

EARTHQUAKE RETROFIT PROPOSAL FOR OUR MEETING HOUSE

June 8, 2020

To read footnotes, click on blue footnote numbers.

Recommendation

The Property Committee recommends that Meeting for Worship on the Occasion of Business approve the expenditure of \$ 77,700 to retrofit the foundation of the Meeting House for earthquake safety.

Background

Our Meeting House sits within three miles of faults that could generate earthquakes greater in destructive power than the Northridge Earthquake of 1994. The Meeting House foundation, built in 1908, is of a type that is particularly vulnerable to earthquakes: unreinforced brick. Since 1933, it has been illegal in California to build foundations of this type. The California Seismic Safety Commission recommends that existing unreinforced brick foundations be retrofitted for earthquake safety.

The Property Committee proposed building a new foundation for the Meeting House in 2015. It secured one bid of \$206,000. The Meeting considered and rejected the bid as too high. Due to the risk of severe damage to the Meeting House, this year the Property Committee again researched the issue. We were able to secure bids that will bring the foundation up to current earthquake safety standards at about one-third the proposed 2015 cost.

Can Our Meeting House Withstand a Large Magnitude Earthquake?

The Meeting House sits within three miles of three faults in the San Andreas Fault System. Each could generate an earthquake in the range of magnitude 7.0.¹ It has never experienced a quake even close to this in force.²

Were it not for its vulnerable foundation, according to engineers with whom we have consulted, our wood-frame building could withstand a strong quake.³ Wood-frame buildings are among the most earthquake-resistant structures because, when shaken, they bend and sway rather than collapse. The Meeting House was designed by a noted local architect and solidly built with old-growth redwood beams. The building has stood for over 100 years and could, potentially, stand for another 100 years or longer. Our Meeting, itself, is flourishing and could continue on as a community for as far as we can see into the future.

A Beloved Historic Building with an Achilles Heel

The Meeting House has been listed by the State of California as eligible for inclusion in the National Register of Historic Places.⁴ Due to its historic status, our beloved Meeting House is irreplaceable.

But its foundation of unreinforced brick is an Achilles heel. Modern foundations are concrete with steel rods running through them for reinforcement; and the building is bolted to the reinforced concrete foundation. Our brick foundation does not have steel reinforcing rods, and it's not possible to bolt the wooden structure to it. In a quake, the mortar in the foundation could be shaken to

powder and the foundation could crumble. Or, as it is unbolted, the wooden structure could shift away from its foundation.⁵



Robert A. Eplett, OES

Caption: This photo along with the caption are from a State of California document. The caption notes that the house was “considered a total loss.” The house appears to be wood-frame, like our Meeting House. It, like our Meeting House, was not bolted to its foundation. The house experienced the Loma Prieta quake, magnitude 6.9, in the Santa Cruz Mountains south of San Francisco. That approaches the maximum magnitude, 7.0 that a quake in the vicinity of the Meeting House might generate. During the Loma Prieta quake, the house slid out of position on its foundation.

[Source: California Seismic Safety Commission, *Homeowner’s Guide to Earthquake Safety*, 2005, p. 10]

Figure 2 - Loma Prieta Earthquake, Oct. 17, 1989
Home moved off of its foundation and was considered a total loss.

Should the foundation of our Meeting House crumble or the building slide away from the proper position on its

foundation, even by a few inches, it could experience major structural damage to its walls, floor, and ceiling. Plaster could fall from the ceiling and walls, injuring occupants. Water and gas pipes could break. And doors could jam, impeding occupants from exiting.⁶

Probability of Damage and Danger

How probable is such damage and danger to the occupants? All four engineers and seismologists whom the Property Committee consulted⁷ on this issue said that it is not possible to predict how much damage any particular building might sustain in a quake nor whether occupants would be injured or killed nor whether structural damage might be repairable. However, they all recommended retrofitting to reduce risk given the known vulnerabilities of our type of foundation.

[Note: Our three other campus buildings were built between 1938 and 1955 and are not considered vulnerable to significant earthquake damage. They have adequate foundations (not unreinforced brick) and are bolted to their foundations. The number of bolts for the Resident Friend’s apartment (Building 2) is not up to current earthquake safety standards. We received a bid of \$6,000 for adding more bolts. However, a structural engineer⁸ with whom we consulted felt that the risk to the building was minimal. He did not recommend additional bolting, considering the cost.]

