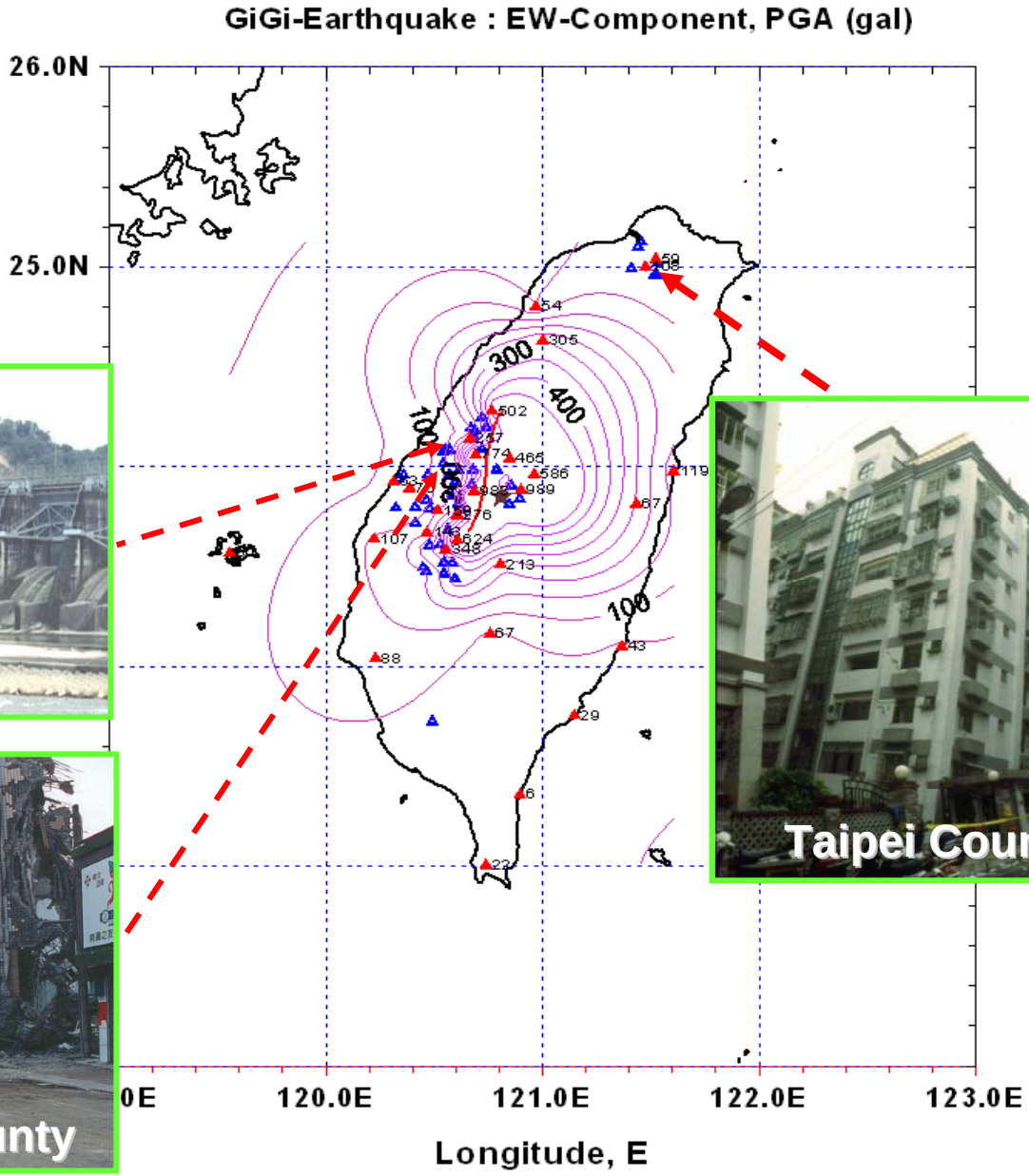
Earthquake Distribution of Taiwan (A.D.1900-2009)

國家地震工程研究中心
National Center for Research on Earthquake Engineering

1999 Chi-Chi Earthquake

Ml=7.3

Sept. 21, 1999



Evolution of NCREE

- Project awarded by NSC to NTU in 1990
- Merged into NARL as one of the Centers in 2003
- Directorship
  - Prof. K.C. Chang（2010- Present）
  - Prof. K.C. Tsai（2003- 2010）
  - Prof. C.H. Loh（1997-2003）
  - Prof. C.S. Yeh（1990-1997）
- Major experimental facilities have been in operation since 1997 when the construction of the lab was completed

Vision and Mission

- Pre-quake preparation, emergency response and post-quake recovery
- Integrate research capacities of various earthquake engineering research institutes in Taiwan to enhance the research capability of the nation
- Promote international research cooperation for earthquake hazard mitigation, and play a key role in the earthquake engineering research community of the world

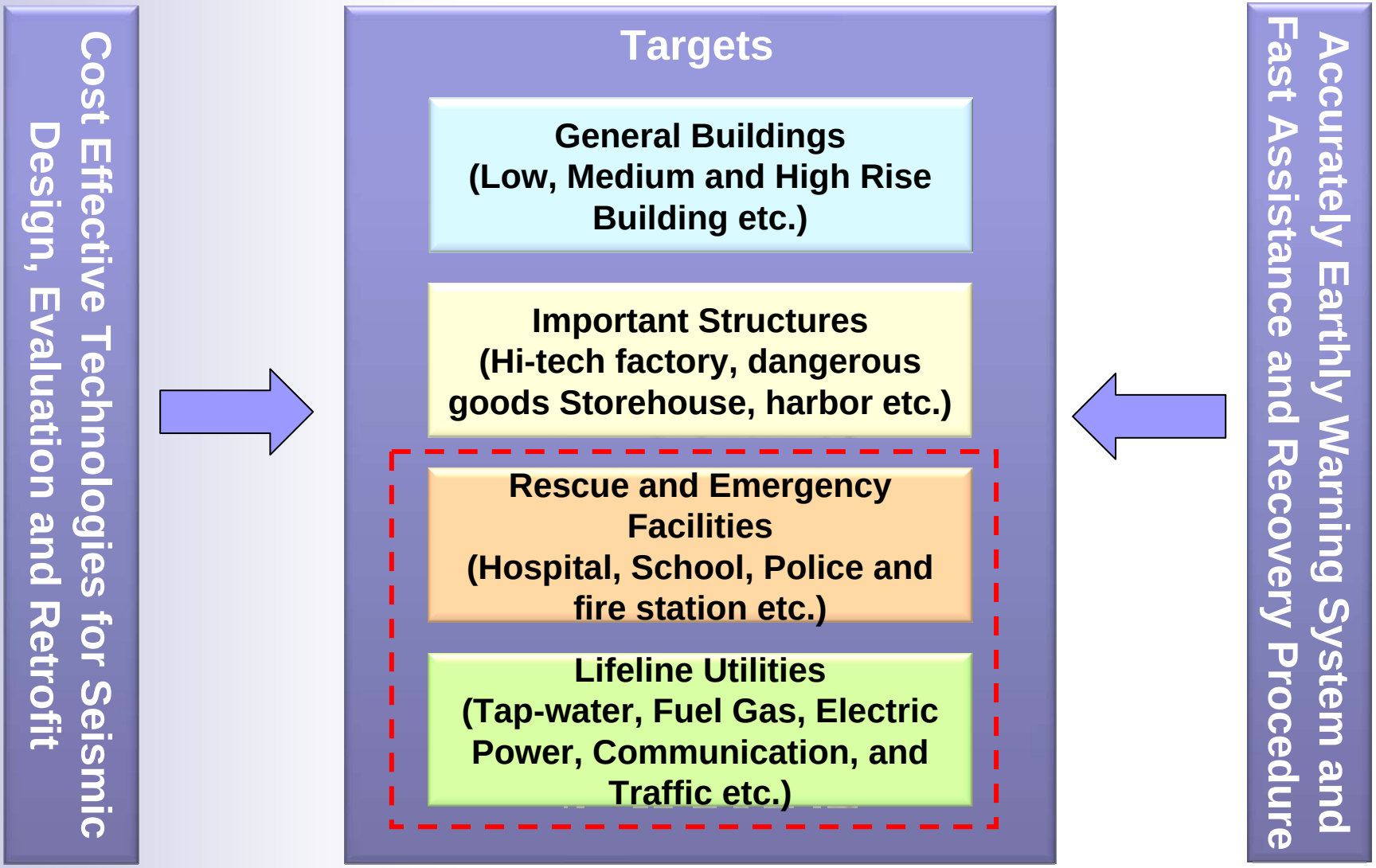
Vision - Recoverable and Sustainable Communities

Fast recovery

Safe and Operational

Safe and Usable

Medium-term: Enhancing Community Resilience



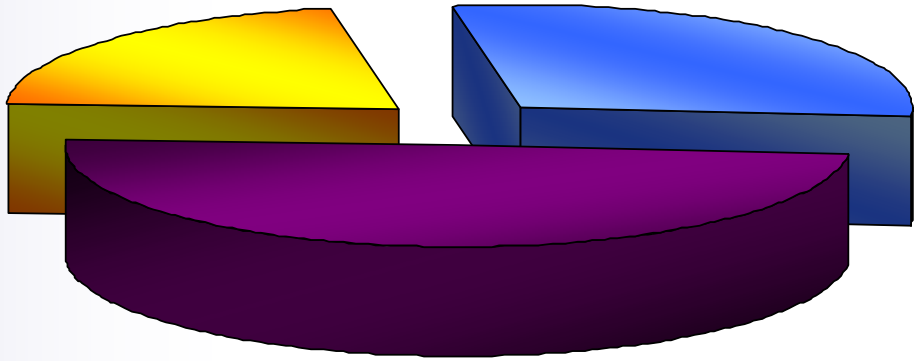
Improving Seismic Resistance of Specific Structures

Personnel (2010)

A total of 106 employees

23 others
22%

30 PhD
28%



53 MS
50%

Revenue in 2009

(9.58 million US dollars for 2009)

