

# Chi-Chi EQ.(1999) vs. Meinong EQ. (2016)

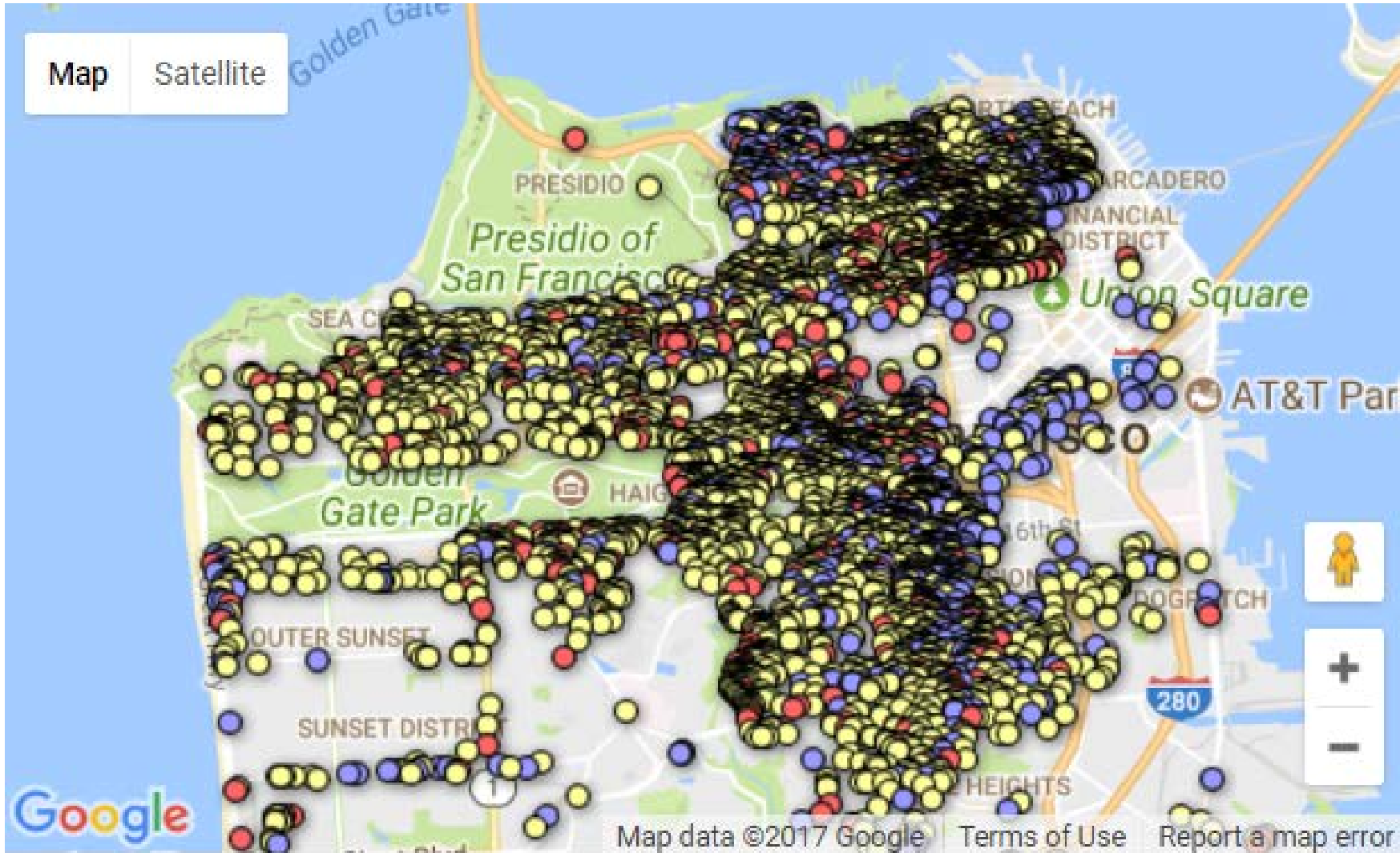
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## WEAK/SOFT STORY & NON-DUCTILE CONCRETE & TORSION



