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National Council of Structural Engineers Associations

Changes to 2016 Edition of AISC 341 (AISC Seismic Provisions)

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Introduction

- 341-16 changes completed at the end of 2015
- Commentary completed in early 2016.
- Incorporated into ASCE 7-16 and eventually into IBC 2018
- Changes are more limited than in previous editions of the Seismic Provisions
  - Clarifications
  - Coordination
  - New Materials and Research Results
- Presented here in same order as Provisions

Incorporation of E_{cl} Term

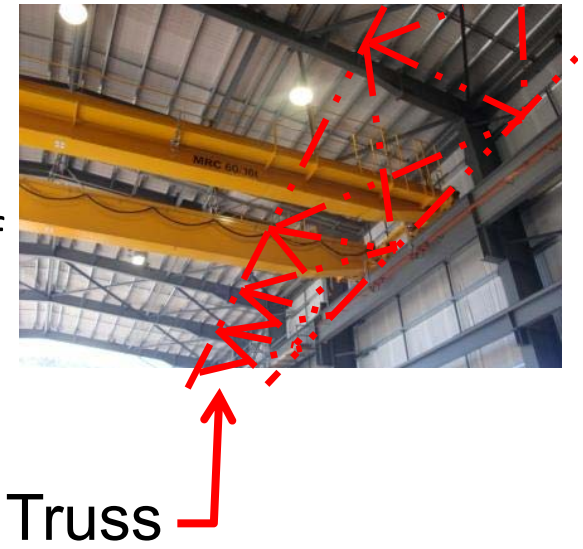
- Included to be consistent with ASCE 7
- "Capacity Limited Horizontal Seismic Load Effect" can be used as a substitute for E_{cl} from ASCE 7 (overstrength effect)
  - To be used to reflect capacity based concepts used throughout the Seismic Provisions
- Entire provisions have been modified to ensure it is applied consistently

ASTM 1085 Steel

- New specification for HSS steel with better properties (akin to A992 for wide flange shapes)
  - Single yield stress of 50 ksi
  - Limits on Fy (70 ksi max) and the Fy/Fu ratio
  - Tighter material tolerances added to allow more efficient design based on full wall thickness (rather than 0.93)
  - Ry=1.25 and Rt=1.15
- If you push for it, you can get it. Start using it!!!

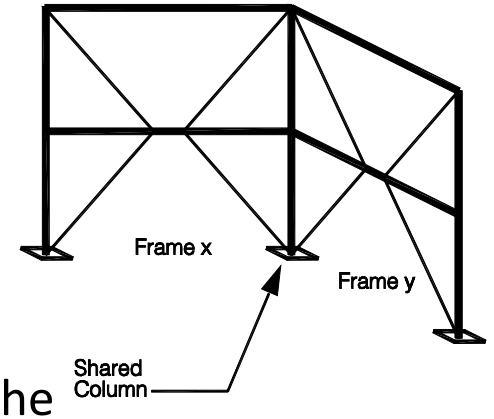
Steel bracing used as a diaphragm

- 2010 Seismic Provisions did not give explicit requirements for steel members used as truss diaphragm, so added following:
  - "When a truss is used as a diaphragm, all members of the truss and their connections shall be designed for forces calculated using the load combinations of the applicable building code, including overstrength."
  - Exceptions for the following:
    - design of truss similar to SCBF, or
    - three dimensional system with ordinary lateral system (OMF or OCBF) and diaphragm designed similar to OCBF



Columns participating in orthogonal frames

- Concern about high R factor systems with columns that resist lateral load in both directions
  - Likely will have simultaneous yielding during response, so 100/30 rule may not be adequate
  - Possibly more important for low rise buildings
- New language:
  - "For columns that are common to intersecting frames, determination of the required axial strength, including the overstrength seismic load or the capacity-limited seismic load, as applicable, shall consider the potential for simultaneous inelasticity from all such frames…."
    - Not required for Ordinary (low R factor) systems or when NLRH analyses are performed
- Similar language for checking SC/WB condition for SMF's.

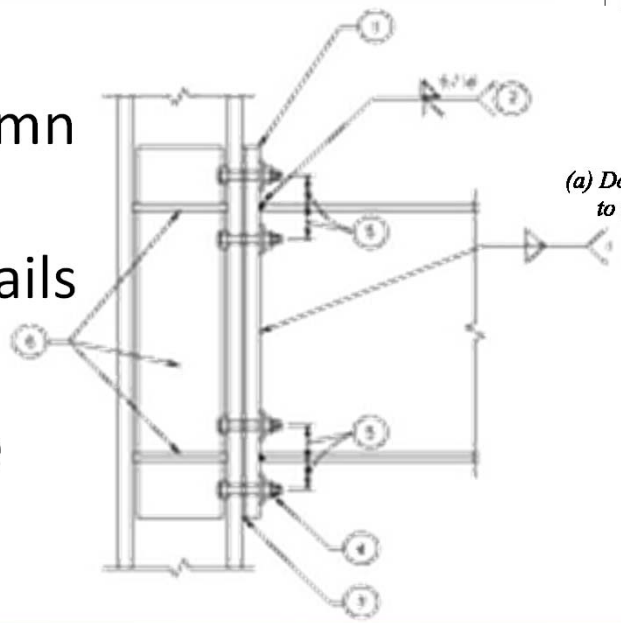


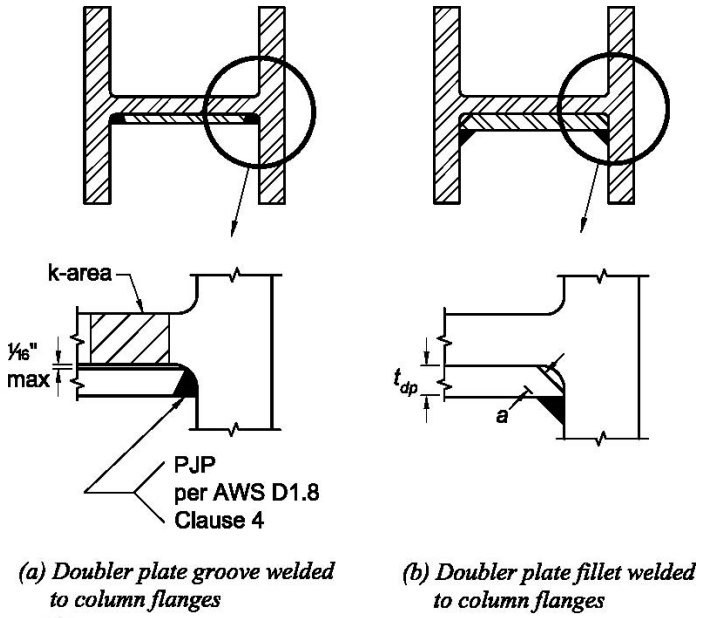
Oversized bolt holes

- When the seismic force is transmitted by tension in the bolts, oversized and short-slotted holes are now permitted with the following language:
  - "Oversized holes or short-slotted holes are permitted in connections where the seismic load effects are transferred by tension in the bolts but not shear in the bolts."

