

Introduction of **N**ational **C**enter for **R**esearch on **E**arthquake **E**ngineering (**NCREE**)

Prof. Keh-Chyuan Tsai

Director, NCREE

Professor, National Taiwan University, Taipei, Taiwan



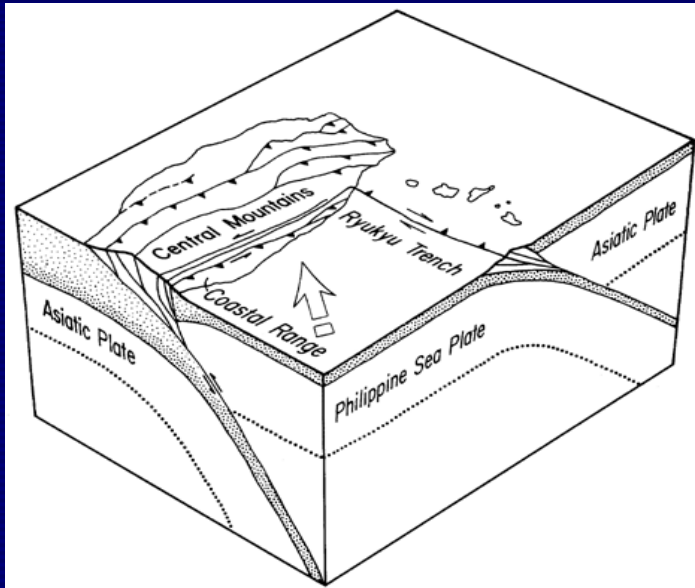
Taiwan: A living laboratory of earthquakes

Area: 36,000 km²

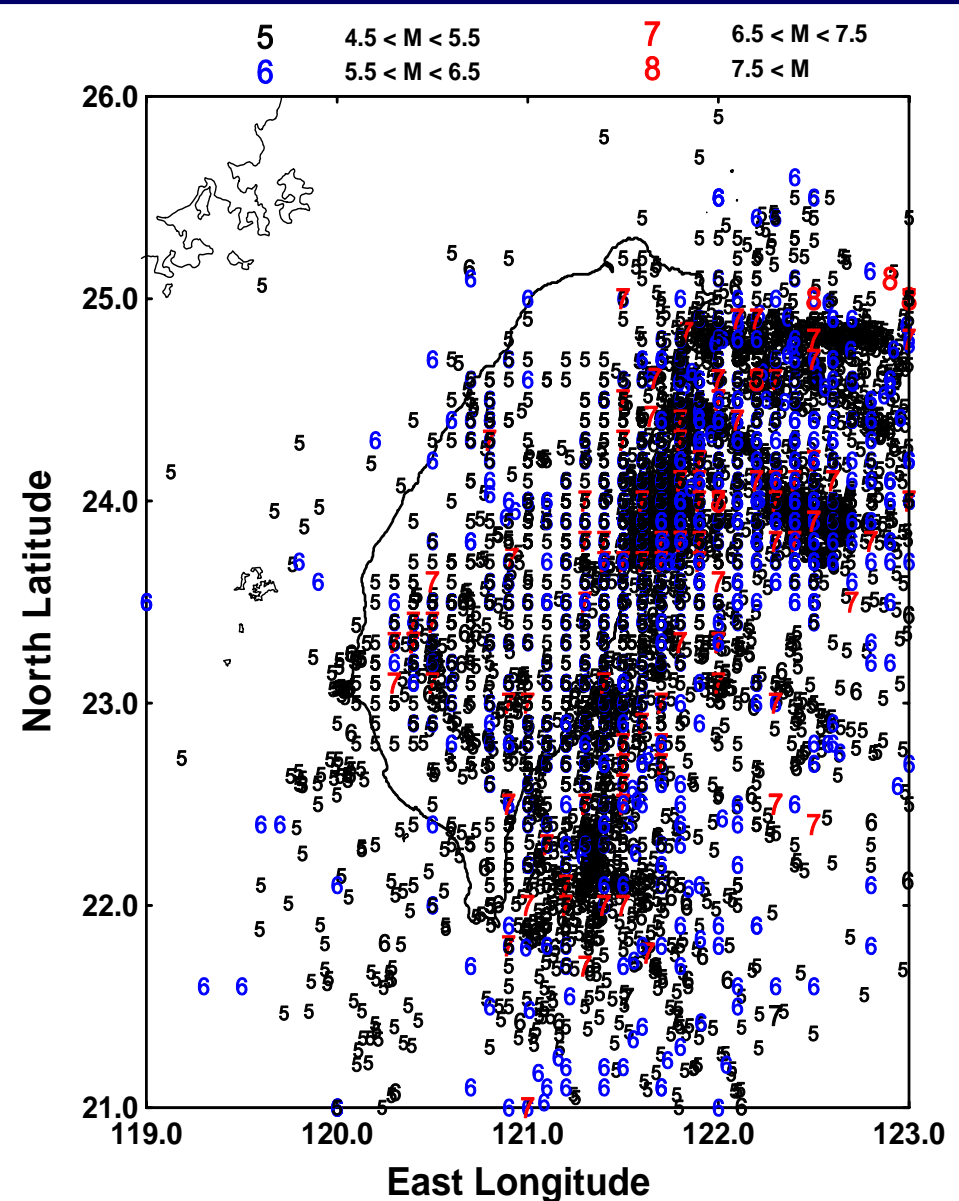
Population: 23 millions



Seismicity in Taiwan (1900-2002)



Tectonics of Taiwan



1999 Chi-Chi Earthquake



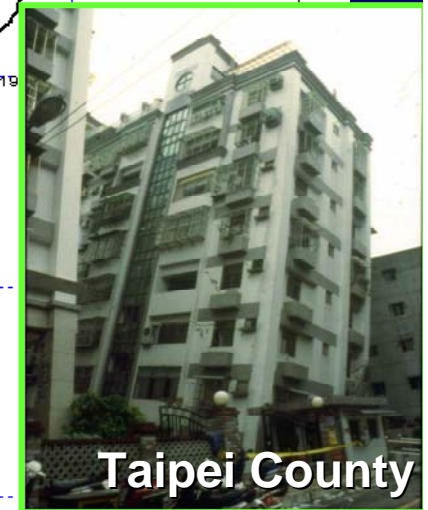
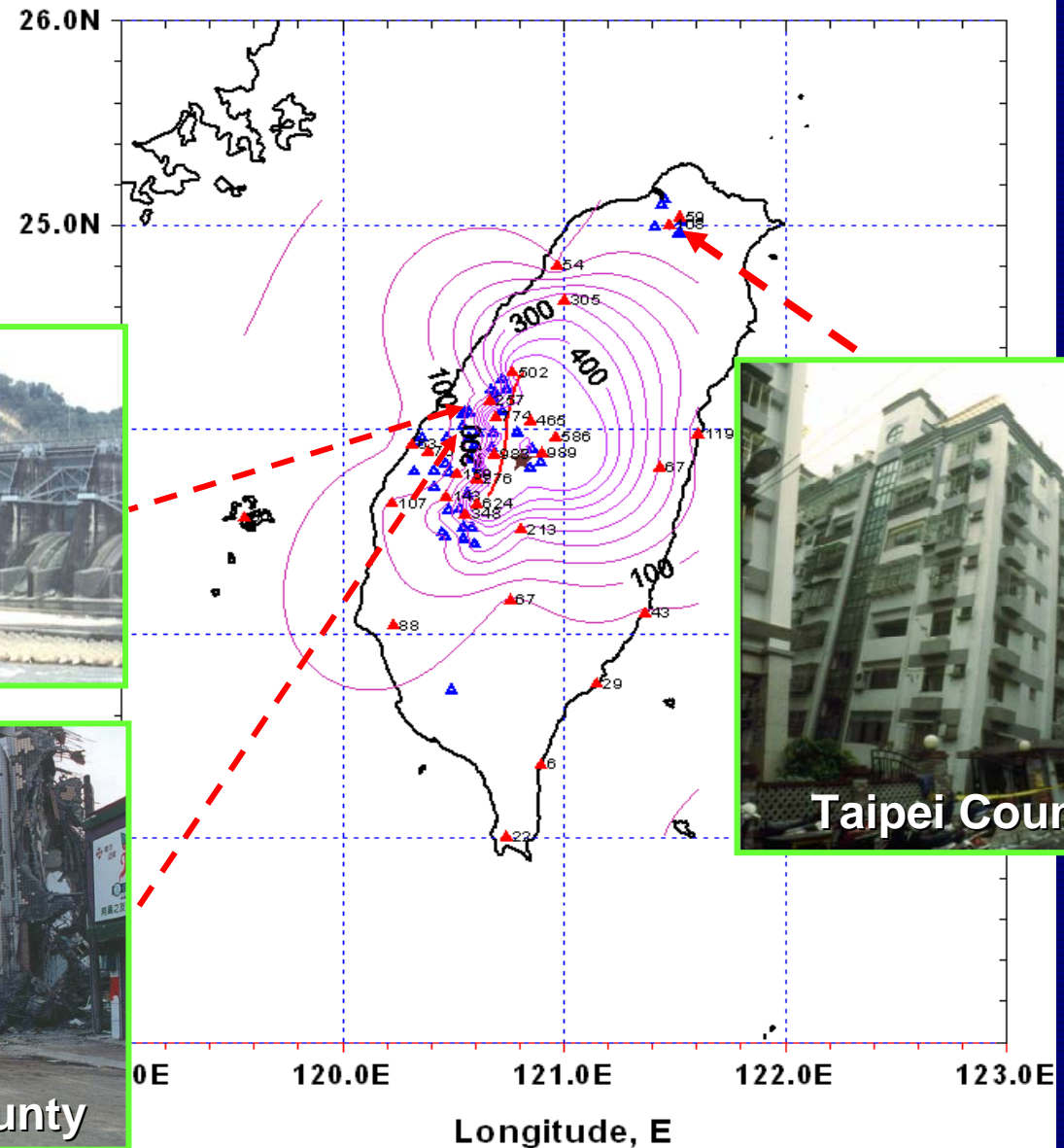
$M_L=7.3$
Sept. 21, 1999

Vertical Rupture = 9.0m



Tai-Chung County

GiGi-Earthquake : EW-Component, PGA (gal)



Taipei County



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**

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. Tsai (2003-)
 - 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

