Oregon Seismic Safety Policy Advisory Commission

OSSPAC

Single-Family Home Retrofit in Oregon

Improving Access, Consistency, and Implementation

OSSPAC Publication 21-02
July 13, 2021

THE STATE OF OREGON
Mike Harryman, State Resilience Officer

Oregon Seismic Safety Policy Advisory Commission

After the Loma Prieta earthquake in 1989, Oregon residents demanded that the State of Oregon better address earthquake hazards throughout the state. The state legislature established the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) in 1991 through Senate Bill 96. The Commission is a group of eighteen individuals appointed by the Governor. They represent a variety of interests regarding public policy and earthquakes and include representatives of many state agencies, a member each from the Oregon House and Senate, representatives of important stakeholder groups, and members of the public. The OSSPAC mission is to positively influence decisions and policies regarding pre-disaster mitigation of earthquake and tsunami hazards; increase public understanding of hazard, risk, exposure and vulnerability through education; and be responsive to new studies or issues raised around earthquakes and tsunamis.

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Petros Keshishian / Petros Keshishian, accessed through

preface

In 2018, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) published a report, *Encouraging Homeowner Resilience: Earthquake Insurance and Seismic Risk*, which looked at the current state of earthquake insurance for homeowners in Oregon. One of the major findings of that study was that earthquake insurance is not as resilient as seismic retrofitting. Mitigating a home through retrofit prevents the damage from happening in the first place, thus enabling a quicker recovery. Since that time, there have been a number of developments, and California and federal agencies have produced multiple reports and products aimed squarely at this issue. It seemed worthwhile to return to this important topic which effects millions of Oregon homeowners. In 2020, OSSPAC voted to form a working group to investigate ways to increase the seismic safety of single-family homes in Oregon.

This report focuses on practical ways to increase the resilience of single-family homes by addressing the significant barriers faced by Oregon homeowners. Often, they are hindered by poor access to reliable information, lack of consistent retrofit standards and inadequate inspection.

Throughout this report, the term "Cascadia event" is used to represent the Cascadia Subduction Zone earthquake and resulting tsunami.

In gathering input for this report, the Single-Family Homes Working Group of OSSPAC consulted with the State Resilience Officer and engaged other state and local government officials. Testimony was provided to OSSPAC from representatives of non-governmental engineering organizations, code committees, stakeholder representatives and members of the public. Included in Appendix A is a list of the stakeholders that provided testimony.

OSSPAC received support from the Office of Emergency Management. OSSPAC gratefully acknowledges the financial support of the Department of Consumer and Business Services, Oregon Health Authority, Department of Geology and Mineral Industries, and the Office of Emergency Management.

Jeffrey Soulages
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executive summary

In 2020, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) voted to form a working group to investigate ways to increase the seismic safety of single-family homes in Oregon. Through work group meetings and stakeholder testimony, OSSPAC investigated the state of the industry for individual home seismic retrofits, including available engineering standards, disclosure laws, and access to reliable information. The commission's major findings and recommendations are as follows:

Major Findings

A. **Most homeowners currently view the process of securing a seismic retrofit for their home as the "Wild West."** There are significant challenges with design standards, permitting, and inspection. Differing construction approaches lead to wildly varied costs and erode confidence in the work delivered and benefits provided. Without more guidance and standards for design and implementation, the barriers for most homeowners are simply too high.

B. **Many new reports, standards, and products have been developed in the past 10 years that specifically target the seismic performance of single-family wood homes.** Most of these are national-consensus documents that were developed and paid for by either the federal government and/or the California Earthquake Authority, which sells earthquake insurance to California homeowners. These standards address the most common structural vulnerabilities in homes and are free to use and available for Oregon to adopt, expand, or customize with minimal effort.

Recommendations

A. **Improve the required homeowner earthquake disclosure made at the time of sale.** Currently, only a simple disclosure is required to relay seismic deficiencies to a new owner, and it is often ineffective because a current owner can simply indicate "unknown." Seek permission to adopt and expand the California Earthquake Authority's "QuakeGrade™" online assessment application (based on FEMA P-50) for use in Oregon. Develop training for design professionals, building officials, contractors, and home inspectors to use the QuakeGrade™ application and issue disclosure certificates. Replace the current disclosure at time of sale with a QuakeGrade™ report or a seismic evaluation provided by a licensed Professional Engineer.

B. **Develop educational information for consumers and professionals regarding earthquake safety of single-family homes.** While some information is currently available, it is often focused on Washington and California, and it is decades old. Create an informational pamphlet that applies to all single-family homes in Oregon. Develop training videos or other materials for real-estate professionals, home inspectors, contractors, etc. To provide funding, direct the Office of Emergency Management to apply for a grant under the Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) program. Require the new pamphlet to accompany the earthquake disclosure provided to buyers of the most vulnerable homes in Oregon - those built before 1974.

C. **Adopt FEMA P-1100 as the statewide retrofit standard for single-family homes.** Currently, there is no state-wide standard for the seismic retrofit of single-family homes. Some jurisdictions like the City of Portland have adopted a standard, but this does not apply statewide. Lack of consistent requirements makes it confusing for homeowners who want to know what they are getting when they hire a contractor to retrofit their home or purchase a home that has already been retrofit. FEMA P-1100 builds on existing standards and adds cutting-edge research and includes pre-engineered design plan sets for many home types. It was published as a pre-standard in 2019. Potential statutory barriers that could preclude BCD from adopting a voluntary retrofit standard may need to be removed. Funding for training and other program costs should be considered.

