

# StEER: Structural Extreme Event Reconnaissance Network & Earthquake Engineering Research Institute (EERI)

## ALASKA EARTHQUAKE PRELIMINARY VIRTUAL ASSESSMENT TEAM (P-VAT) JOINT REPORT



Earthquake damage on Vine Road, near Wasilla, Alaska, on Nov. 30, 2018.  
(Source: Time Magazine, Image Credit: Marc Lester - *Anchorage Daily News/AP*)

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# Executive Summary

On November 30, 2018, a magnitude 7.0 earthquake occurred near the City of Anchorage, Alaska. The main event was followed by a large number of aftershocks. Though warnings were issued, the earthquake did not trigger an actual tsunami. While there were notable geotechnical failures, such as the major damage to Glenn Highway, Seward Highway and other roadways in the Anchorage area, preliminary observations suggest that this M 7.0 produced less than expected damage to buildings like businesses, homes, and schools near the epicenter, with the majority of damage limited to non-structural elements and contents. While this still causes disruption to commerce, education and family life, the absence of major structural damages is indicative of successes in promoting sound structural and geotechnical engineering designs. Some hospitals experienced temporary disruptions, but maintained emergency services. Utilities were largely restored services within 24 hours of the event. Widespread ruptured water and natural gas lines/mains constituted the majority of utility infrastructure impacts. Overall, the level of damage in Eagle River was relatively higher compared to the City of Anchorage, with minimal damage reported in the communities on the Kenai Peninsula.

For the community of earthquake engineering researchers and practitioners, the wealth of multidisciplinary reconnaissance information available right after the event provides an important opportunity to learn from this major domestic earthquake, both technically and also from a policy and decision making perspective. As such, this report gathers this wealth of publicly-available information, by (i) overviewing the hazard characteristics event, (ii) summarizing the preliminary reports of damage to wide-ranging of infrastructure, (iii) presenting data from instrumented structures, (iv) enhancing situational awareness to guide subsequent reconnaissance missions, and (v) fostering collaboration and knowledge exchange between StEER and EERI. This **Preliminary Virtual Assessment Team (P-VAT) Report**, jointly released with EERI and inclusive of its Virtual Earthquake Reconnaissance Team briefing, represents the first product of StEER's larger coordinated response to this event, informing and supporting other research teams seeking to learn from this disaster.

# Introduction

On November 30, 2018, a magnitude 7.0 earthquake occurred near the City of Anchorage, Alaska. The main event was followed by a large number of aftershocks. Though warnings were issued, the earthquake did not trigger an actual tsunami. For the community of earthquake engineering researchers and practitioners, the wealth of multidisciplinary reconnaissance information available right after the event provides an important opportunity to learn from this major domestic earthquake, both technically and also from a policy and decision making perspective. In particular, there are several instrumented structures in the affected area that can serve as testbeds for damage correlation to recorded data -- instrumental for successful structural health monitoring and for future expansions of strong motion programs monitoring building response.

Although there were notable geotechnical failures, particularly those affecting transportation systems, preliminary observations suggest that this M 7.0 produced less than expected damage to buildings, with the majority of damage limited to non-structural elements and contents. While this still causes business disruption and monetary losses, the absence of major structural damages is indicative of successes in promoting sound structural and geotechnical engineering designs. The causes of this “better than expected” performance is important to highlight and carefully understand as lessons of the value of mitigation that can be replicated elsewhere. As such, enacted codes and provisions should be examined carefully in the context of the observed and documented structural, particularly building, performance. Future efforts should focus on critical evaluation of issues related to the ground motion characteristics, depth, directivity, and the soil profile in the region.

StEER further hopes to use this event to exercise the protocols, procedures, policies and workflows that StEER will be developing over the next two years in collaboration with the wider hazards community including the Natural Hazards Engineering Research Infrastructure (NHRI) and other members of the Extreme Events Reconnaissance Consortium. Of particular importance is the collaboration in this event with the Earthquake Engineering Research Institute (EERI), who are included as joint publishers of this report.

The first product of the StEER response to the 2018 Alaska Earthquake is this **Preliminary Virtual Assessment Team (P-VAT) report**, which is intended to:

1. Overview of the hazard characteristics
2. Summarize preliminary reports of damage to wide-ranging of infrastructure
3. Explore select case studies for instrumented structures to conduct rapid damage assessment
4. Enhance situational awareness to guide subsequent missions conducted by StEER and the engineering reconnaissance community, particularly EERI Learning from Earthquakes (LFE)
5. Integrate knowledge through collaborations between StEER and EERI, particularly through the coupling of the EERI Virtual Earthquake Reconnaissance Teams (VERTs) and StEER’s Virtual Assessment Teams (VATs)
6. Overview StEER’s event strategy in response to this earthquake

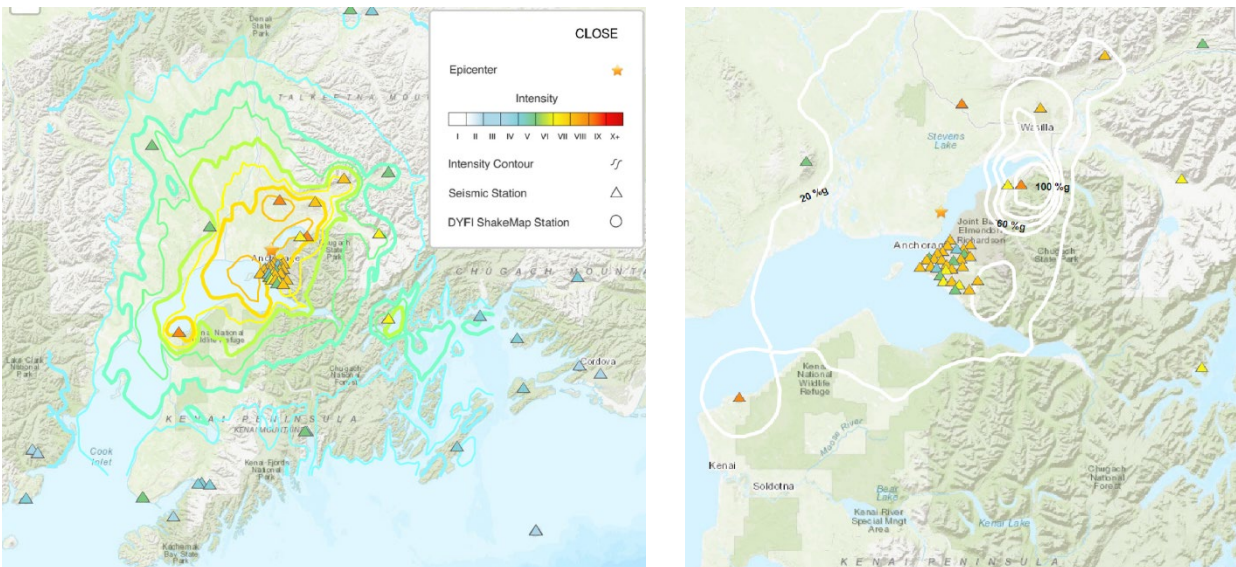
Specifically regarding the collaboration with the EERI Virtual Earthquake Reconnaissance Team (VERT), the StEER VAT, which authored this report, worked independently of the EERI VERT to gather data from public sources. The VERT product, a slide deck, is used to brief the Learning From Earthquakes (LFE) Executive Committee and is generally released before the more traditional narrative-style P-VAT Report. As such, the VERT briefing is included as Appendix B of this P-VAT report and cross referenced throughout using call out boxes so that readers may benefit from the knowledge collected by both organizations. StEER and EERI hope to further formalize these collaborative products for future events.



It should be emphasized that all results herein are preliminary and based on the rapid assessment of publicly available online data within 5 days of the event. Damage assessments discussed herein are based largely on the judgment of the authors without access to additional aerial imagery and ground-truthing.

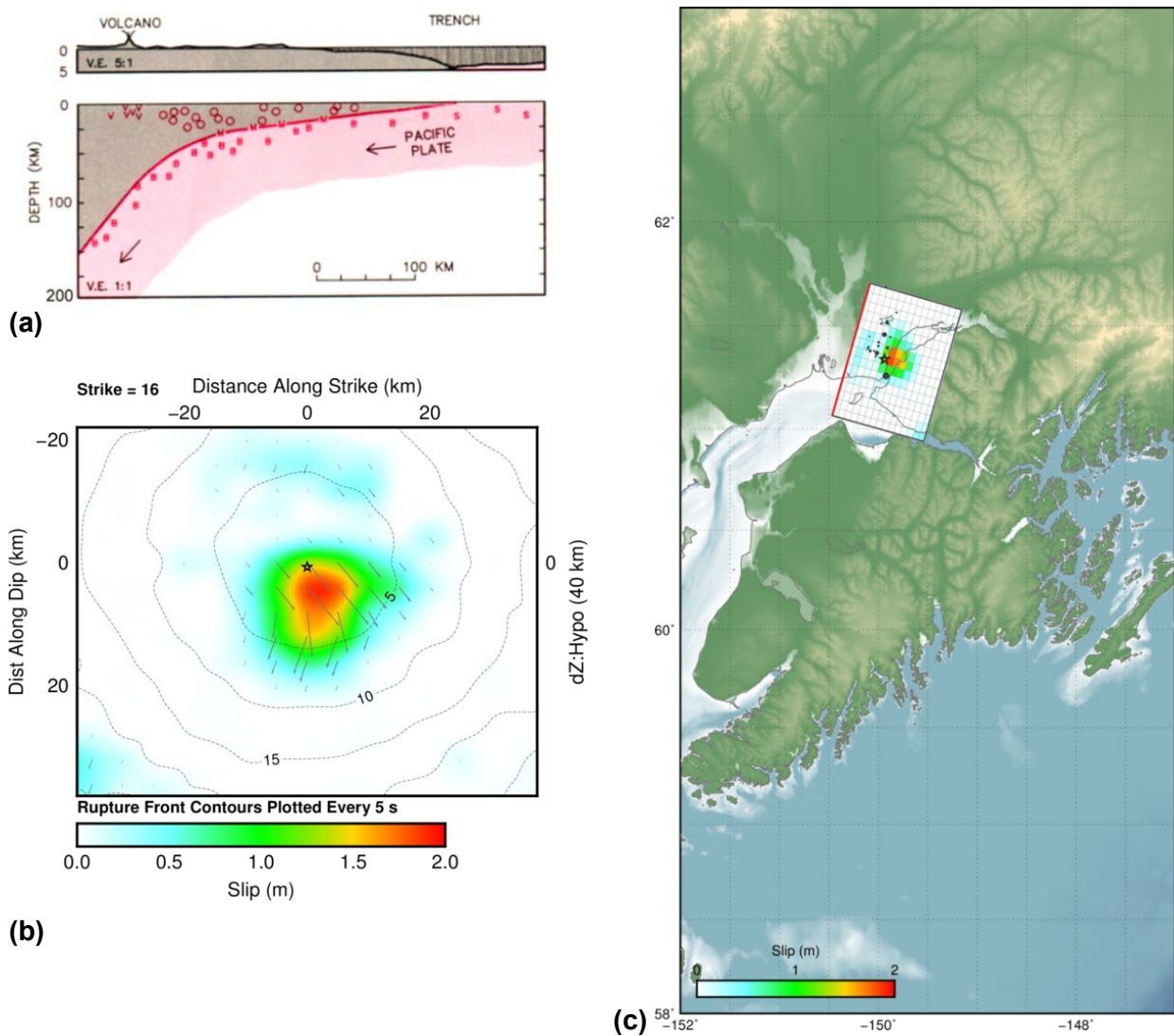
## Earthquake Details and Tectonic Summary

On November 30, 2018, at 17:29:28 UTC (8:29:29 local time), a magnitude (M) 7.0 earthquake occurred 12 km north of the City of Anchorage, Alaska. The hypocenter of the earthquake was located at 61.323°N, 149.923°W at a depth of 44.1 km (USGS, 2018). Figure 1 shows intensity and PGA maps produced by the U.S. Geological Survey. This was followed by a large number of aftershocks (as of December 1, 2018, 17:24 UTC): the largest being of M 5.7 about 3 miles (4.8 km) north of Anchorage; about 17 aftershocks of M 4.5 or greater; nine of which were greater than M 5. Although there was an initial tsunami warning, the earthquake did not trigger an actual tsunami, according to the National Weather Service.



**Figure 1:** USGS ShakeMap products for the 2018 M 7.0 Anchorage earthquake (USGS, 2018).

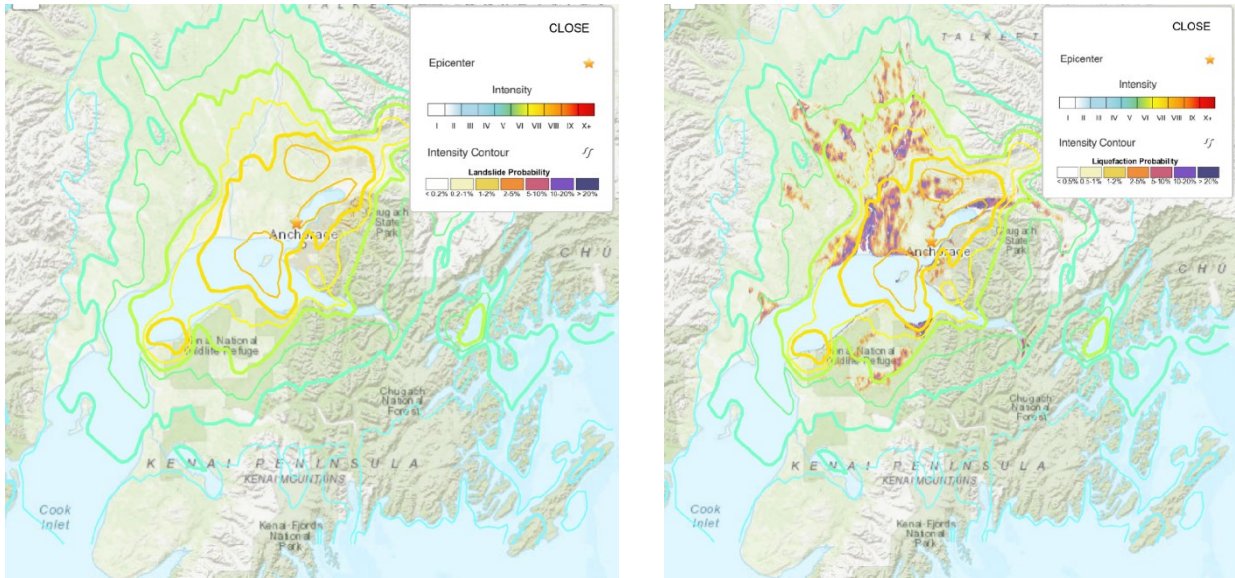
Alaska is located at a convergent tectonic plate boundary where the Pacific Plate is subducting beneath the North American Plate at an average rate of 57 mm/year near Anchorage. This plate interaction makes Alaska one of the most seismically active regions in the world. Seismicity in southern Alaska is associated with five distinct classes of earthquakes (Fig. 2a), each with different characteristics and design implications for civil engineering infrastructure: (a) main thrust-zone earthquakes along the interface between the subducting oceanic plate and the overriding continental plate (interface earthquakes) [Labeled M]; (b) subsea earthquakes within the oceanic plate beneath or seaward of the trench [Labeled S]; (c) Wadati-Benioff zone earthquakes within the subducted part of the oceanic plate landward of the trench (intraslab earthquakes) [Labeled B]; (d) overriding plate earthquakes in the overriding continental plate exclusive of those along the volcanic axis (crustal earthquakes) [Labeled O]; and (e) volcanic axis earthquakes in the overriding continental plate along the volcanic axis (volcanic earthquakes) [Labeled V] (Page et al., 1991).



**Figure 2:** (a) Schematic cross section showing earthquake classification in southern Alaska. Upper profile shows topography and bathymetry with 5:1 vertical exaggeration. Lower graph shows distribution of five distinct classes of earthquakes: main thrust zone (M), subsea (S), Wadati-Benioff zone (B), overriding plate (O), and volcanic axis (V) (Page et al., 1991). Accompanied by preliminary finite-fault model of the 2018 M 7.0 Anchorage earthquake (USGS, 2018); (b) slip distribution on fault plane, and (c) surface projection of slip distribution.

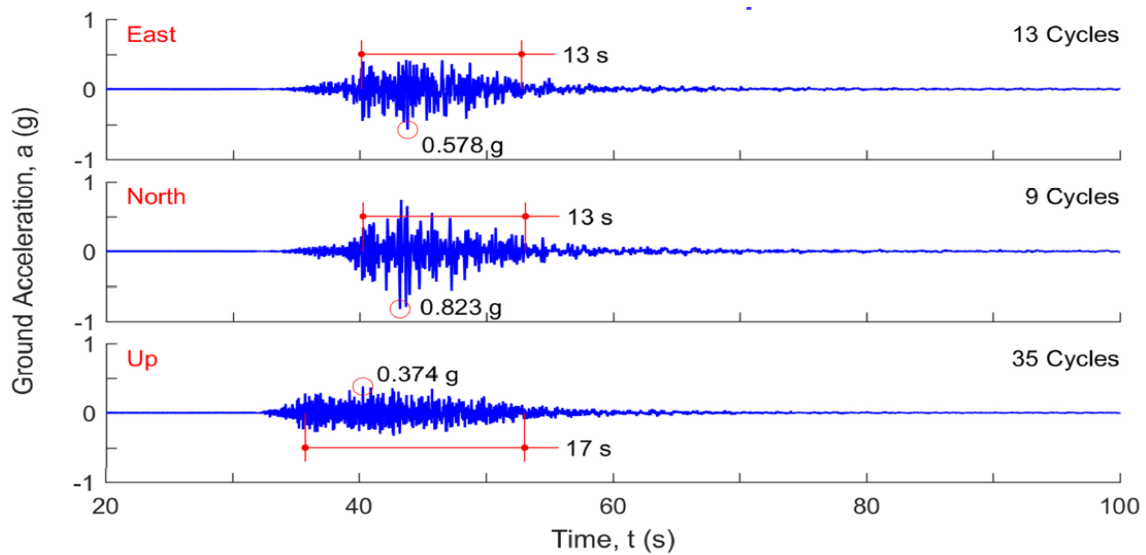
The focal mechanism solutions of the event indicate that slip occurred on a fault striking approximately in the north-south direction and dipping either to the east at about 30 degrees or to the west at about 60 degrees. The location and mechanism of the earthquake indicate that rupture occurred on an intraslab fault within the subducting Pacific Plate, rather than on the shallower thrust-faulting interface between the Pacific and North American plates (USGS, 2018). By analyzing 64 teleseismic broadband P waveforms, 12 broadband SH waveforms, and 81 long-period surface waves selected based on data quality and azimuthal distribution and by using a finite-fault inversion algorithm, USGS proposed a preliminary fault model of the earthquake with

strike = 16 degrees, dip = 29 degrees, and maximum slip of about 2 m (Figs. 2b and 2c; USGS, 2018). While the landslides triggered by the earthquake are estimated to be limited in number and/or spatial extent, liquefaction is estimated to be significant in severity and/or spatial extent (Fig. 3).



