

30 Nov 2018 Alaska M7.0 Earthquake:

Anchorage Bowl Mobile Homes & Chimneys

Quick Report

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Preliminary Findings

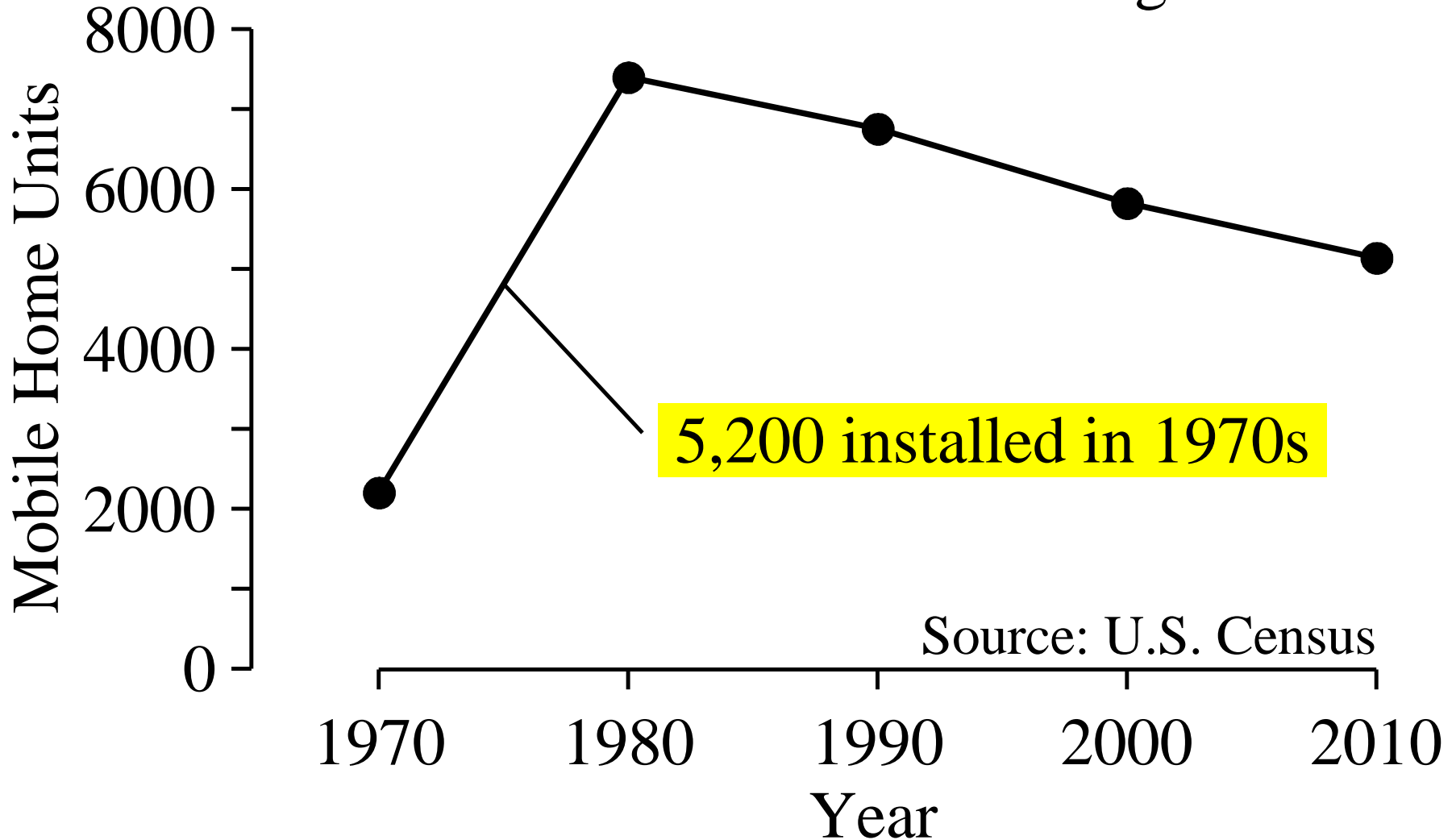
- Mobile homes
 - No reported collapses (toppling off piers)
 - Apparently only slight damage
 - Performed better than expected
 - Compared to California
- Chimneys
 - Survey teams report few damaged
 - Still better than expected performance
 - Compared to California
- *Why the difference...?*

