

Seismic Retrofit of Buildings in Taiwan: Policy, Regulations, and Progress

台灣建築結構耐震補強：政策、法規與進展

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National Institutes of Applied Research
July 27, 2026



1999/09/21

Chi-Chi Earthquake



2008/03/12

Wenchuan Earthquake

Global Financial Crisis



2016/02/06

Meinong Earthquake

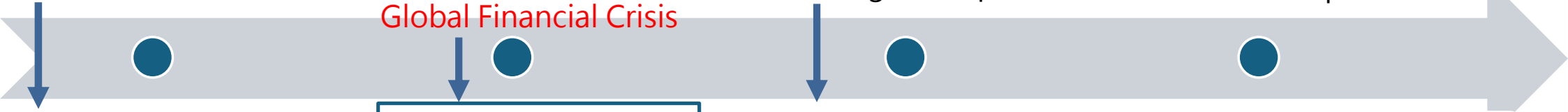


2018/02/06

Hualien Earthquake

驗研究院
S OF APPLIED RESEARCH

ETtoday新聞雲



Government Office bldg.

Executive Yuan Policy:
Implementation of Seismic Assessment and Retrofit Plans for **Public** Buildings.

NCREE Technology:
1. Seismic Design Code of Buildings
2. Taiwan Earthquake Assessment for Structures by Pushover Analysis (TEASPA)

MOE and NCREE
kick off **School
Retrofitting Project**

Executive Yuan Policy: Plan for Seismic Assessment, Rebuild, and Retrofit of **Private Buildings**.

Residential (encouragement):
Executive Guidelines for Conducting Seismic Preliminary Evaluation of Buildings and Providing Subsidies for **Weak-Story Retrofit**.

Public usage (mandatory):
Regulations for Public Safety Inspection of Buildings

School Buildings

School Buildings Damaged by the Chi-Chi EQ 國家實驗研究院 NATIONAL INSTITUTES OF APPLIED RESEARCH

$M_L = 7.3$; 01:47 AM, Sep. 21, 1999



Actions

- The government started to do seismic retrofit for public buildings and public school buildings.
- NCREE played an important role in developing the seismic evaluation and retrofit methods.
- NCREE had an office to help the government to do the school seismic retrofit project.

School Retrofitting Project in Taiwan

1999



2009



2022



Preparation – 10 years

- Strategy
- Technology Development

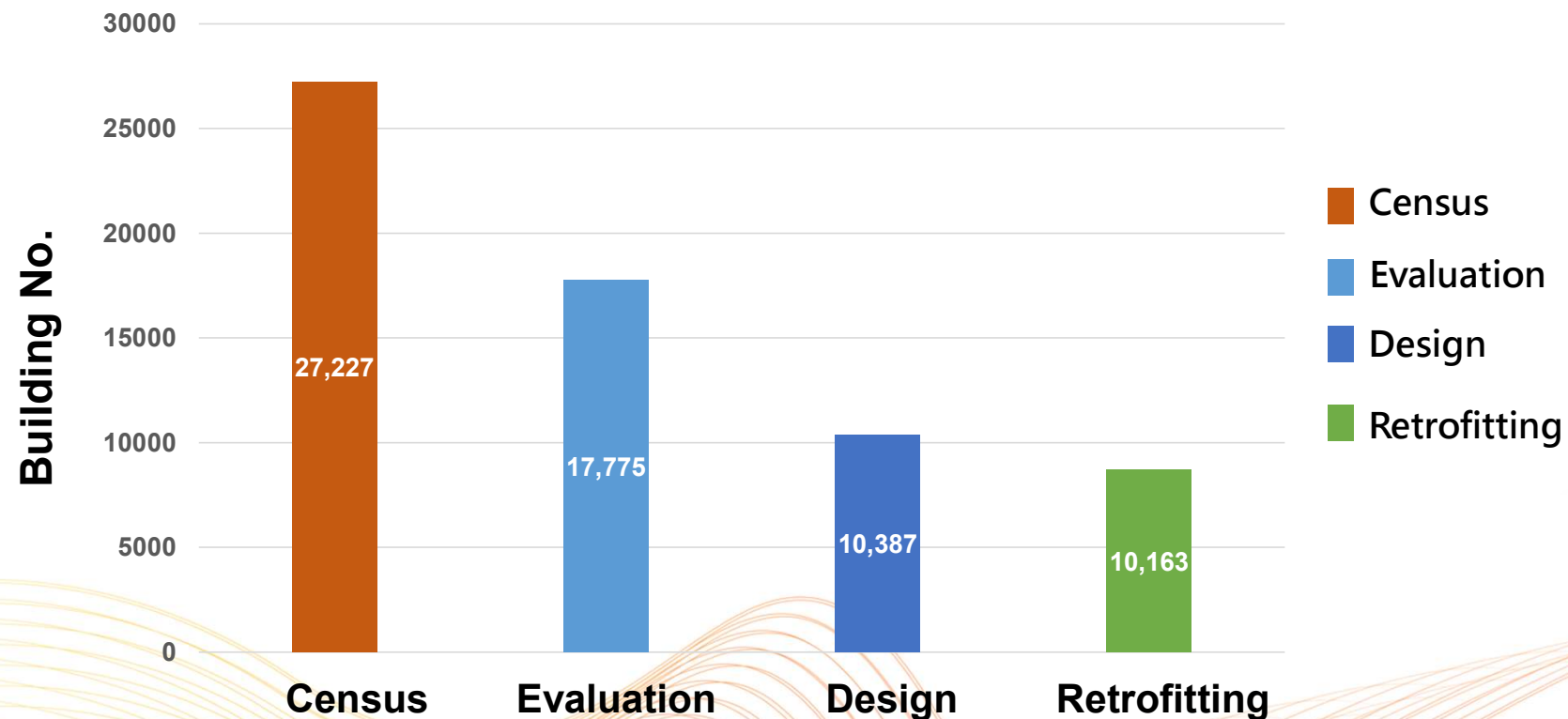
Execution – 14 years

- Administrative Measures
- Budgets **US\$ 4 billion**

$$\frac{\text{Retrofitted}}{\text{Total}} = \frac{10,163}{27,227} = 37\%$$

School Buildings Upgrading Projects

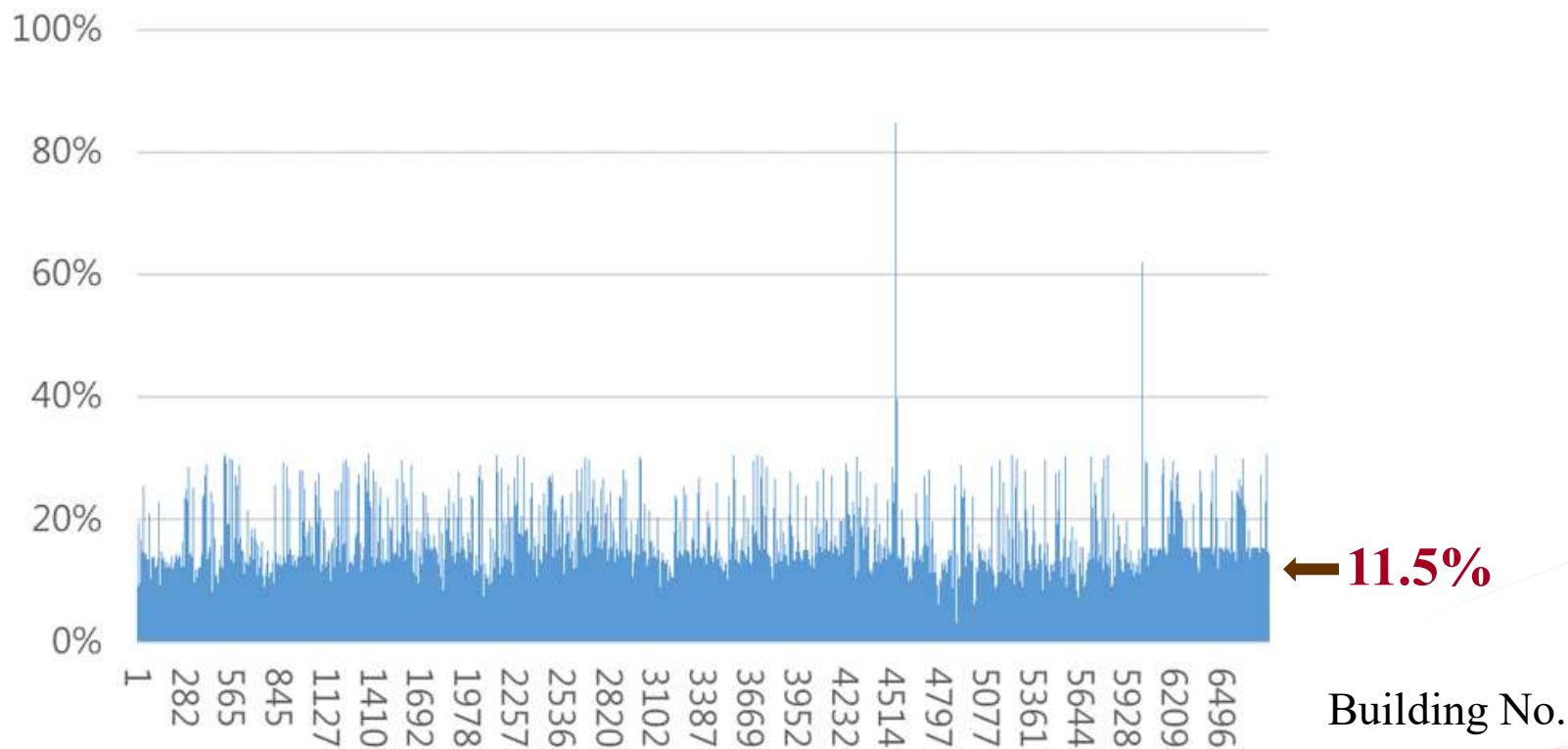
- Project Span: from 2009 to 2022
- Upgrading rate (by construction): up to 37%



