Seattle Fault Earthquake Scenario

Conference

February 28, 2005

Earthquake Engineering Research Institute




Seattle Fault Earthquake Scenario

Transportation

Greg MacRae, PhD, P.E.
University of Washington

UNIVERSITY OF WASHINGTON




Seattle Fault Earthquake Scenario

Transportation Team

Engineer	Task	Organization
David Arndt, PE, SE	Airports	KPFF Consulting Engineers
Don Ballantyne, PE	Network	ABS Consulting
William Byers, PE	Railways	Formerly with BNSF Railroad
Greg MacRae, Ph.D., PE	Coordinator/Editor	University of Washington
Dan Mageau, PE	Waterfront Ports	GeoEngineers
Lee Marsh, Ph.D., PE	Road and Bridges	Berger ABAM Consulting Engineers

Seattle Fault Earthquake Scenario

Transportation Network

Roads and Bridges

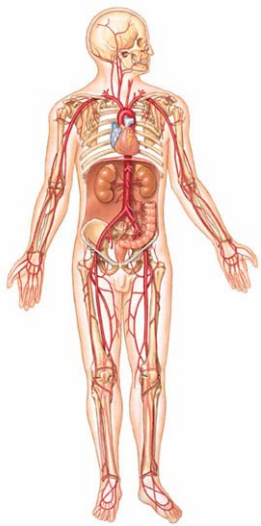
Rail

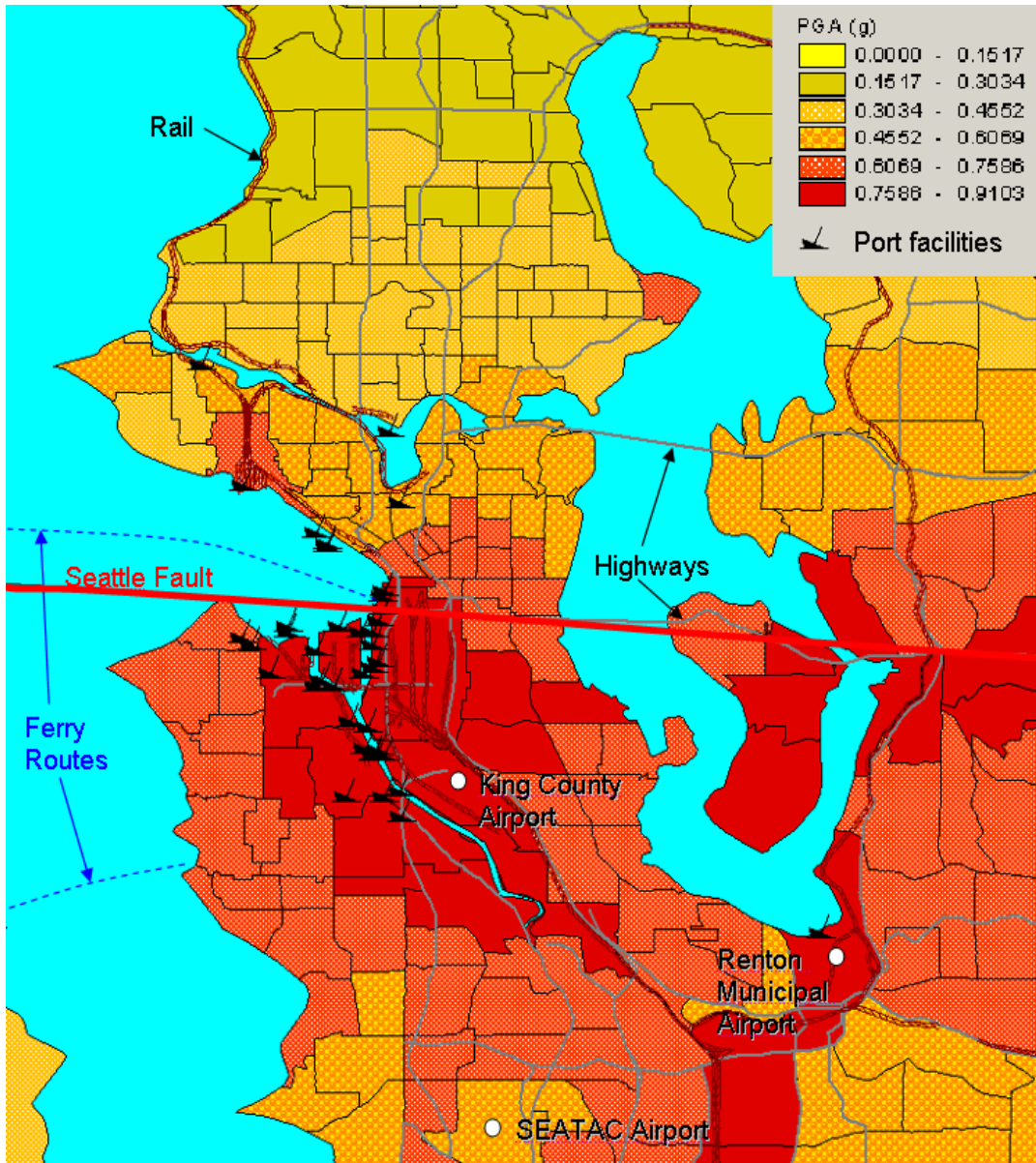
Airports

Ports

Ferries

Interdependent








Seattle Fault Earthquake Scenario

Roads and Bridges

Major arterial roads near fault region:

- I-5 > 240,000 vpd
- I-90 (Seattle east) > 148,000 vpd
- I-405 (N-S through Bellevue) > 200,000 vpd
- I-520 (Seattle east) > 100,000 vpd
- SR-99 > 110,000 vpd