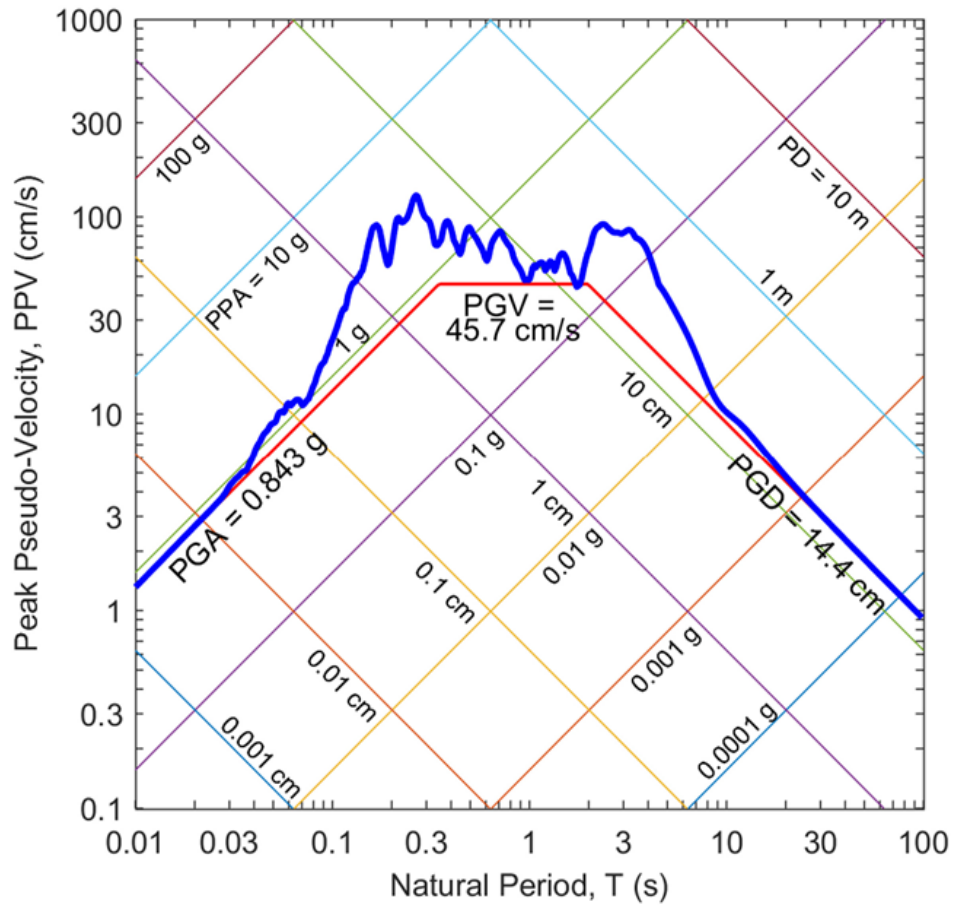
**Figure 3:** Preliminary landslide and liquefaction probability maps for the 2018 M 7.0 Anchorage earthquake (USGS, 2018).

The recorded ground accelerations reached 0.823g (Fig. 4) with corresponding response spectrum of horizontal ground motion (5% damping) shown in Figure 5 at station 8047 located 18 km from the epicenter (Fig. 6).

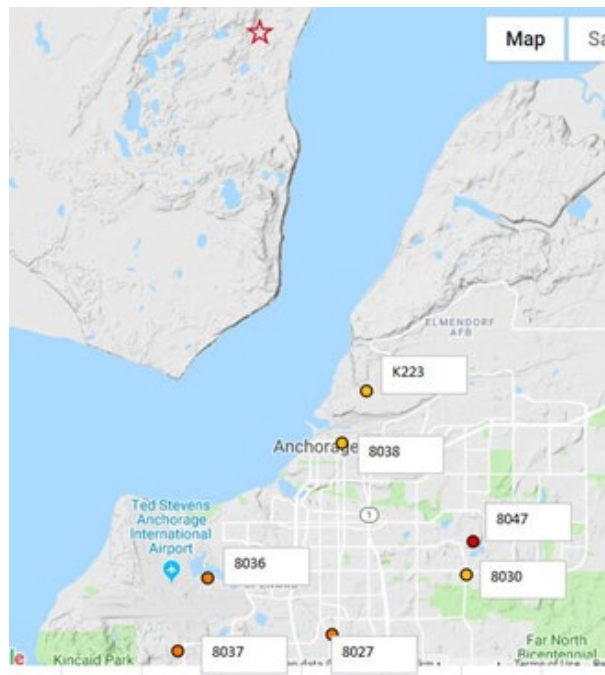


**Figure 4:** Recorded ground motion at station 8047 of the Anchorage earthquake (Malhorta, 2018).





**Figure 5:** Response spectrum of horizontal ground motion at station 8047 (5% damping) (Malhorta, 2018).



**Figure 6:** Location of the 8047 strong-motion station in Anchorage, Alaska (Lu, 2018).



See [Appendix B: EERI VERT Briefing](#) for more information on:

- **Earthquake Characteristics (Topic #1)**
- **Tsunami Warning (Topic #2)**
- **Aftershocks (Topic #3)**

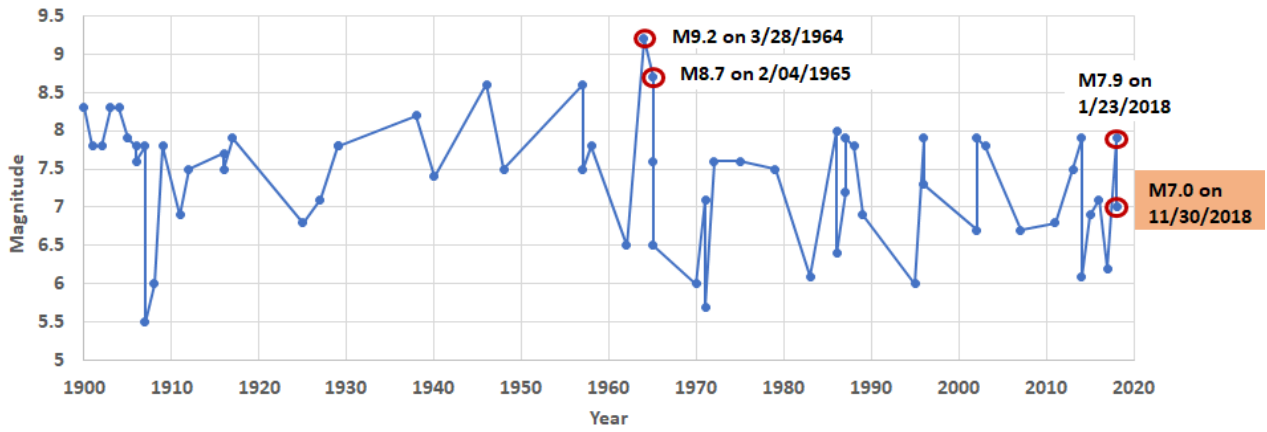
## Historical Context

Figure 7a lists the Alaskan earthquake events in the 20th and 21st centuries in terms of magnitude (mostly Moment Magnitude, M); those with values 5.5 or greater are detailed in Figure 7b. Over the past century, 14 other M6+ earthquakes have occurred within 150 km of the November 30, 2018 event<sup>1</sup>. Two of these are M 6.6 earthquake in July 1983 and M 6.4 event in Sept. 1983. Most notable is the M9.2 great Alaska earthquake of March 1964, causing significant damage (Fig. 8).

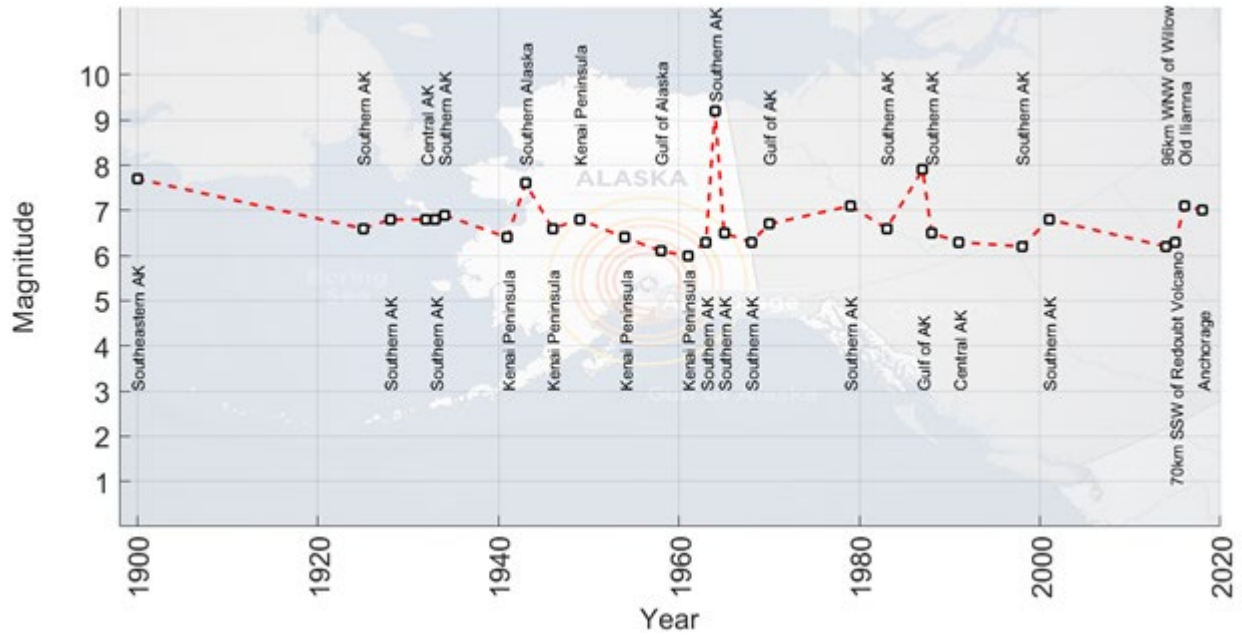
The description of the different photographs in Figure 8 are listed below where the image name is also shown according to the NISEE image database.

- a) RO011- Alaskan Hotel. Copyrighted to National Geographic.
- b) RO012 - Alaska Native Hospital with good view of ground failure.
- c) RO024 - Structural failure due to ground movement (Anchorage, Alaska).
- d) S2022 - House in Turnagain slide area (Note soils) (Anchorage, Alaska).
- e) S2292 - Government hill school, looking north, damage is due to landslide (Anchorage, Alaska).
- f) S2663 - Tsunami damage (Seward, Alaska).
- g) S2424 - Looking north along "C" Street in Fourth Avenue slide area (Anchorage, Alaska).
- h) S2437 - 4th Ave. and "B" St. in slide area, Northeast corner, looking north (Anchorage, Alaska).
- i) S2443 - 4th Avenue and "C" Street in slide area, looking west (Anchorage, Alaska).
- j) S2333 - Northwest corner of Hillside Manor building (Anchorage, Alaska).
- k) S3261 - Cracked highway (Portage, Alaska).
- l) S2293 - Government hill school, looking north, damage is due to landslide (Anchorage, Alaska).
- m) S2592 - Tsunami damage (Seward, Alaska).

<sup>1</sup> <https://earthquake.usgs.gov/earthquakes/eventpage/ak20419010/executive>



(a)



(b)

**Figure 7:** Timeline of major earthquakes in Alaska in the 20th and 21st centuries (Primary data sources: (a) <https://www.ngdc.noaa.gov/>, (b) <https://earthquake.usgs.gov/earthquakes/search/>)





(a)



(b)



(c)



(d)



(e)



(f)



(g)



(h)



(i)



(j)



(k)



(l)



(m)

**Figure 8:** Damage photographs from M9.2 great Alaska earthquake of March 1964 (Source: NISEE Library, PEER, <https://nisee.berkeley.edu/elibrary/>).

# Local Codes & Construction Practices

According to a statement made by Dr. William Leith from U.S. Geological Survey on April 14, 2011, the 1964 Alaska earthquake had some lasting effects on national earthquake safety policies, by illustrating the societal disruption that can be caused by a major earthquake, particularly in an urban setting, and thus highlighting the complexity of earthquake effects that needed to be addressed in any national mitigation policy. Furthermore, it highlighted the importance of considering earthquake effects in urban planning<sup>2</sup>.

In terms of policy changes, the great 1964 earthquake laid the groundwork that would result later the creation of the National Earthquake Hazards Reduction Program (NEHRP) in 1977. Moreover, as reported by the *Anchorage Daily News*: “Alaskans got serious about seismic hazards. Scientists, planners, government officials and business investors spent years amassing data and rules aimed at ensuring that people and structures would be safe from future quakes. They mapped out vulnerable spots in earthquake-prone parts of Alaska. They beefed up tsunami warning systems, practiced and drilled for future tsunamis and mapped out evacuation zones. They insisted on earthquake-safe building standards.”<sup>3</sup> As a result of implementing such measures, Alaska adopted stricter building codes that have made it one of the leading US states in terms of earthquake safety.

According to the official website of the Municipality of Anchorage, at the time of the November 30, 2018 earthquake, the 2012 International Building Code (IBC) was adopted at the state-level as the latest building standards, by the authority of the Alaska State Fire Marshal<sup>4</sup>. The Alaska local building code is updated regularly following every IBC code cycle, though it missed the 2015 version due to logistical and timing issues. In addition, the local building code amends the IBC with Alaska-specific requirements, such as permafrost and frozen ground construction and design provisions.

The level of code enforcement varies widely between the City of Anchorage, with stricter enforcement, and the smaller cities and towns in the Anchorage Borough, such as Eagle River, Peters Creek, Chugiak and Girdwood, in which code conformance is not necessarily enforced or monitored, especially for residential construction. USGS further reports that the population, overall, in this region resides in structures that are resistant to earthquake shaking, though vulnerable structures exist, specifically brick masonry and reinforced masonry construction<sup>5</sup>. Such variations in code conformance might explain the widespread non-structural and minor structural damage reported in Eagle River in contrast with the lesser non-structural damage and rare structural damage in the City of Anchorage.



See [Appendix B: EERI VERT Briefing](#) for more information on construction and regulatory context -- Other Buildings Damage (Topic #9)

<sup>2</sup> [http://oversight.house.gov/wp-content/uploads/2012/02/4-14-2011\\_Leith\\_Tsunami\\_Testimony.pdf](http://oversight.house.gov/wp-content/uploads/2012/02/4-14-2011_Leith_Tsunami_Testimony.pdf)

<sup>3</sup> <https://www.adn.com/alaska-news/article/aftermath-giant-quake-anchorage-allowed-rebuilding-slide-prone-turnagain-area/2014/03/25/>

<sup>4</sup> <https://www.muni.org/Departments/OCPD/development/BSO/Pages/Codes.aspx>

<sup>5</sup>

<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/pager?fbclid=IwAR1L7oZ6cy8xsuGaFXdXOE6QEfBJINc20gOwnpiixFDgivkA34Sz5%E2%80%A6>

# Federal, State and Local Response

Federal, state and municipal (City of Anchorage, Matanuska-Susitna Borough, and Kenai Peninsula Borough) responses to this event are summarized herein.

## Federal Response

President Trump issued a Federal Emergency Declaration to assist local, state, and non-government response and recovery efforts at Governor Walker's request. Nearly 150 FEMA employees have mobilized to support Alaska earthquake response and recovery efforts. FEMA remains in motion as of December 4, 2018, with FEMA Region 10 providing the state with technical assistance for collecting initial damage assessments to ensure support for future recovery activities. The agency was soliciting information on building code conformance, as federal support will likely be conditioned that 2018 building code is strictly followed for retrofit/reconstruction.<sup>6</sup>

## State Response

- Alaska Governor Walker issued a verbal disaster declaration on December 1, 2018 and announced all state offices in Southcentral Alaska would be closed on Monday, December 3, 2018 due to extensive damage on the Glenn Highway. Commissioner John Quick similarly announced that all state offices in Anchorage, Eagle River, Wasilla, and Palmer will remain closed for business on Tuesday, December 4.
- The State of Alaska activated the State Emergency Operations Center to support local government response.
- The Alaska Department of Transportation & Public Facilities (DOT&PF) similarly released a strategy to respond to the damage to transportation infrastructure and assist with safety and movement of people, goods, and services. Alaska Department of Transportation deployed several teams to inspect highways and bridges to expedite repairs. DOT&PF continues to release regular situation updates on its website.
- The State Emergency Operations Center (SEOC) activated with the SEOC preparedness level of 3 (full activation), which indicates that the SEOC is staffed and responding to the earthquake.

## Local Response

The Municipality of Anchorage (MOA), Matanuska-Susitna Borough, and Kenai Peninsula Borough respectively activated their emergency operations centers (EOC) to coordinate response activities. MOA deployed building inspection teams (non-engineers) to assess state and public building conditions. The Alaska Department of Transportation (AKDOT) has deployed several assessment teams to inspect about 245 structures throughout the region. The inspection is to be concluded Dec 7th. Repairs have already started on many of the damaged portions of the highways and bridges and are to continue for the short and long terms.



See [Appendix B: EERI VERT Briefing](#) for more information on Emergency Response (Topic #5)

<sup>6</sup> <https://www.drj.com/industry/industry-press-releases/fema-remains-in-motion-to-support-alaska-earthquake-response.html>

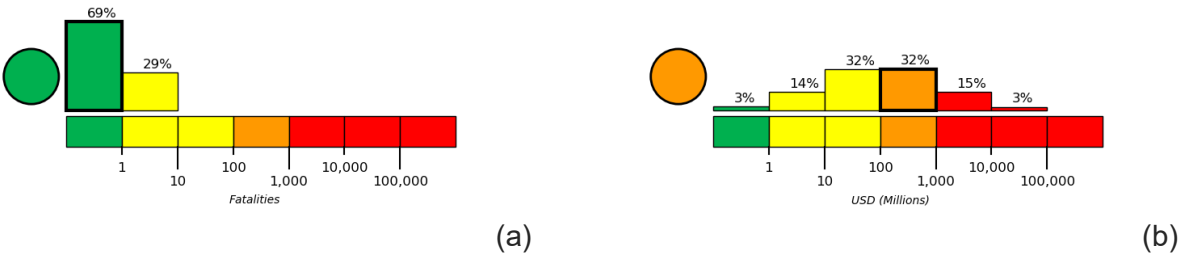


# Impacts

## Loss of Life and Injuries

The probability of shaking-related fatalities in this event was projected as low (Fig. 9a), as most people in the region live in earthquake resistant structures, according to the USGS. Economic losses were projected to be significant (Fig. 9b) but less than 1% US GDP, with damage likely and potentially widespread impacts. Past events with this alert level have required a regional or national-level response.

Consistent with the projections in Figure 9a, there were no reports of earthquake-related deaths in Anchorage. A number of earthquake-related injuries, at least one serious, were reported in Anchorage and Matanuska-Susitna (Mat-Su) Borough due to fire, broken glass and fallen shelves. One Houston resident received serious injuries when a fire started in his ammunition room, while another was treated for a broken arm from a falling shelf. Hospitals in Anchorage and Mat-Su reported other minor injuries such as lacerations from broken glass.



**Figure 9:** Estimated probability of (a) fatalities and (b) economic losses in November 30, 2018 Anchorage Earthquake (USGS, 2018)

## Buildings

At the time of this P-VAT’s publication, no major residential or commercial structural damage had been reported by news outlets or government agencies. Furthermore, no large-scale building collapse had been reported. This doesn’t mean that structural damage to residential or commercial construction didn’t occur. In fact for the level of shaking experienced on November 30th “there are thousands of homes and businesses and buildings that were damaged in some fashion, be it a deck that slid downhill, a cracked foundation, a gas line disconnected from the house,” according to Mike West an Alaska state seismologist.<sup>7</sup> Some structural damage was reported in the City of Eagle River north to Anchorage, where building codes are not strictly enforced.

Non-structural and contents damage, on the other hand, has been widely reported in homes, public buildings, hospitals and businesses across the City of Anchorage (Fig. 10). Moreover, damage to single family residences, particularly foundations, has been reported by experts conducting preliminary observations in the field.

<sup>7</sup> <https://www.foxnews.com/us/alaska-hit-by-dozens-of-small-earthquakes-in-wake-of-fridays-major-temblor>



**Figure 10:** Aisoli Lealasola prepares to clean up fallen cases of beer in a cooler at Value Liquor in Anchorage, Alaska. (Source: AP Photo/Dan Joling<sup>8</sup>)

## Critical Facilities

Typical critical facilities include hospitals, fire stations, police stations and critical records archives. Two of Anchorage's main hospitals, Alaska Regional Medical Center and Providence Alaska Medical Center, reported multiple water leaks, though emergency rooms remained open. One emergency room was closed briefly to repair a water leak and resumed operation swiftly. Alaska Regional Hospital experienced major water flooding that affected large segments of floors and ceilings due to sprinkler system failure that led to almost shutting down two outpatient clinic buildings. These two buildings have partially resumed operation with an estimated 20-30% capacity. One of the three major hospitals in the city of Anchorage experienced some minor structural shear damage cracks in the concrete core walls in one of its pre-1970 buildings. The Providence Alaska Medical Center Hospitals in Anchorage canceled elective surgeries and kept only emergency rooms open. The Mat-Su Regional Medical Center remained open.