California Recommends Retrofitting Unreinforced Brick Foundation Buildings

The California Seismic Safety Commission states in its 2005 report⁹:

“Unreinforced masonry—brick, concrete block, or stone—foundations often cannot resist earthquake shaking. They may break apart, or be too weak to hold anchor bolts. Homes may shift off such foundations during earthquakes, damaging the walls, floors, utility lines, and home contents.

“Solution: The most common approach is to replace all or part of the existing foundation with a poured reinforced concrete foundation. Remember: It is cheaper to do this before an earthquake damages the house than after.”



These two houses, next door to each other, experienced the South Napa Earthquake, magnitude 6.0. (Anticipated maximum 7.0 quakes within 3 miles of our Meeting House would release 32 times more destructive energy than the South Napa quake.) Both houses are wood-frame like our Meeting House. The house on the right was retrofitted and did not experience major structural damage. The house on the left was not retrofitted, slid away from its foundation, and experienced major structural damage. This is indicated by the tilted rooflines and pillars on the porch. A red line drawn across the top of the photo shows how the roofline of the house on the left has tilted, whereas it has remained horizontal on the right. Note the chain link fence in front of the house on the left to prevent entry. [Source: [California Earthquake Authority](#), a nonprofit organization that offers earthquake insurance, established by the California Legislature]

AVAILABLE OPTIONS

OPTION (1) BUY EARTHQUAKE INSURANCE

Currently, all four campus buildings are covered by all the usual types of property insurance except earthquake insurance. Earthquake insurance covers only property damage, not injuries. For personal injuries, OGMM carries \$1,000,000 in Liability Insurance.

When our insurance broker recently solicited earthquake insurance bids on OGMM's behalf, few agents expressed interest, and the few who did, informed our agent that the yearly premium would run, at a minimum, \$25,000. In addition, OGMM's deductible could amount to \$200,000.

Given the high cost of earthquake insurance, and the possibility of premiums rising, our Meeting has long set aside money in an Earthquake Reserve. In 2020, we budgeted \$4,000 for this fund. Should a damaging earthquake occur, this money would be used to repair or replace campus buildings. Including this year's set-aside, we have accumulated \$234,000 in the Earthquake Reserve.

If an earthquake damaged our campus buildings, the \$234,000 in the Earthquake Reserve could be used to cover the deductible. A good policy would allow us to make major repairs or demolish and replace campus buildings as necessary. This approach involves a commitment to paying a minimum of \$25,000 every year to an insurance company even during a difficult economy.

OPTION (2) CONTINUE THE STATUS QUO

Another option is to continue to set aside a few thousand dollars a year in the OGMM Earthquake Reserve, but NOT retrofit the Meeting House's foundation.

If an earthquake were to require the demolition, clearing of debris, and replacement of our Meeting House, the cost could be on the order of \$600,000.¹⁰ In a worst-case scenario, there could be injuries or deaths, resulting in legal suits based on a claim that our Meeting had been negligent in failing to undertake State-recommended retrofits to meet current earthquake standards.

OPTION (3) RETROFIT THE MEETING HOUSE TO MEET CURRENT EARTHQUAKE STANDARDS; DO NOT BUY EARTHQUAKE INSURANCE

Under this option, OGMM would retrofit by installing a new concrete foundation strengthened with reinforcing steel bars (rebar). The wooden structure would be bolted to the new foundation. This would bring the foundation up to current earthquake safety standards.¹¹ To meet City of Pasadena historic preservation requirements, the existing brick foundation would be retained. The new concrete foundation (called a "sister foundation") would be built within its perimeter, hidden from view.¹²

The new foundation would be designed in accordance with the City of Pasadena building code for sister foundations. City engineers in the Department of Building and Safety would review and approve the plans. During construction, City inspectors would inspect the work on three different occasions, including upon completion.

Installation of Rain Gutters

Foundation retrofitting companies will usually provide warranties for their work only if the new foundation is protected from water damage. Rain gutters, which the Meeting House used to have, prevent such damage. (Steel rain gutters on our Meeting House rusted out decades ago. The gutters were removed and not replaced.) The Property Committee recommends installing painted aluminum rain gutters, similar in appearance to the building's original gutters, as part of the retrofit project.

Cost

The Property Committee invited bids from three earthquake retrofitting companies for engineering and construction of a sister foundation and bolting. The bids range from \$66,700 to close to \$100,000. We are recommending the low bid of \$66,700 by Golden Retrofit. This company has 220 customer reviews on Yelp, averaging the highest rating possible, 5.0.