民間委託計畫

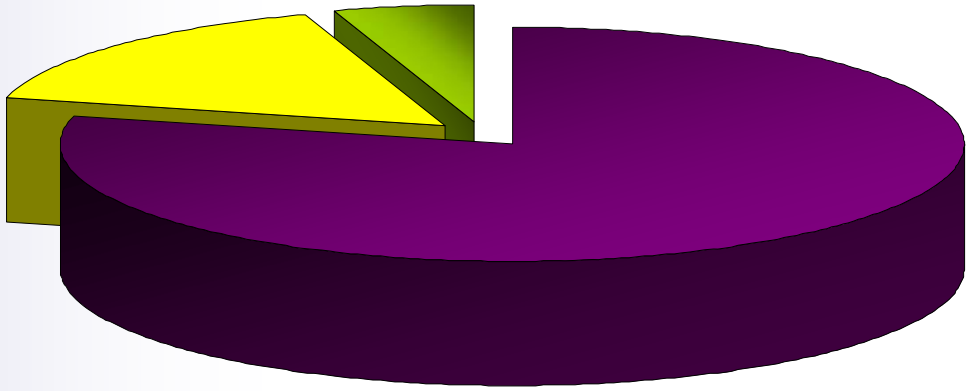
US 472 thousand

4.9%

政府委託計畫/個案服務收入

US 1,549 thousand

16.2%



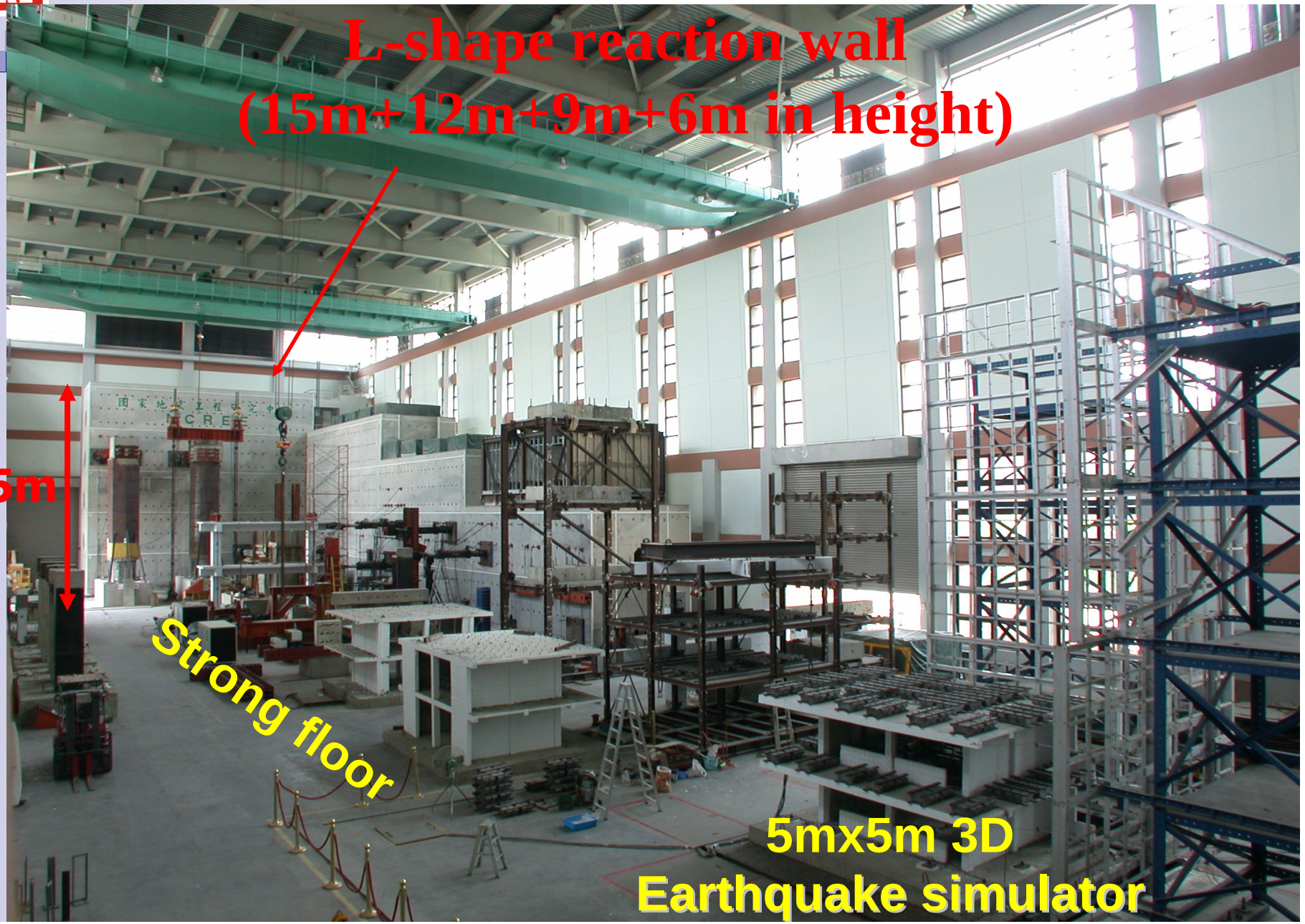
公務預算

US 7,560 thousand

78.9%

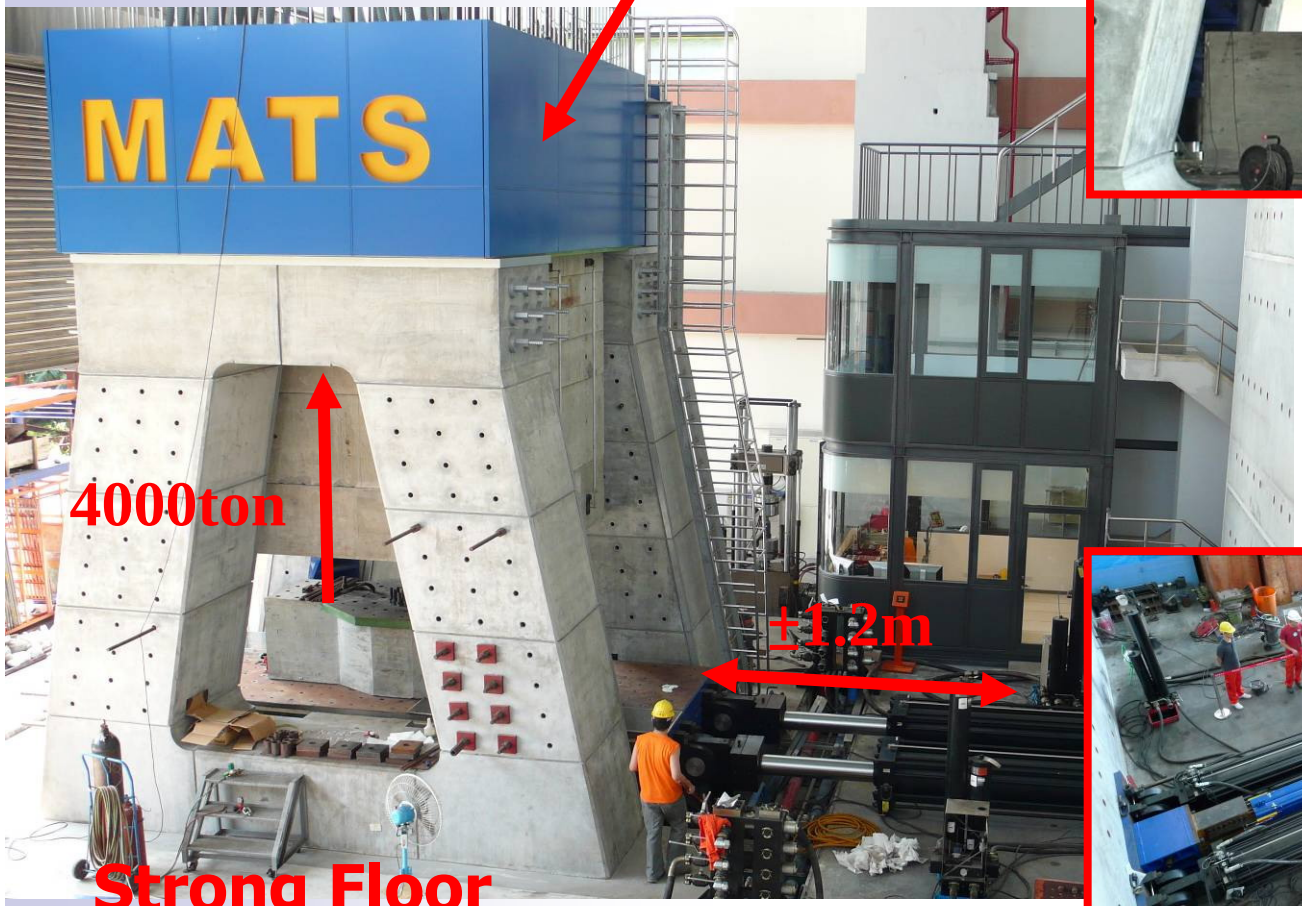
(7.56 million US dollars from NSC)

