



Column Base and Splice Details

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Acknowledgments

■ Sponsors

- National Science Foundation
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■ Students

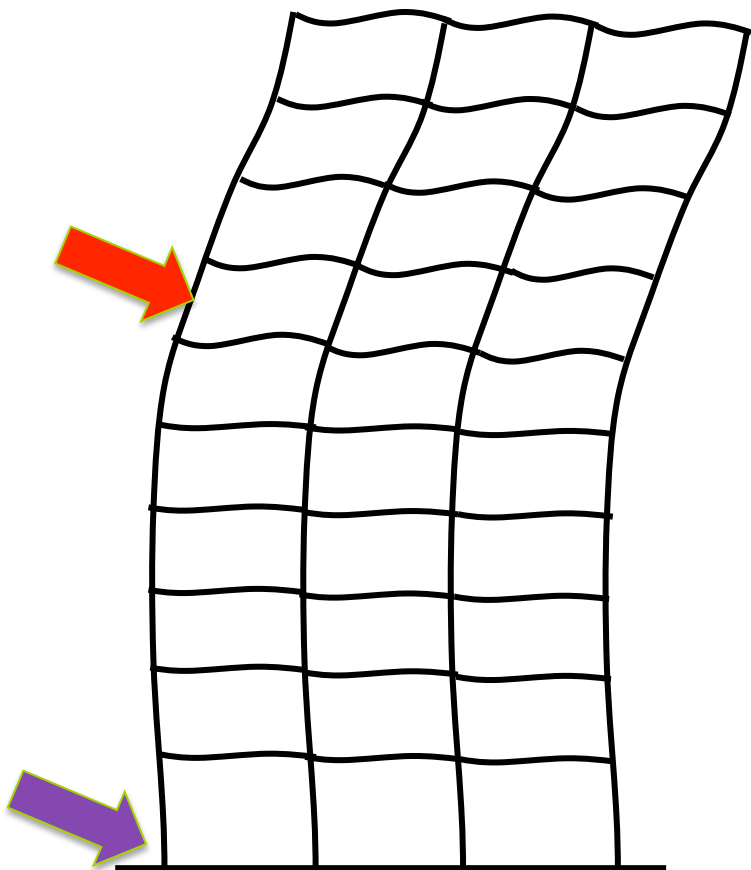
- Ivan Gomez
- Andrew Myers
- Ryan Cooke
- Sean Shaw
- Kimberly Stillmaker

■ Collaborators

- Greg Deierlein
- Farzin Zareian
- Peter Higgins



Overview

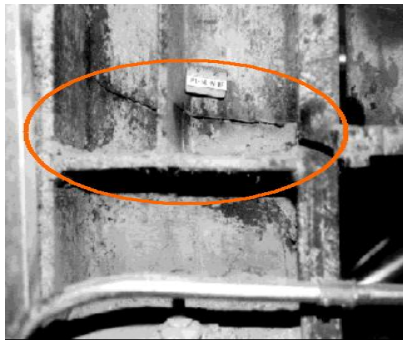


Base connections

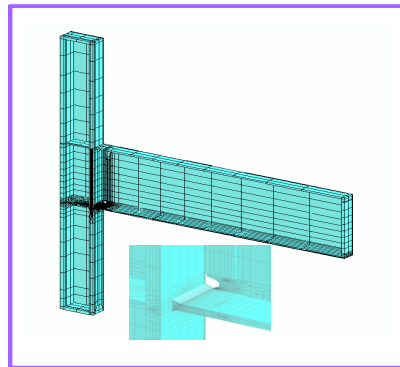
Column splices

- **Less research compared to beam-column connections**
- **Different modes of response**
- **Findings that may be good news**
- **Some concerns too**

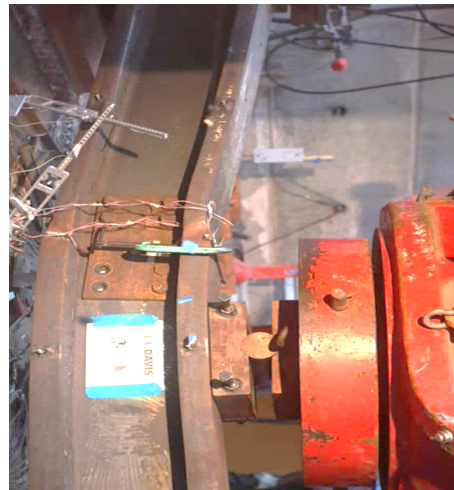
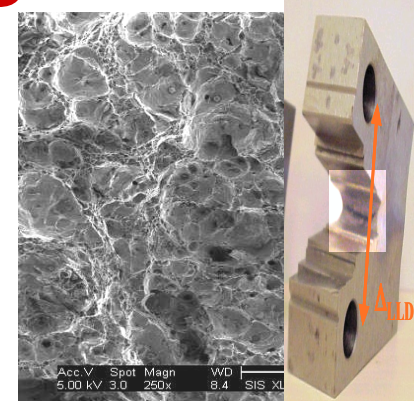
Overview, and how we got here



Northridge 94



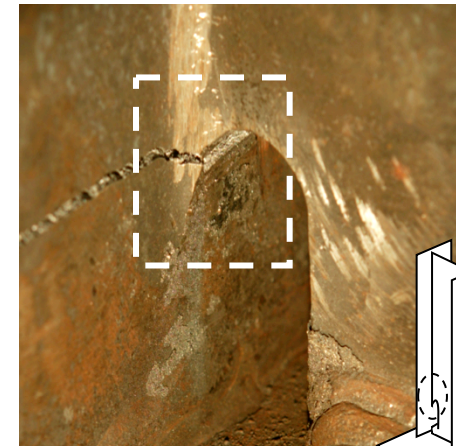
US-Japan/NSF 96-2003



AISC 2008-2013-..