Mobile Homes



Anchorage Mobile Homes

Mobile homes in Anchorage

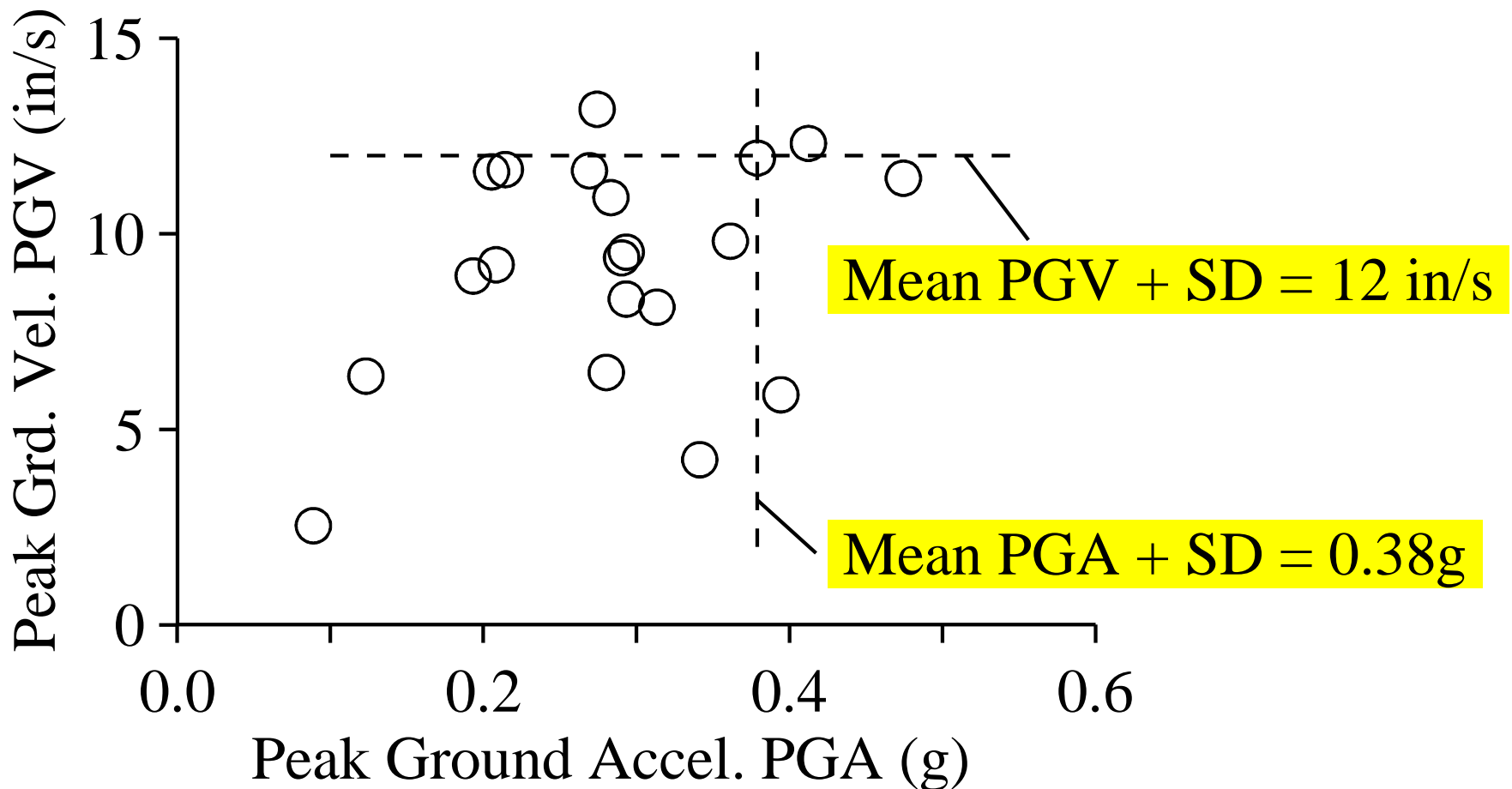


1970s Enabling Legislation

- 1971 Alaska law AS 45.30
 - Deals with mobile homes
 - Based on NFPA 501B (*aka* ANSI 119.1)
 - Rules for tie-downs
- 1976 Dept of Housing & Urban Dev. (HUD)
 - Set nation-wide “HUD-code” certification
 - Requires tie-downs on all mobile homes

