INFLUENCE OF THE 1964 GREAT ALASKA EARTHQUAKE ON CIVIL ENGINEERING AND BUILDING CODES IN ALASKA (AND THE USA)

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ALASKA SEISMICITY

• Most seismically active State

• Since early 1900s:
  – 11% of instrumented earthquakes in world; 3 of 12 largest in world; and 9 of 10 largest in N.A.
  – 50 to 100 earthquakes daily; ≈ 24,000 annually, including at least one M6-7; M8+ every 13 years

• One of the most prominent sources of tsunamis in the world
Earthquakes in Alaska

Earthquake risk is high in much of the southern half of Alaska, but it is not the same everywhere. This map shows the overall geologic setting in Alaska that produces earthquakes. The Pacific plate (darker blue) is sliding northwesterly past southeastern Alaska and then dives beneath the North American plate (light blue, green, and brown) in southern Alaska, the Alaska Peninsula, and the Aleutian Islands. Most earthquakes are produced where these two plates come into contact and slide past each other. Major earthquakes also occur throughout much of interior Alaska as a result of collision of a piece of crust with the southern margin.

Three magnitude 7 earthquakes occurred within 50 miles of Fairbanks in the last 90 years.

The Denali fault generated a magnitude 7.9 earthquake in 2002. This part of the fault ruptured, with horizontal offset of up to 29 feet.

The Queen Charlotte–Fairweather fault presents the greatest earthquake hazard to residents of southeast Alaska.

The 1964 earthquake was the second largest ever recorded in the world. The area within this pink patch slipped seaward up to 88 feet.

This piece of crust is being pushed into and beneath the southern Alaska margin. As a result it causes large earthquakes here and throughout interior Alaska.

A fault beneath a fold in Cook Inlet resulted in a magnitude 7 earthquake in 1933 that strongly shook Anchorage.

These arrows show the speed and direction at which the Pacific plate moves by and underneath Alaska.

The 1964 earthquake and date of most recent rupture

Active and potentially active faults

(North American Plate)

(Pacific Plate)

(Arctic Plate)

(USGS OFR 95-624)
Aleutian Subduction Zone

Anchorage

Princeton William Sound

North American Plate

Pacific Plate

+2”/year

Castle Mt Fault

SUBDUCTION ZONE/INTERPLATE FAULT

MEGATHRUST ZONE

TRANSITION ZONE

BENIOFF ZONE

Vertical Scale Equals Horizontal Scale

Statute Miles

Kilometers
27 March 1964 Great Alaska (Good Friday) Earthquake

- M9.2 (largest recorded earthquake US History)
- Strong Shaking (almost 5 minutes in Anchorage)
- $311 million damage ($2.3 billion in 2013 dollars); 131 deaths (122 in tsunamis)
- Extensive Ground Failure (accounted for most of damage in Anchorage, versus ground shaking)
Post 1964 Earthquake Plate Movements (1992-2001)
Damage at Anchorage due to Ground Shaking

JC Penny Building
Low-Angle Landslides
4th Avenue Slide
Government Hill Slide
L Street Slide Pressure Ridge
Turnagain Heights Slide
Post 1964 Earthquake Engineering Milestones in Anchorage

- Geotechnical Advisory Commission (1976)
- Geologic Hazards Study (HLA, 1979)
- Coastal Zone Management Plan (1981)
- Local Amendments to the 1988 UBC (1989)
- Seismic Microzonation Study (1993 to date)
- Seismic Hazards Studies (WCC, 1986 & 1987)
- Downtown Seismic Risk Assessment (MMI, 2010)
ANCHORAGE GEOTECHNICAL ADVISORY COMMISSION

• Established in 1976; 9 members (civil engineers & geologists)

• Technical advisory resource to the Mayor, Assembly & City Departments

• Key Accomplishments:
  – Inventory of geologic hazards (HLA, 1979)
  – Local amendments to the building code
  – Review major projects in high earthquake hazard zones
  – Downtown Seismic Risk Assessment (MMI, 2010)
MOA Seismic-Induced Ground Failure Hazard Map

- ZONE 5 - (Very High Ground Failure Susceptibility)
- ZONE 4 - (High Ground Failure Susceptibility)
- ZONE 3 - (Moderate Ground Failure Susceptibility)
- ZONE 2 - (Moderately-Low Ground Failure Susceptibility)
- ZONE 1 - (Lowest Ground Failure Susceptibility)
Alaska State (Nesbitt) Court House
Turnagian Heights then and now
Post 1964 Earthquake Engineering Milestones in Alaska

1964 Great Alaska Earthquake


Alaska Earthquake Center (1986)


USGS Seismic Hazard Maps (1999 & 2007)
ALASKA SEISMIC HAZARDS SAFETY COMMISSION

• Established in 2002, first members appointed in 2005; 11 members (civil engineering, geology, seismology, emergency management, local government, insurance)

• Advisory body empowered to recommend to the governor, legislature, state departments and local governments goals, priorities, programs, research, recovery practices, etc. to mitigate seismic hazards in Alaska.

• Key Objectives & Projects:
  – Identify and prioritize schools at risk from earthquakes
  – Independent review of designs and construction of public facilities
  – Kodiak scenario earthquake study
  – Advocate for Alaska earthquake research
  – Regulations for seismic knowledge of civil engineers licensed in Alaska
On a national scale, the 1964 Great Alaska Earthquake strongly affected:

- Geology - *Theory of plate tectonics*
- Seismology — *Subduction zone earthquakes*
- Seismic Engineering — *Geotechnical hazards*
“The great Alaskan earthquake on Good Friday 1964 was a major turning point and a trigger for new [national] programs. To my thinking, and most people’s thinking, I believe, the Alaskan earthquake was the beginning of, and stimulus for, our whole modern earthquake program. That earthquake showed what great seismic events could do very close to home.”

(in USGS 1996; OFR 96-260)
Post 1964 Earthquake Engineering Milestones in the USA

- National Earthquake Reduction Act (1977)
- Federal Emergency Management Agency (1979)
- 1964 Great Alaska Earthquake
- 1994 Uniform Building Code
- NEHRP Recommended Provisions for Seismic Regulations for New Buildings (FEMA, 1988)
- Tentative Provisions for the Development of Seismic Regulations for Buildings (ATC 3-06, 1978)
- California Seismic Safety Commission (1975)
**National Building Codes**

- The design codes are intended to protect the safety of a building’s occupants during and immediately after an earthquake – not to eliminate structural damage or loss of property.

- Design codes are based on a premise that the ground is and remains stable.

- Provisions to design for earthquake loads have been included in national building codes since the late 1920s; however, specific requirements to consider the potential for earthquake-induced ground failure were not included until the 1994 UBC (despite recommendations in ATC 3-06 {1978} and NEHRP {1988}, etc.)
1964 Great Alaska Earthquake—A Photographic Tour of Anchorage, Alaska

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