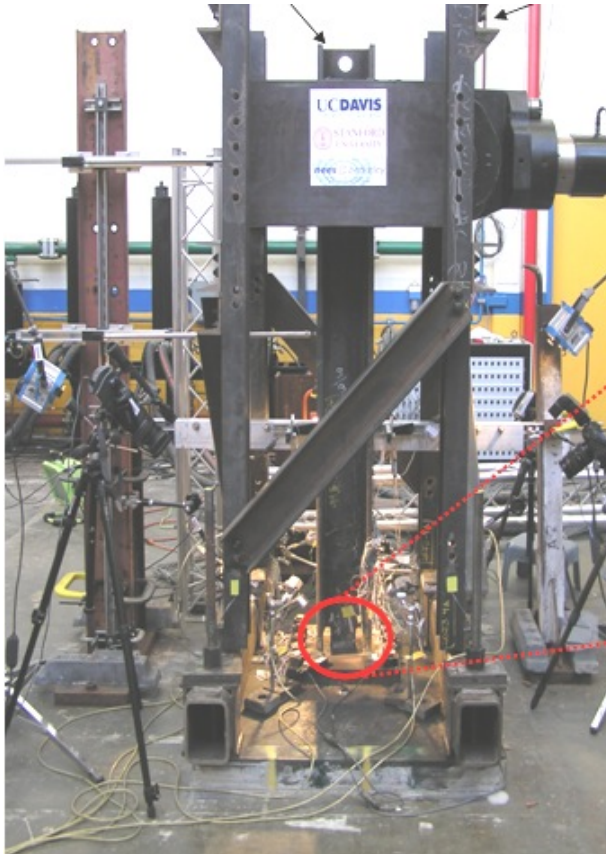
NEESR 2003-2008



Column bases – three major research programs (2003-2009)

Test series	Tests	Purpose
NEESR	6	Fracture model verification
AISC	7	Design Guide One Seismic Performance
Wildeck	8	Alternate details/layout

NEESR Tests on Bases

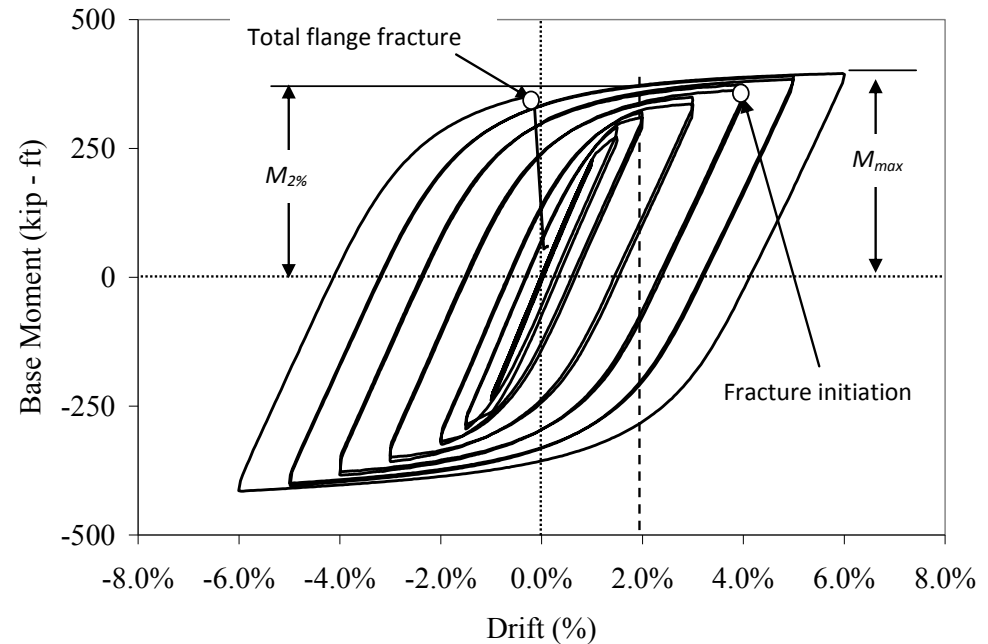
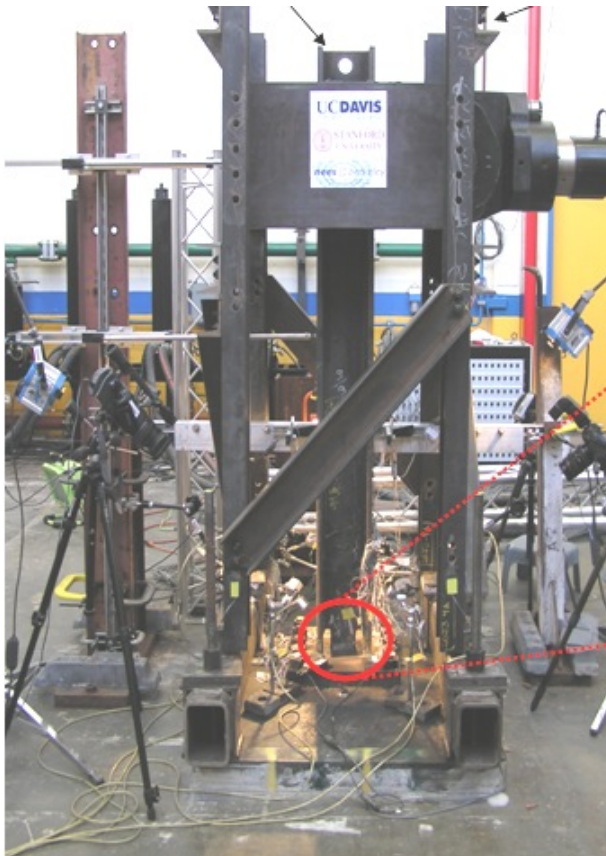


NEES03 Phase 2

**Specimen CJP4 (NW)
under Far-Field time history**

**10/18/06 Run026
(nees@berkeley)**

NEESR Tests on Bases



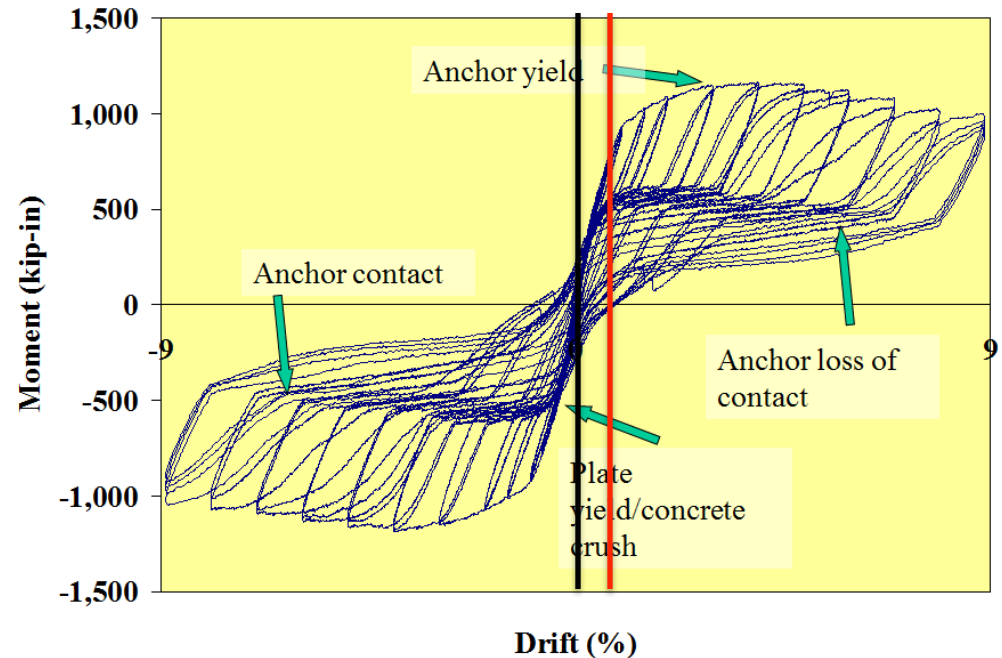
- Excellent ductility
- PJP performance better than CJP
- Fracture models advanced

