



Credit: Wael Hassan



Janise Rodgers / Janise Rodgers, accessed through EERI photo-archive
Credit: Janise Rodgers

M7.1 Anchorage, Alaska Earthquake Reconnaissance Results

Structural and Nonstructural Damage

Wael M. Hassan, Ph.D., S.E.



Associate Professor
University of Alaska, Anchorage

Acknowledgement: Janise Rodgers, John Thornley, Chris Motter



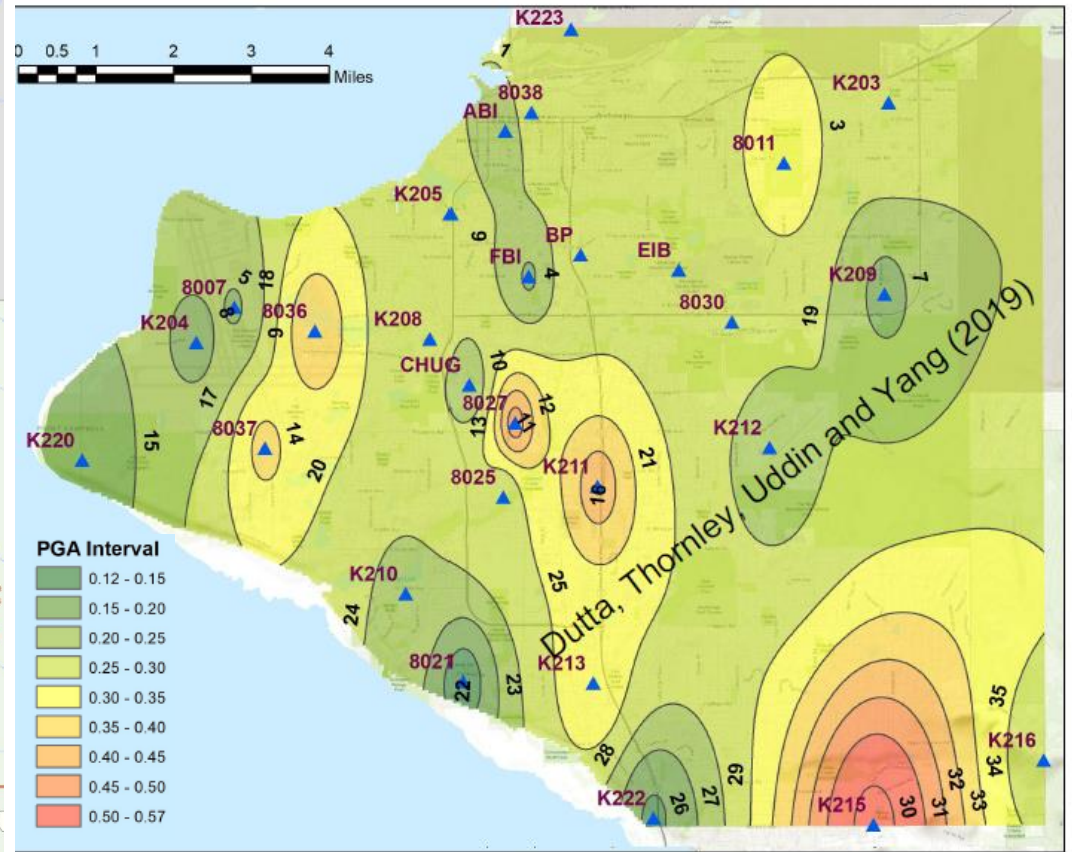
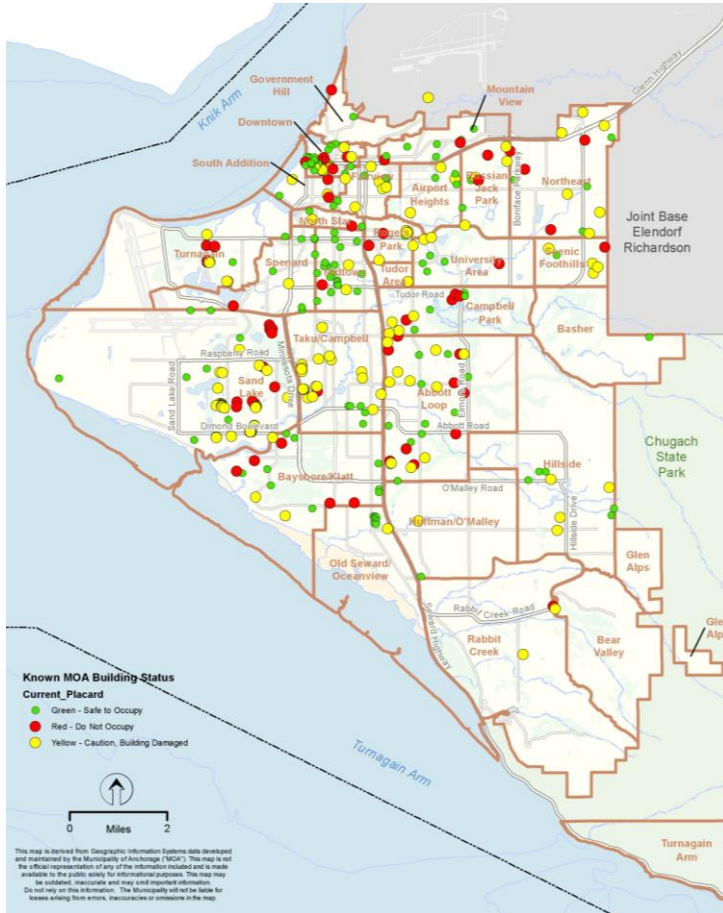
Overview

- Minor structural damage (engineered/newer)
- Moderate structural damage (non-engineered/older)
- No collapses, fatalities or serious injuries
- Moderate to heavy non-structural damage
- Widespread piping/equipment and water damage
- Contrast to Christchurch 2011? Have we really been tested?

