

Update on Resilient Design for Functional Recovery for U.S. Building Codes, and Qualification of Additional Structural Systems for New Code Provisions

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Professor @ California State University, Chico

Acknowledgement of Many Collaborators :

BSSC Functional Recovery Task Committee, BSSC PUC, SP3 Team (Almeter, DeBock, Welch), many visionary Structural Engineers in our profession, ATC-138 Team (FEMA-funded), NIST project by Liel/Cook, and many more....!

HB RG | where research meets practice

www.sp3risk.com

Resilient Design Coalition Webinar | September 11, 2025

- Webinar will be recorded (including Q&A, unless requested to not) and video will be distributed
- All phone lines are muted to start (can open line and video at end for questions)
- Questions are highly encouraged
- Handouts will be available – presentation slides



■ Questions:

- Zoom allows verbal questions at the end (so we can actually interact more), so please feel free to use that feature.
- You can type in questions as we go and we can discuss them at the end of the webinar.
- For further questions, or for feedback on forward development, please contact Allison at the SP3 office and she can connect you with the right person (allison@hbrisk.com).



- The codification efforts for resilient design for functional recovery have been ongoing, have been moving fast, and have many people and sub-committees/groups involved.
 - NEHRP 2026 - Functional Recovery Task Committee and PUC
 - ASCE 7-28 committees
 - Resilient Design Coalition
- We gave you an update on this in Feb/March (Webinars #1/#2).
- Since then, we have been head-down working for the last 6 months on:
 - Final edits and refinements to the new Appendix A functional recovery code.
 - Qualifying as many new structural systems as possible in this code cycle.
- The purpose of today is to give a status update on all this work (and also give context for how this fits into all the development in recent years).
- We plan to follow this with more webinars with more detailed content (and suggestions on topics are welcomed!).

Major Recent Development:

- We now have a complete set of prescriptive code requirements for Resilient Design for Functional Recovery (“App. A”).
- This was approved by the Building Seismic Safety Council Provisions Update Committee ***Tues. August 26th!***
- This is slated for the 2026 NEHRP Provisions (not final).
- This also in the hands of ASCE 7-28 Task Committee 10.

1	APPENDIX A, SEISMIC DESIGN
2	CRITERIA AND OTHER
3	REQUIREMENTS FOR FUNCTIONAL
4	RECOVERY
5	Add Section A.1 as follows:
6	A.1 GENERAL
7	A.1.1 Scope This appendix is not a mandatory part of the provisions but may be adopted by an Authority
8	Having Jurisdiction. Where adopted, the seismic analysis, design, documentation, review, observation,
9	and quality assurance for structures assigned to Functional Recovery Categories A through E shall
10	comply with the applicable requirements of this appendix in full, in addition to all applicable
11	requirements in Chapters 11 through 21 and 23.
12	A.1.2 Seismic Design Category The Seismic Design Category assignment for a structure shall be in
13	accordance with Section 11.6 with S ₁ , S _{0s} and S ₀₁ unmodified by this appendix.
14	A.1.3 Exemptions The following structures shall be permitted to be exempt from the requirements of
15	this appendix:
16	1. Structures assigned to Seismic Design Category A.
17	2. Structures exempt in accordance with Section 11.1.2.
18	3. Detached one- and two-family wood-frame dwellings with not more than two stories above
19	grade plane, satisfying the limitations of and constructed in accordance with the IBC.
20	4. Structures assigned to Functional Recovery Category E.
21	A.1.4 Deemed to Comply The following structures shall be deemed to comply with the requirements of
22	this appendix. No further analysis, design, documentation, review, observation, or quality assurance
23	in accordance with this appendix shall be required.
24	1. Structures assigned to Functional Recovery Category D in Seismic Design Category B.
25	2. Seismically isolated structures assigned to Functional Recovery Category D designed in
26	accordance with Chapter 17 for the MCEs.
27	A.1.5 Applicable Requirements Except as permitted in accordance with Section A.1.3 or A.1.4:
28	• Buildings and their nonstructural components shall comply with the sections referenced for
29	either a prescriptive or explicit assessment in Table A.1-1. The prescriptive assessment
30	procedure shall not be permitted for buildings with damping systems.

- The Resilient Design Movement (context)
- Technical Methods for Resilient Design
(e.g. FEMA P-58 Functional Recovery Module)
- Adoption/Use of Resilient Design
- Codification of Resilient Design

The Resilient Design Movement



The Resilient Design Movement

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- Over the past decade, FEMA P-58 resilient design and risk assessment methods have been **used and vetted** by many early-adopter seismic-focused structural engineering companies. This has been instrumental in **providing confidence** for current resilient design codification efforts.



The Resilient Design Movement

~1997...

