The challenges for seismic retrofit of hospitals

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Earthquake Damages in Hospitals (California)

1971 San Fernando earthquake
California Olive View Hospital

1989 Loma Prieta Earthquake
Mostly Nonstructural Damage

Earthquake Damages of Nonstructures in Hospitals (1999 Taiwan Quake)

■ Fall-off of air condition outlet

Damages to ceilings

Off-track of elevator counter weight

電梯平衡錘脫軌

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SB 1953： California Hospital Seismic Retrofit Program

1971： San Fernando Earthquake

1972：Senate Bill 519-- the Hospital Seismic Safety Act (HSSA)

For new hospital construction after 1973

1983：OSHPD regulate the design and construction of healthcare facilities

1994：Northridge Earthquake

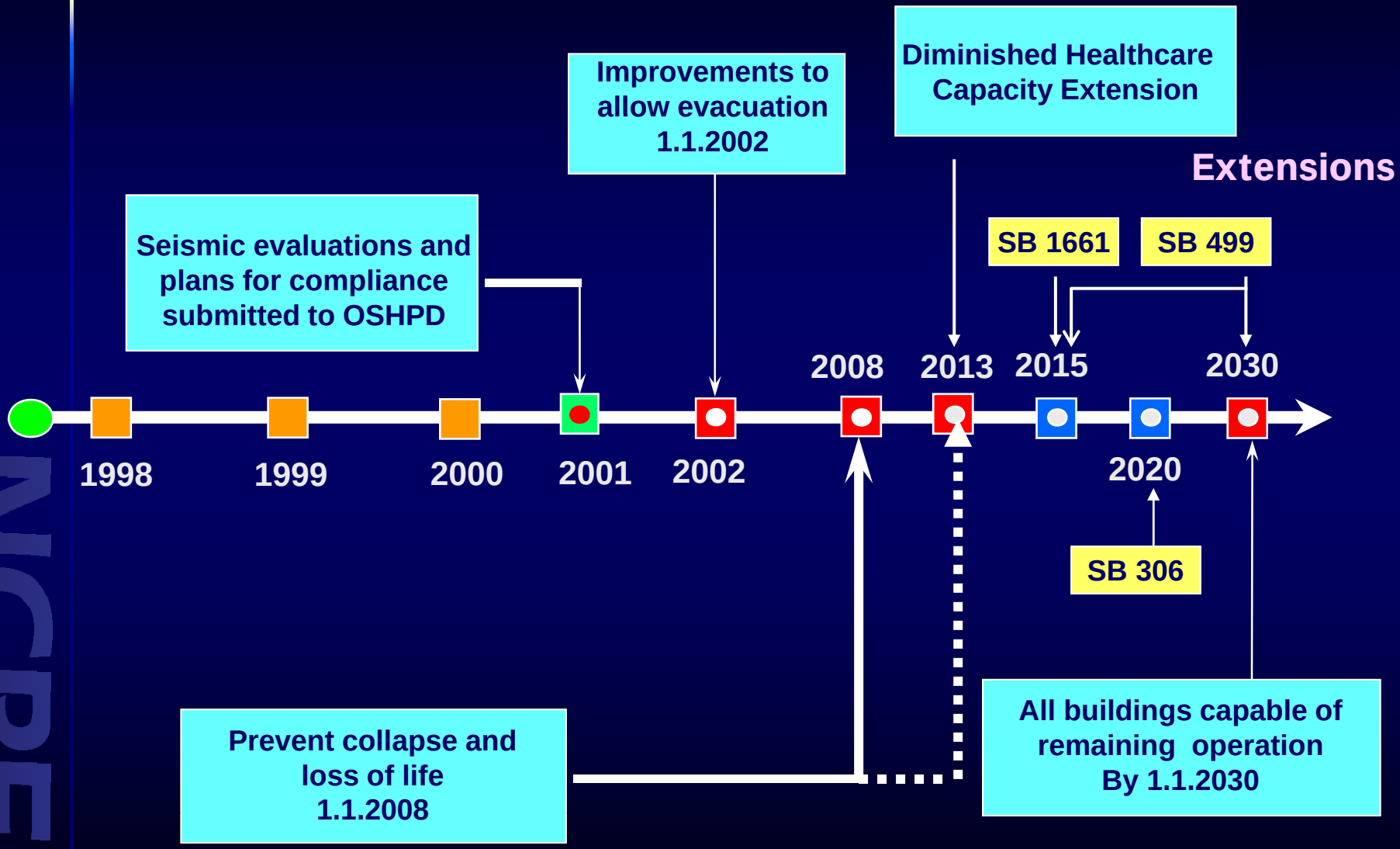
Hospitals built after HSSA had minimal structural damage, but serious nonstructural damage.

