Peer review of civil structures: why, by, when, scope

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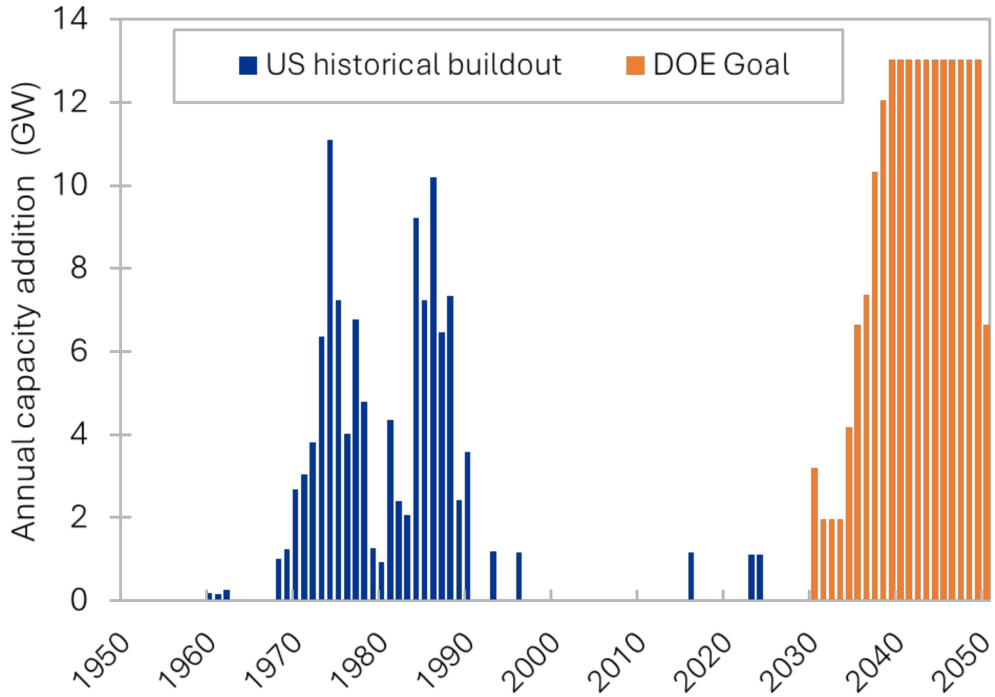
NRIC, Washington, DC, December 2024

W. Robb Stewart (Alva) and DOE LPO



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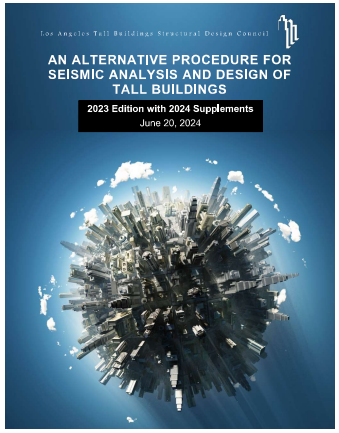
Peer review of civil structures

- History?
  - Regions of high seismic hazard (e.g., CA)
    - Limit state A (collapse prevention) through Limit State D (essentially elastic)
  - Seismically isolated (i.e., high performance) structures
    - Since the early 1990s
    - ASCE/SEI 7-22, Sections
  - CA regulators, including OSHPD (or HCAI) and DSA
  - Performance-based seismic design
    - Infrastructure projects
    - Tall buildings in the US and abroad, LATBSDC

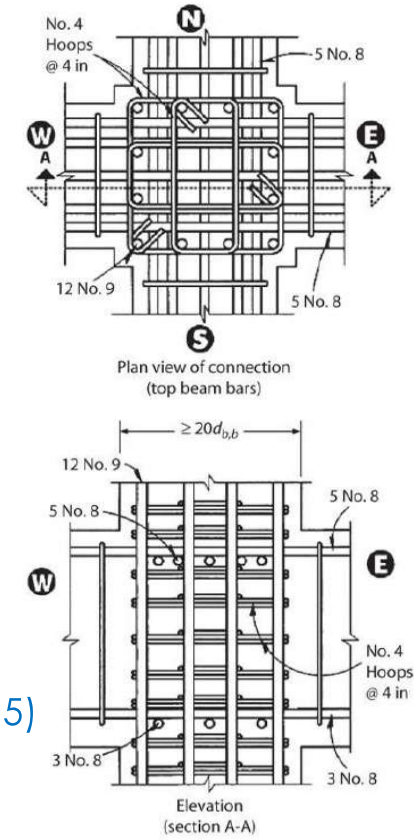


Peer review of civil structures

- Why?
  - Ensure *quality* of the engineered product
    - Construction drawings, supported by specifications
- By?
  - Peers, or better, of the design team leads
    - "*...shall consist of experts who are widely respected and recognized for their expertise in relevant fields...*" LATBSDC (2024)
  - Independent of the design team, contractor, owner, regulator
  - Answer to the regulator (e.g., OSHPD)
- When?
  - Start at scheme design, ends with construction documents