2001
FEMA/ATC
Start
FEMA P-58

2012

2013

2014

2015

2016

2018

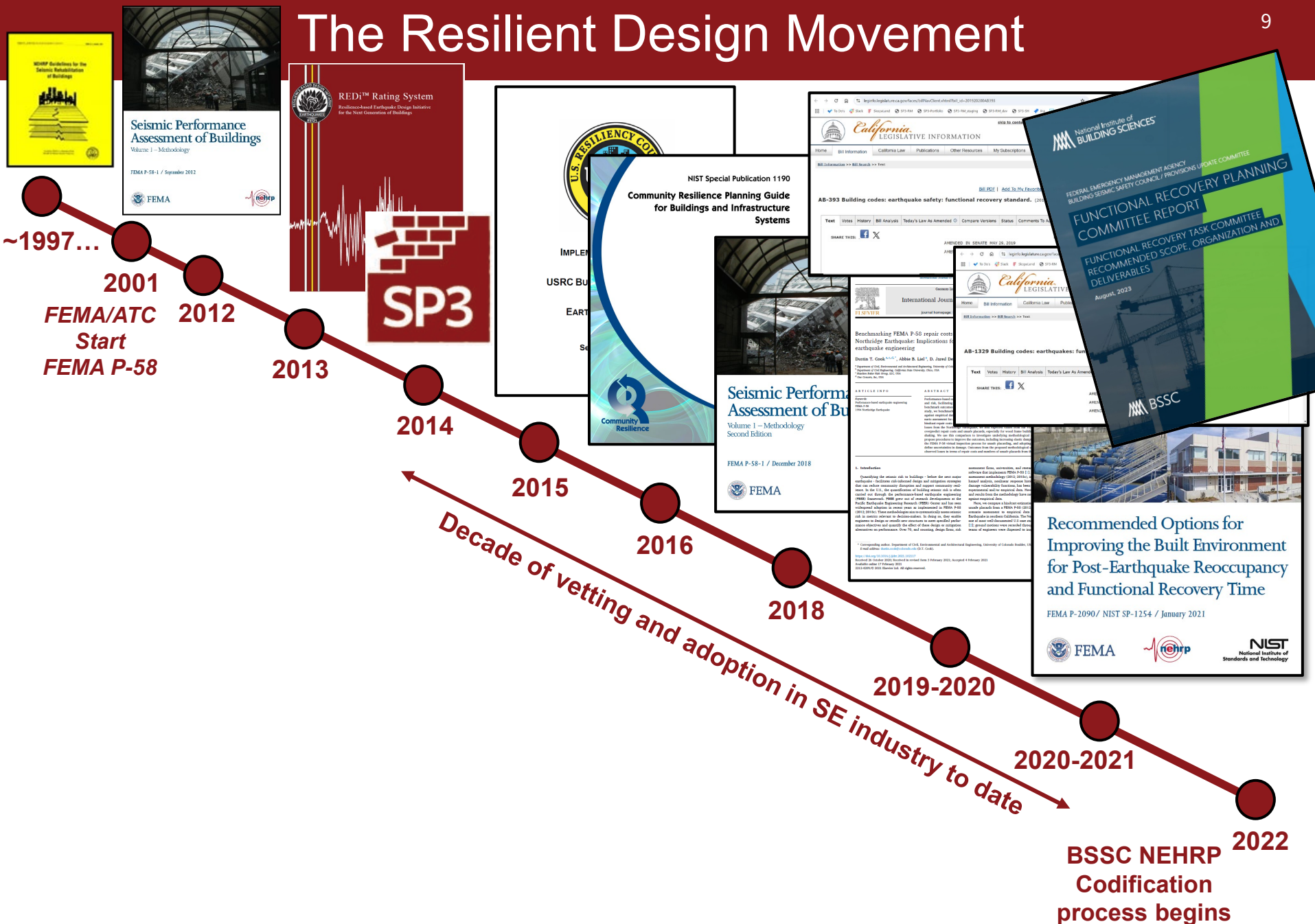
2019-2020

2020-2021

2022

Decade of vetting and adoption in SE industry to date

BSSC NEHRP
Codification
process begins



The Resilient Design Movement

~1997...

2001

2012

2013

2014

2015

2016

2018

2019-2020

2020-2021

2022

Lots of Intermediate Drafts!

BSSC NEHRP Codification process begins

PUC-Approved Draft for NEHRP

August 26th, 2025

Work of the Resilient Design Coalition (2025-2026)

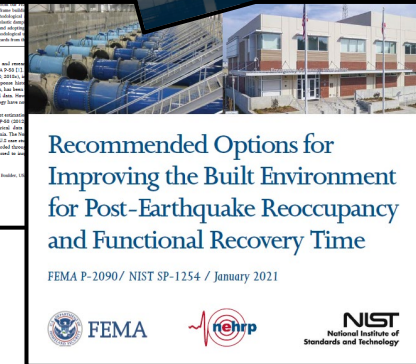
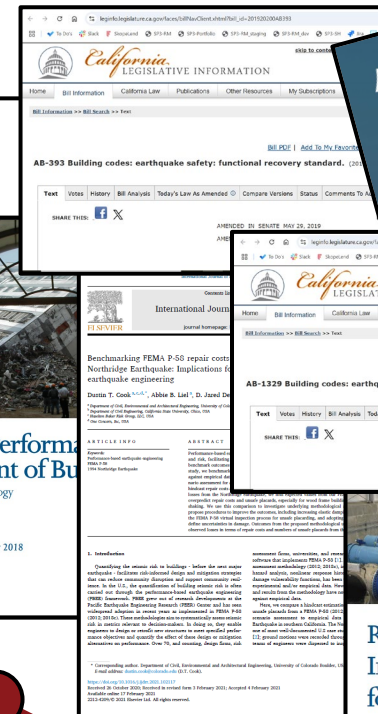
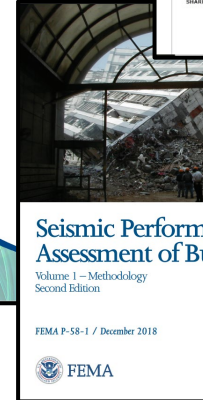
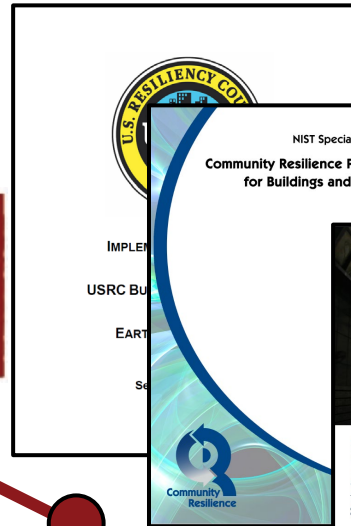
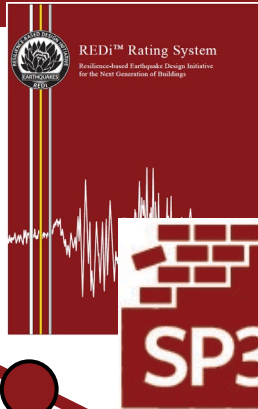
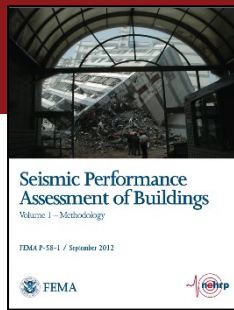
2026 NEHRP Provisions