See [Appendix B: EERI VERT Briefing](#) for more information on Hospitals (Topic #6)

<sup>8</sup> <https://abc7chicago.com/alaska-earthquakes-crack-anchorage-roads-cause-fires-damage/4798756/>

## Commercial Construction

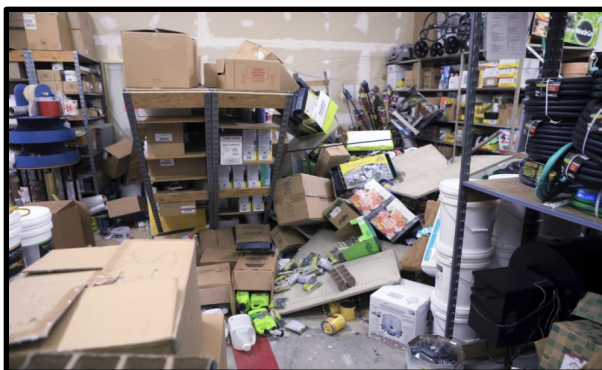
Widespread non-structural damage was reported in commercial construction. KTVA office, shown in Figure 11, was reported to have window pane, ceiling, and office equipment damage. Window damage, equipment and inventory damage were also reported in stores and local businesses (Fig. 12). Many stores had to suspend operations to deal with clean up and assessment, after shelves of merchandise toppled to the ground. Most of the grocery stores resumed business in Anchorage on Saturday, December 1, 2018; however, stores at Eagle River and Wasilla remained closed on Saturday. The US Federal Building and courthouse located on the Seventh Avenue in downtown Anchorage suffered boiler damage. The building was later found to be structurally sound, but federal officials closed it December 4 for ongoing clean up. Significant cracks were also observed in Anchorage Grand Hotel (Fig. 13).



See [Appendix B: EERI VERT Briefing](#) for more information on Other Buildings Damage (Topic #9)



**Figure 11:** Window and ceiling damage at the CNN affiliate KTVA's offices<sup>9</sup>



**Figure 12:** Inventory and window damage at stores following the earthquake<sup>10</sup>

<sup>9</sup> <https://www.cnn.com/2018/11/30/us/alaska-earthquake/index.html>

<sup>10</sup> <https://www.yahoo.com/news/aftershocks-shake-alaska-back-back-earthquakes-215518233.html>





**Figure 13:** Major cracks observed in Anchorage Grand Hotel, Downtown Anchorage, Alaska<sup>11</sup>

### Instrumented Buildings

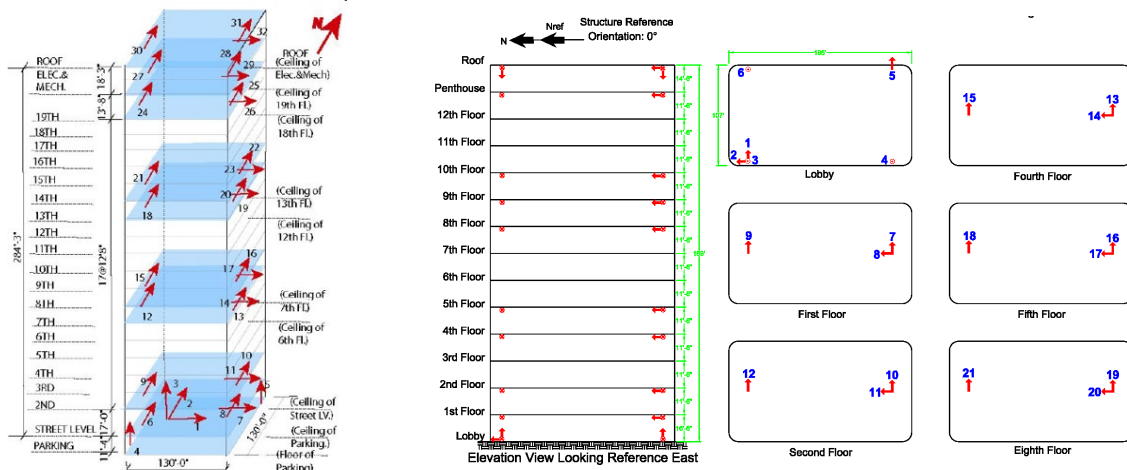
USGS has instrumented a number of buildings in the affected region, including the Atwood Building (Delaney Park Geotech Array next to Atwood Bldg.), the Frontier Building (which suffered minor cosmetic damages), the BP Building, the Hilton (downtown) and the Veterans Affairs (VA) hospital.

#### **Atwood Building**

The Robert Atwood Government Building is one of the first buildings in Anchorage to be fully instrumented under the Advanced National Seismic System (ANSS) (Çelebi, 2006). The 20-story

<sup>11</sup> <http://www.learningfromearthquakes.org/2018-11-30-anchorage-alaska/photo-gallery>

steel moment frame/steel shear wall building (constructed in 1982) is located in downtown Anchorage. The monitoring system comprises a 32-channel structural array and a 21-channel site array. Figure 14a shows the 32-channel structural array that is deployed in the building. Sensors are deployed on 10 levels of the building, equipped at each level to detect motion in the east-west (HNE) and north-south (HNN) directions; vertical direction of motion is monitored in the basement. North-south components are measured in the west side as well as the east side of the building, whereas east-west components are measured in the east side only.

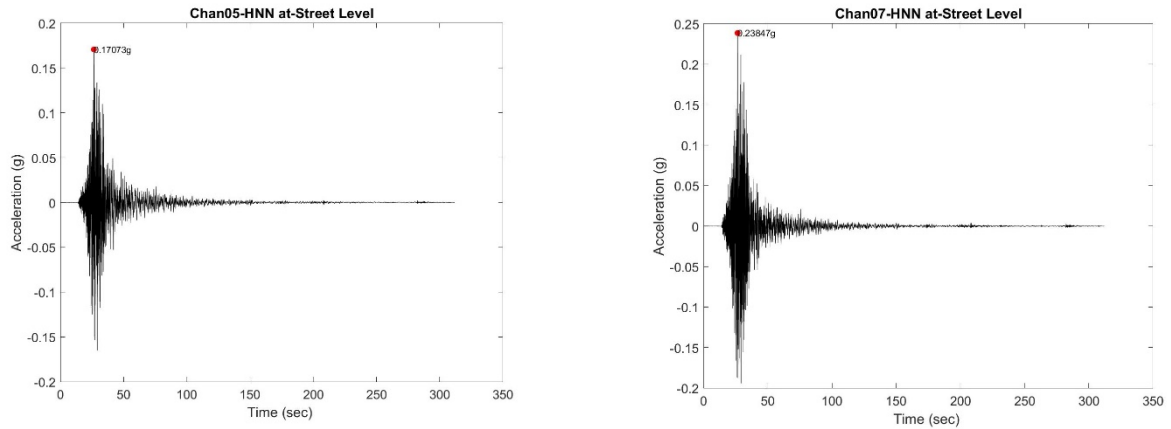


**Figure 14:** Sensor locations for (a) Atwood Building (Courtesy: Utpal Dutta, UAA) and (b) Frontier Building (Courtesy: USGS/NSMP)

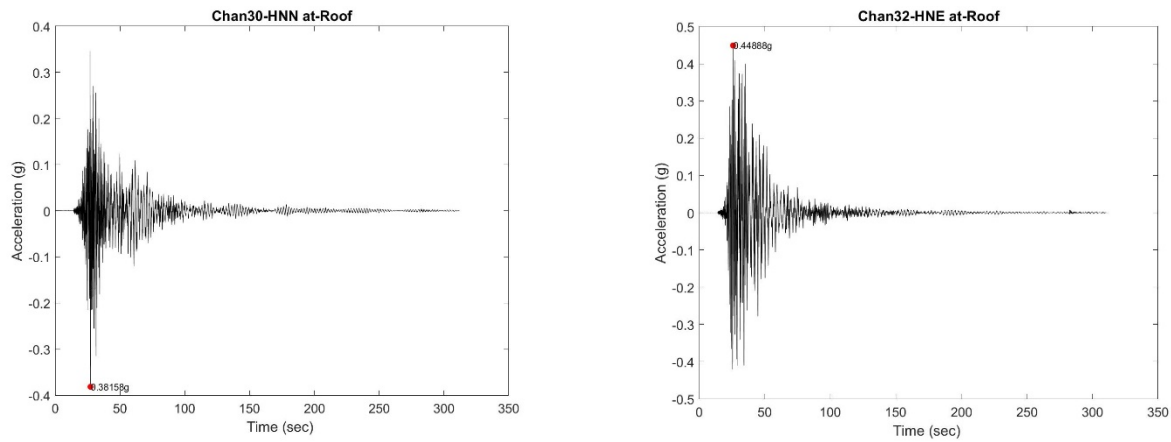
This monitoring system recorded the accelerations of the structure during the November 30, 2018 earthquake at 0.005 sec intervals for 312 seconds. Table 1 lists the peak accelerations for HNN and HNE components on the west and east sides of the instrumented floors. Note the peak ground acceleration (PGA) is 0.23g on the east side and 0.17g on the west side. The peak floor acceleration (PFA) values gradually increase with height; however, the 13th, 14th and 19th floor PFAs are lower than the 8th floor PFA. An unusual rise of 0.1 g peak value is observed in the Electrical & Mechanical (EM) floor HNE component. Peak accelerations at the roof were 0.38 g, 0.41 g, and 0.44 g. Figure 15 shows the acceleration time series of the structure at the street level and at the roof level with peak values marked by red dots.

**Table 1:** Peak acceleration at different floors in the Atwood building

Floor	HNN-West	HNN-East	HNE-East
Street Level	0.17g	0.23g	0.22g
2nd	0.17g	0.26g	0.26g
7th	0.22g	0.28g	0.31g
8th	0.22g	0.28g	0.33g
13th	0.18g	0.18g	0.25g
14th	0.17g	0.18g	0.23g
19th	0.19g	0.17g	0.23g
EM	0.22g	-	0.33g
Roof	0.38g	0.41g	0.44g



(a)



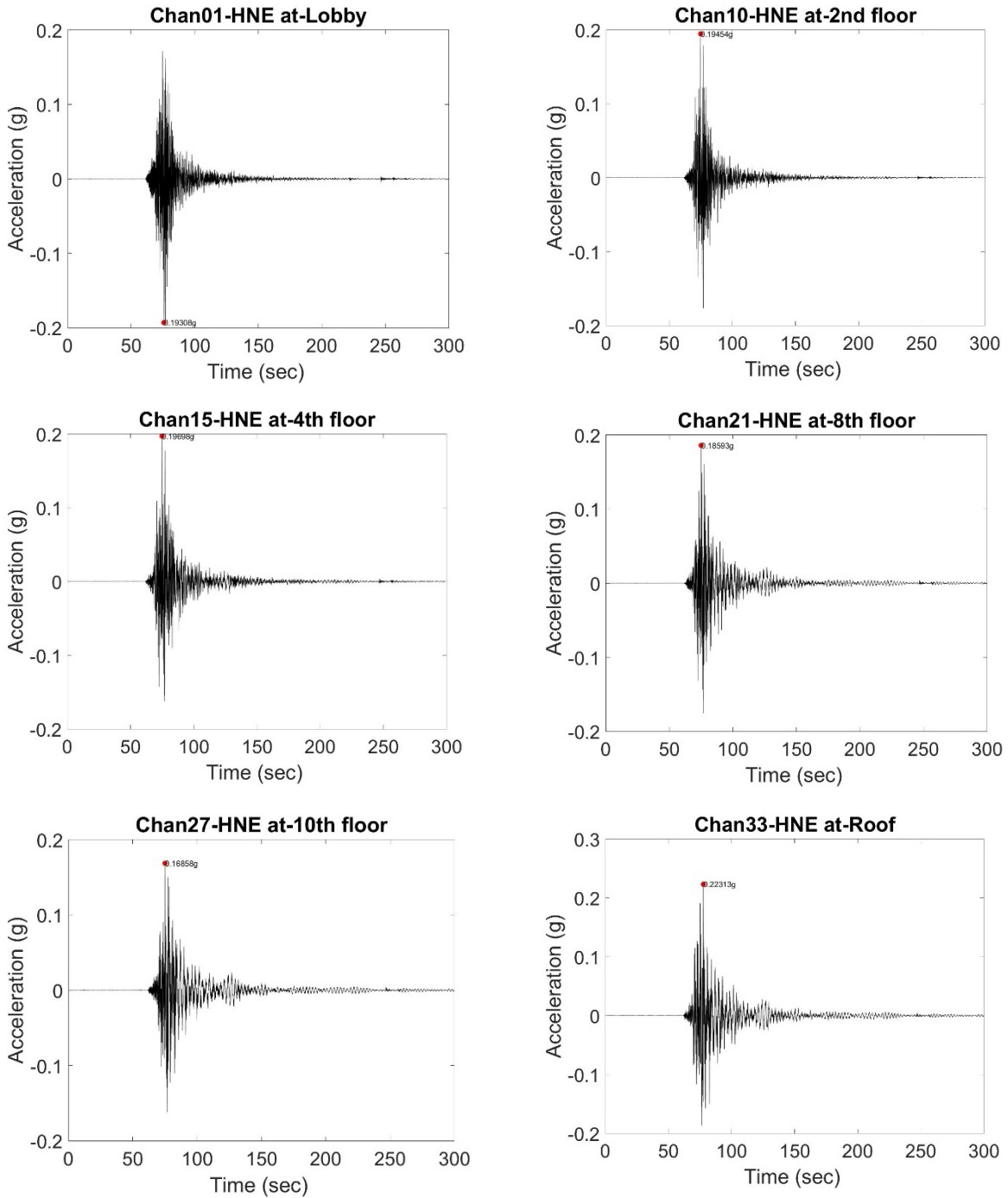
(b)

**Figure 15:** Atwood building recorded acceleration time histories at (a) street level and (b) roof level.

### Frontier Building

The Frontier building in Anchorage was also instrumented by USGS. Acceleration response of this 14-story building was recorded and made available through Center for Engineering Strong Motion Data (CESMD)<sup>12</sup>. Sensors are deployed on 9 levels of the building, equipped at each level to detect motion in the east-west (HNE) and north-south (HNN) directions; vertical direction of motion is monitored at the lobby and roof (Fig. 14b). The monitoring system is comprised of a 36-channel structural array. Figure 16 shows the acceleration time series in the east-west direction at different floors of the building. The PGA for this building was 0.193g. The peak structural acceleration of 0.223g was recorded at the roof. The building experienced vertical acceleration of 0.11g at the ground level, which amplified to 0.18g at the roof level.

<sup>12</sup> <https://strongmotioncenter.org/cgi-bin/CESMD/stationhtml.pl?stationID=NP8042&network=NSMP>



**Figure 16:** Frontier building recorded acceleration time histories at different floors.



## Residential Construction

The damage to residential construction includes siding wall collapse, external wall cracks, structural fire, and damage to contents. Some smaller structures were reported to have collapsed but no more details were provided. For example, a residence in Eagle River lost its brick veneer (Fig. 17), while interior content losses were caused by toppled bookcases. A claw-foot tub shifted several feet in this home. These and other common contents damages like dislodged light fixtures and shattered housewares were widely reported in residences across the area. Another house in Eagle River, partially built on fill, lost one wing of the home due to a geotechnical failure (Fig. 18). A possible soft-story failure was also observed in a residence in Eagle River (Fig. 19). Four structural fires were reported in Anchorage: one in South Anchorage (Fig. 20a) and one at the Jubilee Christian Center at 13th and Karluk (Fig. 20b).



See [Appendix B: EERI VERT Briefing](#) for more information on Housing (Topic #11)



**Figure 17:** Brick veneer damage at residence in Eagle River<sup>13</sup>

<sup>13</sup> <https://www.adn.com/alaska-news/2018/12/02/the-day-after-alaskans-sweep-up-and-reflect-following-70-quake/>



**Figure 18:** Home in Eagle River with significant structural damage due to geotechnical failure<sup>14</sup>



◀ **Figure 19:** Partially collapsed two-story home on Dome Circle in Eagle River<sup>15</sup>



(a)



(b)

**Figure 20:** Structural fire in (a) South Anchorage and (b) at the Jubilee Christian Center<sup>16</sup>

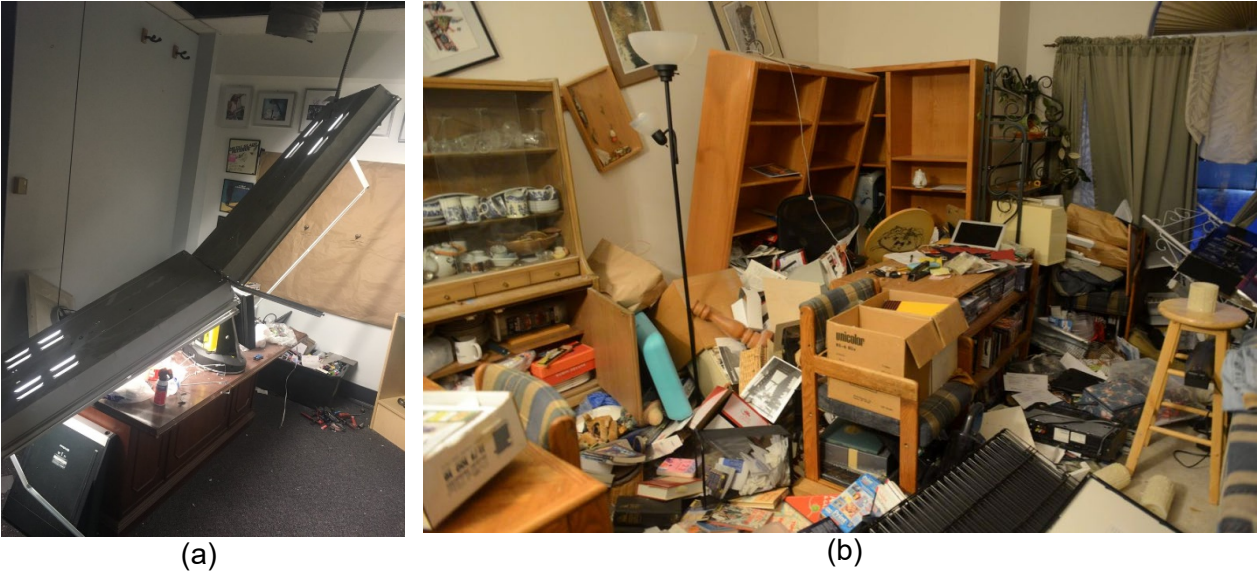
<sup>14</sup> <https://www.adn.com/alaska-news/2018/12/01/anchorage-fire-chief-how-to-look-for-serious-structural-damage-at-home/#>

<sup>15</sup>

<https://www.adn.com/alaska-news/anchorage/2018/12/03/eagle-river-couple-lucky-after-home-collapses-in-earthquake/>

<sup>16</sup> <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>





**Figure 21:** Typical residential contents losses such as (a) detached lighting fixtures<sup>17</sup> and (b) disrupted home office with toppled bookcases in west Anchorage<sup>18</sup>

## Schools

Most of the schools in the region sustained minor to major non-structural damages. Non-structural damages include damaged ceiling tiles, light fixtures, water lines and cinder block partition walls (Figs. 22-24). In most of the schools books were shaken off the shelves in the library. As of December 3, Anchorage School District (ASD) released a color-coded assessment of its schools: 12 safe to occupy (green), 85 repairs in progress (yellow). Out of 6,000 staff and 48,000 students, only two earthquake-related injuries were reported. Nonetheless, Anchorage School District closed all schools until Monday, December 10, with staff reporting December 5 to initiate clean up. University of Alaska Anchorage and Mat-Su College also were closed after the earthquake.