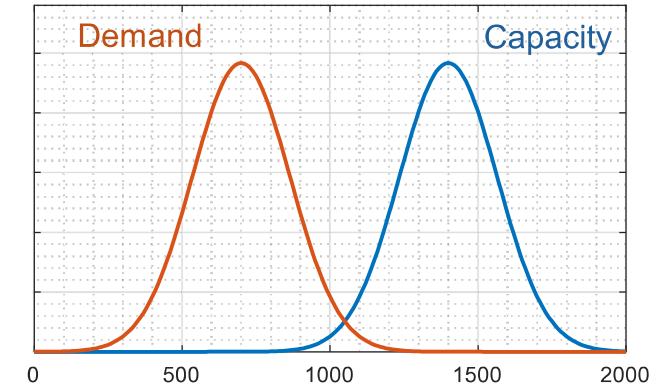
Peer review of civil structures

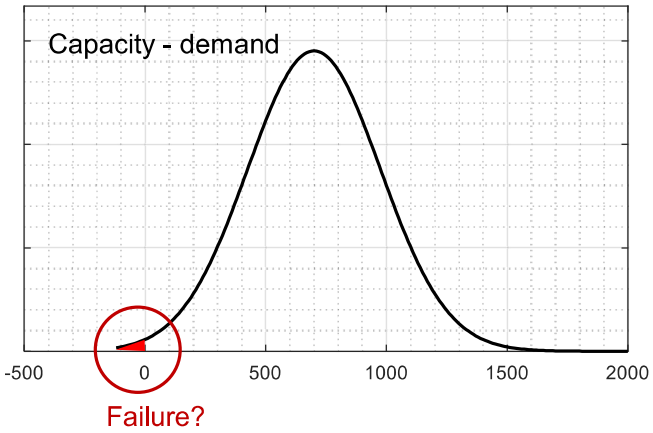
- Scope
  - High-level, and **not** to replace regulator plan check
  - Design criteria
  - Hazard analysis (e.g., seismic, flood, wind)
  - Geotechnical engineering, including foundations
  - Structural engineering
  - Nonlinear dynamic analysis, including ISRS
  - Seismic isolation, if used
  - Specifications, if non-typical
  - Construction details (e.g., main components and connections)



Moehle (2015)

An inconvenient truth





Hypotheses

- Modern standards treat loads and strengths as random variables that can be fit to statistical distributions
- Component failure is postulated to occur when the randomly low strength falls below a randomly high load
- Bell curves, and thus failure rates, can be calculated from standards and QA/QC measures, as shown in the graph
- These graphs suggest that imposing ever more onerous QA/QC to skinny-up the bell curves will make failure much less likely

And plain wrong

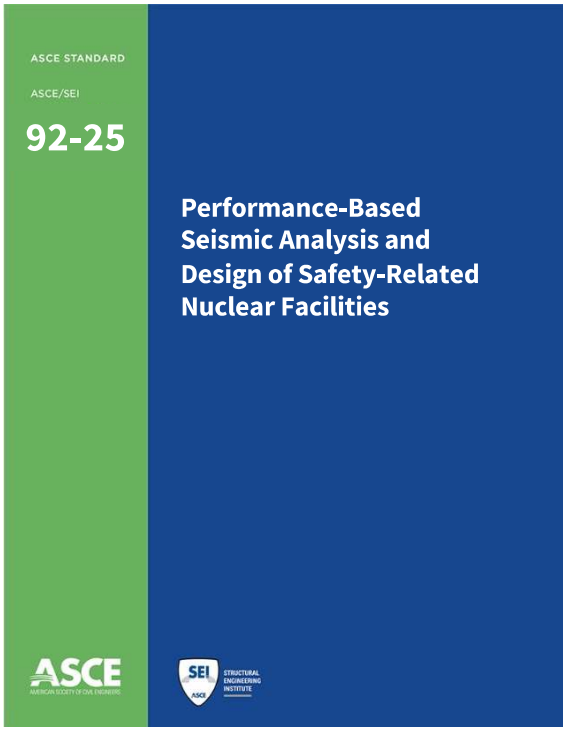
- Nowak* and others show actual failure rates to be much higher than calculated (2+ orders of magnitude)
- Why? Almost all structural failures are due to **human error** in design and construction not contemplated in these curves
- How do we prevent these mistakes?
  - Independent design peer reviews
  - Special inspections by knowledgeable professionals
  - Simplifying (but not weakening) standards and regulations

* *Reliability of Structures*, Nowak and Collins, 2000

ASCE 92-25

- ASCE 92 = merger of ASCE 4-16 and ASCE 43-19
  - ASCE 4-16 = analysis
  - ASCE 43-19 = design
  - Roots of both documents in the late 2000s
  - Need for explicit performance-based design procedures
    - Microreactors, advanced reactors, LLWRs, DOE facilities
  - Publish in late 2025
    - Driven by WH, SDO collaborative, developers
  - Staying in our (ASCE) lane
- *Draft* TOC
  - Introduction, including peer review
  - Earthquake ground shaking
  - Seismic analysis
  - Seismic design
  - Seismic isolation

McDonald and Whittaker, 2024



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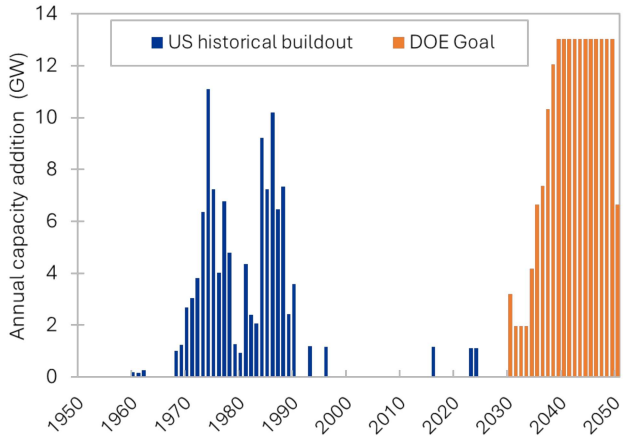

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