D. **Require building departments to provide permits, inspect construction, and issue a Certificate of Compliance for seismic upgrade of single-family homes.** Having a retrofit standard is critical, but it is equally important to have building departments certify the work to give homeowner's confidence. Develop and provide a training program for building departments and inspectors to introduce and understand the new FEMA P-1100 standard once adopted. Require that all seismic retrofits done in the state have a permit and on-site inspections. Ensure that inspections can be performed by local building departments, and provide resources to support local jurisdictions which may not have sufficient resources or demand to sustain a local retrofit program. Develop a certificate of compliance that is issued at the successful completion of a seismic retrofit which indicates the retrofit standard used and description of the upgrade (full or partial) completed. Create a procedure to review, inspect, and issue certificates for previously completed retrofits that follow the new or other recognized standards.

chapter one

Single Family Homes are Critical to Oregon's Resilience

If the Cascadia Subduction Zone earthquake were to happen today, it would devastate Oregon. We would experience human and financial loss on a scale that could dwarf the impacts of _the COVID-19 pandemic. This report will focus on a Cascadia event's impact on housing, which is critical to human health.

Housing is Critical to Resilience

After a Cascadia event, it is estimated that 17,000-85,000 Oregonians will be displaced from their homes, depending on the season and the time of day when the earthquake occurs (2018 DOGAMI report). They will be displaced because their homes did not withstand the strong shaking. Those homes can and should be made more resilient.

Earthquake-resilient homes enable families to "shelter in place." This is better for individual and community outcomes. Physical, social, emotional, and financial health decline when people are displaced. If enough people are displaced from their homes, disaster response and recovery efforts will be greatly diminished. Increased demand for external shelter beds and increased movement locally and regionally will strain resources and complicate the logistics of recovery. As we've seen elsewhere in the U.S. and globally, mass displacement can become permanent if people relocate to other areas en masse. Our economy may never recover, or it may take many decades to rebuild.

Oregon's Vulnerable Housing Stock

According to a 2019 survey of Oregon housing data, the largest number of structures in the state are single family homes. There are approximately 1,750,540 single-family housing units distributed throughout the state, and the vast majority are in areas of high seismic risk. Over 50% of these homes were built before Oregon had any seismic building standards. In Portland, it is much worse. 78% of Portland homes were built before the first seismic standard in 1974.

The current code standard for a new single-family home in Oregon is a life-safety standard. As detailed in previous OSSPAC reports, a life-safety standard does not guarantee that a structure will be usable after an earthquake. But it does drastically increase the odds that the building will not collapse on its occupants. The exact number of homes that have already been retrofit is not known because permits are usually not required or obtained for this work. But we are confident that it is a very small percentage of the total homes at risk. Even where retrofits have been performed, it's impossible to know their effectiveness in providing life safety because there are no uniform standards and often no inspections.

Issues with Ensuring Safety of Single-Family Homes

Many Oregonians don't know the seismic safety of their home. For those who understand the risks and want to pursue seismic safety, there is no clear path forward. Disclosures provided during a home sale regarding seismic risk or previous retrofits are overly simplified and provide little information. Their effectiveness is further diminished because a current owner may not know or may not want to take the time to find out and can simply indicate "unknown."

If a house has been retrofit, there is no simple way to determine if it was done effectively. If one wants to hire a contractor to perform a retrofit, there is no simple way to determine if the contractor is qualified.

If multiple contractors provide vastly different bids, there's no simple way for a homeowner to determine which is the most effective or reasonably priced. Consumers are left guessing. Those with time and resources may spend many hours trying to self-educate, but there is no guarantee they will end up with accurate information.

Local government provides little help. The State offers minimal guidance on the Oregon Construction Contractors Board and Oregon Emergency Management websites, and many Oregon cities do not provide any guidance. In 2020, FEMA published FEMA P-530, Earthquake Safety at Home, which includes some basic information about retrofits and refers to other more technical documents. But the FEMA guide is not widely promoted in Oregon. Even if consumers are able to find the guide online, we can assume that many do not possess the time, knowledge, or patience to track down the necessary technical information about retrofits. For those consumers, reliable building codes and clear standards for contractors are essential to ensuring quality retrofits.

And yet, there is currently no statewide standard for the seismic retrofit of single-family homes, which means a contractor could tell a consumer just about anything. And building inspectors are not trained to adequately examine the completeness or adequacy of seismic retrofits. They are simply trained to follow the basic code, which only requires that a retrofit not make a home less safe than it was before. Additionally, many seismic retrofits are done without a permit, so those are not inspected or approved by anyone.

Alex R., Homeowner

Alex hired a company to do a seismic retrofit of his pre-1974 NE Portland house. He obtained a permit and received an inspection from the building department. However, the inspector only looked at the work plans—not the completed work. Eventually, Alex hired a third-party contractor to inspect the work which was found to be faulty.

Some homeowners opt to perform retrofits themselves. This approach is perfectly acceptable, and doing a partial retrofit is much better than no retrofit at all. However, the resources available to guide a homeowner through a do-it-yourself retrofit are likely to be found through an internet search, which could lead to any number of unvetted resources, many of which are outdated, inaccurate, or focused on Washington and California where some of the common home construction practices and vulnerabilities can differ from those most common in Oregon.