# Develop and Implement Evaluation/Retrofit Guidelines, Tools and Programs

## San Francisco: Mandatory Soft Story Retrofit Ordinance





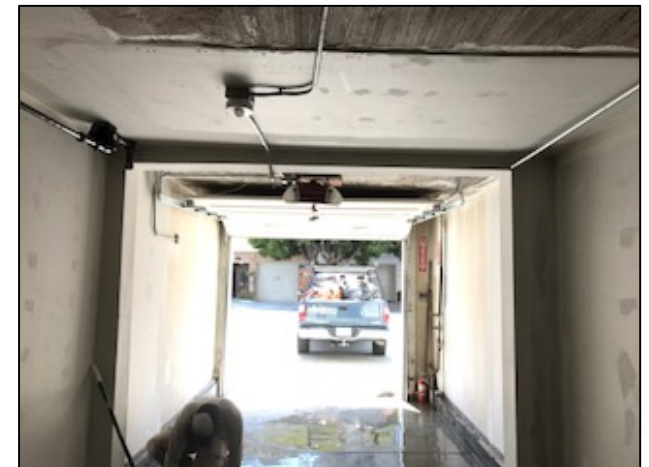
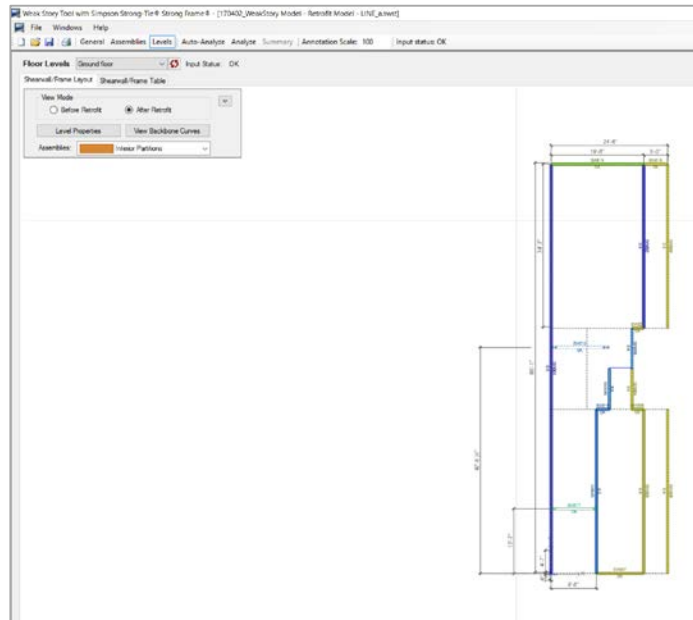
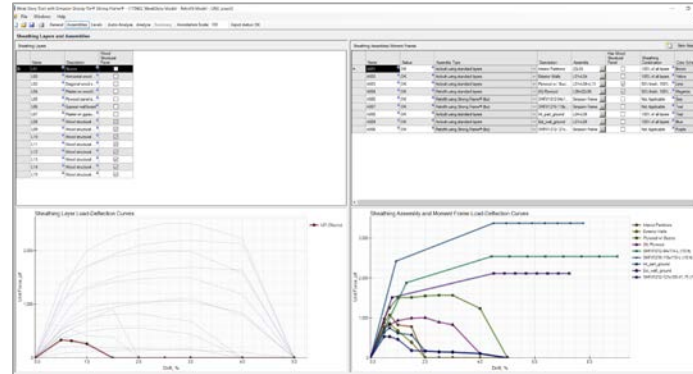
# Develop and Implement Evaluation/Retrofit Guidelines, Tools and Programs

## San Francisco: Mandatory Soft Story Retrofit Ordinance



### Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings With Weak First Stories