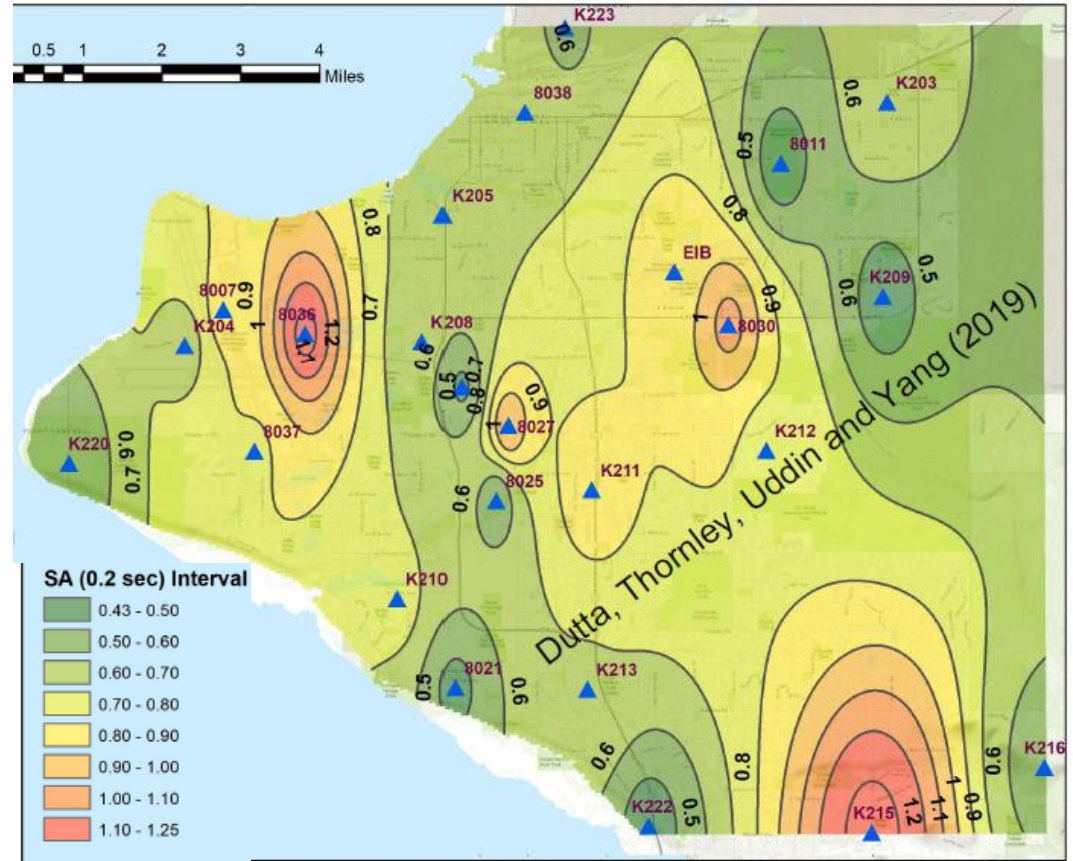
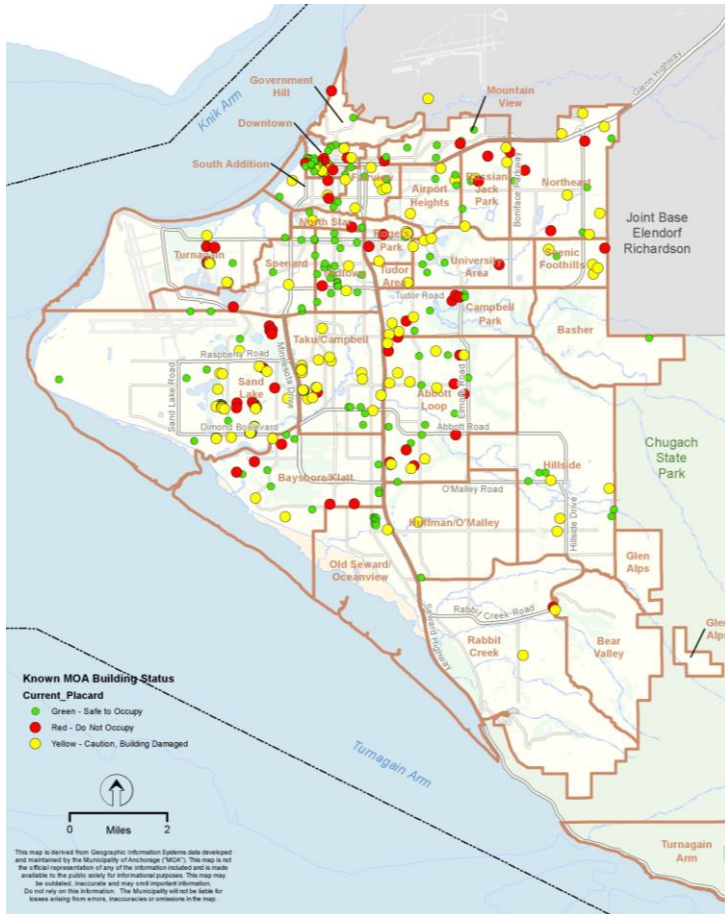
Building Code Background

- Changes Following 1964 M9.2 Earthquake
- NEHRP 1977
- Seismic details early to mid-eighties (UBC 1979)
- Currently IBC 2012
- Local Alaska Building Code Amendments
- Level of enforcement varies (all building types)