Rebecca R., Homeowner

Rebecca owns a 2-story 2,300 sf home in NE Portland which was built in 1926. Her house is simple enough to apply Portland's prescriptive design standards. She requested retrofit bids from three companies ranging from $3,685-$30,000+. She had no way of knowing which to select. Ultimately, she went with the cheapest option because she felt mistrustful of the higher priced bids. She was nearly dissuaded from doing the work due to the lack of consistency in the bids, and she felt "swindled" by the company that gave her the highest bid. They wanted to sell her foundation repair work when the other two companies never mentioned the need for it. (see Sidebar: Foundation Quality, page 8)

Financial Considerations for Homeowners

A critical element in the discussion of single-family home resilience is money. The estimated loss to single-family homes from a Cascadia event is $2.7 billion (2018 DOGAMI study). This figure only represents immediate loss - it does not include the immeasurable long-term impacts to psychosocial and financial wellbeing of the people who lived in those houses.

One approach to mitigating financial loss from an earthquake is insurance. However, only ~15% of Oregonians have earthquake insurance for their home. And as detailed in OSSPAC's 2018 report on earthquake insurance, resilience is not built by focusing only on the aftermath of a disaster. Mitigation through retrofitting is far more effective at minimizing losses. It helps people return to work, school, and normalcy more quickly. It would minimize widespread devastation to Oregon's families and economy.

Retrofitting the average house is usually not as expensive as other major home repairs, such as re-painting or re-roofing. But it is still beyond the reach of a good percentage of Oregonians. And many who might be able afford it choose not to prioritize it over repairs that are much more straightforward and show immediate benefit. Additionally, many consumers report getting conflicting or wildly variable bids, which adds to their hesitancy. Preparing for catastrophic disaster is psychologically challenging, and it is human nature to avoid it. It is even more tempting to avoid it if the path forward is unclear and financially daunting.

Unlike solar or other long-term-benefit home improvements, there are no immediate financial incentives for a homeowner to retrofit for earthquakes. And yet, the return on investment for retrofits of pre-code and low-code homes is very positive. OSSPAC's 2018 report Encouraging Homeowner Resilience through Earthquake Insurance and Seismic Retrofit details a number of options for financial incentives to convince homeowners to retrofit.

Major Finding

Most homeowners currently view the process of securing a seismic retrofit for their home as the "Wild West." There are significant challenges with design standards, permitting, and inspection. Differing construction approaches lead to wildly varied costs and erode confidence in the work delivered and benefits provided. Without more guidance and standards for design and implementation, the barriers for most homeowners are simply too high.

chapter two

New Federal and State Research and Resources

Petros Keshishian / Petros Keshishian, accessed through EERI photo archive

A number of new federal and state resources have recently become available. These tools can be used to help educate homeowners and professionals, as well as create Oregon-specific retrofit standards, assessment tools, and training materials.

FEMA P-530 – Handbook on Earthquake Safety for Homeowners

As mentioned above, FEMA published FEMA P-530, Earthquake Safety at Home in 2020. It includes basic information about preparing for, protecting against, surviving, responding to, and recovering from a major earthquake. The guide was created specifically for homeowners. FEMA used professional writers and graphic designers to translate engineering concepts for a lay audience. The document includes short-, medium-, and long-term projects that a homeowner can do to address risk, and it is a comprehensive guide for use nationwide.

FEMA P-1100 – Retrofit Pre-Standard

In 2019, FEMA collaborated with the California Earthquake Authority (CEA) to publish the multi-volume FEMA P-1100 (Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings). P-1100 addresses both assessment and retrofit and includes pre-engineered plan sets and contractor training materials for most scenarios. The prescriptive designs are based on simplified engineering retrofit. In cases where the prescriptive design doesn't apply perfectly to a home, it allows an engineer to provide a few missing details to enable the standard to be used. Volume 1 addresses evaluation and retrofit with options for simplified or detailed assessments, or an engineered assessment. Similarly, retrofit methods include options for prescriptive or engineered retrofits. Volume 2 provides pre-made plan sets for retrofit of Crawlspace Dwellings, Living Space Over Garage Dwellings, and Masonry Chimneys.