\$66,700	New Foundation & Bolting for Meeting House, "Sister Foundation"
<u>\$6,000</u>	Rain Gutters for Meeting House
\$72,700	SUBTOTAL
<u>\$5,000</u>	Unexpected contingencies (It's prudent to set aside for contingencies, though none come to mind.)

\$72,700 to \$77,700 TOTAL

Funds Are Available in the Earthquake Reserve

Using the Earthquake Reserve monies to retrofit the Meeting House's foundation would bring it up to current earthquake standards and reduce our risks. Approximately \$156,000 would remain in the Reserve if the funds were utilized in this manner.

Option	Reduces Risk by Meeting Current Earthquake Standards	One-Time Cost	Annual Cost	Possible Cost of Property Damage to the Meeting House by a Large Quake
Earthquake Insurance (No Retrofit)	No	\$0	\$25,000 minimum	At least a \$200,000 deductible.
Status Quo: Continuing to Fund the Earthquake Reserve (No Retrofit)	No	\$0	Approx. \$4,000	On the order of \$600,000.
Retrofit and Continuing to Fund the Earthquake Reserve	Yes	\$72,700 - \$77,700	Approx. \$4,000	Less than without the retrofit.

RECOMMENDATION TO RETROFIT

The Property Committee recommends retrofitting, Option (3):

- Bring the Meeting House foundation up to current earthquake standards,
- Install rain gutters on the Meeting House, and
- Continue to set aside annual contributions for the Earthquake Reserve.

It further recommends that OGMM use funds from the Earthquake Reserve to pay for the retrofit. The retrofit might be the best possible insurance that our Meeting House will survive a quake and that we will have met our responsibility to protect the safety of the building's occupants. A retrofit would also make it less risky to lower our annual contributions to the Earthquake Reserve during difficult economic times.

We cannot predict whether our Meeting House will experience a large magnitude earthquake. We cannot predict with certainty how our Meeting House would respond, with retrofitting or without. Similarly, it is not possible to predict if one's family will be in a serious vehicle accident nor if wearing seat belts will save everyone's lives. But it is prudent to reduce risk by wearing seatbelts. It is prudent to reduce risk by bringing our foundation up to current earthquake standards.

Footnotes to Earthquake Retrofit Proposal for Our Meeting House

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¹ **Potential for Earthquakes in the Vicinity of the Meeting House:** The Meeting House is located near three faults. According to the US Geological Survey (USGS), here are the largest quakes that can be expected:

Fault	Largest Magnitude Expected	Miles to Meeting House
Verdugo	6.9	1.5
Raymond	6.8-7.0	2.7
Sierra Madre	7 approximately	3

The faults near the Meeting House are capable of quakes of about magnitude 7.0. Property Committee confirmed this projected magnitude with staff of the California Geological Survey, Janis Hernandez and Brian Olson (phone conversations, May and March 2020, respectively). They based this projection on the 1998 State publication, *the California Seismic Hazard Zone Map*.

Comparison with the Northridge Earthquake: The projected magnitudes of potential quakes near the Meeting are higher than that of the Northridge Earthquake of 1994. The Northridge Quake was magnitude 6.7. Its epicenter was about 25 miles from our Meeting House. In the San Fernando Valley, the Northridge Quake killed 57 people and injured about 12,000. It severely damaged or destroyed about 60,000 housing units, including homes and apartments. The Northridge quake was the most destructive earthquake in California since the 1906 San Francisco Earthquake. [Source: Public Policy Institute 2006 report: https://www.ppic.org/content/pubs/jtf/JTF_NorthridgeJTF.pdf]

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² **Earthquakes Experienced by the Meeting House:** The Meeting House has never experienced a quake close to the magnitude of the Northridge Quake nor close to the magnitude of potential quakes on faults in the vicinity of the Meeting House (7.0).

These are the largest nearby quakes that the Meeting House has experienced:

- 1988 Pasadena Quake (on the Raymond Fault)—4.9 (about 2.7 miles away)
- 1991 Sierra Madre—5.6 (about 3 miles away)

The only earthquake damage that the Meeting House has experienced appears to be during the 1991 Sierra Madre quake (magnitude 5.6). The Meeting House chimney (unreinforced brick) was damaged. It was rebuilt.

