

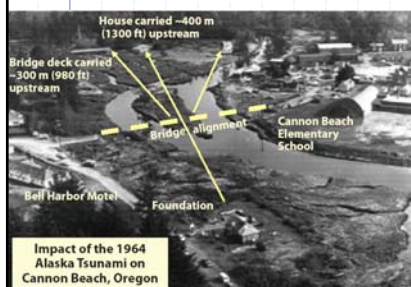
Structural Design Considerations

- ◆ CBTEB Design Scenarios
- ◆ CBTEB Design Performance Objectives
- ◆ Design Loads and Forces
- ◆ Structural Systems
 - Self-Centering Reinforced Concrete Post-Tensioning Frame System
 - Conventional Reinforced Concrete Moment Frame System
 - Foundation

Kent Yu

Structural Design Scenarios

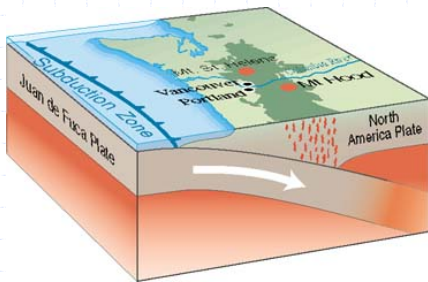
- ◆ Tsunami Generated by Distant Earthquakes
 - 1964 Alaska Earthquake
 - 2004 Indian Ocean Earthquake



Structural Design Scenarios

◆ Tsunami Generated by Cascadia Subduction Fault

- Strong Ground Shaking (M9.0 w/ 5min shaking)
- Tsunami



Design Performance Objectives

◆ Performance objective

- Immediate Occupancy for EQ (comparable or better than hospitals)
- Little Residual deformations after EQ
- Some Repair Expected After Tsunami



Design Loads

◆ Dead Loads

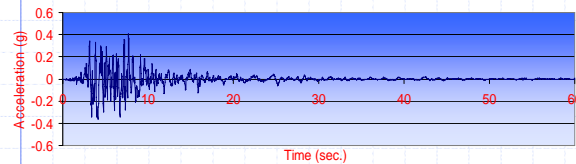
- Self Wt of Structure (beams, columns, slabs)
- Cladding/Partitions
- Mechanical/electrical/plumbing
- Flooring/Roofing

◆ Live

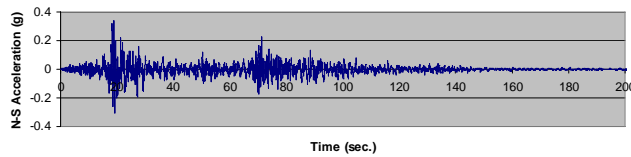
- Evacuation Zone (100psf)
 - ◆ Non-Reducible

Design Loads

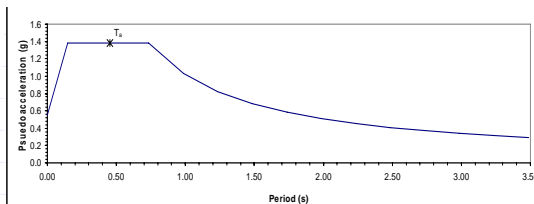
◆ Seismic Loads



In Oxnard from 1994
Northridge EQ

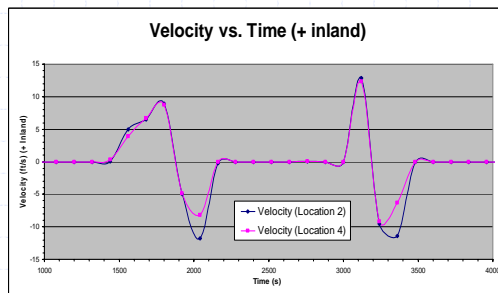
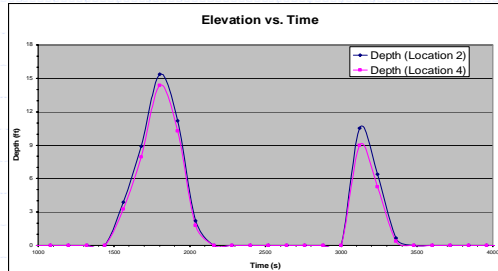