ASCE 7-28

Initial Adoption by Jurisdictions (e.g. State of WA)

IBC 2030

BSSC NEHRP Codification process begins



- This stuff often feels new, but it is really not! This has been developed and vetted extensively over the past 25 years.

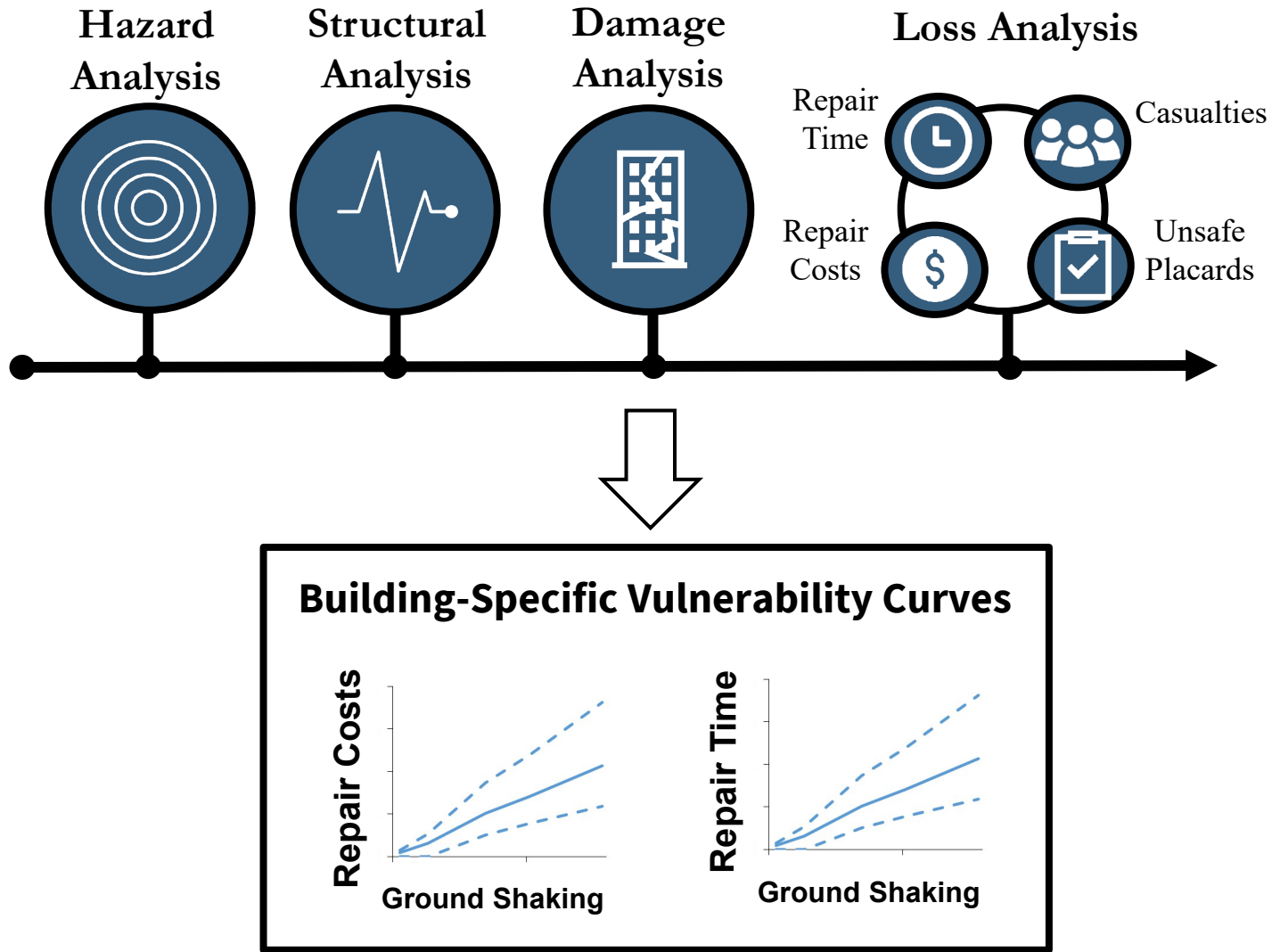
Last 25 Years:

- **Decade #1 (2001-2012):** Creation of FEMA P-58 seismic risk assessment method.
- **Decade #2 (~2012-2022):**
 - ✓ Broad early-adopter use, vetting, building confidence, and many refinements.
 - ✓ Development of extensive FEMA P-58-based Functional Recovery (FR) methods.
 - ✓ Development of extensive FEMA P-58 automations to make building-specific analysis possible even with limited building information (preliminary design, portfolios, etc.).
- **Decade #3 (2022-Present):**
 - ✓ Development of building code requirements for Resilient Design for FR (Functional Recovery Task Committee, PUC, 2026 NEHRP Provisions and ASCE 7-28).
 - ✓ Adoption of resilient design provisions by jurisdictions (e.g. State of Washington feasibility study).
 - ✓ Further adoption in practice and mainstream use for Resilient Design for FR.