Damage Correlation to Shaking Intensity

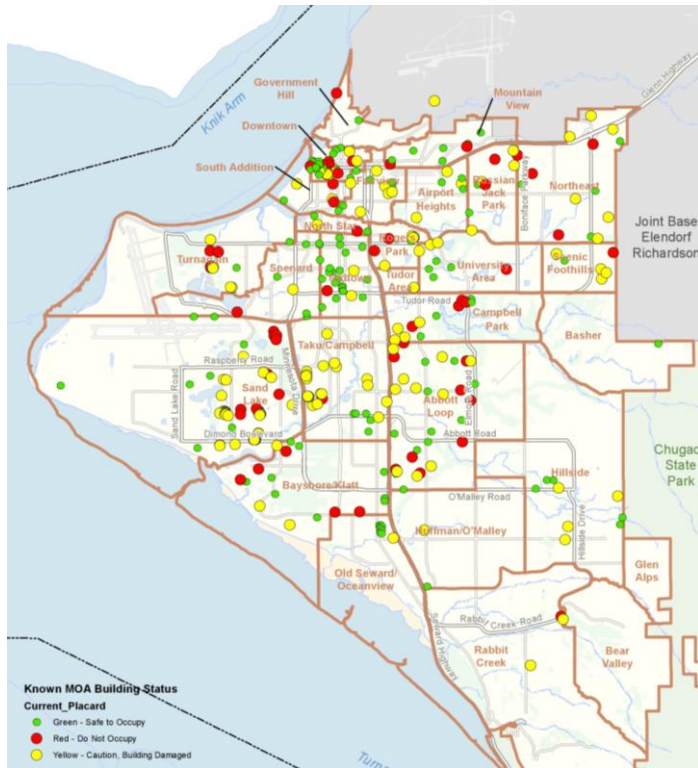


Damage Correlation to Shaking Intensity

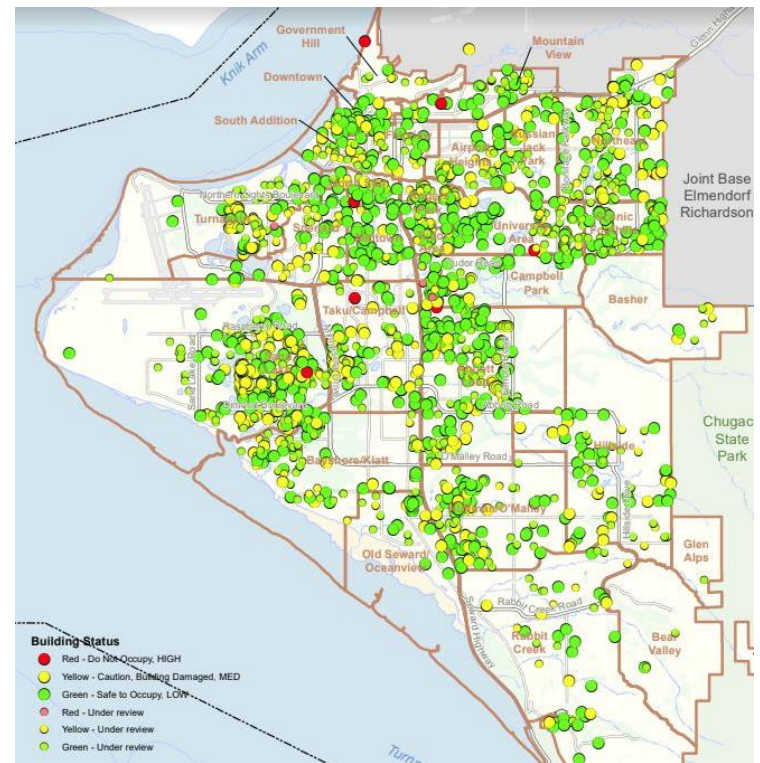


Damage Correlation to Shaking Intensity

Dec 10, 2018



Jan 30, 2019



Damage Distribution

MOA Inspection Data

- **Anchorage:**

Requests: 2228 (2%)

Inspected: 1298 (1.18%)

Red: 28 (0.025%)

Yellow: 606 (0.55%)

- **North Communities:**

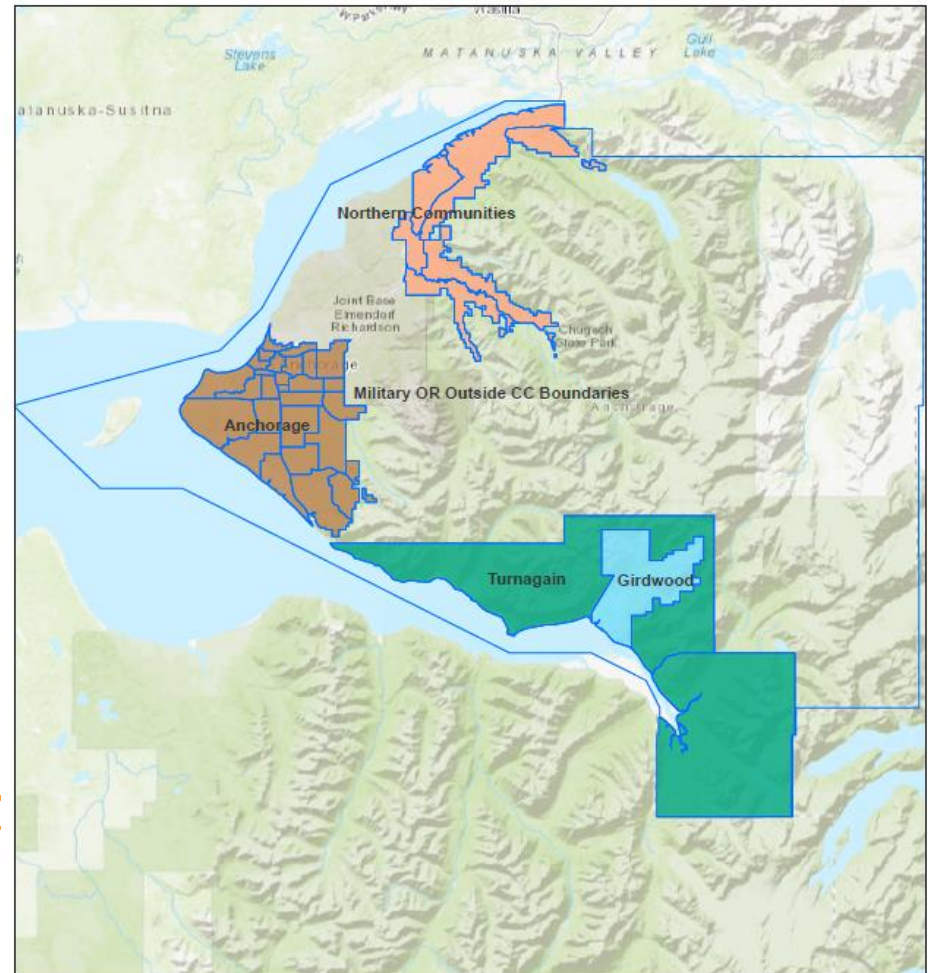
Requests: 1068 (7.43%)