Personnel



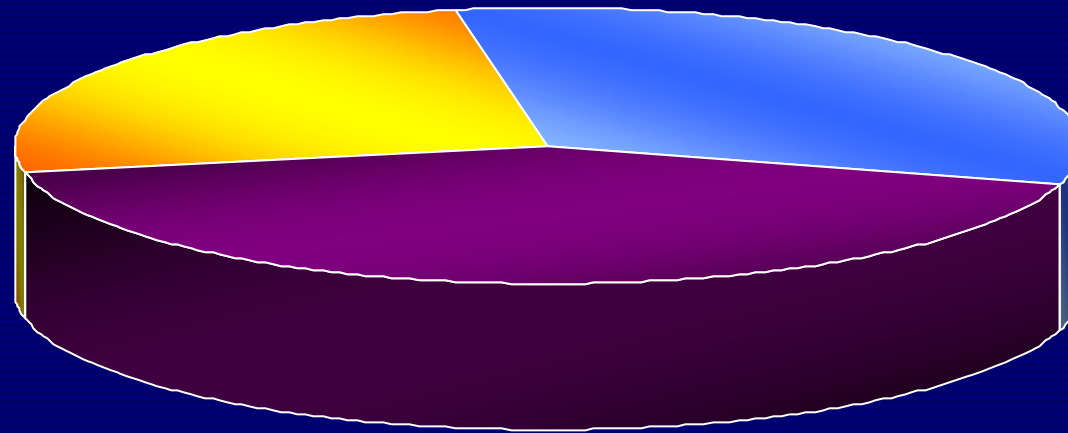
A total of 115 employees

29 others

25%

37 PhD

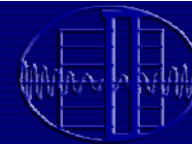
32%



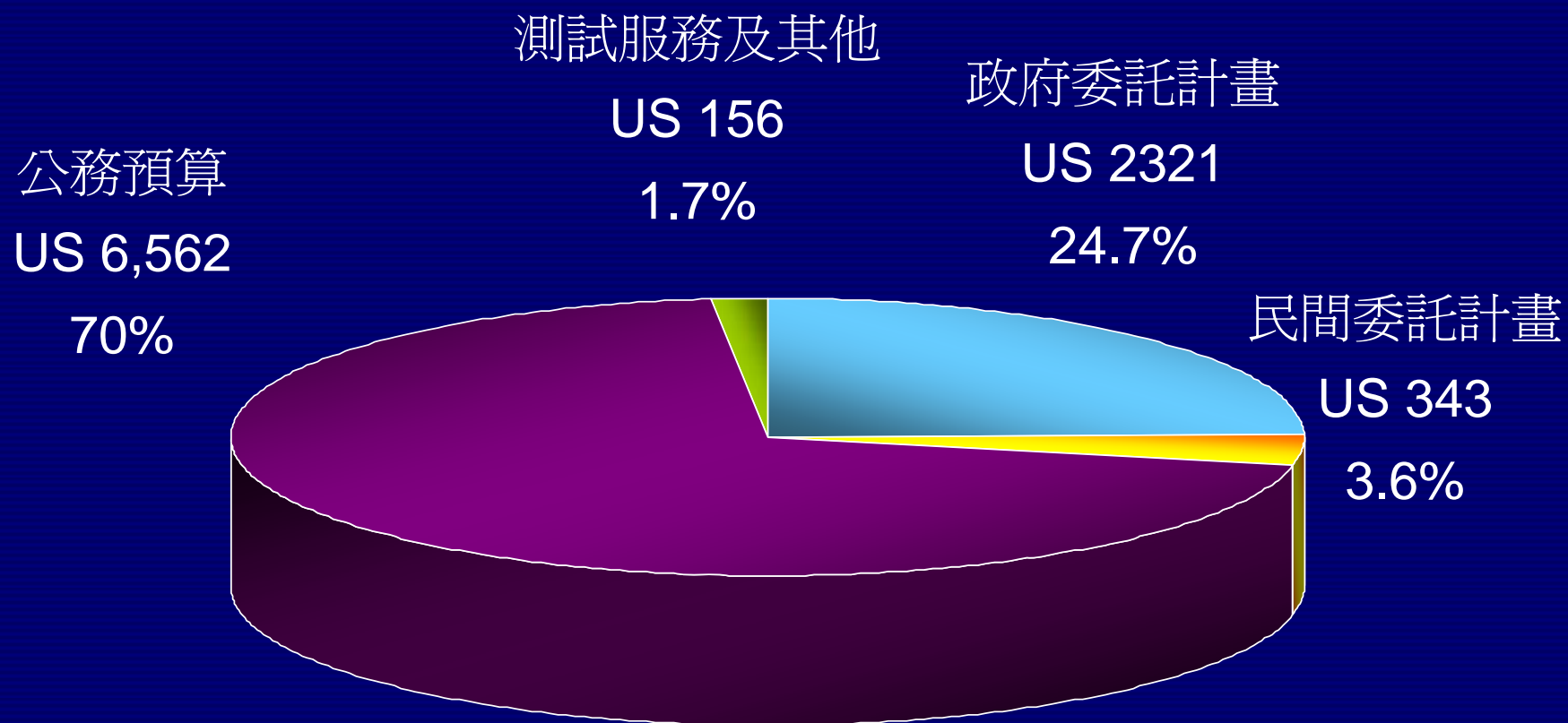
49 MS

43%

經費來源 (Revenue in 2008)



(9.38 million US dollars for 2008)



(6.6 million US dollars from NSC)

Experimental Facilities



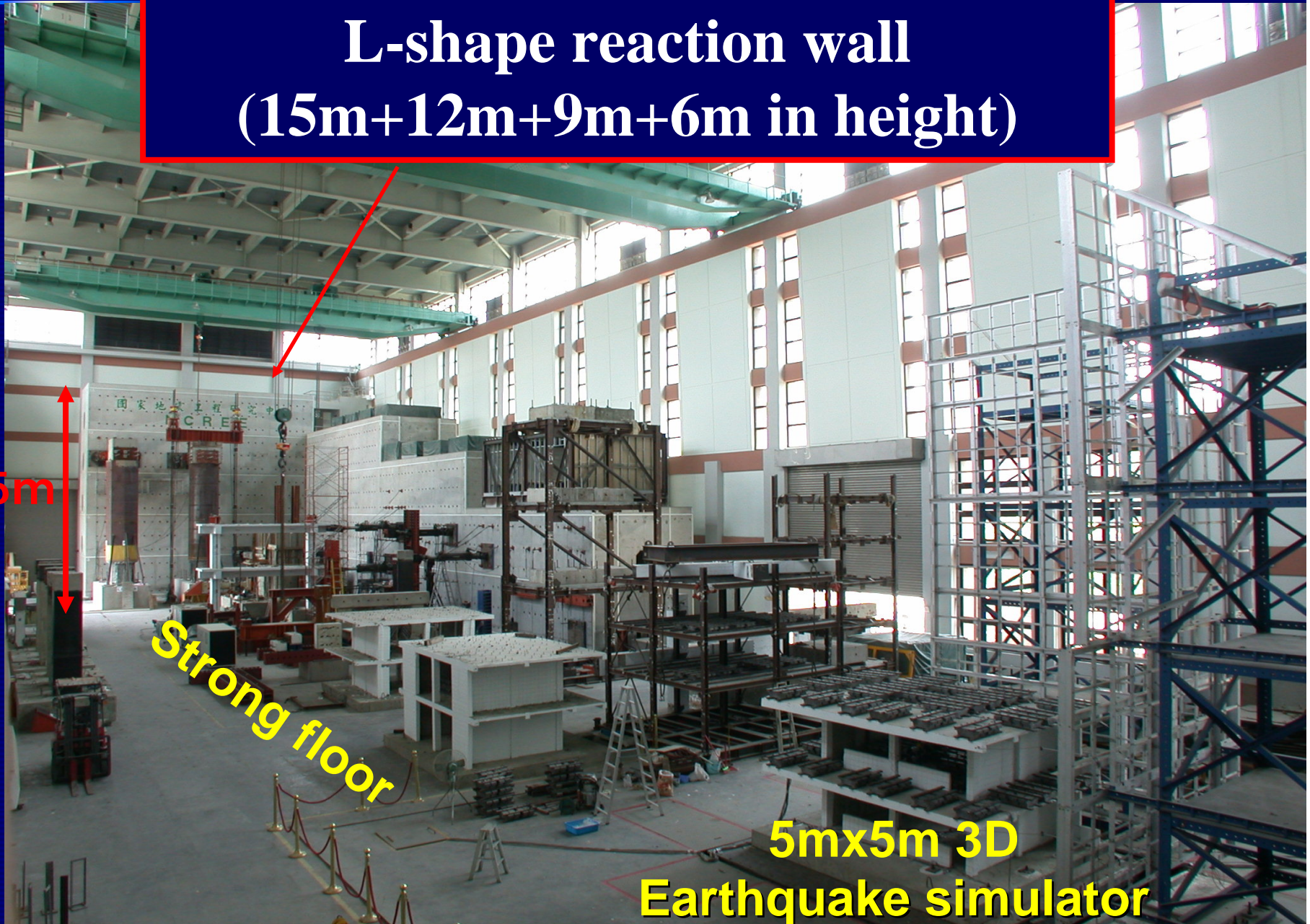
**L-shape reaction wall
(15m+12m+9m+6m in height)**

15m

Strong floor

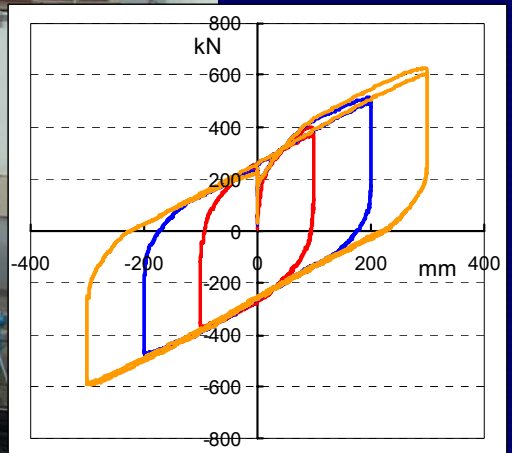
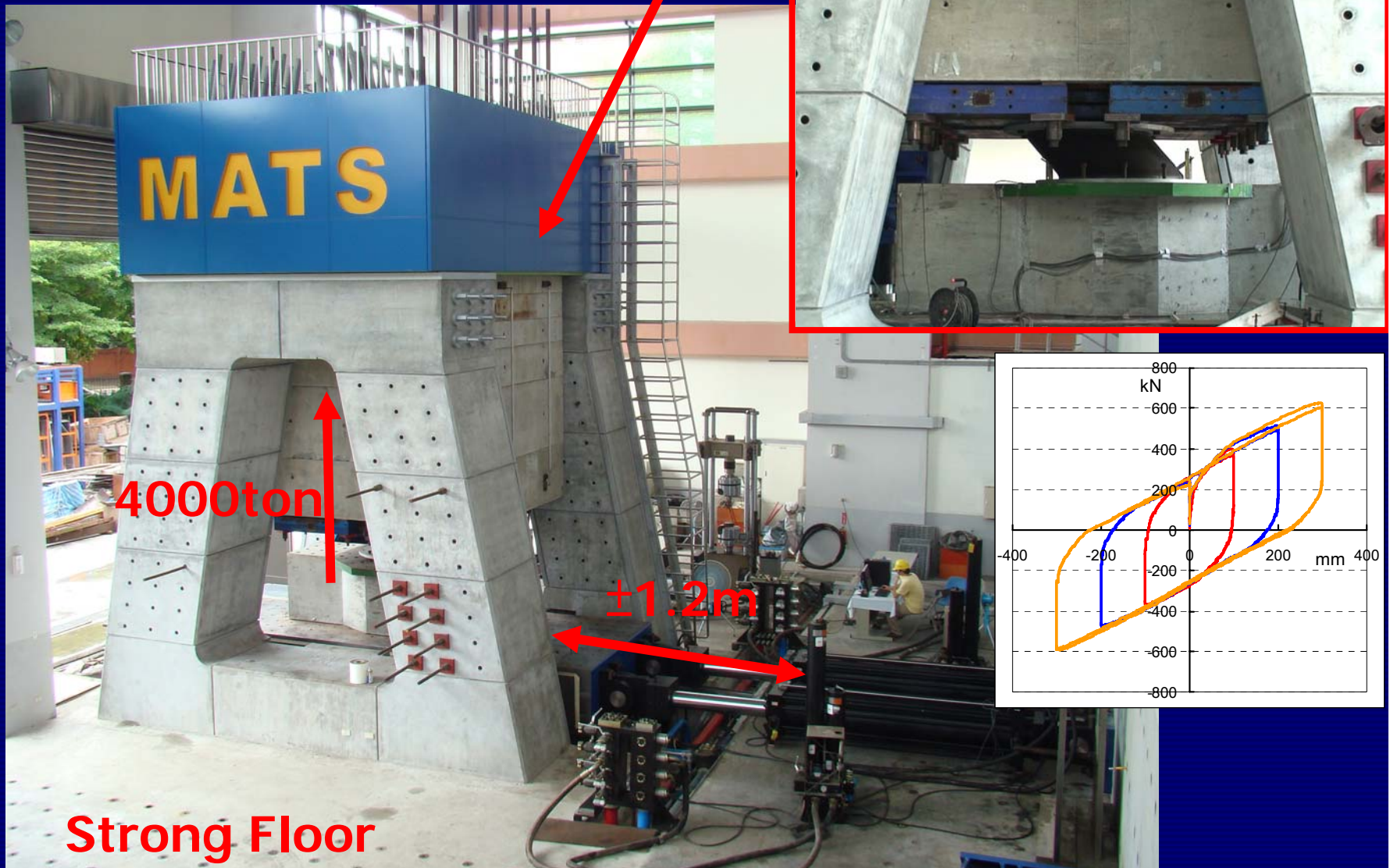
**5mx5m 3D
Earthquake simulator**