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FEMA P-58 (with Function Module) provides the **comprehensive** and **standardized** approach to evaluate functional recovery times (with ~\$20M to develop).



SP3 provides a user-friendly software to integrate all steps of FEMA P-58 (with Functional Recovery Module), with ~\$10M to develop.

The initial assessment should take a couple **hours** and **not weeks** (with huge focus on automations).

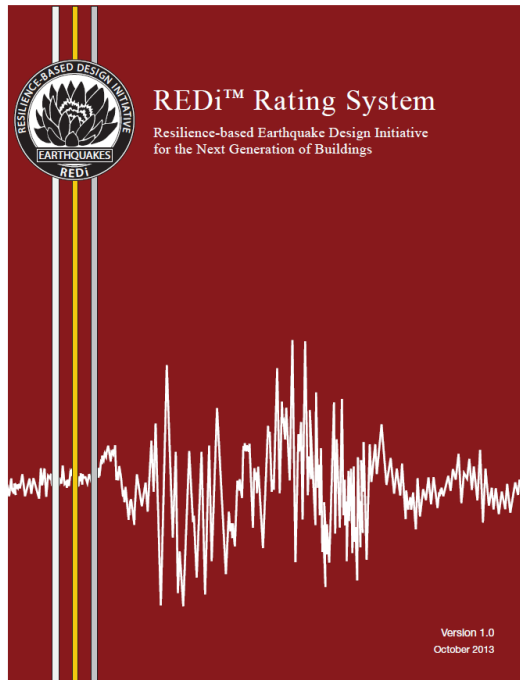
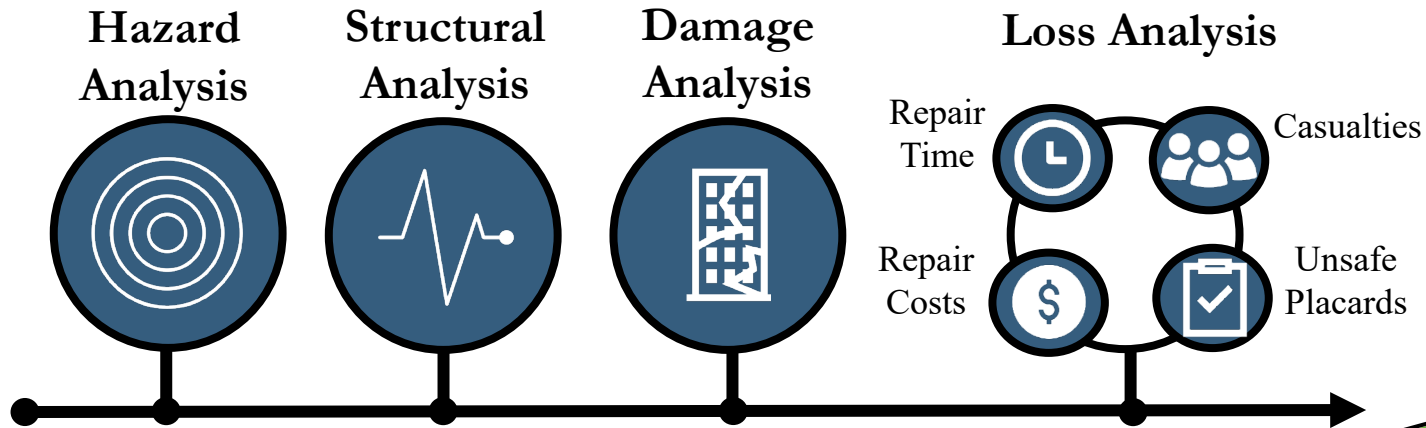
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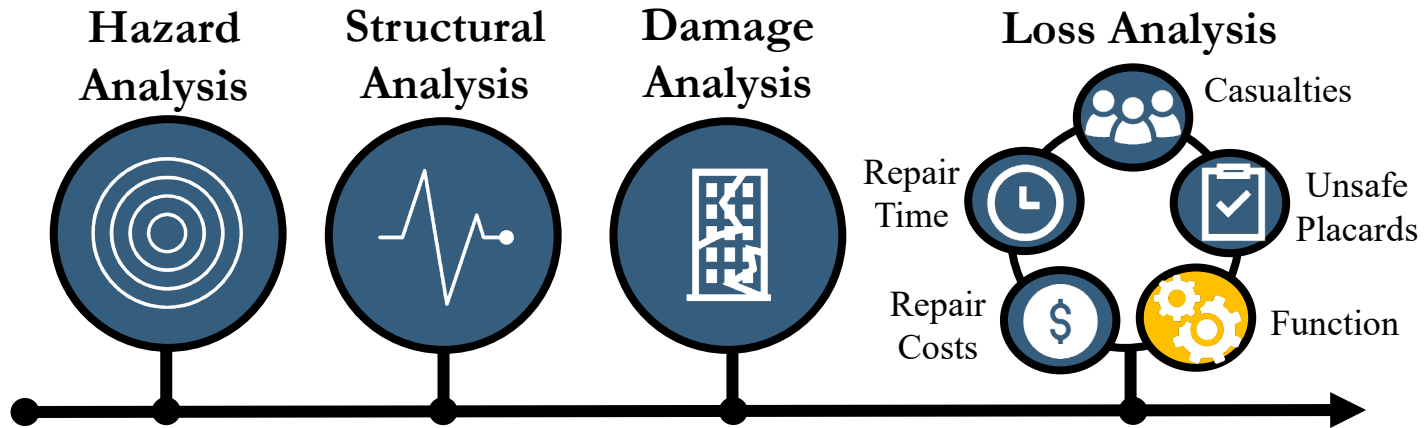
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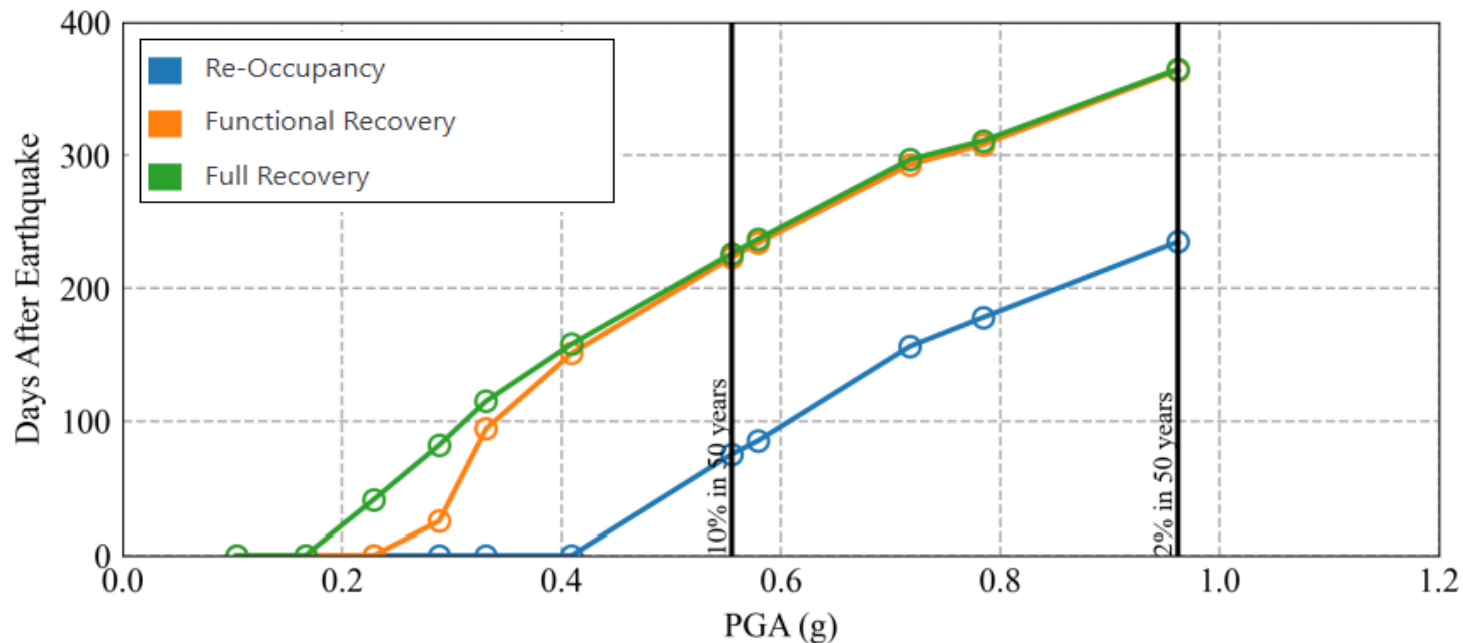
FEMA P-58 with Functional Recovery Module