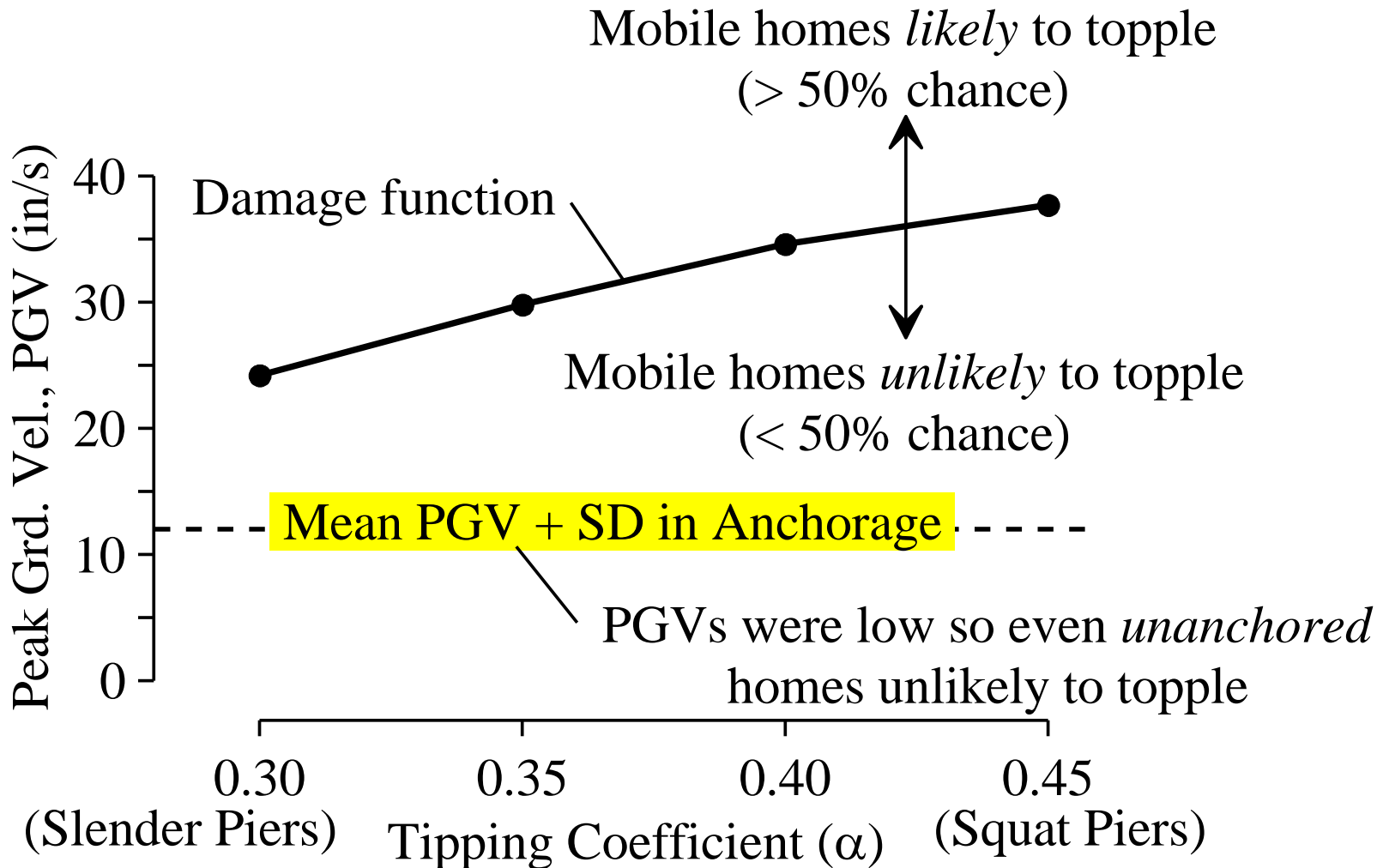
2018 Alaska Earthquake (M7.0)

- 17 recording stations in Anchorage Bowl
- $PGA < 0.4g$ and $PGV < 12$ in/sec



Mobile Home Damage Function

- For *Unanchored* mobile homes



Why Good Performance...?