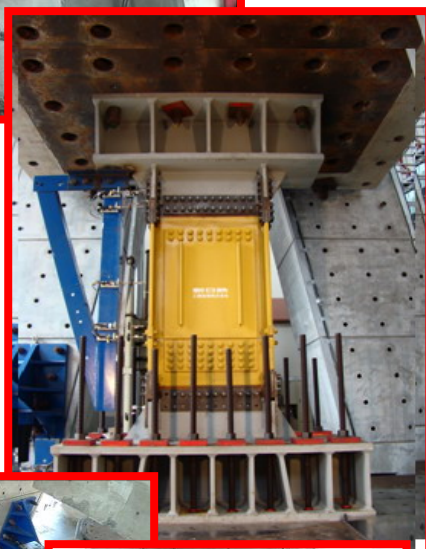
Experimental Facilities



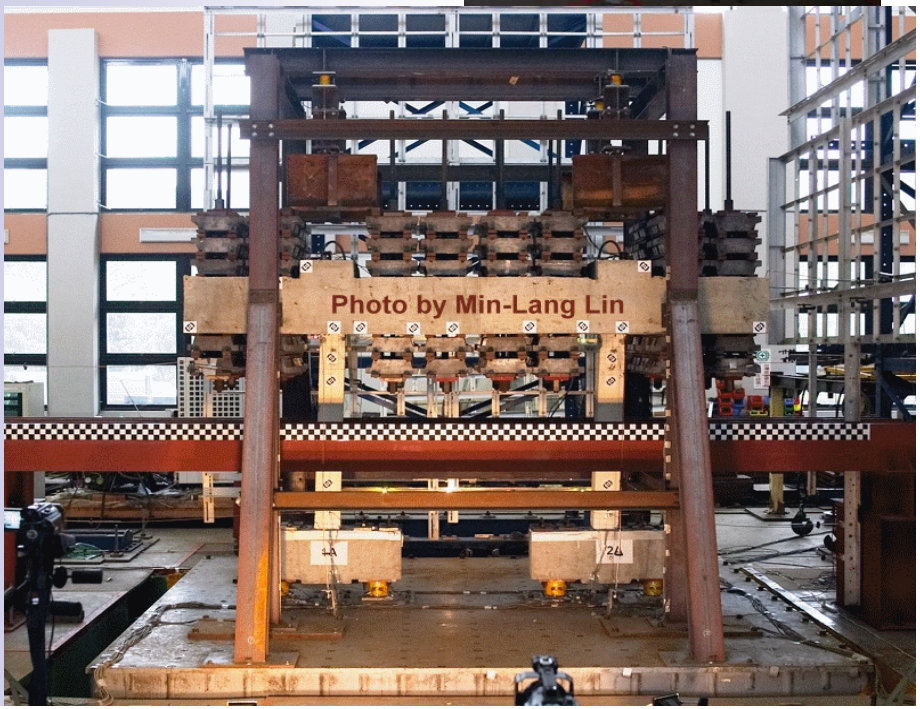
Experimental Facilities

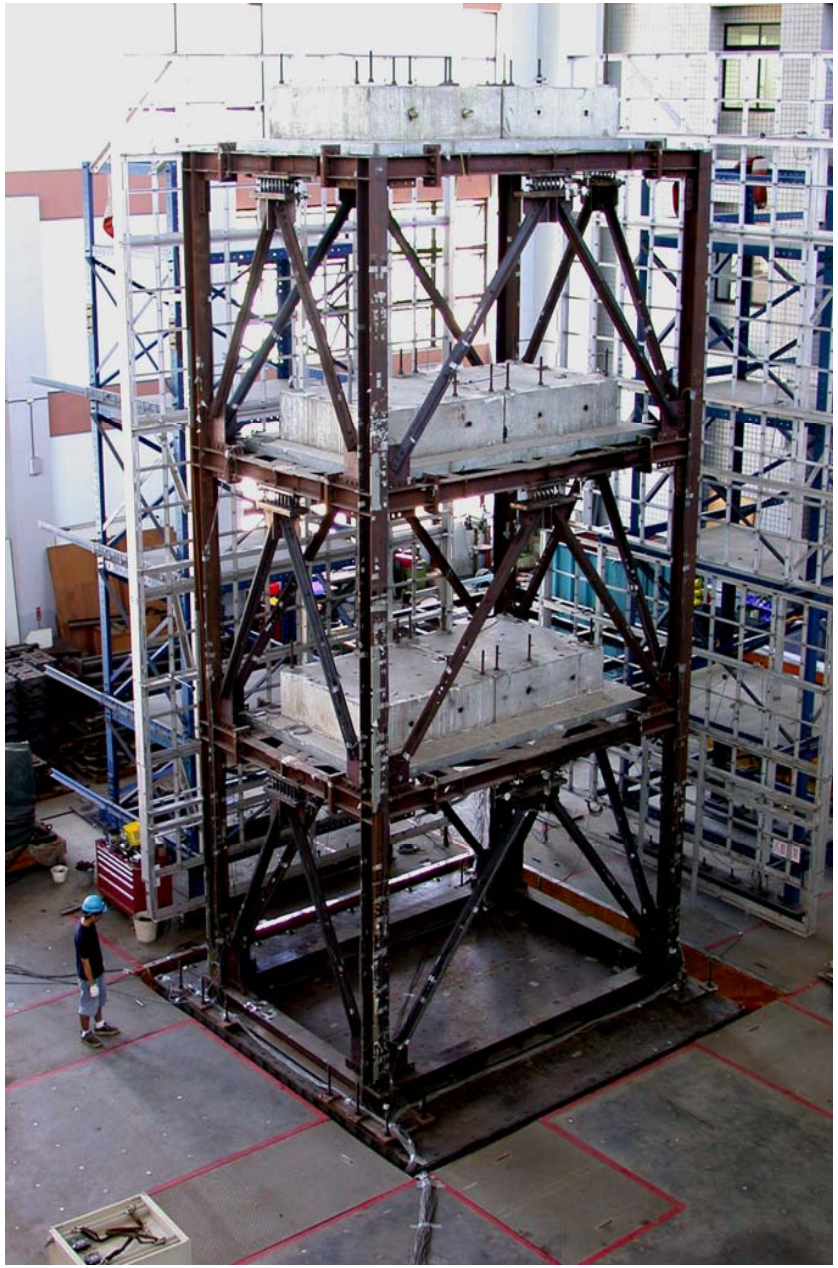
Multi-Axial Testing System (MATS)





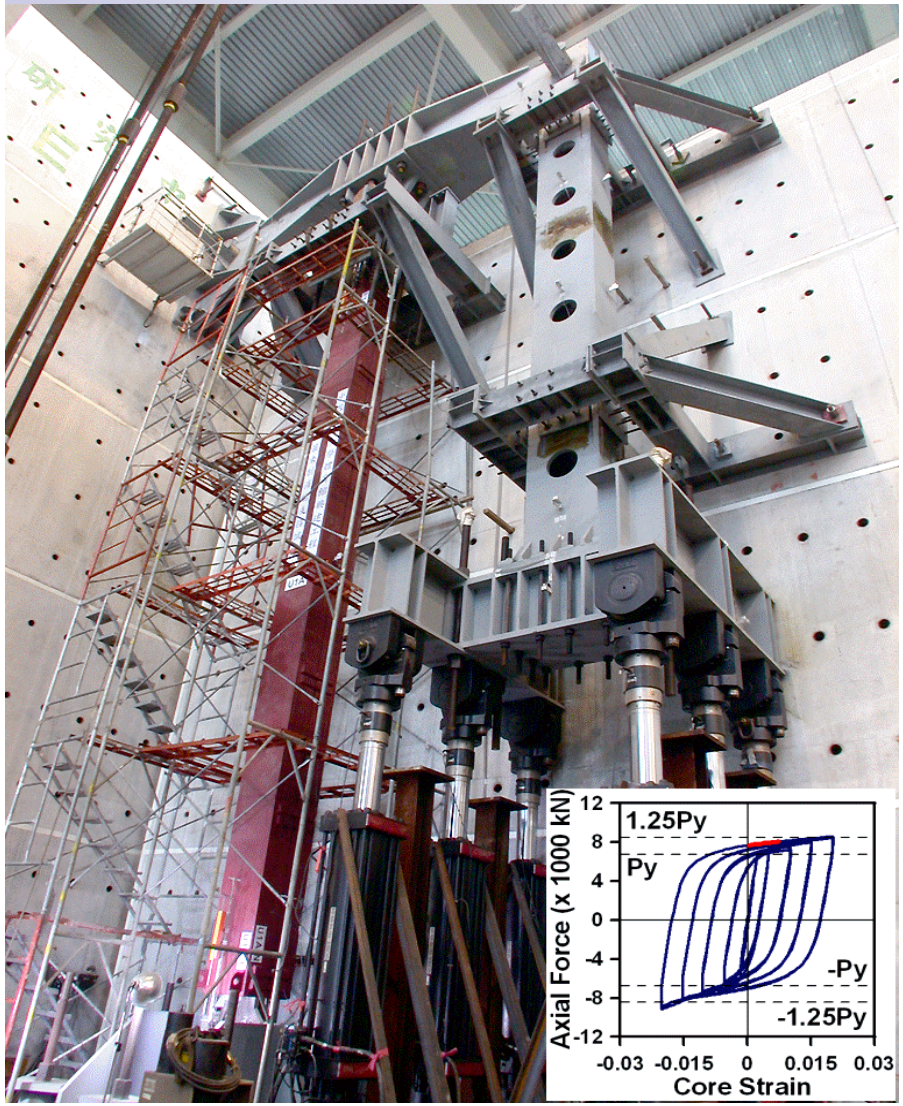
Shaking Table Tests





Reaction Wall Tests - Full Scale Structural Element Tests

World-Largest BRB Test



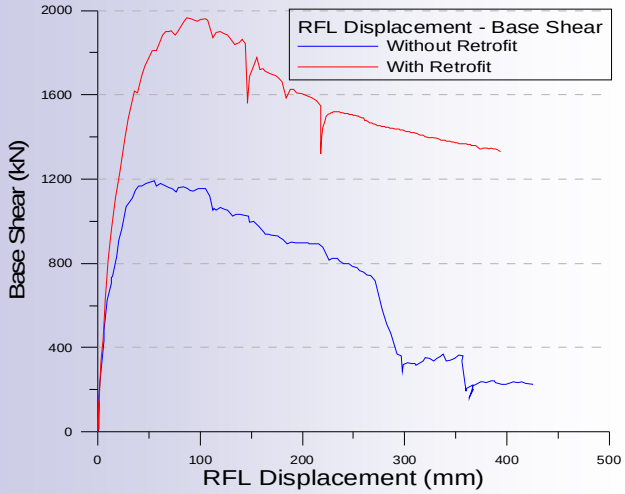
Contribution to Evolution of Seismic Design Codes

- Building structures
- Highway bridges
- Seismic isolation and energy dissipation design
- Railway bridges
- Qualification for seismic isolation and energy dissipation devices

Seismic Evaluation and Retrofit of School Buildings

- Strategy was proposed.
- Methods for simple survey, preliminary evaluation, detailed evaluation and retrofit design were developed.
- Handbook was published.
- Workshops were held for engineers and school administrations.