Continuity and doubler plates in SMF

- Continuity plate requirements more explicitly refers to the limit states of Section J10 of the Specification (WLY, WLC)
- Doubler plate to column web weld refers to prequalified joint details in AWS D1.8
- Relax continuity plate thickness to 0.75 tf



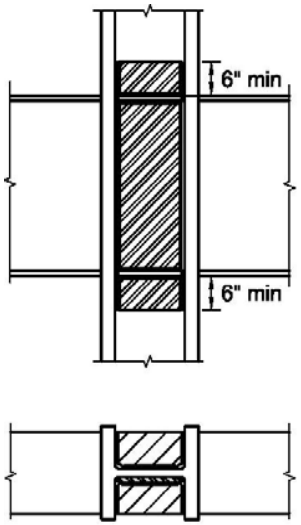


(a) Doubler plate groove welded to column flanges

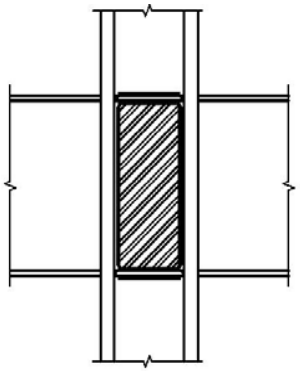
(b) Doubler plate fillet welded to column flanges

Continuity and Doubler Plates in SMF

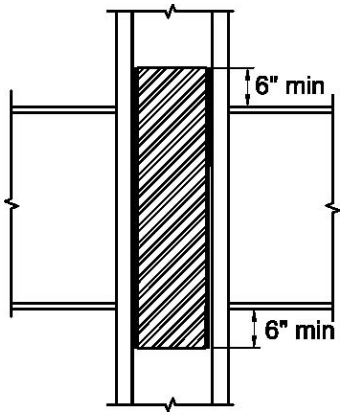
- Tricky doubler plate and continuity plate geometry have more options outlined: doublers spaced away from web and doublers extending above and below CPs, e.g.



(a) Doubler plate extended beyond continuity plates



(b) Doubler plate placed between continuity plates

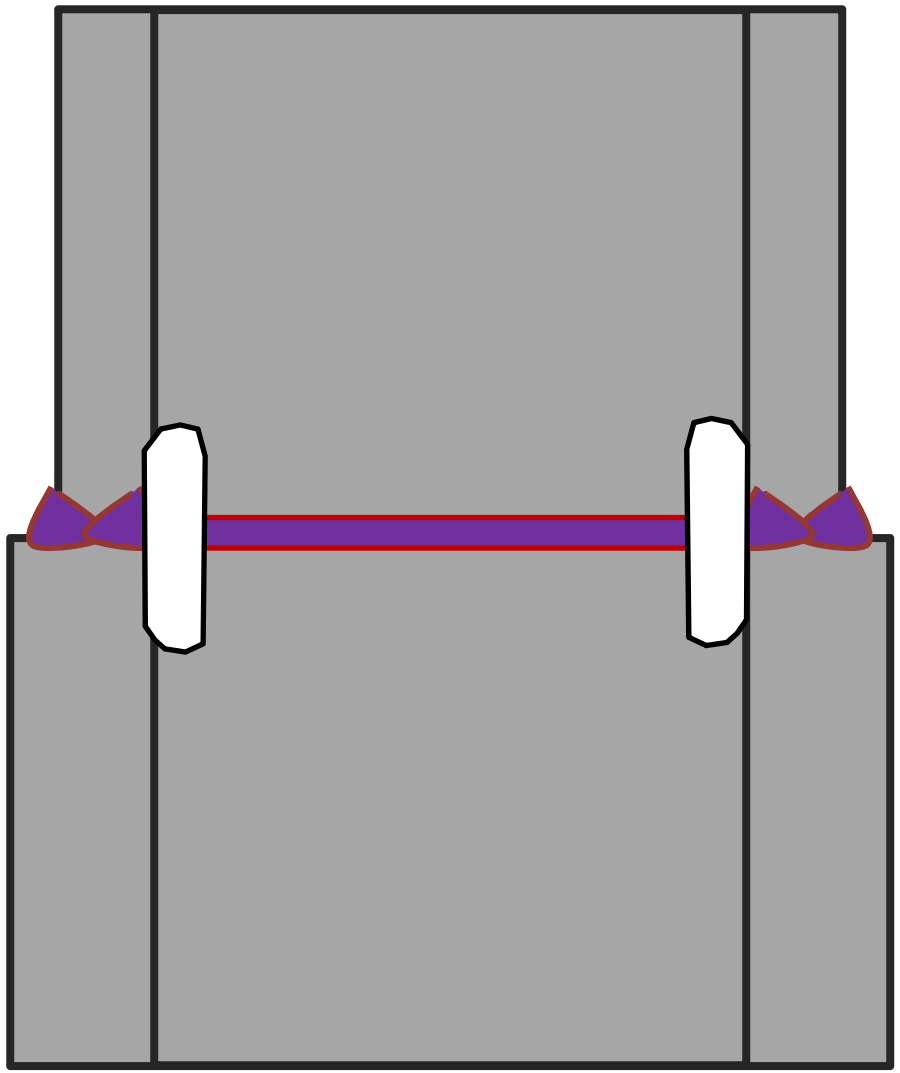


2010 Seismic Provisions

For Intermediate Moment Frames and Special Moment Frames

"Where welds are used to make the splice, they shall be complete-joint-penetration groove welds."