NCREE

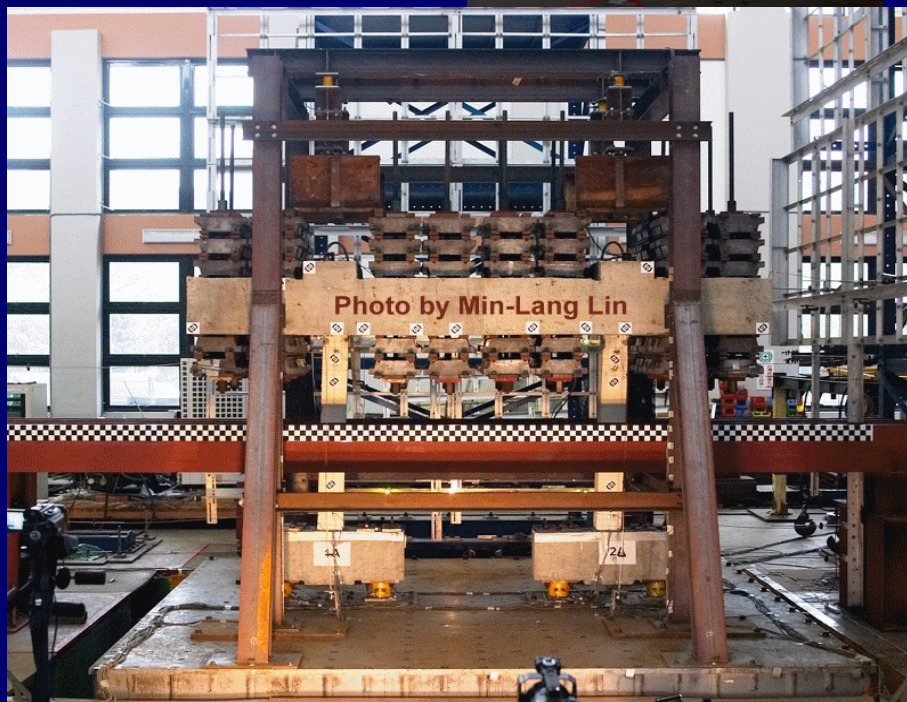


Experimental Facilities

Multi-Axial Testing System (MATS)

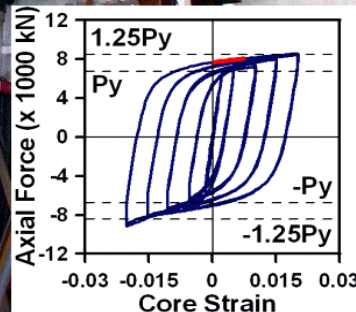
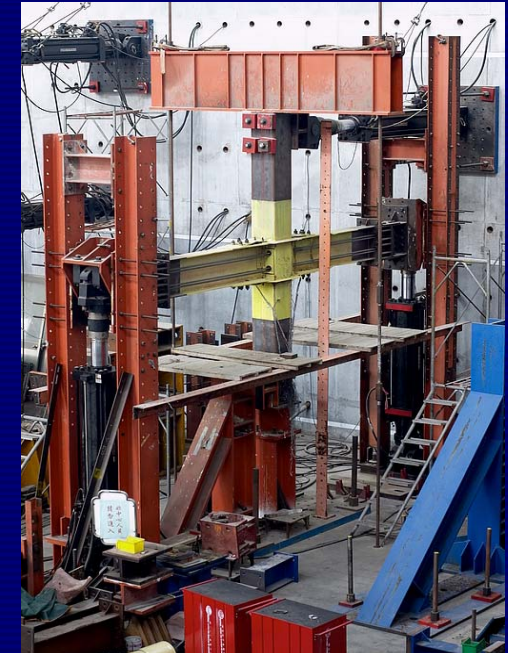
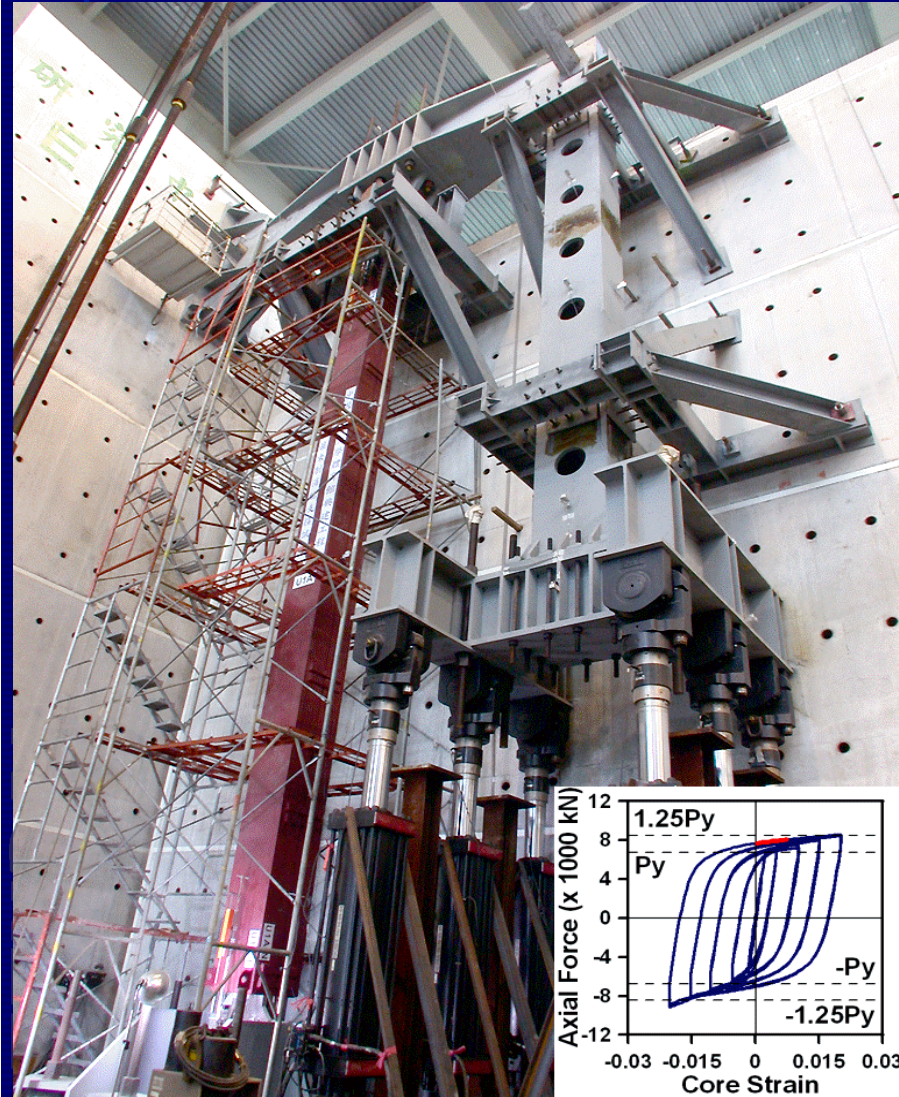


Shaking Table Tests



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

Consultation to Important Engineering Projects



- Damage potential of near-fault ground motions and associated design parameters
- Underground substructure design
- Site characteristics of nuclear power plants
- Electrical power transformers and associated facilities

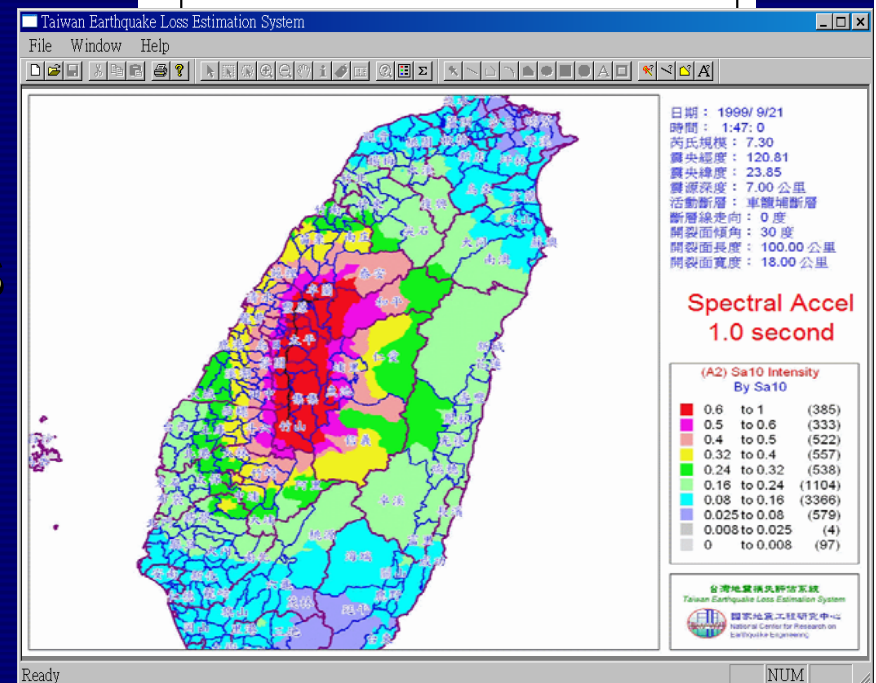
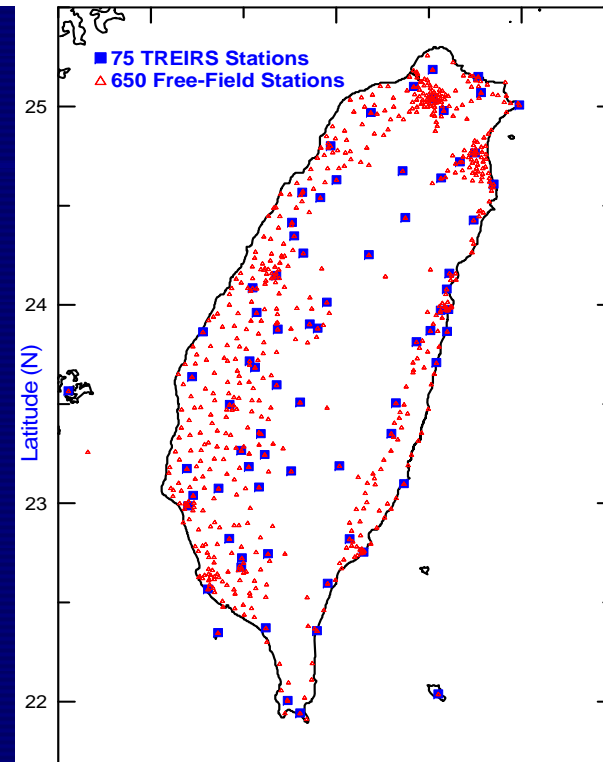
Consultation to Important Engineering Projects (cont'd)



- **Seismic retrofit of high-tech industrial factories (semi-conductor and TFT LCD)**
- **Map of soil liquefaction potential**

Earthquake Scenario

- Establish TELES system for earthquake scenario of Taiwan
- Estimate the severity of damaged areas in 30 seconds to support the emergency response by the government officials
- Help county authorities to establish emergency response plans