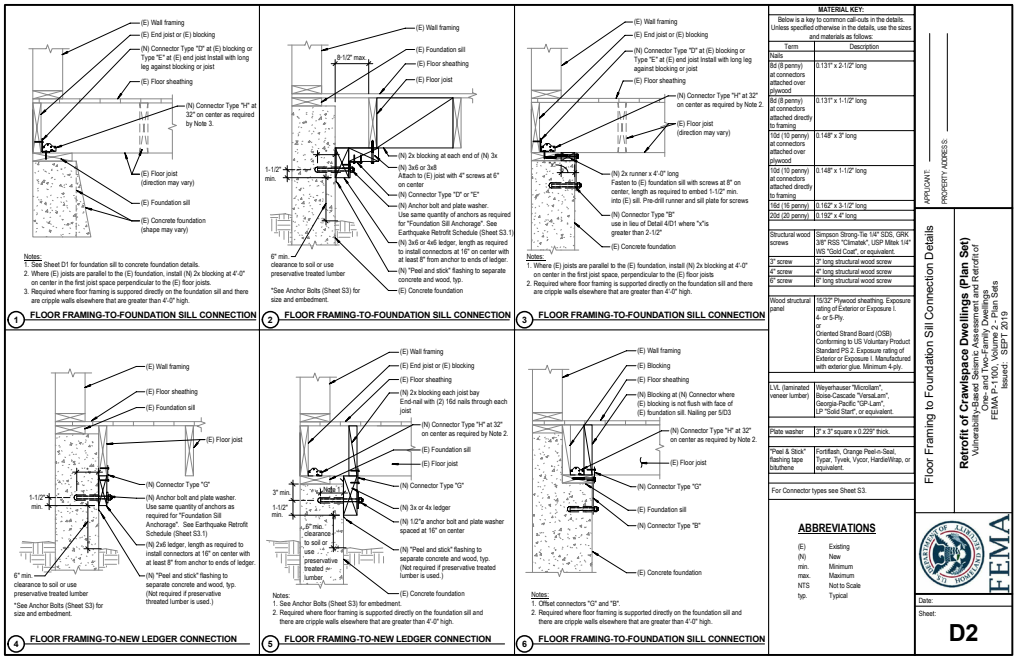


Figure 2.1. Sheet D2 - Floor Framing to Foundation Sill Connection Details from FEMA P-1100. An example pre-engineered plan for a suggested minimum level of retrofit design for use by a general contractor or homeowner without having to involve a registered design professional.

Foundation Quality

Concrete foundations must be of sufficient quality in order to perform a "typical" single-family home retrofit where the house is anchored to the foundation. But the average homeowner does not know how to assess the quality of their foundation, and many have reported receiving variable assessments from contractors.

FEMA P-1100 has guidance that can provide clarity and hopefully uniformity between contractors. For example, it states, "examples of poor quality include excessive spalling, large rock pockets, cracks extending completely through footing greater than ¼" wide or low strength concrete cement or mortar easily scrapable with a metal knife or trowel."

The standard also contains a quantitative measure where a test screw or adhesive anchor can be installed in the existing foundation and torque tested. For example, the torque value for a 1/2-inch diameter adhesive anchor is only 15 ft-lbs. If it passes the test, then the foundation can be used for anchor installs.

The scope of P-1100 is limited and addresses only the most common vulnerabilities, which are:

- Anchorage of the walls to the foundation and connection of the first floor above the foundation (homes with a crawlspace and hillside homes).
- Bracing of cripple walls (crawlspace homes).
- Lower-level bracing of living space over a ground level garage.
- Brick masonry chimneys.
- Anchorage of masonry fireplace surrounds.

Evaluation or retrofit of the full structural system in a home is not within the scope of the document. It is also important to note that compliance with the standard will not prevent all earthquake damage.

However, the evaluations and retrofit measures P-1100 provides are specifically targeted to address the most common vulnerabilities that are repeatedly seen in homes of these types following significant earthquakes. The standard has been designed with homeowners in mind. It makes it easier and less expensive to protect certain types of homes from earthquakes and is intended to reduce the time needed for design and permitting of seismic retrofits. For example, it eliminates special inspection of anchors, which was deemed too expensive for homeowners and reduces it down to a visual inspection only. And it only requires knowledge of wall/siding type, roof type, and interior finish in order to complete simple calculations.

P-1100 is currently a pre-standard draft document that is being made into a standard by the American Society of Civil Engineers (ASCE). When approved and adopted by the International Code Council, it will be added to the International Existing Building Code and replace Appendix A.3.

CEA-PEER Report on Performance of Single-Family Homes

In 2020, the Pacific Earthquake Engineering Research (PEER) Center collaborated with the California Earthquake Authority to create Quantifying the Performance of Retrofit of Cripple Walls and Sill Anchorage in Single-Family Wood-Frame Buildings. It is a comprehensive study on the benefits of retrofitting single-family homes. More specifically, it examines the factors that contribute directly to losses and how effective retrofits targeted at the most common vulnerabilities are for reducing loss.

PEER researchers analyzed 48 different buildings at four different sites. They also utilized a large shake table at the University of California San Diego to run actual full-scale tests of houses with and without retrofits. Their intent was to provide better data to insurance underwriters whose data set is severely limited to claims in previous earthquakes and are often very conservative.

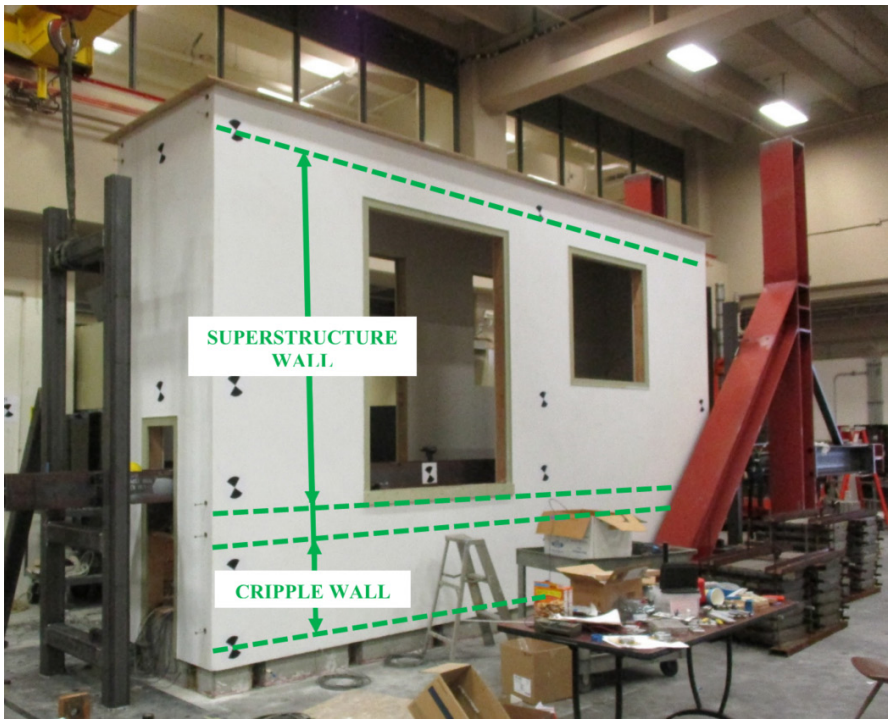


Figure 2.2. Specimen AL-1 prior to start of testing; figure shows superstructure wall above and cripple wall below; source: Figure 3-1 from Large-Component Seismic Testing for Existing and Retrofitted Single-Family Wood-Frame Dwellings