In Situ Pushover Test



Effectiveness of Retrofit

In Situ
Pseudo Dynamic Test

Laboratory
Full Scale Cyclic Test

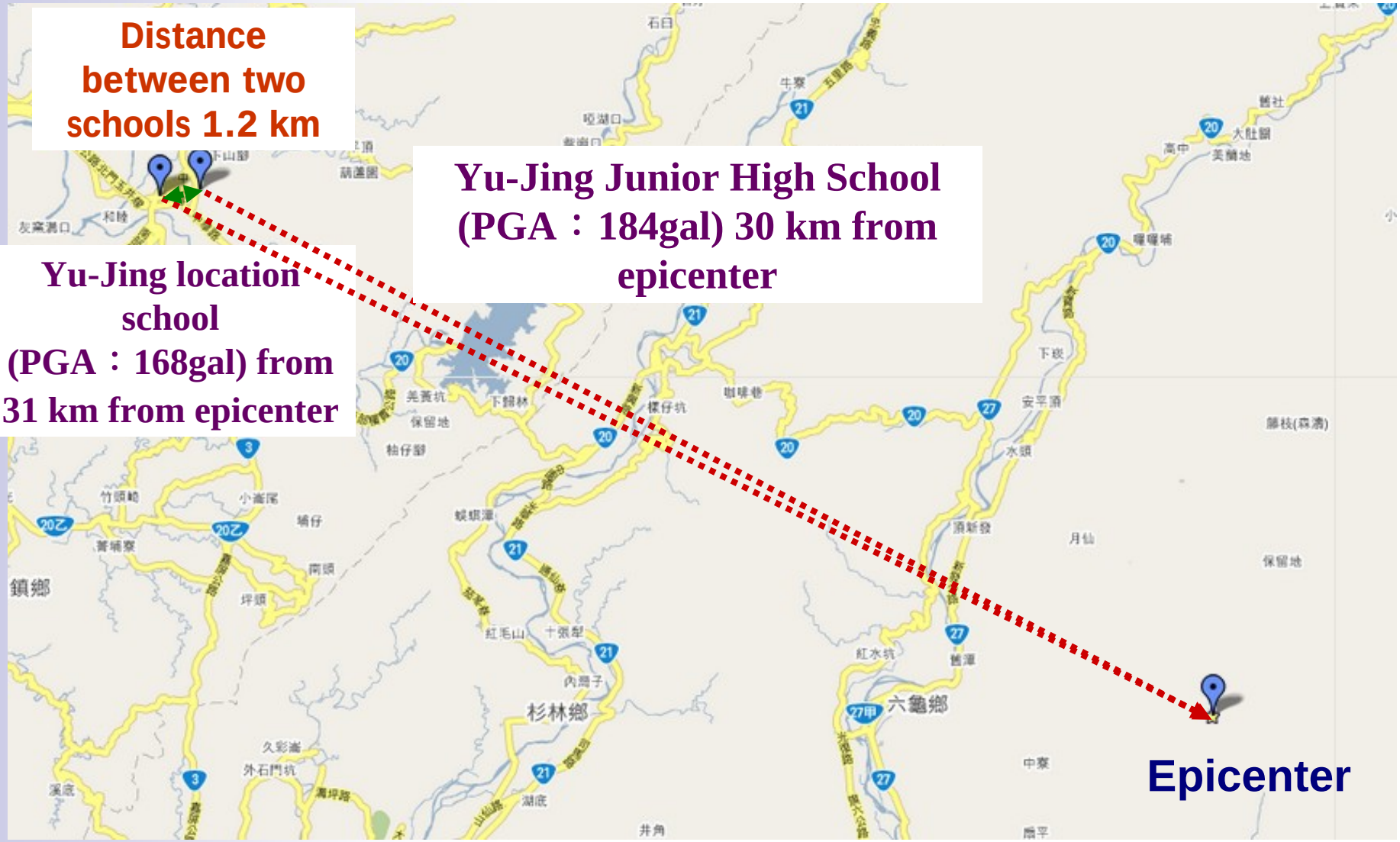
國家地震工程研究中心
National Center for Research on Earthquake Engineering

Project on Seismic Upgrading for Buildings of Elementary and Secondary Schools

- Project was approved by the Legislation Yuan as part of economy stimulus to expand investment in public works in response to financial tsunami.
- NT$18.3 billion was allocated for seismic upgrading of elementary and secondary school buildings. 1,500 school buildings will have been retrofitted in four years, from 2009 to 2012.
- In order to conduct the project systematically and effectively, NCREE was entrusted by the Ministry of Education to establish a special office to offer support on administration and technology. Data base was set up to support decision making. Specification was drafted to standardize operation procedures. Training courses were held for dissemination.

In Situ Experiment on Seismic Performance of School Buildings

20100304 Jia-Xian Earthquake Location of Yu-Jing Junior High School (Grades 7-9) and Yu-Jing Vocational School (Grades 10-12)



20100304 Damages of School Building in Jia-Xian Earthquake

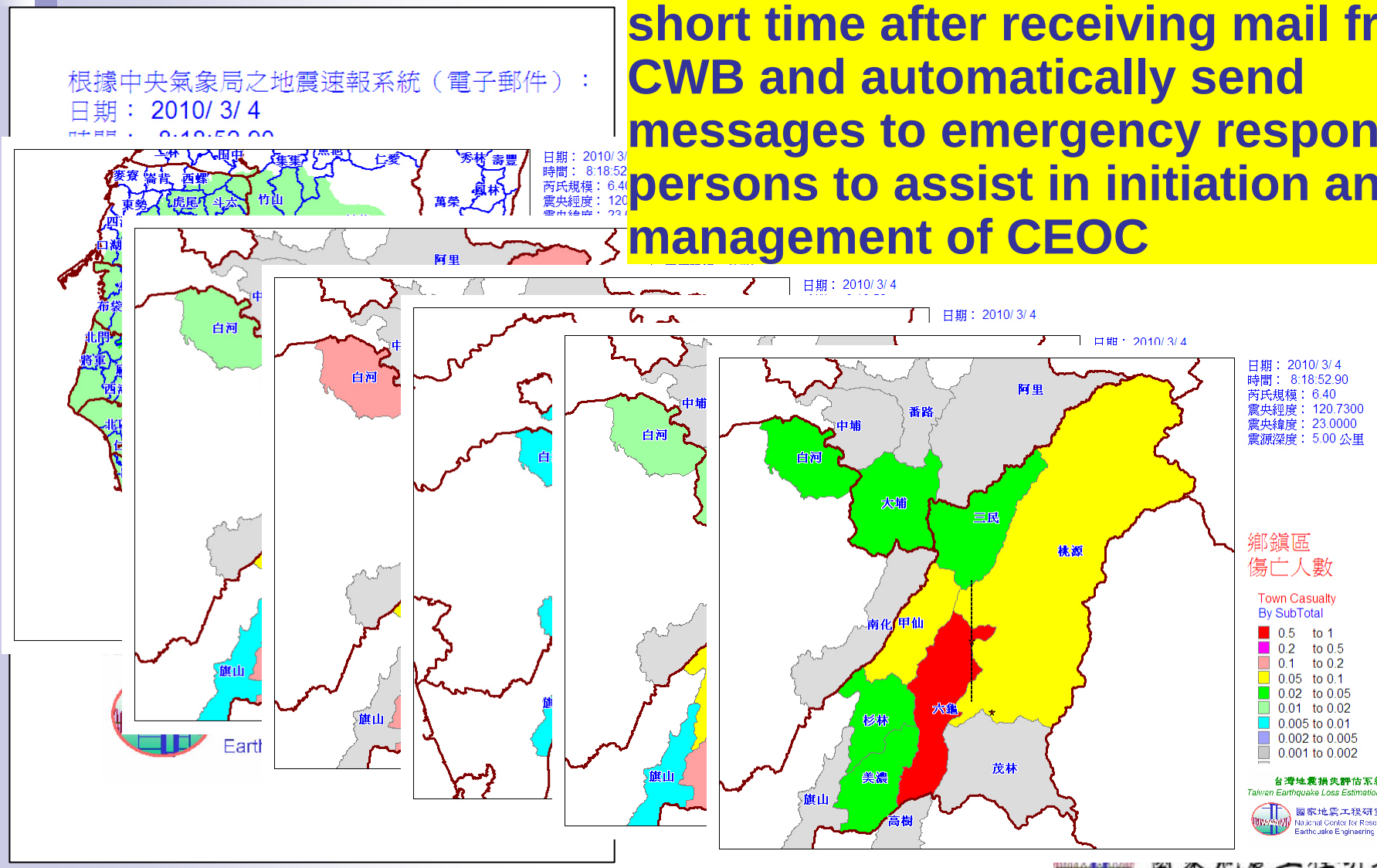
- After the earthquake, three reconnaissance teams were sent to the disaster area.
- Yu-Jing Junior High School and Yu-Jimg Vocational School were about 30 km from the epicenter. The distance between the two schools is about 1 km.
- Three buildings without retrofit in Yu-Jing Junior High School were found seriously damaged.
- No damage was observed in the buildings with retrofit in Yu-Jing Vocational School.

Yu-Jinh Junior High School

Yu-Jinh Junior High School

Taiwan Earthquake Loss Estimation System (1/2)

Complete loss assessment within short time after receiving mail from CWB and automatically send messages to emergency response persons to assist in initiation and management of CEOC

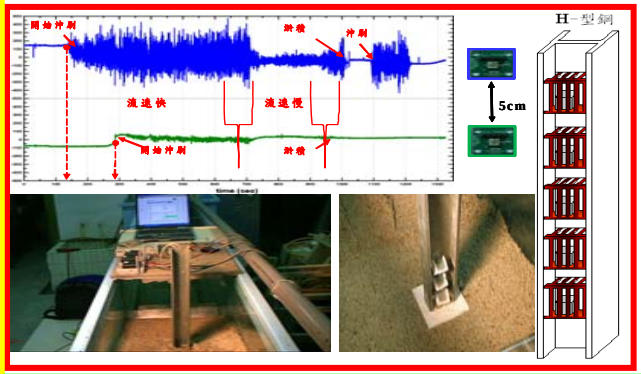


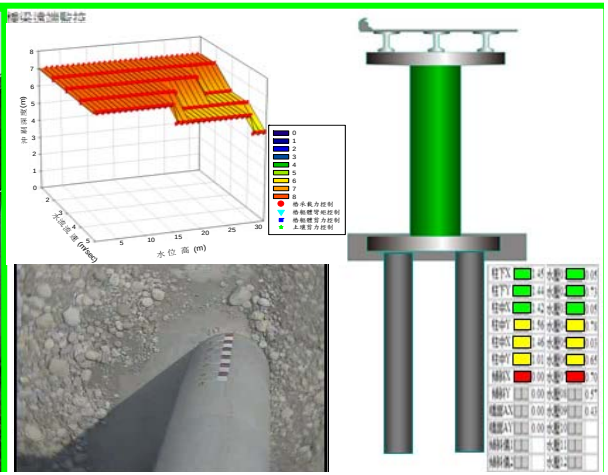
Taiwan Earthquake Loss Estimation System (2/2)

- Early seismic loss estimation improves the efficiency of emergency responses
- Seismic disaster simulations provides useful data (PME, rescue & medical resources, etc.) for disaster reduction plans
- Probabilistic seismic risk assessment has been applied in TREIF-ERA to study insurance policy and to update risk measures
- Risk assessment of highway bridges has been applied in prioritization of retrofit sequence of bridges of DGH, MOTC

Bridge Multiple Hazard Monitoring System

- Multiple hazards, especially earthquake and flooding scour, must be properly considered and constant monitored for crucial bridges. Scour failures tend to occur suddenly and without warning. Hydraulic scouring is one of the major factors for bridge failure. Bridges that are subject to periodic flooding should be monitored during high-flow seasons for the safety of the public. NCREE has been focused on this bridge scouring problems and developed a series multiple hazards monitoring systems using the wireless sensor network technology.
- The performance of the resistance characteristics of a pier under the condition of a torrential flood or earthquake can then be monitored in real-time, whenever it happens. Wireless sensor networks using the Zigbee protocol provide real-time information will be of significant help to bridge authorities for both bridge operation and maintenance under natural disaster conditions.