Inspected: 851 (5.92%)

Red: 62 (0.43%) (20 times ANC)

Yellow: 252 (1.75%) (3 times ANC)

MOA Earthquake Building Inspections Summary



Observed Damage Overview

● Structural Damage

- Single-family residential foundation and foundation related damage
- Retaining wall shear cracking (mostly above ground)
- Severe damage/partial collapse: few non-engineered single family residential
- CMU wall damage (even in post 1980s)
- Shear cracks in concrete girders and shear walls
- Out-of-plane masonry wall buckling/deformation
- CMU wall diagonal cracks
- CMU connection detachment from floors (especially with no column)
- Floor joist unseating

Observed Damage Overview

- **Nonstructural Damage**

- Ceiling grid failure and/ or tile fall
- Glass and façade breakage
- Masonry veneer cracking/failure
- Drywall cracking
- Partition wall damage

- **MEP & Equipment Damage**

- Water flooding due to firefighting system damage (sprinklers, piping, tanks)
- Water boilers sliding and connection failure (with severe water flooding)
- Electric panels, wiring, elevators counterweights
- Gas lines pipe and connection damage

Observed Damage

Residential



Credit: Wael Hassan



Credit: Chris Motter



Credit: Chris Motter



Credit: ADN



Observed Damage

Residential Buildings (Mat-Su)



Credit: Chris Motter



Credit: Janise Rodgers

Observed Damage

Residential Wood Buildings (Mat-Su)



Credit: Wael Hassan



Credit: Chris Motter

Observed Damage

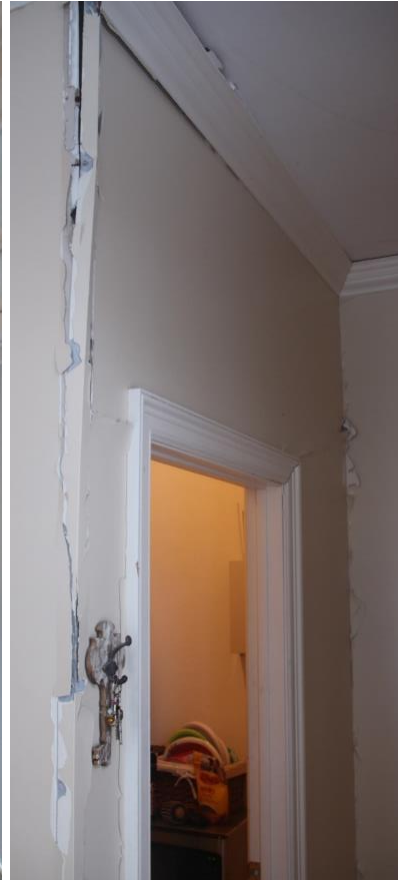
Residential Wood Buildings (Mat-Su)



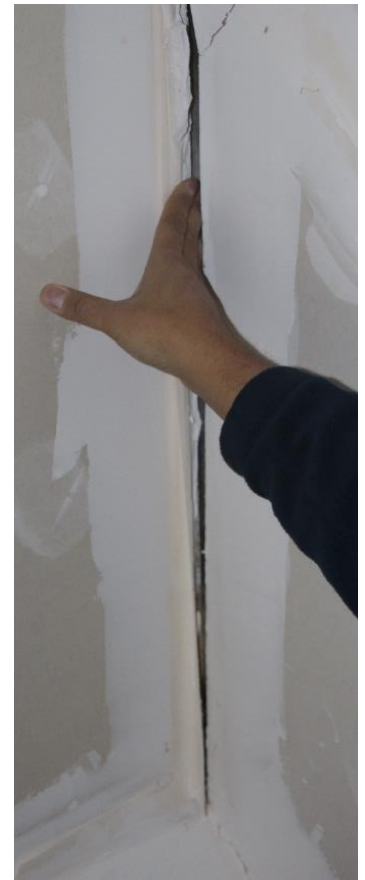
Credit: Janise Rodgers



Credit: Chris Motter



Credit: Chris Motter



Credit: Chris Motter

Observed Damage

Commercial (Anchorage)



Credit: Wael Hassan

Observed Damage

Commercial (Eagle River)



Credit: Chris Motter



Credit: Wael Hassan

Observed Damage

Commercial (Eagle River)



Credit: Chris Motter



Credit: Wael Hassan

Observed Damage

Commercial (Eagle River)



Credit: Wael Hassan



Credit: Wael Hassan



Credit: Wael Hassan

Observed Damage

Office Buildings (Anchorage)



Credit: MOA

Observed Damage

Office Buildings (Anchorage)



Credit: Wael Hassan



Credit: Wael Hassan

Brace Foundation Failure

Observed Damage

High-Rises (Anchorage)



Credit: Wael Hassan



Concrete girder shear cracking
Aftershocks effect

Credit: Wael Hassan

Boiler
Failure



Credit: Wael Hassan

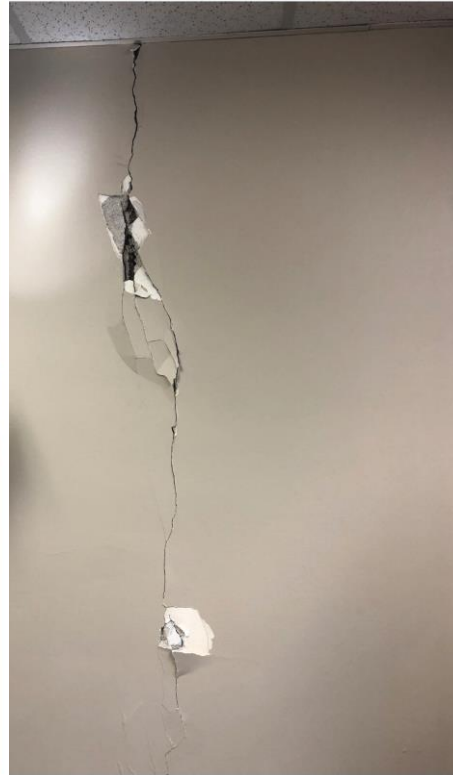


Observed Damage

Mid-rise Buildings (Anchorage)