In Ica from 2007
Peru M8 EQ (105 km
from epicenter)



- M9 Earthquake
- 1.4g lateral force
- up to 5 min shaking

Tsunami Effects



Design Loads

◆ Tsunami Loads

- Hydrodynamic Load
 - ◆ Drag on Columns
- Impulse Load
 - ◆ Leading edge of wave
- Impact Loads
 - ◆ Impact of large objects (cars)
- Damming Between Columns
- Buoyancy Forces

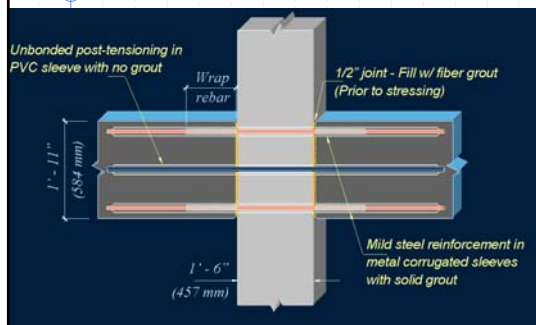


Structural Layout Consideration

- ◆ Design Vertical Layout to Minimize Tsunami Loads
- ◆ Breakaway Walls
- ◆ Prevent Progressive Collapse
- ◆ Multiple Line Defense

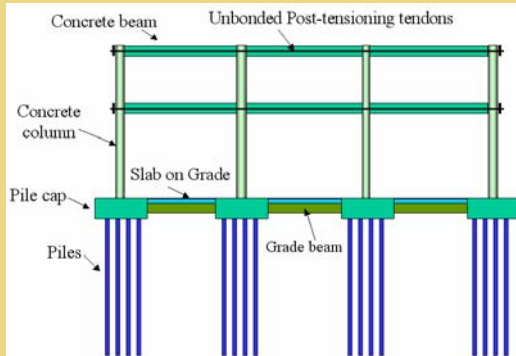
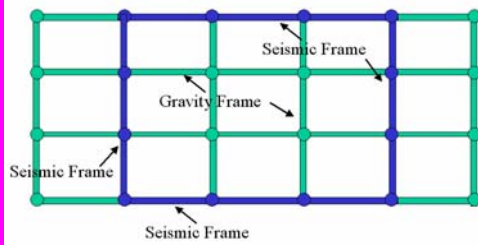


Self-Centering Post-tensioning Concrete Frame

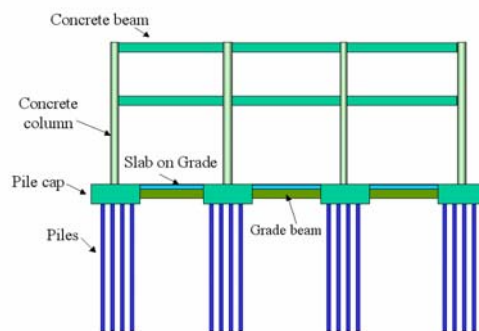
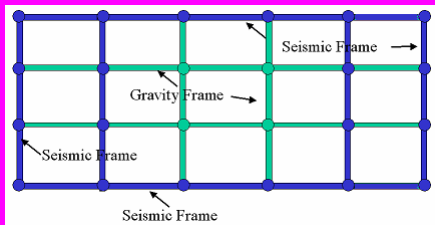


Post-tensioning hybrid concrete frame (Sritharan et al. 2000, UCSD)

TEB Seismic System Layout



Conventional Concrete Frame



TEB Structural Design

◆ Foundations

- Scouring Issue
- Piles to provide structural support
- Grade beams to interconnect pile caps
- Slab-on-grade tied to grade beams

Needed Information

- ◆ Geotechnical/Site-specific Hazard Report
- ◆ Site-specific ground motion records