USSC

REPORT FROM THE GROUND MOTION SUBCOMMITTEE

AUGUST 15, 2024

PRESENTED BY BRENT MAXFIELD

Subcommittee Members

- Chair: Brent Maxfield – USSC Ex-Officio/The Church of Jesus Christ of Latter-day Saints
- Mohsen Zaker – USU
- Brady Cox – USU
- Robert Grow – USSC/Envision Utah
- Ari Bruening – USSC/Envision Utah
- Ryan Beck – Envision Utah
- Divya Chandrasekhar – USSC/UofU
- George Deneris – Utah.gov
- John Crofts – USSC/Utah.gov
- Jessica Chappell – USSC/Structural Design Studio
- Sean McGowan – FEMA Region 8
- Jim Pechmann – UofU
- Tim Strickland – SEAU/Structural Design Studio
- Justin Marshal – SEAU/DuraFuse Frames
- Zach Hansen – SEAU/ARW Engineers

These are Draft Messaging Statements

- We seek your input
- Are the statements clear?
- What improvements can be made?

These statements address two overarching concerns about new building performance in a future large Wasatch fault earthquake:

1. Safety:
   - Stronger buildings are needed to reduce the risk of building collapse.
2. Resilience:
   - Stronger buildings will help make the Wasatch Front community more capable of recovering from the disaster.

Each of the below statements will have footnotes that will provide technical discussion and backup.

1) There is a high risk of a large earthquake—many times stronger than the 2020 Magna earthquake—in the Wasatch Front Region in the coming years.

- Studies show that we could experience one of the deadliest and most disruptive disasters in U.S. history.
- There are things we can do to improve our resilience.

2) The new buildings we are constructing leave us vulnerable to a future disaster.

- The building code design shaking level for new buildings is roughly one-half as strong as the shaking that could occur in some locations when a large Wasatch fault earthquake occurs.
- The building code design shaking levels for new buildings along the Wasatch Front are based, in part, on the relatively long average return period for large earthquakes on the central Wasatch fault (1100 to 1300 years at any one location). The code does not require buildings to be designed for the higher shaking levels that could occur in a large Wasatch fault earthquake.
- New buildings constructed along the Wasatch Front are about 3 times more likely to collapse from a large Wasatch fault earthquake than new buildings in San Francisco due to a large San Andreas fault earthquake. The reason is that the code requires new buildings in San Francisco to be designed for the higher potential shaking levels, but the building code along the Wasatch Front does not, for the reasons noted above.

3) For very little additional cost, buildings along the Wasatch Front can be constructed stronger than the current building code requires, which will reduce the chance of collapse in a large Wasatch fault earthquake.

4) A study by the Structural Engineers Association of Utah (SEAU) shows that the increase in construction cost for these stronger new buildings would be as follows.

- Single family homes: About ¼ %
- Multistory multifamily residences: Less than 2%
- Commercial buildings: Between 2% and 5%

5) Stronger new buildings will result in a more resilient Wasatch Front.

- There will be a higher probability that emergency services will remain operational
- Schools will be safer and able to be used as emergency shelters.
- More residents will be able to remain living in their homes
- More buildings can be occupied following a Wasatch fault earthquake.
- More businesses will be able to stay open following the earthquake.
- There will be fewer deaths and injuries.
- There will be fewer collapsed buildings and buildings that must be torn down.
- Buildings will be less expensive to repair following the earthquake.
- Studies have shown that the economic and safety benefits of strengthened buildings will result in a savings of $4 for every dollar spent.
- Wasatch Front buildings will be a better investment for lending institutions and insurers.

6) Now is the time to begin building stronger, more resilient buildings.

- Every new building constructed will likely be around for decades. It is much more cost-effective to ensure the building is resilient when first built than to retrofit the building later.
- If we begin today, in 30 years, about one-half of the building stock will consist of stronger, more resilient buildings.

7) We need building regulations that will provide a safer, more resilient community for us, our children, and our grandchildren.

Short Term Goal

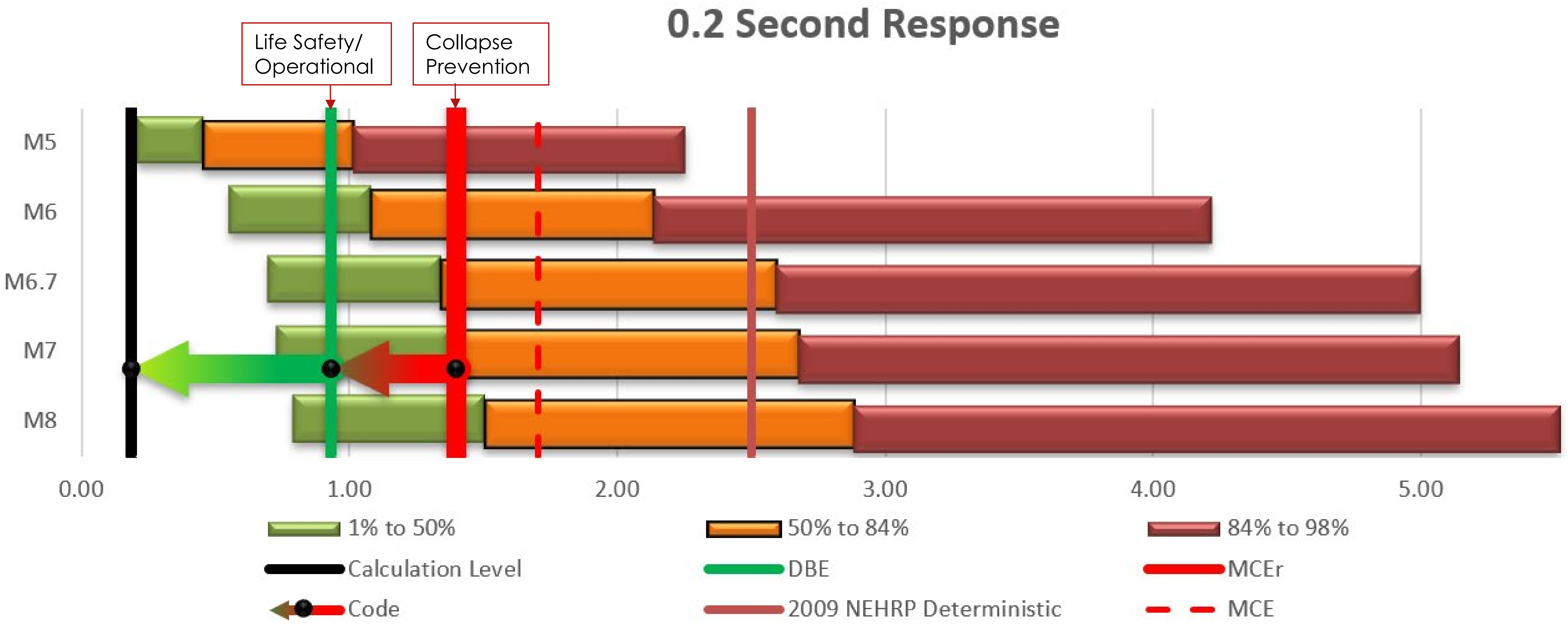
- We seek $300,000 for a study to better quantify the extent of repair costs, deaths and injuries, and recover time if we stay with the current building code compared to the losses from an enhanced building code. The study will explore approaches to remedy the seismic design forces in a special Wasatch Front seismic region.