Patrick Murren



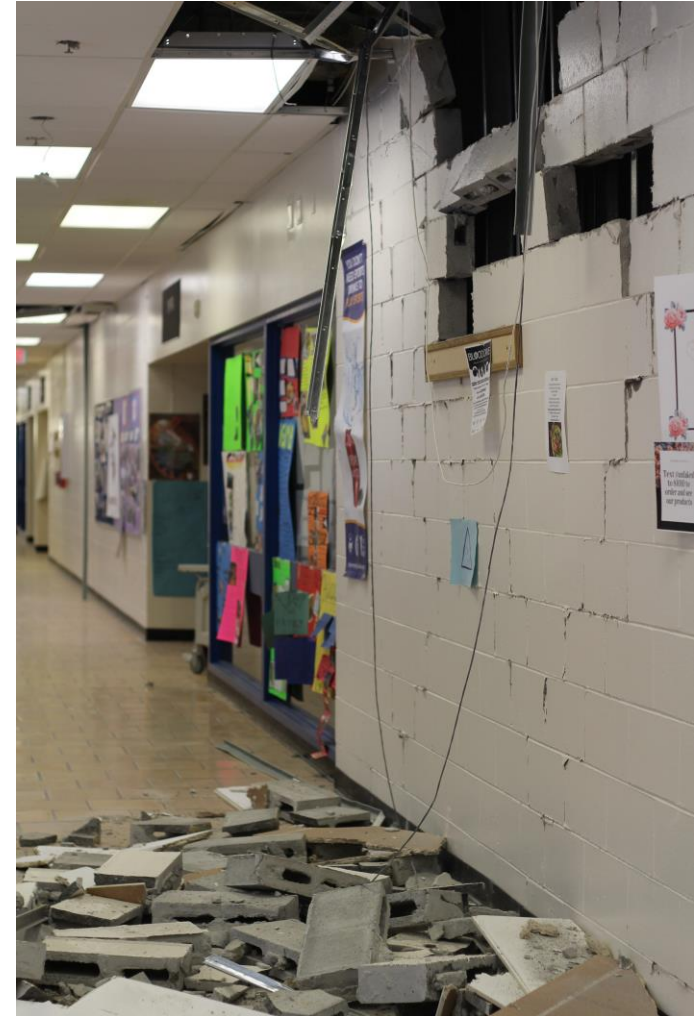
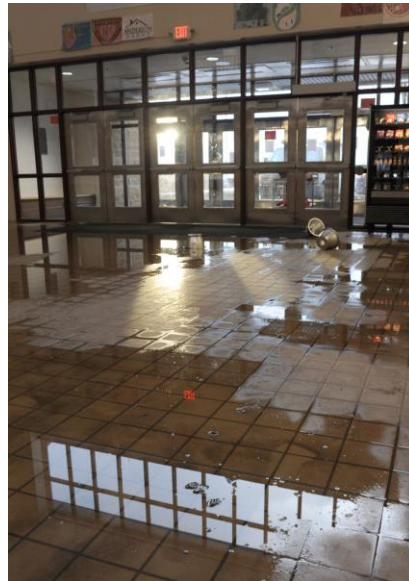
Patrick Murren



EERI

Schools and Educational Buildings

Anchorage Schools



Schools and Educational Buildings

Anchorage School District

- 85 of 97 schools had sort of damage
- Only two schools had moderate to severe structural damage (CMU); still shut down
- 15 schools received thorough structural eval due to minor structural damage, 7 of which in Eagle River
- Schools reopened Dec 10
- Estimated PGA 0.2-0.3g

Mat-Su School District

- Most of 50 schools had sort of damage
- Only two schools had moderate to severe structural damage (CMU); still shut down
- 11 schools suffered minor structural damage
- Schools reopened Dec 2 thru Dec 5
- Estimated PGA 0.2-0.3g

