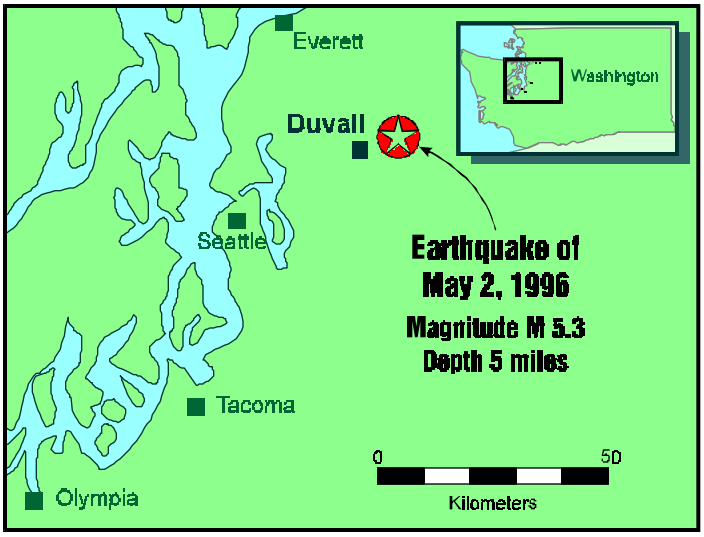
PUGET SOUND EARTHQUAKE ALERT
DUVALL EARTHQUAKE OF MAY 2, 1996

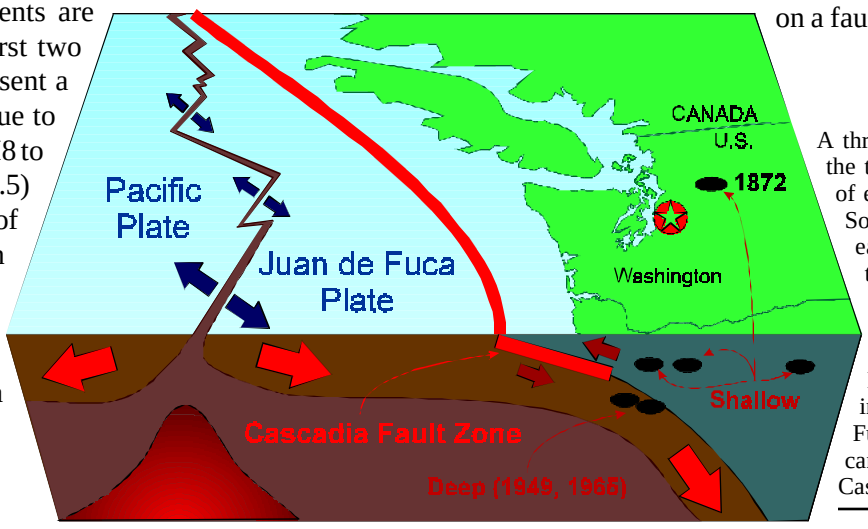
At 9:04 P.M. local time on Thursday, May 2, 1996, a local magnitude (M) 5.3 earthquake with an epicenter approximately 25 miles east-northeast of Seattle, near the town of Duvall, shook parts of western Washington, southern British Columbia, northern Oregon, and east to Spokane. The Duvall Earthquake was a shallow event, with a depth of only five miles.