AISC Tests on Bases



- Design Guide One is fine/conservative
- Excellent ductility
- Models for strength refined/stiffness models developed

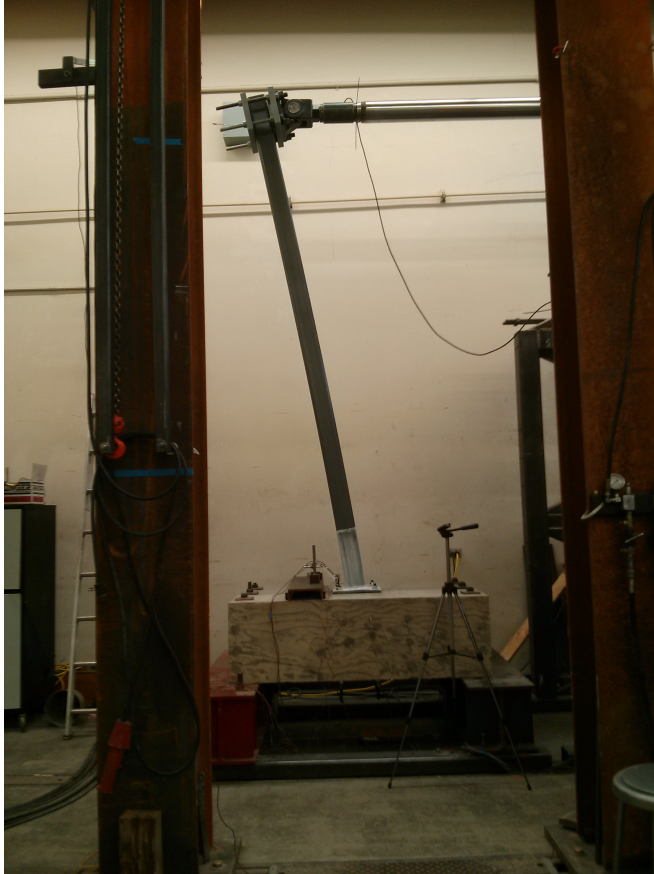
AISC Tests on Bases



Main surprise

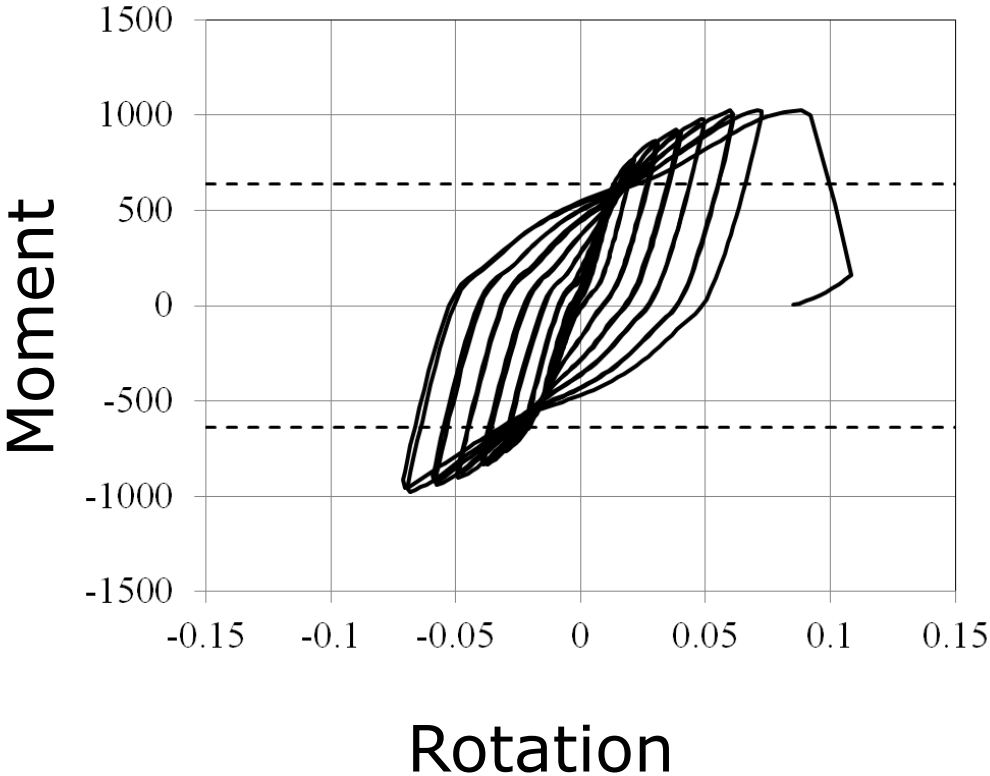
- Stiffness much lower than anticipated even when designed as fixed

HSS Column bases



- Excellent ductility
- New method for eight-rod configuration
- Stiffness still lower than desired