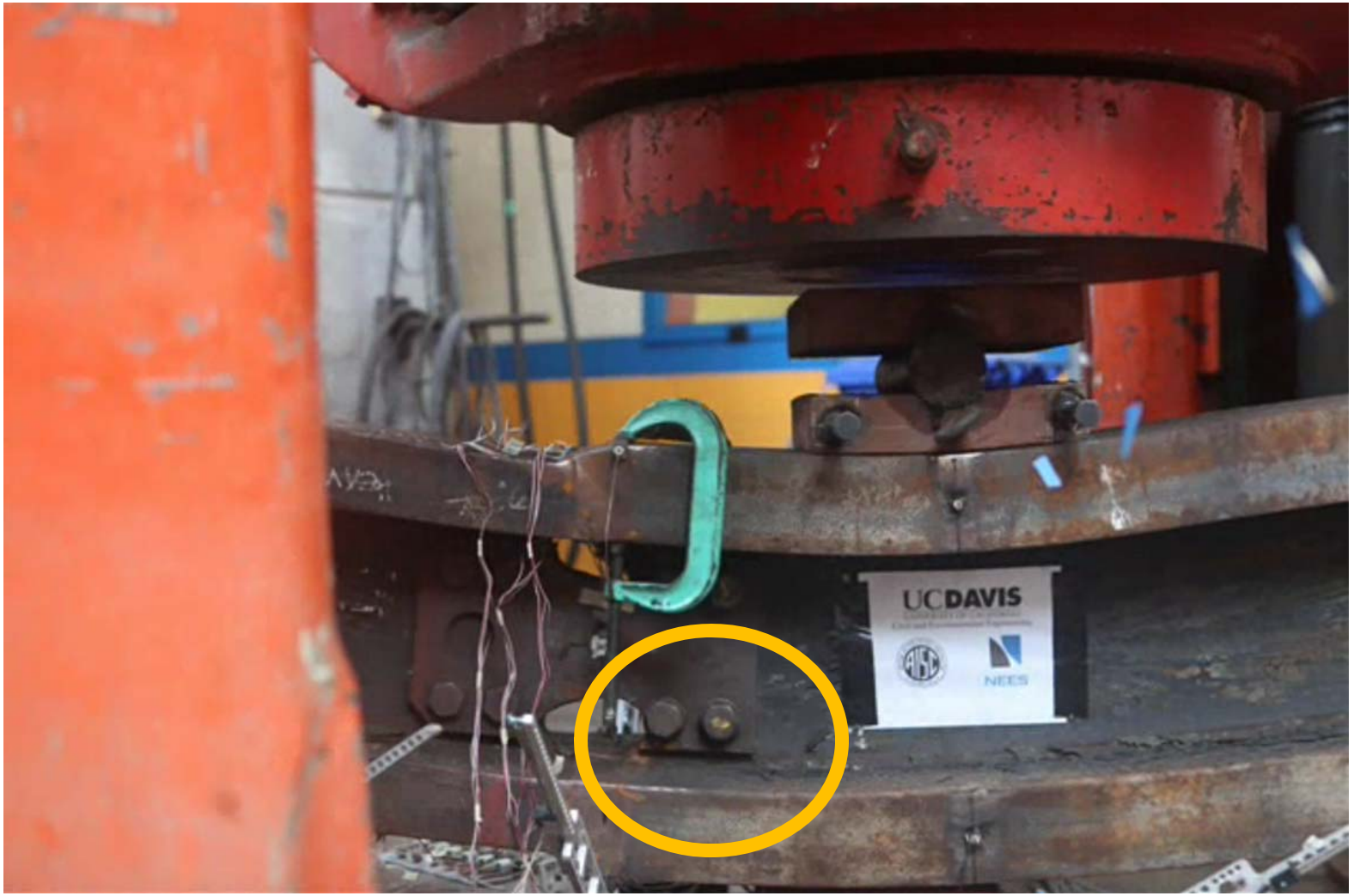
CJP Splice

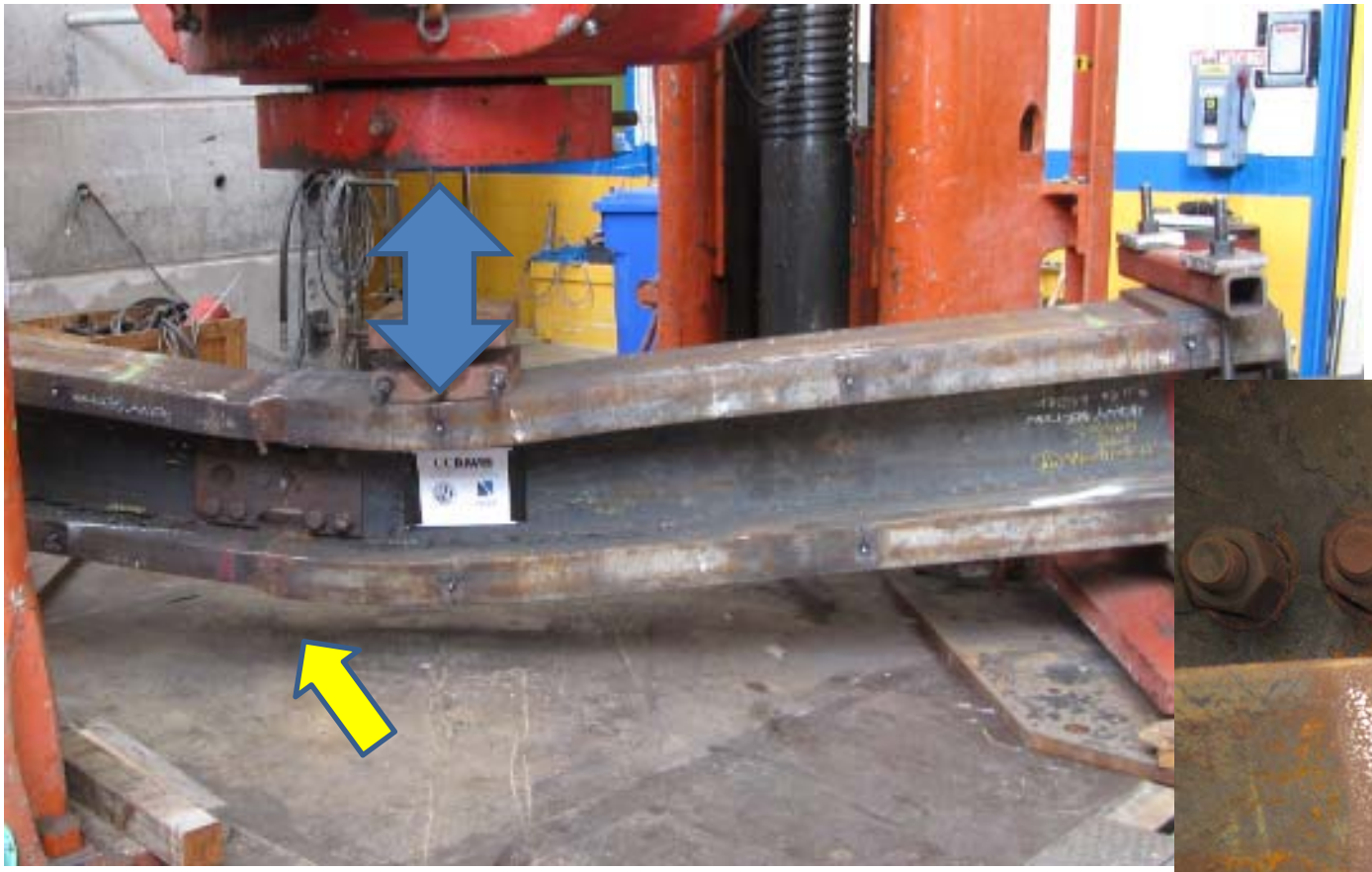


Test Matrix