Cost of School Retrofitting in Taiwan

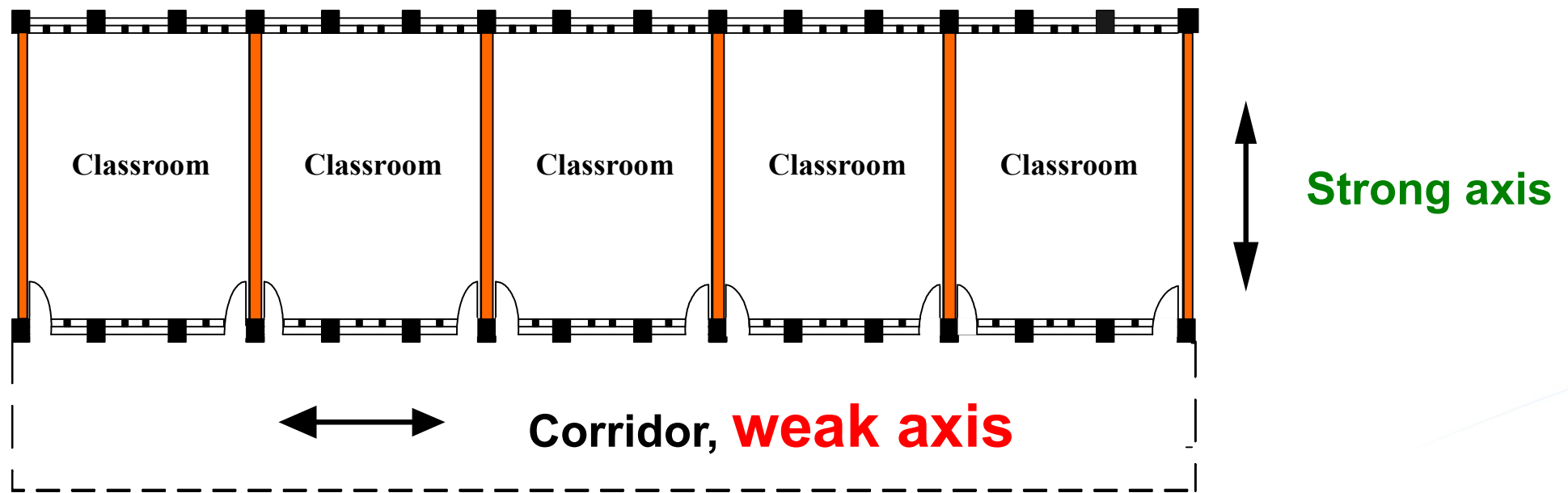
校舍重建及補強經費比

Retrofit
Rebuild



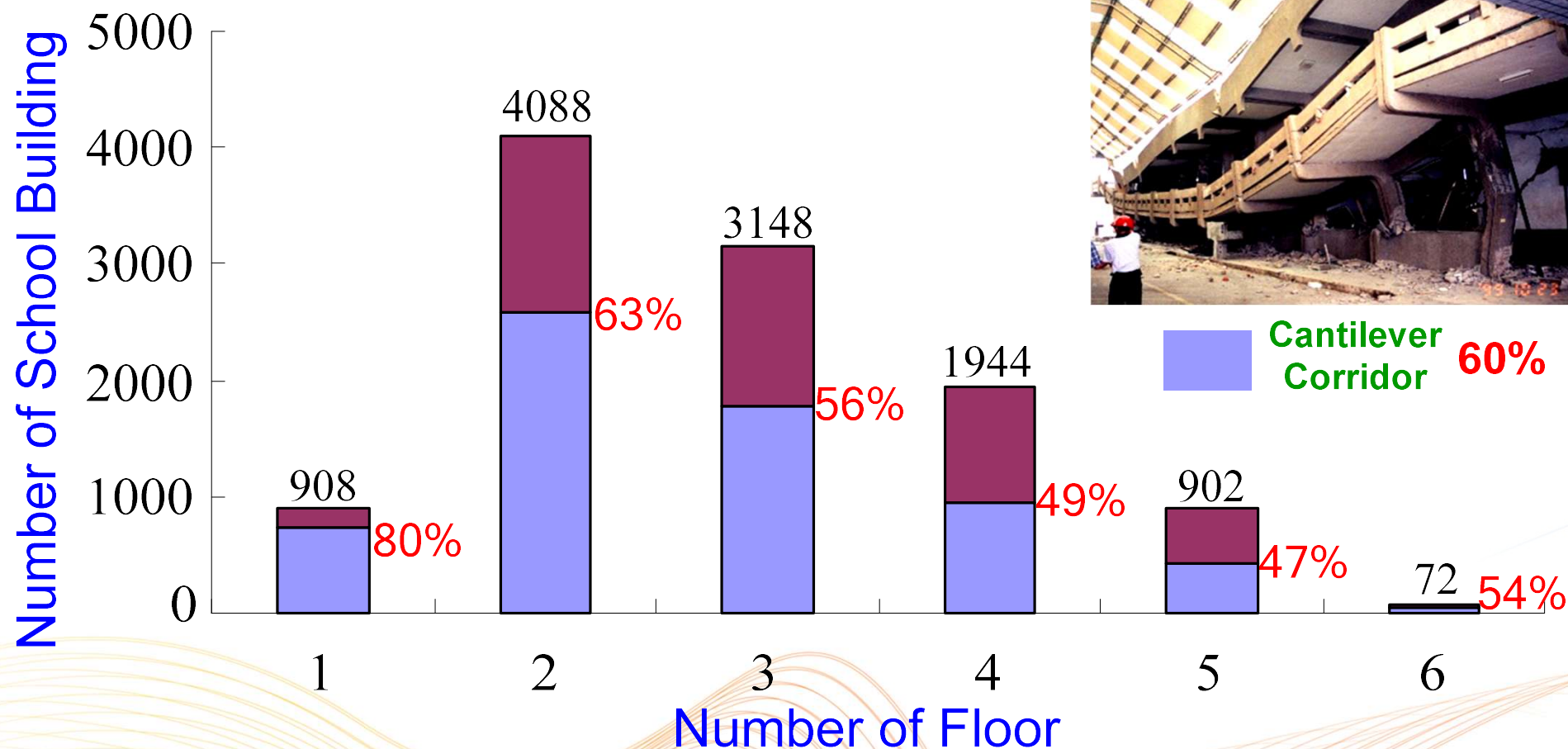
$$\text{Actual Cost: } \frac{\text{Retrofitting Cost}}{\text{Rebuilt Cost}} = \frac{\text{NT\$ 3,000 /m}^2}{\text{NT\$ 26,000 /m}^2} = 11.5\%$$

Identifying Building Vulnerabilities for Collapse



Typical Structural Plan of School Building

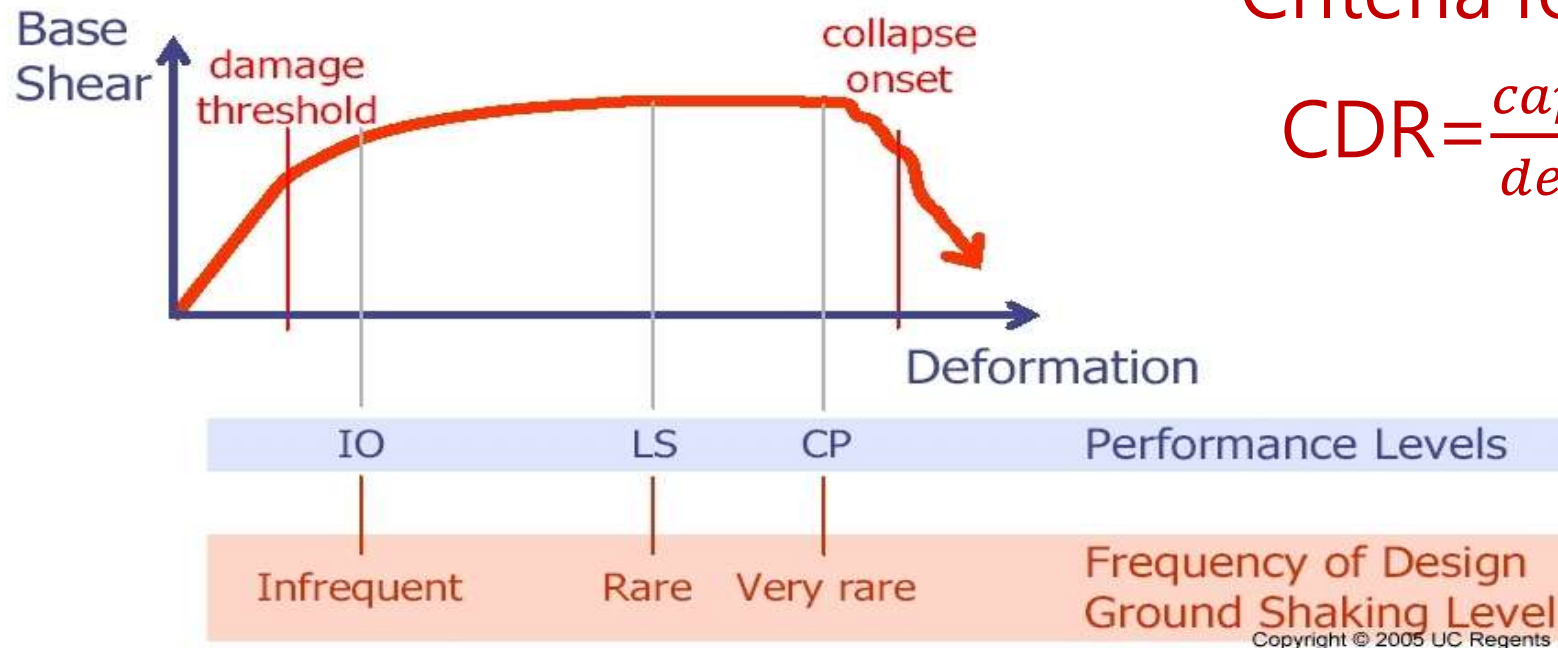
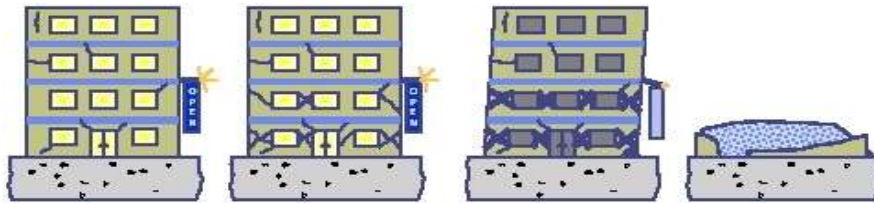
School Buildings with Cantilever Corridors