HSS Column bases

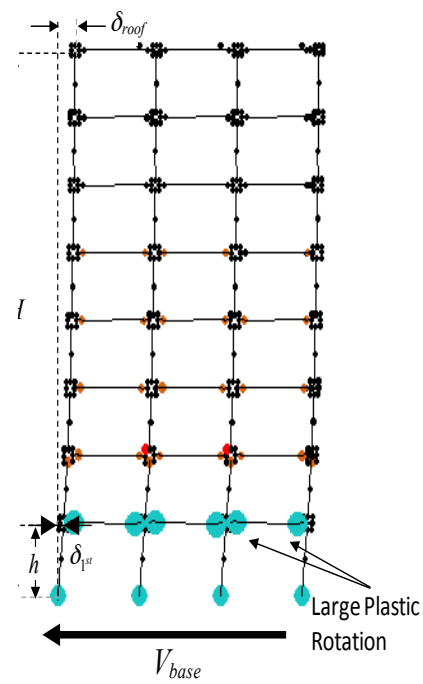


Column bases – 21 tested over the last 8 years

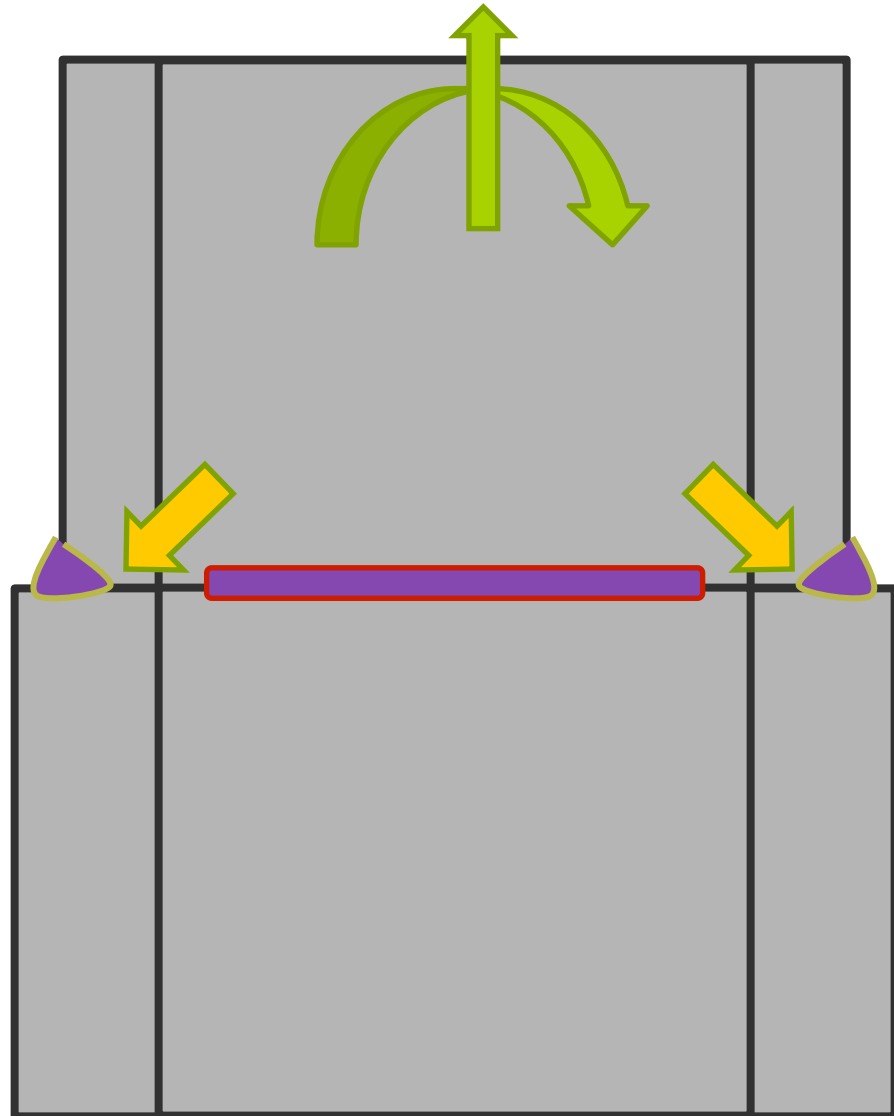
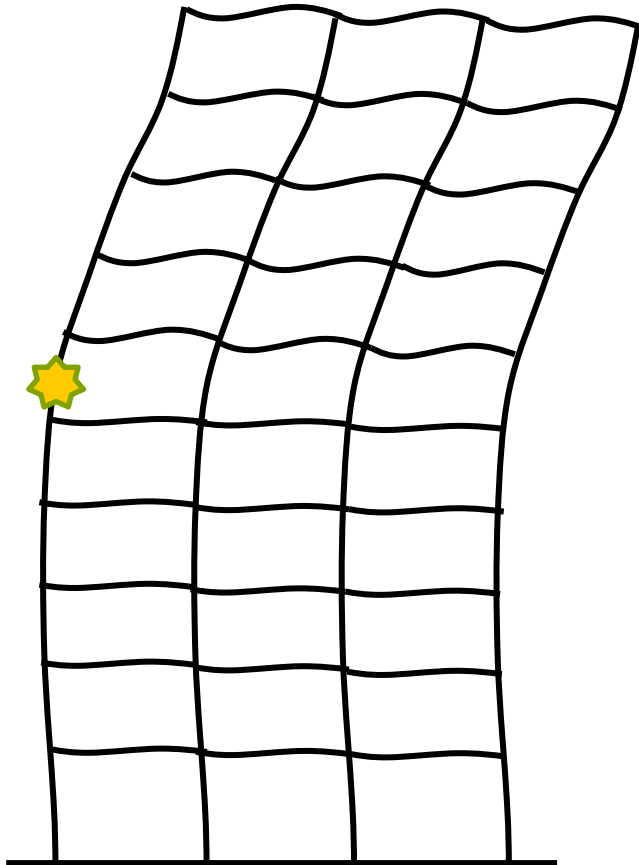
Test series	Tests	Purpose	Avg drift
NEESR	6	Fracture model verification	6.7%
AISC	7	Design Guide One	8%
Wildeck (HSS)	8	Design Philosophy/ displacement based design Eight rod layout	11%