Credit: Rodgers et al 2019

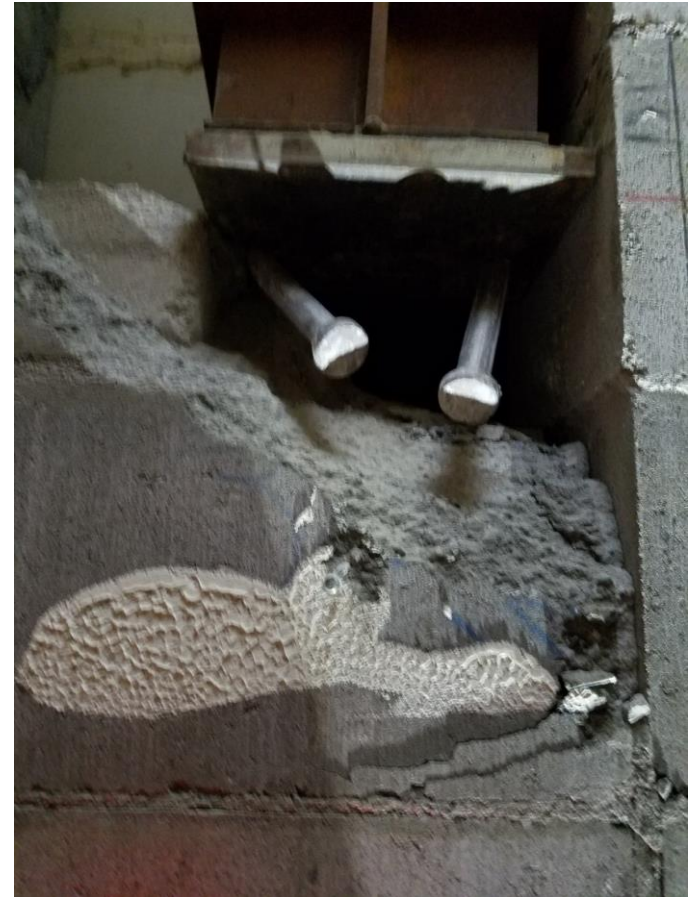


Schools and Educational Buildings

Mat-Su Valley Schools



Credit: Chris Motter



Credit: Bill Noyes

Schools and Educational Buildings

Mat-Su Valley Schools



Credit: Wael Hassan



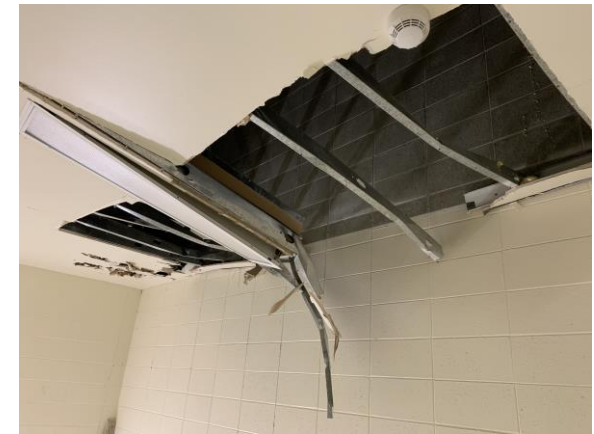
Credit: Wael Hassan



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Credit: Wael Hassan

Schools and Educational Buildings

Mat-Su Valley Schools



Credit: MSVSD

Schools and Educational Buildings

Mat-Su Valley Schools



Credit: MSVSD



Schools and Educational Buildings

Mat-Su Valley Schools



Credit: Janise Rodgers



Credit: Janise Rodgers

Schools and Educational Buildings

Mat-Su Valley Schools



Credit: Mat-Su School District

Schools and Educational Buildings

Mat-Su Valley Schools



Credit: Janise Rodgers



Schools and Educational Buildings

Eagle River (Anchorage Borough)



Credit: Chris Motter



Credit: Chris Motter



Credit: Chris Motter

Schools and Educational Buildings

Eagle River (Anchorage Borough)



Credit: Chris Motter

Schools and Educational Facilities

University of Alaska, Anchorage Campus



Credit: UAA



Credit: Wael Hassan



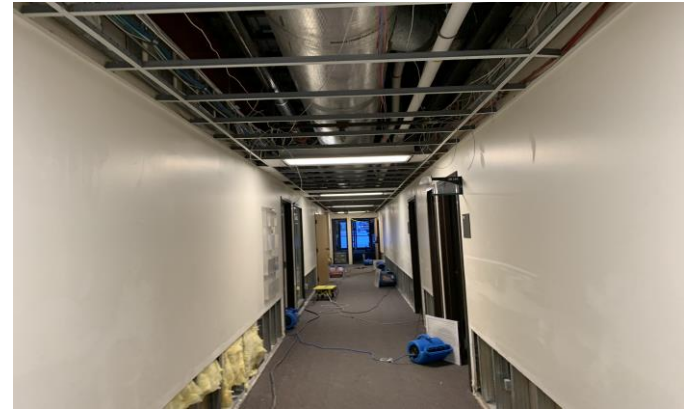
Credit: Wael Hassan



Credit: Wael Hassan

Schools and Educational Buildings

University of Alaska, Anchorage (Eagle Rive Campus)



Photos Credit: Wael Hassan



Hospitals and Healthcare Facilities

Four Major Hospitals in Anchorage Borough & one in Mat-Su:

- Alaska Regional
- Providence Medical Center
- Alaska Heritage
- VA Hospital
- Mat-Su Regional

Questions aside from reporting damage:

- Loss estimation studies for DDD under MCE? **DEMAND?**
- Resilience studies: hospital operation resumption after MCE? **CAPACITY?**
- One emergency room down during MCE? **CAPACITY?**
- Emergency air transport capabilities after MCE? **CAPACITY?**
- Communication network failure in MCE? **CAPACITY?**
- **All above D/C ratios in severe winter conditions? CAPACITY?**