1995：Senate Bill 1953: Seismic Retrofit Program

1. To improve Structural and Nonstructural Performance
2. To retrofit existing hospital built before 1973

* OSHPD：California Office of Statewide Health Planning and Development

Major Milestones of SB 1953 and Its extensions



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* The Seismic Retrofit Program for Existing California Hospitals, Chris V. Tokas, SE, OSHPD, FDD

Challenges to implement SB 1953

- **Extremely expensive for new hospital buildings**

(At $1,000 per square foot for a finished facility, new hospitals represent some of the most expensive infrastructure in the built environment.)

- **Difficult to replace individual buildings on a hospital campus seismically vulnerable**

(hospital campuses typically contain multiple connected buildings, with the oldest building in the center. It is often impossible to "replace" the oldest, most vulnerable structure without closing the entire campus.)

- **Calif. Hospital industry has a limited capability to pay for large amount of new infrastructure**

(there is a large mismatch between the profitability of the current California hospital infrastructure and the costs of new construction)

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*RAND, **SB1953 and the Challenge of Hospital Seismic Safety in California,** The California Health Care Foundation, 2007

Enduring regulatory structures (持續性的立法結構) are needed given a large number of vulnerable hospitals and the time scales for mitigation

(it will probably require more than 25 years of construction to bring all California hospitals into compliance with SB1953. Policies and regulatory structures need to be developed so they are uniform and consistent over this period.)

- **Public health policy goals may conflict with disaster mitigation**

(Ultimately, the costs for new hospital construction will be paid out of the bills for health care or by taxpayers. In some cases, disaster mitigation could limit the access to health care if it forces some hospitals to close.)

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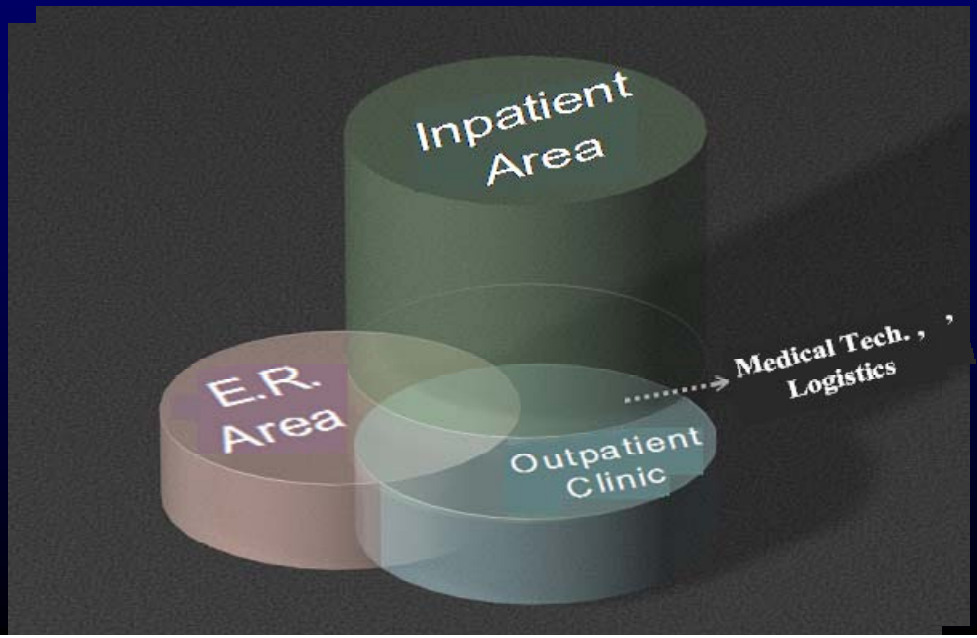
Large Hospitals in Taiwan

- **515 hospitals in Taiwan (2008) – excluding individual clinics**
  - Community Hospital (less than 200 beds)
  - Regional hospital (between 200 to 500 beds)
  - Medical center (more than 500 beds)