See [Appendix B: EERI VERT Briefing](#) for more information on Schools (Topic #10)

<sup>17</sup> [https://twitter.com/kj\\_kjato/status/1069128600647946240](https://twitter.com/kj_kjato/status/1069128600647946240)

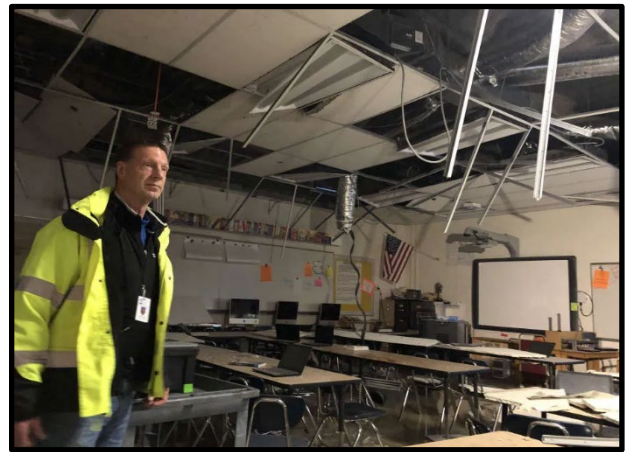
<sup>18</sup> <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage>



(a) Ceiling tiles that had fallen down in one of the rooms on The University of Alaska Anchorage<sup>19</sup>



(b) Ceiling tiles came down at Chugiak High School in Chugiak<sup>20</sup>



(c) Damaged classrooms ceilings at Hanshew Middle School<sup>21</sup>

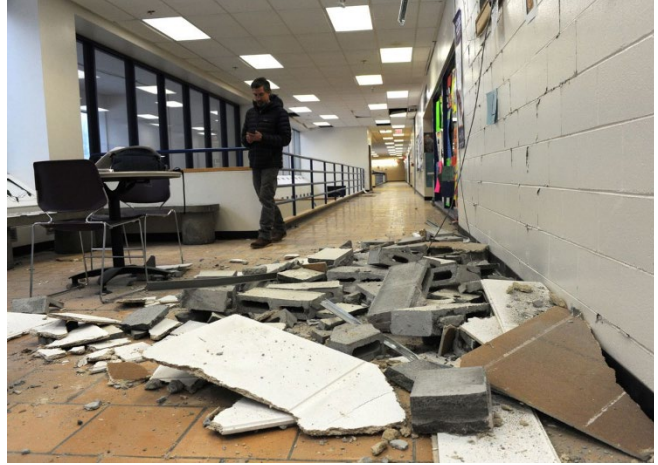
**Figure 22:** Examples of damage to schools.

<sup>19</sup> [https://www.washingtonpost.com/science/2018/11/30/major-damage-tsunami-warning-issued-after-severe-magnitude-earthquake-alaska/?noredirect=on&utm\\_term=.e786156d4c44](https://www.washingtonpost.com/science/2018/11/30/major-damage-tsunami-warning-issued-after-severe-magnitude-earthquake-alaska/?noredirect=on&utm_term=.e786156d4c44)

<sup>20</sup> <https://www.adn.com/alaska-news/education/2018/12/02/anchorage-schools-closed-all-week-as-district-repairs-earthquake-damage/>

<sup>21</sup> <https://www.ktva.com/story/39572971/asd-assesses-extensive-damage-at-several-anchorage>





(a) Damage to masonry infill wall at King Tech High School<sup>22</sup>

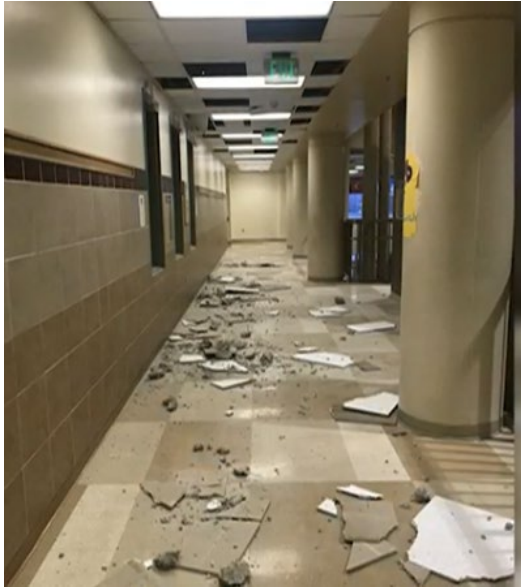


(b) Damaged suspended ceilings and Light fittings at Bartlett High School<sup>23</sup>

**Figure 23:** Examples of damage to non-structural elements in high schools.

<sup>22</sup> <https://www.ktva.com/story/39572971/asd-assesses-extensive-damage-at-several-anchorage-schools>,  
<https://www.adn.com/alaska-news/anchorage/2018/12/03/asd-releases-school-damage-status-list/>

<sup>23</sup> <https://twitter.com/kenzygarfield/status/1068660114402373632>



(a) Damaged ceilings at Diamond High School<sup>24</sup>



(b) Books and ceiling tiles litter the floor at the Mat-Su College library in Anchorage<sup>25</sup>

**Figure 24:** Examples of damage to corridors and libraries in schools.

## Lifelines

The following sections will examine the damage to lifelines, including transportation infrastructure, airports, ports and utilities.

### Roads

Extensive earthquake damage to roads was documented across southcentral Alaska (Fig. 25). Fifty damaged locations on state-maintained infrastructure were identified, with eight major damage sites (Glenn Highway, Seward Highway, and Minnesota Drive). Earthquake aftershocks are continuing to contribute to settling and additional cracking. DOT&PF worked with private sector partners on restarting hot asphalt plants to pave eight high priority highway breaks. A complete list of damaged locations is provided in Appendix A.

### Transportation Structures

Initial inspections of 245 transportation structures (bridges, culverts, pedestrian structures and other non-highway bridge facilities) were completed by Alaska DOT by the evening of November 30th. A second round of more detailed inspections was about half completed as of December 3rd (to be fully completed by Dec 7). The only severely damaged transportation structure discovered was a corrugated metal pipe (CMP) pedestrian undercrossing (discussed later in Fig. 29c). The failure of this structure was due to a waterline breaking and erupting into the tube. It was also reported that the Briggs Bridge could be shut down for at least one week in order to remove the compromised tunnel<sup>26</sup>.

<sup>24</sup> <http://www.hawaiinewsnow.com/video/2018/11/30/damage-alaska-high-school/>

<sup>25</sup> <https://www.nbcnews.com/news/us-news/earthquake-hits-alaska-triggering-tsunami-warning-n942256>

<sup>26</sup> <http://dot.alaska.gov/earthquake2018/>





(a) Damage to Glenn Highway southbound lanes between Eklutna and Mirror Lake<sup>27</sup>



(b) A crack occurred in the road at the International Airport Road off-ramp on southbound Minnesota Blvd.<sup>28</sup>



(c) Collapsed northbound onramp for International Airport Rd. at Minnesota Blvd with stranded vehicle<sup>29</sup>.

**Figure 25:** Damage to transportation systems throughout Alaska.

Figure 26a shows shear key damage to the bridge at the intersection of Glenn Highway and Muldoon Road in Anchorage. Figure 26b shows minor spalling at the abutment of the Seward Meridian Road Bridge over the Parks Highway in Wasilla. Based on the current inspection

<sup>27</sup> <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>

<sup>28</sup> <https://www.adn.com/alaska-news/2018/12/01/inspections-underway-across-southcentral-alaska-for-structural-damage-after-earthquake-aftershocks/>

<sup>29</sup> <https://www.cnn.com/2018/11/30/us/alaska-earthquake/index.html;https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>

progress little significant bridge damage has been found (E. Marx, Alaska DOT, Personal Communication, December 3, 2018).



(a)



(b)

**Figure 26:** (a) Cracking of shear key on the bridge at the intersection of Glenn Highway and Muldoon Road, (b) Abutment spalling on the bridge on Seward Meridian Road over Parks Highway (Courtesy of Elmer Marx, AKDOT)

## Airports

Most arrivals into **Ted Stevens Anchorage International Airport** were halted by the Federal Aviation Administration (FAA) on November 30 and the airport control tower was evacuated. By 11:45 am some departures had resumed. By about 1:15 pm, both arrivals and departures were allowed at a reduced rate, and airport operations were back to normal by about 6:30 pm that evening. Some terminals sustained cosmetic damage: broken glass from light fixtures and windows in the terminal buildings. Some water mains were damaged and elevators and escalators were out of service. Power was on, but heat was disrupted. Some cracked and collapsed roads outside the airport caused traffic barricades midmorning, rerouting drivers away from departure and arrival ramps. By evening, the normal routes for pick-ups and drop-offs had reopened. Cracks were reported in Aircraft Drive near Lake Hood (Fig. 27). Meanwhile, **Merrill Field Airport** was reported to have suffered minor damage, and **Kodiak Airport** was reopened at 10:30 am November 30 by DOT&PF.





**Figure 27:** Cracks in Aircraft Drive near Lake Hood<sup>30</sup>



**Figure 28:** Cracks along parts of Alaska Railroad system<sup>31</sup>

## Railroad

Parts of the Alaska Railroad system north of Anchorage were damaged and impassable, indefinitely shutting down train service between Anchorage and Fairbanks (Fig. 28).

## Port Facilities

The **Port of Anchorage** remained open to inbound and outbound maritime traffic according to the Coast Guard. At the Port of Alaska in Anchorage, there was some minor dock damage, but not damage that would affect cargo handling by the afternoon of the earthquake. There were some “fairly big” cracks in the ground near the north extension at the **Port of Alaska** (Fig. 29a). There were no known injuries at the port and no known fuel spills. Operations for a tanker pumping fuel into the port were stopped immediately when the quake occurred and any fuel in danger of spilling has been secured. Unfortunately, it was not possible to retrieve data from the Port Access Bridge instrumented by USGS due to malfunctioning of the memory card of the recording system.



See [Appendix B: EERI VERT Briefing](#) for more information on Transportation Networks (Topic #8), including roads, bridges, tunnels, ports and railroads.

<sup>30</sup> <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>

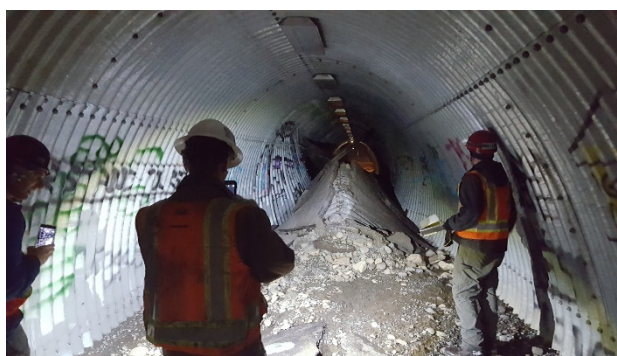
<sup>31</sup> <https://www.adn.com/alaska-news/2018/12/01/alaska-railroad-reports-impassable-sections-of-track-north-of-anchorage-after-earthquake/>



(a)



(b)



(c)

**Figure 29:** Damage to lifelines: (a) Crack near the north extension at the Port of Alaska<sup>32</sup>, (b) oil leak in distribution transformer next to the National Park Service Building<sup>33</sup>, (c) failure of 8" water main under the pedestrian tunnel just to the north of Briggs Bridge over Eagle River<sup>34</sup>.

## Utilities

Interruption of power, water and gas utilities were reported across southcentral Alaska. Utility providers steadily restored normal service. Phone service was disrupted for 7000-10000 homes in Anchorage. Details of other utility disruptions are outlined in the sections below.

### Power

More than 32,000 power outages were reported in Anchorage after the quake. Chugach Electric Association started November 30th with about 21,000 power outages, often caused by overturning or oil leaks in large transformers at substations (Fig. 29b). Some of those outages occurred at individual residences that reported downed lines after poles or trees toppled. A light

<sup>32</sup> <https://www.adn.com/alaska-news/anchorage/2018/11/30/anchorage-airport-open-again-for-arrivals-after-landings-were-halted-due-to-earthquake/>

<sup>33</sup> <https://www.adn.com/alaska-news/2018/12/01/utilities-will-work-through-night-to-fix-widespread-gas-leaks-and-outages-after-70-earthquake/>

<sup>34</sup> <https://www.facebook.com/AnchorageWaterAndWastewaterUtility/photos/a.733667883388673/1967626766659439/?type=3>

burst in South Anchorage resulted in a power shutdown possibly due to two power lines swaying in close proximity during the violent shaking. Matanuska Electric Association, based in Palmer but with customers as far as Eagle River, reported 50,000 service disruptions just after the quake. By late afternoon on November 30th, only about 6,000 customers in Anchorage were without power, including 1,000 downtown. By December 1st, the electricity was restored for almost the entire city. Chugach Electric customers were also almost completely restored with power within a day of the earthquake.

### **Natural Gas**

Hundreds of natural gas leaks have been reported across the Anchorage area. More than 300 reports of gas leaks were logged with Enstar by late Friday (Nov. 30) afternoon, primarily by homeowners detecting odors. One gas line ruptured and was repaired in the Matanuska-Susitna Borough. Another gas leak led to the evacuation of a medical office building next to Mat-Su Regional Medical Center.

### **Oil**

No oil pipeline damage was reported across Southcentral Alaska. The following summarizes preliminary reports from different oil companies and organizations.

- Alyeska Pipeline Services Co. reported no damages for the trans-Alaska pipeline system (TPS) ending in Valdez roughly 100 miles to the east of Anchorage at the time and Alyeska's Earthquake Monitoring System did not trigger any alarms, though a precautionary shutdown was initiated due to the tsunami warning (later canceled around 10 am). The pipeline was restarted on November 30 at 3:30 pm.
- **Hilcorp Alaska LLC** found no spills or injuries but similarly executed a temporary shut down for inspection of its oil and gas infrastructure, which includes numerous oil and gas platforms in Cook Inlet.
- Officials for the Kenai-based **Cook Inlet Regional Citizens' Advisory Council (CIRCAC)**, a federally mandated nonprofit organization focused on preventing and responding to oil and gas spills in Cook Inlet, reported no oil spills or commercial gas leaks in the region.
- **Interior Gas Utility** General Manager Dan Britton stated that the Fairbanks-based gas utility's small Titan Liquefied Natural Gas (LNG) plant, which produces LNG that is trucked up the Parks Highway for use in Fairbanks, was without power and was automatically shut down. While located on Point MacKenzie very near the epicenter of the quake, preliminary inspections revealed no damage to the plant itself.

### **Water**

Two dozen pipe breaks were reported throughout Anchorage according to officials with the Anchorage Water and Wastewater Utility (AWWU). The utility fielded about 70 requests to turn off residential water service because of flooding. Water line ruptures were reported at the Anchorage jail complex and Hiland Mountain Correctional Center in Eagle River and at a Target retail store in Wasilla. Alaska Railroad's Anchorage Operations Center on Ship Creek, including its dispatch center, experienced severe damage due to flooding from burst pipes and power outages.

Water crews have also responded to 39 suspected water main breaks in Anchorage since the earthquake (Fig. 29c). One emptied a water reservoir in Eagle River. In fact, reservoirs all over the region were drawn down by pipe breaks after the earthquake. All reservoirs have been recharged to normal levels as of late on December 1st and two-thirds of breakages have been resolved. Note that the main rupture in Figure 29c also caused significant damage to the



pedestrian tunnel and adjacent pathway, as noted in a previous section. Equipment is being mobilized to the area to decommission the pedestrian crossing and then repair the main.



See [Appendix B: EERI VERT Briefing](#) for more information on Lifelines (Topic #4)

## Geotechnical Failures

A number of ground failures and landslides were caused by the earthquake at various locations in Anchorage (Figs. 30-36), potentially associated with liquefaction and lateral spreading.



See [Appendix B: EERI VERT Briefing](#) for more information on Geotechnical Damage (Topic #7)



**Figure 30:** Aerial photo of damage on Vine Road, south of Wasilla<sup>35</sup>

<sup>35</sup> <https://www.washingtonpost.com/science>





**Figure 31:** Aerial photo of the damage on the Glenn Highway near Mirror Lake in Anchorage, approximate location: 61.42° N, 149.42° W<sup>36</sup>



**Figure 32:** Landslide occurred after the earthquake, on the northwest side of Knik Arm in the Anchorage area<sup>37</sup>

<sup>36</sup> <https://www.washingtonpost.com/science>

<sup>37</sup> <https://www.washingtonpost.com/science>





**Figure 33:** The Seward Highway near McHugh Creek was temporarily closed due to a rockslide<sup>38</sup>



**Figure 34:** Rock falls triggered by the Alaska earthquake<sup>39</sup>

<sup>38</sup> <https://www.washingtonpost.com/science>

<sup>39</sup> <https://twitter.com/RyanHobbsMMA>



**Figure 35:** Landslide along coastline of Point Woronzof<sup>40</sup>



**Figure 36:** Mudslide along Minnesota Blvd. near Diamond<sup>41</sup>

## Current Conditions

### Affected Municipalities

The most impacted regions include Anchorage, Matanuska-Susitna, and Kenai Peninsula, though utilities and services have been swiftly restored even in these areas. While the disruptions and impacts in various sectors are outlined in previous sections of the report, Table 2 offers a quick summary of the anticipated impacts to the building inventory in each of these municipalities.

<sup>40</sup> <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>

<sup>41</sup> [https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage](https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/)



**Table 2: FEMA's Earthquake Incident Journal spatial decision-making data<sup>42</sup>**

Region	Red Tag	Yellow Tag	Green Tag	Displaced Households	Potential Public Sheltering Population
Anchorage	3.541	199.621	26,666.476	211.44	121.371
Matanuska-Susitna	1.161	52.296	9,432.913	17.868	10.583
Kenai Peninsula	0	0.127	266.908	0.035	0.021

Note: Red Tag is complete modeled building damage; Yellow Tag is extensive modeled building damage; Green Tag is slight or moderate modeled building damage; Displaced Households and Potential Public Sheltering Population is from HAZUS modeled damage and loss estimate.

## Access Restrictions

At the time of the report's authorship, access restrictions are primarily driven by the damage to transportation infrastructure across the affected region, regularly updated at <http://dot.alaska.gov/earthquake2018/>. Figure 37 provides a status update as of December 4, 2018.

### Updates: Dec. 4

12:00 p.m.

#### Update on 8 Major Work Sites in Anchorage and Mat-Su:

**Eagle River Loop Road Bridge (Briggs Bridge):** Bridge is closed to all traffic for work to remove the nearby compromised pedestrian tunnel. The bridge has been inspected by Bridge Design and has no structural concerns. AWWU is actively working the site.

**Glenn Highway Northbound Eagle River Bridge:** Two lanes opened to traffic. Far left lane remains closed. Speed reductions.

**Glenn Highway Mirror Lake (MP 23-25):** Due to difficulties with filling the sink holes and the continued shifting of the ground, there are several humps in the road surface that will make the roadway unsafe. Crews are actively working on these issues. One lane detours on southbound and northbound highway continue. Please continue to plan for substantial delays and additional commuting time.

**Glenn Highway/Old Glenn MP 29.3:** SB reduced to one lane. NB all lanes OPEN. Paving and striping complete. Crews are working on safety issues. Speed reduction in area.

**Glenn Highway Northbound Palmer Flyover:** Approach is open to one lane. Temporary repairs complete.

**Seward Highway between Tudor & 36th:** SB lanes OPEN, NB lane one lane closed. Speed reduction in area.

**Seward Highway MP 114 to 104:** The department advises against travel in this area. Rock fall is an ongoing issue due to continued aftershocks. Please do not stop in the area. Please do not gather water at MP 109; rock fall at MP 109 is particularly active. In the interest of safety we are temporarily closing the water site.