Summary of observations from base connection tests

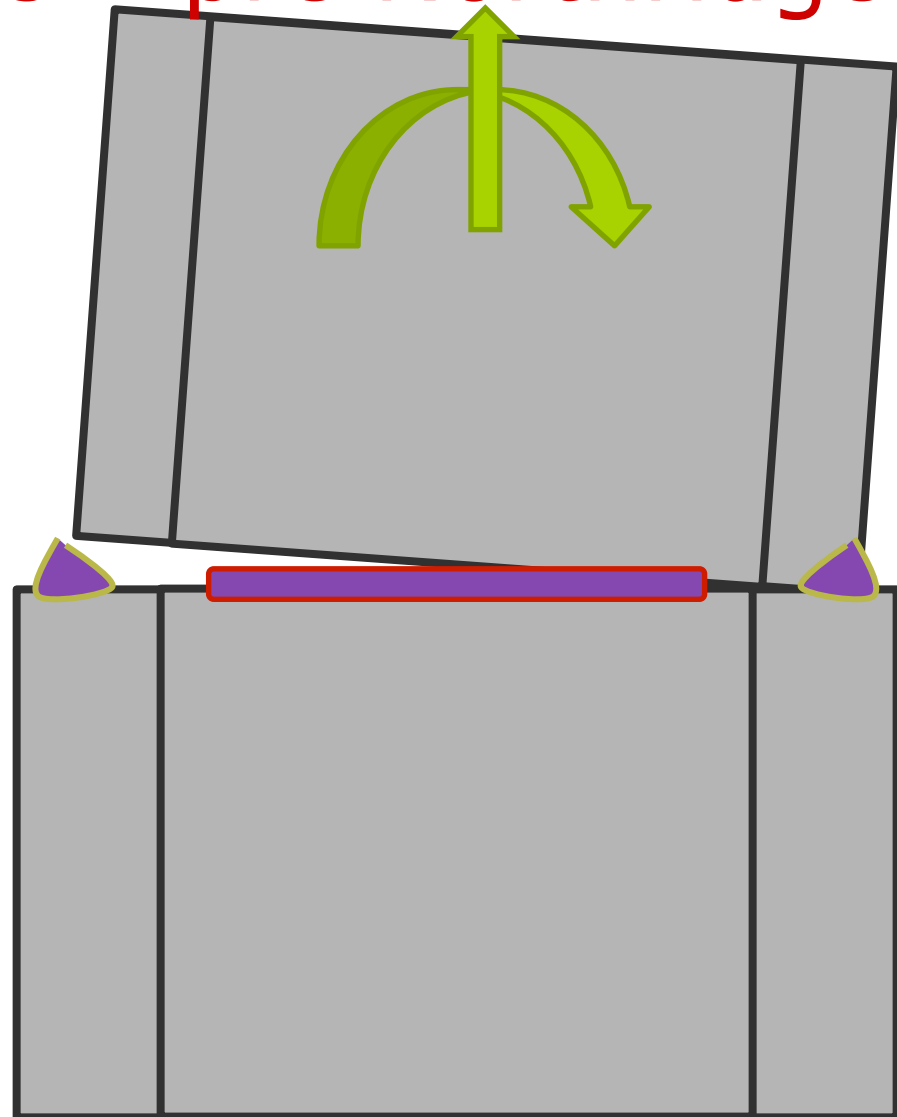
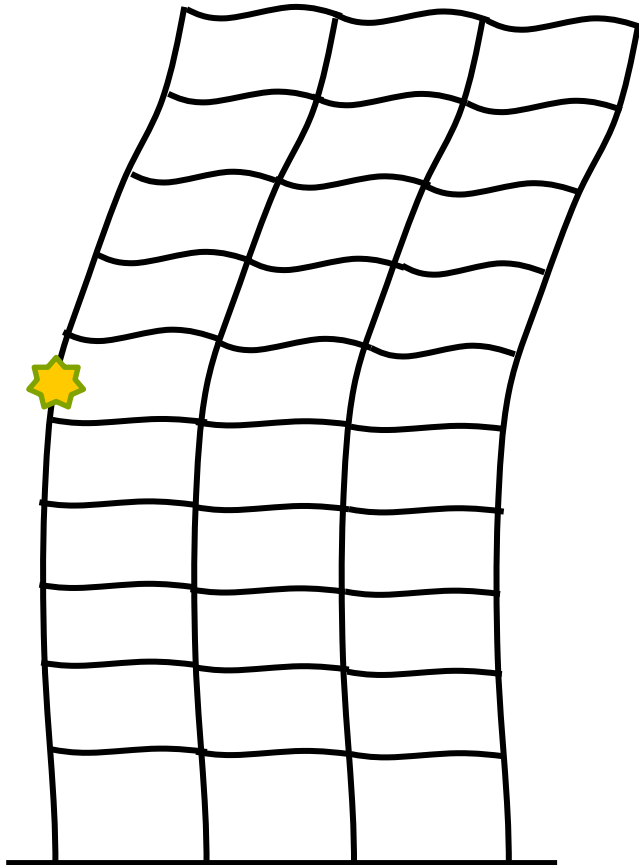
- Stringent detailing/material guidelines work
- Excellent deformation capacity
- Not leveraged in design – should we?
- Stiffness (even for connections designed as fixed is low)
- This low stiffness matters!



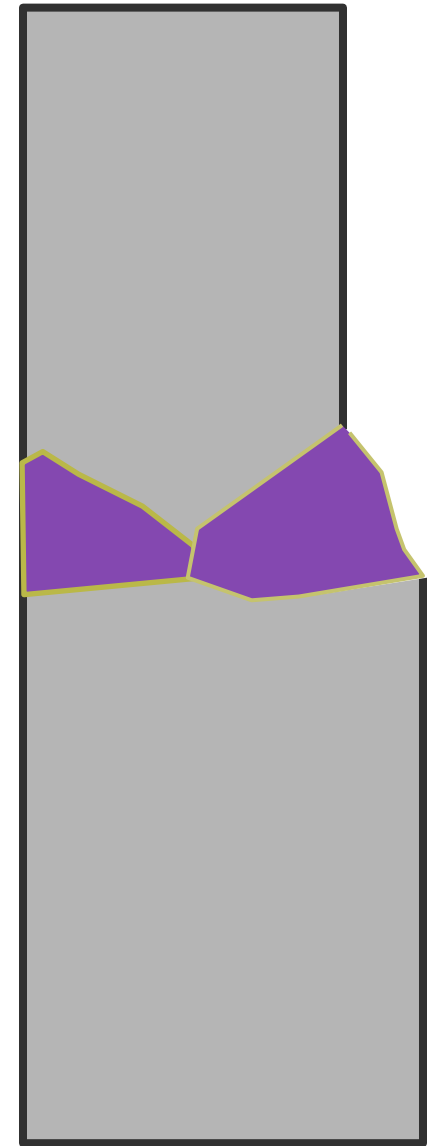
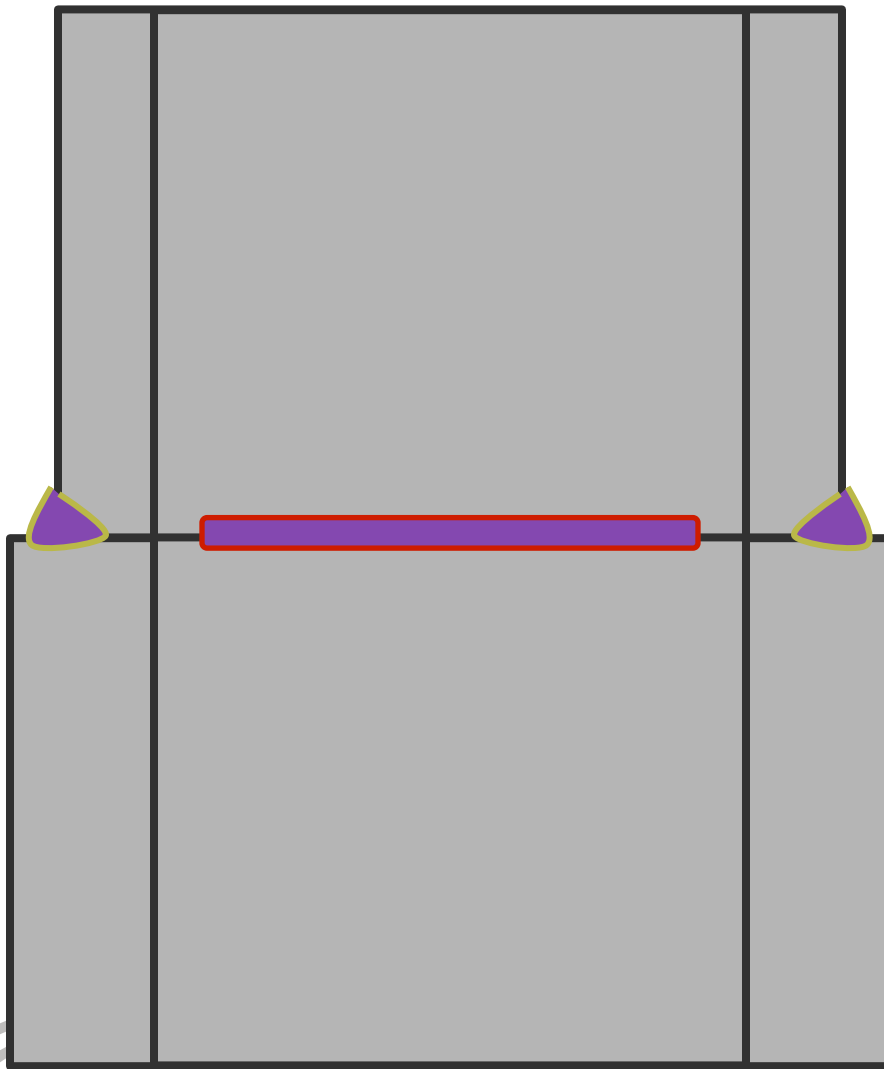
Column Splices – pre Northridge