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

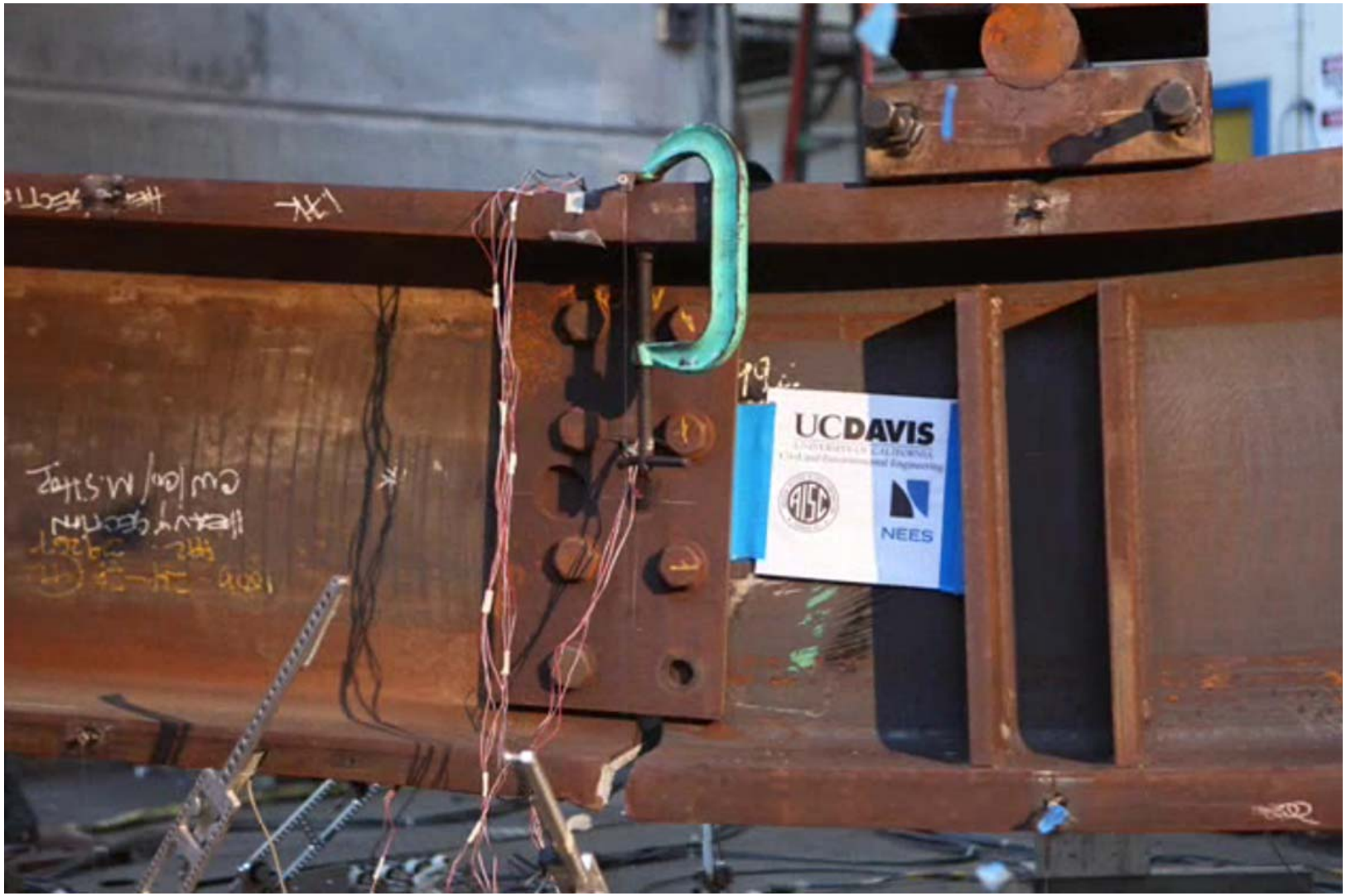
W14A (post-test)