FEMA P-807 / May 2012



# Develop and Implement Evaluation/Retrofit Guidelines, Tools and Programs

## Taiwan School Evaluation/Retrofit Program

NCREE-13-023

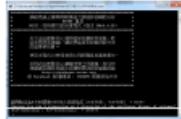

校舍結構耐震評估與補強技術手冊  
第三版  
Technology Handbook for Seismic Evaluation and Retrofit of  
School Buildings  
Third Edition

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中華民國一百零二年十二月  
December 2013

### 臺灣耐震評估方法

- TEASPA  
– Taiwan Earthquake Assessment for Structures by Pushover Analysis  
  
臉書粉絲專頁：  
<https://www.facebook.com/groups/1420428518211927/>
- SERCB  
– Seismic Evaluation of Reinforced Concrete Building  
  
技術交流網頁：  
<http://sercb.dyndns.org/SERCBWeb/Default.aspx>

**NAR Labs** 國家實驗研究院  
National Applied Research Laboratories

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# “Affordable” Retrofit Techniques / Collaborations





# “Affordable” Retrofit Techniques / Collaborations





# Quality Control in Construction / Modification

**SPECIAL INSPECTION AND STRUCTURAL OBSERVATION**  
A COPY OF THIS DOCUMENT SHALL BE KEPT WITH THE APPROVED STRUCTURAL DRAWING SET

JOB ADDRESS \_\_\_\_\_ APPLICATION NO. \_\_\_\_\_ ADDENDUM NO. \_\_\_\_\_  
OWNER NAME \_\_\_\_\_ OWNER PHONE NO. ( \_\_\_\_\_ ) \_\_\_\_\_

Employment of Special Inspection is the direct responsibility of the OWNER, or the engineer/architect of record acting as the owner's representative. Special inspector shall be one of those as prescribed in Sec.1704. Name of special inspector shall be furnished to DBI District Inspector prior to start of the work for which the Special Inspection is required. Structural observation shall be performed as provided by Section 1704.6. A preconstruction conference is recommended for owner/builder or designer/builder projects, complex and highrise projects, and for projects utilizing new processes or materials.

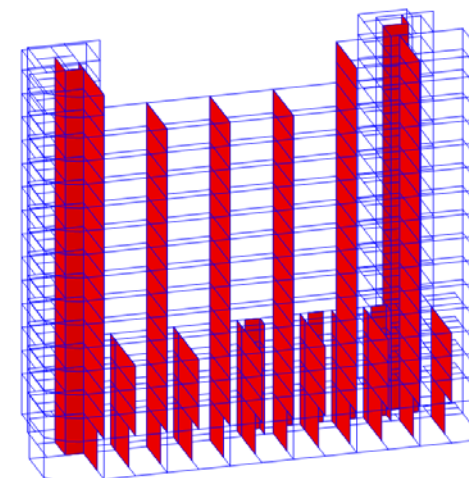
In accordance with Chapter 17 (SFBC), Special Inspection and/or testing is required for the following work:

