
# ASCE 41

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# FEMA 357: ASCE/FEMA 273 Prestandard Project

- Global Topics Report:
  - Incorporating Results of the SAC Joint Venture Steel Moment Frame Project
  - One of numerous reports produced as part of FEMA 357
- Modifications Proposed to the 2nd Draft of the FEMA 356 *Prestandard for the Seismic Rehabilitation of Buildings*
- Report is located in Appendix K

# Source Documents for Review

- FEMA 350 – Recommended Seismic Design Criteria for Moment-Resisting Steel Frame Structures

- FEMA 351 – Recommended Seismic Evaluation and Upgrade for Existing Welded Steel Moment-Resisting Frame Structures

# Source Documents for Review

- FEMA 355c – State of Art Report on Systems Performance
- FEMA 355d – State of Art Report on Connection Performance
- FEMA 355f – State of Art Report on Performance Prediction and Evaluation

# Key Findings/Changes—Chapter 1

- Commentary added describing FEMA 351 and its applicability for evaluation and rehabilitation of steel moment frames
- FEMA/SAC reference documents added

# Key Findings/Changes—Chapter 5

- Section 5.3.2.5 Default Properties
  - Default values updated to reflect SAC research
    - Expected and lower-bound values changed to mean and mean minus one standard in Table 5-2
- Section 5.5.1
  - New Table 5-X (became 5-4) added to describe new connections
    - Includes most connections contained in FEMA 351 and FEMA 355d
    - Connections are defined as FR or PR

# Key Findings/Changes—Chapter 5

5 -X Steel Moment Frame Connection Types

| Connection | Description [1,2] | Type |
|---|---|---|
| Welded Unreinforced Flange (WUF) | Full-penetration welds between beam and columns flanges, bolted or welded web, designed prior to code changes following the Northridge earthquake | FR |
| Bottom Haunch in WUF w/ Slab | Welded bottom haunch added to existing WUF connection with composite slab [3] | FR |
| Bottom Haunch in WUF w/o Slab | Welded bottom haunch added to existing WUF connection without composite slab [3] | FR |
| Welded Cover Plate in WUF | Welded cover plates added to existing WUF connection [3] | FR |
| Improved WUF-Bolted Web | Full-penetration welds between beam and column flanges, bolted web [4] | FR |

# Key Findings/Changes—Chapter 5

| | | |
|---|---|---|
| Improved WUF-Welded Web | Full-penetration welds between beam and column flanges, welded web [4] | FR |
| Free Flange | Web is coped at ends of beam to separate flanges, welded web tab resists shear and bending moment due to eccentricity due to coped web [4] | FR |
| Welded Flange Plates | Flange plate with full-penetration weld at column and fillet welded to beam flange [4] | FR |
| Reduced Beam Section | Connection in which net area of beam flange is reduced to force plastic hinging away from column face [4] | FR |
| Welded Bottom Haunch | Haunched connection at bottom flange only [4] | FR |
| Welded Top and Bottom Haunches | Haunched connection at top and bottom flanges [4] | FR |
| Welded Cover-Plated Flanges | Beam flange and cover-plate are welded to column flange [4] | FR |

# Key Findings/Changes—Chapter 5

- Section 5.5.2.4 Acceptance Criteria—Linear
  - Beams
    - Added modifiers based on effects of web slenderness
  - Columns
    - Commentary added to note that SAC procedure for axial compression and splice tension differ (no flexural consideration)
    - Added modifiers based on effects of web slenderness
      - Vary based on $P/P_{CL}$ ratio

# Key Findings/Changes—Chapter 5

- Section 5.5.2.4 Acceptance Criteria—Linear
  - FR Beam-Column Connections
    - Added modifiers based on effects of beam web slenderness
      - Varies for 0.5 for upper slenderness limit to 1.0 for lower limit
    - Based on FEMA 356 approach that linear procedure *m* values are set at 0.75 times those permitted in nonlinear procedures:
      - Assigned *m* values for ductility capacity for linear procedures of 1.0 and 0.86 times those for nonlinear procedures (IO and CP)

# Key Findings/Changes—Chapter 5

- Section 5.5.2.4 Acceptance Criteria—Nonlinear
  - FR Beam-Column Connections
    - Added adjustment for plastic rotation capacity for small span-to-depth ratios
      - Reduced plastic rotation capacity by ½ as L/d goes from 8 to 5
    - Based on FEMA 356 approach that ductility capacity for primary elements be taken as 0.75 times those permitted secondary elements
      - Used $1/\gamma$ average for CP performance of SAC connection types 1 and 2 (0.76 and 0.66) to develop primary acceptance criteria taken from FEMA 355d secondary acceptance criteria

# Key Findings/Changes—Chapter 5

- Section 5.5.2.4 Acceptance Criteria—Nonlinear
  - Resulting Table 5-5 (became Table 5-6):