The Problem is Getting Worse!

Detailed Evaluation

Performance-Based Engineering

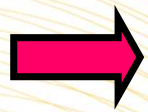
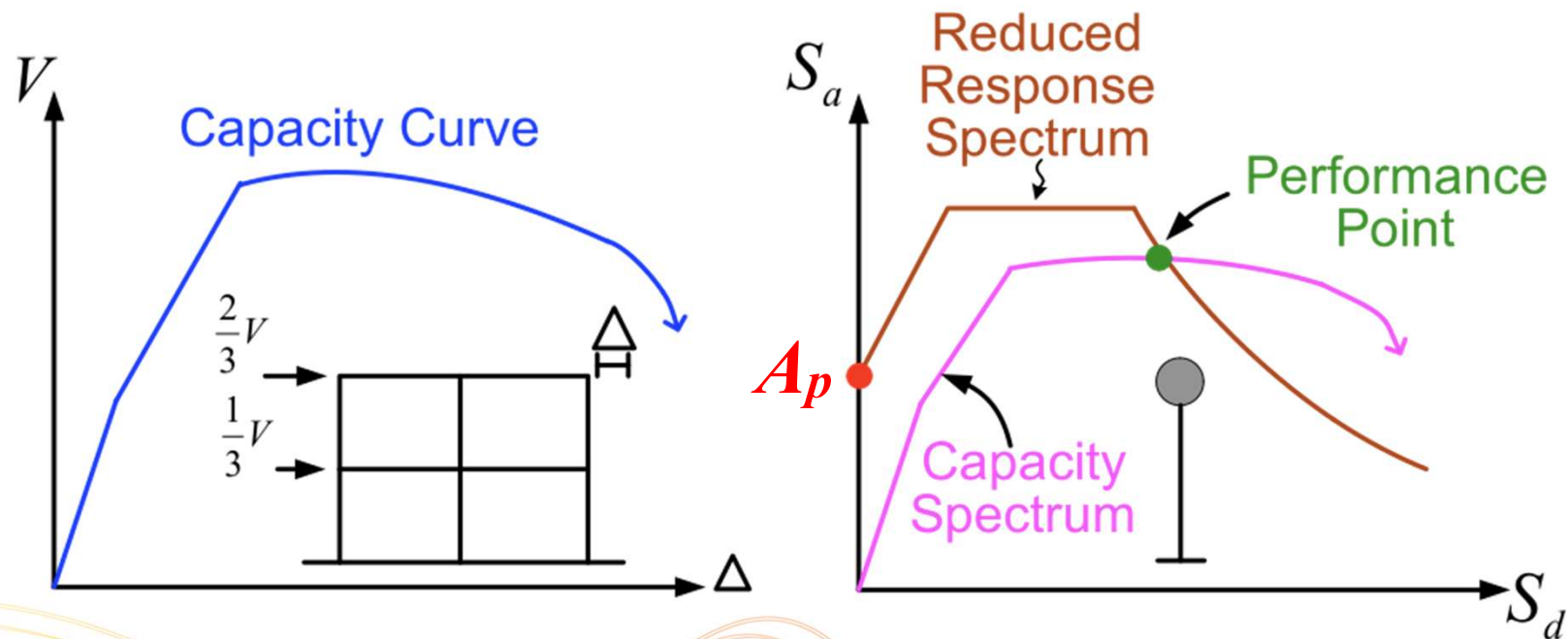


Criteria for Retrofit :

$$CDR = \frac{\text{capacity}}{\text{demand}} > 1.0$$

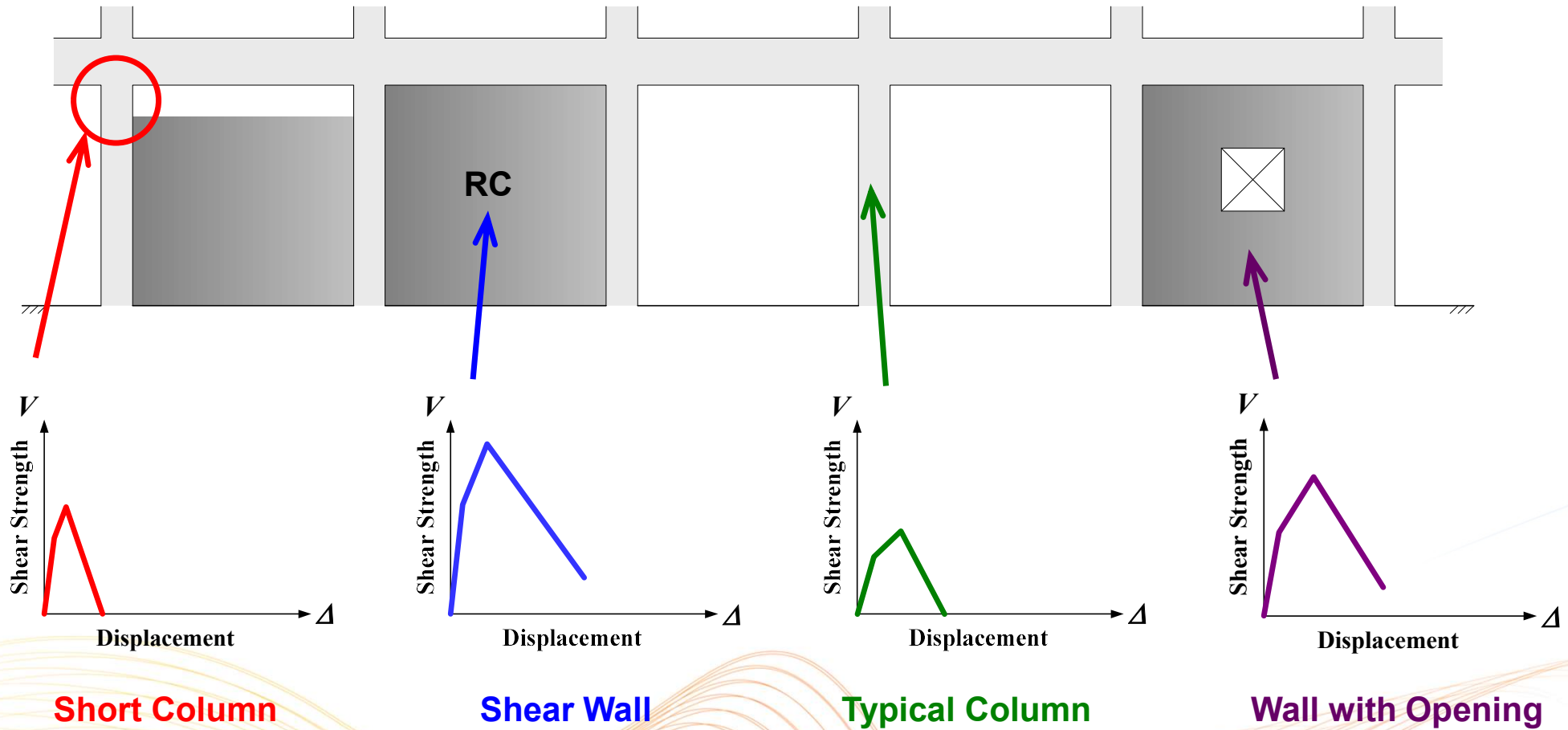
Nonlinear Static Analysis

Pushover Analysis $\Rightarrow$ Capacity Spectrum Analysis



Performance-Target Ground Acceleration A_p

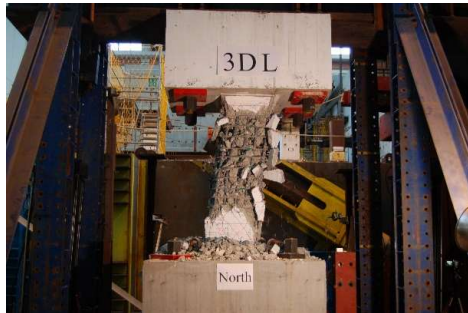
Backbone Curves for Shear Critical Members