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The **FEMA P-58 Functional Recovery Module** now provides **reoccupancy** and **functional recovery** times.



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Codification of Resilient Design (BSSC/NIBS)

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- 1) Our current **early-adopter projects** only help the building being designed to be resilient (kind of).
- 2) Community resilience requires a **majority of buildings** to remain functional.
- 3) Building **code requirements are necessary** for broad resilient design for most/all buildings!

Hurricane Ike, Houston 2008, Reuters Pictures, Dunya News



Lahaina Maui Fire,
2023, Courtesy
CBS News

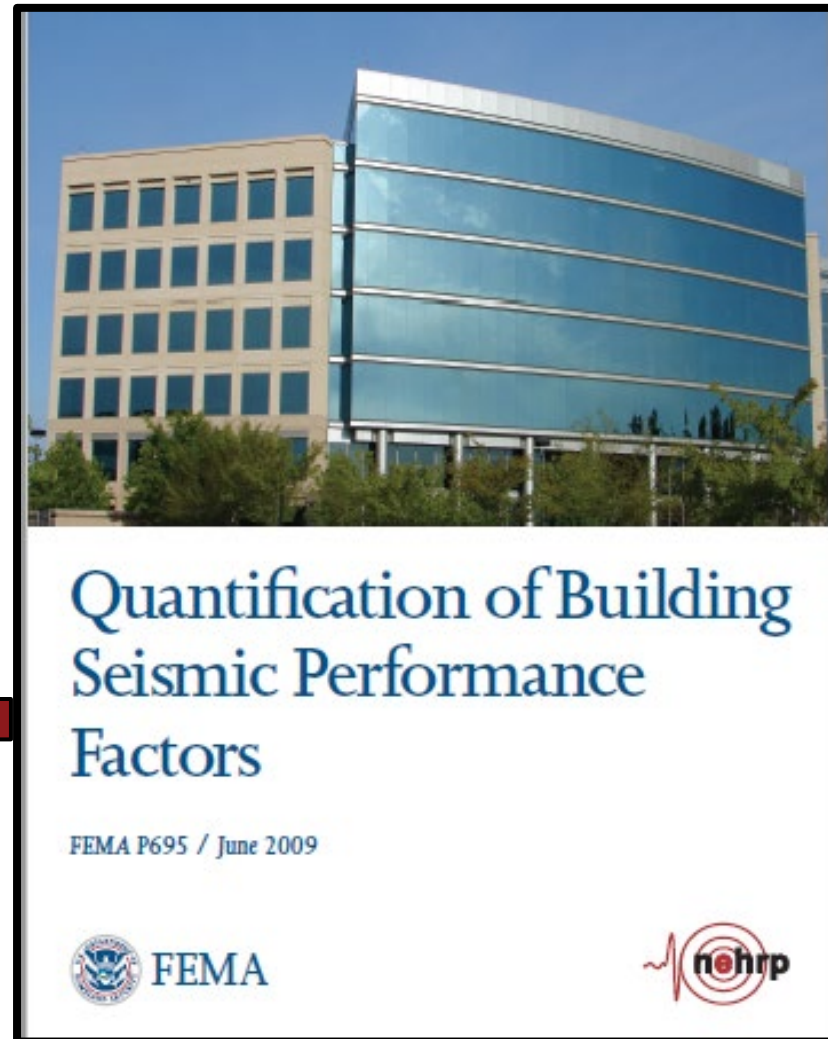
Review of Code Development Process for Safety (current):