Figure 2.3. Foundation sill plate uplift during full scale testing; source: Figure 4-20 from Large-Component Seismic Testing for Existing and Retrofitted Single-Family Wood-Frame Dwellings

The research showed that retrofitting cripple wall houses provides a clear cost benefit. There is more benefit for wood than stucco, for two stories rather than one story, and for sites in higher seismic risk. It also showed that there was a consistent improvement in performance even with relatively modern houses that had similar features. And it showed a large difference in performance between houses with stucco siding versus wood siding.

FEMA P-50 and QuakeGrade™ Simplified Assessment

In 2012, FEMA published FEMA P-50, which helps homeowners do a simplified seismic assessment of their detached single-family wood frame dwellings. It helps them identify structural and nonstructural vulnerabilities, including identification of site hazards such as poor soil, landslides, and ground failure. Houses start with a grade of 100 and penalty points are removed for poor features, resulting in a grade between A and D–. Next, the guide provides specific solutions to improve the seismic performance of a home.

Table 5. Seismic Performance Grade Based on Structural Score and Regional Seismic Hazard Score

Seismic Hazard Score		0 - 1	2 - 3	4 - 5	6 - 7	8 - 10	11 - 12
Structural Score	1.0 - 45.9	B-	C+	C	D	D-	D-
	46.0 - 64.9	B+	B	C+	D+	D	D-
	65.0 - 74.9	A-	B+	B	C	C-	D+
	75.0 - 84.9	A-	A-	B+	B-	C	C
	85.0 - 100	A	A	A-	B+	B	B-

G. Determination of Seismic Performance Grade

		Penalty Sum
1.	**Structural Score**	
a.	Foundation (Section A)	[3.7]
b.	Superstructure Framing and Configuration (Section B)	[7.3]
c.	General Condition Assessment	[2.4]
d.	Nonstructural Elements, Age, and Size (Section D)	[5.0]
e.	Local Site Conditions (Section E)	[1.3]
	Total Penalty Points (a to e):	19.7
	Structural Score = (100 – Total Penalty points from line above):	80.3
2.	**Seismic Hazard Score** (from Section F):	6
3.	**Seismic Performance Grade** (from Table 5) Note: insert this grade, including + or -, if applicable in box on page 1	B-

4. Anticipated Seismic Performance[1]

Following anticipated seismic events:[2]

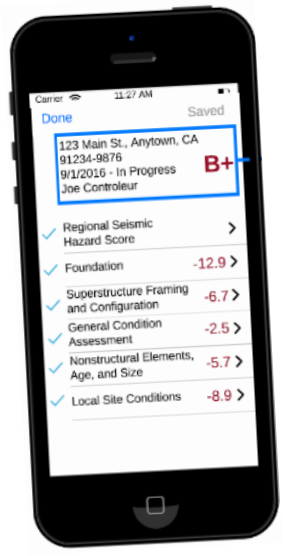
Grade A, A-: Excellent Performer
(Potential minor structural and finish damage, earthquake damage ratio[3] of 0%-10%, continued occupancy is likely)

Grade B, B+, B-: Good Performer
(Potential moderate structural and finish damage, continued occupancy likely following minor structural repairs, earthquake damage ratio[3] of 0%-50%, seismic retrofit measures are encouraged)

Grade C, C+, C-: Fair Performer
(Potential moderate to major structural and finish damage, structural repairs may be required prior to continued occupancy, earthquake damage ratio[3] of 10%-60%, seismic retrofit measures are strongly encouraged)

Grade D, D+, D-: Poor Performer
(Potential severe structure and finish damage requiring significant repairs prior to re-occupancy, earthquake damage ratio[3] of 20% – 100%, significant seismic retrofit measures are strongly encouraged)

Figure 2.4: Seismic Performance Table from FEMA P-50, Simplified Seismic Assessment of Detached, Single-Family, Wood-Frame Dwellings, uses the Simplified Seismic Assessment Form to identify structural and nonstructural vulnerabilities.



Currently P-50 is done in Oregon by hand with a clipboard, rendering it cumbersome for homeowners and inspectors. But the CEA created a web-based application based on FEMA P-50 for use by contractors and engineers in California called QuakeGrade™. QuakeGrade™ greatly speeds up the process of inspections, providing consistency and instant access to results. There is no charge to use the application online, though it is limited to qualified professionals and not available for general homeowner use. Additionally, it currently does not have the parameters needed to conduct assessments in Oregon. However, this extremely useful tool could be modified to be used for homes in Oregon and eventually allow home inspectors to quickly, easily and inexpensively determine ratings for homes during the sale process giving homeowners not only a more detailed, accurate and consistent picture of their home's seismic safety but specific solutions needed to improve their safety "grade."

Figure 2.5: QuakeGrade™ is optimized for mobile devices; source: California Earthquake Authority.