Precast segmental post-tensioned concrete bridge columns

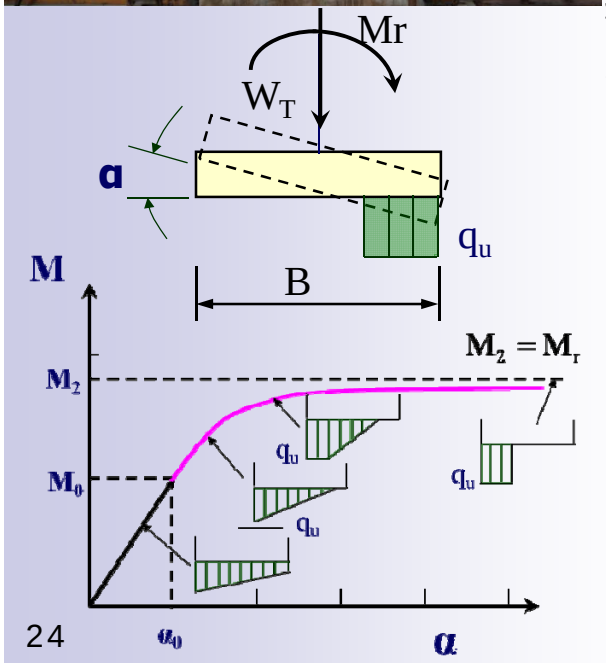
Reduce environmental impact and traffic disruption; applied to Taichung Area Expressway No. 4.

Tests of columns with high performance steel energy dissipation bars

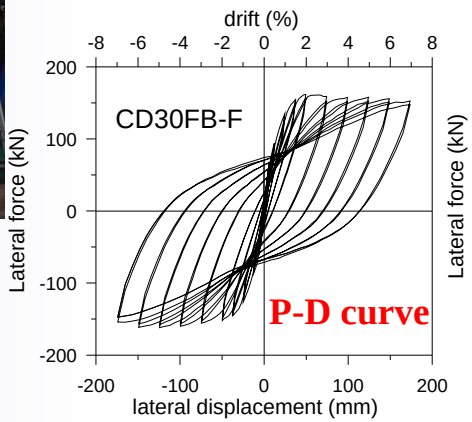
Tests of columns with lead-rubber seismic isolation bearings

Installation of column cap

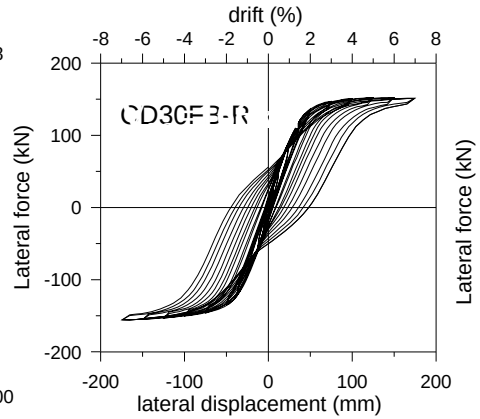
Effect of Rocking on the Seismic Performance of Pier with Spread Footing



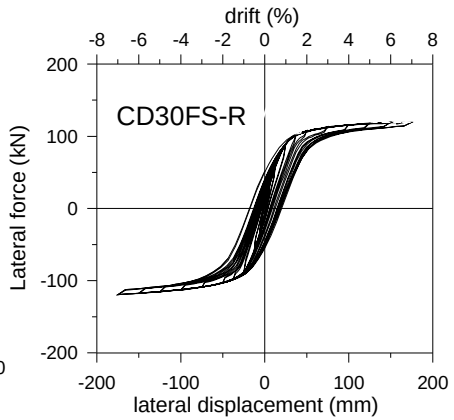
Improve the regulation related to footing size in the seismic design code for bridges



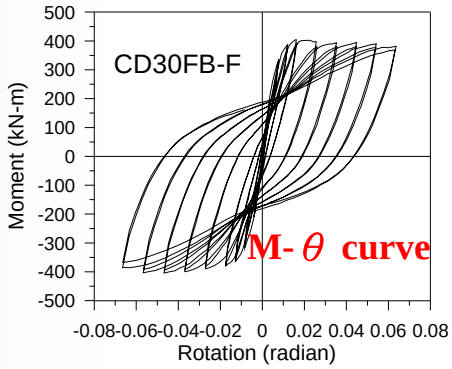
B= ∞ cm

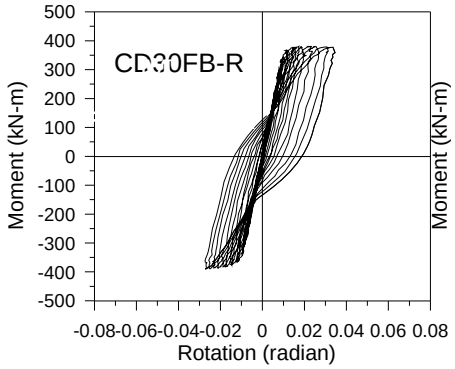


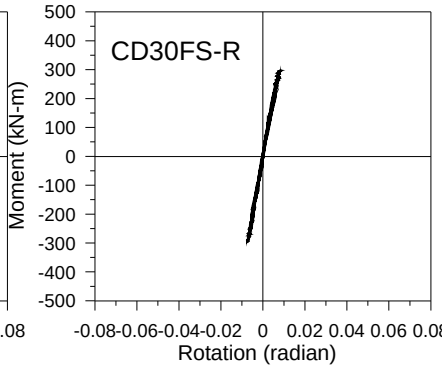
B=170cm



B=140cm

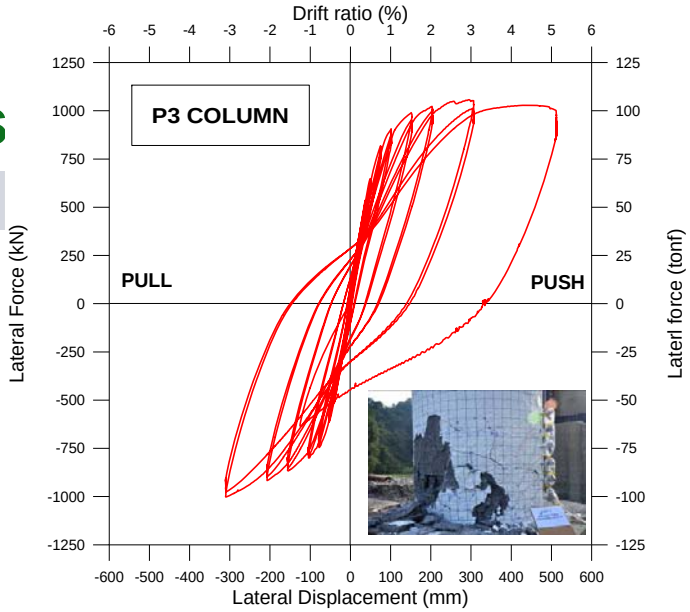






In Situ Experiment on Seismic Performance of Niu-Tou Bridges

- NCREE coordinated professors and researchers from NTU, NCTU, NCU, NTUT, and YUNTECH to executive the interdisciplinary research.
- This is the first case about in situ experiment on seismic performance of bridges in the world.
- The research results will be provided for the Ministry of Transportation and Communication (MOTC) to review the seismic design codes for bridges.

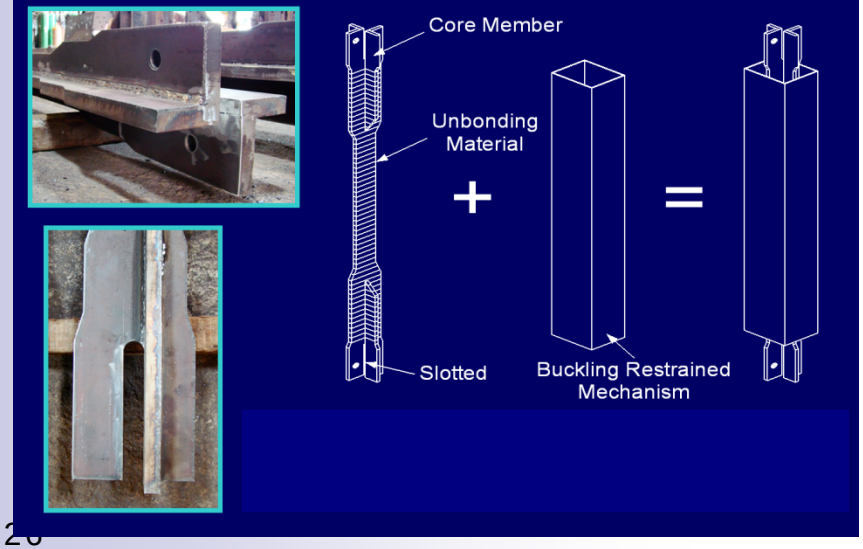


Buckling Restrained Brace

More than **10000 pieces** of **Double-Core BRBs** have been used in Seismic retrofit and new construction projects in Taiwan.

Taichung City Government Building

Slotted Buckling Restrained Brace

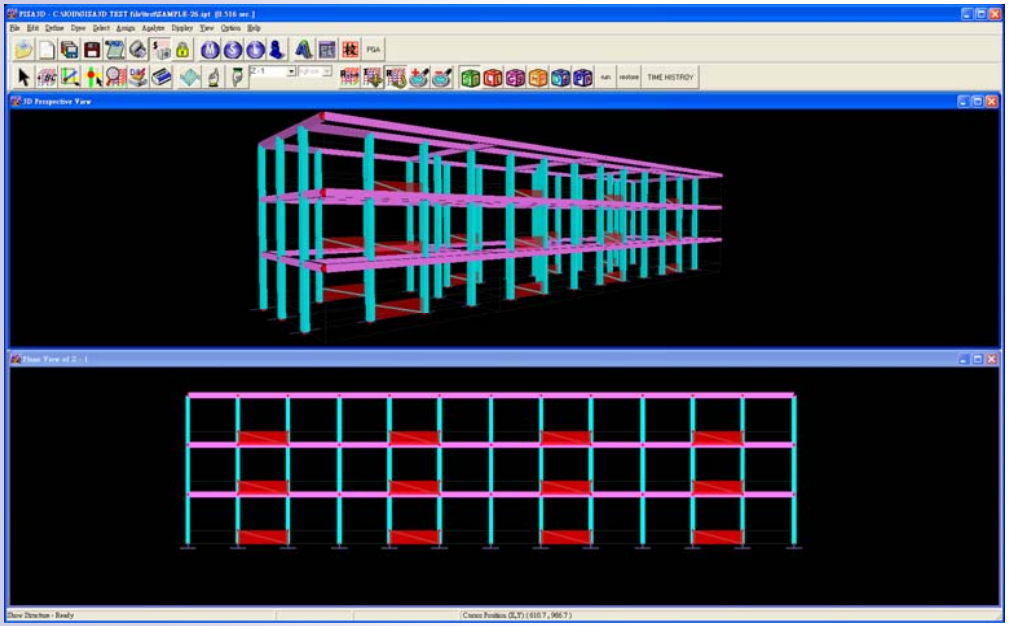


Slotted BRB Patent Pending:

- Canada
- China
- Italy
- Japan
- Korea
- Taiwan
- U.S.A.