Column Splices – pre Northridge

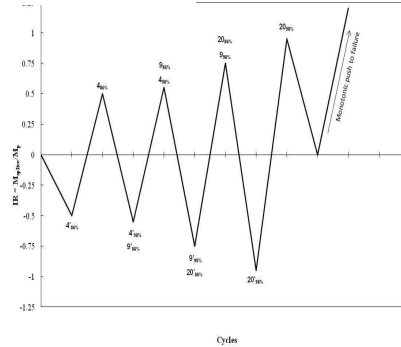
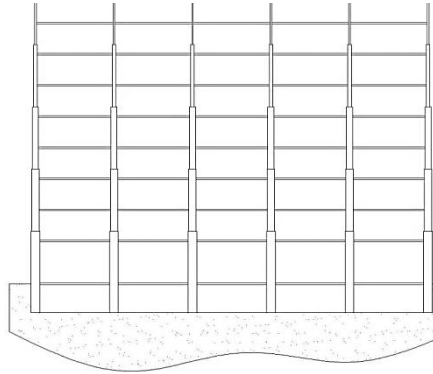


Column splices - now

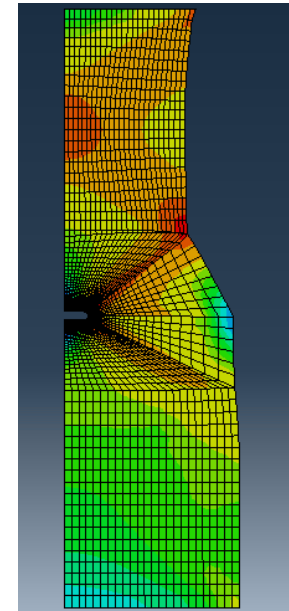


Study splices with PJP welds

Frame analysis, Protocol



Synthesis,
findings,
implications



Fracture
mechanics,
ancillary testing



PJP Splice
tests



SYMPOSIUM

Splice tests

Test	Column Size	Flanges	Webs	Access Hole
24A	W24X279- W24X370	Single Bevel 82% PJP	87% PJP	No
24B	W24X279- W24X370	Single Bevel 82% PJP	87% PJP	No
14A	W14X550- W14X730	Double Bevel 82% PJP	87% PJP	Yes
14B	W14X342- W14X455	Double bevel 55+40%	84% PJP	No
14C	W14X145- W14X132	Single Bevel 89%	Bolted splice	Yes