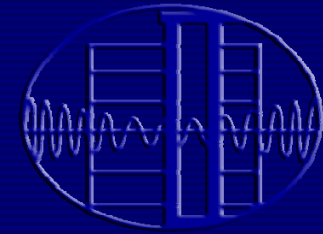
Structural Health Monitoring



- Assist Highway Bureau for bridge instrumentation and health monitoring system
- Assist the Central Weather Bureau for geotechnical survey on TSMIP stations and establish the database for research sharing with other institutes in Taiwan



International Collaborations on Research of Steel Panel Shear Wall (MCEER and NCREE 2003)



NTU

NCREE

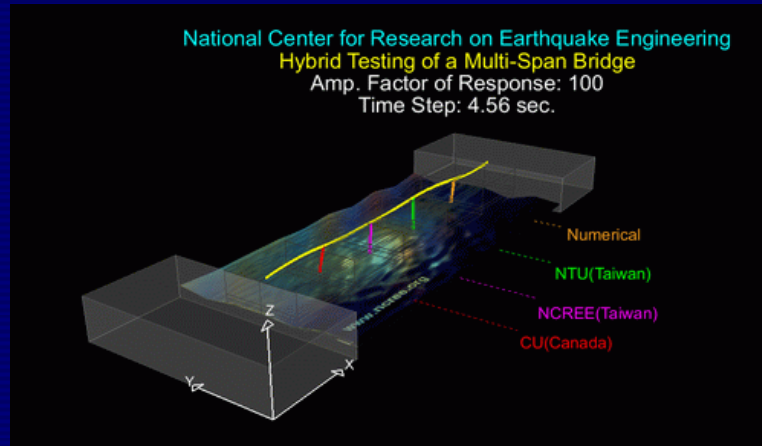
Taiwan-US-Japan Cooperative Full-scale Composite CFT/BRB Braced Frame Tests (2003)



R&D of Innovative Technologies



Internet-based Simulation for Earthquake Engineering



The model of bridge



Taiwan-Canada Collaborative Experiment



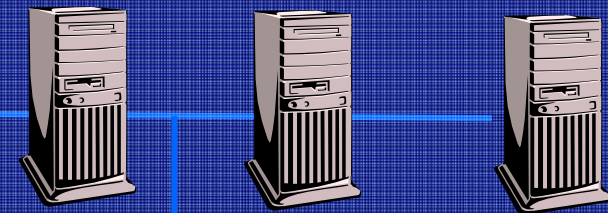
NCREE Lab. in Taiwan



NTU Lab. in Taiwan



Carleton Univ. Lab. in Canada



Database Web server Video server



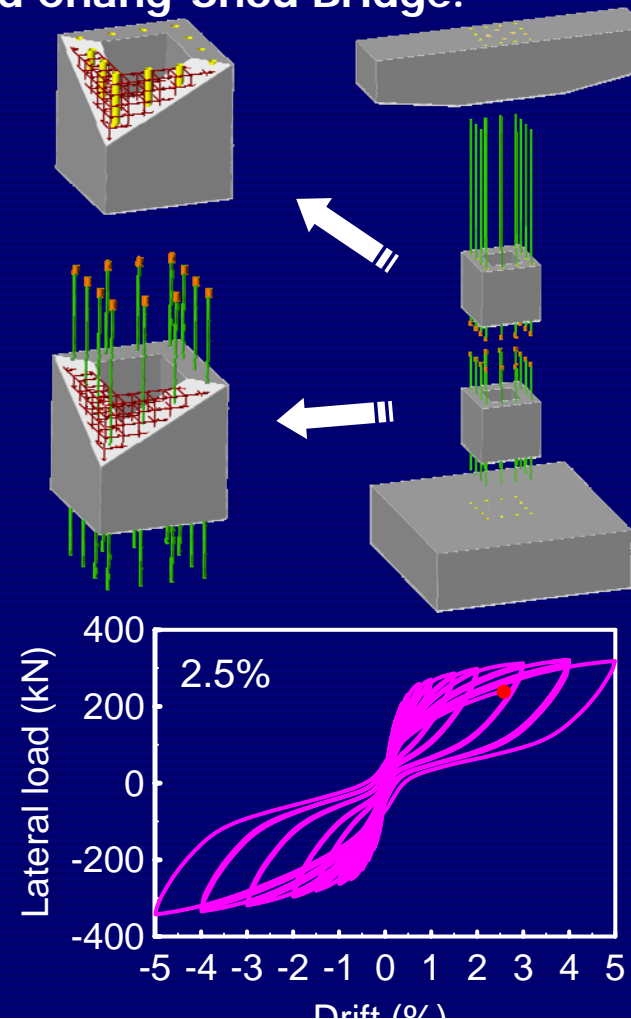
Analysis engine

Development and Application of New Technology

Taiwan-US Cooperative research Program on Development of Precast Segmental Bridge Columns for Seismic Regions



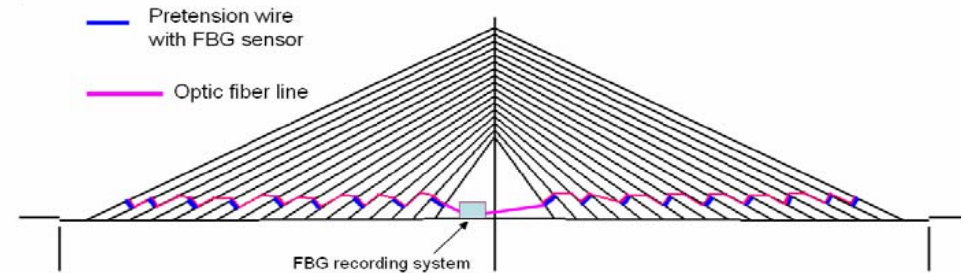
High Energy Dissipation Capacity and Low Residual Displacements. Applied in practice to the Yu-Le Bridge and Chang-Shou Bridge.



Functional Bearing System Development & Bridge Safety Verification after Retrofit

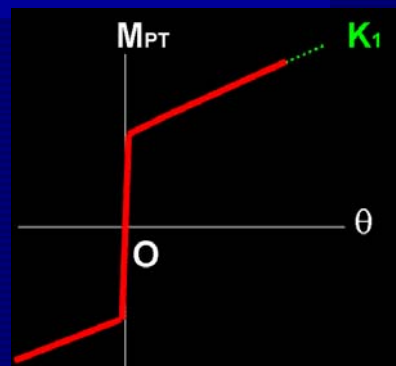
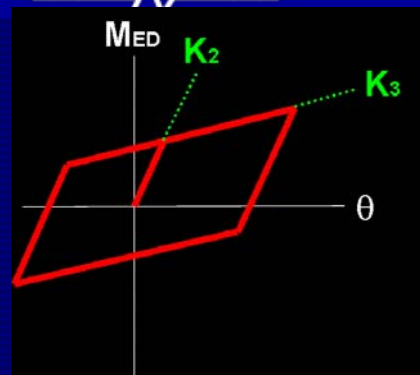
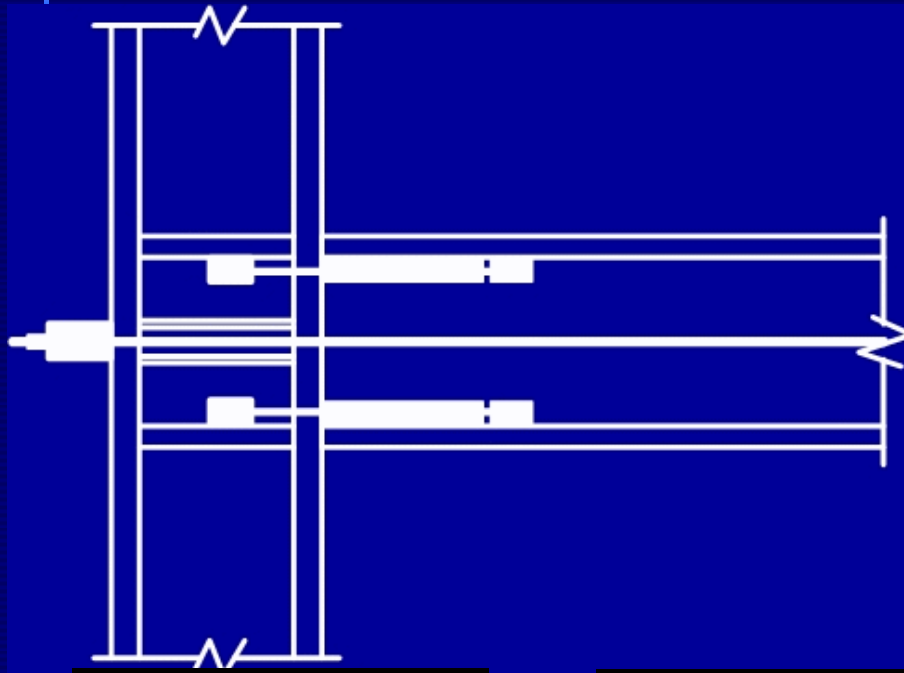
Single-Span Bridge: Simulation and Verification of Functional Bearing System

Safety Verification of a Cable-Stayed Bridge after Seismic Retrofit

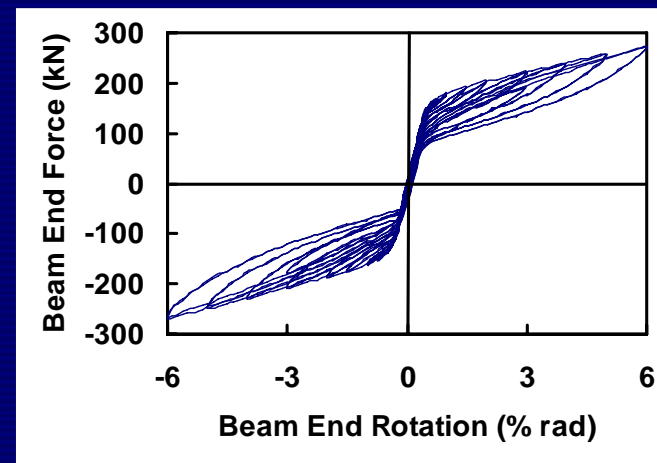




Post-Tensioned Seismic Structural Systems



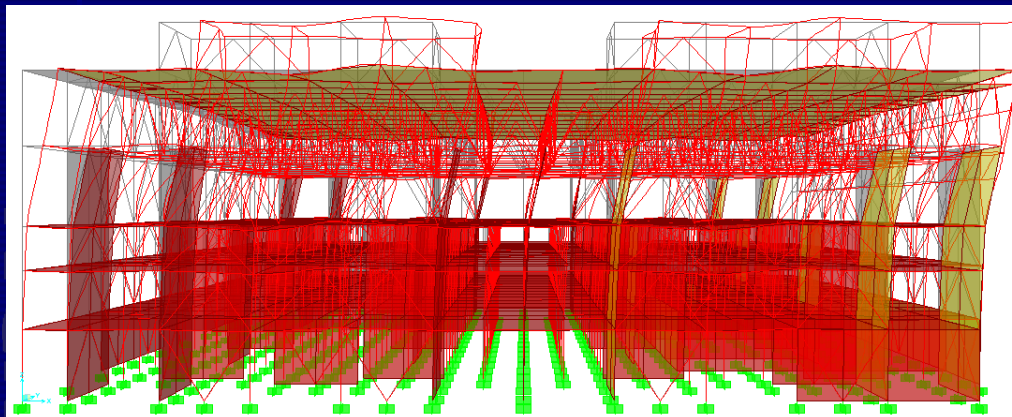
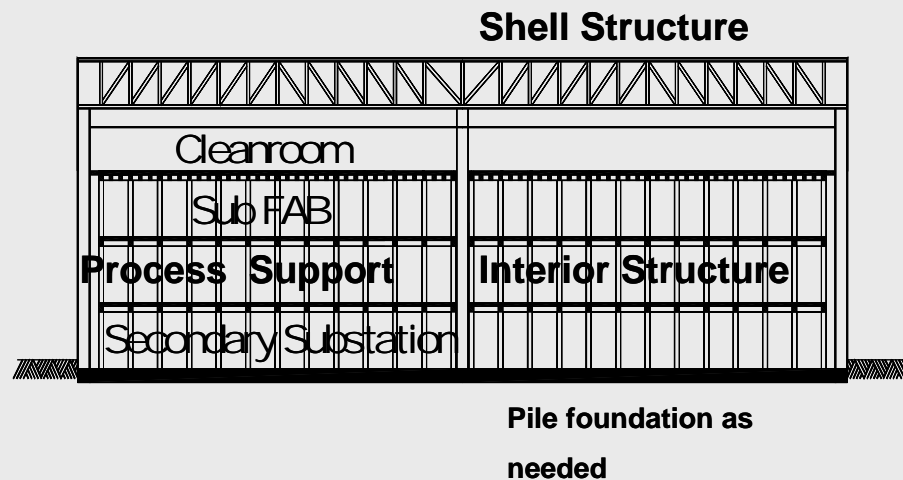
Idealized hysteretic behavior of a post-tensioned energy dissipating joint