- 1970s mobile homes were tied-down
 - Anchorage historic high wind area
 - Recent memory of Great 1964 quake
- Low PGV in Anchorage Bowl
 - Even *unanchored* homes unlikely to collapse
- Contrast with California
 - Many older mobile homes *lack* tie-downs
 - Suffer collapses during earthquakes

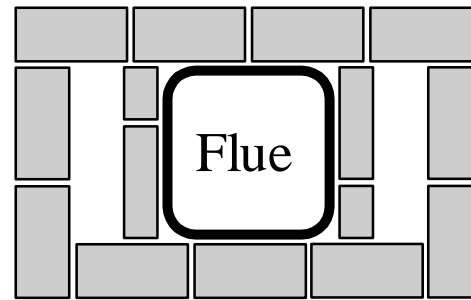
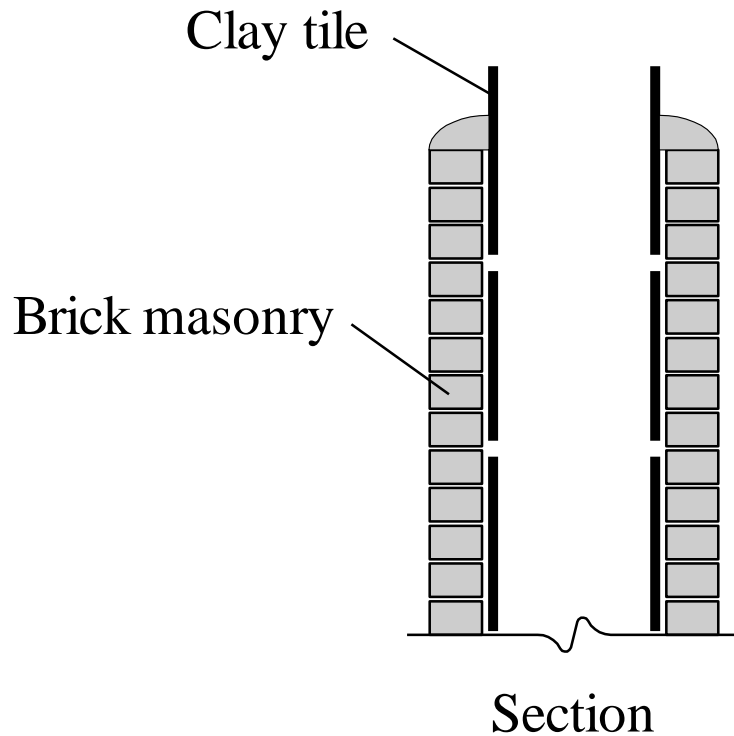
Anchorage Chimneys

- Two types:
 - Masonry (on older homes)
 - Metal flue in wood chase (newer homes)



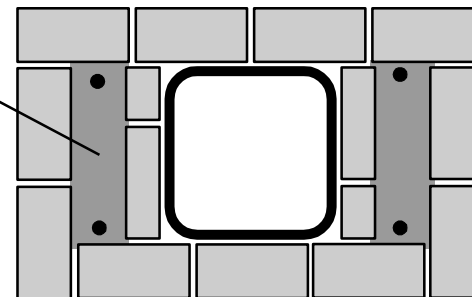
Masonry Chimneys

- Plain masonry (vulnerable)
- Reinforced masonry (rugged)



