Learning from Earthquakes

The Magnitude 8.2, Hokkaido Toho-oki, Earthquake

At 10:22 pm, Japan Standard time, on October 4, 1994, a moment magnitude 8.2 earthquake occurred approximately 170 km to the east of the coast of the Nemuro Peninsula. The epicenter of the earthquake was located at North 43° 22', East 147° 40'. The fault dimensions were estimated at 100 to 150 km long and 40 to 50 km wide; the focal depth was estimated at approximately 30 km. The most severe damage occurred on the Kuril Islands (*Newsletter*, Nov. 1994). This report summarizes the damage observed in Hokkaido.

The intensity of the earthquake, as measured on the Japan Meteorological Agency Scale, was reported to be 6 in Kushiro-city, Nemuro-city, Hamanaka-town, Atsukeshi-town, Wakemi-town, and Nakashibetsu-town, and 5 in Nemuro-city, Hiroo-city, and Urakawa-town. The Building Research Institute of the Ministry of Construction reported peak horizontal and vertical ground velocities of 3.92 and 1.89 m/sec, respectively, recorded at the Kushiro Meteorological Observatory, a distance of 269 km from the epicenter. At the Hiro-town municipal building, a distance of 375 km from the epicenter, a peak horizontal ground velocity of 2.78 m/sec was recorded, the peak vertical velocity there was 0.94 m/sec.

There were no deaths directly attributed to the earthquake; however, 342 persons were injured, 12 of them seriously. The majority of the injuries occurred in Nakashibetsu-town (101) and Kushiro-city (49). The total number of reported cases of damage to constructed facilities included: 2024 residences, 1,427 civil structures, 169 harbor and fishing facilities and 191 educational facilities. Numerous residences were without water and electric service; however, the disruption of gas service was limited. One fire was reported in Kushiro-city.

Damage to buildings from the earthquake appeared to be lighter than the damage suffered as a result of the January 15, 1993, Kushiro-oki Earthquake. Most of the damage to buildings in Kushiro could be classified as nonstructural. This included fallen exterior tile cladding, broken window glass, damage to expansion joints due to impact, displaced furniture and lockers, light cracking of interior partition walls (reinforced concrete or concrete blocks), displaced desktop computers, and overturned bookshelves. A steel silo collapsed at Nakahara Meadows, Bekkai-oho. Steel bracing fractured in the school gymnasium ceilings.

Other specific cases of reported damage to buildings included:

(1) The 2-story, reinforced concrete Nemuro city hospital suffered moderate damage. Shear failure was observed in short columns and structural walls. Flexural and shear cracks were observed in other columns.

(2) The Nemuro city municipal building, a 3-story reinforced concrete building, suffered only minor damage. Shear cracks were found in a nonstructural reinforced concrete wall.

(3) The ceiling of the Nemuro Cultural Center collapsed.

(4) Shear cracks were observed in the columns of the 3-story, reinforced concrete Nakashibetsu-town hospital.

(5) The Nakashibetsu Cultural Center, a 3-story reinforced concrete structure built in 1962, suffered moderate damage. Shear failure was observed in two columns. Shear failure of a nonstructural reinforced concrete wall was also observed.

(6) The reinforced concrete Kushiro Technical High School building, which was damaged during the 1993 Kushiro-oki earthquake and subsequently retrofit using structural walls, survived with only minor cracking.

(7) The 3-story reinforced concrete Bokkai-oko-town municipal building, built in 1966, suffered moderate damage, with shear failure observed in 3 columns.

Approximately 13,000 residences in Nakashibetsu-town and Rausu-town, both in Nemuro county, were reported without power after the earthquake. Power was restored to all but approximately 1,800 residences by 8:00 am on October 5.

Gas lines suffered only moderate damage as a result of the earthquake. Breaks were reported at 20 locations in Kushiro-city, but problems were found at only 10 locations. The limited damage to gas lines can be attributed to mitigation measures taken by the gas companies after the 1993 Kushiro-oki earthquake. The utilities converted the steel pipes and joints to shock-resistant polyethylene pipes. Gas companies also promoted the use of automatic shut-off devices in gas lines: the number of automatic shut-off devices in use increased from 10 to 20 percent over the last two years. More than 350 shut-off devices were activated during this earthquake.