FEMA P-1024 – 2014 South Napa Earthquake

On August 24, 2014, a Magnitude 6.0 earthquake struck Napa, California. Extensive damage in the central business district led the National Institute of Standards and Technology (NIST) and the Federal Emergency Management Agency (FEMA) to study a number of areas, including the Browns Valley neighborhood just west of downtown. They examined one- and two-story single-family and duplex homes. All had wood frames and were built between 1900 and 1965.

The overwhelming majority of residences performed well and suffered little damage. The earthquake was of a moderate size and smaller than what current building codes require new homes to withstand. However, there were some notable exceptions. There was significant damage to homes built directly on top of the fault rupture, chimney failures, and cripple-wall failures or lateral shifting off foundations.

The report led to two FEMA Recovery Advisories that contain best practices. The first covers the reconstruction of earthquake-damaged masonry chimneys. The second covers the seismic retrofit of cripple-wall foundations. This document was instrumental in informing the eventual retrofit pre-standard FEMA P-1100. The report also recommended not to build directly on top of fault traces and to use preventative land-use planning laws, as was done around the Alquist-Priolo area of California.

Other Standards

There are other standards that can be used for retrofitting, though these will likely require design by a licensed Professional Engineer. They include:

- **ASCE 41-17 Seismic Evaluation and Retrofit of Existing Buildings:** This is the primary standard used for the evaluation and retrofit of commercial buildings. Although it can be used for residential structures, the document is not intended to be used by a lay audience and will typically require that an experienced Structural Engineer provide the needed assessment and retrofit plans. Evaluations and retrofits can be conducted based on one or several of three tiers depending on the retrofit objectives and building structure. Tier 1 is a screening procedure that uses a series of checklists to evaluate the structure. Tier 2 provides deficiency-based evaluation of specific elements, and Tier 3 is a procedure for systematic evaluation. One important advantage of the standard is that it allows for archaic materials not allowed in current building code.

- **2017 Oregon Residential Specialty Code (ORSC):** This is the current building code specifically for residential structures. It is based on the 2015 International Residential Code and adopted by Oregon as the ORSC through a review and amendment process overseen by the State's Building Code Division. While it is possible to upgrade homes to comply with the current code, many of the provisions can be difficult to meet in an existing structure. For instance, meeting newer minimum concrete reinforcement requirements or mitigating existing straight-sheathed walls no longer recognized in the code can be a challenge. This can lead to unnecessary and expensive repairs which may not always be necessary.
- **2019 Oregon Structural Specialty Code (OSSC):** This is the current building code used for commercial construction, though it can also be used for residential structures as well. It is based on the 2018 International Building Code (IBC) and adopted by Oregon as the OSSC through a review and amendment process overseen by the State's Building Codes Division. The IBC is typically updated on a 3-year cycle, though Oregon's adoption can vary or skip cycles. As with the ORSC, the OSSC can be used for retrofit and will provide a quality result but may not always be the best, easiest or least expensive choice.

Major Finding

Many new reports, standards, and products have been developed in the past 10 years that specifically target the seismic performance of single-family wood homes. Most of these are national-consensus documents that were developed and paid for by either the federal government and/or the California Earthquake Authority, which sells earthquake insurance to California homeowners. These standards address the most common structural vulnerabilities in homes and are free to use and available for Oregon to adopt, expand, or customize with minimal effort.

chapter three

Making Oregon's Single-Family Homes More Resilient

In order to encourage earthquake resilience, we need to educate and empower people to make informed decisions. They need to understand the risks, potential costs, and steps necessary to evaluate and mitigate risks. In the case of retrofits, that is not currently an option due to the lack of clear information available to homeowners about their houses, retrofit standards, and contractors. If we can help them understand their options and trust that they are receiving reliable information and advice, we can increase the likelihood that they will prioritize retrofit work. There are multiple ways we can go about this.

Improve Home Sale Disclosure

Current home sale disclosure of retrofit currently provides very little information. Sellers are asked to disclose whether their house was constructed before 1974 and if so, whether or not the home has been bolted to its foundation. This amount of information says nothing about the type or quality of a retrofit, and a seller can simply indicate "unknown" – rendering the disclosure unhelpful to the prospective buyer. Additionally, the disclosure does nothing to address hillside homes, cripple wall foundations, or other vulnerable construction aspects. It also does not address the heart of the matter – whether or not the home provides life safety or not. An uninformed buyer might see these simple disclosure questions and assume the home is earthquake resilient when it may be far from it.

8. SEISMIC

A. Was the house constructed before 1974? ..... ☐ Yes ☐ No ☐ Unknown

If yes, has the house been bolted to its foundation? ..... ☐ Yes ☐ No ☐ Unknown ☐ NA

Figure 3.1: Seismic disclosure questions on Oregon Real Estate Sale Agreement; source: Oregon Real Estate Forms.

During home sales, we should require more and provide homebuyers with critical information about what for many is the largest financial decision of their lives. Requiring a version of QuakeGrade™ customized for Oregon would allow inspectors to provide that information quickly, easily, and inexpensively.

More robust investigation and disclosure of retrofit history and quality during the inspection period will allow buyers to make more informed decisions, increase motivation for sellers to retrofit, and increase awareness of the need for earthquake readiness.

Increase Opportunities for Education

If a home buyer or seller is exposed to more robust earthquake inspection requirements, their awareness of earthquake risks will increase. But homeowners of all kinds, regardless of their involvement in a home sale, lack pathways to finding accurate and trustworthy information about risks and mitigation choices. Some Oregonians - including real estate professionals, home inspectors, and contractors - have little or no knowledge of earthquake risks. Reliable information about retrofit options should be made available to all homeowners, and the sale of a house is a prime opportunity to ensure everyone involved in the process is exposed to educational materials.