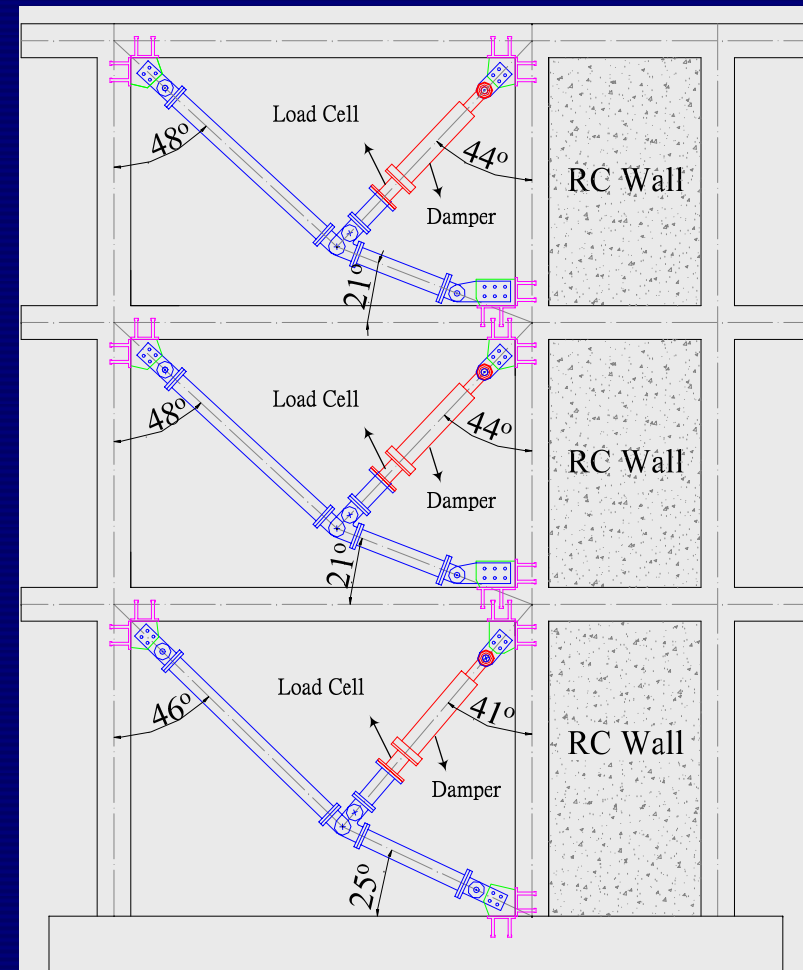
The beam deflection to force diagram

R&D of Innovative Technology

Seismic protection of high-tech industrial factories



Evaluation of the seismic performance of high-tech industrial factories

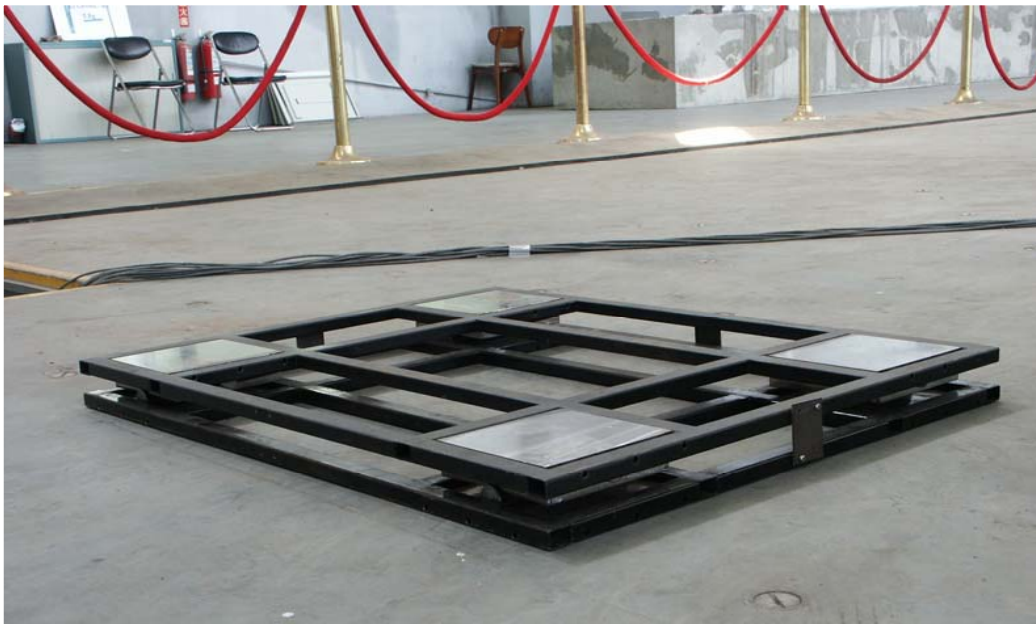


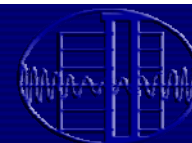
Experimental investigation on effectiveness of upper-toggle-brace-damper system

R&D of Innovative Technologies



The Rolling Type Base Isolation – US patented



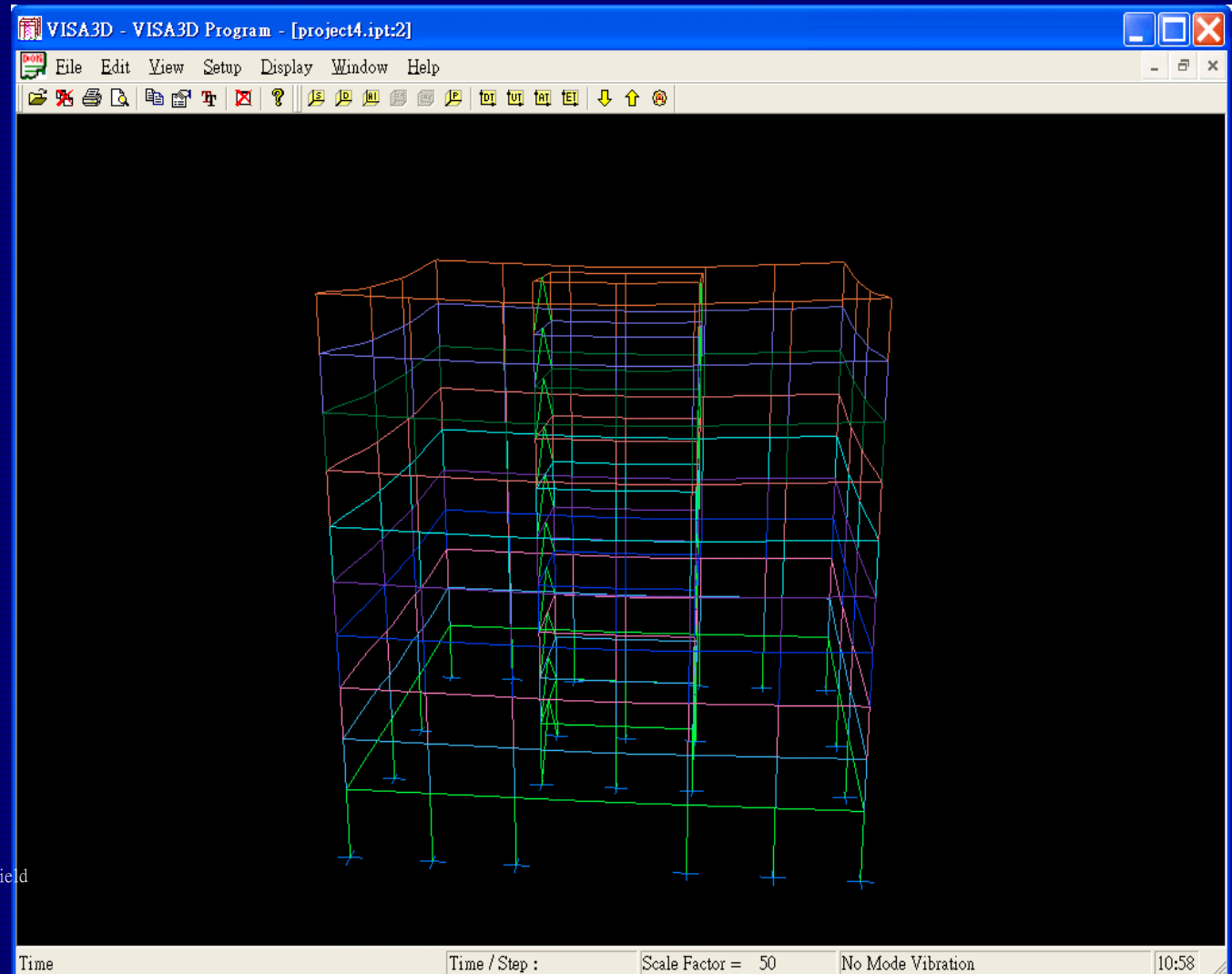
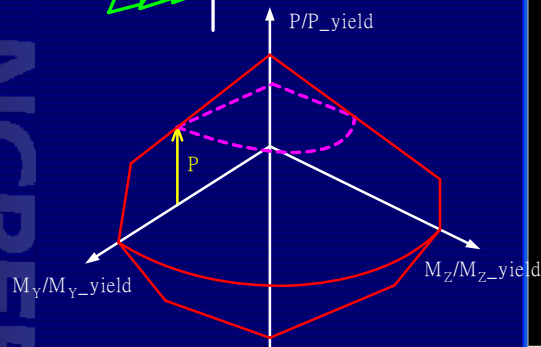
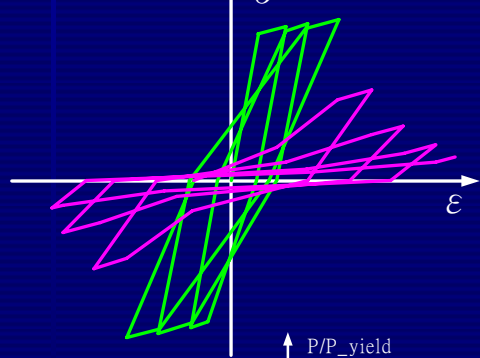
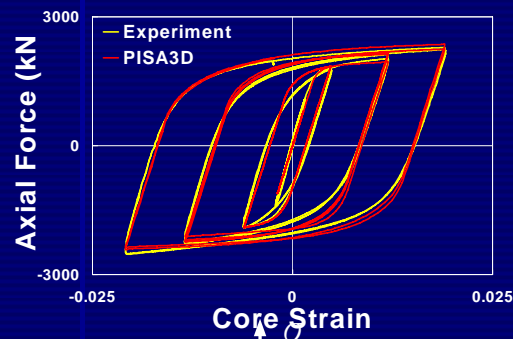