PISA3D Development and Applications

Has been certified and applied in practical engineering



E-Defense Blind Analysis Contest 2009

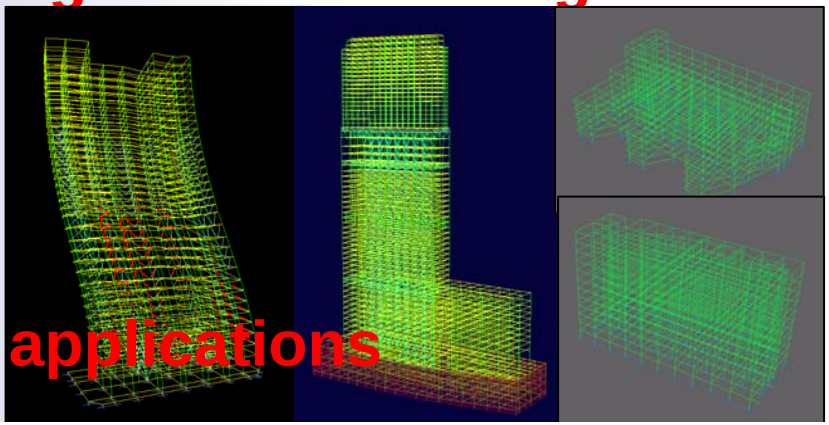
The numerical prediction of 5-story frame

2nd place winner in 3-D category, steel damper

3rd place winner in 3-D category, viscous damper

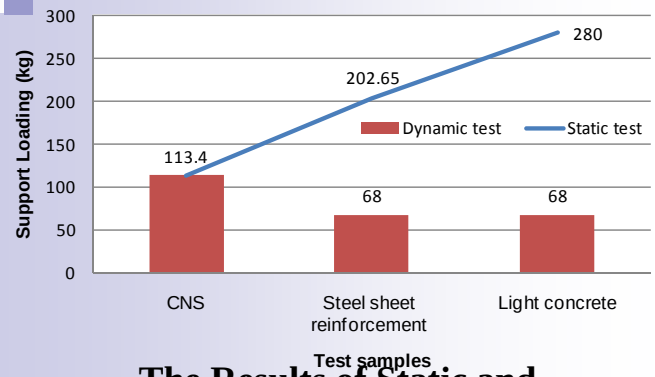
3rd place winner in 2-D category, steel damper

Detailed Seismic Evaluation of Existing School Buildings

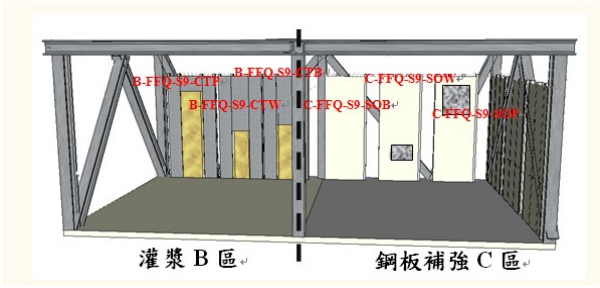


Practical applications

Shaking Table Test and Numerical analysis of the Medical Equipment Fixed on the Light-Weight partition Wall



The Results of Static and Dynamic Experiments



Experiment Devices

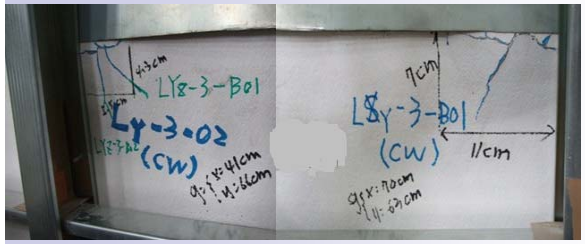
Punching Shear Failure

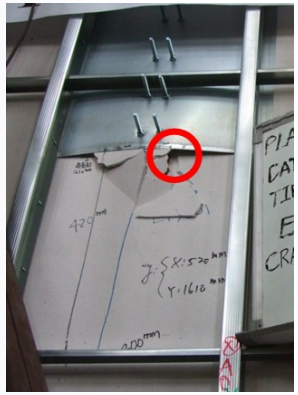
Bending Failure

Block Shear Failure

Tension Failure

Handrail Device





States of Failure for The Light Partition Board

Hand-Washing Equipment

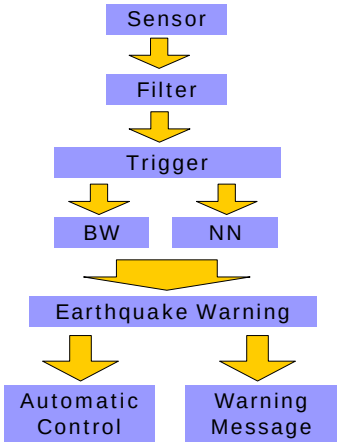
Crib Equipment

On-site Earthquake Early Warning System

On-site EEWS

Seismic sensor

On-line EEW calculation System



Earthquake Warning

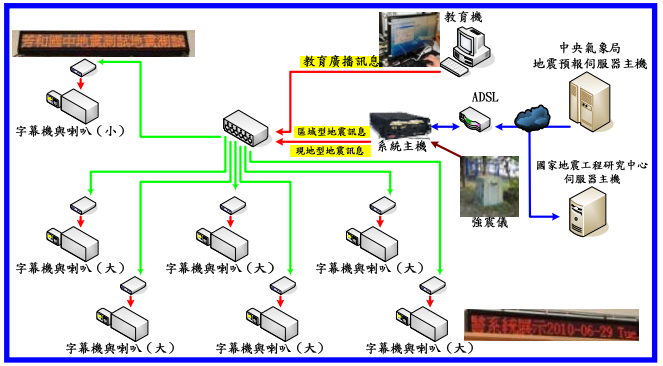
Automatic Control

1. Message broadcast
2. LED message Display
3. Automatically door opening
4. Evacuation instructions
5. Emergency lightening switch
6. Automatic Bookshelf Stopper

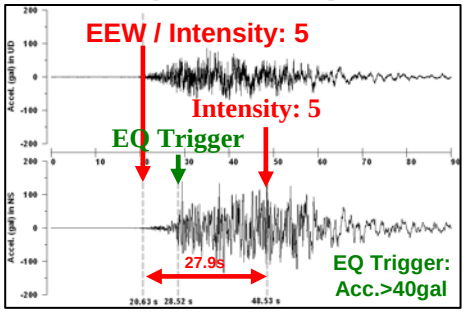
1. EEW message switch to TV
2. Automatically cut off the gas
3. Evacuation instructions
4. Emergency lightening switch
5. Emergency power switch
6. Emergency park the elevator to the closest floor

Campus-type EEWS Demonstration Station

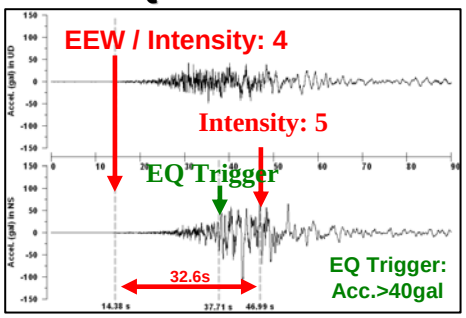
Taipei, Fanghe J.H.S. / Yilan, Yilan E.S.