While the magnitude of the Sierra Madre quake at 5.6 might seem close to the magnitude of potential future quakes in our vicinity (7.0), it must be remembered that magnitudes are measured on a logarithmic scale. This means that by some measures, a 7.0 quake is 10 times greater than a 6.0 quake. But by the most important measure, energy release, a 7.0 quake is **32 times greater** than a 6.0 quake and **1,000 times greater** than a 5.0 quake. Damage is correlated with energy release.

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³ In addition to three foundation retrofitting companies, we consulted with:

- Sarkis Nazerian, the director of the Department of Building and Safety, City of Pasadena,
- Melvyn Green, a leading expert on seismic retrofitting of historic buildings. On May 13, 2020, Mr. Green inspected the foundation of the Meeting House and the building itself. He felt it likely that the wooden structure of the Meeting House could withstand a large magnitude quake. But it might shift away from its foundation. He recommended building a sister foundation and bolting the building to its new foundation.

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⁴ See the section "[Orange Grove Meeting House](#)," within the tab "About Orange Grove Friends" on our website www.OGMM.org.

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⁵ California Seismic Safety Commission, *Homeowner's Guide to Earthquake Safety*, 2005. A section of this report is quoted on page 2 of the Property Committee proposal to retrofit. The possibility of our unreinforced brick foundation crumbling and the building shifting away from its foundation was also confirmed by:

- All three foundation retrofitting companies who inspected our Meeting House and submitted bids;
- David Gaines, structural engineer, who drew up plans for a retrofit of our Meeting House in 2015. He wrote about these risks in an April 24, 2020 e-mail to Lou Byerly, Finance Committee Clerk;
- Sarkis Nazerian, director of City of Pasadena Department of Building Safety in a March 2020 phone conversation;
- Melvyn Green, a structural engineer and leading expert on seismic retrofitting of historic buildings. Mr. Green inspected our Meeting House personally on May 13, 2020.

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⁶ California Seismic Safety Commission, *Homeowner's Guide to Earthquake Safety*, 2005. Melvyn Green, structural engineer and leading expert on seismic retrofitting of historic buildings inspected our Meeting House on May 13, 2020. He specifically mentioned these potential dangers, including the possibility of doors jamming.

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⁷ We asked experts about how much structural damage and danger to persons we should expect in a large quake if we fail to retrofit. They all said, essentially, that it's an unanswerable question. The specific amount and type of shaking and the specific ways in which our building might respond cannot be accurately predicted. We asked this of:

- Dr. Lucy Jones, seismologist, Cal Tech, phone conversation of March 6, 2020.
- Brian Olson, seismologist, California Geological Survey, phone call in March 2020.
- Sarkis Nazerian, director of Dept. of Building & Safety, City of Pasadena, phone conversation in March 2020.
- Melvyn Green, structural engineer, a leading expert on the seismic retrofitting of historic buildings. In person consultation at our Meeting House on May 13, 2020.
- In addition, none of the representatives of the three foundation retrofitting companies which gave us bids ventured to answer this question.

While they did not venture to predict the level of structural damage and danger to persons, every retrofitter, engineer, and seismologist whom the Property Committee consulted on this question, recommended retrofitting our foundation.

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⁸ Melvyn Green, structural engineer, in his visit to our campus on May 13, 2020.

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⁹ California Seismic Safety Commission, *Homeowner's Guide to Earthquake Safety*, 2005.

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¹⁰ The figure of \$600,000 is an estimated maximum. Based on prices listed on the Internet for demolition and hauling, the maximum for the Meeting House might be \$100,000. The current maximum for construction costs in Pasadena is \$200 per square foot. At 2,500 square feet, constructing a new Meeting House would cost \$500,000.

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¹¹ The broad meaning of "current earthquake safety standards" in regard to a foundation is: (1) a concrete foundation strengthened with reinforcing steel bars, together with (2) sufficient bolting of the structure to the foundation. This is the

recommended type of foundation in such publications as the California Seismic Safety Commission's *Homeowner's Guide to Earthquake Safety*, 2005.

More specifically, for our Meeting House, "current earthquake safety standards" refers to the current requirements for seismic safety of foundations in the Pasadena Building and Safety Code. This Code provides specifications, with engineering calculations and drawings, for reinforced concrete foundations and bolting. Any seismic retrofit of the foundation of the Meeting House would be required to meet these requirements.

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¹² Kevin Johnson, staffperson with the City of Pasadena Design and Historic Preservation Review section, outlined this requirement in a phone conversation in April 2020.

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