A Shaking Table Test Demonstration



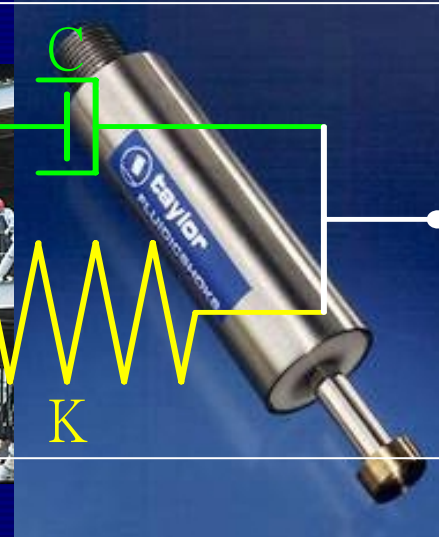
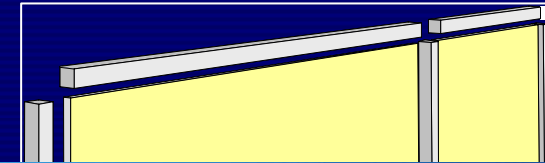
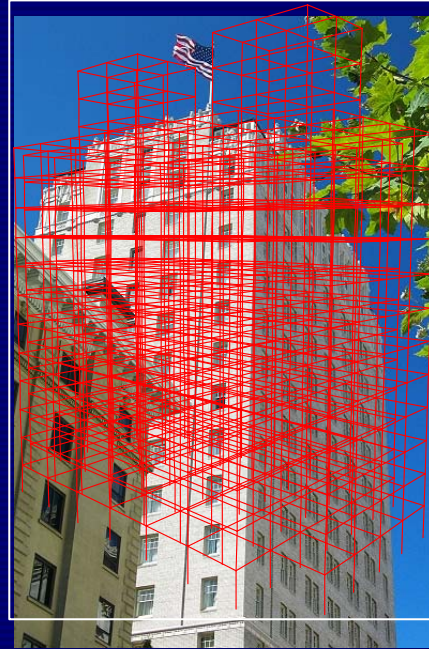
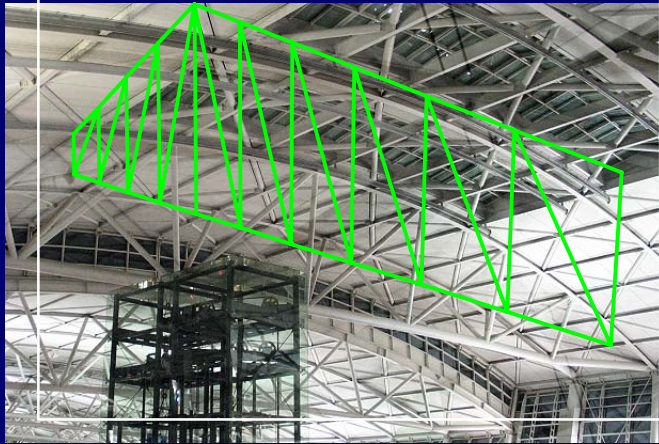
R&D of Innovative Technologies

Structural Analysis and Visualization Platform, PISA3D and VISA3D



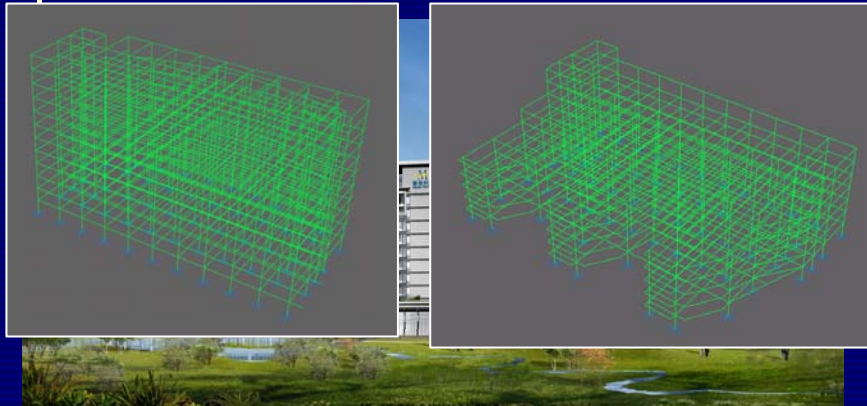
PISA3D Nonlinear Element Library

非線性元素程式庫

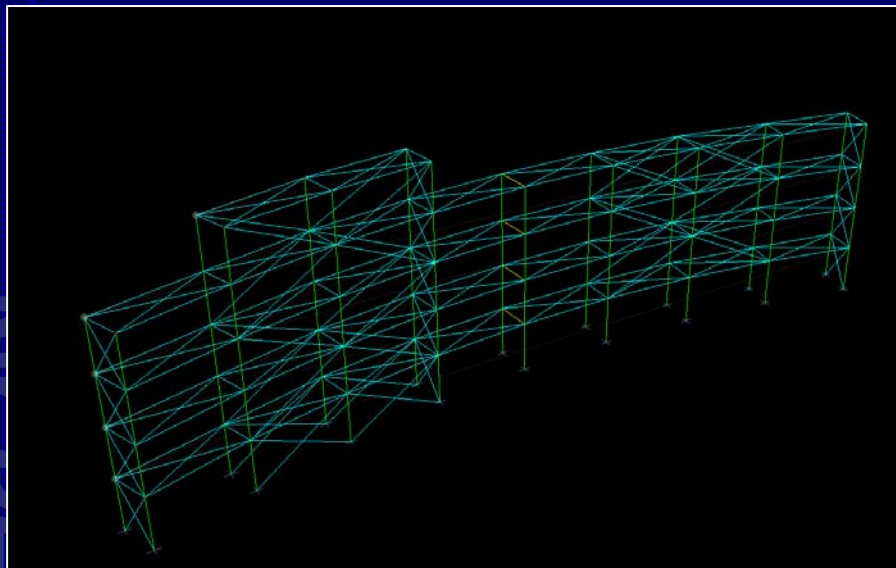


NCREE

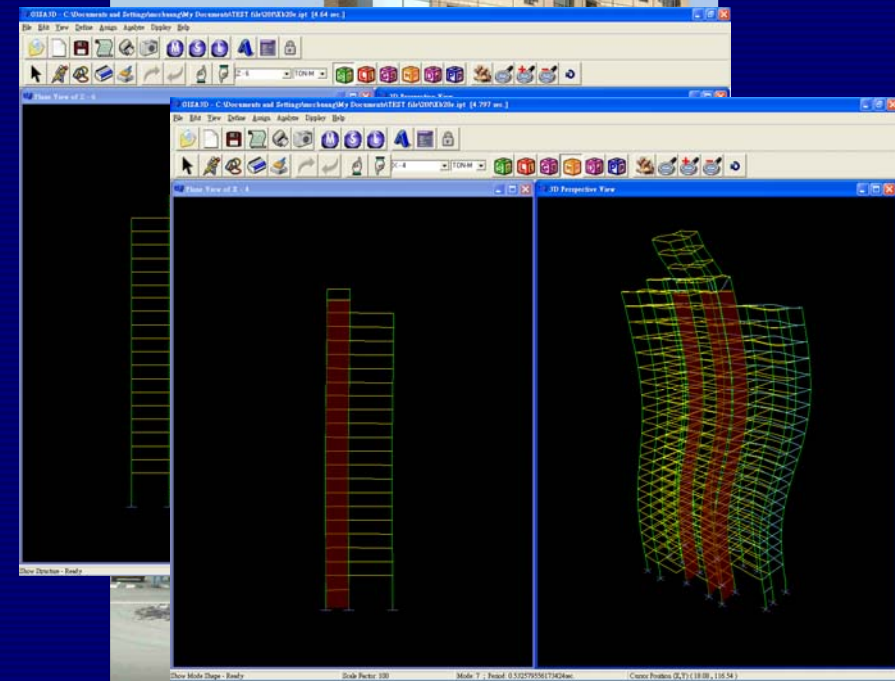
Analysis cases using PISA3D (PISA3D分析實例)



The headquarters of MediaTek Inc.



Scoring Board of Stadium



Residential Building

Applications of Innovative Technologies



Applications of Buckling Restrained Braced (BRB) to Real Structure Construction



Applications of Innovative Technologies

Applications of Viscous Dampers



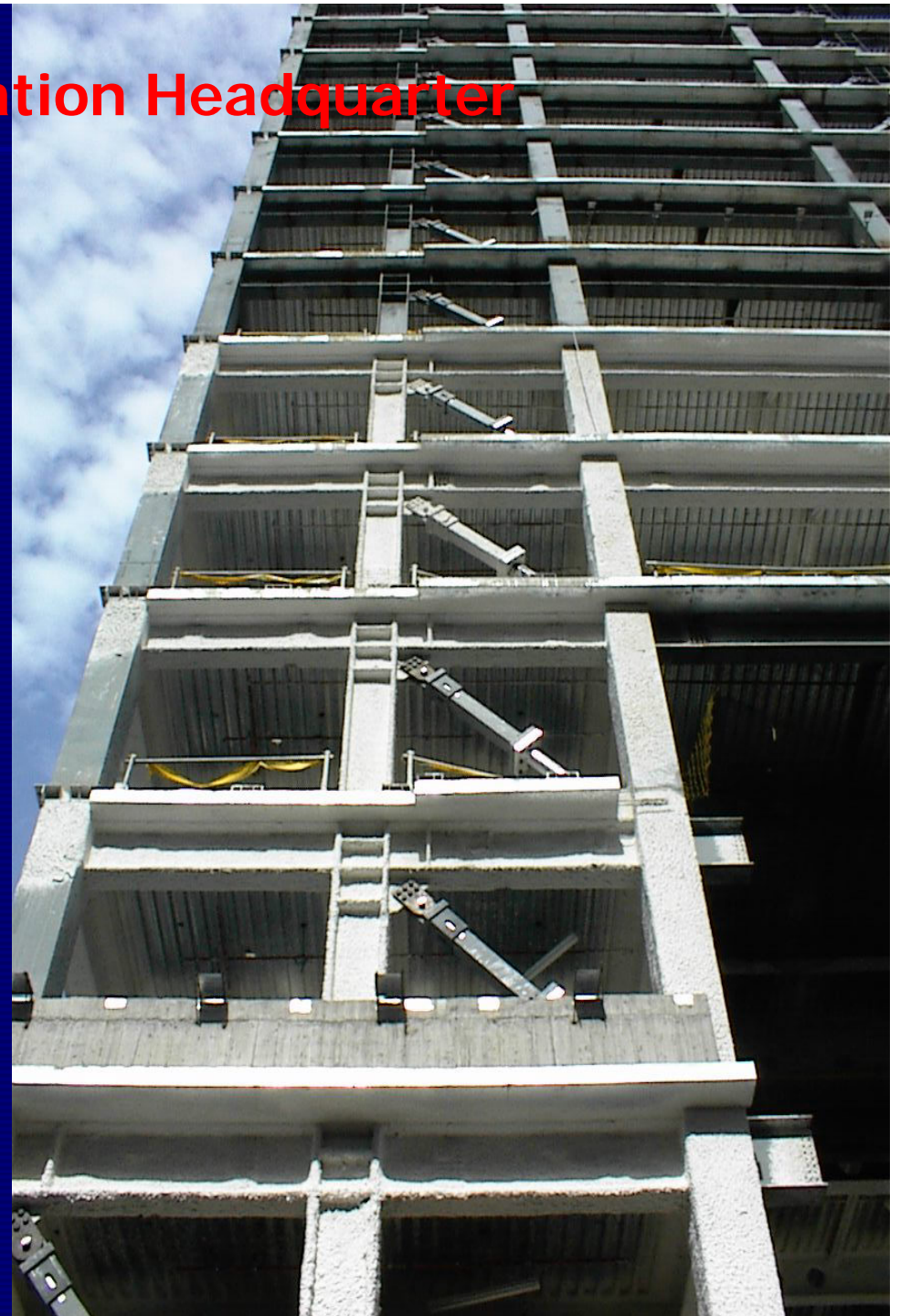
Tai-Shin Bank Headquarter



Buddhist Association Headquarter



2003/07/13



Applications of Innovative Technologies

Applications of Seismic Isolation



Tzu-Chi Taipei Hospital



IDEERS

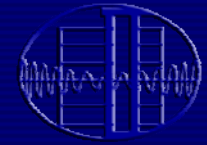
Educational programs for high school, undergraduate and graduate students