Plain Masonry

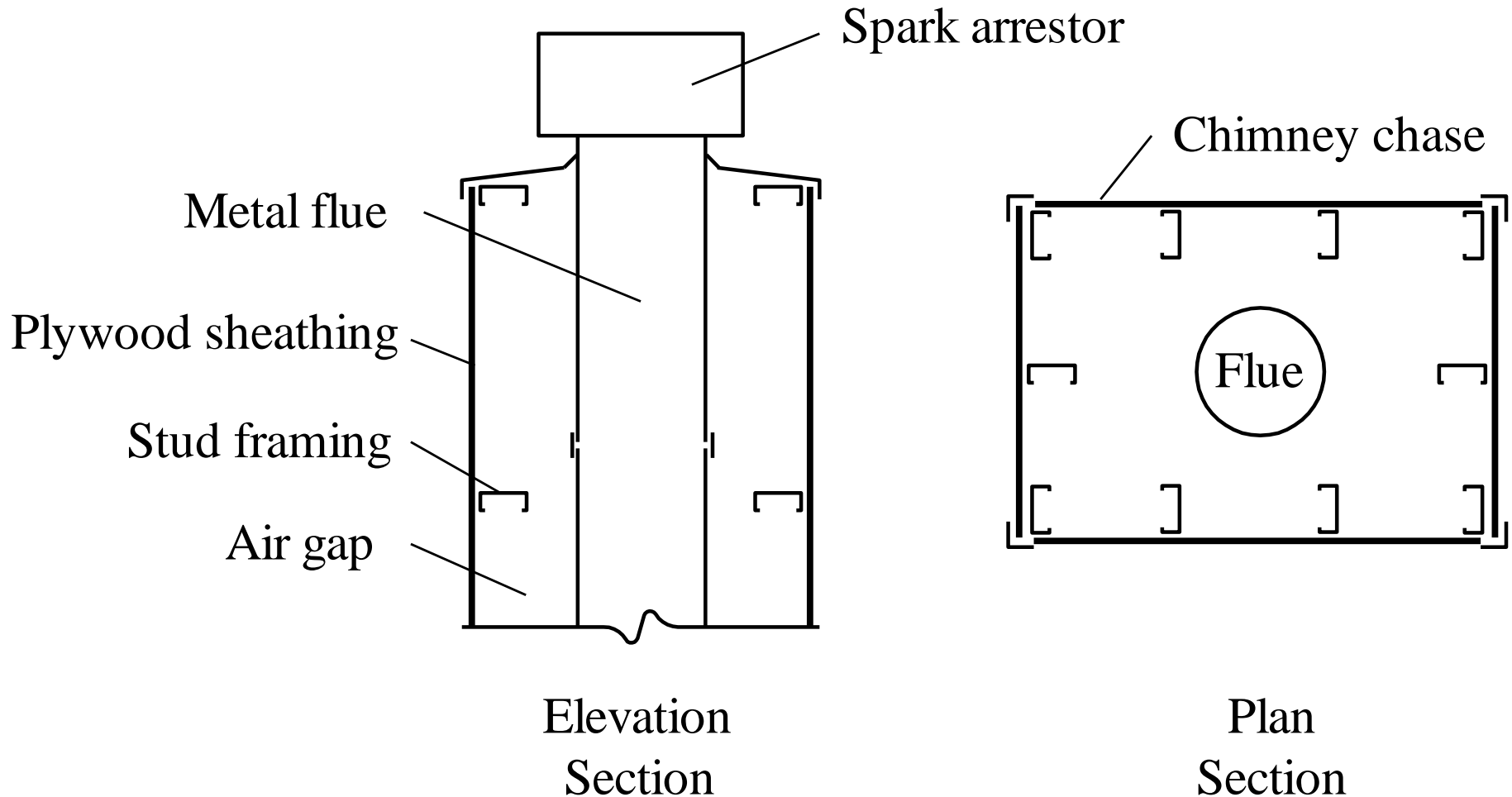
Rebar in fully grouted cavities



Reinforced Masonry

Metal Chimneys

- Light-weight and very rugged
- No damage expected



Chimney Vulnerability

- Plain masonry: *can be highly vulnerable*
 - Depends on many factors:
 - Height, tensile strength, shaking intensity, etc
- Reinforced masonry: *low vulnerability*
 - If properly meeting code
- Metal type: *very low vulnerability*
 - No reported failures in any quakes