Table 1.3-2 Target Reliability (Conditional Probability of Failure)
for Structural Stability Caused by Earthquake

Risk Category	Conditional Probability of Failure Caused by the MCE_R Shaking Hazard (%)
I & II	10
III	5
IV	2.5

Lots of Analysis Runs
for Lots of Design Cases

Prescriptive Design
Requirements for the Code



Similar use of FEMA P-58 for Functional Recovery Provisions:

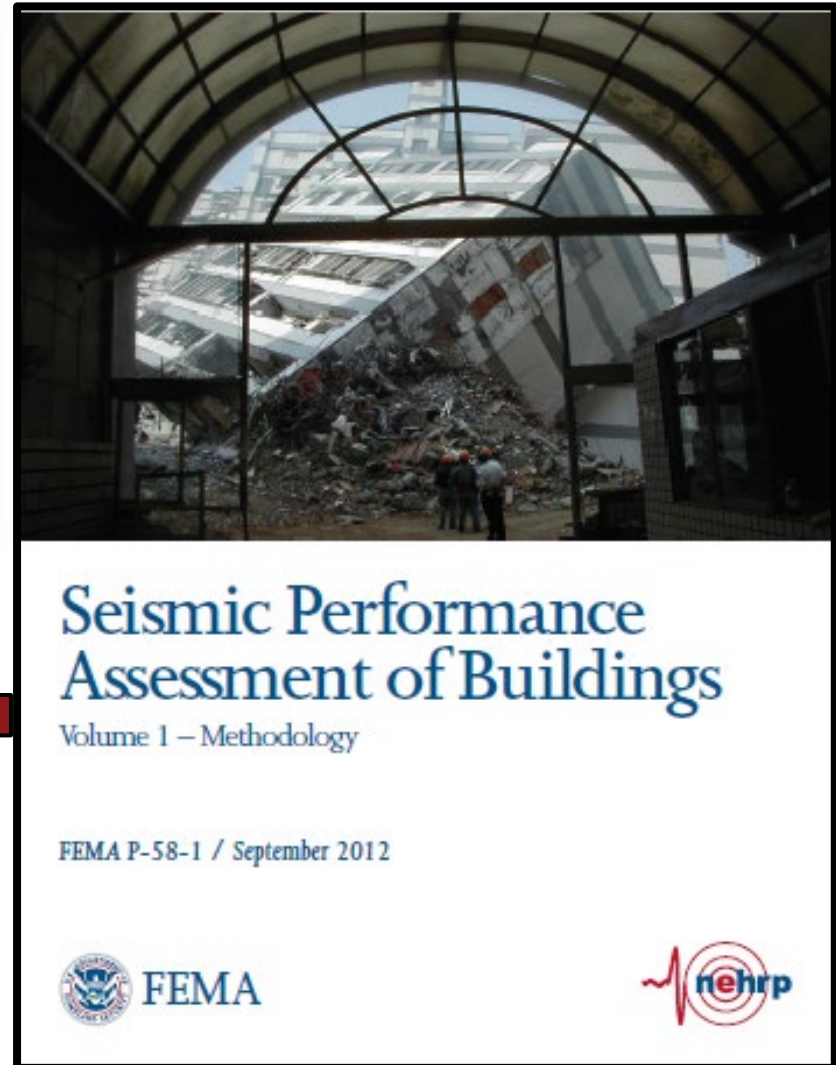
Table 24.1-1. Target Functional Recovery Time

Functional Recovery Category	Target Functional Recovery Time	
	General Expectation	Acceptance Criteria
A	Immediate	0 hours
B	Within a few days	72 hours
C	Within a couple of months	2 months
D	Within half a year	6 months