Local roads

Seattle Fault Earthquake Scenario

Washington State Highway Bridges Years Constructed

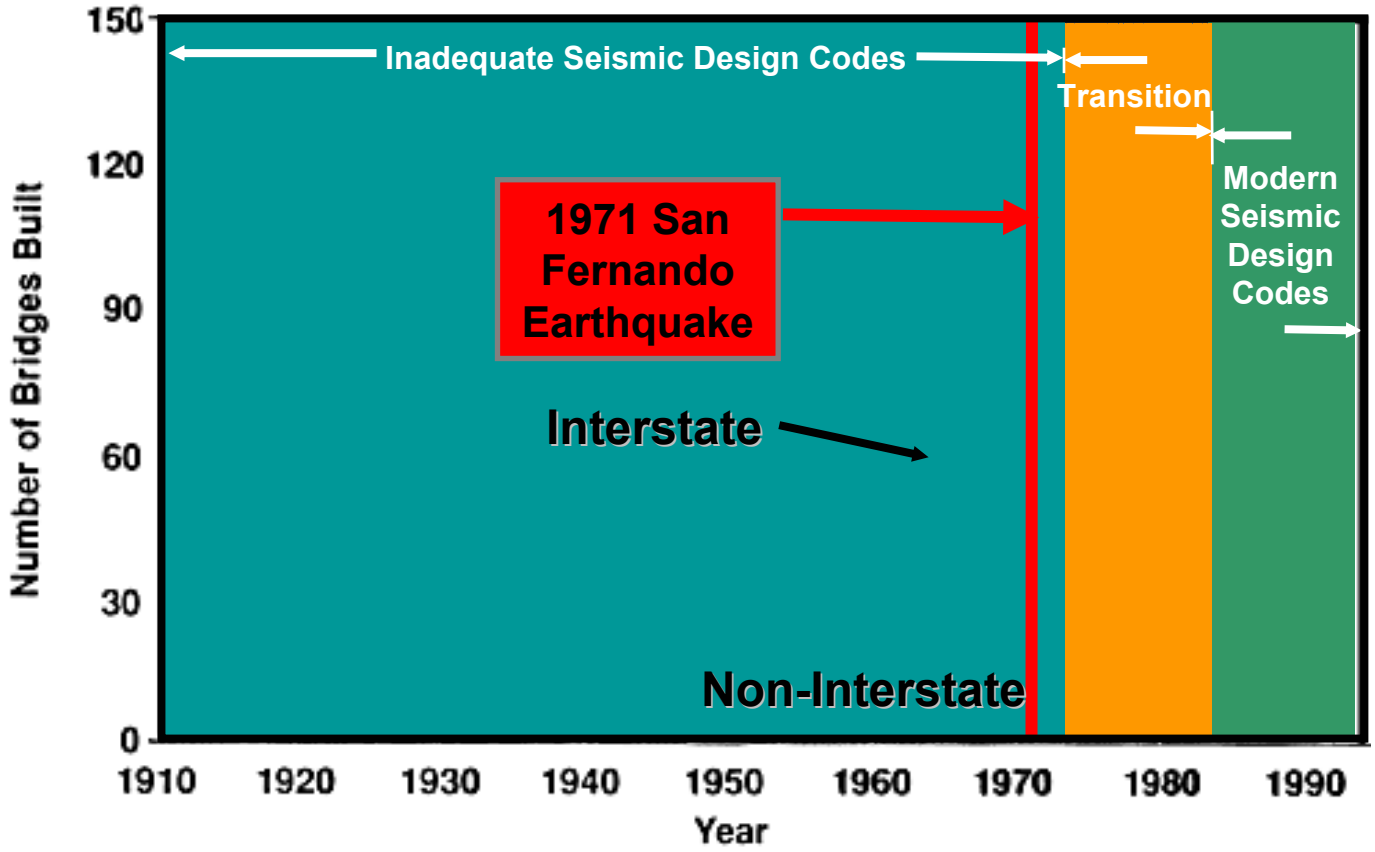
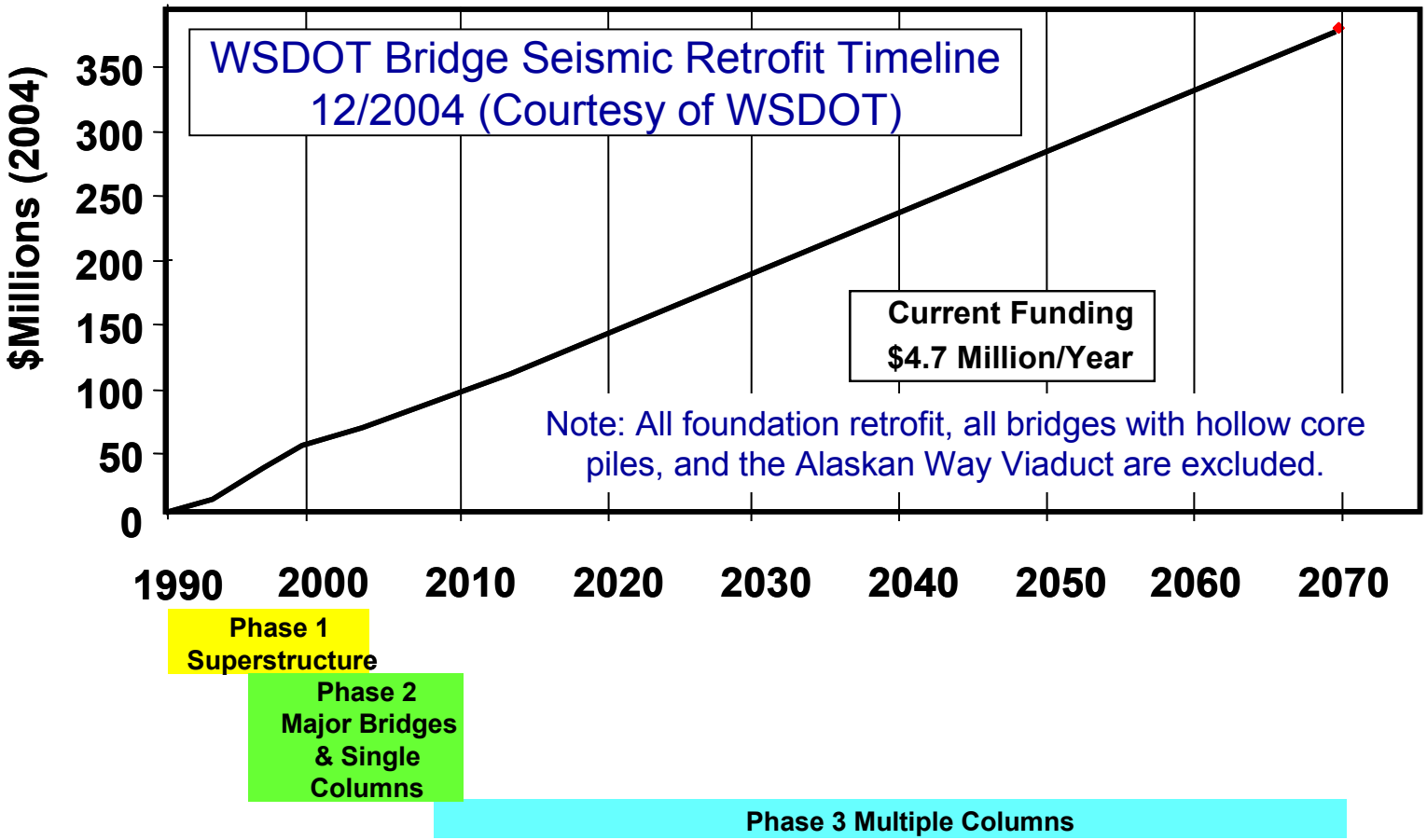