The State should develop an informational pamphlet that applies to all single-family homes in Oregon. Such a pamphlet should include: a lay explanation of the earthquake hazards faced by Oregonians, steps homeowners can take to make their homes safer, recommendations for seismic retrofitting their homes, a resource list, and what to do before, during, and after an earthquake. Well-designed materials will convince homeowners of the need to learn more. The State should also create training videos or other materials for real-estate professionals, home inspectors, contractors, etc. For example, they could be trained using FEMA P-530 plus an additional training on the basics of Oregon's version of QuakeGrade™. This increased awareness and education will help our state make incremental advances towards resiliency.

Adopt National Consensus Standards

Once a homeowner has the necessary information regarding the need for retrofit, they should have trustworthy options for pursuing professional assistance. Currently, there is no clear way for homeowners to determine if a contractor is qualified or offering reasonably priced services. In the earthquake home retrofit arena, anyone can claim to be an expert, as there are no clear standards or oversight for contractors offering their services.

We believe that there should be one consistent standard throughout Oregon, adopted into the state building code, to address the seismic retrofit of single-family homes. Doing so will provide a level playing field for contractors to provide bids on a common scope and homeowners will not have to guess which contractor is providing the proper services they need to make their house safe. Right now, the best nationally accepted standard that will be adopted eventually into the building code for seismic retrofit of houses is FEMA P-1100.

There are concerns with a statewide adoption that will need to be addressed. Historically, Oregon Revised Statute 455.020 has been interpreted as precluding the Building Codes Division (BCD) from adopting a statewide retrofit standard because the regulation of dangerous buildings is reserved to the municipalities and the statute specifically addresses municipal adoption of seismic rehabilitation plans as an element of the regulation of dangerous buildings. Concerns have also been raised regarding partial retrofits, inspections, additional costs, and the limited scope of P-1100 which doesn't include all buildings and conditions. OSSPAC agrees there needs to be a funding mechanism to cover costs of training, permit administration and inspections. If statutes or other hurdles limit BCD's ability to adopt and recommend a voluntary retrofit standard, or acknowledge partial retrofits, these barriers may need to be removed.

Improve Retrofit Inspections

Standards are meaningless unless they are enforced. And yet currently, building inspectors are not trained to adequately examine the completeness or adequacy of seismic retrofits which means homeowners have no assurance if the work performed is done properly.

First, we believe building departments should issue permits for all seismic retrofits. This permit review should ensure that the proper engineering standard has been used and that the details referenced are applicable to the actual house being retrofit. Second, building departments should inspect the work being done and ensure that the standard has been properly implemented by the contractor. If training is required to enable building officials to perform this work, then we believe the state should provide it to state building departments. Finally, we believe that the homeowner should receive a certificate that not only assures them that the work has been done properly but is easily transferable to future owners. A proposed "Certificate of Compliance" is shown in Appendix B for consideration. It indicates the standard used for the upgrade as well as a description of whether or not the upgrade was fully or partially implemented.

Local building departments are taxed and resources are strained. While permit fees should cover administrative and inspection costs, additional resources for training need to be provided. Plan reviews also present an added burden. If local departments do not have a sufficient quantity of retrofit work to justify program costs, some portions of a retrofit program may need to be supported from a state level or private partners. Concerns have also been raised that some building inspectors are not able to do crawlspace inspections because of liability. Solutions for confirming construction might include the use of third party inspection agencies in some jurisdictions even though "special inspection", as defined by the code, may not be required.

Recommendations

Improve the required homeowner earthquake disclosure made at the time of sale. Currently, only a simple disclosure is required to relay seismic deficiencies to a new owner, and it is often ineffective because a current owner can simply indicate "unknown." Seek permission to adopt and expand the California Earthquake Authority's "QuakeGrade™" online assessment application (based on FEMA P-50) for use in Oregon. Develop training for design professionals, building officials, contractors, and home inspectors to use the QuakeGrade™ application and issue disclosure certificates. Replace the current disclosure at time of sale with a QuakeGrade™ report or a seismic evaluation provided by a licensed Professional Engineer.

Develop educational information for consumers and professionals regarding earthquake safety of single-family homes. While some information is currently available, it is often focused on Washington and California, and it is decades old. Create an informational pamphlet that applies to all single-family homes in Oregon. Develop training videos or other materials for real-estate professionals, home inspectors, contractors, etc. To provide funding, direct the Office of Emergency Management to apply for a grant under the FEMA Building Resilient Infrastructure and Communities (BRIC) program. Require the new pamphlet to accompany the earthquake disclosure provided to buyers of the most vulnerable homes in Oregon - those built before 1974.

Adopt FEMA P-1100 as the statewide retrofit standard for single-family homes. Currently, there is no state-wide standard for the seismic retrofit of single-family homes. Some jurisdictions like the City of Portland have adopted a standard, but this does not apply statewide. Lack of consistent requirements makes it confusing for homeowners who want to know what they are getting when they hire a contractor to retrofit their home or purchase a home that has already been retrofit. FEMA P-1100 builds on existing standards and adds cutting-edge research and includes pre-engineered design plan sets for many home types. It was published as a pre-standard in 2019. Potential statutory barriers that could preclude BCD from adopting a voluntary retrofit standard may need to be removed. Funding for training and other program costs should be considered.