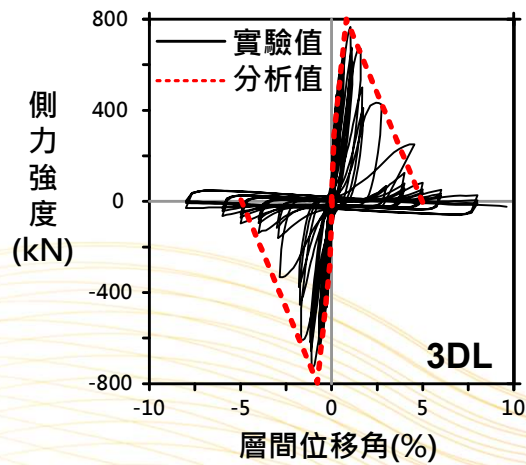
Softened Strut-and-Tie Model

Research on Seismic Capacity of Members

Static Test



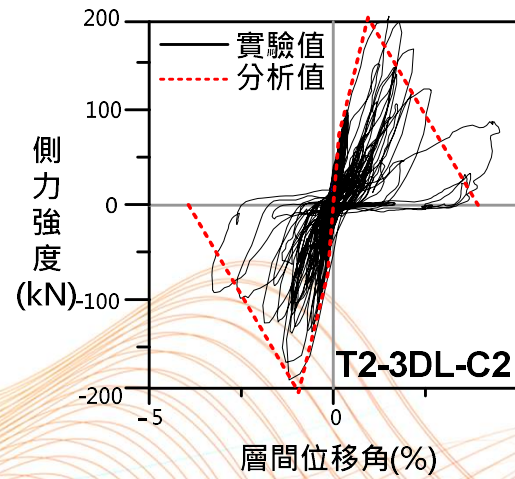
Column



Shaking Table Test



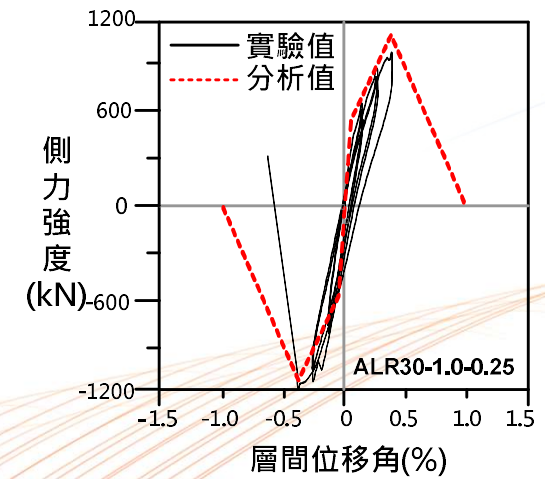
Columns



Static Test



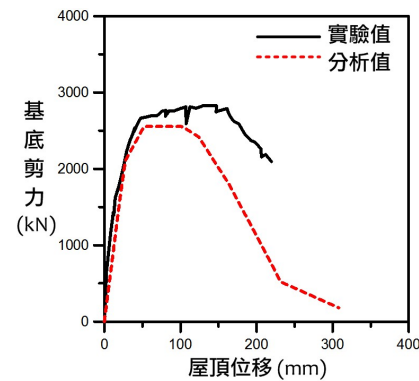
Wall



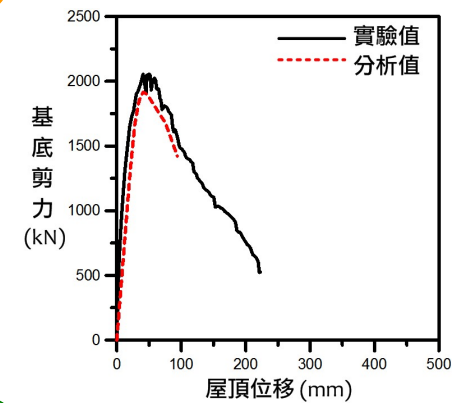
In-Situ Tests of School Buildings

Verification of Pushover Analysis

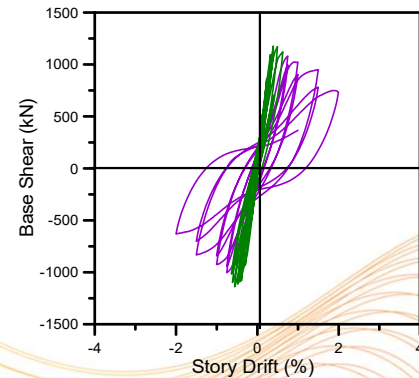
Hualien (2005)



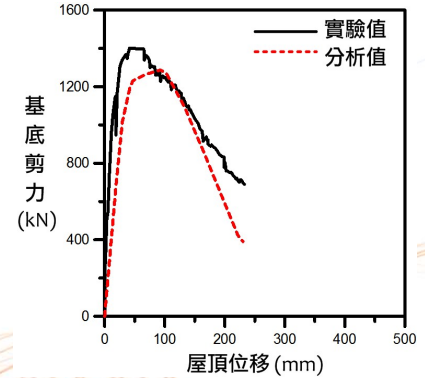
Yunlin (2005)



Taoyuan (2006)



Tainan (2007)



Budget Control - Economic Methods

✓ Traditional Retrofitting Method ⇒ Encouraged

RC Column Jacketing



RC Wing Wall

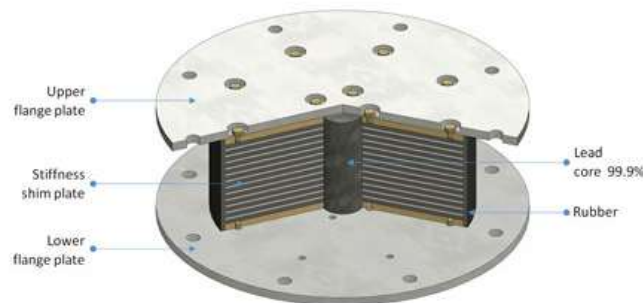


RC Shear Wall



⊘ Seismic Devices with Patents ⇒ Prohibited

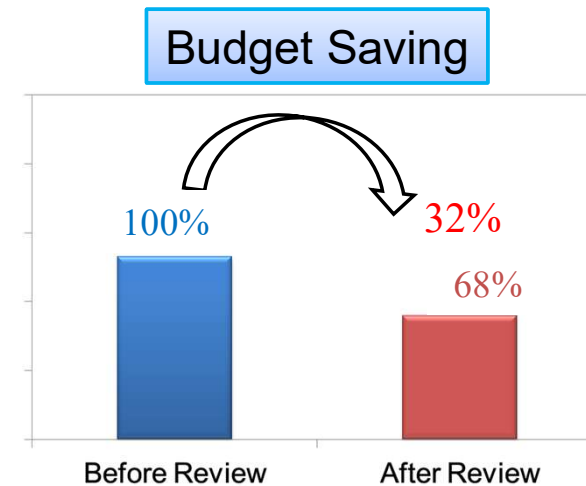
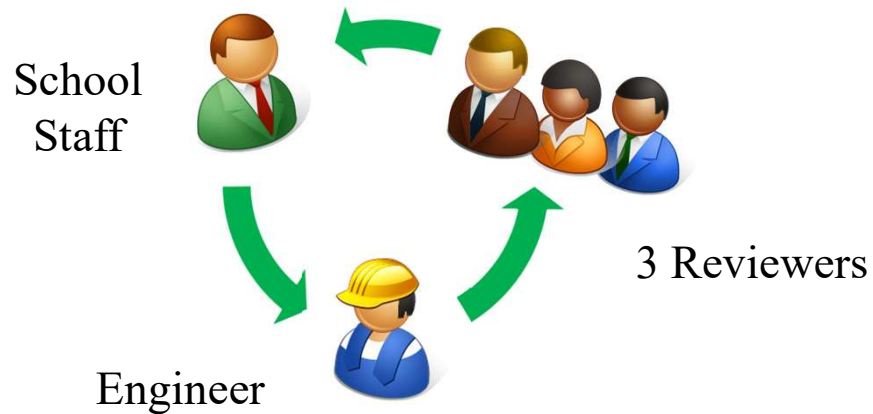
Isolated Device