Figure Courtesy WSDOT/EQE/ABS Consulting

Seattle Fault Earthquake Scenario

WSDOT Bridge Seismic Retrofit



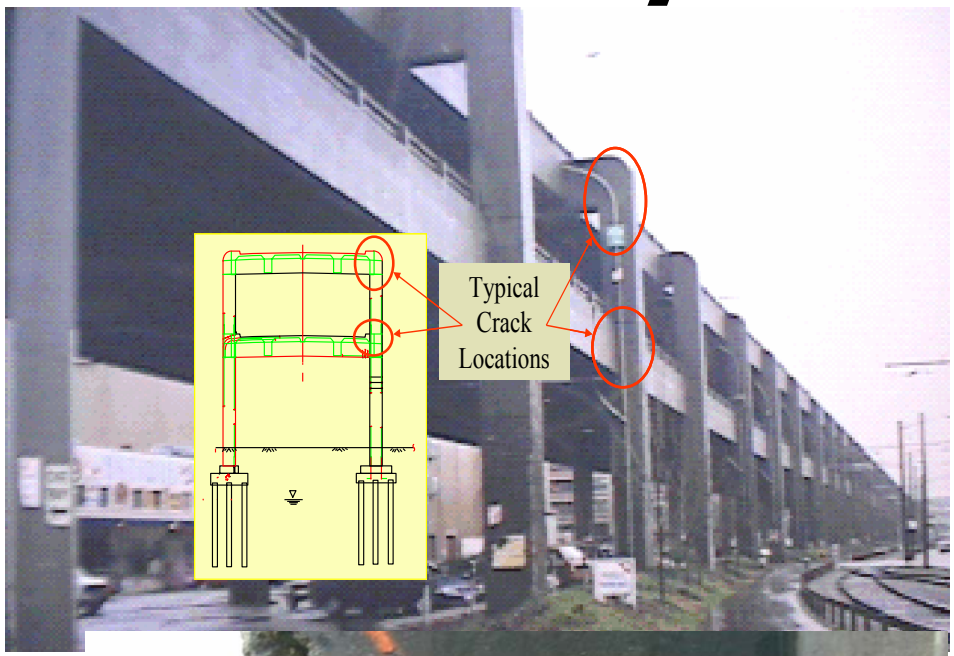
Seattle Fault Earthquake Scenario

Multicolumn Bents (Courtesy: WSDOT)




Seattle Fault Earthquake Scenario

Alaskan Way Viaduct



Alaskan Way Viaduct

Cypress Viaduct
(Loma Prieta, 1989)

Eberhard, and http://www.glaciermedicaled.com/Earthquake_html/EQ_Cal/Cal_eq_3.html