Discussion

1) **There is a high risk of a large earthquake—many times stronger than the 2020 Magna earthquake—in the Wasatch Front Region in the coming years.**
    a) Studies show that we could experience one of the deadliest and most disruptive disasters in U.S. history.
    b) There are things we can do to improve our resilience.
2) **The new buildings we are constructing leave us vulnerable to a future disaster.**
    a) The building code design shaking level for new buildings is roughly one-half as strong as the shaking that could occur in some locations when a large Wasatch fault earthquake occurs.
    b) The building code design shaking levels for new buildings along the Wasatch Front are based, in part, on the relatively long average return period for large earthquakes on the central Wasatch fault (1100 to 1300 years at any one location). The code does not require buildings to be designed for the higher shaking levels that could occur in a large Wasatch fault earthquake.
    c) New buildings constructed along the Wasatch Front are about 3 times more likely to collapse from a large Wasatch fault earthquake than new buildings in San Francisco due to a large San Andreas fault earthquake. The reason is that the code requires new buildings in San Francisco to be designed for the higher potential shaking levels, but the building code along the Wasatch Front does not, for the reasons noted above.
3) **For very little additional cost, buildings along the Wasatch Front can be constructed stronger than the current building code requires, which will reduce the chance of collapse in a large Wasatch fault earthquake.**
4) **A study by the Structural Engineers Association of Utah (SEAU) shows that the increase in construction cost for these stronger new buildings would be as follows.**
    a) Single family homes: About ¼ %
    b) Multistory multifamily residences: Less than 2%
    c) Commercial buildings: Between 2% and 5%
5) **Stronger new buildings will result in a more resilient Wasatch Front.**
    a) There will be a higher probability that emergency services will remain operational
    b) Schools will be safer and able to be used as emergency shelters.
    c) More residents will be able to remain living in their homes
    d) More buildings can be occupied following a Wasatch fault earthquake.
    e) More businesses will be able to stay open following the earthquake.
    f) There will be fewer deaths and injuries.
    g) There will be fewer collapsed buildings and buildings that must be torn down.
    h) Buildings will be less expensive to repair following the earthquake.
    i) Studies have shown that the economic and safety benefits of strengthened buildings will result in a savings of $4 for every dollar spent.
    j) Wasatch Front buildings will be a better investment for lending institutions and insurers.
6) **Now is the time to begin building stronger, more resilient buildings.**
    a) Every new building constructed will likely be around for decades. It is much more cost-effective to ensure the building is resilient when first built than to retrofit the building later.
    b) If we begin today, in 30 years, about one-half of the building stock will consist of stronger, more resilient buildings.
7) **We need building regulations that will provide a safer, more resilient community for us, our children, and our grandchildren.**

Range of Shaking

Pay attention to the orange



Selecting S_s and S_1

Basic Parameters

Name	Value	Description
S_S	1.484	MCE_R ground motion (period=0.2s)
S_1	0.542	MCE_R ground motion (period=1.0s)
S_{MS}	1.484	Site-modified spectral acceleration value
S_{M1}	0.542	Site-modified spectral acceleration value
S_{DS}	0.99	Numeric seismic design value at 0.2s SA
S_{D1}	0.361	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	D	Seismic design category
F_a	1	Site amplification factor at 0.2s
F_v	1	Site amplification factor at 1.0s
CR_S	0.859	Coefficient of risk (0.2s)
CR_1	0.859	Coefficient of risk (1.0s)
PGA	0.673	MCE_G peak ground acceleration
F_{PGA}	1	Site amplification factor at PGA
PGA_M	0.673	Site modified peak ground acceleration
T_L	8	Long-period transition period (s)
SsRT	1.484	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.729	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	2.692	Factored deterministic acceleration value (0.2s)
S1RT	0.542	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.63	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	1.16	Factored deterministic acceleration value (1.0s)
PGAd	1.089	Factored deterministic acceleration value (PGA)

S_S is the lower of SsRT and SsD

Ss=1.484

SsRT=1.484
SsD=2.692

S_1 is the lower of S1RT and S1D

S1=0.542

S1RT=0.542
S1D=1.16