Anchorage Chimney Damage

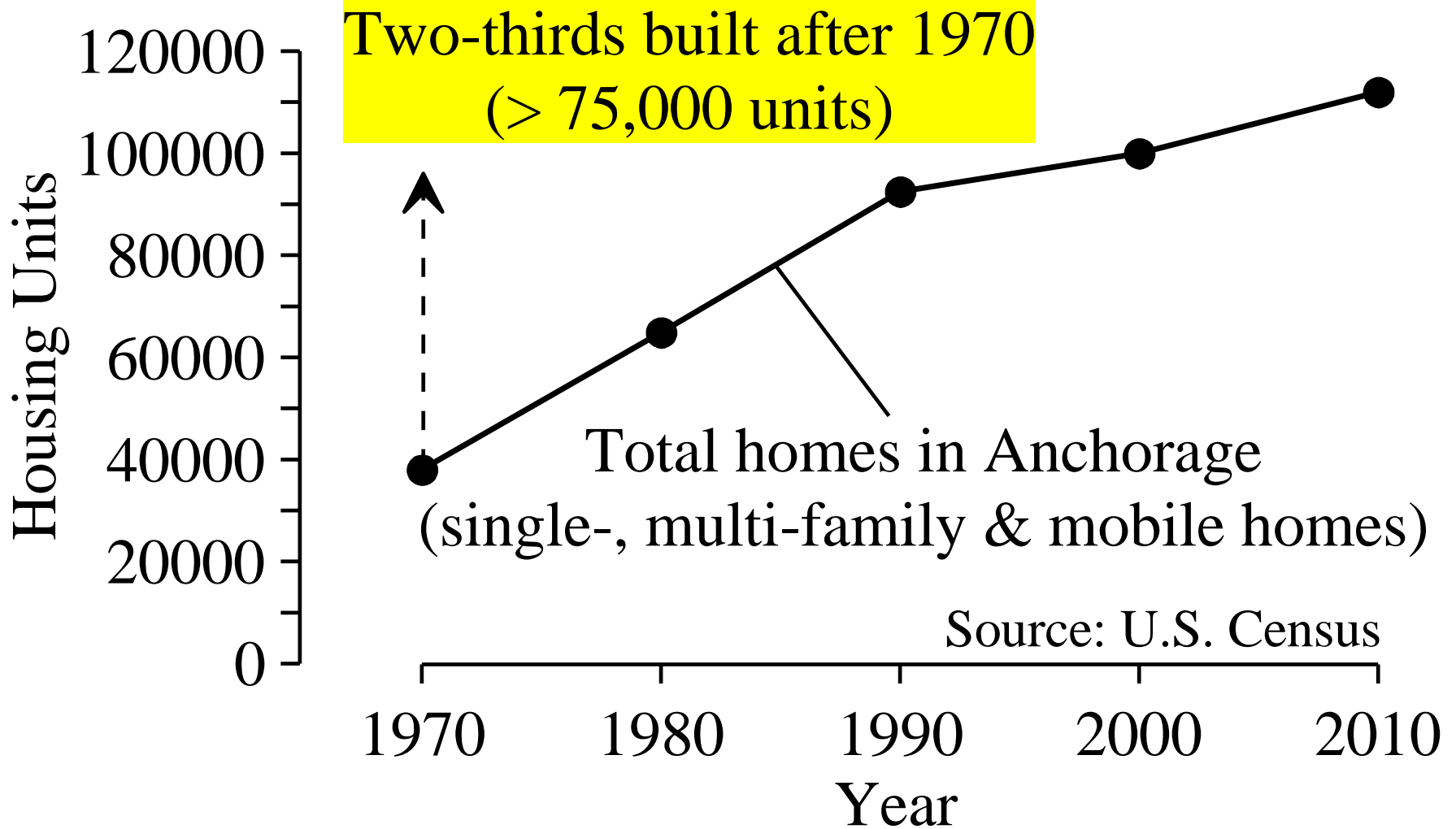
- Plain masonry chimneys



Masonry Chimney Codes

- Anchorage used UBC prior to IBC
- 1946 UBC required chimneys to be reinforced and anchored to house
 - CA experience: many chimneys were not meeting code even after that date
- Prescriptive requirements later set
 - Four #4 bars in 1967 UBC
 - Metal strapping in 1970 UBC
- Pre-1995 construction *might* not meet code
 - 1994 Northridge CA quake was wake-up call
 - 30,000 chimneys damaged in Los Angeles