Seattle Fault Earthquake Scenario

E.Q. Effects on Highways

Likely Scenario

- I-5, I-90 and I-405, and SR 99, 167 and 520 have major damage or collapse.
- Moveable bridges will be jammed open or shut
- Other local bridges may experience damage
- Landslides/slips and liquefaction will affect local roads

Impacts - Immediate

- Severe traffic congestion
- Emergency services will be limited

Recovery Issues

- Surface streets cannot carry increased traffic volumes.
- Single bridges on some major routes may be replaced within a year
- Probably take > 6 years to replace Alaskan Way Viaduct on SR-99

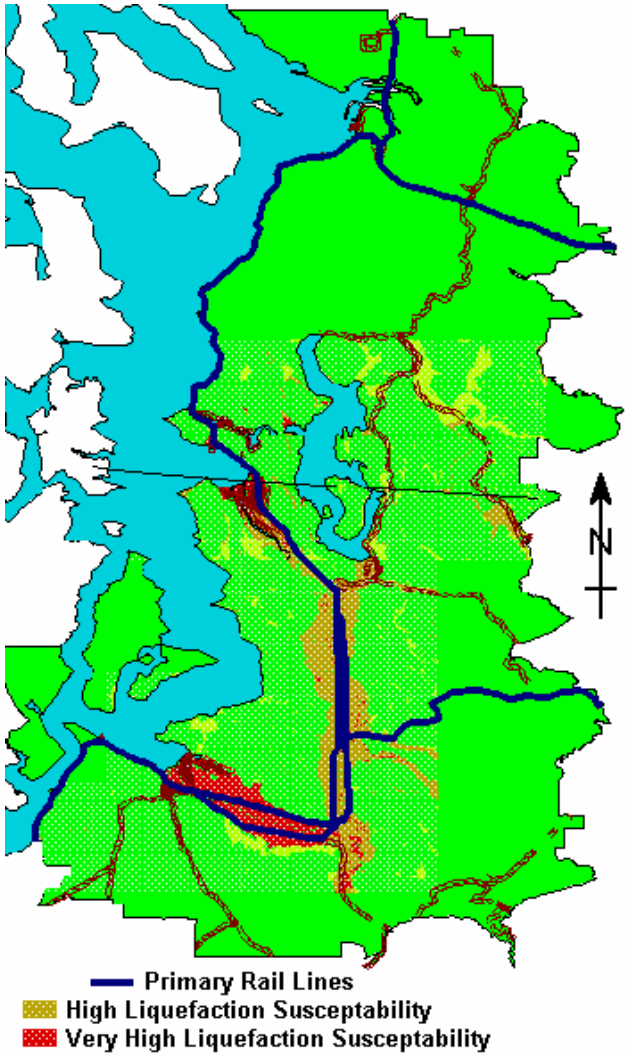
Impacts – Long term

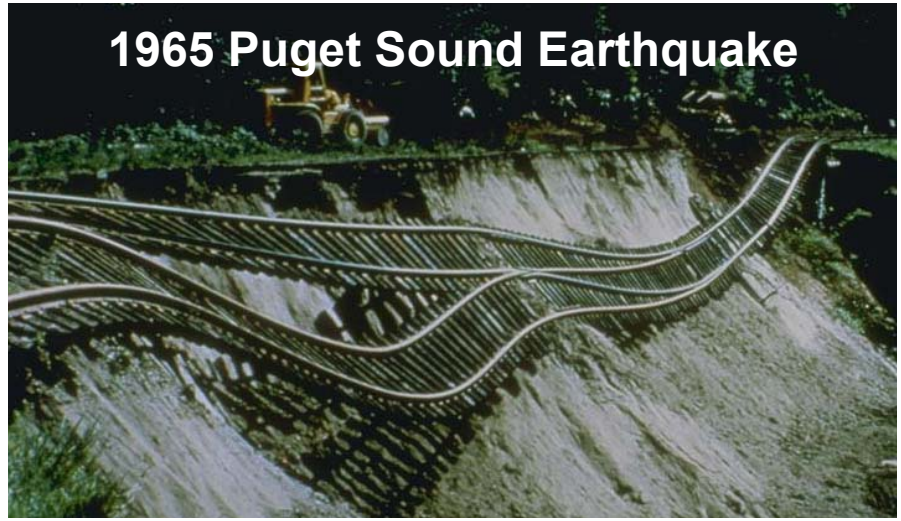
- Severe traffic congestion will occur for at least a year
- Commutes to work that took 30 minutes could take hours
- Movement of goods to final destinations – manufacturers, retail outlets, and hospitals, for example – will be much slower.
- Businesses will move from Seattle




