Basic Seismological Characterization for Laramie County, Wyoming

by

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BACKGROUND

Seismological characterizations of an area can range from an analysis of historic seismicity to a long-term probabilistic seismic hazard assessment. A complete characterization usually includes a summary of historic seismicity, an analysis of the Seismic Zone Map of the Uniform Building Code, deterministic analyses on active faults, "floating earthquake" analyses, and short- or long-term probabilistic seismic hazard analyses.

Presented below, for Laramie County, Wyoming, are an analysis of historic seismicity, an analysis of the Uniform Building Code, deterministic analyses of nearby active faults, an analysis of the maximum credible "floating earthquake", and current short- and long-term probabilistic seismic hazard analyses.

Historic Seismicity

The enclosed map of "Earthquake Epicenters and Suspected Active Faults with Surficial Expression in Wyoming" (Case and others, 1997) shows the historic distribution of earthquakes in Wyoming. Only two earthquakes have been recorded in Laramie County. These earthquakes are discussed below.

The first earthquake that was recorded in Laramie County occurred on March 24, 1927. This intensity III event was centered approximately 5 miles north of Cheyenne. The earthquake was felt by at least five residents who described a rapid trembling that lasted five seconds. Two people on the fourth floor of a building also felt the earthquake. Some reports indicated that two shocks were felt, and that the ground "trembled and bumped" (Neumann, 1929).

The U.S. Geological Survey recorded a very small earthquake, located approximately 10 miles west-southwest of Cheyenne, on June 5, 1967. No magnitude or intensity have been associated with the event.

On September 12, 1980, a magnitude 3.2 non-tectonic earthquake occurred approximately 16 miles west of Cheyenne. The event was identified as an explosion of 150 tons of dynamite and it was felt 20 miles west-northwest of Cheyenne (Stover and von Hake, 1982).

Regional Historic Seismicity

Several earthquakes have also occurred near Laramie County. Two of the first earthquakes to be felt and recorded in southeast and south-central Wyoming occurred between Laramie, Wyoming and Estes Park, Colorado on November 7-8, 1882. The first and largest earthquake, which occurred on November 7, 1882, was estimated to have a magnitude of 6.2 and a maximum intensity of VII. It was felt over most of Colorado, the southern half of Wyoming, and northeastern Utah (Kirkham and Rogers, 1985). The second earthquake, which occurred on November 8, 1882, was only felt from Denver to Laramie. In Laramie, the first event caused considerable apprehension, and some people ran out into the streets. Clocks were stopped, plaster was cracked, and some glass in windows was broken (Case, 1993). Kirkham and Rogers (1985) documented that the earthquake was felt as an intensity VI event in Laramie.

The earliest recorded earthquake that originated in Albany County occurred in the Laramie area on January 13, 1898. The intensity IV event shook buildings and rattled dishes, windows, and loose objects in Laramie. Before the shock waves were felt, many Laramie residents reported that they "heard a noise similar to that which a heavy wagon would make moving at a good speed a block or two away" (The Daily Boomerang, January 14, 1898). Because the earthquake occurred at 11:45 pm, a number of people were awakened by the shaking of their beds.

On September 20, 1931, an earthquake with a maximum intensity of IV was felt in Laramie and at the Summit Tavern, located east-southeast of Laramie in the Laramie Mountains. There were reports from Laramie that windows and dishes rattled, and some residents ran from their homes (The Laramie Republican-Boomerang, September 21, 1931).

Another intensity IV earthquake occurred on November 10, 1935. This earthquake, thought to have an epicenter in Laramie, was felt in Laramie, Rawlins, and Rock River. In Laramie, buildings shuddered slightly, dishes rattled, and a low rumbling sound was heard. The earthquake lasted less than ten seconds (The Laramie Republican-Boomerang, November 11, 1935).

The most significant earthquake to occur in the area, a magnitude 5.5, intensity VI event, occurred on October 18, 1984. That earthquake, with an epicenter located approximately 4 miles west-northwest of Toltec, was felt in Wyoming, South Dakota, Nebraska, Colorado, Utah, Montana, and Kansas. Stover (1985) reports that cracks were found in the exterior brick walls of the Douglas City Hall and a public school in Medicine Bow. Chimneys were cracked at Casper, Douglas, Guernsey, Lusk, and Rock River. A wall in a Laramie-area school was slightly cracked by the earthquake. The earthquake was one of the largest felt in eastern Wyoming. There were a number of aftershocks to the main event, with the most significant being a magnitude 4.5, intensity IV event, and a magnitude 3.8 event occurring on October 18, 1984; a magnitude 3.5 event on October 20, 1984; magnitude 3.3 events on October 19, November 6, and December 17,

1984; a magnitude 3.1 event on October 22, 1984; a magnitude 3.2 event on October 24, 1984; and a magnitude 2.9 event on December 5, 1984.

Uniform Building Code

The Uniform Building Code (UBC) is a document prepared by the International Conference of Building Officials. Its stated intent is to "provide minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within this jurisdiction and certain equipment specifically regulated herein."