Anchorage Housing Inventory

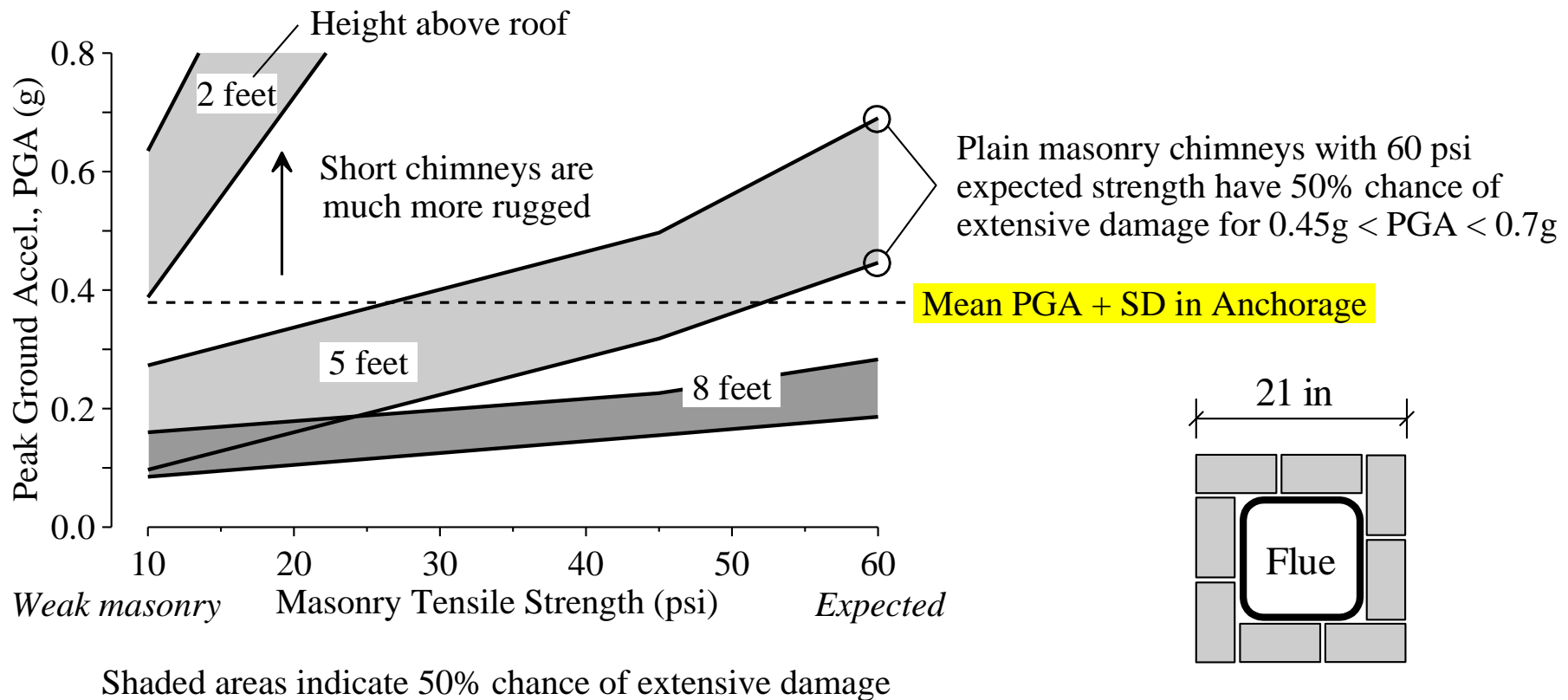


Anchorage Chimney Inventory

- Metal chimneys popular in Anchorage starting in the early 1980s
 - Low cost a key factor
- Two-thirds of Anchorage homes built after 1970...thus:
 - Many metal chimneys
 - Fewer masonry chimneys
 - Reinforced if meeting code
- Vulnerable plain masonry chimneys are in the minority