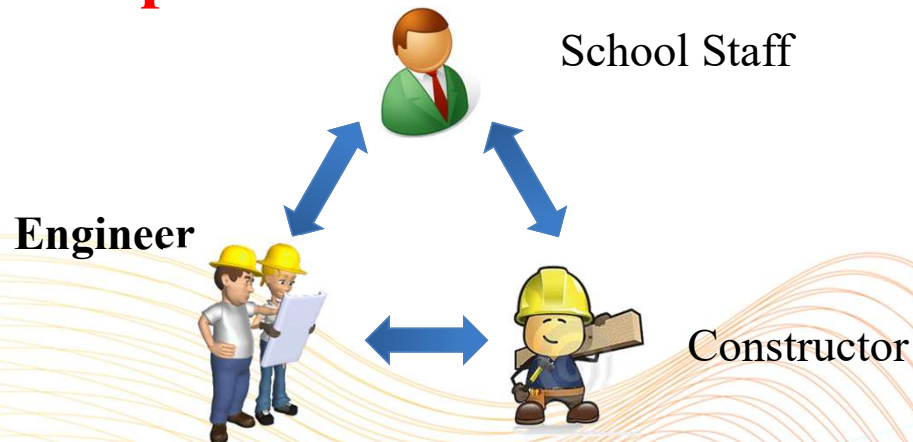
Damper

Quality Control - Review and Inspection

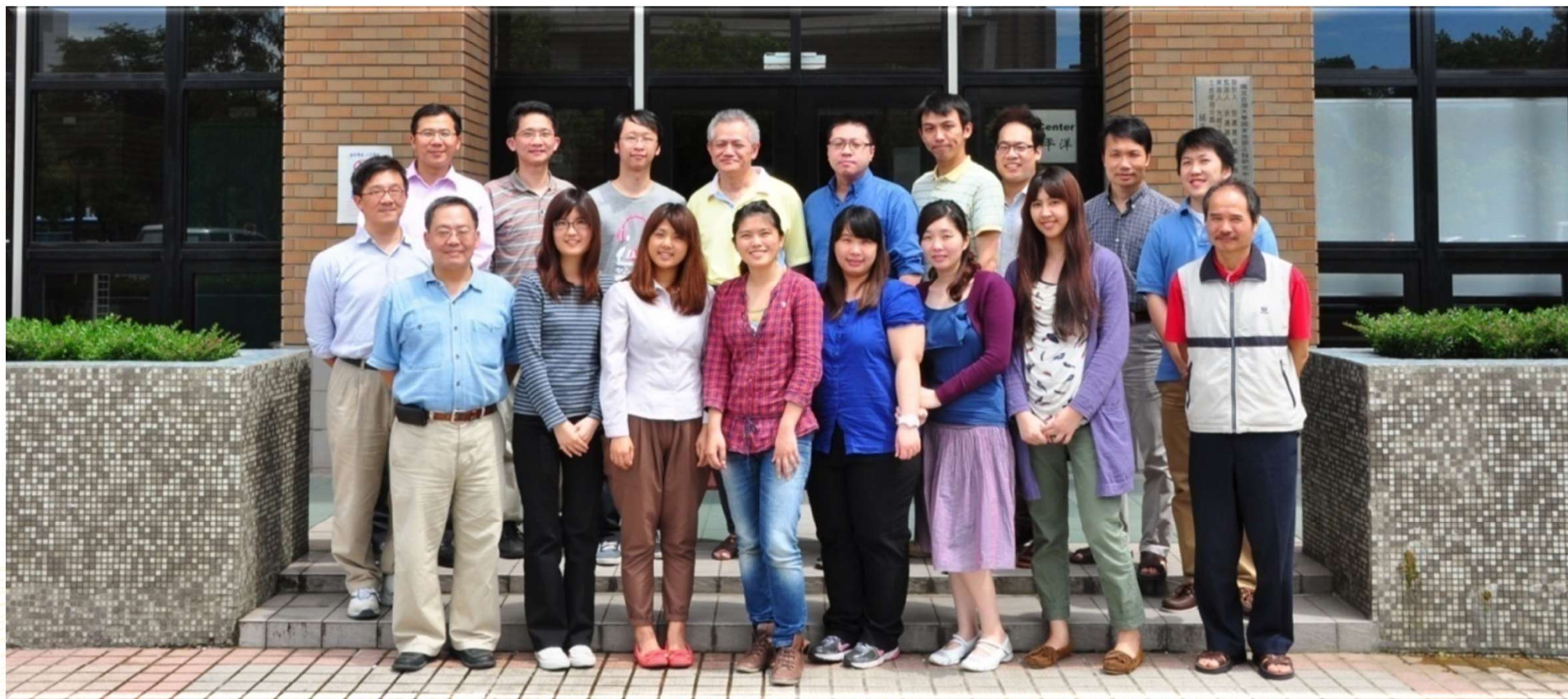
- Peer Review for Design



- Inspection for Construction



NCREE Office of School Building Retrofitting



Private Buildings for Public Usage

2016 Meinong Earthquake

$M_L = 6.6$; 03:57 am, Feb. 6, 2016

- Human Impact:
 - Deaths: 117
(Weiguan: 115)
 - Injuries: 551
- Building Damage:
 - Red tag: 249
 - Yellow tag: 336

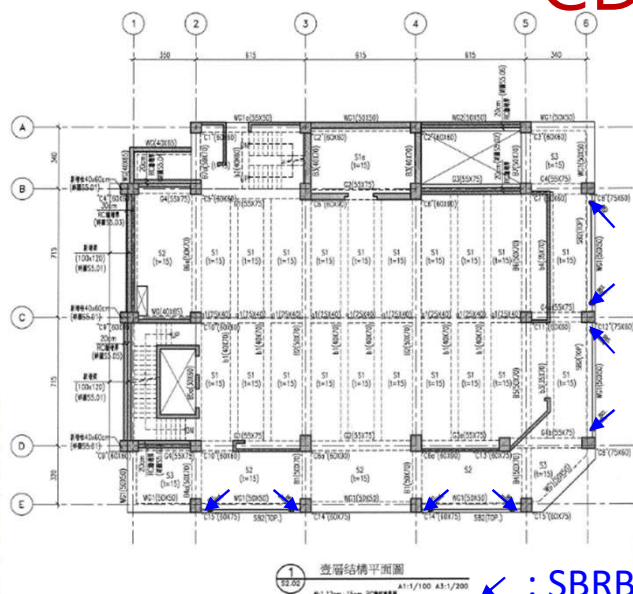


Actions

- The government issued a new regulation on 2018/02/21
 1. Mandatory seismic evaluation for buildings with public usage of more than 1000 m² floor area and for a single owner.
 2. Inspection every two years until seismic capacity is upgraded.

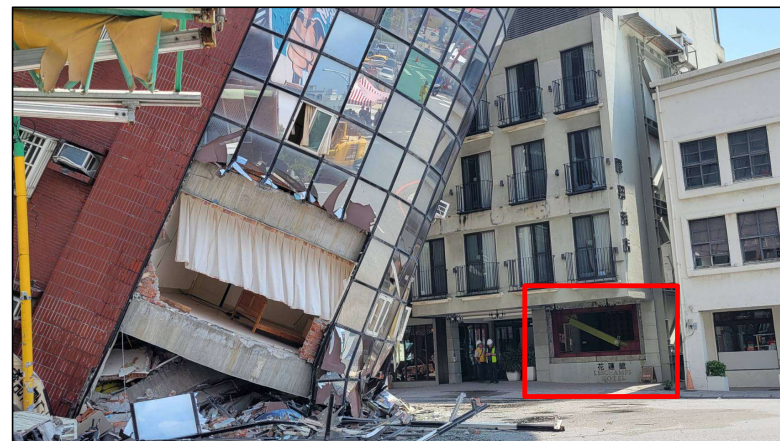
Commercial Office Building Retrofitted by SBRB

- The Mega Bank office building was diagnosed as seismically insufficient.
- The bank finished seismic retrofitting using BRB at the end of March 2024. No structural damage was observed after the April 3, 2024 Hualien Earthquake.



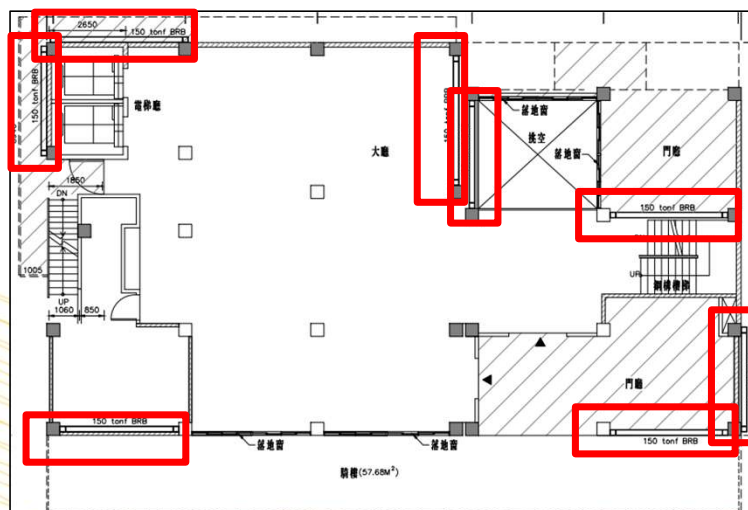
Hotel Building Retrofitted by BRB

- This hotel was diagnosed as seismically insufficient.
- It finished seismic retrofitting using BRB before the 2024 Hualien Earthquake.
- Compared to its neighbor, a collapsed residential building, the retrofitted hotel remained safe after the April 3, 2024 Hualien Earthquake.



林旭翎 攝

CDR > 1.0



Award and Penalties by Local GOV.



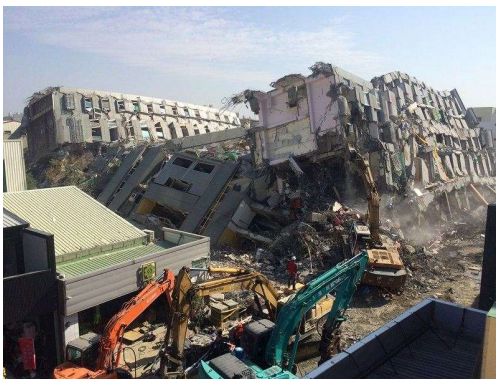
Hualien County GOV. announces locations of seismically qualified hotels in the city.



Taipei City GOV. notifies locations of seismically disqualified public markets in the city.

Private Buildings for Residences

Failure Mode Controlled by Soft and Weak Bottom Story



Weiguan Building
2016.02.06



Yunmen Building
2018.02.06

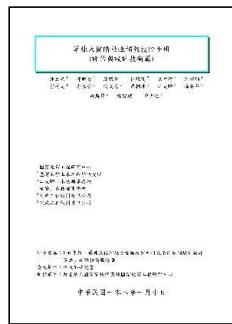


Tongshuai Hotel
2018.02.06

Seismic Weak-Story Retrofit of Private Buildings in Taiwan



Preparedness (2017~2019)



● Chung et al. “**Technical handbook** for seismic retrofit in stages of residential buildings. (Vol. I: **Assessment and Design**)” CPAMI report, 2019.

● Chung et al. “**Technical handbook** for seismic retrofit in stages of residential buildings. (Vol. II: **Construction and Supervision**)” CPAMI report, 2021.



