

Lessons Learned from Disastrous Earthquakes

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We had an earthquake last year
... which was quite disastrous.

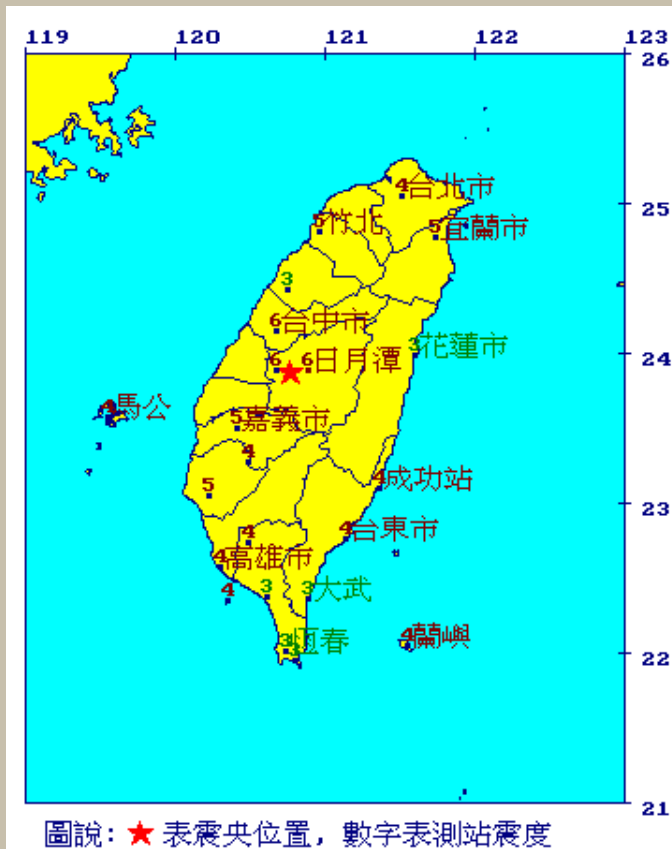


It reminded me of my first lesson
from a disastrous earthquake
... 18 years ago.

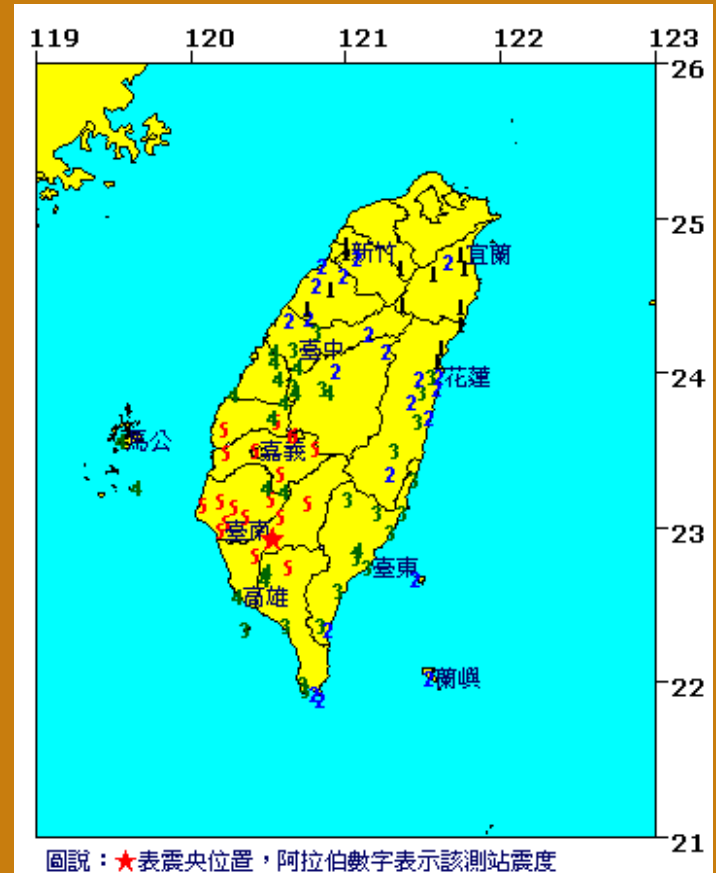


Although they were quite different

Chi-Chi Earthquake, 1999
Richter magnitude: 7.3



Meinong Earthquake, 2016
Richter magnitude: 6.4



It seems that some things never change

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Street corner buildings

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Typical street buildings ... sat on cars!

