Lessons from Northridge and SAC:

The Changes that Resulted in Research

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Changes in Codes

- **Materials Codes**
  - AISC 341
  - AISC 358
  - AWS D1.8
  - ASCE 41
- **Loadings Codes**
  - ASCE 7
  - IBC

Change 1: Set A Model

SAC Joint Venture

- A Problem-Focused, Nationwide Team Effort
- Interdisciplinary
- Practicing engineers and researchers work together

Change 2: Mentality

Responsibility of Weld Fracture:

before Northridge	after Northridge
Welder	Researcher
	Designer
	Inspector
	Electrode Manufacturer
	Welder

Issues and Changes
in

Seismic Moment Connection Research and Design

Expected Seismic Demand

- Force
- Deformation

Seismic Force Demand

Steel Materials

- For seismic capacity design, stronger steel hurts!
- Capacity steel design provisions first appeared in 1988 UBC.
- Before Northridge, we naively thought A36 W-shapes still existed.

Change 3: Steel Materials

- A992 Steel Introduced
- Explicitly Considered in Design:

  Material overstrength (R_y)

  Cyclic strain hardening (C_{pr})

Seismic Deformation Demand

- Before Northridge EQ.

$$0.005K \times (3/K) = 1.5\% \ \textit{story drift}$$

or

$$(0.04/R_w) \times (3R_w/8) = 1.5\% \text{ story drift}$$

- After Northridge EQ.

4% story drift

Test Loading Protocol Issue

- Krawinkler, H., (1992), "*Guidelines for Seismic Testing of Components of Steel Structures,*" Report No. ATC-24.
- Δ_y based
- Used 1 SAC Phase 1 testing

Change 4: Loading Protocol Standardization

- After Northridge EQ.
  - SAC or AISC Loading Protocol
  - Story drift based
  - Acceptance criteria established

Change 5: Specimen Scale Issue

- Before Northridge EQ.
  - ♦ Small-scale models were tested
  - ♦ SAC study showed size effect and welding/heat effect
- After Northridge EQ.
  - ♦ Full-scale testing
  - ♦ AISC 358 member size limits based on available full-scale testing

Change 6: Specimen Construction

- Before Northridge EQ.

  Little attention paid to who welded and how the welding (welding electrode, welding procedure) was done.

- After Northridge EQ.

  Always simulate field welding and document the process.

Change 7: Proprietary Connections and Alternate Systems

- Before Northridge EQ.

  No proprietary moment connections

- After Northridge EQ.
  - ♦ Proprietary connections
  - ♦ BRBF, SPSW, SCBF

Change 8: Steel Researchers

- Before Northridge EQ.

  Steel/concrete researcher ratio was low.

- After Northridge EQ.
  - ♦ Ratio is improved, although is still low
  - ♦ SAC era produced some talented younger students/researchers
  - ♦ AISC follows up with Fellowship program