The UBC contains information and guidance on designing buildings and structures to withstand seismic events. With safety in mind, the UBC provides Seismic Zone Maps to help identify which design factors are critical to specific areas of the country. In addition, depending upon the type of building, there is also an "importance factor". The "importance factor" can, in effect, raise the standards that are applied to a building.

The current UBC Seismic Zone Map (Figure 1) (1997) has five seismic zones, ranging from Zone 0 to Zone 4, as can be seen on the enclosed map. The seismic zones are in part defined by the probability of having a certain level of ground shaking (horizontal acceleration) in 50 years. The criteria used for defining boundaries on the Seismic Zone Map were established by the Seismology Committee of the Structural Engineers Association of California (Building Standards, September-October, 1986). The criteria they developed are as follows:

Zone	Effective Peak Acceleration, % gravity (g)
4	30% and greater
3	20% to less than 30%
2	10% to less than 20%
1	5% to less than 10%
0	less than 5%

The committee assumed that there was a 90% probability that the above values would not be exceeded in 50 years, or a 100% probability that the values would be exceeded in 475 to 500 years.

Laramie County is in Seismic Zone 1 of the UBC. Since effective peak accelerations (90% chance of non-exceedance in 50 years) can range from 5%-10%g in this zone, and there has been some historic seismicity in the county, it may be reasonable to assume that a maximum peak acceleration of 10.0%g could be applied to the design of a non-critical facility located in the county if only the UBC were used. Such an acceleration, however, is less than would be suggested through newer building codes.

Recently, the UBC has been replaced by the International Building Code (IBC). The IBC is based upon probabilistic analyses, which are described in a following section. Laramie County will have adopted the IBC as of January 2003.

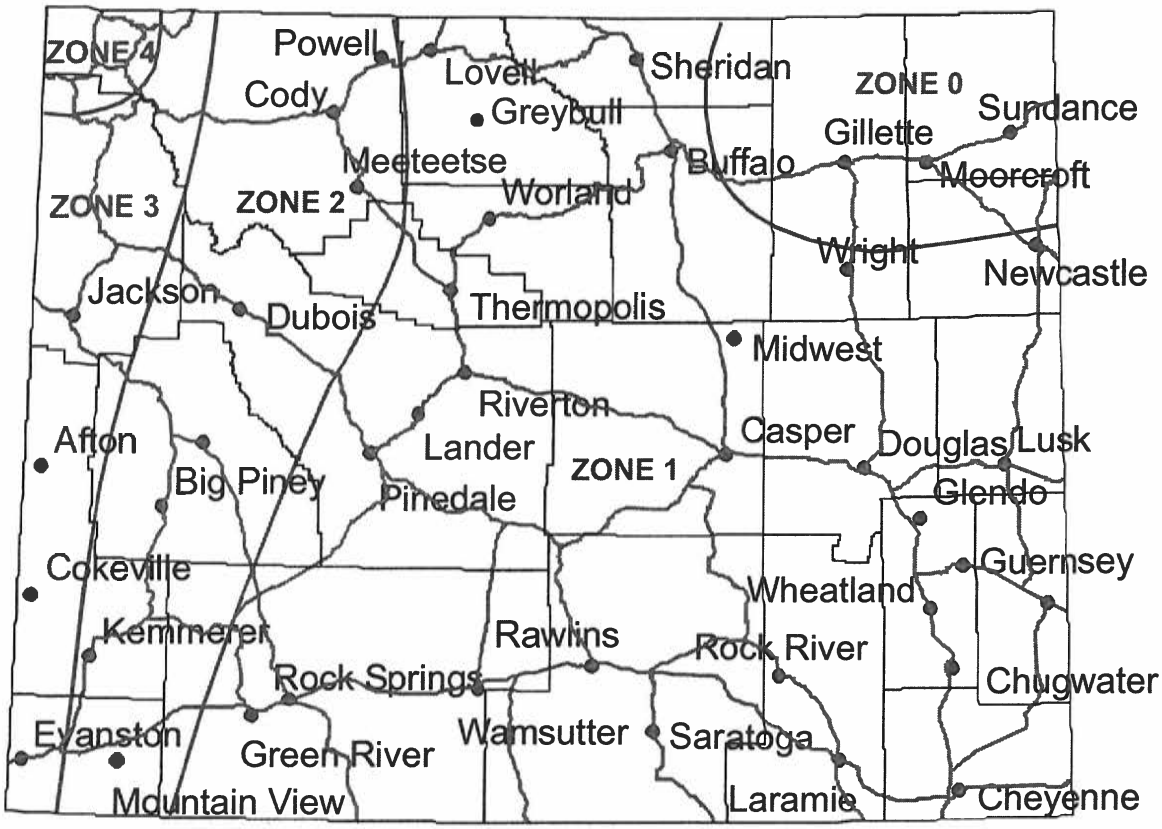

Figure 1. UBC Seismic Zone Map.