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016

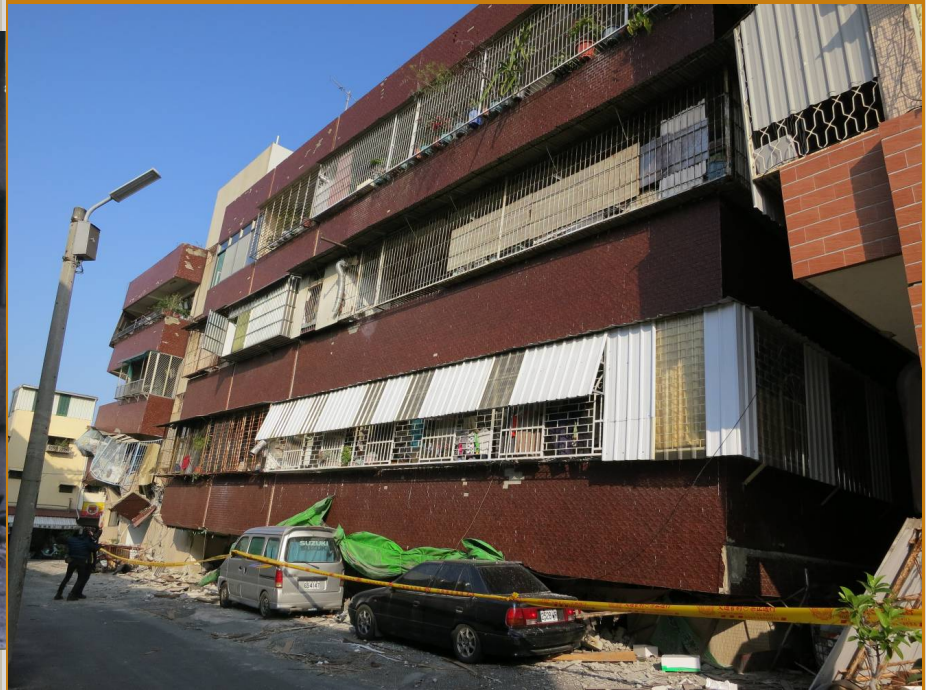


Soft base floors

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Short columns

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Even shorter columns

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016

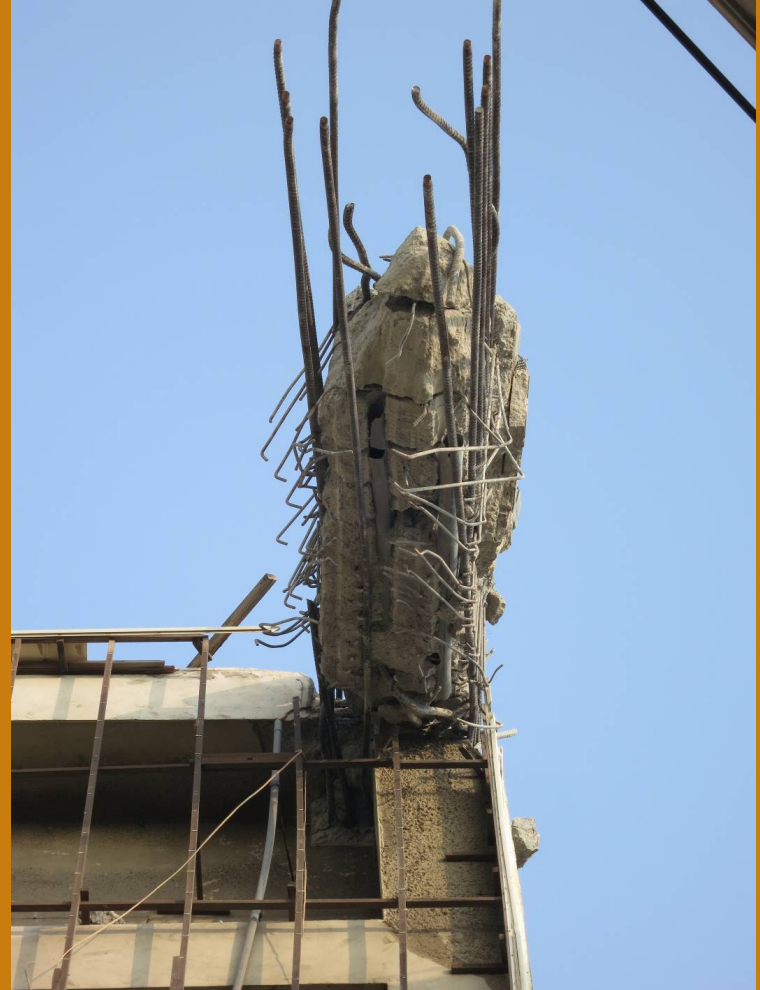


Pulled-out column rebars

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Poor anchorage... and insufficient hoops

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



Damaged “non-structural” walls

Chi-Chi Earthquake, 1999



Meinong Earthquake, 2016



- ~~Lessons learned from earthquakes~~
 - Problems remaining unsolved

Problems remaining unsolved

- Urgent need of retrofit for private buildings
 - Retrofit for public buildings has been performed for years
 - Not just an engineering problem but also a political/social issue
- Construction quality control
 - Practical supervision and inspection
 - More about administration than engineering



Retrofitted public office building



Retrofitted public school building

Problems remaining unsolved

■ Confront the “Non-structural” wall issues

- Partition walls, windowsills, outer walls with openings
- Masonry and cast-in-place RC ($t < \text{or } = 150\text{mm}$)
- Stiffness contribution not considered in structural analysis

- Still a common habit in structural design for new buildings today!

- Properly evaluate their stiffness contribution in analysis
- Isolate their effect to structural elements
 - Ex: using curtain walls with seismic anchor design
- Use less stiff partitions. Ex: drywalls
- and so on...