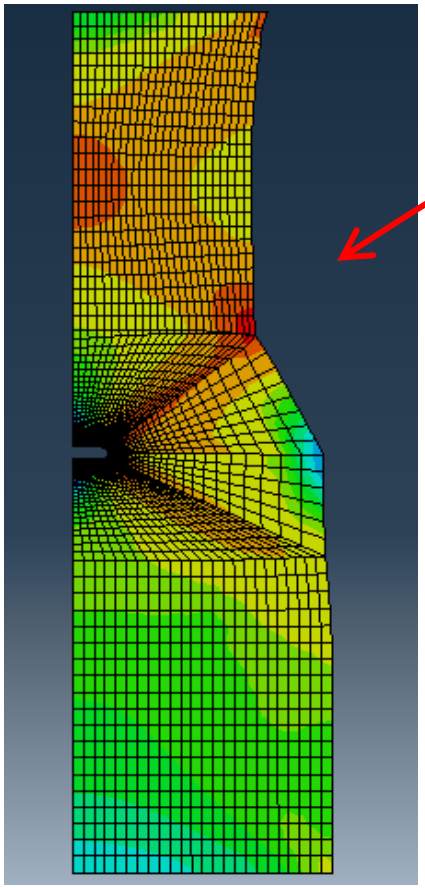


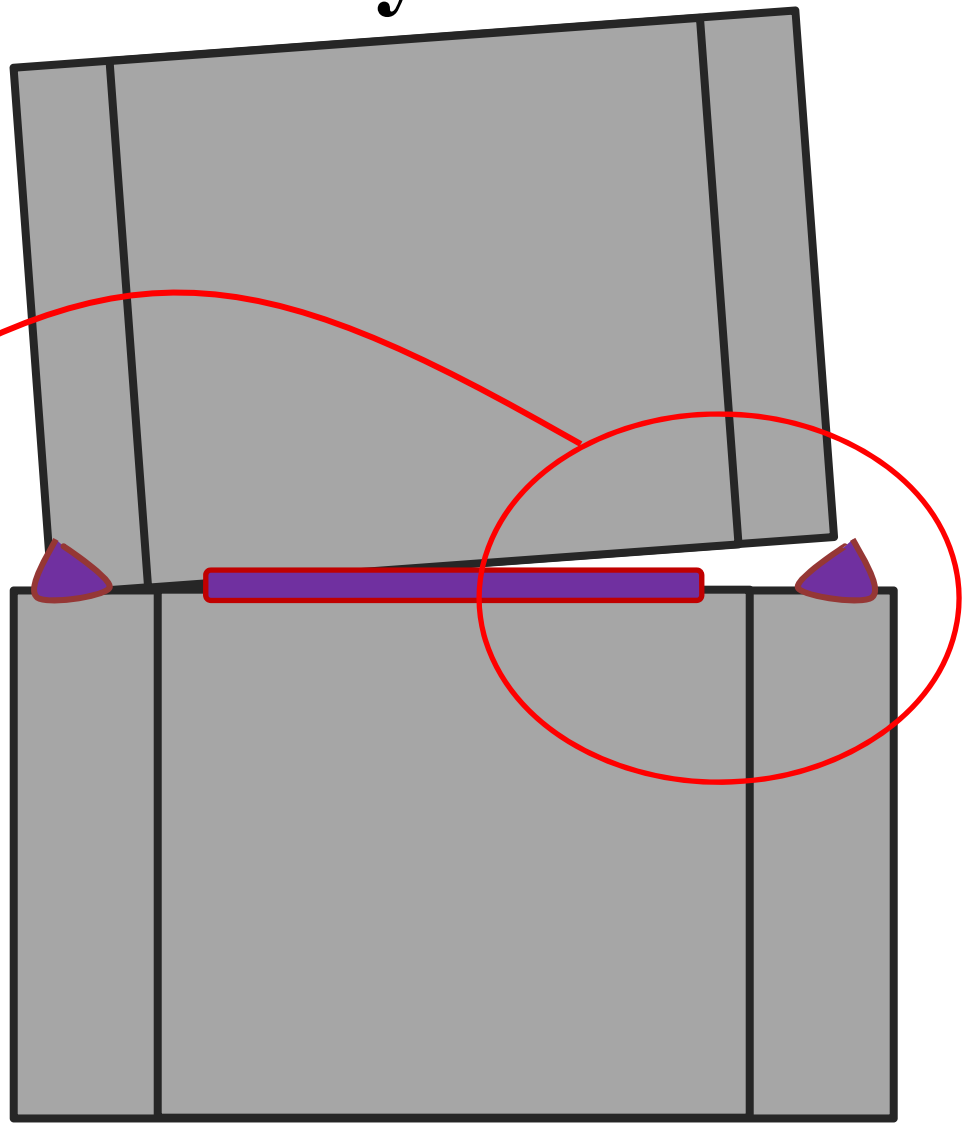
W14A (post-test)

W24B (post-test)



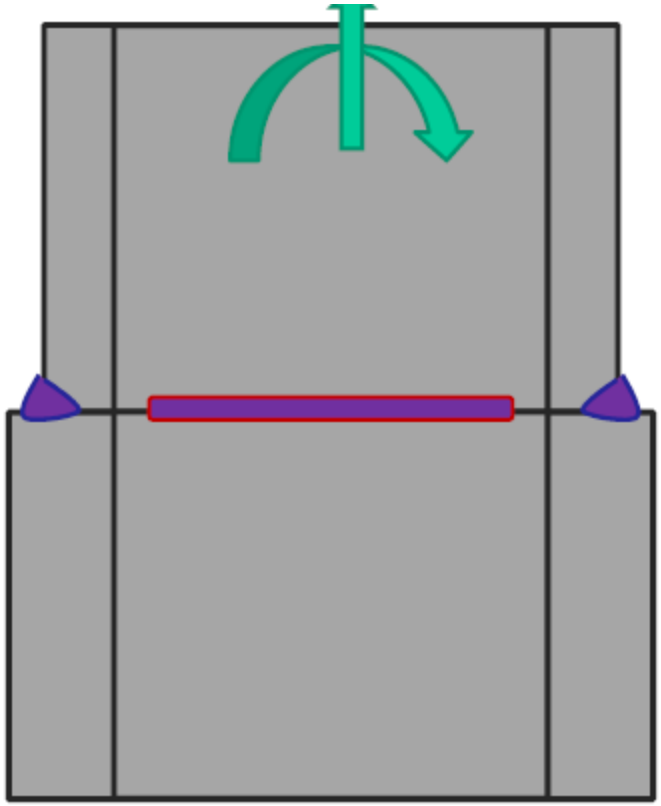
Fracture mechanics analysis





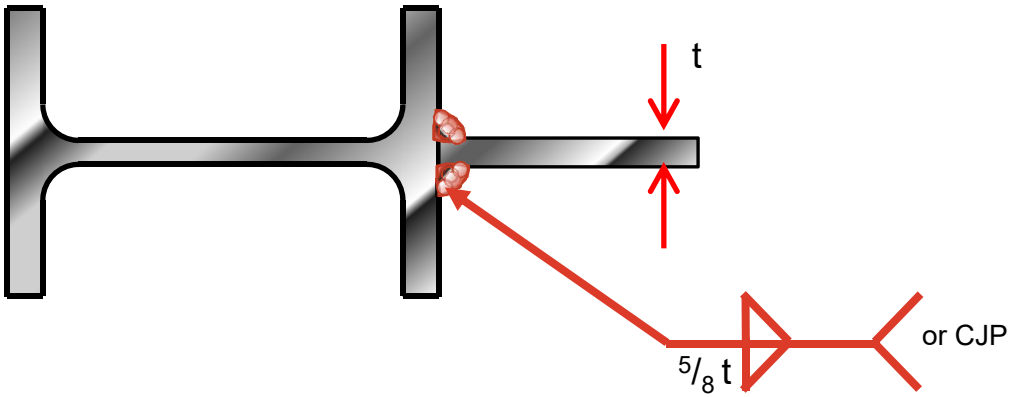
Allowance for PJP welds to be used in SMF column splices

- In 2010, if SMF column splices were welded, they had to be made with CJP welds
- 2016 allows for PJP welds, with the following requirements (among others):
  - Thicker flange at least 5% thicker than thinner one
  - Minimum effective throat of 85% of the smaller flange thickness
  - Tapered transition specified
  - Companion UT requirements developed