AWS

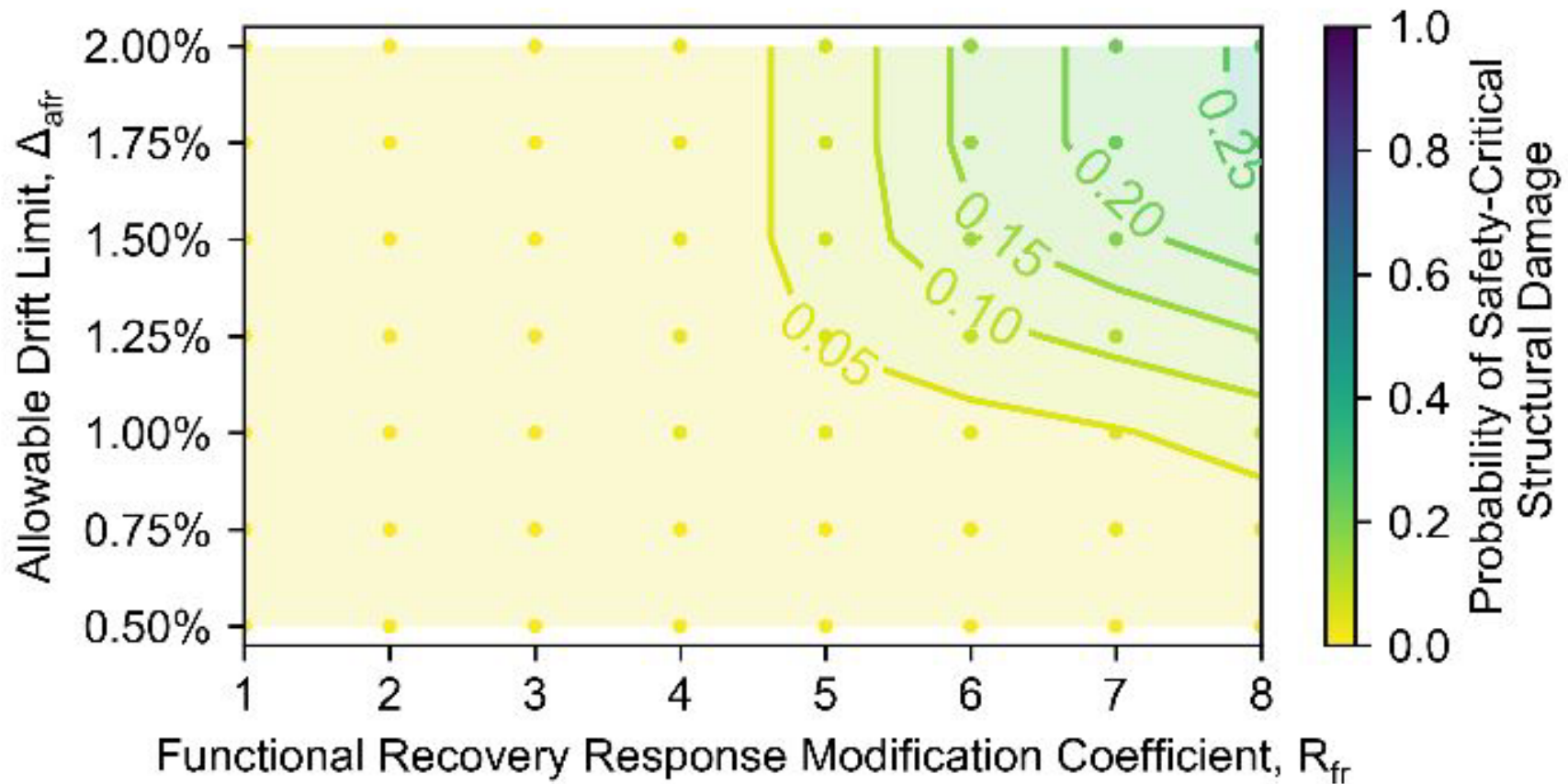
Lots of Analysis Runs
for Lots of Design Cases

Prescriptive Design
Requirements for the Code



Process for Qualifying a Structural System

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- We now have completed Appendix A Functional Recovery Provisions approved by the PUC (still draft).
- This was the results of a 3+ year volunteer effort of the Functional Recovery Task Committee (20 voting members, many corresponding members).
- This is on-track for being in the official 2026 NEHRP Recommended Provisions.
- This is a big deal (at least for nerds like me).

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29	either a prescriptive or explicit assessment in Table A.1-1. The prescriptive assessment
30	procedure shall not be permitted for buildings with damping systems.

- BSSC Functional Recovery Task Committee Work:
 - The FRTC worked on a volunteer basis for ~3+ years and completed App. A.
 - However, at the August 2024 Provisions Update Committee meeting, it was clear that the PUC desired a more complete set of structural systems in the new Rfr table (beyond the capacity of the volunteer effort).
 - We had a ~1 year window of opportunity to further impact this code cycle.

- The Idea:
 - Could we find win-win support to expand work beyond the volunteer FRTC effort? (i.e. refill the gas tank)
 - We found this win-win by working with structural system supporters to qualify more structural systems.

■ The Resilient Design Coalition Founding Supporters:

- Charles Pankow Foundation – anchor supporter with matching funds (\$230k for Phase I, \$120k additional requested at Sept. Board mtg.)
- Resilient structural system supporters



■ Initial Structural Systems (all are non-proprietary):

- SpeedCore
- Precast hybrid moment frame
- Steel damped moment frame
- Steel buckling-restrained braced frame (qualification report, possible refinement)
- Wood light-frame (possible refinement)
- Tilt-up (rigid-wall flexible-diaphragm)



Smarter.
Stronger.
Steel.



■ Additional Systems added in 2025:

- Masonry rigid-wall flexible diaphragm (funded by the Concrete Masonry and Hardscapes Association)
- General masonry (funded by the Concrete Masonry and Hardscapes Association and the Concrete Masonry Checkoff program)
- Steel Special Concentric Braced Frame (funded by AISC)
- Mass Timber Rocking Walls (funded by the US Forest Service WIG)
- Wood Light-Frame refinement studies (funded by the American Wood Council)



AMERICAN WOOD COUNCIL

- Keep Coalition work separate from FRTC (at request of PUC Leadership).
- Be sure Coalition work does not delay the FRTC work (e.g. App. A).
- Separate roles and steps (work of FRTC and Coalition done separately):
 - 1) **FRTC:** Produce an Appendix A that is “complete but not fully comprehensive”.
 - 2) **Coalition:** Evaluate more structural systems and provide targeted ballots to enhance line items in the Rfr table of Appendix A.

