Earthquake Mitigation for Hospitals: Workshop

Part 8 – Building Mitigation

Structural Mitigation

RISK = f(HAZARD, VULNERABILITY)

Structural Mitigation Outline

- Building Mitigation options
- Challenges unique to hospitals
- Structural Mitigation tools and resources
- Structural Mitigation measures for buildings
- Examples of structural strengthening of buildings

Earthquake Losses

- Direct Damage:
  - Physical asset damage
  - Repair and restoration costs
- Indirect Damage:
  - Loss of facility operations
  - Loss of service to the community in the time of greatest need
  - Loss of Good Will
  - Patient evacuation/relocation
  - Loss of life

Earthquake Mitigation

- Mitigation of earthquake damage – Where to begin?
- Questions to ask and answer before any actual mitigation or major strengthening measures can be performed:
  - What is your facility/site risk?
  - What are your critical operations/functions that require protection?
  - What back-up/redundancy capabilities are available, and can they be relied upon?

Earthquake Mitigation

- Existing facility risk must be known
- Initial Facility Risk Assessment:
  - Desk-top survey $
  - Rapid visual survey of the facility $$
  - Comprehensive facility engineering risk assessment of building and nonstructural components $$$
- Rank & Prioritize the risks also considering critical functional aspects and long-term use of the facility.
- Develop a Mitigation Plan (FEMA 396) from the assessment findings and recommendations.
- Capitalize and begin to implement the Mitigation Plan.

Remember – reducing earthquake risk cannot be achieved overnight. Earthquake Mitigation is a long term process.

Earthquake Mitigation Options

- Do nothing – ignore the risk
- Accept the risk
- Modify emergency response & business recovery plans
- Adjust business operations:
  - Relocate critical functions to lower risk facilities
  - Locate non-critical functions to higher facilities
- Perform facility strengthening
- Perform nonstructural component strengthening and anchorage improvements
- Combination of the above

Earthquake Mitigation

- *Do it right the first time from today forward*
- *Long-term strategy:*
  - New Construction
  - Planned facility outages
  - Renovations & remodels
  - New equipment installations
  - Aging equipment replacement
  - During equipment maintenance activities
- *Earthquake mitigation does not happen overnight*

Hospital Mitigation Challenges

- Disruption to operations
- Loss of space
- Temporary relocation of patients and patient care services
- Specialized areas
  - MRI, X-ray, etc.
  - Pharmacies
  - Bio Hazards
  - Records
- Deep foundations

Hospital Challenges (Cont.)

- Interstitial (above ceiling) spaces

Hospital Challenges (Cont.)

- Typically congested mechanical & electrical rooms

Hospital Challenges (Cont.)

- Construction process:
  - Inherently a dirty environment
  - Noisy
  - Impact on building systems
    - Coordination with necessary system outages
    - Air filtration impact from dust & debris
    - Medical air and gases
    - Outside utility reliability during construction

Structural Mitigation Measures

- Member strengthening
  - New reinforcing steel and concrete encasement
  - Carbon-fiber wraps

Structural Mitigation Measures (Cont.)

- Connection strengthening
  - Simple bolting/welding and clips
  - Complex connection detailing

Structural Mitigation Measures (Cont.)

- Addition of new lateral force resisting systems
  - Construction of new concrete shear walls
  - Construction of new steel braced frames

Structural Mitigation Measures (Cont.)