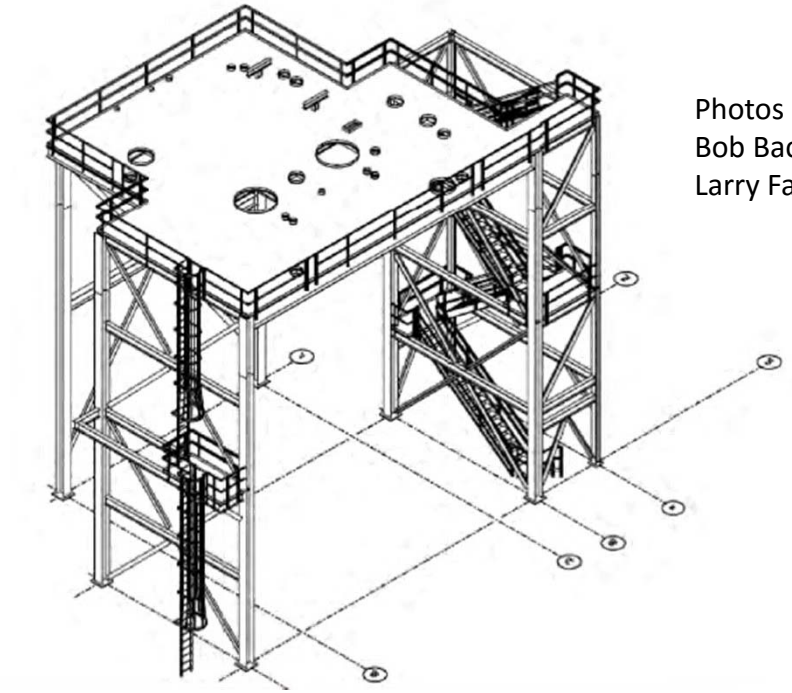


Welds at SCBF gusset plate interfaces

- Exception allows desinging the welds joining gusset plates to beams and columns to develop the demands on the gusset plate from shear, tension and bending due to hinging in compression.
  - Primary approach is to develop shear capacity of plate as noted below.



Multi-tiered braced frames

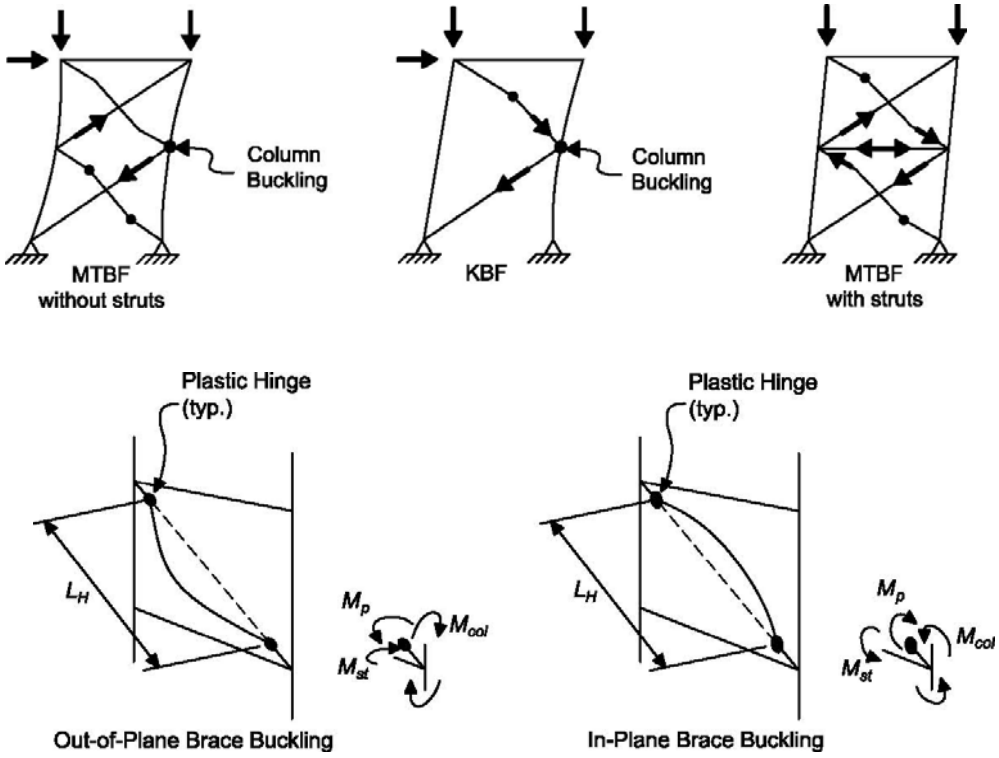


Photos courtesy of Bob Bachman and Larry Fahnestock

- A braced frame configuration with two or more tiers of bracing between diaphragm levels or out of plane support (called an MTBF) will now be allowed within OCBF, SCBF, and BRBF systems
- Currently considered by some to not be allowed in the 2010 Seismic Provisions because it was considered a K-braced frame