**Minnesota Drive Northbound and Southbound Ramps to International:** OPEN all lanes

**Figure 37: Screenshot of access restrictions from Alaska DOT website<sup>43</sup>**

<sup>42</sup> <https://fema.maps.arcgis.com/apps/MapJournal/index.html?appid=637ac220386e4e0f8728f0b2ee3d82be>

<sup>43</sup> <http://dot.alaska.gov/earthquake2018/>



# StEER Response Strategy

StEER is currently engaging with EERI, the Pacific Earthquake Engineering Research (PEER) Center, and other actors in phasing its response for this event. Within 24 hours of the earthquake, StEER formed its **Virtual Assessment Team (VAT)** -- the authors of this report -- who worked to assemble data on the event from public sources and lead authorship of the **Preliminary Virtual Assessment Team (P-VAT) Report** (this document).

Working closely colleagues at the University of Alaska, Anchorage, the US Geological Survey, and EERI, StEER is now evaluating the assessments of those who traveled to the affected area the week of December 3rd on scouting missions. Should those assessments reveal opportunities to generate valuable knowledge of structural performance in this event, StEER will assemble and deploy a **Field Assessment Team (FAT)** from those who enrolled for StEER event responses (using the form circulated to the community within 48 hours of the event).

A Field Assessment Team is generally comprised of individuals with prior field experience and expertise relevant to this type of event. They are tasked with rapidly gathering essential data only visible from the ground, with the understanding that these will be enriched with additional sources of data through aligned StEER efforts. The VAT will work to process the data from the first FAT (FAT-1) in near real time and issue the **Early Access Reconnaissance Report (EARR)** based on the data from FAT-1 and/or data from the scout missions referenced above. The VAT will also work to enrich FAT data with other information gleaned from inventory and high-resolution imagery, and participate in quality assurance and data cataloging processes.

Regardless of the exact field assessment strategy of StEER, this event constitutes an important first test of domestic earthquake response in close partnership with colleagues at EERI and other organizations and thus provides a valuable opportunity to develop and improve critical collaborative workflows for future events.

## Appendix A: Damage to Transportation Infrastructure

(Source: <http://dot.alaska.gov/earthquake2018/docs/Damage-Locations-earthquake2018.pdf>)

Site Number	Location	Damage	Status/Initial Action
<b>REGIONAL</b>			
<b>SEWARD HIGHWAY</b>			
001	Tudor to 36th	Rippled Asphalt	FAST LANE CLOSED BOTH SIDES
002	SB OFF RAMP @ DIMOND	WATER ACROSS ROADWAY	OPEN
003	Seward Hwy MP 109	Rock Slide	
004	Seward - 6 Mile Bridge	Cracking	Open
005	Seward Hwy at Dowling - NE Quadrant On Ramp		Open
007	Seward Hwy @McHugh Creek	Rock/Mud Slide	Open
008	RABBIT CREEK BRIDGE (1392)	EASTSIDE 3RD GIRDER CRACKED (LIGHT)	Open
009	DIMOND BRIDGE (1325)	BRIDGE CRACKED BOTH SIDES (LIGHT)	Open
010	TUDOR BRIDGE (1323)	ADBU TMENT CRACKED BOTH SIDES	Open
011	O'MALLEY BRIDGE (1380)	NORTH BASE END CRACKED (LIGHT)	Open
<b>GLENN HIGHWAY</b>			
012	Glenn SB Mirror Lake ON ramp	SLOPE FAILURE SIGNIFICANT CRACKING	Closed
013	Glenn SB Mirror Lake OFF ramp	Sink hole	Closed
014	Glenn HWY MP 58.7	Longitudinal Shoulder Cracks	
015	Glenn Parks Interchange	Slope Failure.	Closed
016	NB Eagle River Bridge	Abutment Damage	Closed
017	SB EAGLE RIVER BRIDGE	DIP AT APPROACH	Open
048	Knik Bridge ??	Slope Sloughing	Open
<b>PARKS HIGHWAY</b>			
<b>STERLING HWY</b>			
025	MP-82 Bridge (0672)	Cracking	Open
<b>ANCHORAGE</b>			
<b>MINNESOTA &amp; INTERNATIONAL INTERCHANGE</b>			
026	SB Minnesota Off Ramp	Slope Failure	Open

027	N/B On Ramp	Slope Failure	Closed
<b>MINNESOTA DR</b>			
028	Minnesota Bridge @ 100th	Bridge Cracks	Open
029	Dimond - 100th	Slope Failure	Open
<b>C STREET</b>			
030	SB @ Dowling Road	Pavement Cracks, 2" DEFLECTION & SPLIT	Open
031	C St Undercrossing at Campbell Creek (0971)	Longitudinal concrete wall cracking	Open
<b>EAGLE RIVER LOOP ROAD</b>			
032	BRIGGS BRIDGE PEDESTRIAN UNDER CROSSING	CULVERT STRUCTURE COMPROMISED BY WATER MAIN	OPEN
033	BRIGGS BRIDGE OVER EAGLE RIVER (1739)	SB EXPANSION JOINT BOTH SIDES	SB CLOSED. NB OPEN
<b>A &amp; C BRIDGEWAY</b>			
034	GENERAL	EXPANSION JOINT CONCERNS	OPEN
035	DOWLING WB ELMORE-LAKE OTIS	SLUMPING 12-18 inches	LANE CLOSED BY M&O
<b>MATSU</b>			
036	Clark-Wolverine Road	Slope Failure	One Lane
037	Vine and Pittman Roads	3" Subsidence	One Lane
038	Vine Road @ 3 Bears	State Road ok	Open
039	Buffalo Mine Road	Longitudinal Shoulder Cracks	Open
040	KGB Road MP-15.2	CRACKING	Open
041	KGB Road MP-14.7	SUBSIDENCE 4" MAYBE CULVERT	Open
042	Fairview Loop @ Jackfish	Shoulder Separation 2-10"	Open
043	Seward Meridian Bridge	Cracks	Open
044	PITTMAN RD MP 0.7	SUBSIDENCE/SINK HOLE	Open
	PT MACKENZIE	MAJOR CRACKING GROWING	UNKNOWN
<b>KENAI</b>			
Kenai Spur Hwy			
045	MP 19	Settlement	Open
046	MP 35.1	Settlement	Open
047	MP 35.7	Settlement	Open

## Appendix B: EERI VERT Briefing



### **Virtual Earthquake Reconnaissance Team (VERT): Phase 1 Response to M7.0 Anchorage, Alaska Earthquake, November 30, 2018**

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# Topic #1: Earthquake Characteristics

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake

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## Earthquake Characteristics

**Date:** November 30th 2018 17:29:29.206 UTC

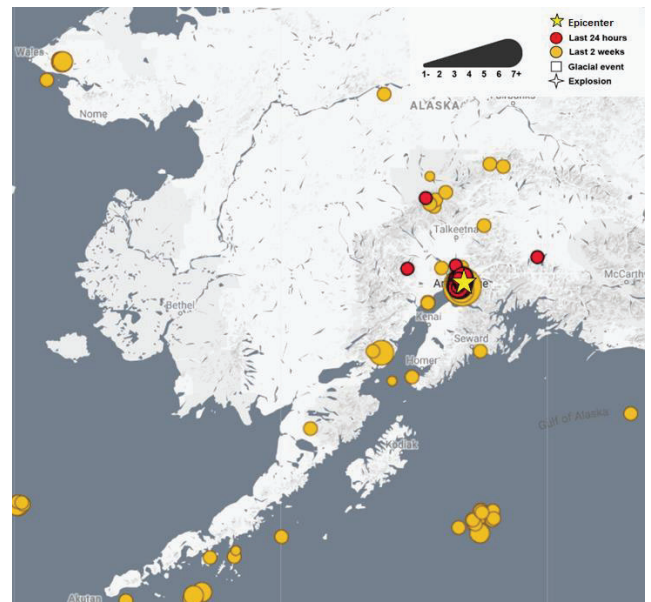
**Magnitude:** Mw 7.0 (USGS).

**Location:**

- Epicenter located 12 km North of Anchorage
- 61.323°N latitude and 149.923°W longitude

**Depth:** 44.1 km (USGS).

*The figure on the right shows the epicenter of the earthquake along with aftershocks of magnitude equal or higher than 3.0 (figure modified after Alaska Earthquake Center).*



Note: Epicenter located for reference only (not actual coordinates).  
Source: <https://earthquake.alaska.edu/earthquakes>

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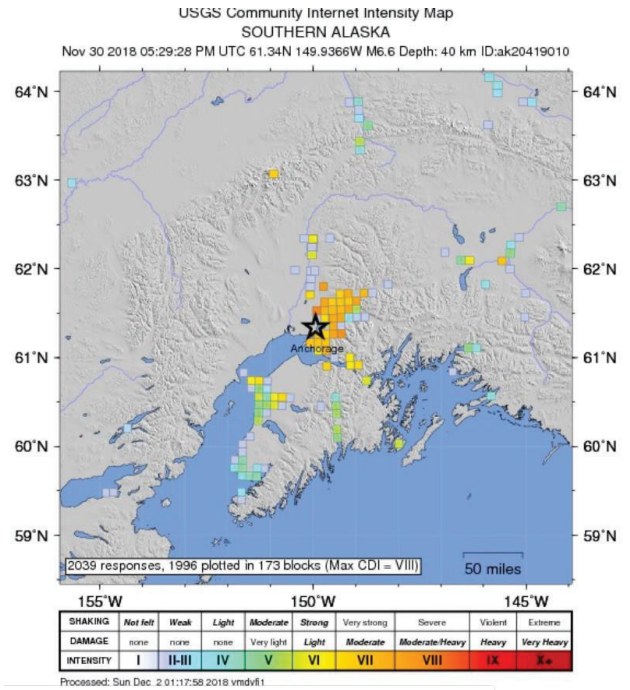
# Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

## Fault Mechanism:

- The earthquake resulted from a ruptured occurred on an intraslab fault within the subducting Pacific slab (USGS).
- Maximum Slip 1.6m (USGS)

**Max Intensity:** VII Severe shaking, Moderate/Heavy damage

<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/dyfi/intensity>



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# Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

## Aftershocks:

- 67 magnitude 3 or higher earthquakes
- 9 magnitude 5 or higher earthquakes, which are large enough to do damage

**Aftershock Forecast:** within the next 1 Week until 2018-12-08 02:00:37 (UTC)

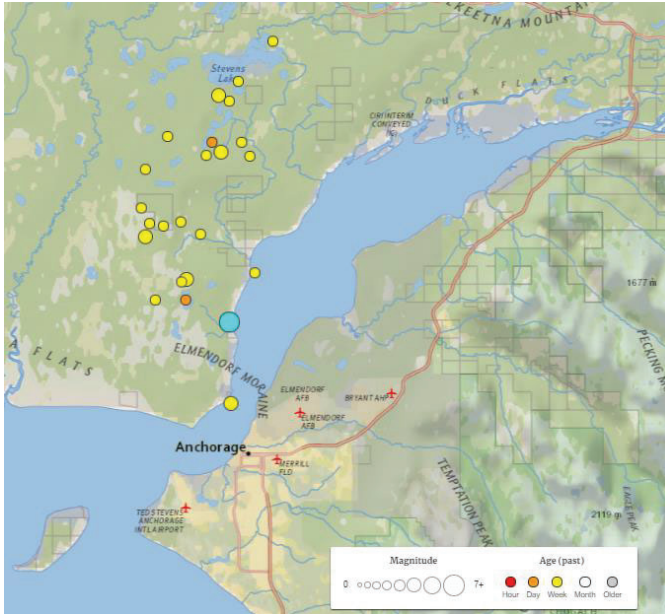
- The chance of an earthquake of magnitude 3 or higher is > 99 % (expected 84 to 610)
- The chance of an earthquake of magnitude 5 or higher is 88 % (expected 0 to 8)
- The chance of an earthquake of magnitude 6 or higher is 24 % (expected 0 to 2)
- The chance of an earthquake of magnitude 7 or higher is 3 %, such an earthquake is possible but with a low probability.

<https://earthquake.usgs.gov/earthquakes/eventpage/ak20419010/oaf/commentary>

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## Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data



*(left) Map of aftershocks*

*Blue = Anchorage Earthquake*

<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/executive>  
*ANSS Comcat*

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## Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

- USGS estimates suggest a low probability of fatalities, however damage is likely to be significant and potentially widespread (<1% of the GDP of the US) (<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/pager>).
- No fatalities or serious injuries reported directly caused by the earthquakes. Only minor bruises and cut wounds from falling objects and furniture.

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# Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

## Landslides

Estimated Area Exposed to Hazard

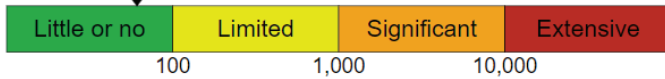
6.1 km<sup>2</sup>



Landslides triggered by this earthquake are estimated to be limited in number and (or) spatial extent.

Estimated Population Exposure

61



The number of people living near areas that could have produced landslides in this earthquake is low, but landslide damage or fatalities are still possible in highly susceptible areas. This is not a direct estimate of landslide fatalities or losses.

[VIEW LANDSLIDES MAP](#)

## Liquefaction

Estimated Area Exposed to Hazard

180 km<sup>2</sup>



Liquefaction triggered by this earthquake is estimated to be significant in severity and (or) spatial extent.

Estimated Population Exposure

3,600



The number of people living near areas that could have produced liquefaction in this earthquake is limited. This is not a direct estimate of liquefaction fatalities or losses.

[VIEW LIQUEFACTION MAP](#)

<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/ground-failure/summary>



## Topic #2: Tsunami Warning

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake



## Summary of Tsunami Warning System, Location of Impact

- A tsunami warning issued for the Cook Inlet and southern Kenai Peninsula regions was later cancelled

(<https://www.bbc.com/news/world-us-canada-46403405>).

- Tsunami cancellation was not properly announced through phone network providers.

United States Department of Commerce  
NOAA / National Weather Service  
U.S. Tsunami Warning System

Home News Organization Search for: [ ] NWS All NOAA Search

**No Tsunami Warning, Advisory, Watch, or Threat**

**Earthquake:**

Magnitude: 4.6	Origin Time: 12/1/2018, 8:52:15 PM
Depth: 17 mi.	Lat: 61.3° N Lon: 149.9° W
Location: 35 miles SW of Palmer, Alaska	

**NWS Tsunami Alerts** ✓  
@NWS\_NTWC

CANCELLATION: M7.0 005mi N Anchorage, Alaska  
0829AKST Nov 30: No tsunami observed

#NTWC

♥ 688 10:59 AM - Nov 30, 2018

🗨 632 people are talking about this

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## Summary of Tsunami Warning System, Location of Impact

- A tsunami warning system exists but there is an overlapping issue that cause residents of some parts of Anchorage who are not at a high risk of tsunami to receive unnecessary warning. Those were trying to evacuate randomly without following particular evacuation route or signage.
- Tsunami evacuation signage do exist downtown Anchorage.
- Seems warning system issues need to be resolved and more education to the public on the actual tsunami risk is much needed.

*Some field observation by Wael Hassan*

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# Topic #3: Aftershocks

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake



## Overview & and how it affected various regions

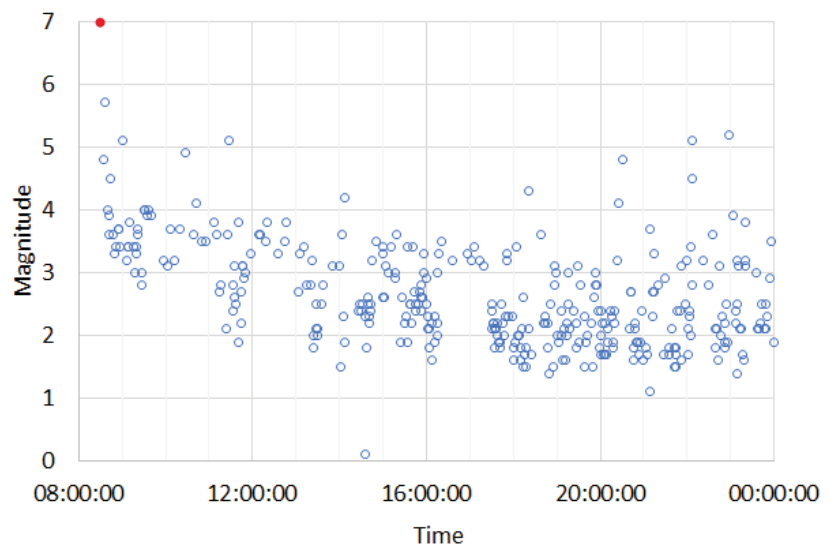
According to the AK Earthquake Center, 600+ aftershocks have been reported

[<https://twitter.com/AKearthquake/status/1069010063849750529>].

These include several magnitude 5 or larger events based on available data from the USGS

[2].

Aftershocks in Alaska since main earthquake:  
30-Nov-2018 Only

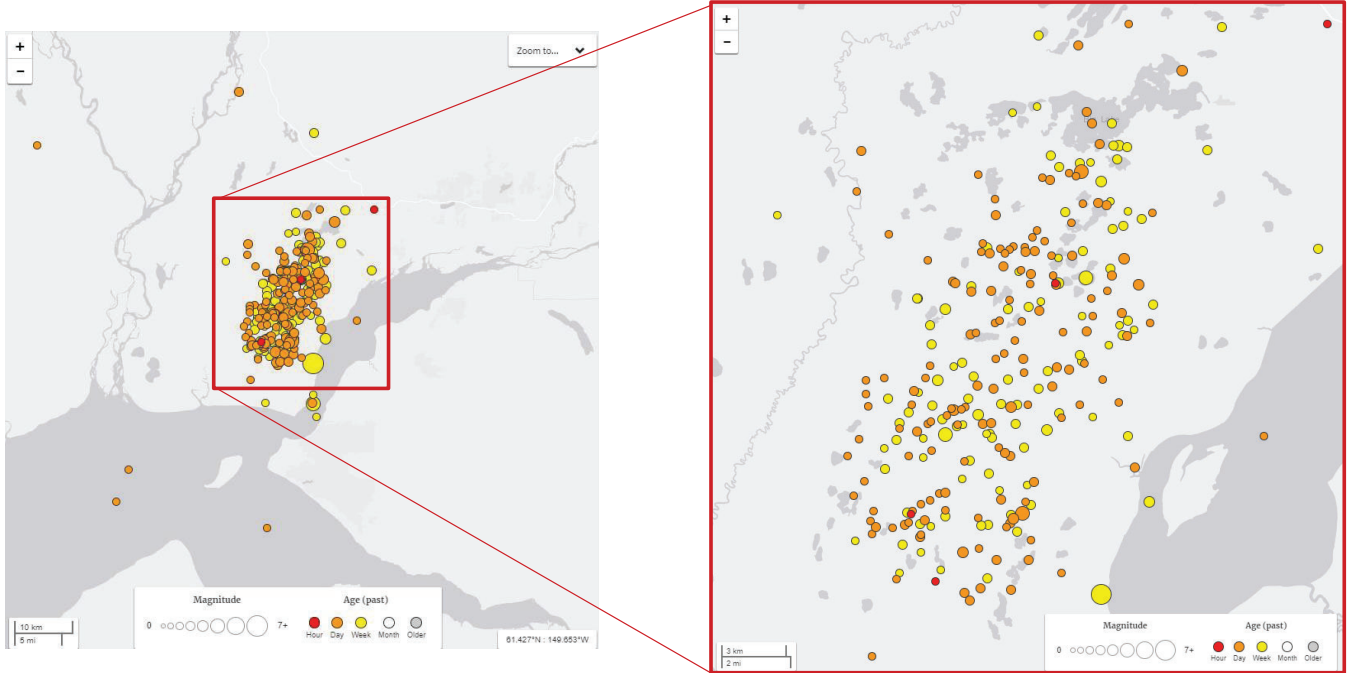




## Overview & and how it affected various regions

USGS maintains a map of M2.5 larger earthquakes [here](#).

Below are M2.5 and larger in the last 1 week (including foreshocks) as of 2-Dec



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## Overview & and how it affected various regions

The news of aftershocks has been shared widely by media outlets [1,2]. The number and intensity of aftershocks provoked rumors that an aftershock as big as the main shock was coming at a specific time. This rumor was being shared via Twitter [3,4].