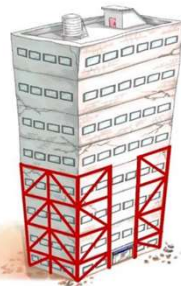
Execution (2019~2025)

- Goal: **30** buildings/year
- Budget: **US\$ 4.5 million/year**
- **148** cases have been approved, of which **24** cases have been completed.
- There are over **100** buildings in process of application.

<https://privatebuilding.ncree.org.tw/>



Retrofitting for soft-weak bottom story



Retrofitting for whole building

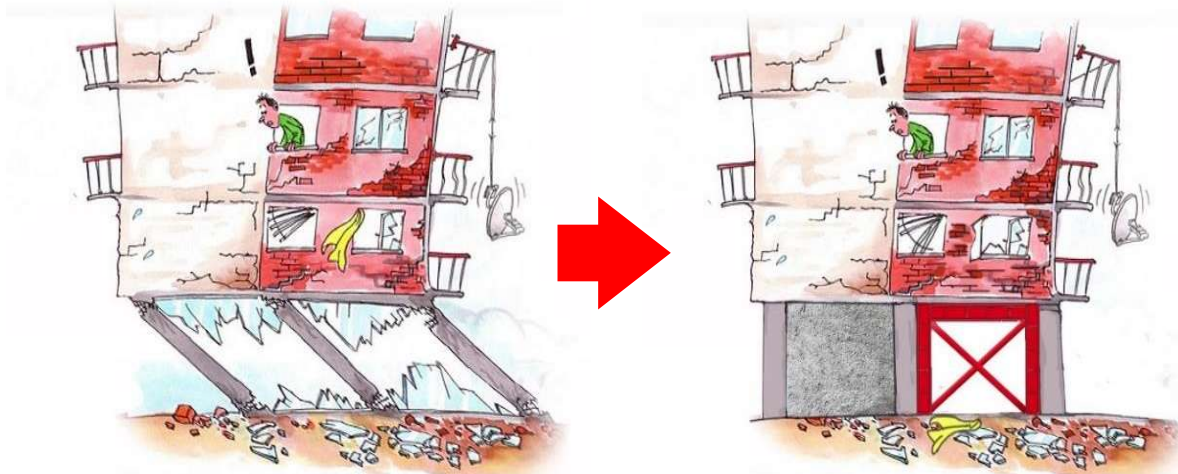
Plan A

Plan A

Reduce the risk of concentrated damage in weak story

After retrofitting, the probability of collapse is greatly reduced. However, other failure modes may still occur.

Residents are encouraged to complete the retrofit of the entire building in the future to comply with seismic design code requirements.



Before retrofitting

After retrofitting

Criteria of Weak-Story

$$\text{Retrofit} : \frac{V_{CDR}^i}{V_{CDR}^{i+1}} \geq 80\%$$

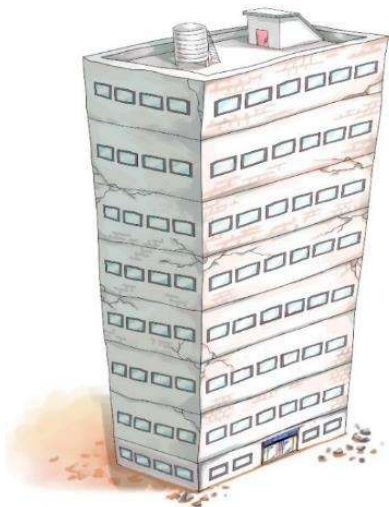
Plan B

Plan B

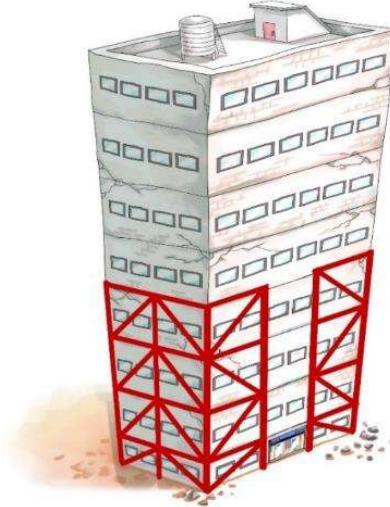
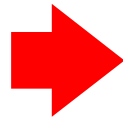
Seismic resistance upgraded to at least 80% of new building standards

Eliminates the weak-story phenomenon while also improving seismic resistance for collapse prevention .

Retrofit place: Entire building, may affect private space.



Before retrofitting

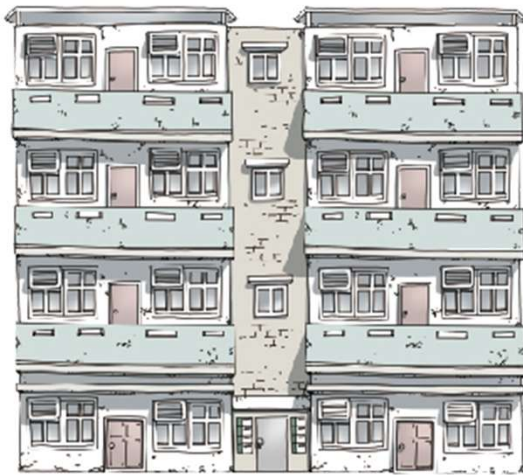


After retrofitting

Criteria of Retrofit :

$$CDR = \frac{\text{capacity}}{\text{demand}} > 0.8$$

Subsidies



1. Apartment



2. Residential Building
or
Mixed-Use Building



3. Street House

※ Buildings at least half of which are used solely for residential purposes

※ Not owned by a single entity only.

Weak-Story Retrofit: Subsidy

Plan A and B:

Upper bound: **NTD\$ 4.5 million**

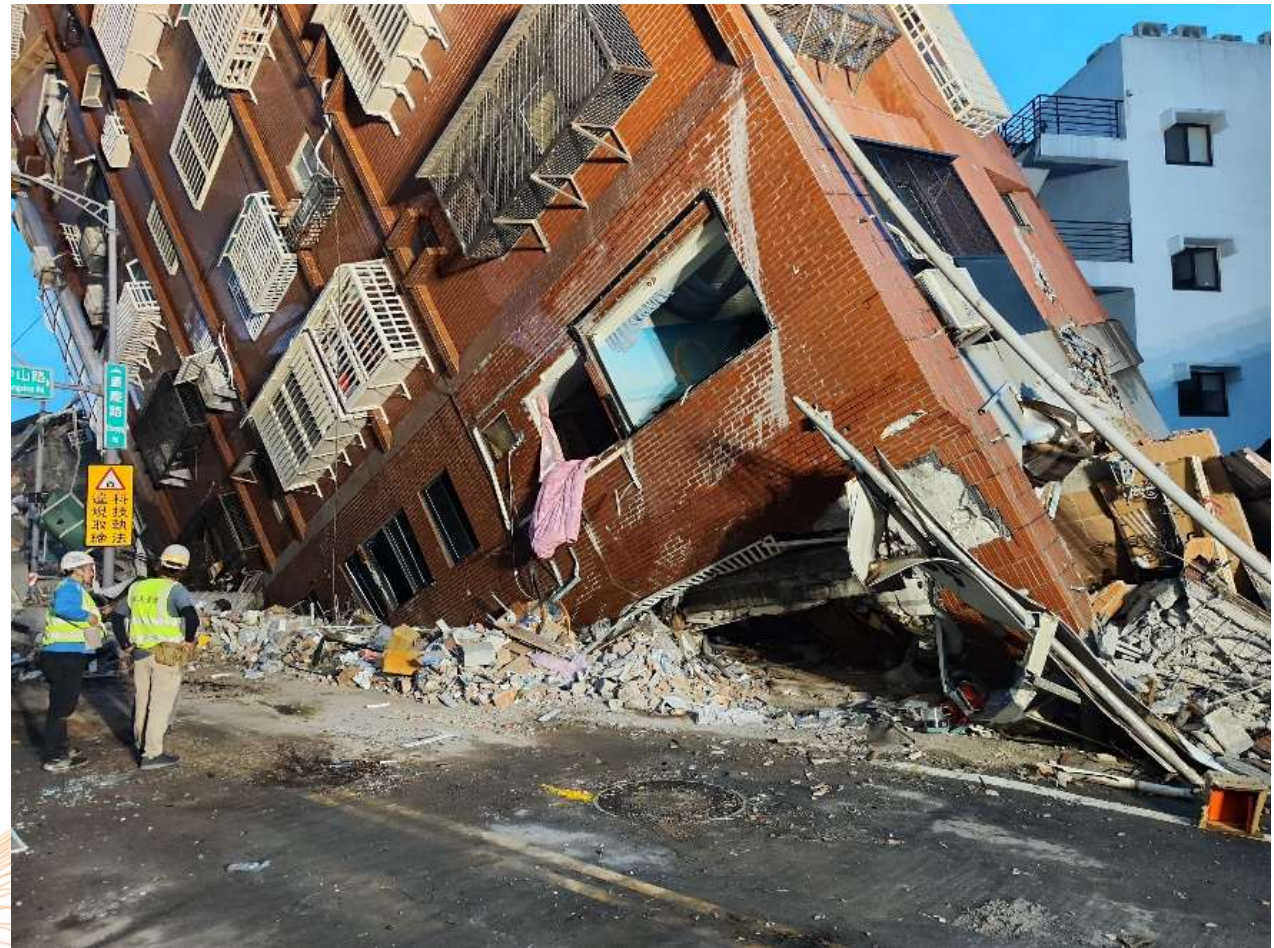
No more than **85%** of total cost (design and construction)