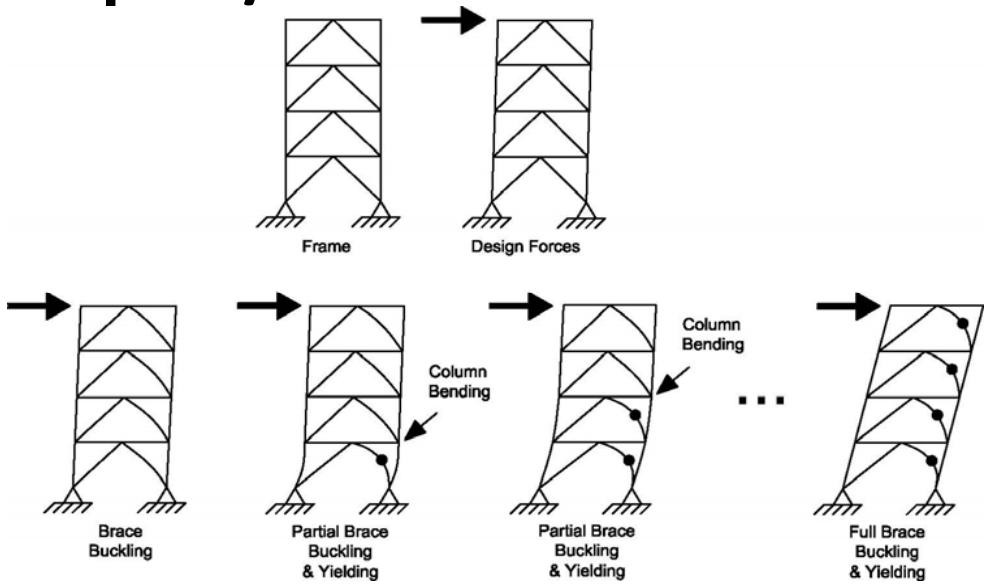
MTBF Concepts/Issues

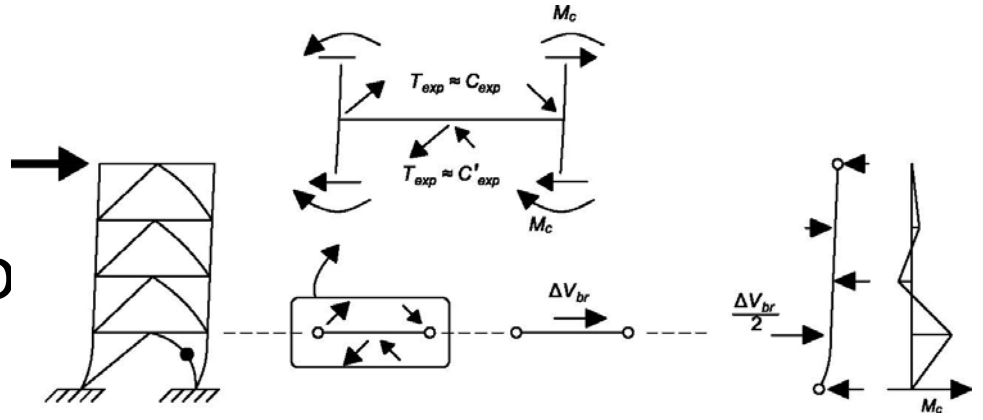
- Strut members are needed to allow frame-like action
- In buckling brace systems (SCBF/OCBF), the effects of hinging moments at ends of braces must be considered



MTBF Concepts/Issues

- Desire is to avoid all deformation in one tier
- Want to force a progression of yielding up the height of the frame
- Need to design shears/moments on columns to allow this to occur

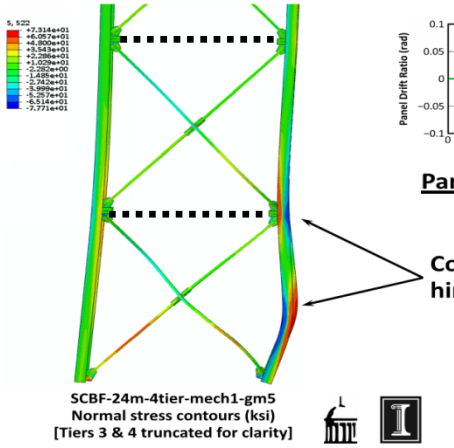


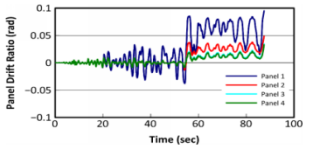


Multi-tiered braced frames

- New provisions for MTBF in OCBF, SCBF and BRBF calls for:
  - Torsional bracing of columns
  - Horizontal struts at all tier levels
  - Capacity design of column that accounts for brace yielding and buckling
  - Mitigation of tendency for inelastic deformation to concentrate in one tier

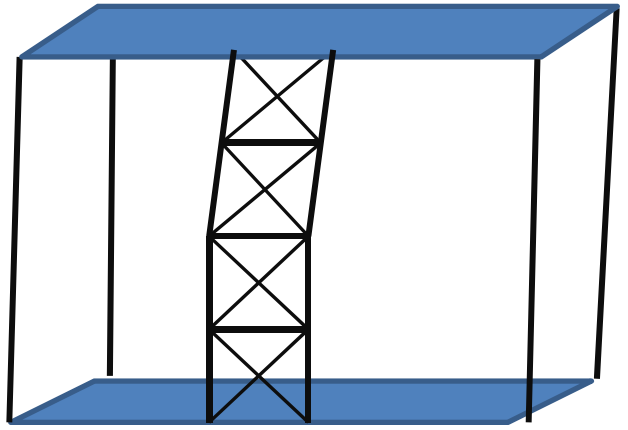
The column strength limit state varied with frame height and number of tiers under GM5.