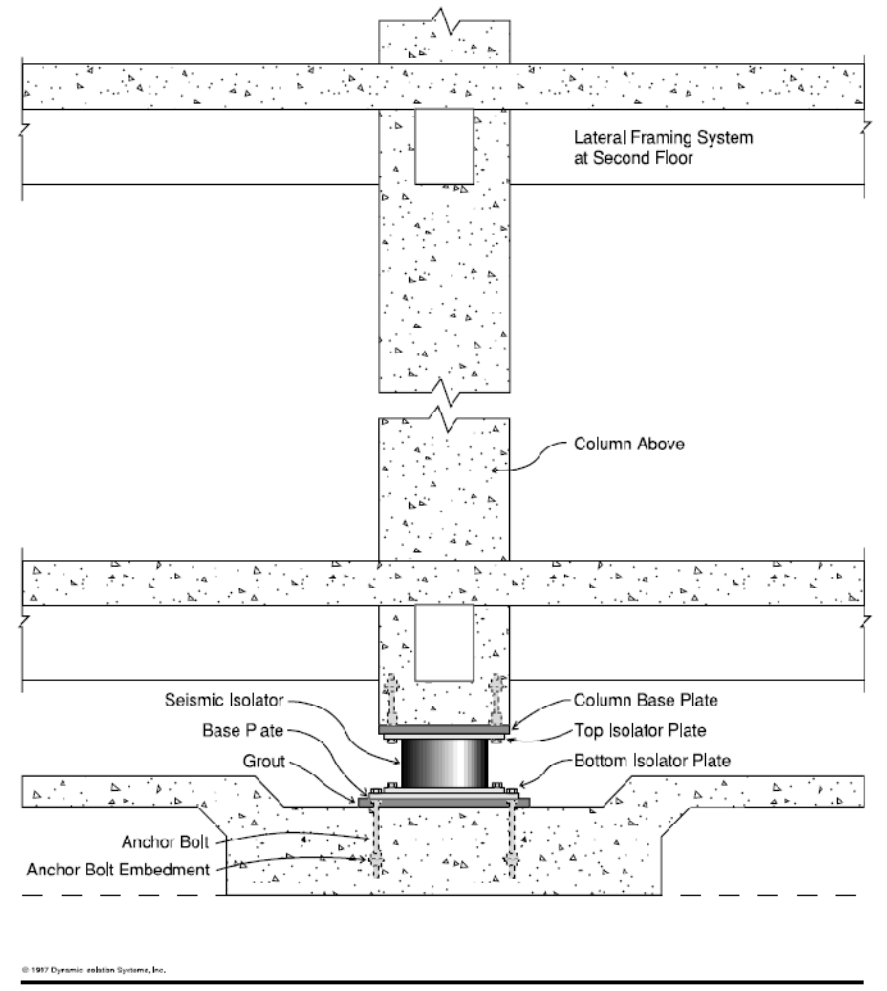
- Foundation strengthening

Specialized Mitigation Systems

- Energy dissipation devices – Braced frame viscous damper systems

Specialized Mitigation Systems (Cont.)