1. <input type="checkbox"/> Concrete (Placement & sampling)	6. <input type="checkbox"/> High-strength bolting	18. <b>Bolts installed in existing concrete masonry:</b> <input type="checkbox"/> Concrete <input type="checkbox"/> Masonry
2. <input type="checkbox"/> Bolts installed in concrete	7. <input type="checkbox"/> Structural masonry	
3. <input type="checkbox"/> Special moment-resisting concrete frame	8. <input type="checkbox"/> Reinforced gypsum concrete	19. <input type="checkbox"/> Shear walls and floor systems used as shear diaphragms
4. <input type="checkbox"/> Reinforcing steel and prestressing tendons	9. <input type="checkbox"/> Insulating concrete fill	20. <input type="checkbox"/> Holdowns
5. <b>Structural welding:</b>	10. <input type="checkbox"/> Sprayed-on fireproofing	21. <b>Special cases:</b>
<b>A. Periodic visual inspection</b>	11. <input type="checkbox"/> Piling, drilled piers and caissons	<input type="checkbox"/> Shoring
<input type="checkbox"/> Single pass fillet welds 5/16" or smaller	12. <input type="checkbox"/> Shotcrete	<input type="checkbox"/> Underpinning: <input type="checkbox"/> Not affecting adjacent property
<input type="checkbox"/> Steel deck	13. <input type="checkbox"/> Special grading, excavation	<input type="checkbox"/> Affecting adjacent property: PA _____
<input type="checkbox"/> Welded studs	<input type="checkbox"/> And filling (Geo. Engineered)	<input type="checkbox"/> Others _____
<input type="checkbox"/> Cold formed studs and joists	14. <input type="checkbox"/> Smoke-control system	22. <input type="checkbox"/> Crane safety (Apply to the operation of Tower cranes on highrise building) (Section 1705.21)
<input type="checkbox"/> Stair and railing systems	15. <input type="checkbox"/> Demolition	23. <input type="checkbox"/> Firestops in high-rise building
<input type="checkbox"/> Reinforcing steel	16. <input type="checkbox"/> Exterior Facing	24. <input type="checkbox"/> Others: "As recommended by professional of record"
<b>B. Continuous visual inspection and NDT (Section 1704)</b>	17. <b>Retrofit of unreinforced masonry buildings:</b>	
<input type="checkbox"/> All other welding (NDT exception: Fillet weld)	<input type="checkbox"/> Testing of mortar quality and shear tests	
<input type="checkbox"/> Reinforcing steel; and <input type="checkbox"/> NDT required	<input type="checkbox"/> Inspection of repointing operations	
<input type="checkbox"/> Moment-resisting frames	<input type="checkbox"/> Installation inspection of new shear bolts	
<input type="checkbox"/> Others _____	<input type="checkbox"/> Pre-installation inspection for embedded bolts	
	<input type="checkbox"/> Pull/torque tests per SFBC Sec.1607C & 1615C	

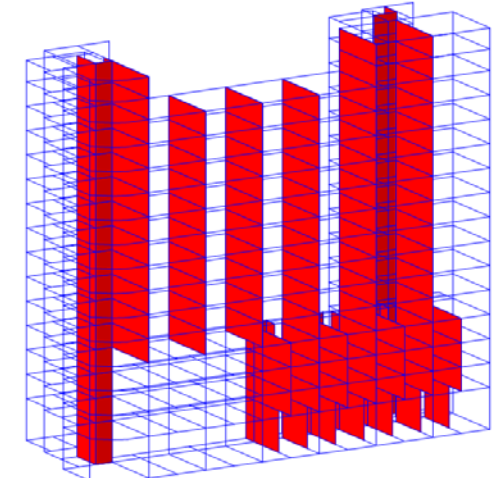
25. **Structural observation per Sec. 1704.6 for the following:**  Foundations  Steel framing  
 Concrete construction  Masonry construction  Wood framing  
 Other: \_\_\_\_\_