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Medical Space Layout

12F	Negative Pressure Isolation Room
11F	Inpatient Ward
10F	Inpatient Ward
9F	Inpatient Ward
8F	Inpatient Ward
7F	Inpatient Ward
6F	Inpatient Ward
5F	Administration
4F	Nursery, Pediatric Intensive Care Unit, Deliver
3F	Operating Room, Intensive Ca
2F	Outpatient Service, Laboratory medicine, Kidney Dialysis
1F	Outpatient Service, E.R., Pharmacy, Hall, Radiology, Rehabilitation
B1F	Central Supply, medical record room, Medicine Storeroom, Anamnesis
B2F	Mortuary, Radiology, Parking
	Water Tank

Respiratory Isolation Area

Independent HVAC System

Inpatient Area

Higher floor levels; Require Ventilation and Day Lighting

Operation Room

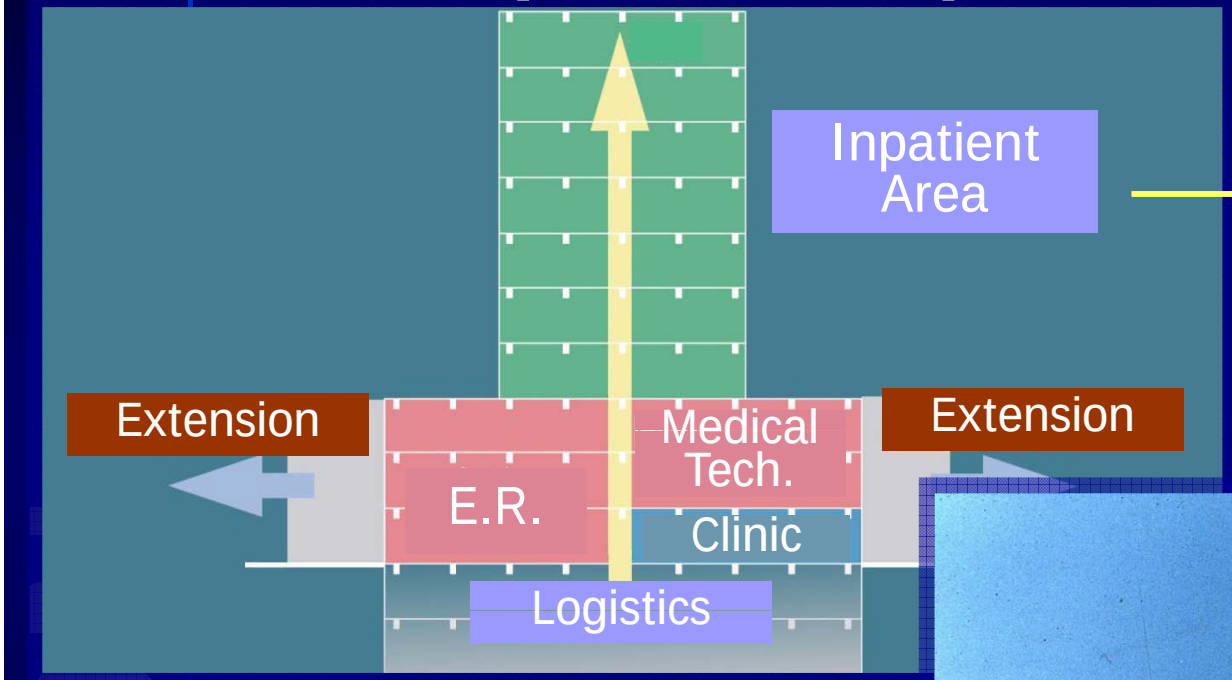
High Ceiling; Complex Piping

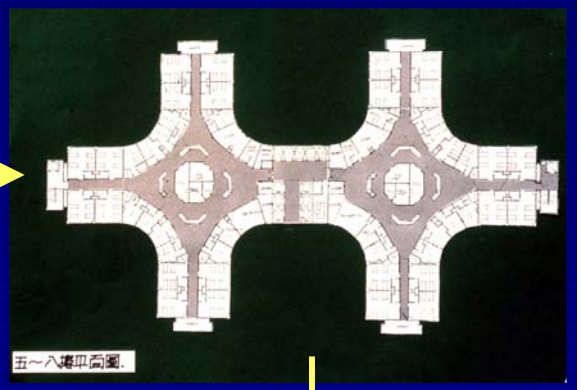
Basement Space

Radiology; Large Dead Load

Hospital Building Type in Taiwan

■ Metropolitan Hospital--Centralized Type





Other Hospital Examples

Seismic Upgrading Methods of Structures

- Energy Dissipation / Seismic Isolation Systems
  - Hospital structural characteristics
    - ➢Horizontal irregularity —torsional effect
    - ➢Vertical irregularity—soft stories, setbacks
  - Construction difficulties
    - ➢24 hours operation in a hospital
    - ➢Minimum disturbance to inpatients and medical functions
      - ➢Noise and vibration
      - ➢Dust