Hospitals and Healthcare Facilities

Concrete Shear Walls



Credit: Wael Hassan

Hospitals and Healthcare Facilities

Concrete Shear Walls



Credit: Wael Hassan

Hospitals and Healthcare Facilities

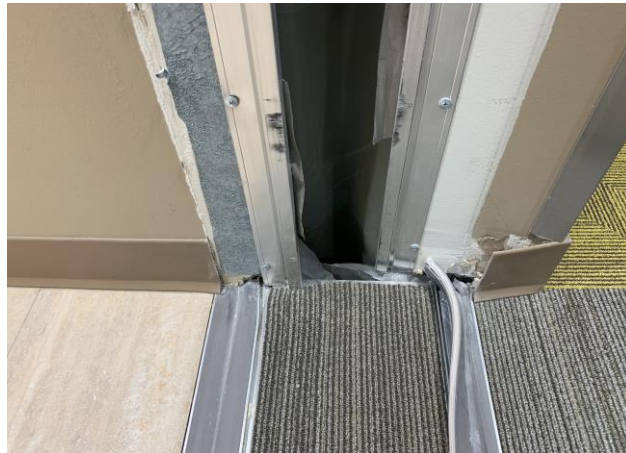
Water Flooding



Credit: Wael Hassan

Hospitals and Healthcare Facilities

Nonstructural Damage



Photos Credit: Wael Hassan

Hospitals and Healthcare Facilities

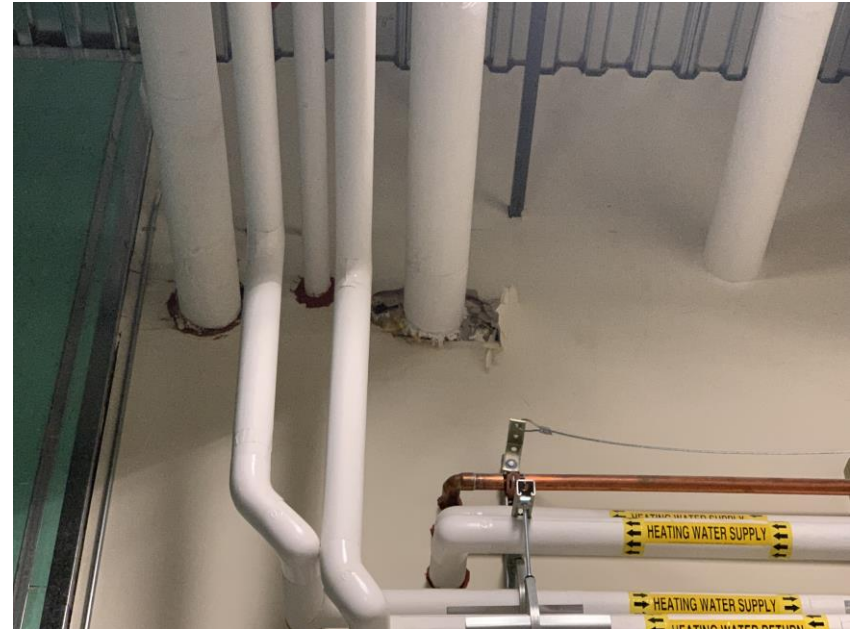
Nonstructural Damage



Photos Credit: Wael Hassan

Hospitals and Healthcare Facilities

Nonstructural Damage



Photos Credit: Wael Hassan

Hospitals and Healthcare Facilities

Mat-Su Regional Hospital



Photos Credit: Janise Rodgers



Photos Credit: Janise Rodgers

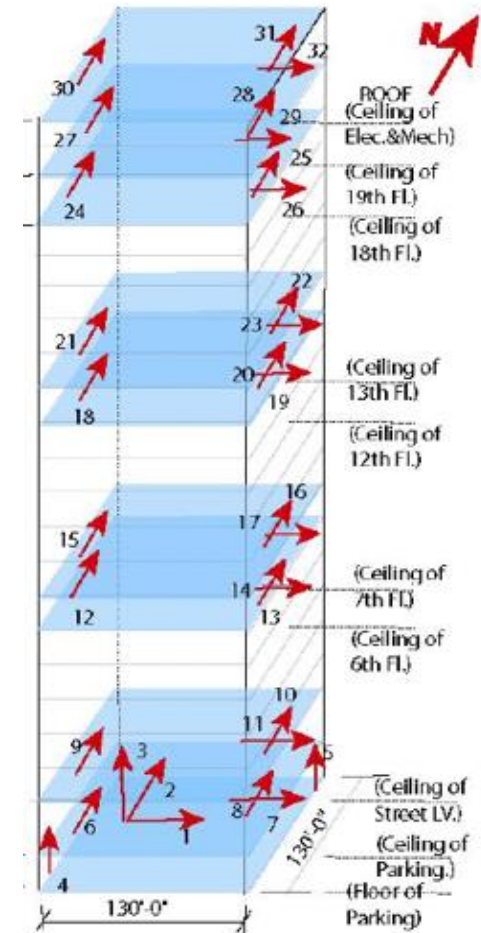
Performance of Instrumented & Tall Buildings

- Atwood Building
- Frontier Building
- BP Building
- EIB Building
- VA Hospital Building
- Hilton Tower
- Port Access Bridge

Performance of Instrumented Buildings

Atwood Building 20 Story, Steel Frame/Shear Wall (1982)

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



Credit: M. Celebi

Performance of Instrumented Buildings

Atwood Building 20 Story, Steel Frame/Shear Wall



Credit: Wael Hassan



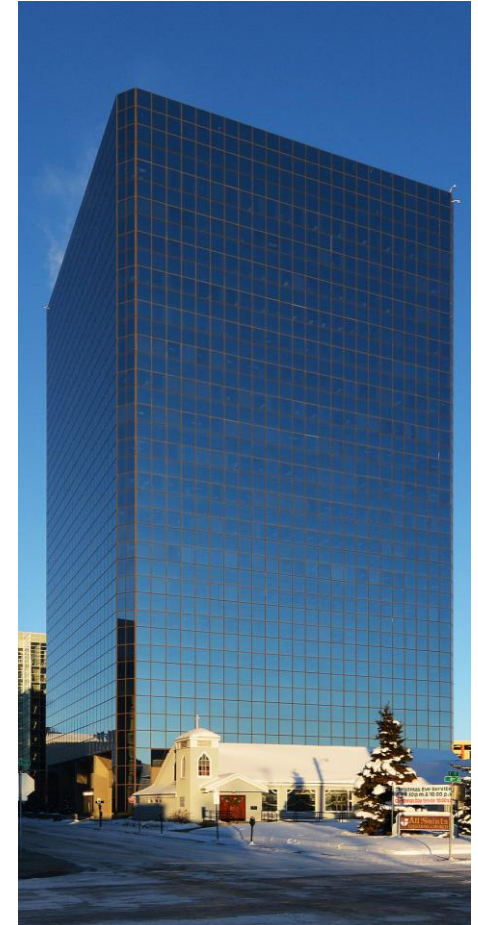
Credit: Wael Hassan



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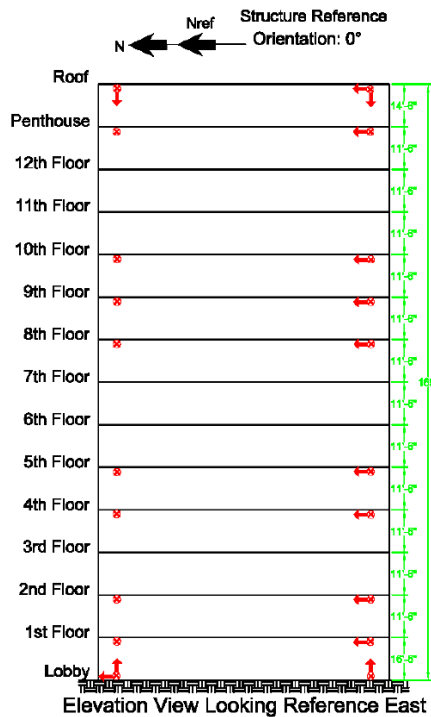
Credit: Wael Hassan