Courtesy of NCREE & 施忠賢 Justin C.H. Shih



依原始設計圖 original drawing

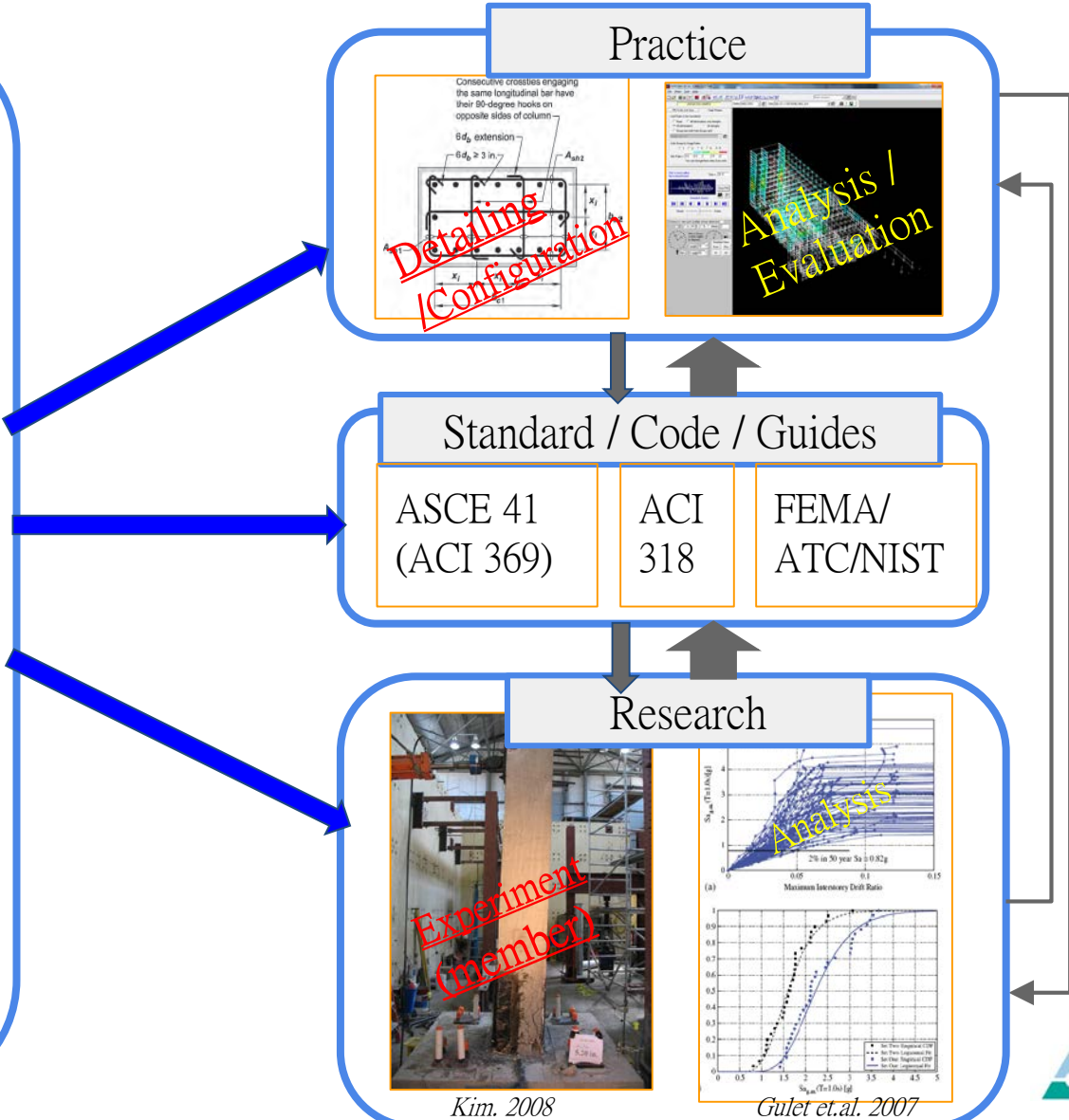


依竣工圖 complete drawing

# Damaged Buildings: Real World Specimens



Damage Records  
+ Construction Documents  
+ Ground Motions  
**= *Real World Specimens***





# Operational Performance: Chi-Mei Medical Center

- 12 Stories + 2/4 below
- 2 Towers: 1986/ 1992
- 1200 Beds
- Minor non-struct. damage
- No disruption of service



# Lessons Learned from Disastrous Earthquakes

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- ❑ Develop and Implement Evaluation/Retrofit Guidelines, Tools and Programs
- ❑ “Affordable” Retrofit Techniques
- ❑ Collaborations between Experts in Different Material Research Fields
- ❑ Quality Control in Construction / Modification
- ❑ Real World Specimens
- ❑ Confirm Expected Performance