Require building departments to provide permits, inspect construction and issue a Certificate of Compliance for seismic upgrade of single-family homes. Having a retrofit standard is critical, but it is equally important to have building departments certify the work to give homeowner's confidence. Develop and provide a training program for building departments and inspectors to introduce and understand the new FEMA P-1100 standard once adopted. Require that all seismic retrofits done in the state have a permit and on-site inspections. Ensure that inspections can be performed by local building departments, and provide resources to support local jurisdictions which may not have sufficient resources or demand to sustain a local retrofit program. Develop a certificate of compliance that is issued at the successful completion of a seismic retrofit which indicates the retrofit standard used and description of the upgrade (full or partial) completed. Create a procedure to review, inspect, and issue certificates for previously completed retrofits that follow the new or other recognized standards.

references

"Oregon Resilience Plan." February 2013, OSSPAC.

"Encouraging Homeowner Resilience through Earthquake Insurance and Seismic Retrofit." Sept. 25, 2018, OSSPAC Publication 18-01, OSSPAC.

"Mass Care and Mass Displacement after a Cascadia Subduction Zone Earthquake." September 25, 2018, OSSPAC Publication 18-02, OSSPAC.

"Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings. October 2019, FEMA P-1100, FEMA.

"Simplified Seismic Assessment and Retrofit Guidelines for Detached, Single-Family Wood-Frame Dwellings." May 2012, FEMA P-50, FEMA.

"Earthquake Safety at Home." March 2020, FEMA P-530, FEMA.

"Quantifying the Performance of Retrofit Cripple Walls and Sill Anchorage in Single Family Wood-Frame Buildings." 2020, PEER.

"Oregon Housing Data." https://www.towncharts.com/Oregon/Oregon-state-Housing-data.html

"The Big One Is Coming. What Will Happen to Portland?" 2018, Portland Monthly magazine. https://www.pdxmonthly.com/home-and-real-estate/2018/02/the-big-one-is-coming-what-will-happen-to-portland

"Residential Seismic Strengthening - Methods to Reduce Potential Earthquake Damage (Brochure 12)." 2020, City of Portland, Oregon, Bureau of Business Development Services. https://www.portland.gov/bds/documents/residential-seismic-strengthening-methods-reduce-potential-earthquake-damage-brochure

"Open-File Report O-18-02, Earthquake regional impact analysis for Clackamas, Multnomah, and Washington counties, Oregon." 2018, DOGAMI. https://www.oregongeology.org/pubs/ofr/p-O-18-02.htm

Earthquake Strengthening of Cripple Walls in Wood-Frame Dwellings (FEMA P-1024-RA2)

Repair of Earthquake-Damaged Masonry Fireplace Chimneys (FEMA P-1024-RA1)

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South Napa, USA Earthquake Clearinghouse: cover, Betsy Mathieson; p. ii, 6, Petros Keshishian; p. 1, David McCormick; p. 19, A1, Steven E. Pryor. p. iv, California Earthquake Authority. p. 11, Janiele Maffei, California Earthquake Authority, It could happen today: FEMA P-50 and QuakeGradeTM, PowerPoint presentation, May 12, 2020. p. 14, B1, Bonnie Magura.

appendix a

List of Stakeholders

Steven E. Pryor / Steven E. Pryor, accessed through EERI photo arc

Testimony to OSSPAC – July 13, 2016

Alex R.	Homeowner

Testimony to OSSPAC – November 14, 2017

Tim Miller	Enhabit
Steve Gemmell	EQ Tech
Michael Weber	NW Seismic

Testimony to OSSPAC – March 13, 2018

Janiele Maffei	California Earthquake Authority

Testimony to OSSPAC – March 10, 2020

Colin Blaney	Buehler Engineering

Testimony to OSSPAC – May 12, 2020

Evan Reis	USRC
Janiele Maffei	California Earthquake Authority

Testimony to OSSPAC – February 20, 2021

Rebecca R.	Homeowner

appendix b

Proposed Certificate

Sample certificate of compliance for seismic upgrade of single-family homes. A certificate of compliance could be issued at the successful completion of a seismic retrofit and would indicate the retrofit standard used and provide a description of the upgrade completed.

SEAL

City of _____

Building Department

Certificate of Seismic Upgrade for One- and Two-Family Homes

Issued this ___ Day of _____, _____

Location:	Building Permit No.:
Property Description:	Occupancy Group:
Owner's Name and Address:	Construction Type:
Use:	Code Edition:
Date of Original Construction:	Date of Any Major Additions:

This certifies that structural improvements (a Seismic Upgrade) to the dwelling indicated have been successfully permitted, constructed, inspected, and completed, and to the best of our knowledge comply with the following:

The following standard was used for this seismic upgrade:

- ☐ FEMA P-1100 Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings
- ☐ ASCE 41-17 Seismic Evaluation and Retrofit of Existing Buildings
- ☐ 2017 Oregon Residential Specialty Code (ORSC)
- ☐ 2019 Oregon Structural Specialty Code (OSSC)
- ☐ Other _____

The seismic upgrade completed was a:

☐ **Full Upgrade**

All requirements of the seismic upgrade standard applicable to this dwelling have been completed

☐ **Partial Upgrade**

Some elements of the seismic upgrade standard applicable to this dwelling have been completed. Note that the expected performance of a partial upgrade may be unknown and the results anticipated by full compliance with a standard should not be anticipated until the full upgrade is complete.

If a partial upgrade, list specific elements completed and levels/locations:

_____

_____

_____

Signed: _____