Total cost (design and construction) NTD\$	Subsidy	Owners' expenses
3 million	2.55 million	0.45 million
5 million	4.25 million	0.75 million
7 million	4.50 million	2.50 million

2024 0403Hua-Lien Earthquake

$M_L = 7.2$; 7:58 am, April 3, 2024

- Human Impact:
 - Deaths: 19
 - Injuries: 1155
 - Building Damage:
 - Red tag: 798
 - Yellow tag: 1151
- (Hualien area)



1999 Chi-Chi EQ

$M_L = 7.3$; 01:47 am, Sep. 21, 1999

- Human Impact:
 - Deaths: 2415
 - Missing: 29
 - Severely Wounded: 11305
- Building Damage:
 - Completely Destroyed: 51711
 - Severely Damaged: 53768
 - School Damage: 870
(125 suffering severe damage)



Retrofit effectiveness of weak story

Feb-06 Hualien EQ, 2018 (M_L 6.3)

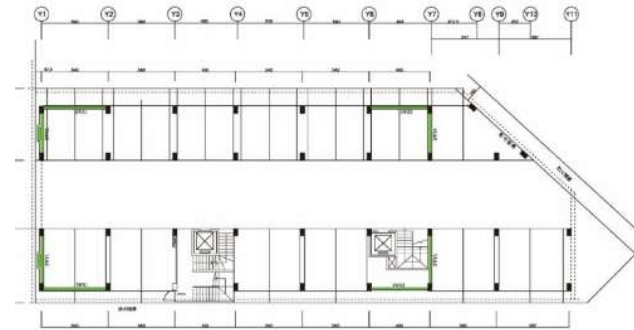


Apartment of 6 story
Ground floor for parking
Built year 1993
shear cracks in beams, walls.
flexural cracks in columns.



Apr-03 Hualien EQ, 2024 (M_L 7.2)

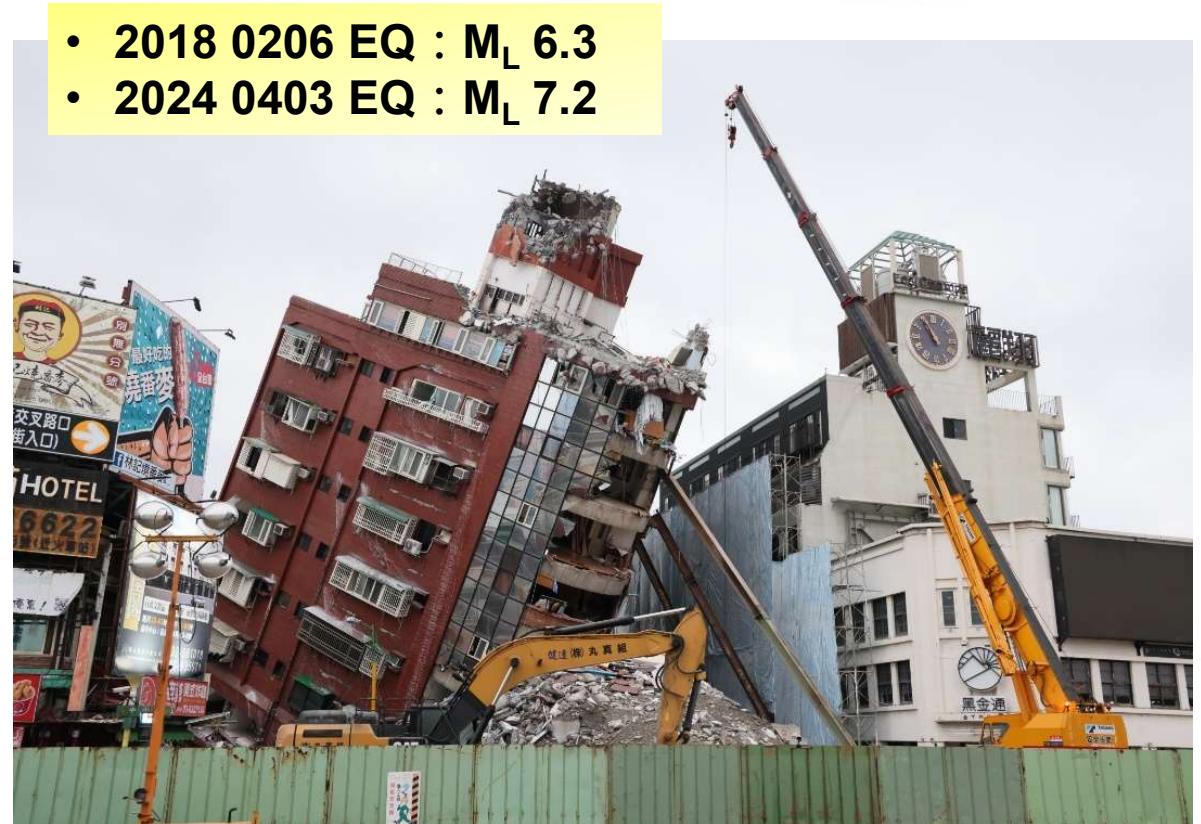
Retrofitted by RC wall
No structural damage



Retrofit effectiveness of weak story



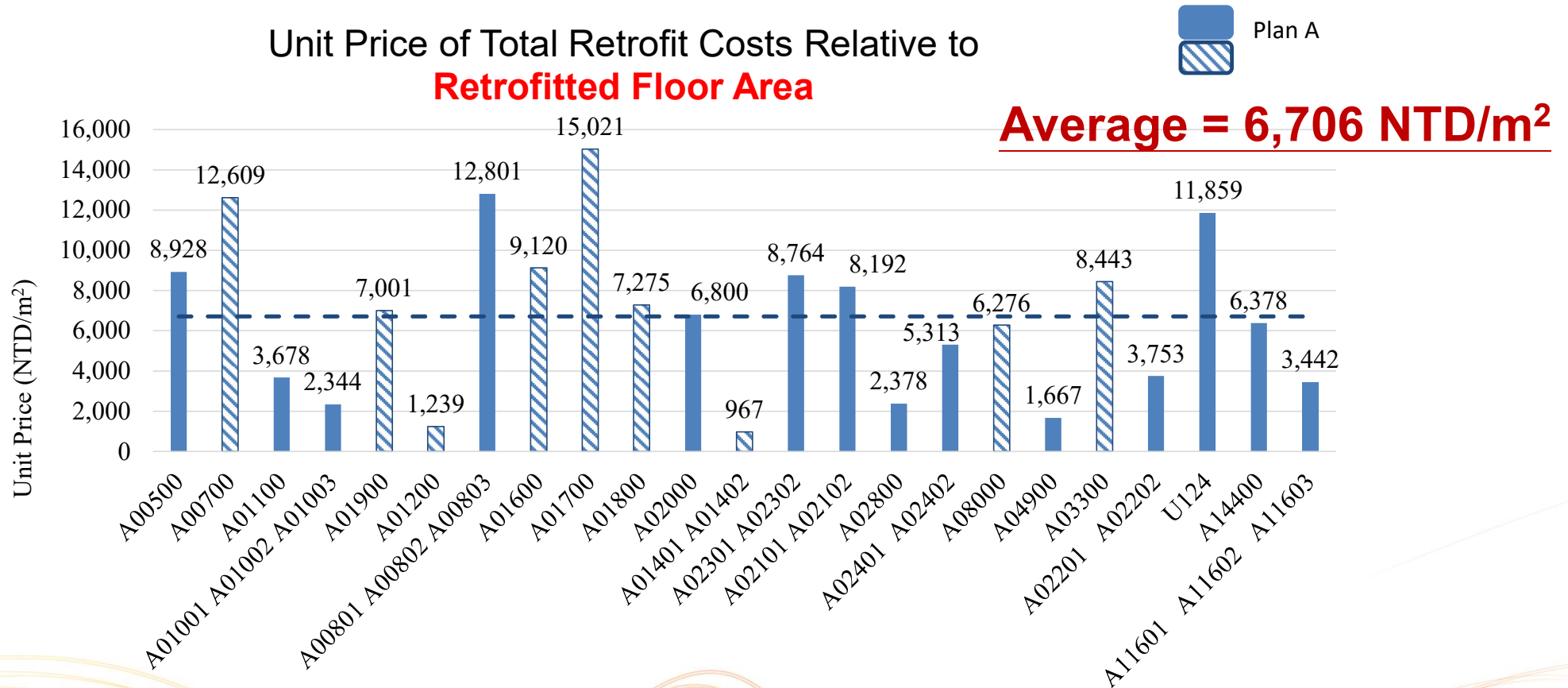
- 2018 0206 Hualien EQ
✓ Yellow tag, retrofitted
- 2024 0403 Hualien EQ
✓ NO damage



- 2018 0206 EQ : M_L 6.3
- 2024 0403 EQ : M_L 7.2

- 2018 0206 Hualien EQ
✗ Yellow tag, repair only
- 2024 0403 Hualien EQ
✗ collapsed

Construction Cost of Weak-Story Retrofit



New Construction = 6,5000 NTD/m²
Retrofit / New Const. = 10.3%

All efforts to implement the project

Workshop:

- For Professional Engineer, Architect, Construction company and Promotion staff
- A total of 39 workshops have been held



Briefing session:

- Large: Neighborhood or district
- Small: community
- A total of 366 briefing sessions have been held



All efforts to implement the project

On-site observation activities:

- For Professional Engineer, Architect, Construction company, Promotion staff and Residents
- A total of 16 on-site observation have been held