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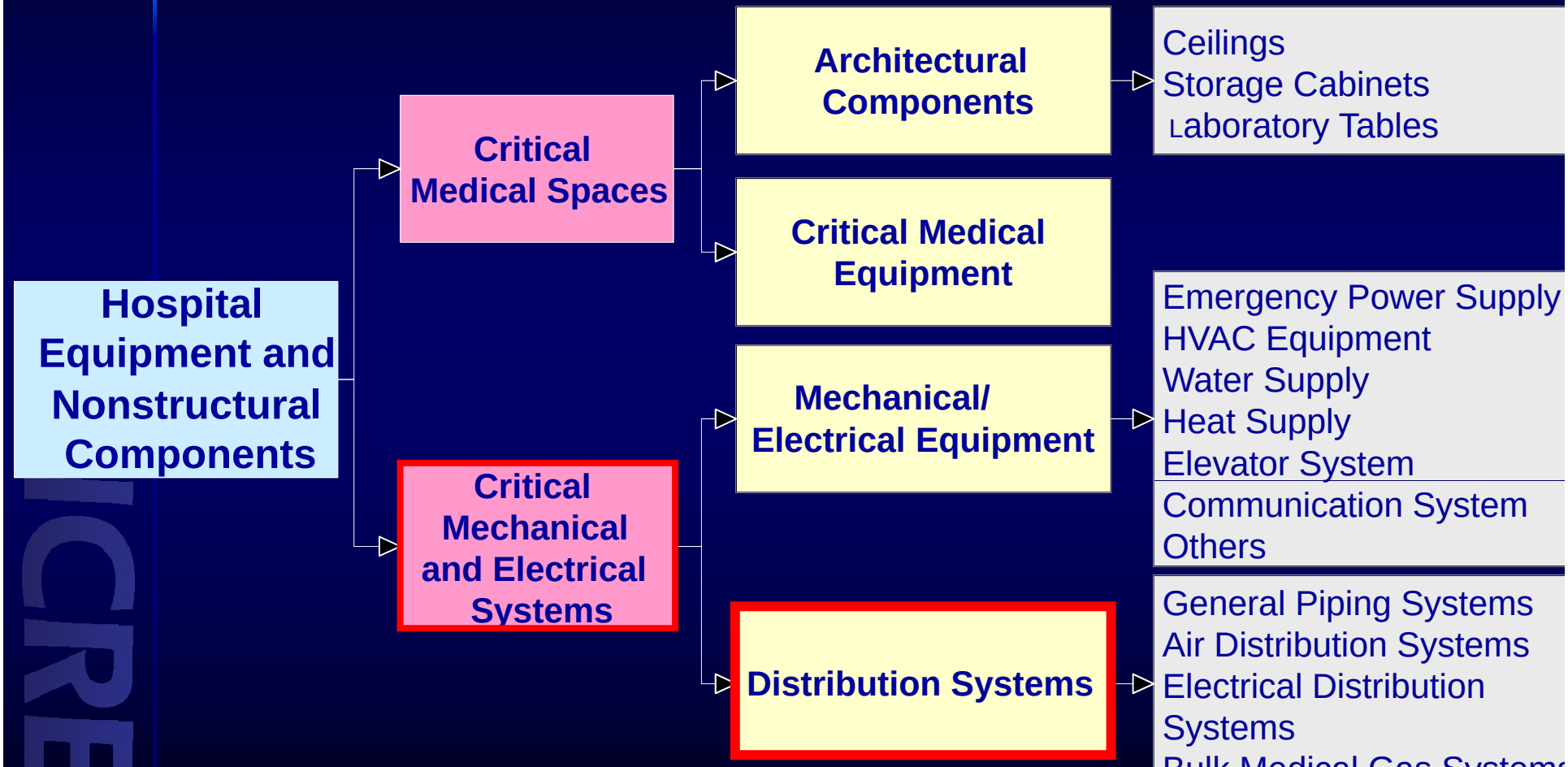
Variety of Nonstructural Components in a Hospital



Discussions

Structures:

- Retrofit Design: structural Irregularity of hospitals
- Construction: minimum vibration, noise, dust

Nonstructuers:

- Identification of critical spaces containing critical medical equipment and facilities
- Identification of critical mechanical/electrical facilities
- Complicated individual and distributed nonstructural systems
- Relatively few research accomplishment and experimentally verified design specification