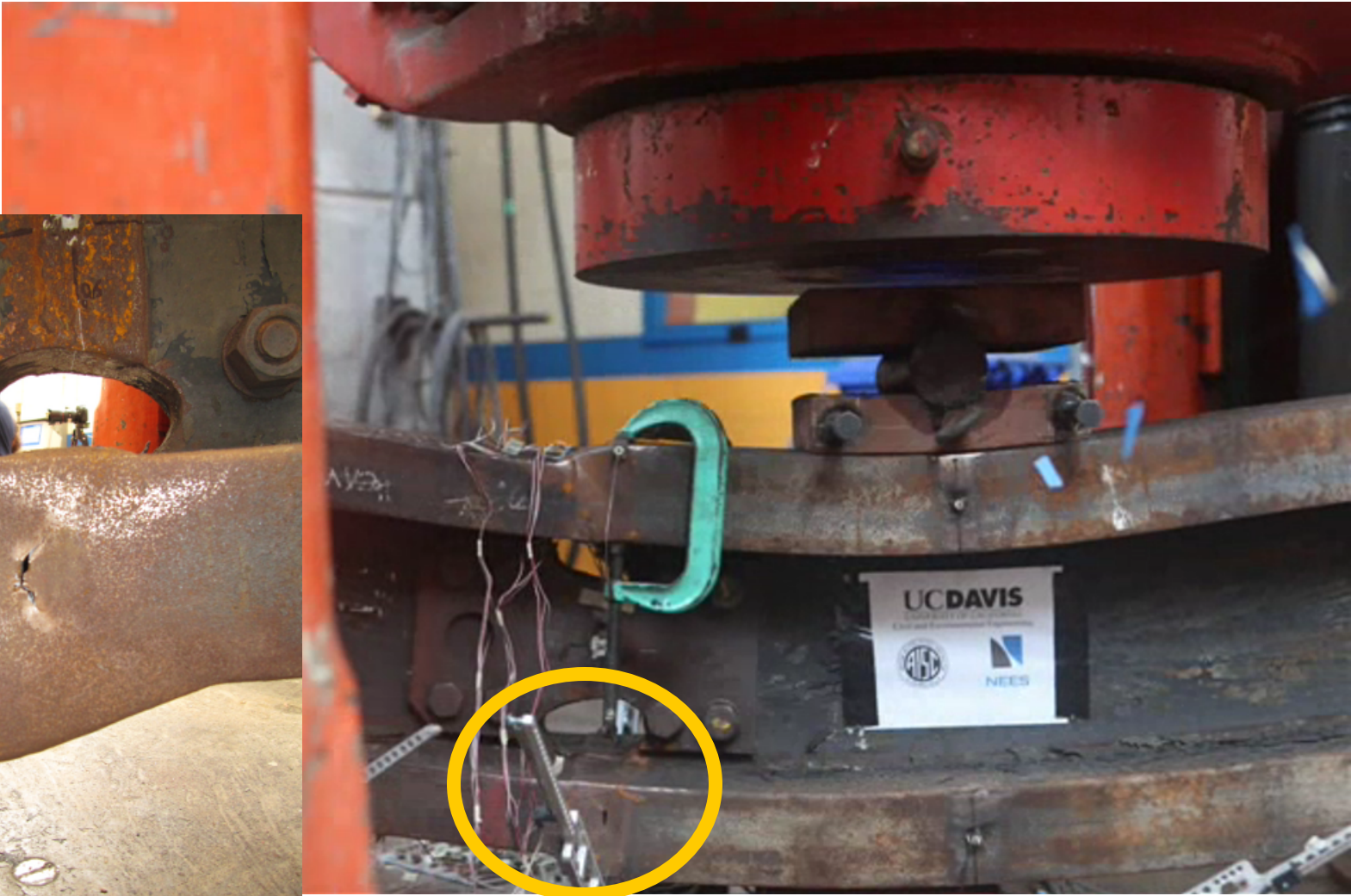
Splice tests – W14A



Splice tests – W14A



W14A (post-test)



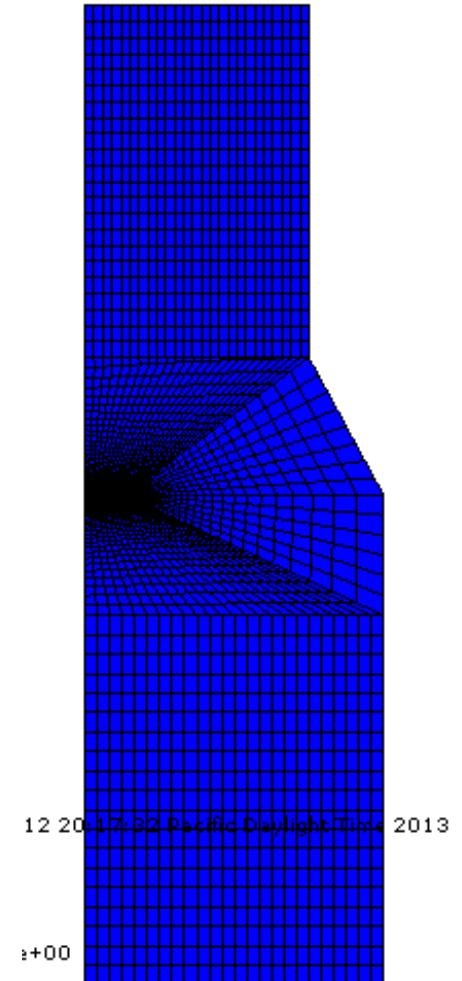
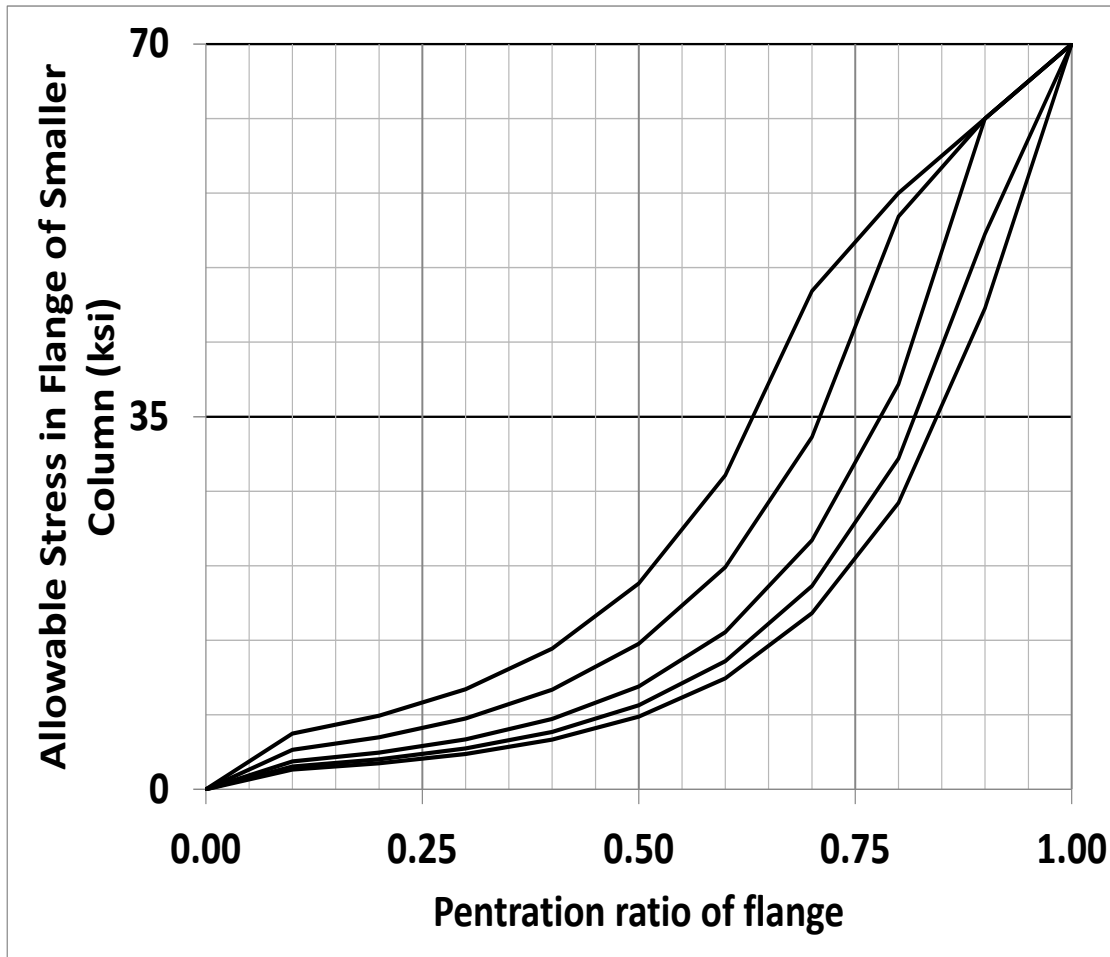
Results of splice tests