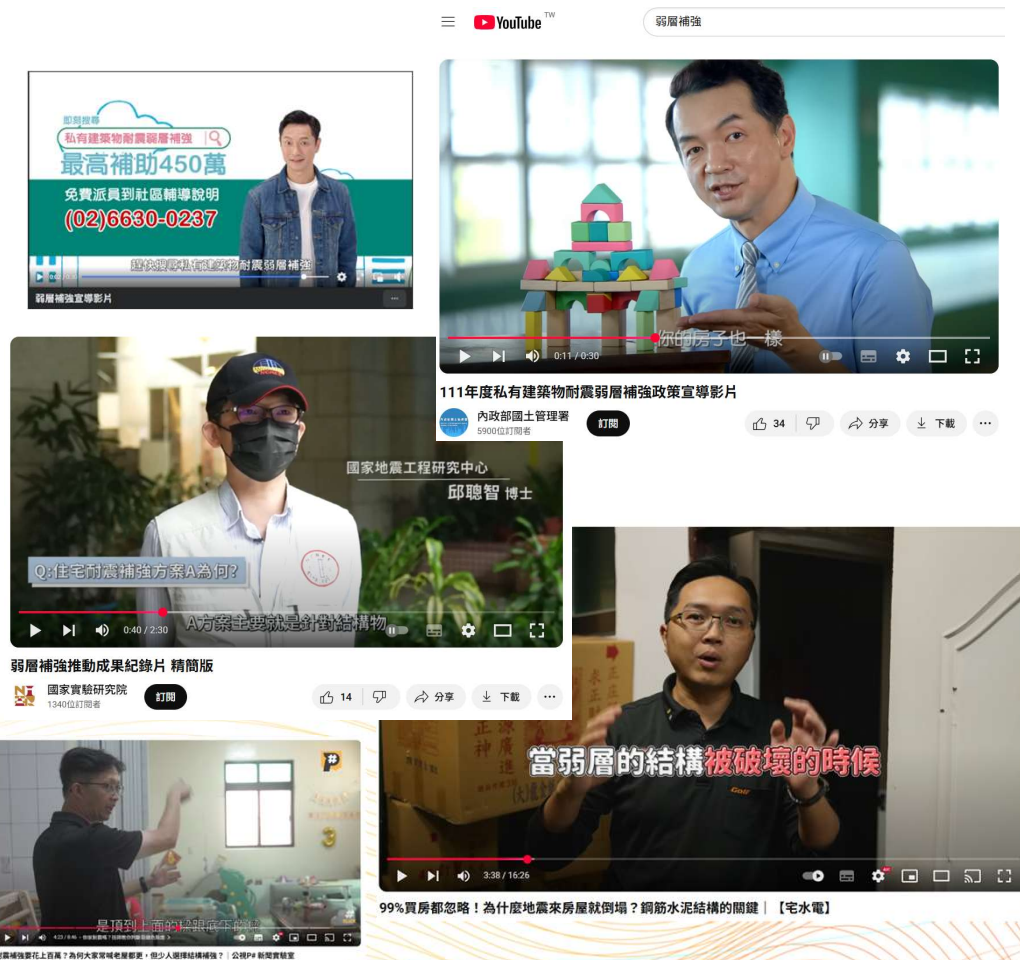
Community Workshop:

- Community college courses, earthquake-resistant educational activities
- Seismic model competition using small portable shaking table
- A total of 17 workshops held



All efforts to implement the project

Online (YOUTUBE) Promotion:



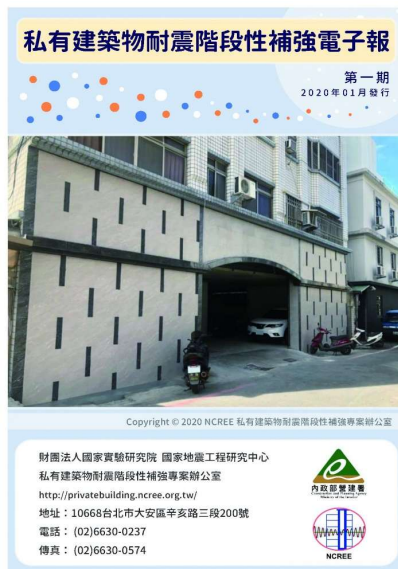
Promotion on TV:



All efforts to implement the project

Newsletter:

- For Professional Engineer, Architect, Construction company, Promotion staff and Residents
- A total of 15 issues of the newsletter have been published



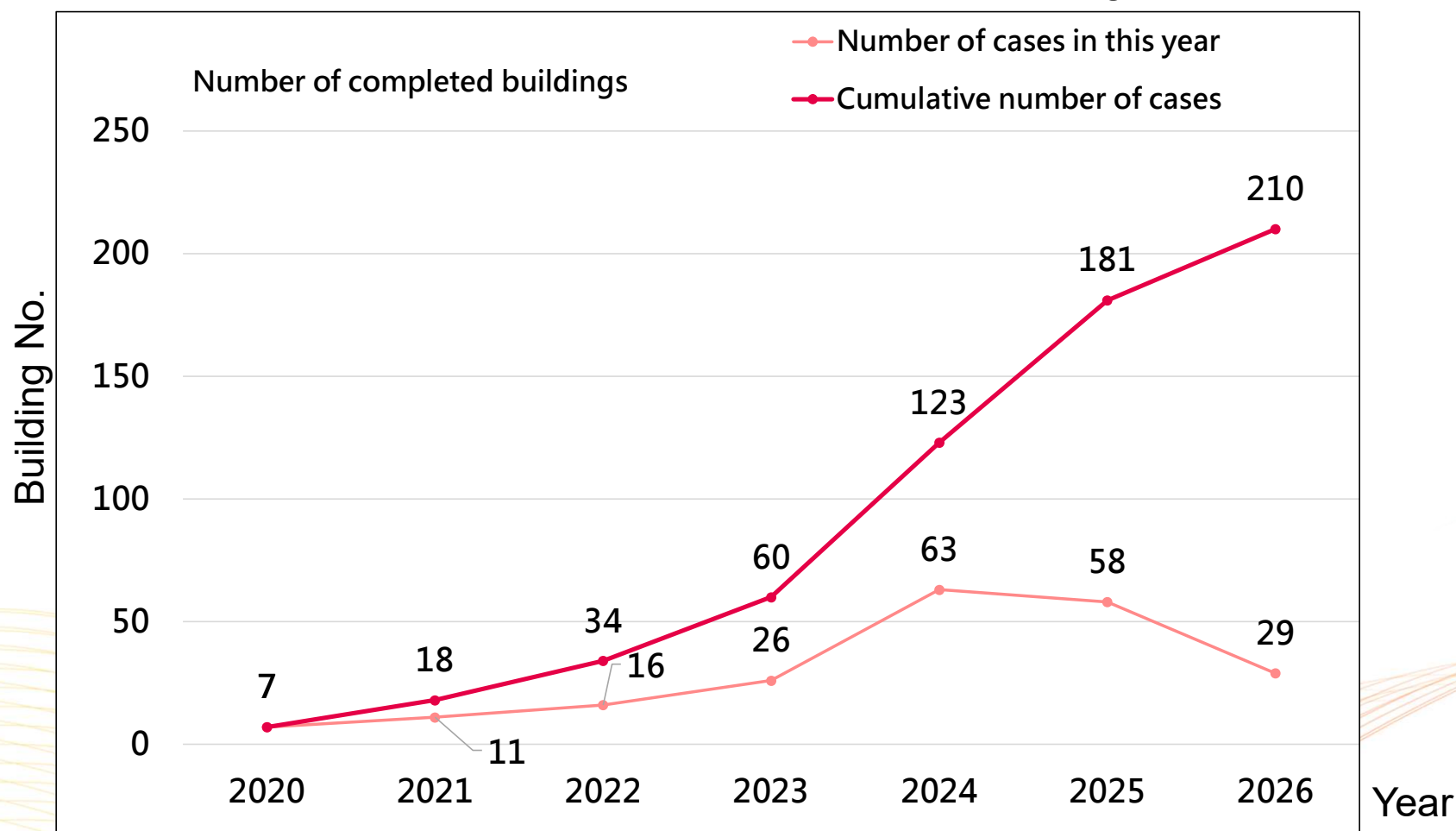
Others:

- **Contact residents by phone** through the Earthquake Rapid Screening Database provided by the National Land Management Agency (NLMA)
- **Advertising in Taipei MRT** by NLMA
- **Website** of Project: Provide all information about the project: technical & application documents (privatebuilding.ncree.org.tw)



Progress of weak story retrofitting for residential buildings

Update to July-27 2026



Progress of weak story retrofitting for residential buildings

Normal
case

- Update to July-27 2026: total 210 bldg.

一般案件
紅黃單案件

全國申請弱層補強經費：已核定210棟

(核定棟數計算) 截至2026年7月2日止

各縣市棟數分配：

臺北市64棟
新北市73棟
基隆市6棟
桃園市8棟
新竹縣1棟
宜蘭縣9棟
臺中市3棟
苗栗縣1棟
雲林縣3棟
臺南市11棟
嘉義市2棟
屏東縣9棟
花蓮縣10棟
臺東縣10棟



*統計數量 自106年「單棟大樓階段性補強技術手冊及示範案例規劃設計監造」技術服務案起算

NCREE Office of Private Building Retrofitting



Now and Future

- We have observed a trend of decreasing damage to structures and fewer human casualties in recent major earthquakes.
- There are still many private buildings built before the 1999 Chi-Chi earthquake. They are vulnerable to earthquake hazards.
- New regulations give the government power to enforce seismic evaluation if a private building has a potential seismic safety concern. But the government never dares to do it.
- The new business is to protect non-structural components and to protect high-tech equipment and production.

Thank you!