Seismic Hazards in the Puget Sound

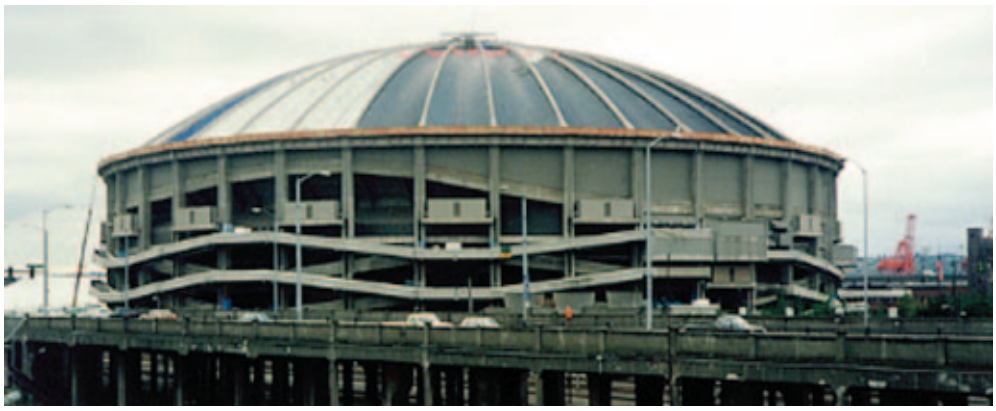
There are three general mechanisms that compose the seismic hazard in the Puget Sound area. First, there are shallow earthquakes of the type that occurred in Duvall. Earthquakes of this type represent adjustments of the earth's crust due to stresses associated with the convergence of the two great crustal plates affecting the Puget Sound area: the Juan de Fuca plate off the west coast of Washington, and the North American plate underlying Puget Sound and Washington state. Second, there are deep earthquakes that have occurred in the Juan de Fuca plate. These earthquakes are believed to be caused by the sinking of the Juan de Fuca plate beneath the North American plate. As the plate sinks, tension develops, and the plate ruptures, causing earthquakes that may be as large as M7.5. Examples of earthquakes of this type are the 1949 (M7.1) and 1965 (M6.5) earthquakes that caused significant damage to communities throughout the Puget Sound area. A third major threat to the area is an earthquake occurring at the interface of the Juan de Fuca and North American plates. Such events are more infrequent than the first two mechanisms, but they represent a potentially greater hazard due to their magnitudes reaching M8 to M9. Giant earthquakes (M>8.5) associated with the thrusting of the Juan de Fuca plate beneath the North American plate have occurred in the past and will likely occur again. This source is called the Cascadia Fault Zone.

These three earthquake sources carry the threat of damage to the Pacific Northwest. Of the three major sources of earthquakes in the area, the magnitude and geographical distribution of possible shallow, damaging shocks such as the Duvall Earthquake is the least understood. Large, shallow earthquakes have not been historically recorded in the Puget Sound area, but they are possible and would do great damage. Further study is needed to confirm whether or not the Duvall Earthquake occurred on a known fault. Shallow faults are known in the Puget Sound area that could be the loci of damaging earthquakes, and these should be studied in more detail. For example, geological evidence indicates that a large, shallow earthquake may have occurred about 1,100 years ago on a fault beneath Seattle.



A three-dimensional view of the three principal sources of earthquakes in the Puget Sound area: (1) Shallow earthquakes similar to the May 2, 1996, shock; (2) Earthquakes within the descending Juan de Fuca plate; and 3) Earthquakes at the interface of the Juan de Fuca and North American Plates, known as the Cascadia fault zone.

Damage Summary



The May 2 event caused no damage to the Kingdome.

The University of Washington Seismology Lab in Seattle described the ground shaking as "moderate," but damage was very light. EQE's damage inspections of several shopping centers and county buildings confirmed the lack of serious structural damage. Near the epicenter, merchandise fell off of shelves and at least one resident reported a cracked chimney. One King County building, the Youth Center, sustained minor cracks, which building inspectors determined as cosmetic. County engineers discovered that some bridges in rural King County had slightly shifted, but the bridges did not sustain any structural impacts. No damage occurred to the river systems, dams, levees, or roads.

King County, Seattle, Kirkland, Issaquah, and Kent activated their Emergency Operations Centers to coordinate response efforts, if necessary. County and city officials collected damage assessment information on government buildings, transportation lifelines, dams, and communities. No further response was necessary. The King County Communications Center where the 911 calls are received experienced a very brief period of excessive call volume, lasting approximately five minutes. Several local government officials reassured the public over radio and television that damage was minimal.

The Kingdome

King County requested our engineers to visually inspect the Kingdome following the Duvall Earthquake to determine whether any earthquake damage had been sustained. Our engineers performed the inspection the day after the earthquake as part of an overall inspection effort, which included engineers from other local firms. As co-authors of the Kingdome Seismic Assessment Report, we visually inspected the areas deemed most likely to sustain possible damage in the event of an earthquake. We reviewed the interior columns, concourse bridges, concourse beams, as well as the beams forming the major external bracing system. The visual inspection revealed that the May 2 event caused no damage or even cracking. Cracks would have been easily discernible in the concrete elements due to the fresh paint in many locations throughout the Kingdome.