ChiChi EQ. / Taichung / 50 km



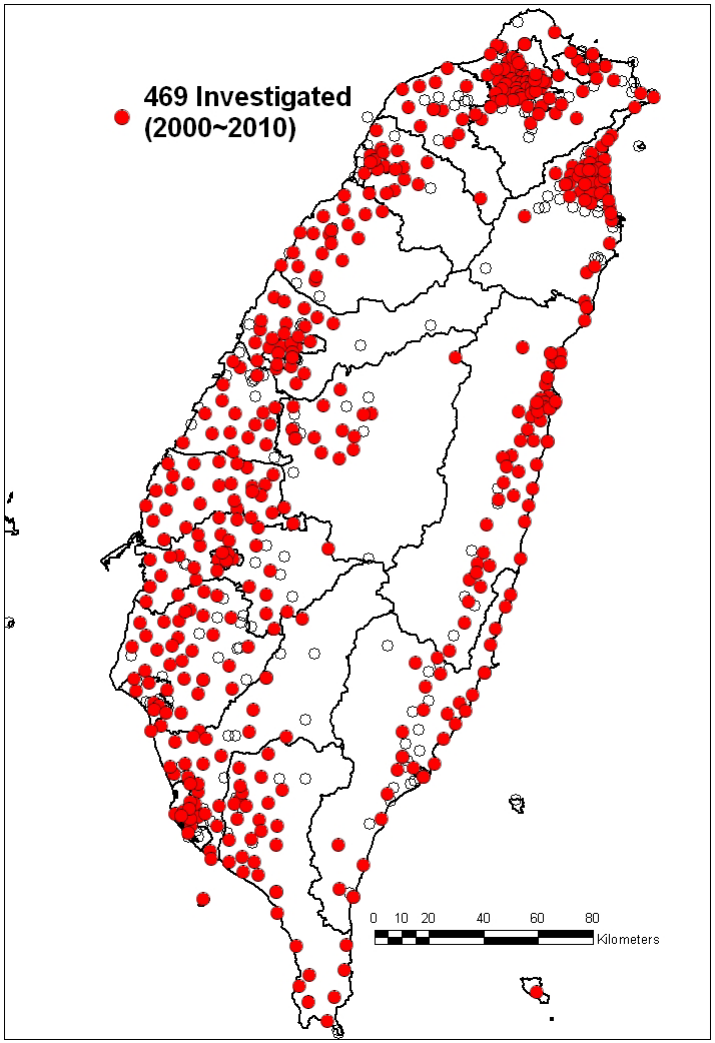
ChiChi EQ. / Hsinchu / 105 km



Geological Survey of Strong Motion Stations

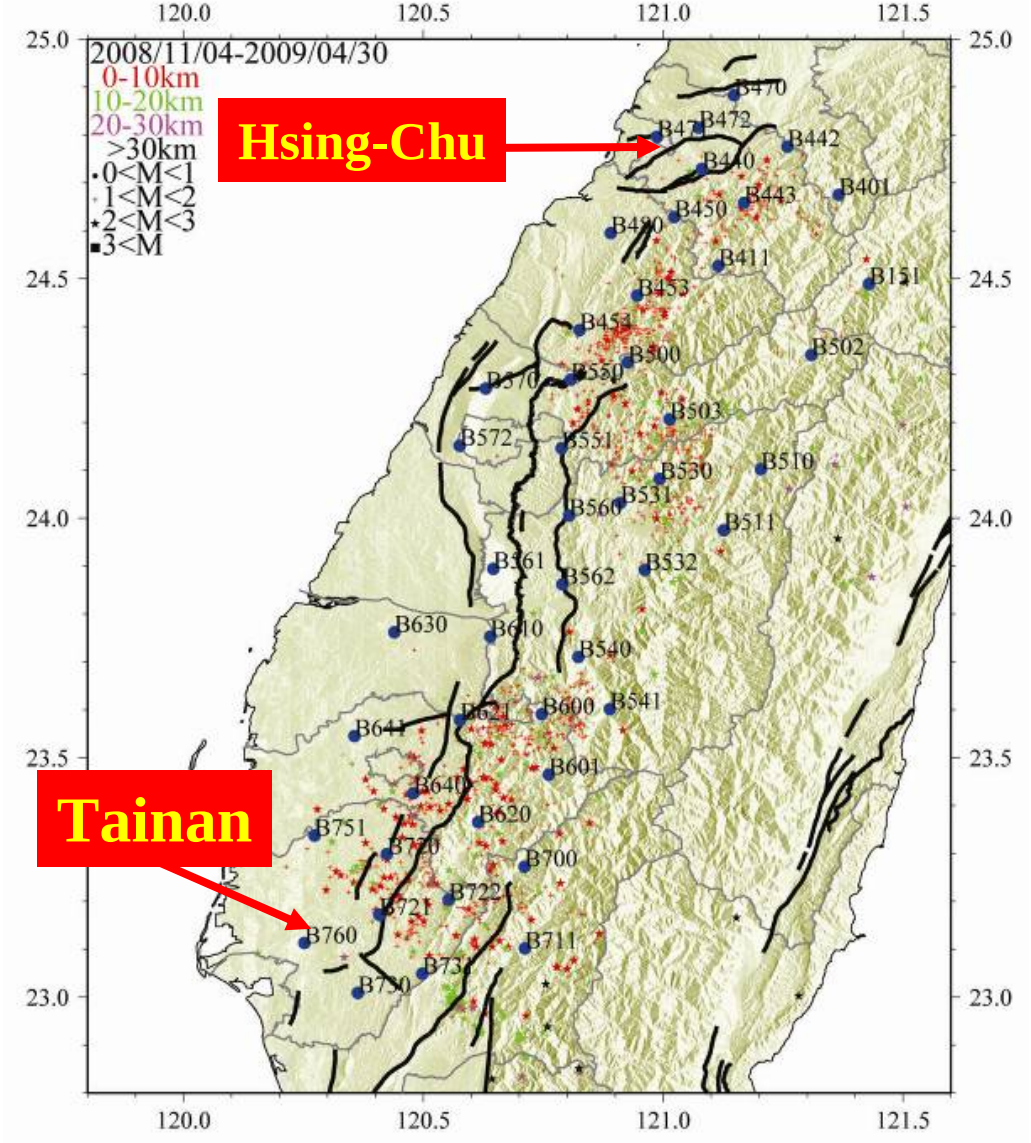
NCREE and CWB are cooperating in the drilling project. 469 stations have been surveyed, and 22 of them have depths greater than 50m. Those results were bulletined in the website below.

http://geo.ncree.org.tw/

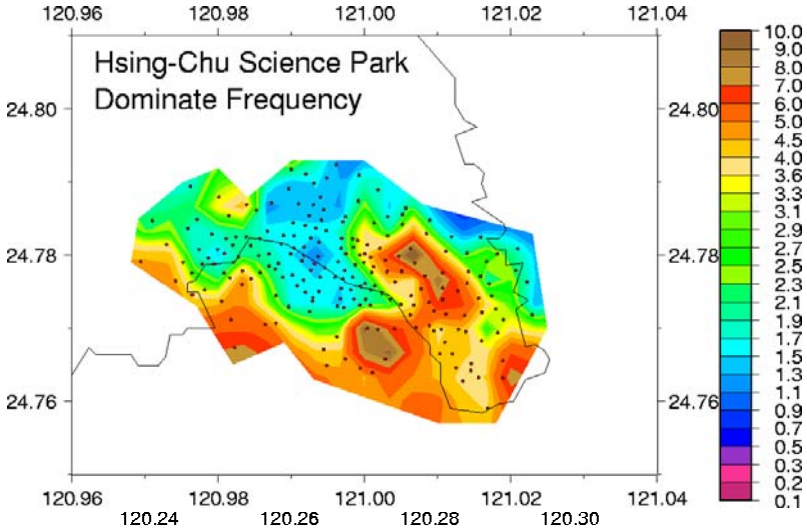


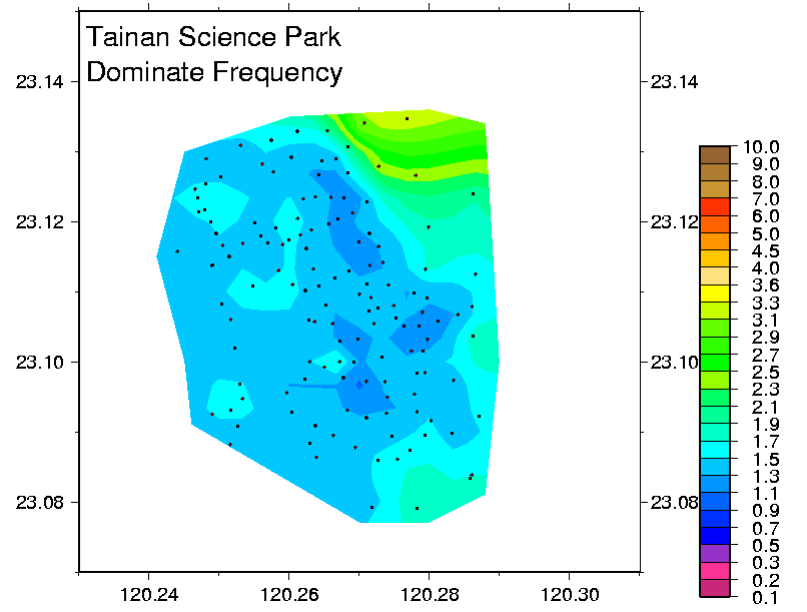
High Technology Science Parks
Earthquake Monitoring and Site Effect Study

NCREE Broadband Seismic Network

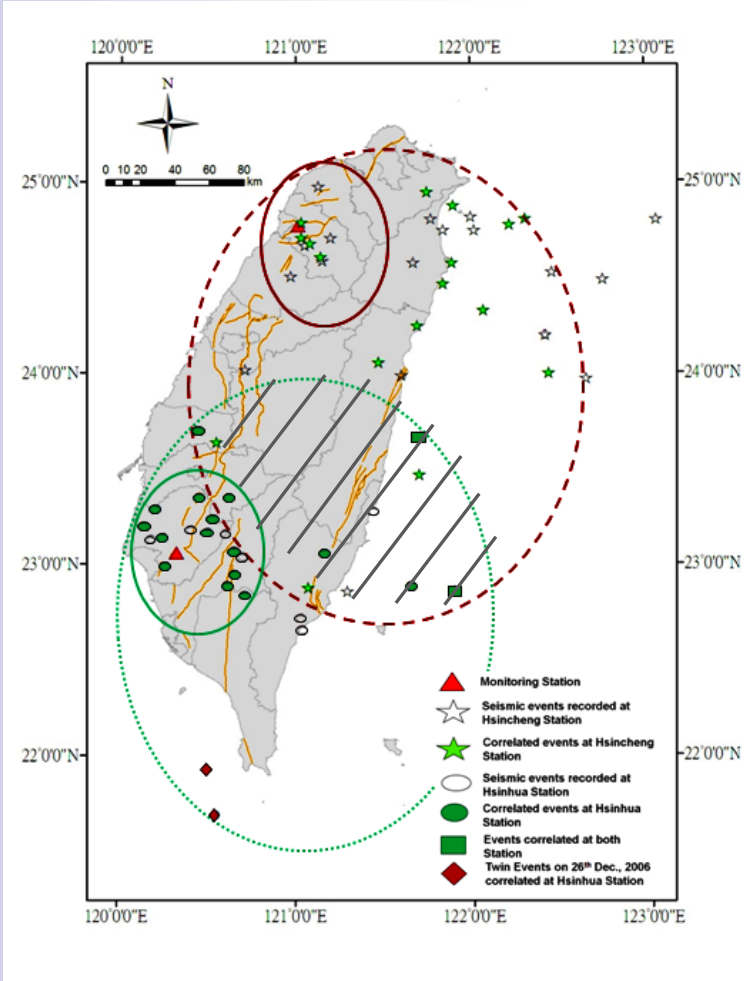


Science Parks Site Effect

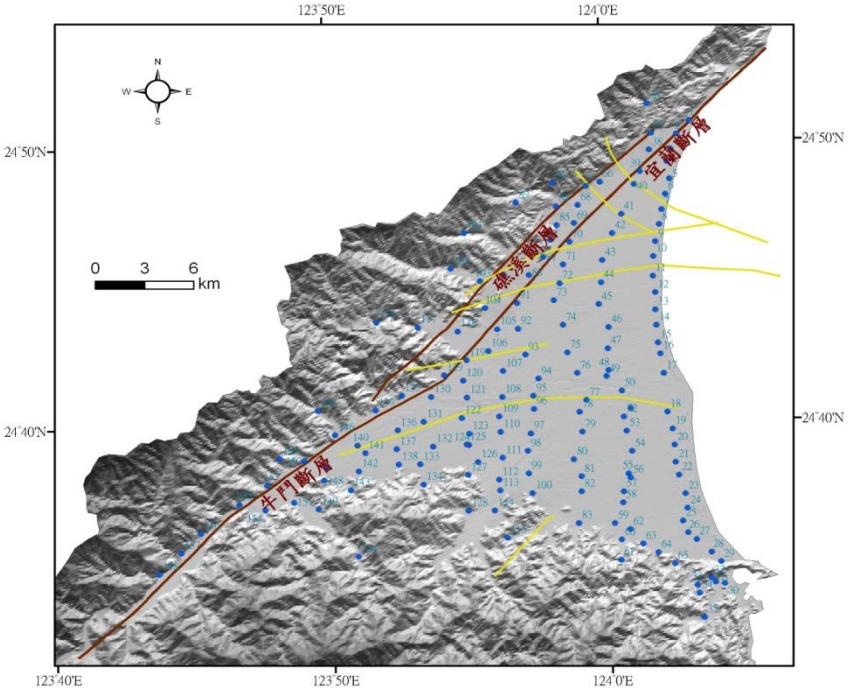




Soil Gas Monitoring



Distribution of soil-gas survey in Ilan Plain ,about 160 samples were collected and analyzed.