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City water pipes broke in Kushiro-city and in many other towns and cities. More than 10,000 of the 13,000 residences in Nemuro-city were without water on October 5. Fourteen supply trucks provided temporary service. As of October 6, 6400 residences were without water service.

Roads were blocked at 68 locations due to settlement and other damage. This included 62 locations in Hokkaido and 3 locations in Miyagi Prefecture on Honshu. National Road No. 391 was closed at 3 sections, and 26 prefectural roads were closed at 27 sections. Six bridges collapsed and there was a reported slope failure at one location.

Immediately after the earthquake all Japan Railways lines in Hokkaido were stopped. The Tohoku Shinkansen was also stopped. Most rail service was back in operation by October 5.

Liquefaction was observed at piers in Kushiro harbor. Evidence of possible liquefaction was also observed at other locations.

The Japan Meteorological Agency issued a tsunami alarm at 10:28 p.m. for the Pacific side of Hokkaido and Tohoku, and a tsunami warning for the Okhotsk side of Hokkaido and the Pacific side in the Kanto area. Expected arrival times were issued for each location. A tsunami wave was observed in Nemuro Hanasaki-harbor at 10:58 p.m. that measured 1.73 m in height. In Kushiro harbor the wave measured 0.82 m. The tsunami alarm and warning were lifted at 5:55 a.m. on October 5.

The information in this report was contributed by Shunsuke Otani (EERI, 1973), of the University of Tokyo. The publication and distribution of this report was funded by National Science Foundation Grant #BCS-9215158.

Learning From Earthquakes

Magnitude 7.0 Earthquake Hits the Philippines November 15, 1994

At 3:15 a.m. Philippine Local Time on November 15, 1994, a magnitude 7.0 (M_s) earthquake struck approximately 125 km south of Manila. The quake occurred on the Lubang Submarine Fault in the Verde Island Passage, which separates the islands of Luzon and Mindoro. The location of the epicenter was calculated as 13.5° N latitude, 121.1° E longitude, with a focal depth of about 7 km. The following intensities (Rossi-Forel) were reported: Mindoro - 7, Manila - 4, Quezon City - 3. Two strong aftershocks were felt in Manila shortly after the main event. A magnitude 5.1 event, also associated with the Lubang Fault, occured at 2:30 p.m. local time on the day of the quake. (Data generated by Philippine Institute of Volcanology and Seismology, aka Philvolcs.)

Most of the damage and casualties were concentrated on the lightly developed island of Mindoro. The island population is approximately 1 million, and the built environment consists mainly of agricultural and fishing villages, coconut plantations, and some scattered coastal tourist resorts.

Tsunami waves up to 1.5 m high were reported along the north coast of Mindoro, primarily in the area of Calapan, capital city of Oriental Mindoro Province. Approximately 74 deaths had been reported as of November 17, most of them children swept away from houses in fishing villages along the coast. Many homes were destroyed by the tsunamis. Damage to structures has also been reported in the area of Puerto Galera, a major tourist area on the northern Mindoro coast.

Eighteen bridges were damaged or destroyed, and extensive road damage due to liquefaction and lateral spreading occurred. The main pier at Calapan Harbor was heavily damaged, limiting ferry access to the area. The power barge which supplies electrical power for much of Mindoro was dislodged from its moorings; it ran aground 2 km from its original site. This resulted in extensive power outages throughout Mindoro. Damage to government infrastructure is reported to be restricted to the island of Mindoro and is estimated to total $4 million.

As of November 16, Philvolcs had monitored 980 aftershocks. They expect that aftershocks will continue to be felt in Manila for about 1-2 weeks. Philvolcs has also voiced a concern that Taal Volcano, approximately 70 km north of Mindoro and currently showing signs of abnormal activity, may become more unstable as a result of the recent seismic activity along the Lubang fault.

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