State seismologists later commented, stating “Anytime an earthquake of this size occurs, there is a low but non-zero chance that another earthquake of similar or larger size could occur.” [5]

USGS [6] released information to the public to help them understand what to expect.

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## Links to key media articles discussing Structural Damage

So far, no damage seems to have been attributed to the aftershocks [[1](#)].

Until Dec 2nd midnight AK time: 17 aftershocks with Mw 4.5 or higher and 9 aftershocks with Mw 5.0 or higher took place.(USGS)

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## Topic #4: Lifelines

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake

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# Overview & and how it affected various regions

Lifeline	Status	Slide #
Electric power	Significant initial disruption (~80,000 customers, 70-85% of customers for some suppliers); mostly restored within 24hr	23
Gas	1-2 gas line breaks reported but repaired within 36hr; 700+ reports of potential gas leaks	24
Water	Water main breaks reported, causing some flooding; precautionary boil advisories lifted in most areas	25
Telecommunications/Internet	No known reports of disruption or damage; some entities advised to use text or social media to avoid clogging phone lines	26
Airport	Some damage within airport (ANC) terminal, but no damage to runways; Fully operational by 3:18PM Friday	27
Port	Minor damage; No disruption of service	27
Trans-Alaska Pipeline/Fuel	No damage found; Seven hour shutdown	27
Public Transit	Bus service in Anchorage (Anchorage People Mover) was disrupted on Friday; resumed Saturday/Sunday offering free rides	28

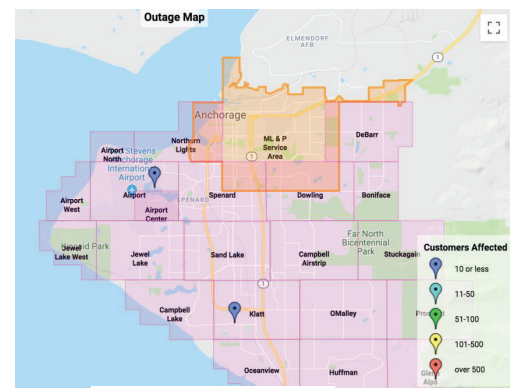
20



# Overview & and how it affected various regions

## Electric power

- Matanuska Electric Association had about 50,000 of its roughly 58,000 customers losing power Friday according to their Twitter feed<sup>1</sup>. This was recovered within 20 hours after the earthquake.<sup>2</sup>
- An Eagle Creek substation required repair as of Friday morning and the repair was completed shortly after.
- Chugach Electric's latest update at 7:10 p.m. stated there were 69 people awaiting restoration of service down from a peak of about 21,000
- As of 8:15 p.m., Municipal Light & Power said on its Facebook page only 500 customers were still without power from an initial estimate of 7,000 to 10,000 affected



Power outage map



**Chugach Electric** @chugachelectric · 6h

Saturday morning: We have 10 remaining members without power. Worked through the night and will get them done today. Thank you to Chugach linemen, dispatchers, member services and everyone inbetween for a great response. We have an incredible team. Here's to a calm weekend!

1 1 9



**Municipal Light & Power**  
@MLandP

Follow

ML&P is still working about 1,000 outages. We currently have NO issues with substations and feeders. Remaining outages are due to equipment damage on the ground (line slap, overhead and underground distribution system repair).

9:12 PM · 30 Nov 2018

<sup>1</sup><https://www.ktva.com/story/39569541/list-closures-cancellations-power-outages-follow-major-anchorage-quake>  
<sup>2</sup>[https://www.facebook.com/matanuska.electric/posts/1980049832048197?\\_tn\\_ =K-R](https://www.facebook.com/matanuska.electric/posts/1980049832048197?_tn_ =K-R)

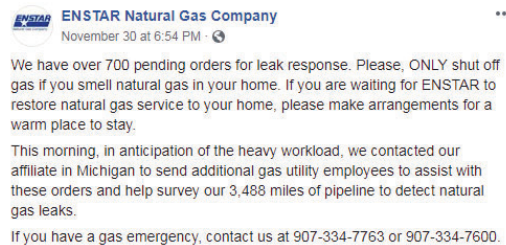
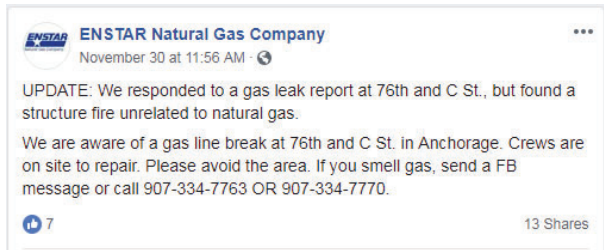
21



# Overview & and how it affected various regions

## Natural gas

- At 11:56 AM Friday - Enstar reported a gas line break at 76th street and C street in Anchorage<sup>1</sup>
- At 6:54 PM Friday, there were approximately 700 leak cases reported to Enstar. At Sunday morning, it was down to 250 pending leak orders.<sup>1</sup>
- Enstar has been advising customers to shut off gas only if they “detect a gas smell or hear the hissing of a leak”; it will take time for technicians to turn gas back on following an earthquake<sup>2</sup>
- Gas line break occurred in Matanuska-Susistna Borough, but has already been repaired as of 12/23<sup>3</sup>



<sup>1</sup><https://www.facebook.com/ENSTARNatGas>

<sup>2</sup><https://www.adn.com/alaska-news/2018/11/30/do-you-smell-gas-or-hear-hissing-heres-how-to-shut-off-your-gas-after-an-earthquake/>

<sup>3</sup><https://www.adn.com/alaska-news/2018/12/01/utilities-will-work-through-night-to-fix-widespread-gas-leaks-and-outages-after-70-earthquake/>



# Overview & and how it affected various regions

## Water

- Water main may have broken at Anchorage Jail<sup>1</sup>
- Water main damage caused road flooding<sup>2</sup>
- In a press conference on Sunday morning, it was reported that previous boil advisory was lifted & city’s water system was functioning normally. Residents of Mat-Su complained about water still being “murky”.<sup>3</sup>
- Damage assessment of Anchorage Water & Wastewater Utility (AWWU) reported “Eklutna Water Treatment Facility and at the headquarters building that will require more extensive work, but that is not impeding operations”<sup>3</sup>



Water main break at Tudor and Old Seward. Customers may be without water as Anchorage Water and Wastewater Utility clean up.

6:12 PM - 19 May 2016



Anchorage Water and Wastewater Utility

16 hrs ·

AWWU has issued a boiled water advisory out of precaution; however, there are no known water contamination issues. Our system has remained pressurized except for isolated areas we are in the process of identifying. If you have pressure to your home, you should be fine.

For personal use, create a supply of water for drinking, food preparation, cooking and brushing teeth by bringing water to a rolling boil for 2 minutes. Timing starts when the water begins to bubble. Cool the water then place in clean containers.

We have no plans to shut down the entire water system. We will have isolated outages as we repair broken water mains. To stay updated, "Like" or "Follow" this page or text AWWU to 888777 to receive Nixle alerts to your cell phone.

<sup>1</sup><https://youtu.be/DaXMIQVbOv8>

<sup>2</sup><https://www.accuweather.com/en/videos/powerful-earthquake-causes-water-pipe-burst-flood-spills-onto-road/t4c2vyzze6lawpleqazinfscrgokgr0>

<sup>3</sup><https://www.ktvb.com/story/39572413/precautionary-boil-advisory-continues-in-anchorage>



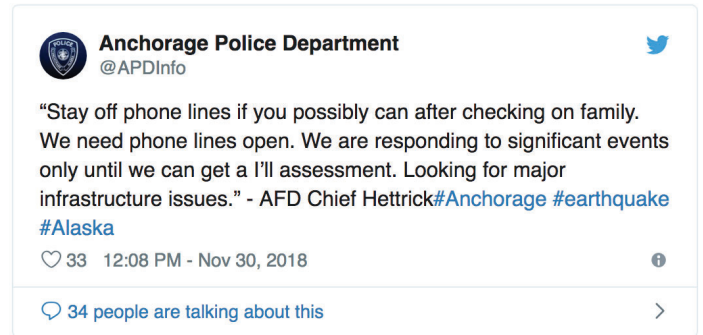


# Overview & and how it affected various regions Telecommunications/Internet

- Broadband/IT provider Alaska Communications stated: "We're grateful all our employees are safe and that we had no major service impacts from the earthquake."<sup>1</sup>
- FEMA and police have advised residents to use text or social media to avoid clogging phone lines<sup>2</sup>
- FEMA and Police announcement were not made through all cell phone users, only to those presubscribed to APD alerts. Shouldn't be the case during an earthquake disaster.

<sup>1</sup><https://www.apnews.com/50faae7e7ed64226b8b076acc7a3c433>

<sup>2</sup><https://abc11.com/facebook-activates-safety-check-for-alaska-earthquake/4799237/>



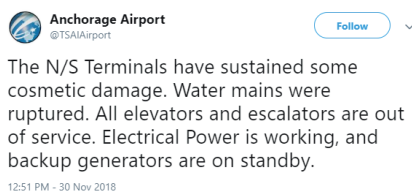
# Overview & and how it affected various regions

## Trans-Alaska Pipeline:

- The Trans-Alaska pipeline was re-started at 3:30 PM Friday after a seven-hour shutdown. There was no damage found.<sup>1</sup>

## Airport and Port:

- No damage was found on the runways and taxiways of Ted Stevens Anchorage International Airport. However, there was some damage to windows and burst water mains in the terminal.<sup>2</sup> The airport was fully operational at 3:18 PM on Friday.<sup>1</sup>
- Minor damage was reported in Port of Alaska, but it did not interrupt the operation of the port



<sup>1</sup><https://www.ktuu.com/content/news/List-of-closures-caused-by-Anchorage--501659691.html>

<sup>2</sup> <https://twitter.com/TSAIAirport>



## Overview & and how it affected various regions Public Transit

- Anchorage People Mover suspended the service on Friday, also AnchorRIDES canceled operating only return trips. <sup>1</sup>
- People Mover offered free rides on Saturday and Sunday. <sup>1</sup>



<sup>1</sup> [https://www.facebook.com/pg/AnchoragePeopleMover/posts/?ref=page\\_internal](https://www.facebook.com/pg/AnchoragePeopleMover/posts/?ref=page_internal)



## Links to key media articles discussing lifelines

- <https://www.adn.com/alaska-news/2018/12/01/utilities-will-work-through-night-to-fix-widespread-gas-leaks-and-outages-after-70-earthquake/>



# Topic #5: Emergency Response

## VERT Immediate Response for: Anchorage, Alaska M7.0 Earthquake

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## Overview & how it affected various regions

- Red Cross of Alaska providing a temporary disaster call line, stating calls returned within 24 hours.
  - Line down at 1 am Dec 1, callers to direct emergency response concerns to 911 instead.
- Anchorage Daily News was manually accumulating emergency response updates through Sunday December 2nd.
  - Collecting reports and tweets from public safety agencies, law enforcement, schools and news media
  - For example, Anchorage Airport tweets out damage to International Airport Road to advise EXTREME caution to any drivers.
  - Providing emergency response tips for individual households, including how to turn off your own gas if you smell gas i



**Alaska DOT&PF**  
@AlaskaDOTPF

Following

Anchorage Shelter Update: The Dena'ina Civic and Convention Center has lost access to utilities. Those that are seeking shelter and cannot reach their home are now advised to make their way to the Egan Civic & Convention Center.

4:13 PM - 30 Nov 2018



**FEMA**  
@fema

Following

If you are trying to contact loved ones affected by the [#earthquake](#) in Alaska, use text and social media to reach out. Phone lines may be overwhelmed and often, texts can make it through when voice calls can't.

**NWS Fairbanks** @NWSFairbanks

We are seeing many reports of damage in south central Alaska from the earthquake. The NWS Anchorage Weather Forecast Office is unavailable due to the 7.2 mag earthquake. Please call NWS Fairbanks WFO 907-458- 3708, for updates or to report damage. #akwx #earthquake twitter.com/LaneSadalu/st...

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# Communication between utilities and the general public through social media to alleviate concerns of rumors



**Glen Vinoya** Rumor spreading that the whole city will have water shut off. Can you please confirm this is not the plan at this time?

Like · Reply · 1d



7



**Joshua Sopko** Agreed, i keep hearing people saying the city may shut off water, but see no news kr announcement for it.

Like · Reply · 18h



**Anchorage Water and Wastewater Utility** Glen and Joshua: Sorry for the delayed response. We have no plans to shut down the entire water system. We will have isolated outages as we repair broken water mains. The Utility will provide updates as they become available. Follow our page or text AWWU to 888777 to receive Nixle updates texted to your smartphone.

Like · Reply · 16h



3

- AWWU is using Facebook to communicate with customers.
- Again phone text was not used although they have all customer's phone numbers.



## Topic #6: Hospitals

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake



## Overview



**Alaska DHSS**  
@Alaska\_DHSS

Follow

Municipality of Anchorage is using this website to communicate Southcentral Alaska earthquake updates: [muni.org](http://muni.org). Cell phone companies are requesting people text instead of calling to keep phone lines open. Only call if it is a current emergency.

8:48 PM - 30 Nov 2018



**Alaska DHSS**  
@Alaska\_DHSS

Follow

Southcentral Earthquake Update: The following shelters are open and available in Anchorage, Girdwood and Chugiak.

- Egan Center (555 West 5th Avenue): Main Exhibition Hall
- Girdwood Fire Department (186 Egloff Drive)
- Chugiak Senior Center (22424 Birchwood Loop Rd)

2:26 PM - 1 Dec 2018



## Overview & and how it affected various regions

- Providence Alaska Medical Center experienced multiple water leaks and canceled elective surgeries [1]. Staff are evaluating isolated damage [2].
  - A structural evaluation was completed and all damage is believed to be cosmetic [3].
  - Emergency rooms kept open. Evaluating damage and water leaks [4].
- Alaska Regional Hospital remains open while damage is being assessed. All elective procedures through the weekend have been canceled [5]. Heavy water damage at buildings E and A (Dec 2nd)
- Alaska Native Medical Center has cancelled elective and clinical appointments. All available personnel have been dispatched to the Emergency Department to prepare for potential influx of injured patients [6].
- Mat-Su Regional Medical Center in Palmer experienced power outage and gas leak reported [7].
- EERI field Recon team planned hospital preparedness surveys and interviews

### References

1. <https://www.bloomberg.com/news/articles/2018-11-30/urgent-the-latest-tsunami-alert-for-southern-alaska-after-quake>
2. <https://twitter.com/ProvAK/status/1068594795734388737>
3. <https://alaska.providence.org/news/2018/11/providence-alaska-medical-center-remains-open-following-earthquake>
4. <https://www.cnn.com/2018/11/30/us/alaska-earthquake-impact/index.html>
5. <https://twitter.com/AlaskaRegional/status/1068613184091652097>
6. <https://fox5sandiego.com/2018/11/30/major-earthquake-rocks-anchorage-prompting-tsunami-warning/>
7. <https://www.ktuu.com/content/news/List-of-closures-caused-by-Anchorage--501659691.html>



# Overview & and how it affected various regions

- Emergency operations at 3 major hospital facilities in Anchorage (Alaska Regional Hospital, Providence Alaska Medical Center, and Alaska Native Medical Center) were open Saturday December 1. All three have received patients with earthquake-related injuries. Elective and non-emergency appointments were cancelled at all 3 medical facilities. Fallen ceiling tiles and broken water lines at Alaska Regional Hospital [1].



Alaska Regional Hospital  
Source: [Alaska Public Media](#)

## References

1. <https://www.alaskapublic.org/2018/11/30/emergency-rooms-open-non-critical-appointments-cancelled-at-anchorage-area-hospitals/>



# Overview & and how it affected various regions



Here's an update on local hospitals. All three Anchorage hospitals, [@ProvAK](#), [@AlaskaRegional](#) and Alaska Native Medical Center ([@ANTHCtoday](#)) are open and accepting patients. All elective surgeries have been canceled for today. Mat-Su Regional Hospital is also open.

5:48 PM - 30 Nov 2018





## Links to key media articles discussing Hospitals / Emergency Response

- <https://www.cnn.com/2018/11/30/us/alaska-earthquake/index.html>
- <https://www.bloomberg.com/news/articles/2018-11-30/urgent-the-latest-tsunami-alert-for-southern-alaska-after-quake>
- <https://www.ktuu.com/content/news/List-of-closures-caused-by-Anchorage--501659691.html>
- <https://fox5sandiego.com/2018/11/30/major-earthquake-rocks-anchorage-prompting-tsunami-warning/>

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## Topic #7: Geotechnical Damage

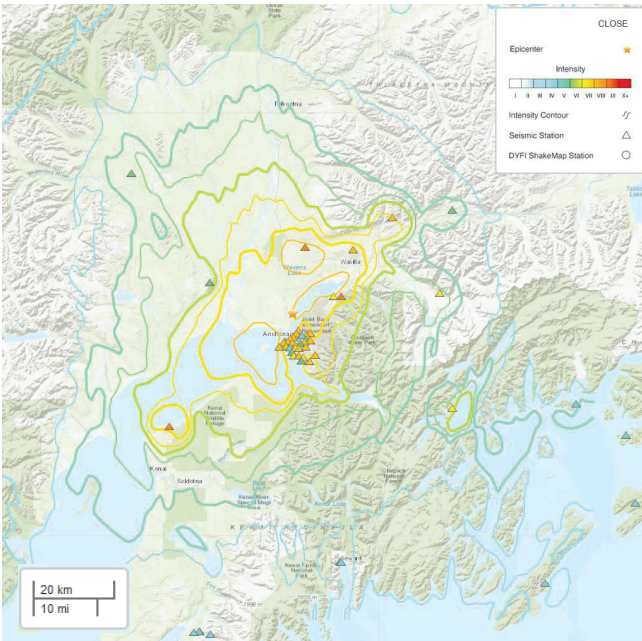
VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake

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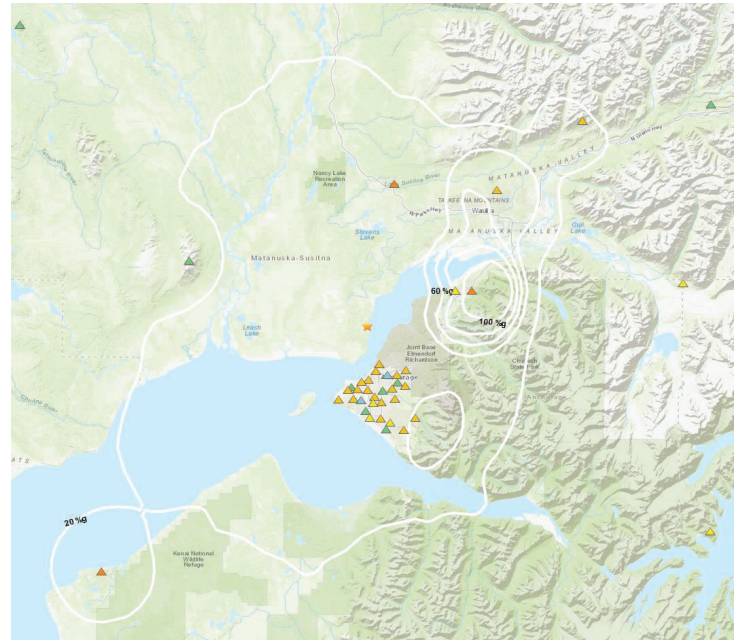
# Overview & and how it affected various regions

USGS ShakeMap (MMI)



<https://earthquake.usgs.gov/earthquakes/eventpage/ak20419010/map?shakemap-code=ak20419010&shakemap-source=ak&shakemap-intensity=true&shakemap-stations=true>