Seattle Fault Earthquake Scenario

Railroads





BNSF and UP handle about 200,000 tons/day share a line south of Seattle. Equipment for realigning track is available after floods, etc.

Expected damage:

- Distortion over the fault
- Track settlement due to liquefaction
- Slumping, landslides
- Some damage to cars and facilities
- Jamming of moveable bridges
- Slumping at bridge abutments
- NOT expected to fixed bridges or tunnels

Inspection will require 6+ hours. Depending on damage extent, full restoration may take much more than one week. Loss of revenue is likely to exceed repair cost.

Airports

- SeaTac International Airport
  (26 million passengers/year)
  - Structural damage
    - potentially even to retrofitted structures
  - Non-structural damage
- King County Int. Airport/Boeing Field and Renton Municipal Airport
  (contributing $1.43billion and $17 million to the economy/year respectively)
  - Significant damage to:
    - liquefaction and runway damage
    - structures, older ones may collapse
- Boeing Field and Renton closed immediately
- Possibly more than a month to open to full operation at some airports




Seattle Fault Earthquake Scenario

Ports

Second largest regional employer (after Boeing)
7% of U.S. trade through Seattle and Tacoma ports
Seattle is 5th largest container port in US
Seattle cargo terminal revenue > $1.58 billion (1999)

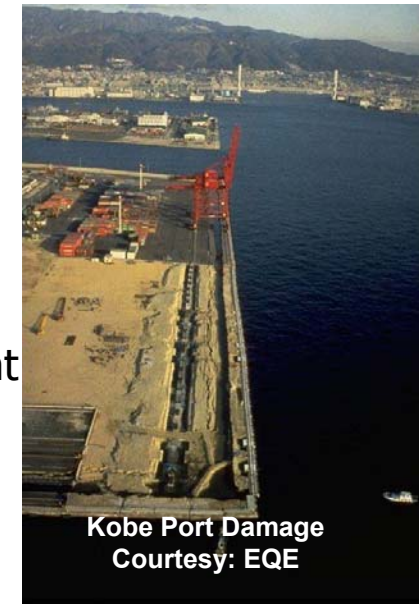
Damage is expected due to:

- pier and wharf deformations due to > 1 ~ 5ft soil movement
- seawalls
- cranes
- structures
- buried structures/pipes
- containers yards (liquefaction)

Recovery:

- full economic recovery may take several years (Kobe)

This will have a multibillion $ effect on local economy


Kobe Port Damage
Courtesy: EQE

Seattle Fault Earthquake Scenario

Ferries

Susceptible Terminals

- Seattle: Pier 50 Terminal – Vashon (walk-on)
- Seattle: Pier 52 Terminal - Bremerton/Bainbridge Island
- Fauntleroy: Vashon/Southworth

Planning

- WS Ferries (WSF) with 26 million passengers/year has contingency plans for other disasters. Other ports will be used with more frequent trips.
- Ferries may be used as alternative transportation

Major Concerns

- Piers and Terminal Structures
- Liquefaction/Spreading ~ similar to port damage




Seattle Fault Earthquake Scenario

Transportation Summary

The system is essential:

- For daily life and the regional economy
- To protect life during an earthquake
- To provide emergency response
- To provide long-term recovery

Many elements of the system are vulnerable

The rate of preparing the interdependent system for earthquake should be increased.

Seattle Fault Earthquake Scenario

Conference

February 28, 2005

Earthquake Engineering Research Institute