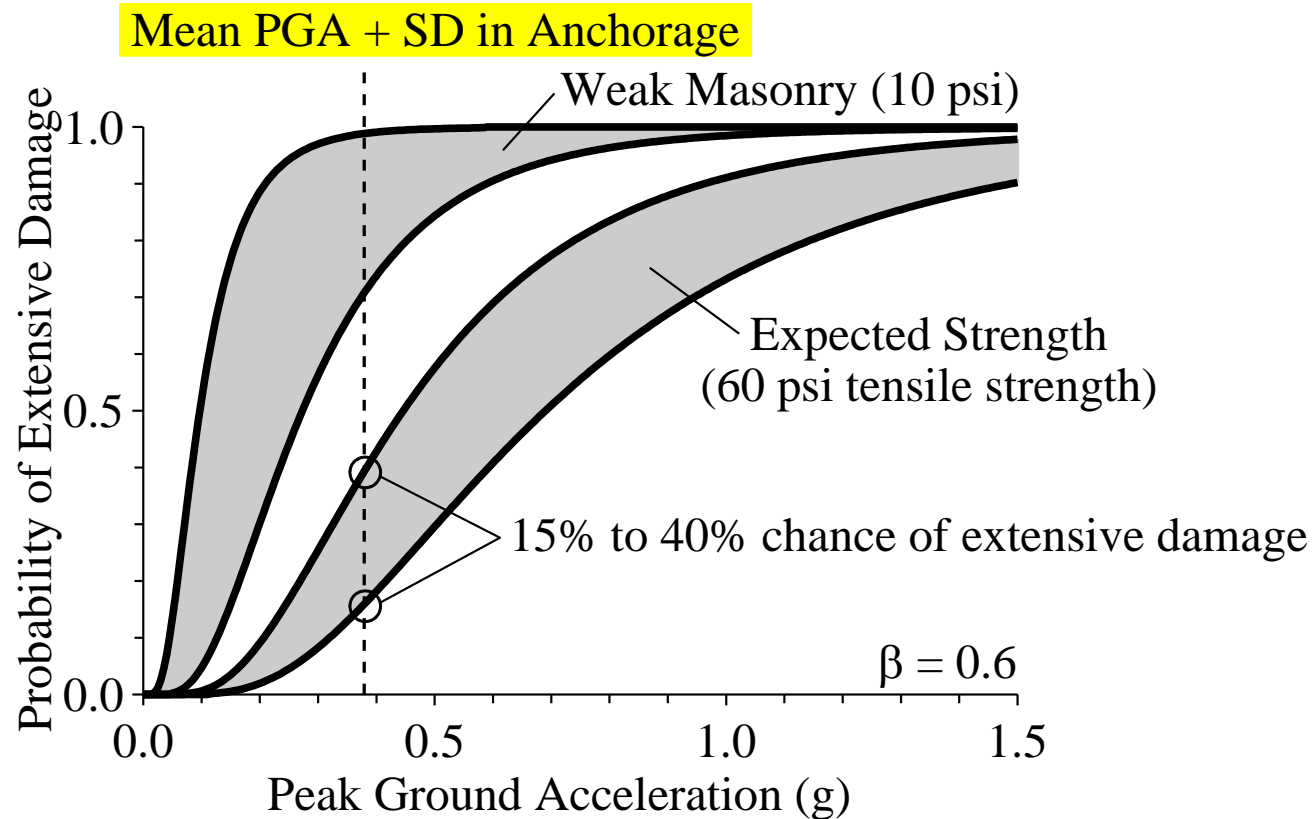
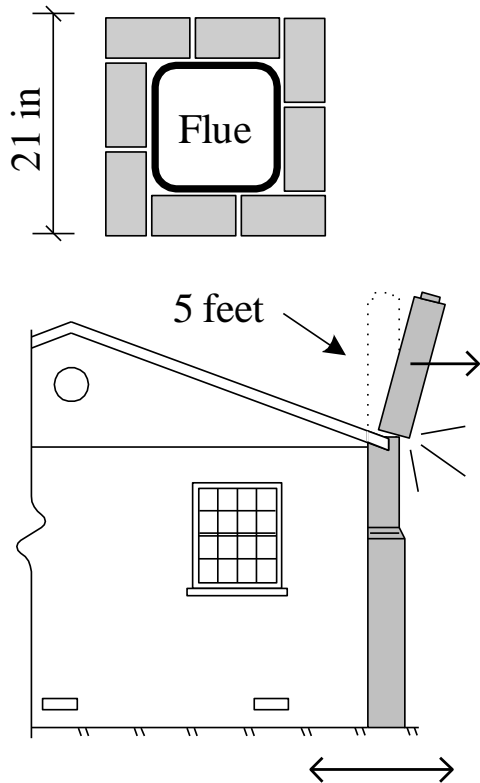
Plain Masonry Chimneys

- Anchorage PGA < 0.4g
 - 2-foot chimneys not vulnerable
 - 5-foot vulnerable if weak masonry
 - 8-foot could have problems



Fragility Curves

- Probability of extensive damage vs PGA



Why Good Performance...?

- Small numbers of *plain* masonry chimneys
 - Versus metal and reinforced masonry
- Anchorage $PGA < 0.4g$
 - **Tall** plain masonry chimneys vulnerable
 - **Weak** masonry vulnerable
 - **Short** well-built masonry **not** vulnerable
 - Appears consistent with damage surveys
- Contrast with California
 - Many older homes w/ plain masonry chim.
 - Hence, more chimneys damaged in quakes

Next Steps

- Quantify damage statistics better
 - Review Anchorage building inspection reports
 - Review Anchorage building permit records
- Anchorage site visit
 - March 2019
- Create report on findings
 - Complete by 4Q this year

Special Thanks

- Jessica Freenstra (Golder Assoc, AK)
 - Photos
- Janise Rogers (GeoHazards, CA)
 - Photos
- EERI Learning From Earthquakes team
 - Discussions on observed damage