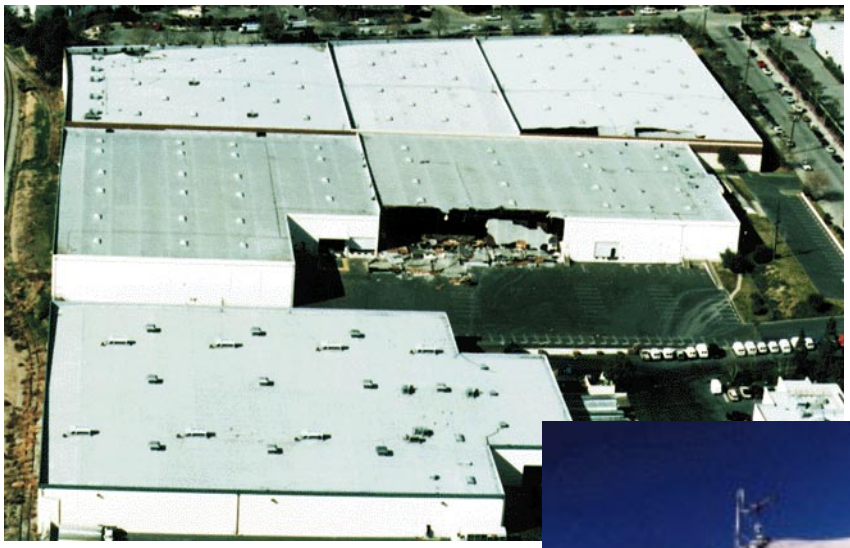
Very little movement was noticed along the expansion joints that separate the Kingdome into six segments, indicating that the Kingdome apparently moved as a unit. The performance of the nonstructural elements within the Kingdome was good. There was no indication of damage to ceiling tiles, television monitors, or other nonstructural items. Light fixtures were all in place, and items on shelves did not fall off during the event. After the inspection was complete, a press conference was held to announce that the Kingdome was safe and available to resume baseball play that evening.

Lifelines

In Snohomish County, 16,000 residents were reportedly without power for several hours as a result of breakers tripping in four substations. There was, however, no report of physical damage to electrical power facilities. At the Everett Water Treatment Plant 20 miles from the epicenter, the senior treatment plant operator at the time of the event indicated that after a brief survey of the facilities, no damage was sustained other than some items falling off shelves. No sloshing in the treatment process tanks occurred.

Building Vulnerabilities

The major metropolitan areas in the Pacific Northwest such as Seattle, Portland, and Vancouver, B.C., have experienced significant growth over the last 20 years. The construction practice in these regions roughly parallels that of other seismic regions in California. Consequently, lessons learned in recent events, such as the 1994 Northridge Earthquake, are directly applicable to the Pacific Northwest.



Typical tilt-up wall and roof failure due to out-of-plane loads.

Structures with wood roofs and perimeter ***reinforced masonry or precast concrete tilt-up*** walls are the most common low-rise, light industrial and commercial construction in the western United States. The 1994 Northridge Earthquake in California caused partial collapse of more than 400 such structures, many of which were of recent vintage. The primary vulnerability of these buildings is inadequate connections between their heavy perimeter walls and flexible floor and roof framing systems.

particular, apartment buildings with first-story garages are particularly vulnerable. Many of these buildings were not "engineered" but were designed using the conventional construction provisions of the code. Buildings less than 10 years old were observed to have few if any plywood walls.

Older (pre-1970s), ***reinforced concrete moment-frame*** and flat-slab buildings are very common in Seattle, Portland, and Vancouver, B.C., and have experienced catastrophic collapses in past earthquakes. This experience was repeated in the Northridge Earthquake. Among modern engineered structures, concrete parking garages had the greatest damage; eight totally or partially collapsed. Three of the collapsed structures had been built within the last six years.

Collapse of this medical building is typical of older concrete building performance.

Historically, ***steel-frame buildings*** have been considered as one of the most earthquake-resistant construction types. However, more than 100 modern steel-frame buildings were severely damaged by the Northridge Earthquake. Repair costs for some structures have exceeded 30% of the replacement costs, and a few have been written off as total losses. In a number of moment-resisting steel frames, highly stressed welded beam-column connections served as initiating zones for brittle fractures that propagated through the connections. Research undertaken since the earthquake indicates that other contributing causes could include the basic strength and toughness properties of the structural steel and welding materials.