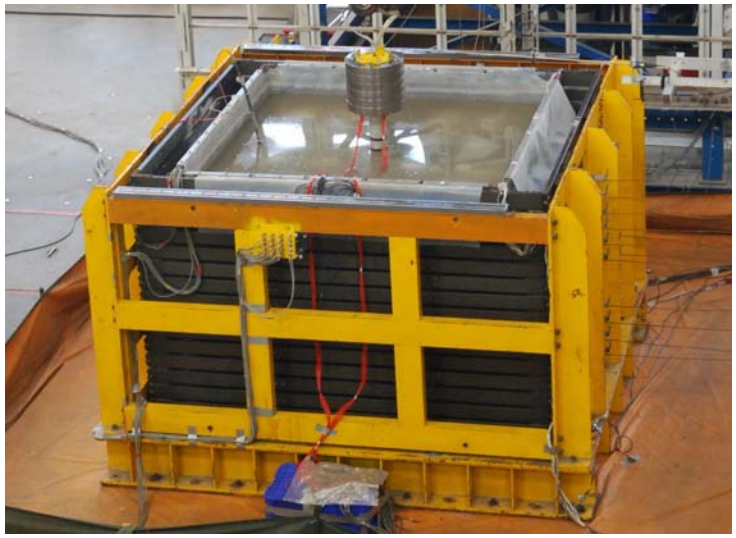


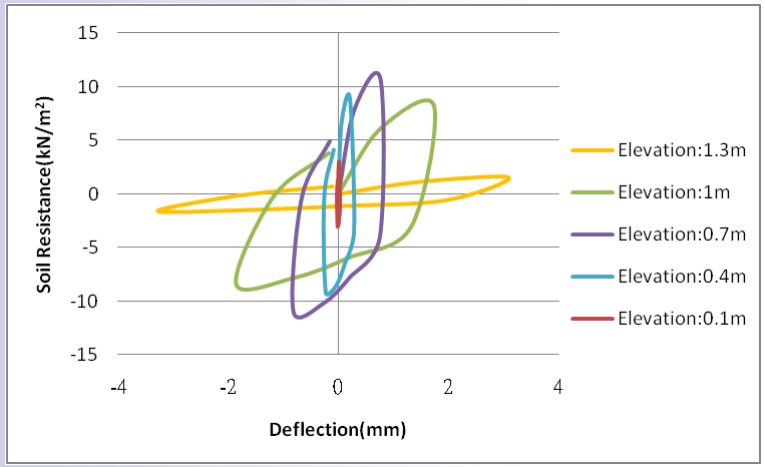
Physical model of Taiwan dividing it into two tectonic zones (red and green circles), whereas dashed area is the common tectonic zone.

Studies on Model Pile in Saturated Sand

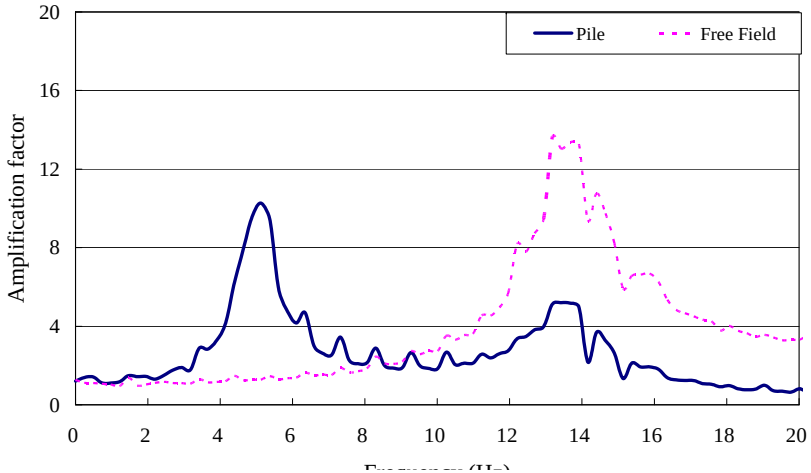
Lateral load test

Shaking table test





Nonlinear p-y relation

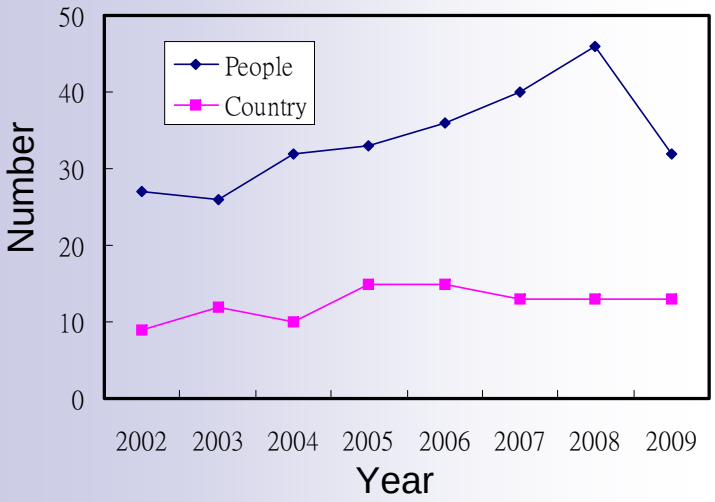


Inertia and kinematic effect on pile

Introducing and Demons
Engineering Research in

Educational programs for high scho
undergraduate and graduate studer

International Training Program (ITP) for Seismic Design of Structures





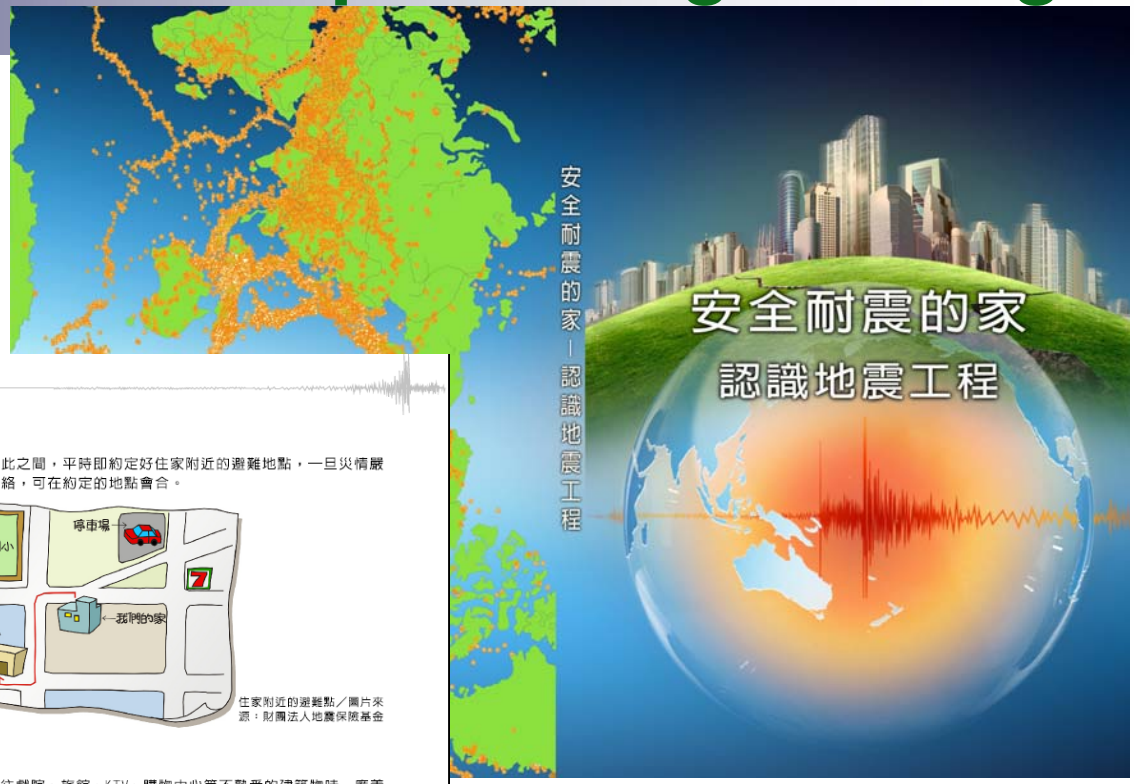








Building a Safe Homeland—Introduction to Earthquake Engineering



(三) 地震避難須知

■ 地震來了怎麼辦？

遇到危急狀況，應冷靜應變，才能自救。居家時，萬一發生大地震，在情況許可下，建議採取以下步驟應變：

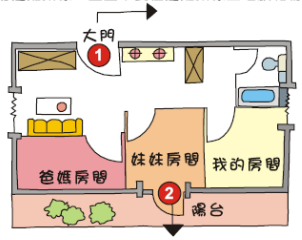
1. 熄滅正在使用中的火源，並關閉瓦斯開關。
2. 打開大門，以避免門框變形而無法開啓。
3. 穿上鞋子。
4. 如果判斷可以及時逃到空曠處，立刻離開屋內（切忌搭乘電梯）；如果判斷來不及逃離屋內，則就近躲避在相對較安全的角落空間。

強烈地震過後，可疏散家人至戶外，並觀察建築結構有無立即的危險（參考附錄一），判斷無立即危險再回家。回到家中，應留意有無瓦斯外洩，確認無瓦斯外洩才能使用電器與爐火。

■ 如何避難到安全的地方？

● 規劃避難路線

預先設想避難路線，就不用在危急的情況下，考驗自己的運氣。家裡最好有二條以上的避難路線，並且不要在避難路線上堆放雜物。另外，因應深夜受災停電，避免黑暗中倉皇無措，最好在床頭處準備手電筒，以應付夜間突發狀況。

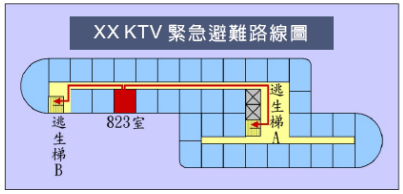


家裡的避難路線規劃

家人彼此之間，平時即約定好住家附近的避難地點，一旦災情嚴重，失去聯絡，可在約定的地點會合。

住家附近的避難點／圖片來源：財團法人地震保險基金

平常前往戲院、旅館、KTV、購物中心等不熟悉的建築物時，應養成觀察緊急避難路線的好習慣，遇上地震或火災時，才能安全逃生。場所中如有工作人員指揮協助，則聽從指示，依序逃離。



Thank you for your attendance