USGS ShakeMap (PGA Contours) and Distribution of Stations

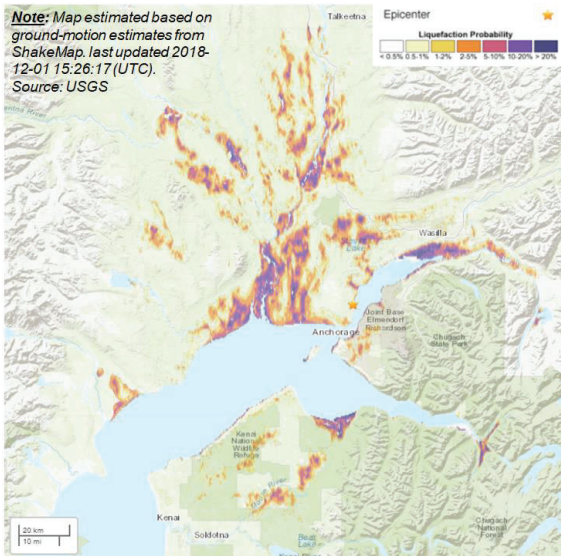


<https://earthquake.usgs.gov/earthquakes/eventpage/ak20419010/map?shakemap-code=ak20419010&shakemap-source=ak&shakemap-intensity=true&shakemap-stations=true>



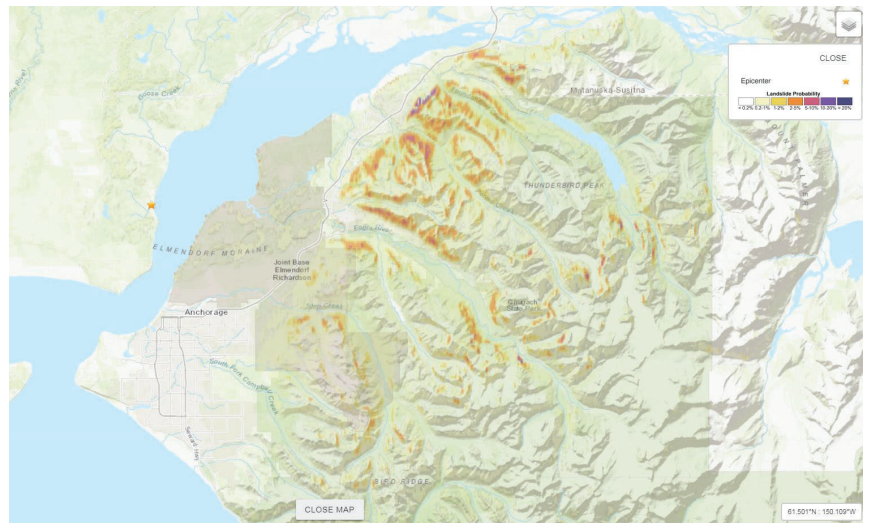
# Overview & and how it affected various regions

Liquefaction Potential (USGS)



<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/map>

Landslide Potential (USGS)



<https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/map>





# Links to key media articles discussing Geotechnical damage

## Overview of damage identified by media outlets and in social media:

- Collapse of the Vine road between Knik Goose Bay Road and Parks Highway [1].
- Collapse of an exit ramp in Minnesota Road near the airport [4].  
Approximate 61.170483, -149.915466
- Damaged roads include Palmer-Wasilla Highway, Pittman Road, Vine Road, and the Parks and Glenn Highway interchange [5]
- Landslide on the Seward Highway by McHugh Creek (Approx. 61.016015, -149.730833) [6].
- Rockslide on Seward highway between Bird Creek and Potter Marsh [6].
- Sinkhole on Glenn Highway southbound lanes between Eklutna and Mirror Lake [7]



Vine Road [2]. Approximate 61.561187, -149.601779



Vine Road [3]

40

### REFERENCES

- [1] <https://www.bbc.com/news/world-us-canada-46403405>  
 [2] <https://twitter.com/ZachBruick/status/1068576075981017088>  
 [3] <https://twitter.com/RyanHobbsMMA/status/1068672511695511552>  
 [4] <https://www.cnbc.com/2018/11/30/earthquake-rocks-buildings-in-anchorage.html>  
 [5] <https://www.adn.com/alaska-news/2018/11/30/road-damage-and-gas-leaks-reported-in-mat-su-after-70-earthquake/>  
 [6] <https://www.ktuu.com/content/news/BREAKING-Massive-earthquake-shakes-Alaska-501647481.html>  
 [7] <https://www.adn.com/visual/2018/12/01/photos-ground-level-views-of-the-earthquake-damage/>

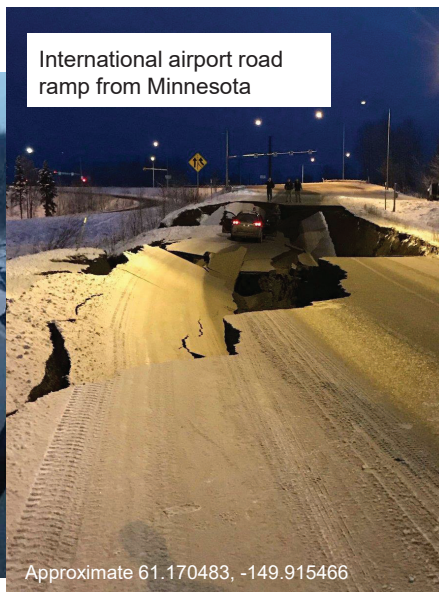


# Overview & and how it affected various regions



Vine Road

Approximate 61.561187, -149.601779



International airport road ramp from Minnesota

Approximate 61.170483, -149.915466



Seward Highway

Approximate 61.016015, -149.730833

<https://twitter.com/RyanHobbsMMA/status/1068580139322171392>

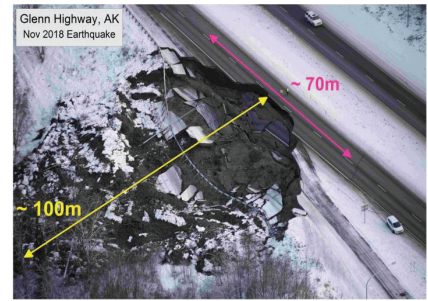
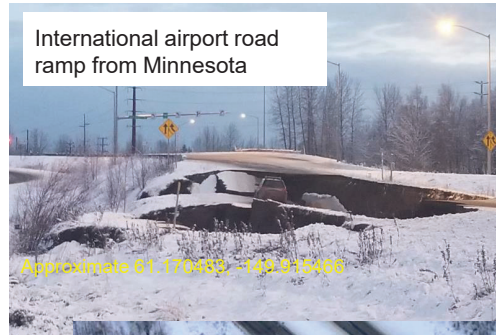
<https://twitter.com/CBCAlerts/status/1068574193946673152>

<https://twitter.com/RyanHobbsMMA>





# Overview & how it affected various regions



Massive coseismic landslide (length= 100 m, width =70 m) in Glenn Highway, AK following the Alaska earthquake (photo modified from AP)

[https://twitter.com/Mo\\_Heidarzadeh/status/1068991587768836097/photo/1](https://twitter.com/Mo_Heidarzadeh/status/1068991587768836097/photo/1)



All from: <https://www.ktuu.com/content/news/BREAKING-Massive-earthquake-shakes-Alaska-501647481.html>

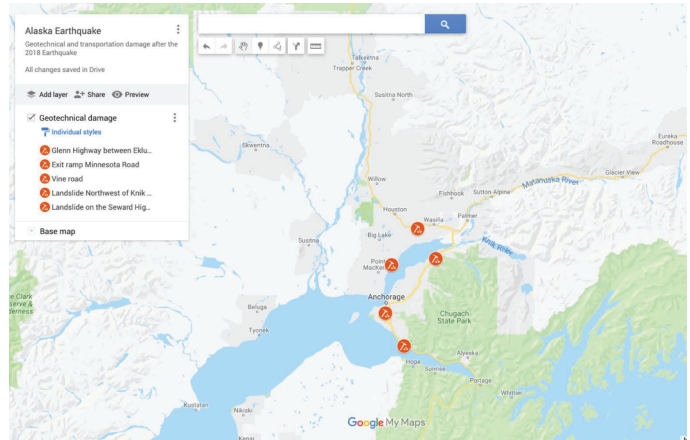
## A preliminary list of geotechnical-related damages (AK DOT)

- Bridge abutment failure
- Sinkhole
- Slope failure
- Road settlement
- Earth Retaining wall failure
- Minor liquefaction damage reported at residential building

[Spreadsheet on Google Drive](#)

Reference:

<http://dot.alaska.gov/earthquake2018/docs/Damage-Locations-earthquake2018updated.pdf>



Map on MyMaps

- <https://drive.google.com/open?id=1ICYq0G1SrS-P4dgZ0svJKoOxWpHdTzAu&usp=sharing>



# Topic #8: Transportation Networks (including roads)

## VERT Immediate Response for: Anchorage, Alaska M7.0 Earthquake

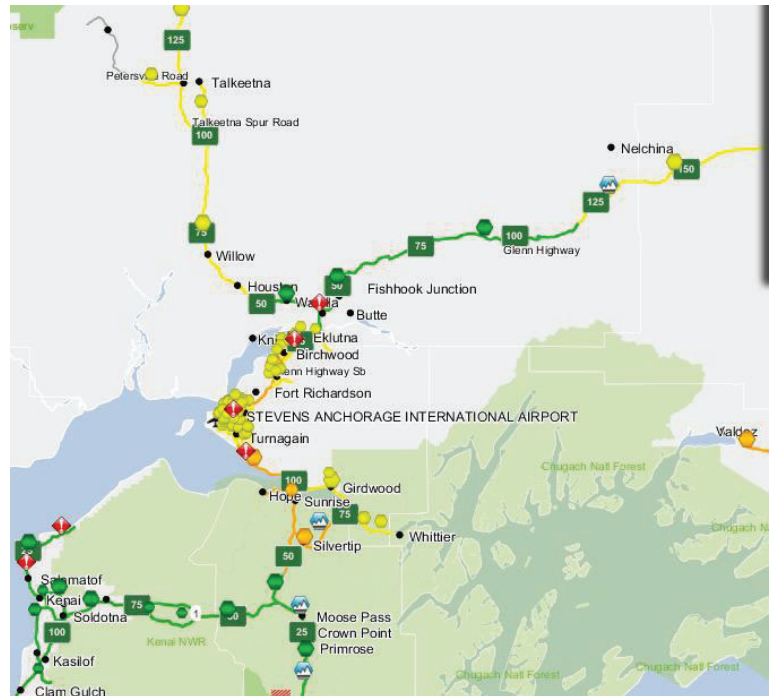


## Overview & how it affected various regions



Photos: Alaska DOT&PF [Flickr page](#), [NBC News](#)

Alaska DOT has posted a roads condition map at [511.alaska.gov/alaska511/mappingcomponent/index](http://511.alaska.gov/alaska511/mappingcomponent/index). The Anchorage area and Glenn Highway are illustrated in the map to the right. Click the thumbnail to enlarge.



Transportation network of Anchorage and nearby regions [Source](#)



# Overview & how it affected various regions

Dec. 1, 2018 8:00 a.m. General Information ([Alaska DOT](#))

- All DOT&PF Bridge inspectors are now in Southcentral Alaska and are conducting technical bridge inspections this morning.
- DOT&PF Maintenance and Construction crews are now actively working the eight major damage sites. Aftershocks are continuing to contribute to settling and additional cracking.
- DOT&PF has documented over 40 damage sites on transportation infrastructure.

## Glenn Highway

Glenn Highway North Bound Eagle River Bridge: Highway is closed, but detour is available through Eagle River. Construction crews are actively working on restoring the approaches.

Mirror Lake/Thunderbird Falls: Slope failure on both sides of the highway. AFTERSHOCKS AND SETTLING ARE EXPANDING THE DAMAGE TO DRIVING LANES. Detours are slow. Construction crews are actively repairing slope failures.

Parks/Glenn Interchange: Off-ramp toward Palmer is closed. Use Trunk Road detour via the Parks Highway to access Palmer. Construction crews are actively working to restore the approach/abutment.

## Seward Highway

Seward Highway MP 104-114: Rock fall continues in this area with continuing aftershocks and settling. DOT&PF recommends avoiding the area unless travel is absolutely necessary.

## Parks Highway

Parks / Glenn interchange has major damage. Off-ramp toward Palmer is closed. Use Trunk Road detour via the Parks Highway to access Palmer.

Bridges and roadways clear from Talkeetna north. All of Parks Highway is passable.

## Kenai Spur Highway

Damage at 35.1 and 35.7. Crack in road 150' by 8" wide. Road is passable. Damage at MP19.7. 500' long by 4" wide, still passable. Maintenance crews are actively repairing these sites.



## Overview

### Inspections:

- The Alaska Marine Highway System inspected terminals and no damage was reported.<sup>1</sup>
- The Whittier Tunnel was also inspected and found to be in good shape.<sup>1</sup>
- No significant bridge damage has been reported. Alaska bridges are design for seismic activity<sup>2</sup>

### Airport:

- A state official says Ted Stevens Anchorage International Airport is open and operating at reduced capacity with delayed flights following earthquakes and aftershocks.<sup>3</sup>
- Airport inbound flights were put on hold for a few hours after the earthquake.
- Alaska transportation and public facilities spokeswoman Meadow Bailey said Friday that no injuries were reported at the airport but light fixtures, water pipes and windows broke in the shaking.<sup>3</sup>

### Port of Alaska:

- The earthquake damaged several dock lights and overhead power lines that have been repaired. Inspectors confirmed that the dock cranes and other equipment are ready for regular operation.<sup>4</sup>
- The general cargo docks and trestles have all been inspected and are safe for regular shipping operations.<sup>4</sup>
- There are reported minor expansion joints damage





# Roadways damage

The ROADS impacted are as follows ([ktuu.com](http://ktuu.com)):

**Glenn Highway:** As of 9 p.m., Glenn Highway is open in both directions, though there are still delays and detours. Detours will continue through the weekend. DOT says to stay off the roads unless necessary.

**Seward Highway at Milepost 112** - Highway has been reopened

**Glenn Highway** - Near the Eklutna exit, a massive sink hole opened up in a wooded area off the highway. Part of the road was impacted. Tractor Trailers or semi-tractor trailers with doubles headed into Anchorage will be stopped prior to Mirror Lake.

**Northbound Eagle River Bridge** - Damage to the bridge is causing some inaccessibility issues. Avoid this area. There are detours

**Knik River Bridge** Periodic closures, according to DOT at 3:32 p.m.

**Vine Road** - A stretch of Vine Road was severely damaged with the road becoming destroyed and uneven from the quake. (Photo below)

**Kenai Spur Road at Milepost 35-39 and Milepost 19** - Road remains partially open, but the surface is damaged. DOT says it is passable but advises caution.

**Minnesota and International Airport Road off ramp** - Damage to the bridge is causing some inaccessibility issues. Avoid this area.

**New Seward and 36th Avenue** - Damage to the road, avoid the area.

**Dimond at Minnesota** - Detours

**Dowling at C Street** - Detours

**Eagle River Loop Rd. at Mills Bay Dr.** - Detours

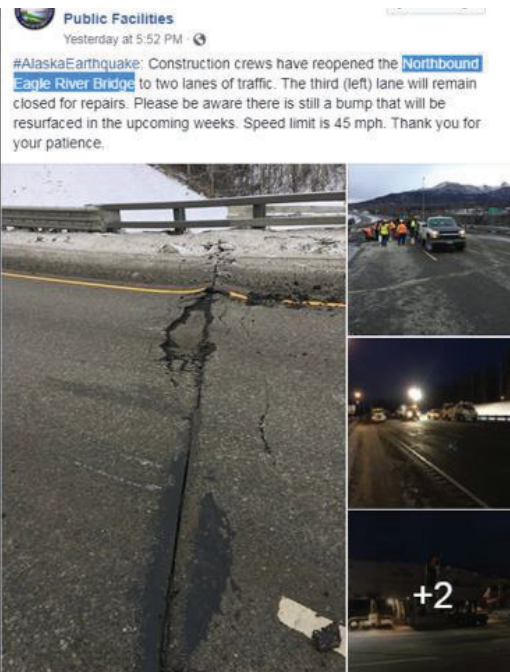
**Point Mackenzie Road** - Damage near Mile 1 - road is still passable, according to Deputy Director of Emergency Services Ken Barkley.



Glenn Highway and Eagle River Bridge ([Source](#))



# Bridges and Tunnels



Water main that failed under the pedestrian tunnel just to the north of Briggs Bridge over Eagle River [Source1](#), [Source2](#)

Eagle River Loop Road Bridge is closed. Glenn Highway Northbound Eagle River Bridge has one lane closed with speed reductions. Reported damage includes cracks in both substructures (e.g. abutments), superstructures (e.g. girder), retaining walls, foundation settlement, ([Source](#))



## Railroad Damage

- Railroad spokesman Tim Sullivan said Saturday there are three areas north of Anchorage that are impassible and preventing trains from making the trek between Anchorage and Fairbanks. The trip is 350 miles each way.
- Cracks up to 4 feet wide and 150-feet long have been found on either side of the tracks near Nancy Lake, about 45 miles north of Anchorage. The damage was caused by ground shifting, cracking or sloughing.
- Heavy equipment will be used to repair the tracks over the next few days. However, a complete inspection of the track and bridges hasn't been completed, so Sullivan said officials do not know when rail service to Fairbanks will resume.
- Train service south of Anchorage is scheduled to resume Sunday. Work also continues to clean up extensive water damage the railroad's operation center in Anchorage.

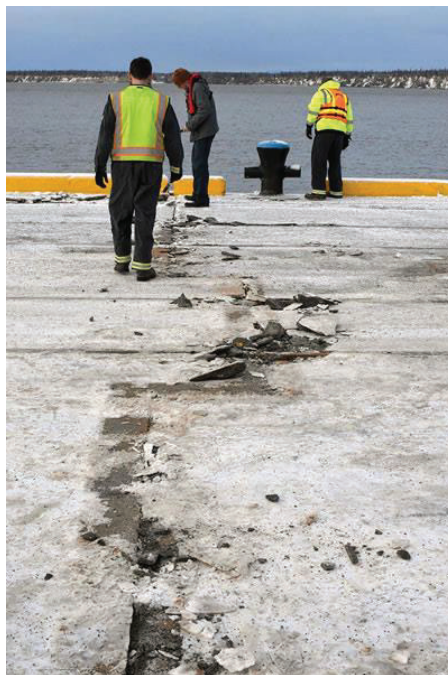
Source: ([ktuu.com](http://ktuu.com))



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## Port Damage



Minor Damages in [Port of Alaska](#)

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## Links to key media articles discussing Transportation Networks



**Federal Highway Admn** ✓  
@USDOTFHWA

Follow

The U.S. Department of Transportation’s Federal Highway Administration today announced the immediate availability of \$5 million in quick release Emergency Relief funds to help begin repairs on roads and bridges damaged by yesterday’s earthquake in Alaska.

5:00 PM - 1 Dec 2018

List of Road Damages by KTUU:

<https://www.ktuu.com/content/news/List-of-closures-caused-by-Anchorage--501659691.html>

Photo Slides from Earthquake Damages by Anchorage Daily News:

<https://www.adn.com/alaska-news/2018/12/01/it-will-be-in-the-millions-of-dollars-earthquake-damage-assessments-other-info-for-saturday/>

‘Severe delays and detours’ on inbound Glenn Hwy as officials recommend working from home:

<https://www.ktuu.com/content/news/Severe-delays-and-detours-on-inbound-Glenn-Hwy-as-officials-recommend-working-from-home-501726981.html>



## Topic #9: Other buildings damage

VERT Immediate Response for:  
Anchorage, Alaska M7.0 Earthquake





## Overview & and how it affected various regions

- “No reports of widespread catastrophic damage or collapsed buildings” source: AP News
- “The Anchorage Fire Department responded to four structure fires as a result of the quake, according to City Hall, and two reports of structure collapse are being investigated. No deaths have been reported.” source NYTimes (<https://www.nytimes.com/2018/12/01/us/anchorage-alaska-earthquake.html?action=click&module=News&pgtype=Homepage>)
- “A lot of drywall cracks and fallen ceiling tiles, but not major structural damage” Anchorage Daily News
- Most damage seems to be infrastructure: roads, lifelines
- Some superficial and non-structural damage was observed: partitions cracking and falling down, windows, ceilings and lighting
- Strong building codes likely prevented damage - and lessons learned from 1964 earthquake
- Large amounts of non-structural damage at the KTVA newsroom
- One collapse: Eagle River home

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## Overview & and how it affected various regions

- Primary damage in buildings is non-structural, heavier in older buildings and more cosmetic in newer buildings.
- Non-structural damage range from light cosmetic to water/sprinkler system/tanks and piping failure and flooding. Floor acceleration related bookcase and cabinet failure are widespread in all types of buildings. None of these appeared to have any strapping system. False ceiling panel failure is common in many buildings. In older buildings, ceiling railings insufficiently supported. Floor acceleration related heavier ceiling panels fell off although the metal railing system is totally intact.