Wood-frame buildings constitute nearly all residential building inventory and a substantial portion of commercial construction. Although most single-family homes performed well in the Northridge Earthquake, more than 34,000 residential units were lost. Multifamily residential buildings and, in

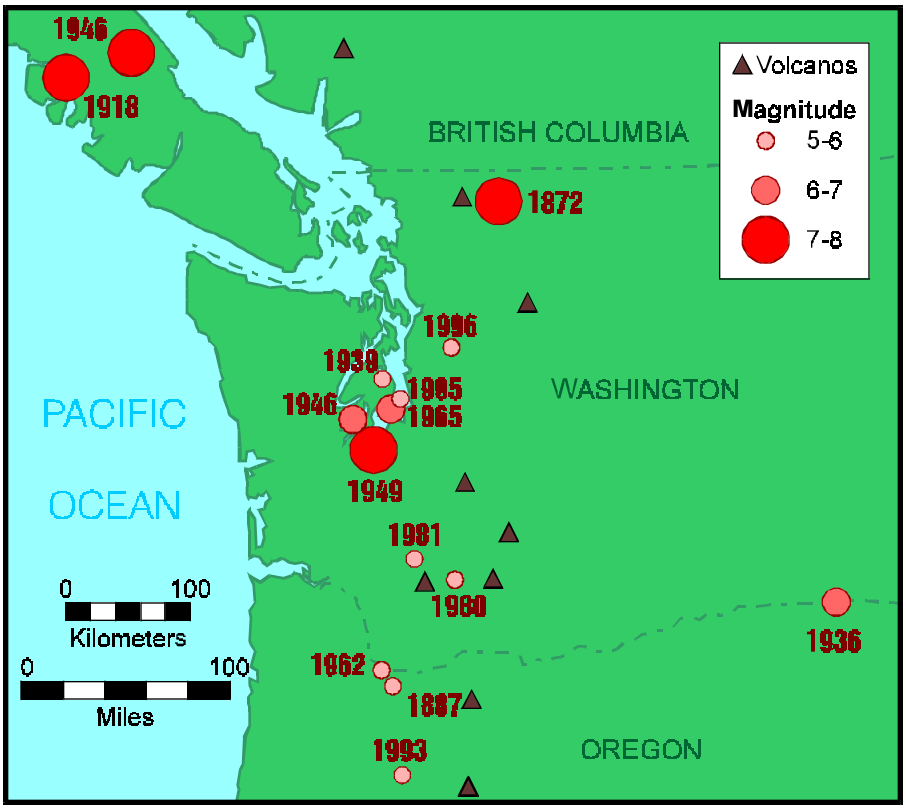
Typical connection fracture in a moment-frame building.

Conclusions

The Duvall Earthquake served as a reminder that the Pacific Northwest is Earthquake Country. Large earthquakes have occurred here in the past and will happen in the future. Recent events, such as the 1994 Northridge Earthquake in California, have demonstrated a number of serious deficiencies in recent earthquake-resistive design and construction practices that are directly applicable to the Pacific Northwest. Building types commonly regarded as having low to moderate risk of damage or life endangerment prior to these earthquakes are now understood to have significant risk. This has several important implications for building owners, investors, insurers, and tenants:

Design practices are continually changing to improve the earthquake response of structures. Consequently, even recently constructed buildings may be vulnerable to significant damage in a major earthquake.

Building codes provide minimum life-safety protection only. Building code criteria may not have adequate earthquake resistance to satisfy the objectives of owners, lenders, or tenants.



Recent earthquakes in the Pacific Northwest.

Risk assessments are now likely to result in higher estimates of risk than those provided in the past.

Potential business interruption losses following a major earthquake may exceed those previously estimated.

EQE International

Corporate Headquarters and Regional Office
44 Montgomery Street, Suite 3200, San Francisco, CA 94104-4805 USA
Telephone (415) 989-2000 FAX (415) 433-5107
World Wide Web: http://www.eqe.com, E-mail: info@eqe.com

Pacific Northwest

1411 4th Avenue Building, Suite 500
Seattle, WA 98101-2207, USA
Telephone (206) 623-7232
FAX (206) 624-8268

Additional U.S. Offices

Aiken, South Carolina
Evergreen, Colorado
Houston, Texas
Irvine, California
New York, New York
St. Louis, Missouri
Stratham, New Hampshire

International Offices

Bulgaria
Chile
France
Japan
New Zealand
Singapore
Spain
United Kingdom