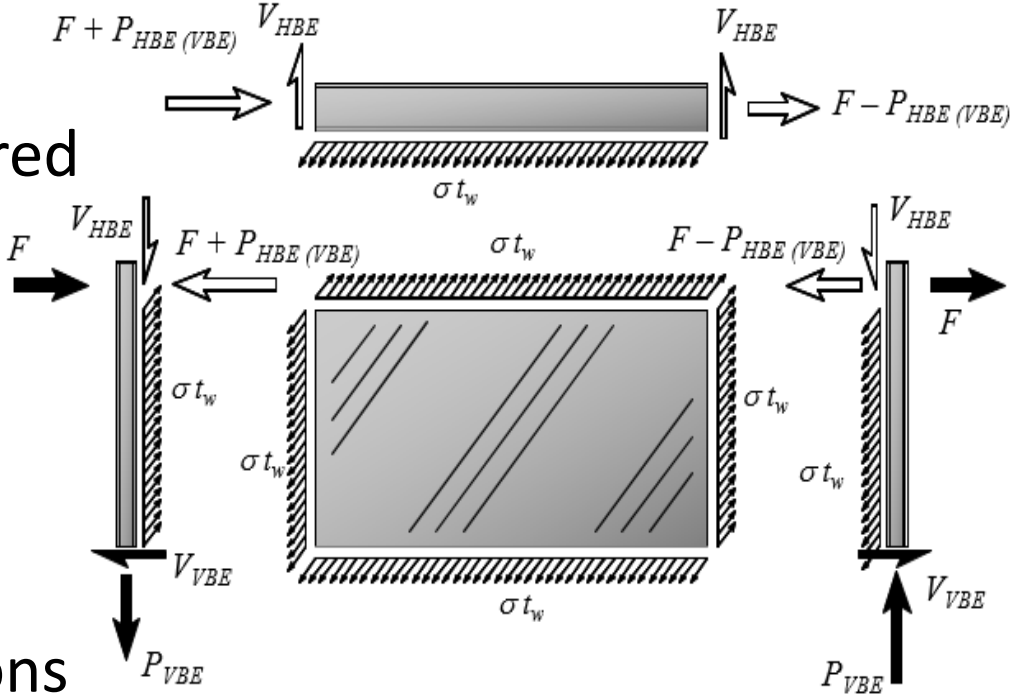
Panel Drift Ratio vs. Time

Stoakes and Fahnestock



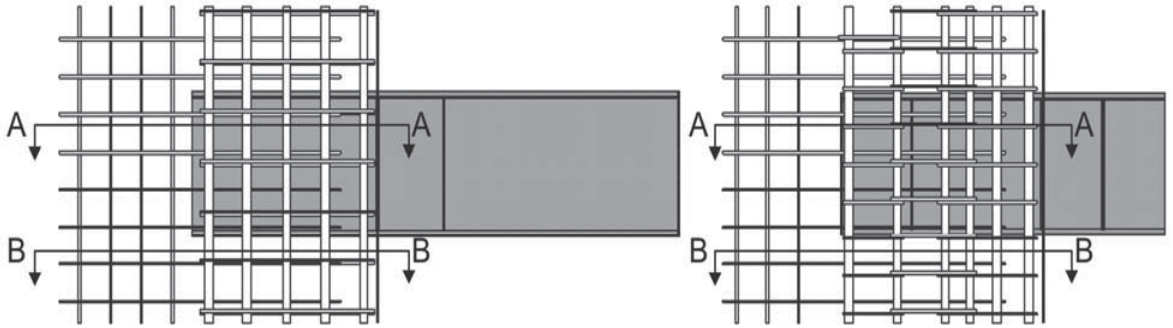
Special plate shear walls

- Web plate now required to carry 100% of frame shear
- Horizontal and vertical boundary elements required to be designed for 25% of the frame shear
- Additional requirements added for horizontal boundary elements to prevent yielding at locations other than near the beam-column connections



Composite Systems Updates

- Brace Connection and Column Splice requirements augmented for C-SCBF
- Reduced some requirements for C- Ordinary Shear Wall system to be more consistent with R factor and system limitations (SDC A & B Only)
- Coupling beam clarifications in composite special shear walls system



Prequalified connections for composite moment frame systems

4b. Beam and Column Parameters for C-SMF and C-IMF

(1) For structural steel members that are part of a composite beam or column: specify parameters required in K1.4a.

(2) Overall depth of compiste beam and column

(3) Composite beam span to depth ratio.

(4) Reinforcing bar diameter

(5) Reinforcement material specification

(6) Reinforcement development and splice requirements

(7) Transverse reinforcement requirements

(8) Concrete compressive strength and density

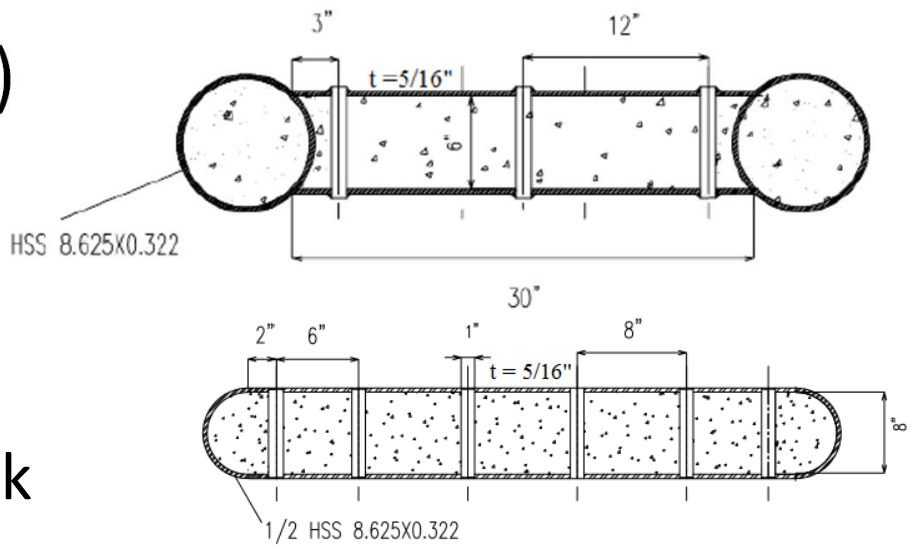
(9) Steel anchor dimensions and material specification

(10) Other parameters pertinent to the specific connection under consideration

- In 2010, Chapter K of the Seismic Provisions gives requirements of prequalification and qualification of beam-to-column and link-to-column connections for steel systems only
- New requirements include composite requirements as well

Concrete-filled steel sandwich panel walls

- New type of composite plate shear wall (C-PSW)
- Benefits include
  - Steel can provide confinement of the concrete
  - Steel can act as formwork for accelerated construction
  - Concrete core delays local buckling of steel plate
  - Reinforcing bars are typically not necessary



Drawings courtesy of Michel Bruneau et al

Decking Attachments with PAF's in Protected Zones

- 341-10 Protected Zone Rules Only Allow Spot Welds
  - Tests at Virginia Tech on Power Actuated Fasteners Showed No Reduction in Rotation Capacity
    - Multiple full scale tests and patterns
    - Small scale bend tests as well
  - Now allow power-actuated fasteners up to 0.18" diameter in flanges.

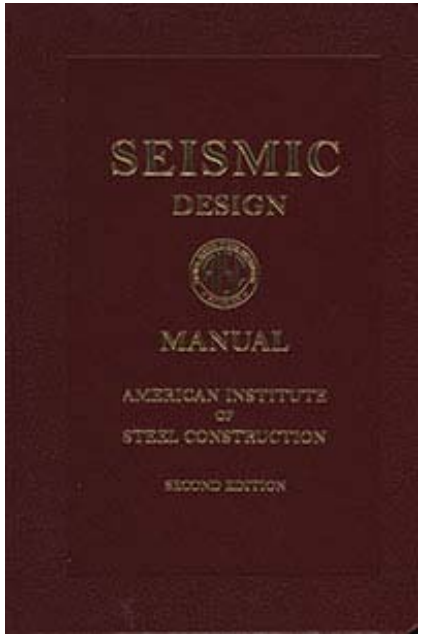
Additional Changes

- The following items are also to be included in the 2016 Seismic Provisions:
  - Guidance for use of built-up members

  - Clarifying language for column base design, including use of ACI 318 for anchorage (Chapter 17), with somewhat reduced shear strength requirement
  - Expanded language for SMF's to allow partial strength connections such as Simpson Strong Frame

Summary and Conclusions

- The 2016 AISC Seismic Provisions present fewer changes than previous editions.
  - However, many of the changes do present now options and direction for common design issues
- Completion of the document in June, 2016. Now available for FREE download on AISC website.
  - Companion new edition of AISC Seismic Design Manual underway with publication expected in 2018.
- Incorporation into ASCE 7-16 and 2018 IBC. Likely adopted by states in 2018 and 2019.
- Work on 2022 edition has begun.
  - We want your input and suggestions!!!!!



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