NCCER

International Training Program (ITP) for Seismic Design of Structures



ITP Participations

Country	2002	2003	2004	2005	2006	2007	2008
India	5	1	0	3	3	6	6
El Salvador	3	2	3	2	1	3	2
Turkey	0	2	1	1	1	0	2
Guatemala	1	2	1	3	3	1	1
Mexico	0	2	2	2	2	3	4
Jordan	0	0	2	2	2	3	3
Vietnam	3	3	5	4	4	5	5
Indonesia	3	2	1	3	4	4	5
Thailand	3	2	4	2	2	3	4
Philippines	5	5	4	1	3	3	6
Malaysia	0	1	2	2	2	4	4
Costa Rica	2	2	0	0	5	0	0
Bolivia	0	0	0	1	1	1	0
Mongolia	0	0	0	1	2	2	2
Dominica	0	0	0	0	1	0	0
Peru	0	0	0	0	1	0	0
Singapore	2	2	0	1	0	0	0
Honduras	0	0	0	0	0	1	2
Total	27	24	25	28	37	39	46



National Applied Research Laboratories¹⁾
National Center for Research on Earthquake Engineering²⁾

Certificate of Completion

This is to certify that³⁾

Jorge A. Postigo⁴⁾
Universidad Catolica Boliviana "San Pablo," Bolivia⁵⁾

has completed the training courses⁶⁾
of the International Training Program for Seismic Design of Structures 2004⁷⁾

hosted by National Center for Research on Earthquake Engineering⁸⁾
of National Applied Research Laboratories⁹⁾

sponsored by National Science Council¹⁰⁾

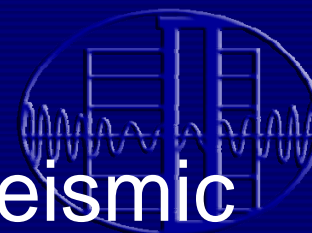
in Taiwan, October 25-29, 2004.



Keh-Chyuan Tsai¹¹⁾
Director¹²⁾

National Center for Research on Earthquake Engineering¹³⁾





Indo-Taiwan Collaborative Plan on Seismic Evaluation and Retrofit of Buildings

Prof. D.K. Paul

Prof. Yogendra Singh

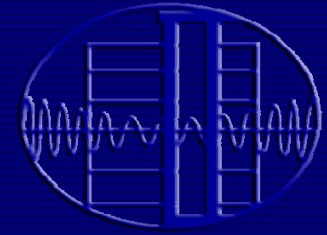
Prof. Shyh-Jiann Hwang

Dr. Yuan-Tao Weng



Collaboration

- **To develop a better understanding on Earthquake Engineering and Disaster Mitigation**
- **To develop or improve national codes, rules, inspection forms and experimental setup for testing**
- **Strengthen the ties between India and Taiwan by joint research**



Current Studies

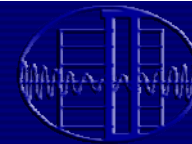
NCREE

School Buildings Damaged by Chi-Chi Earthquake



$$\frac{\text{collapse or severe damaged}}{\text{total (Nantou)}} = \frac{293}{496} \approx \frac{1}{2}$$

Out-of-Plane Brick Wall



June, 2006



Test of Double Curvature Column

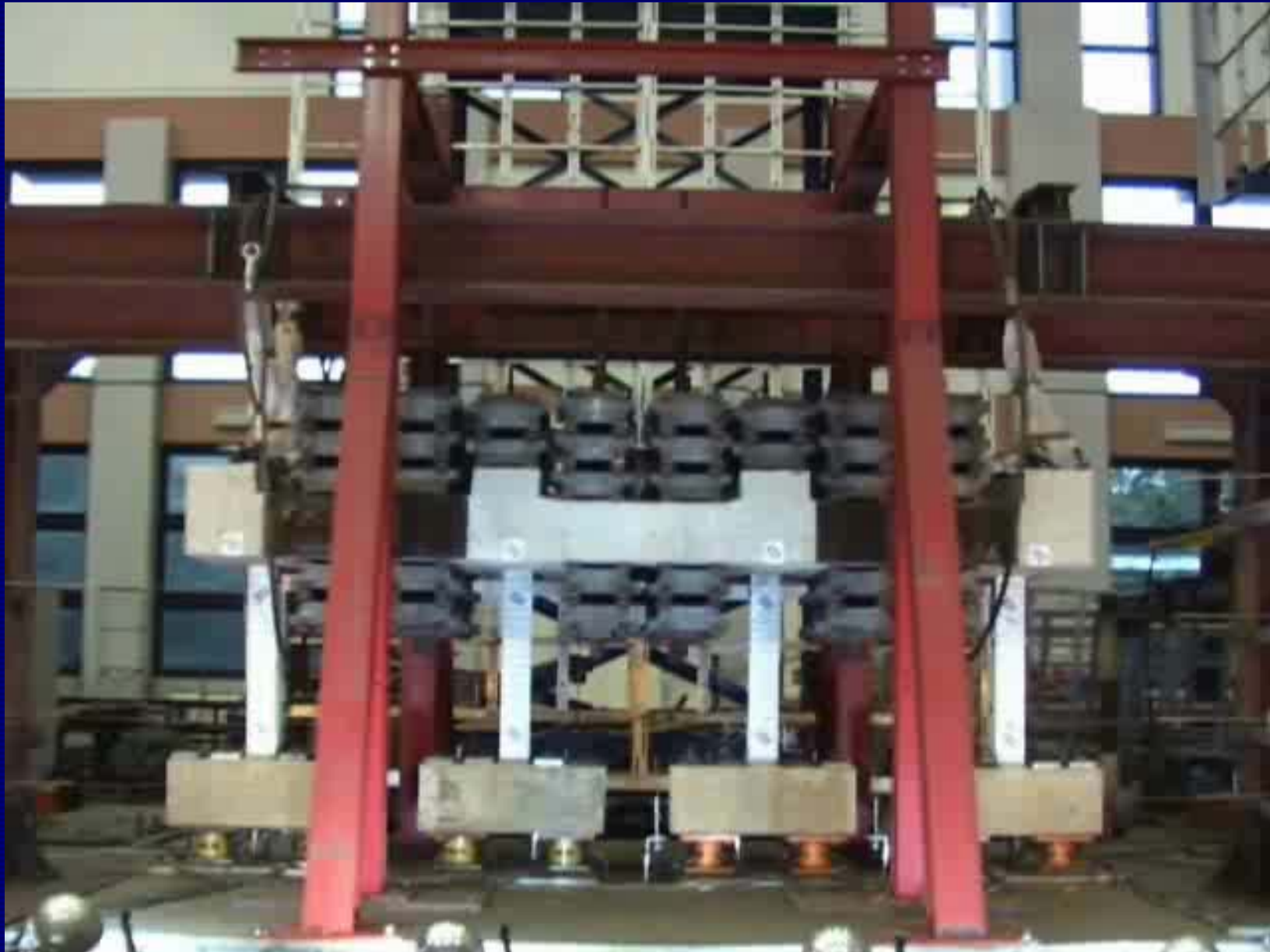
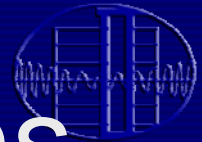