“Tiger Team”: *A small technical team tasked with addressing a specific complex problem over a short period of time.*



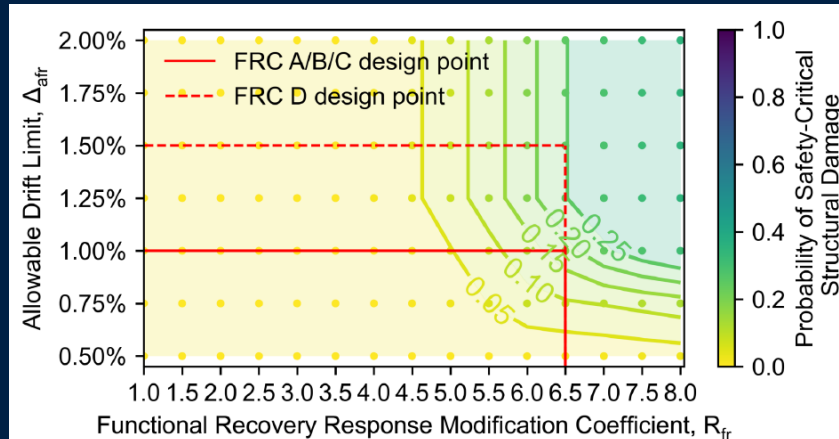
■ Funded Resilient Design Coalition Technical Team:

- University of British Columbia: Dr. Carlos Molina Hutt, Dr. Kristen Blowes (PhD student, soon post-doc), Dr. Huy Pham (newly added post-doc from UC Berkeley)
- KPFF: Reid Zimmerman
- HBRG/SP3: Dr. Curt Haselton, Ed Almeter, Dr. Dave Welch, Dr. Jared DeBock
- Many in-kind contributors and supporters (may try to enumerate and recognize in the future)
- Peer Reviewers: Dr. Deierlein (Chair) (Stanford), Dr. Liel (Boulder), Bob Pekelnicky (Degenkolb)



- Summary of Primary Coalition Deliverables:
 - 1) Structural system quantification/qualification procedure (completed February 2025).
 - 2) BSSC code proposals for new structural systems (line items in Rfr table).
 - 3) Supporting evaluation reports documenting underlying evaluations.
 - 4) Education and outreach
 - Webinars – Open to suggestions on topics!
 - Publications to document analysis-based on the resilient design requirements.

- Evaluation materials being produced for PUC submission:
 - 1) Functional Recovery evaluation report.
 - 2) Full analysis results appendix for all archetype analyses.
 - 3) Ballot proposal for system-specific Rfr and drift limits.



SPEEDCORE FUNCTIONAL RECOVERY PREQUALIFICATION

Complete Draft Report Submitted for Peer-
Review

- Batch #1 Structural Systems (all are non-proprietary):
 - Evaluation reports are done and in peer review.
 - Slated for proposal submission at next PUC September 22nd deadline.
 - SpeedCore [AISC]
 - Steel damped moment frame [Taylor Devices]
 - Steel buckling-restrained braced frame (qualification report, possible refinement) [CoreBrace]
 - Masonry rigid-wall flexible-diaphragm [Concrete Masonry Hardscapes Association]

- Batch #2 Structural Systems (also non-proprietary):
 - Analysis for evaluation reports are in-progress.
 - Slated for proposal submission at the PUC January 5th deadline.
 - Precast hybrid moment frame [Clark Pacific]
 - Masonry (general) [Concrete Masonry Hardscapes Association, and Concrete Masonry Checkoff program]
 - Steel Special Concentric Braced Frame [AISC]
 - Wood Light-Frame evaluation refinements [AWC]
 - Possible refinements to comparative systems, based on updated pre-qualification procedure/criteria (e.g. RC walls, Steel frames, etc.) [Pankow]
- Later (starting project, but will not be done in this code cycle):
 - Mass Timber [US Forest Service Wood Innovation Grant]

- **Sept:** Completing most of peer review and iteration for Batch 1 structural systems.
- **Sept. 22, 2025:** Resilient Design Coalition code proposals for first 4 new structural systems.
- **September-December:**
 - ✓ Do evaluations and reports for the Batch #2 systems (4 systems).
 - ✓ Maybe work on functional recovery evaluation of RC IV design requirements.
 - ✓ Technical webinar series:
 - Updated on Resilient Design for Functional Recovery for U.S. Codes (today)
 - Structural and Nonstructural Design Requirements in FR Appendix A (Parts I/II)
 - Qualification Procedure for Functional Recovery of New Structural Systems
 - Many webinars on specific structural system qualifications
 - Others? Inputs on topics are welcomed!
- **January 5, 2026:** Resilient Design Coalition proposals for final 5 new systems.

- We now have extensive functional recovery and seismic risk assessment methods, as well as initial functional recovery prescriptive code requirements.
- These technologies are now ready for use in resilient design, and many other purposes.
- This all “feels new”, but it is really not new, and has been developed/vetted over past 25 yrs!

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 - ✓ Adoption of resilient design provisions by jurisdictions (e.g. State of Washington).
 - ✓ Further adoption in practice and mainstream use for Resilient Design for FR.

- Please let us know what you think!
- We intentionally kept time for Q&A, but this is important to us.
- Questions?
- Advice or input for this work?
- Any requests for additional technical webinar series topics?
- Contact:
 - Curt Haselton
 - curt@hbrisk.com
 - Direct: (530) 514-8980