- Base Isolation of entire building



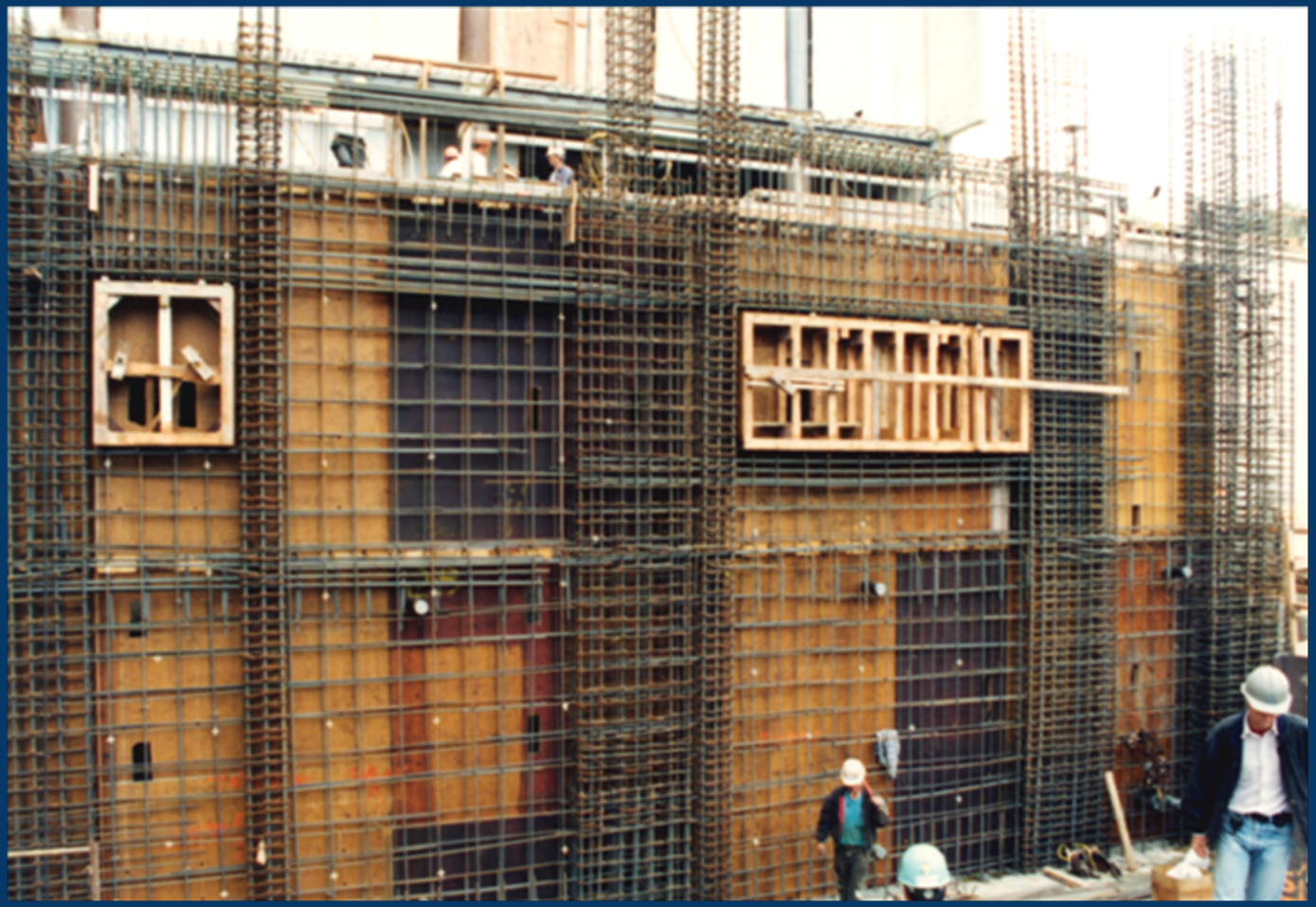
Mitigation Examples

Kaiser San Francisco Medical Center Seismic Strengthening

- Originally built in 1952 in three stages
- 7-Story concrete & steel frame
- 250,000 sq ft
- Function:
  - Nursing Units
  - Surgery Suites
  - Emergency Room
  - Laboratories

Kaiser San Francisco Medical Center

Kaiser Medical Center Shear Wall Construction



Kaiser Medical Center Elevator Shaft Construction

Kaiser Medical Center Foundation Strengthening

Veterans Administration West Los Angeles Medical Center

- Seismic evaluation and retrofit of (3) Campus Buildings
- 6-Story Main Medical Center under design
- Existing structure - Steel braced frame
- 900,000 sq ft
- Exterior steel braced frames being used to minimize disruption to VA operations

VA Medical Center Rendering

VA Medical Center

St. Vincent Medical Center Los Angeles

- Detailed risk assessment and preliminary strengthening design being performed
- Assessing current and future facility needs
- Addressing California SB 1953 compliance
- Construction documents developed for SB 1953 NPC 2 deficiencies

St. Vincent Medical Center Earthquake Strengthening

Stanford University Hoover Pavilion

- 1930's Vintage
- Six-story concrete shear wall structure
- Originally an acute care hospital
- Current facility function is:
  - Outpatient services
  - Medical office facilities
- Seismic strengthening incorporated with a planned infrastructure renovation
- Facility remained operational during construction

Hoover Pavilion Strengthening

UC San Francisco MSB/Moffit

- 15-story Moffitt Hospital
- 15-story Medical Sciences Building
- Buildings seismically separated for compliance with SB 1953 requirements
- Strengthening schemes designed to separate the buildings
- New exterior stair options were incorporated into the project

UC San Francisco Separation Strengthening Project

Veterans Administration American Lake Tacoma, WA

- Mental Health Patient Care facility
- 1932 Vintage
- 3-story concrete frame
- 51,000 sq ft
- Seismic strengthening scheme:
  - Exterior concrete shear walls
  - Objective to minimize disruption to the facility

VA American Lake

Summary Earthquake Mitigation

- *Do it right the first time from today forward*
- *Long-term strategy:*
  - New Construction
  - Planned facility outages
  - Renovations & remodels
  - New equipment installations
  - Aging equipment replacement
  - During equipment maintenance activities

- *Earthquake mitigation does not happen overnight*

Questions?