Test	Column Size	Flanges	Webs	M_{max}/M_p
24A	W24X279- W24X370	Single Bevel 82% PJP	87% PJP	1.13
24B	W24X279- W24X370	Single Bevel 82% PJP	87% PJP	1.16
14A	W14X550- W14X730	Double Bevel 82% PJP	87% PJP	1.30
14B	W14X342- W14X455	Double bevel 55+40%*	84% PJP	1.19
14C	W14X145- W14X132	Single Bevel 89%	Bolted splice	0.98

Follow up fracture mechanics analysis raises issues for pre Northridge Splices

No penetration

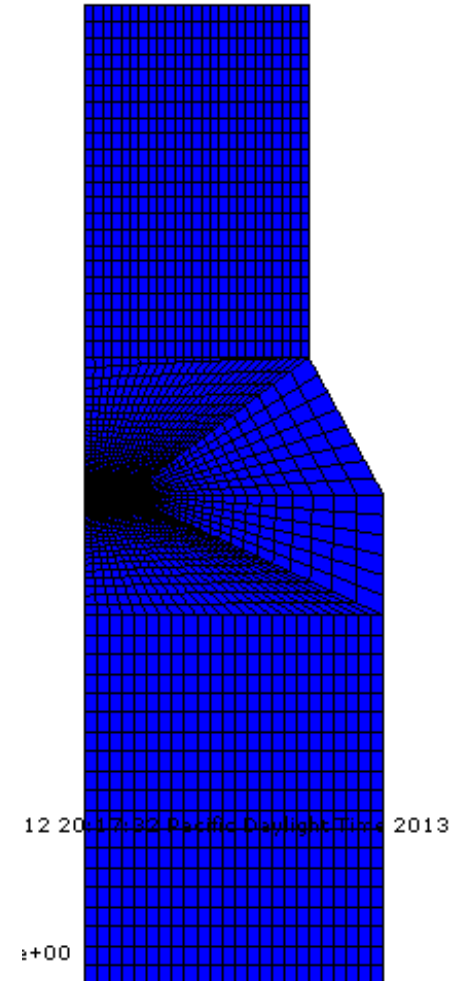
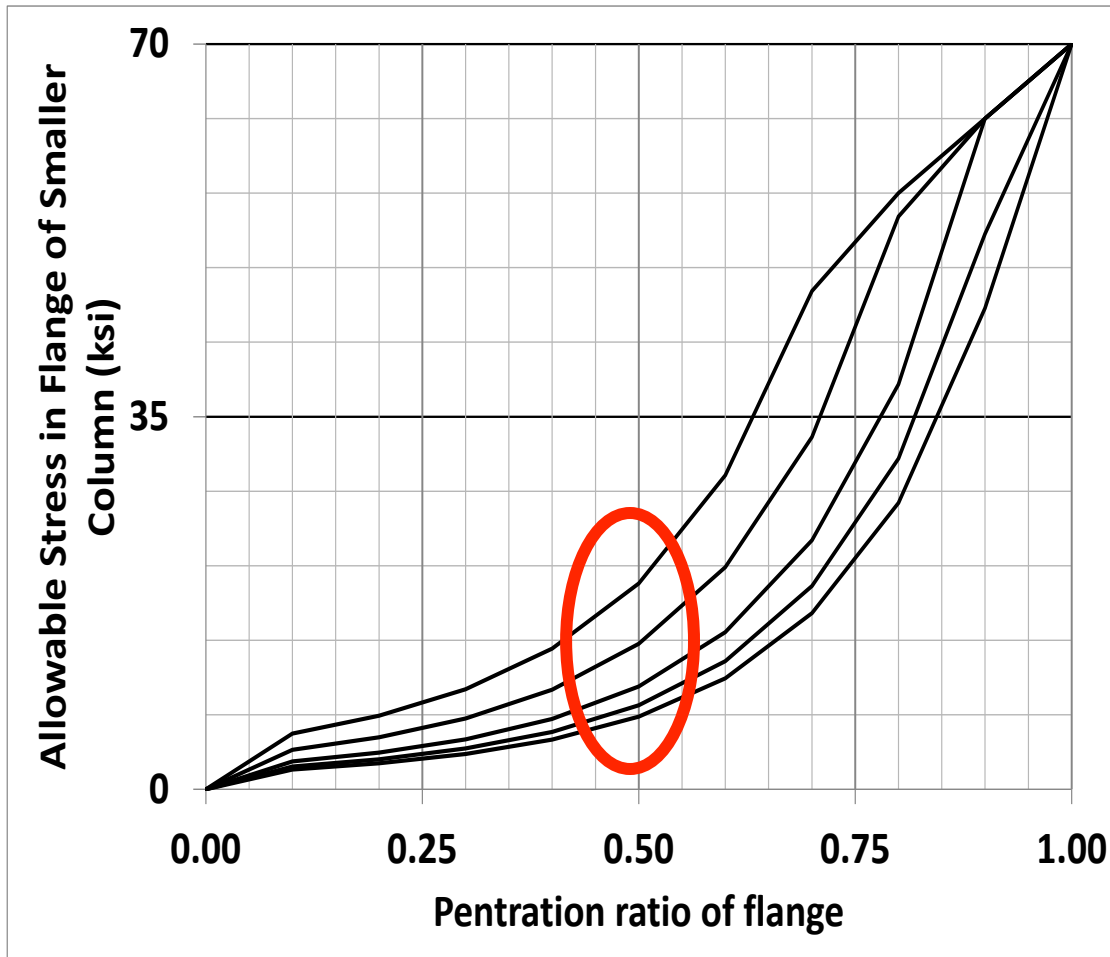
Full penetration



Follow up fracture mechanics analysis raises issues for pre Northridge Splices

No penetration

Full penetration



Next steps, gaps in knowledge

- We know how to make ductile connections in general
- What we're perhaps less better at
 - Quantifying deformation/fracture capacity
 - Even less so at characterizing fracture reliability
 - Reliance on prescriptive material/detailing, and not analysis
- Opportunities to leverage the improved fracture performance for economies
- Bases might not be stiff enough, pre-Northridge splices may be vulnerable