Credit: Unknown

Performance of Instrumented Buildings

Frontier Building (Concrete Framing) 1985



Credit: USGS

PGA 0.193g
PRA 0.223g



Credit: Wael Hassan



Credit: Wael Hassan



Performance of Instrumented Buildings

Frontier Building (Concrete Frame) 1985



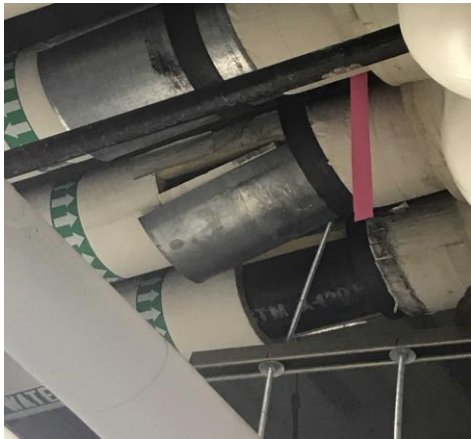
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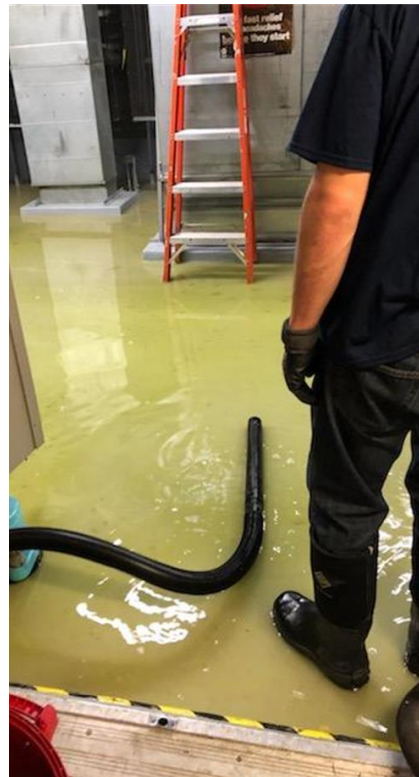
Credit: Wael Hassan

Performance of Instrumented Buildings

BP Building 14 Story (1984)



Credit: BP



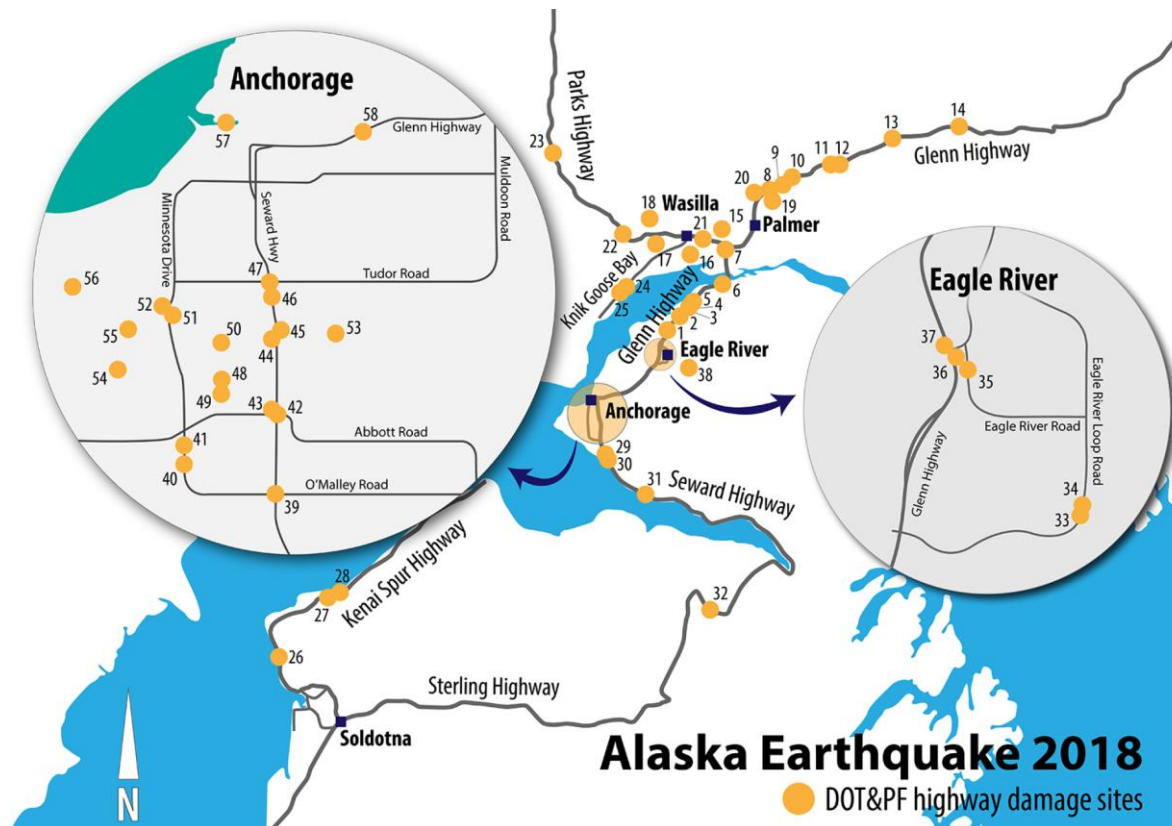
Credit: BP



Credit: Wael Hassan

Bridges

- 245 bridge structures
- 20 bridges with light to moderate structural damage



Bridges

Anchor Bolts



Credit: Nick Murray/Ben Still

Bridges

Wing and Hider Wall Cracks



Credit: Nick Murray/Ben Still



Credit: Nick Murray/Ben Still

Bridges

Abutments



Credit: Jesse Escamilla/Ben Fetterhoff

Lifelines

Bridge Bearing



Credit: Nick Murray/Ben Still

Bridges

Shear Keys



Credit: Sara Manning/Fred Paulsen



Credit: Sara Manning/Fred Paulsen

Bridges

Bridge Displacement



Transverse

Credit: Nick Murray/Ben Still



Longitudinal

Credit: Jesse Escamilla/Ben Fetterhoff

Lifelines

VERT Report (Hassan et. al, 2018), StEER Report 2018,
EERI LFE Report (Hassan et. al Aug 2019)

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



Credit: Hassan, et al. VERT Report

Acknowledgements

- MOA
- AK DOT
- Utpal Dutta
- UAA
- PEER
- Anchorage Mayor
- Facility Management teams at AWWU, UAA, Hospitals, BP, Frontier, School Districts

- More information available at:

<http://learningfromearthquakes.org/2018-11-30-anchorage-alaska/>



Thank You