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# Anchorage Building Code

- IBC /ASCE7
- Seismic design category D,
- Site Class B
- Spectral acceleration for MCE under short period:  $S_s = 1.5g$
- Spectral acceleration for MCE under 1s period:  $S_1 = 0.55g$
- Additional provisions and amendments:
  - AO 2015-127
  - AO 2016-52

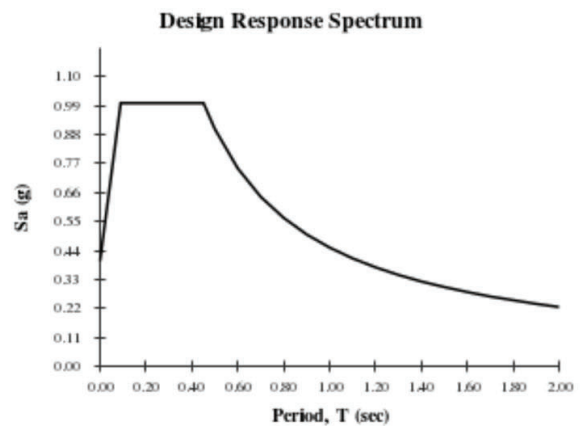
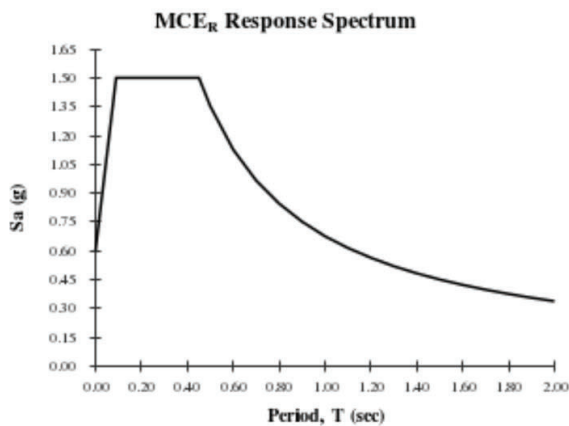


## ASCE 7 - MCE and DBE Spectrum

### USGS-Provided Output

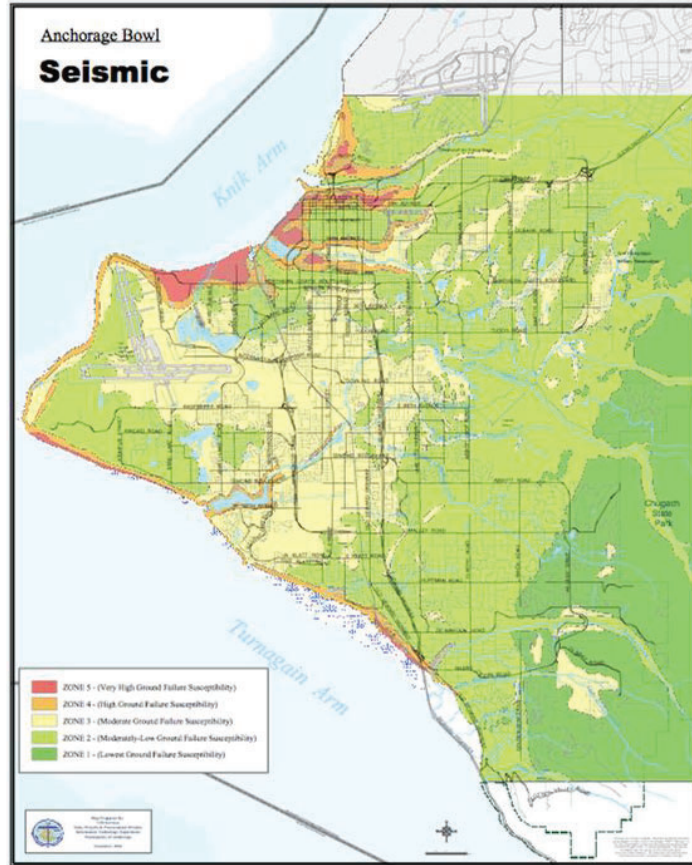
$S_s = 1.500\text{ g}$	$S_{MS} = 1.500\text{ g}$	$S_{DS} = 1.000\text{ g}$
$S_1 = 0.676\text{ g}$	$S_{M1} = 0.676\text{ g}$	$S_{D1} = 0.451\text{ g}$

For information on how the  $S_s$  and  $S_1$  values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





## Ground Failure Map



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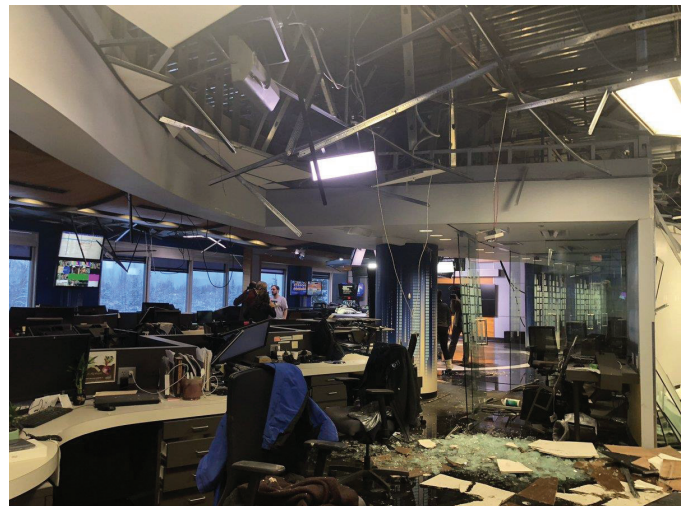
## Non-structural Building Damage



Office building damage, Anchorage



Church caught fire, Fairview



KTVA Newsroom

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## Atwood Building Sample Damage

Primarily non-structural. Building is yellow tagged.



There was also some water pipe failure and limited flooding on one of the floors

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## Eagle River Home Structural Damage



Partial collapse



Severe structural damage

Eagle river is 15 miles NE of Anchorage and closer to the epicenter of the earthquake

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## Links to key media articles discussing other building damage

- [https://www.washingtonpost.com/science/2018/11/30/major-damage-tsunami-warning-issued-after-severe-magnitude-earthquake-alaska/?utm\\_term=.42ae624aabe2](https://www.washingtonpost.com/science/2018/11/30/major-damage-tsunami-warning-issued-after-severe-magnitude-earthquake-alaska/?utm_term=.42ae624aabe2)
- <https://www.apnews.com/75f4de6bdf7541a0a944e72c9e6edf18>
- <https://www.nbcnews.com/science/environment/depth-alaska-earthquake-likely-prevented-more-damage-saved-lives-n942471>
- <https://www.nytimes.com/2018/12/01/us/anchorage-alaska-earthquake.html?action=click&module=News&pgtype=Homepage>
- <https://www.adn.com/alaska-news/2018/12/01/inspections-underway-across-southcentral-alaska-for-structural-damage-after-earthquake-aftershocks/>

### Building Code

- <https://www.muni.org/Departments/OCPD/development/BSD/Pages/Codes.aspx>
- [https://library.municode.com/ak/anchorage/codes/code\\_of\\_ordinances?nodet=TIT23BUCO](https://library.municode.com/ak/anchorage/codes/code_of_ordinances?nodet=TIT23BUCO)

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## Topic #10: Schools

VERT Immediate Response for:  
Anchorage, Alaska M6.7 Earthquake

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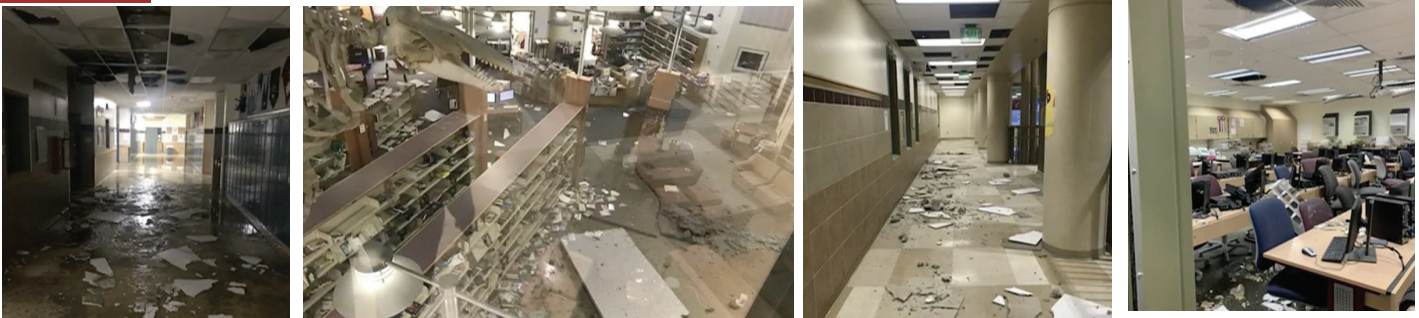
## Overview & and how it affected various regions

- ([KTUU - NBC](#)) Anchorage School District (ASD) status - Parents were asked to pick up students following earthquake as schools remained open. ASD will be closed Monday and Tuesday to assess facility damage (Closure extended until the following Monday on Dec 1). Buses used for evacuations first and then used to conduct normal routes ([Twitter](#)). Note that KTUU lists 4 shelter locations, none of which are schools.
- ASD states that all schools will be closed until further notice ([Twitter](#))
- ([Twitter](#)) Student evacuation/relocation
  - Eagle River High School students remained on site in buses
  - First Lake Elementary evacuated to MAC Center
  - Government Hill evacuated to AT&T
  - Russian Jack evacuated to East High
  - "Turnagain Elementary" evacuated to Lloyd Steele Park
- All Anchorage schools will be closed for the next week while the district fixes widespread damage and most schools in the Matanuska-Susitna Borough School District will be closed Monday and Tuesday([Anchorage Daily News](#))
- All damage seems to be non-structural but heavy. Confirmation needed from field team.

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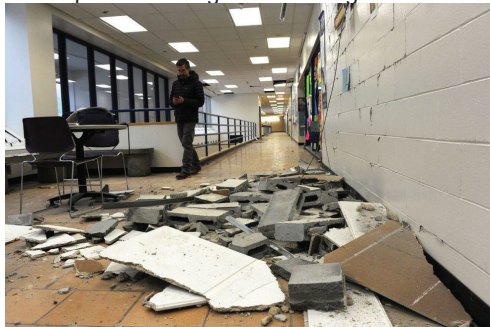
## Overview & and how it affected various regions



([Hawaii News Now](#)) Dimond High School - suspended ceilings and building contents



([Twitter](#)) Damage to school floor - school name not yet identified



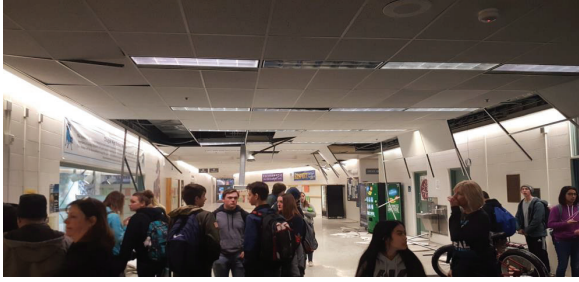
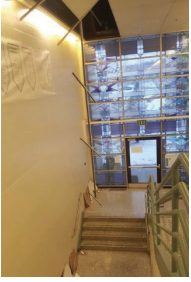
([Anchorage Daily News](#)) Damage to cinder block wall (non-weight bearing) and ceiling at King Tech High School

65





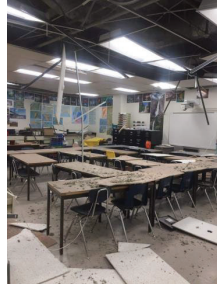
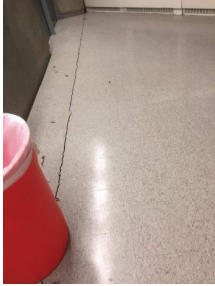
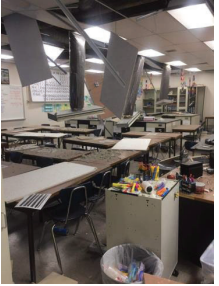
## Overview & how it affected various regions



([Twitter](#)) Chugiak High School - damage to suspended ceilings



([Anchorage Daily News](#)) Failure of ceilings in some classrooms at Hanshew Middle School



([Twitter](#)) Bartlett High School

([Twitter](#)) See Video - damage to suspended ceilings, school unidentified



## Links to key media articles discussing Schools

- <https://www.ktuu.com/content/news/List-of-closures-caused-by-Anchorage--501659691.html>
- <http://www.hawaiinewsnow.com/video/2018/11/30/damage-alaska-high-school/>



# Topic #11: Housing

## VERT Immediate Response for: Anchorage, Alaska M6.7 Earthquake

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### Overview & how it affected various regions

- Building codes are quite followed and enforced in the City of Anchorage although sometimes follow-up is lacking. Thus, most Anchorage residential damage was non-structural.
- No permit requirement is in effect in Eagle River, Chugiak, Peter Creeks, and similar smaller cities and communities in the Anchorage Borough. It appears that more serious damage is evident in those communities. EERI Field Team to confirm.



Residential Building in Eagle River damaged due to earthquake  
<https://www.adn.com/alaska-news/2018/12/01/anchorage-fire-chief-how-to-look-for-serious-structural-damage-at-home/>

69





## Collapsed Masonry walls



Collapsed Masonry Walls in Eagle River, Alaska

<https://www.adn.com/alaska-news/2018/12/02/the-day-after-alaskans-sweep-up-and-reflect-following-70-quake/#>



## Partially collapsed two storey housing



Partially collapsed two story home on Dome Circle in Eagle River

<https://www.adn.com/alaska-news/anchorage/2018/12/03/eagle-river-couple-lucky-after-home-collapses-in-earthquake/>





## Major and Minor Cracks



Both Major and Minor cracks were reported by residents at different locations

<https://twitter.com/hashtag/earthquake?src=hash>

<https://www.thealaskalife.com/blog/alaska-earthquake-damage-stats-photos-videos-of-the-aftermath/>

<https://www.usnews.com/news/news/articles/2018-11-30/alaska-surveys-damage-from-major-earthquakes>

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## Links to key media articles discussing Housing

- <https://www.nbcnews.com/news/us-news/earthquake-hits-alaska-triggering-tsunami-warning-n942256>
- <https://www.adn.com/alaska-news/2018/12/02/the-day-after-alaskans-sweep-up-and-reflect-following-70-quake/#>
- <https://www.adn.com/alaska-news/2018/12/01/anchorage-fire-chief-how-to-look-for-serious-structural-damage-at-home/>
- <https://www.bbc.com/news/world-us-canada-46403405>

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- ADN (2018). <https://www.adn.com/alaska-news/2018/12/02/do-anchorage-residents-still-need-to-boil-their-water-yes-and-no-city-officials-say/>
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- ADN (2018). <https://www.adn.com/alaska-news/anchorage/2018/11/30/anchorage-airport-open-again-for-arrivals-after-landings-were-halted-due-to-earthquake/>
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- Alaska DOT&PF Damage Locations report <http://dot.alaska.gov/earthquake2018/docs/Damage-Locations-earthquake2018.pdf>
- Alaska DOT&PF Update <http://dot.alaska.gov/earthquake2018/>
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- CNN (2018). <https://www.cnn.com/2018/11/30/us/alaska-earthquake/index.html>
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- USGS (2018). <https://earthquake.usgs.gov/earthquakes/eventpage/us1000hyfh/executive>
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StEER also appreciates the collaboration with the Earthquake Engineering Research Institute (EERI) and its Virtual Earthquake Reconnaissance Team (VERT) and the leadership they displayed in encouraging and facilitating this first joint report. Heidi Tremayne, Maggie Ortiz-Millan, and Zoe Yin were incredibly proactive in their partnership with StEER on earthquake response in general, and with particularly urgency when this event occurred. We further recognize the VERT co-chairs, Erica Fischer and Manny Hakhamaneshi for their collaboration in aligning the efforts of our virtual teams. The efforts of all VERT members (see Appendix B for full listing) are greatly appreciated.

The sharing of videos, damage reports and briefings via DesignSafe-CI's Slack channel (#alaska) was tremendously helpful and much appreciated. These collaborations and exchanges of critical data benefited greatly from the work of the DesignSafe CI team who continuously supported and responded to StEER's emerging needs, including rapidly activating VAT members on Slack. Special thanks to Tim Cockerill for his responsiveness and leadership.

## About StEER

The National Science Foundation (NSF) awarded a 2-year EAGER grant (CMMI 1841667) to a consortium of universities to form the Structural Extreme Events Reconnaissance (StEER) Network. StEER's mission is to deepen the structural natural hazards engineering (NHE) community's capacity for reliable post-event reconnaissance by: (1) promoting community-driven standards, best practices, and training for RAPID field work; (2) coordinating official event responses in collaboration with other stakeholders and reconnaissance groups; and (3) representing structural engineering within the wider extreme events reconnaissance (EER) consortium in geotechnical engineering (GEER) and social sciences (SSEER) to foster greater potentials for truly interdisciplinary reconnaissance. StEER also works closely with the NSF-supported Natural Hazards Engineering Research Infrastructure (NHERI) RAPID facility and cyberinfrastructure Reconnaissance Portal to more effectively leverage these resources to benefit StEER missions.

StEER relies upon the engagement of the broad NHE community, including creating institutional linkages with dedicated liaisons to existing post-event communities and partnerships with other key stakeholders. While the network currently consists of the three primary nodes located at the University of Notre Dame (Coordinating Node), University of Florida (Atlantic/Gulf Regional Node), and University of California, Berkeley (Pacific Regional Node), StEER aspires to build a network of regional nodes worldwide to enable swift and high quality responses to major disasters globally.

StEER's founding organizational structure includes a governance layer comprised of core leadership with Associate Directors for the two primary hazards as well as cross-cutting areas of Assessment Technologies and Data Standards, led by the following individuals:

- **Tracy Kijewski-Correa (PI)**, University of Notre Dame, serves as StEER Director responsible with overseeing the design and operationalization of the network.
- **Khalid Mosalam (co-PI)**, University of California, Berkeley, serves as StEER Associate Director for Seismic Hazards, leading StEER's Pacific Regional node and serving as primary liaison to the Earthquake Engineering community.
- **David O. Prevatt (co-PI)**, University of Florida, serves as StEER Associate Director for Wind Hazards, leading StEER's Atlantic/Gulf Regional node and serving as primary liaison to the Wind Engineering community.
- **Ian Robertson (co-PI)**, University of Hawai'i at Manoa, serves as StEER Associate Director for Assessment Technologies, guiding StEER's development of a robust approach to damage assessment across the hazards.
- **David Roueche (co-PI)**, Auburn University, serves as StEER Associate Director for Data Standards, ensuring StEER processes deliver reliable and standardized reconnaissance data.

StEER's response to the 2018 Alaska Earthquake preceded the formation of its official policies, protocols and membership, which are still in active development. All policies, procedures and protocols described in this report should be considered preliminary and will be refined with community input as part of StEER's operationalization in 2018-2019.

# StEER Event Report Library

2018

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