Joint Research between NCREE and Japan

Sep. 2006



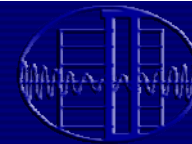
Collapse Tests of RC Columns



Test Setup



Retrofit of Full-Scale School Frames

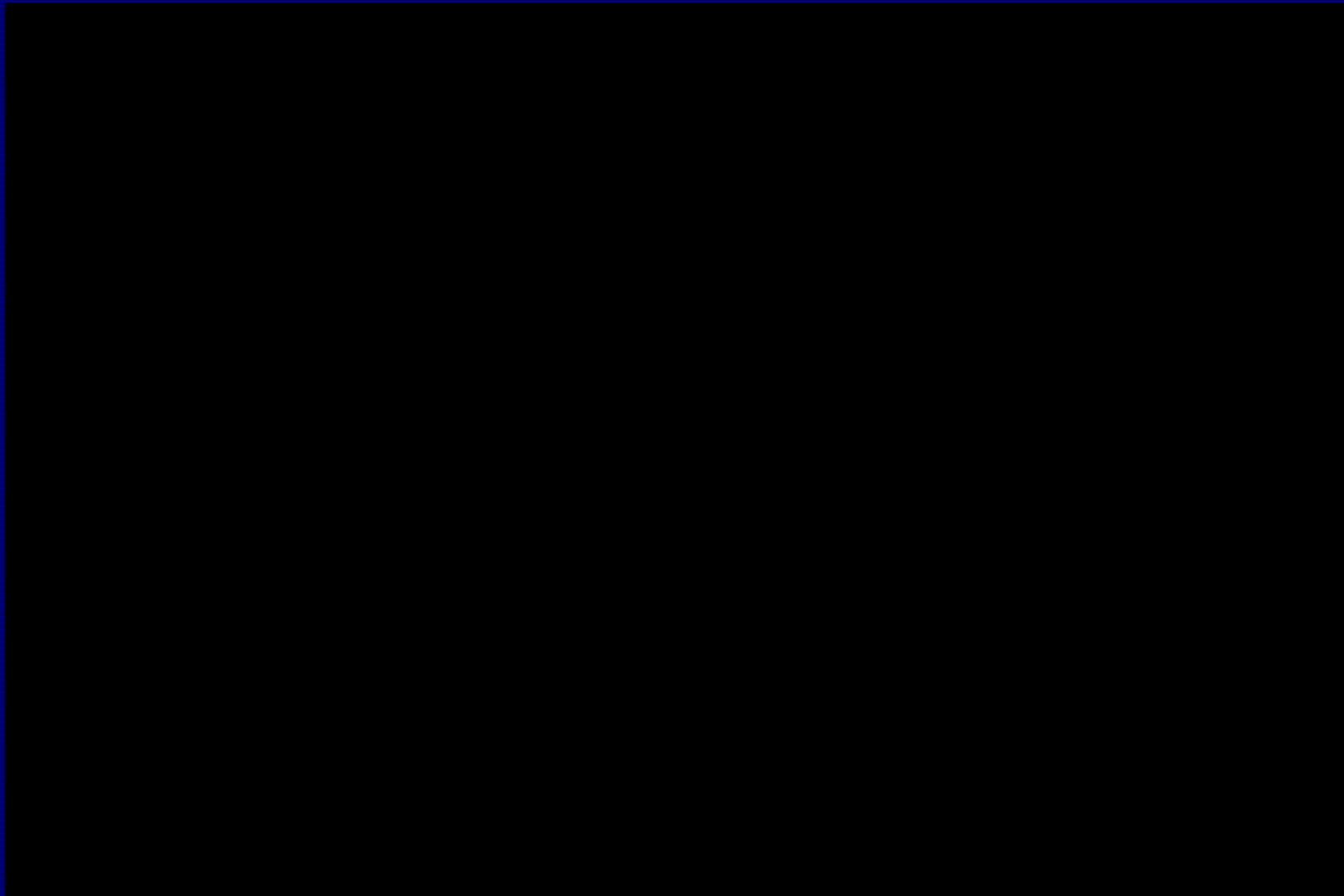


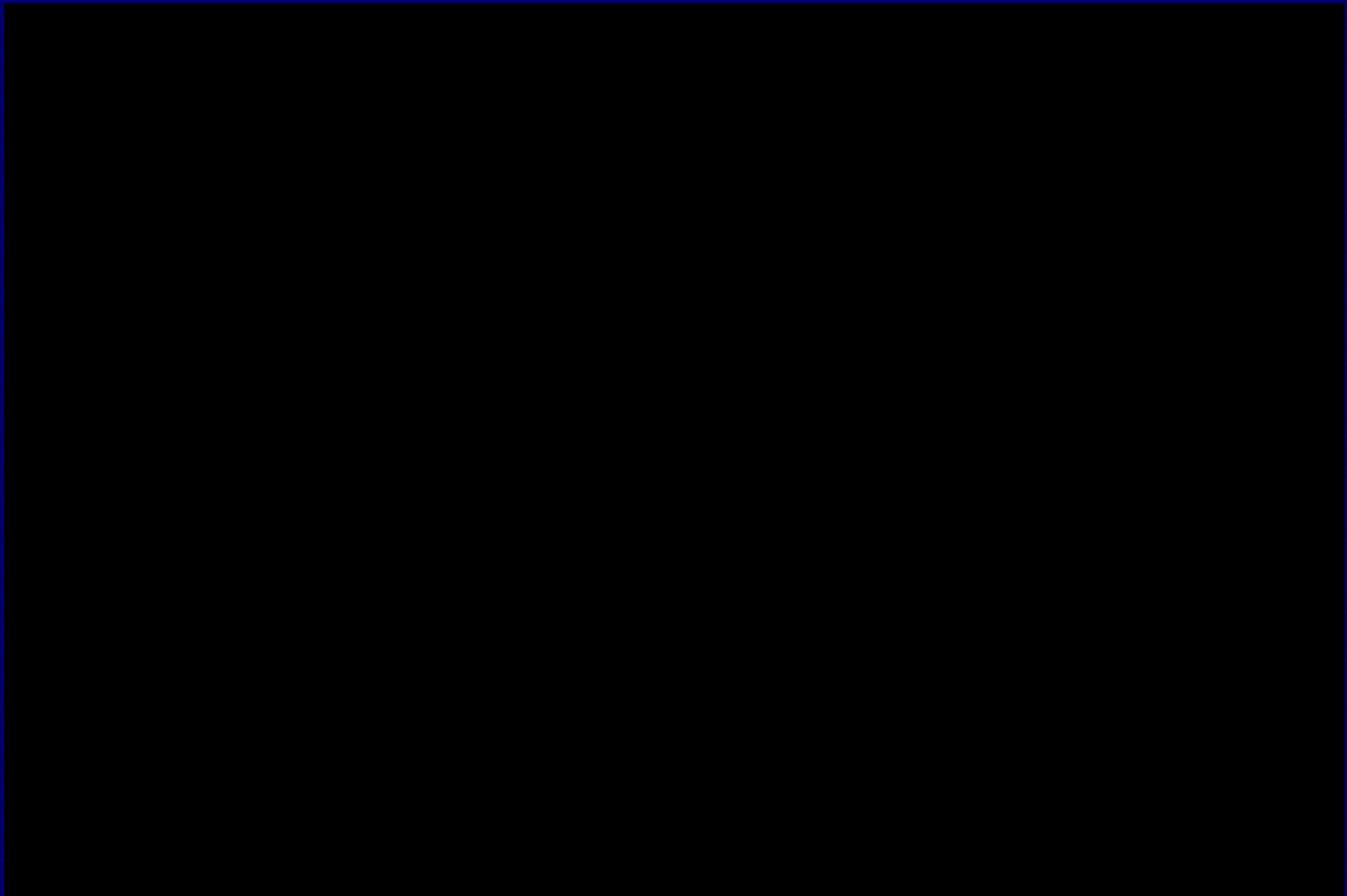
2004

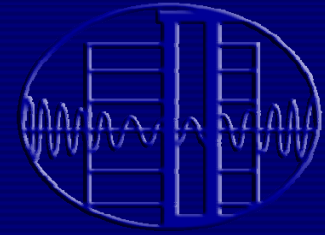


Test Clip



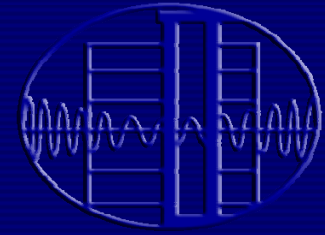






Collaborative Activities

NCREE



Collaborative Workshops

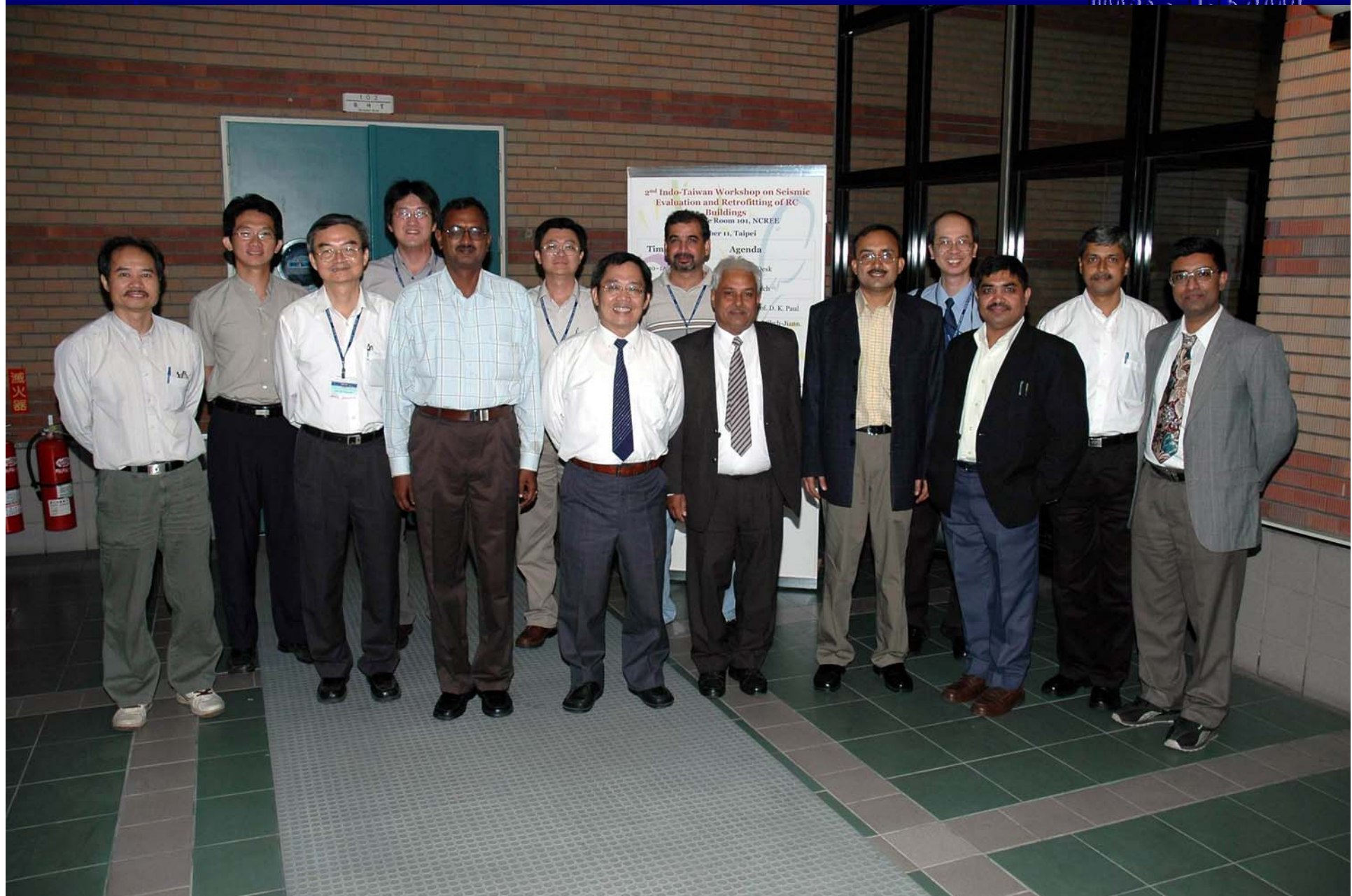
NCREE

Indo-Taiwan Joint Workshop on Seismic Evaluation and Retrofit of Buildings

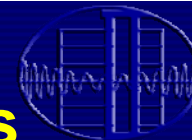


Nov. 2004
New Delhi

The 2nd Indo-Taiwan Workshop on Seismic Evaluation and retrofitting of RC Buildings



Symposiums of 1st and 2nd Collaborative Workshops



SEISMIC EVALUATION AND RETROFIT OF BUILDINGS

November 22-23, 2004; New Delhi, India

INDO-TAIWANESE JOINT WORKSHOP

Editors :

D. K. Paul
Yogendra Singh

Supported by

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New Delhi

Organized by

Department of Earthquake Engineering
Indian Institute of Technology Roorkee
Roorkee 247 667, India

and

Building Materials & Technology Promotion Council
New Delhi



國家地震工程研究中心

NATIONAL CENTER FOR RESEARCH ON
EARTHQUAKE ENGINEERING

Proceedings of the 2nd Indo-Taiwan Workshop on Seismic Evaluation and Retrofitting of RC Buildings

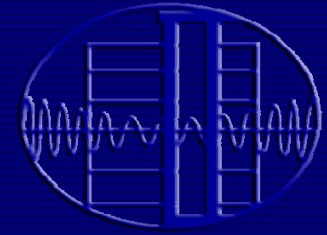
October 11-12, Taipei, Taiwan

Edited by

Shyh-Jiann Hwang Yuan-Tao Weng

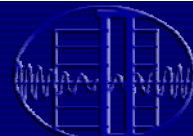
Report Number : NCREE-06-012

October 2006



Bilateral Visiting

NCREE



In-Situ Kouhu School Test

Aug. 2005

Taiwan

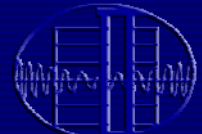


Visiting Taipei 101 Center

Aug. 2007

Taiwan





Aug. 2007

Taiwan

In-Situ Gian-Miao School Test



Collaborative Memorandum



- **Aims: promote the exchange of persons, activities and experience in relevant fields of Earthquake Engineering, Seismic Hazard and Risk Assessment and Research.**
- **Collaborative research will be encouraged by**
 - ◆ admitting Ph.D students under joint supervision from both of the Institutes.
 - ◆ admitting post-doctoral researchers or research associate from both of the Institutes.

Collaborative Project Cost



Seismic Evaluation and Retrofitting of Buildings

**Submitted to : Department of Science and
Technology, India
National Science Council, Taiwan**

- India Site: 1,673,000 Rupees (Three years)
- Taiwan:
 - NSC supported NT\$ 3,400,000 (US\$100,000, Three years)
 - NCREE supported NT\$ 60,000,000 (about US\$1,800,000)

Future Work in NCREE



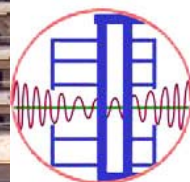
- **Seismic Evaluation and Retrofitting**
School, Hospital, Police Station
- **Calibration of Analytical Models**
- **Seismic Vulnerability Assessment**
Masonry, RC Buildings
- **Data Bank of Existing Buildings**



Thanks for Your Attention



國家實驗研究院
National Applied Research Laboratories



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