*Additional nonlinear modeling and acceptance criteria (add to Table 5-5)*

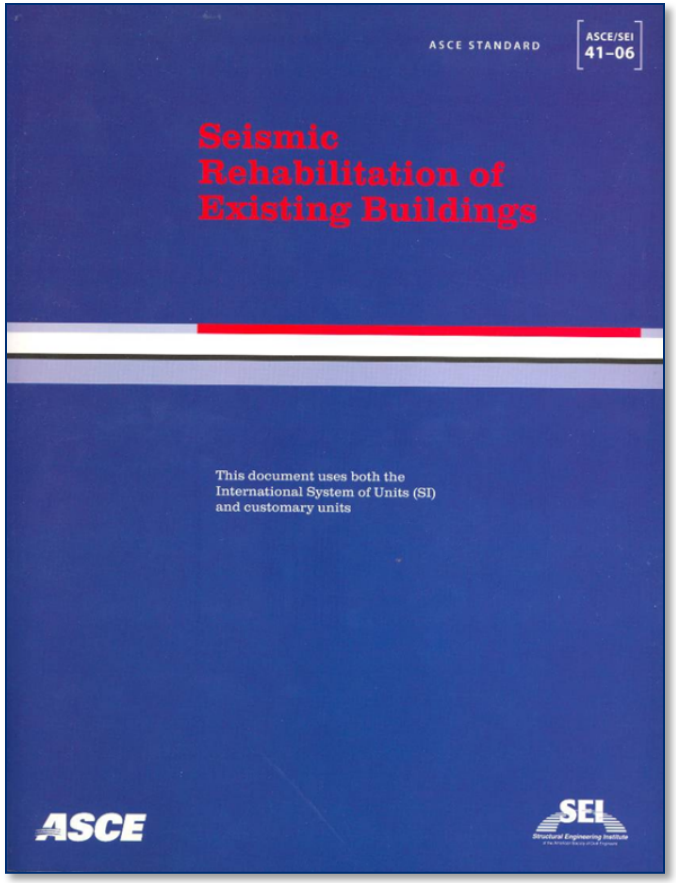
| Connection | a | b | c | IO | Primary | | Secondary | |
|---|---|---|---|---|---|---|---|---|
| | | | | | LS | CP | LS | CP |
| **FR Connections** | | | | | | | | |
| WUF | 0.051 - 0.0013d | 0.043 - 0.0006d | 0.2 | 0.0128 - 0.0003d | 0.0337 - 0.0009d | 0.0284 - 0.0004d | 0.0323 - 0.0005d | 0.043 - 0.0006d |
| Bottom haunch in WUF with slab | 0.026 | 0.036 | 0.2 | 0.0065 | 0.0172 | 0.0238 | 0.0270 | 0.036 |
| Bottom haunch in WUF without slab | 0.018 | 0.023 | 0.2 | 0.0045 | 0.0119 | 0.0152 | 0.0180 | 0.023 |
| Welded cover plate in WUF | 0.056 - 0.0011d | 0.056 - 0.0011d | 0.2 | 0.0140 - 0.0003d | 0.0319 - 0.0006d | 0.0426 - 0.0008d | 0.0420 - 0.0008d | 0.056 - 0.0011d |
| Improved WUF-bolted web | 0.021 - 0.0003d | 0.050 - 0.0006d | 0.2 | 0.0053 - 0.0001d | 0.0139 - 0.0002d | 0.0210 - 0.0003d | 0.0375 - 0.0005d | 0.050 - 0.0006d |
| Improved WUF-welded web | 0.041 | 0.054 | 0.2 | 0.0103 | 0.0312 | 0.0410 | 0.0410 | 0.054 |
| Free flange | 0.067 - 0.0012d | 0.094 - 0.0016d | 0.2 | 0.0168 - 0.0003d | 0.0509 - 0.0009d | 0.0670 - 0.0012d | 0.0705 - 0.0012d | 0.094 - 0.0016d |
| Reduced beam section | 0.050 - 0.0003d | 0.070 - 0.0003d | 0.2 | 0.0125 - 0.0001d | 0.0380 - 0.0002d | 0.0500 - 0.0003d | 0.0525 - 0.0002d | 0.07 - 0.0003d |
| Welded flange plates | | | | | | | | |
| Flange plate net section | 0.03 | 0.06 | 0.2 | 0.0075 | 0.0228 | 0.0300 | 0.0450 | 0.06 |
| Other limit state | force-controlled | | | | | | | |
| Welded bottom haunch | 0.027 | 0.047 | 0.2 | 0.0068 | 0.0205 | 0.0270 | 0.0353 | 0.047 |
| Welded top and bottom haunches | 0.028 | 0.048 | 0.2 | 0.0070 | 0.0213 | 0.0280 | 0.0360 | 0.048 |
| Welded cover-plated flanges | 0.031 | 0.031 | 0.2 | 0.0078 | 0.0177 | 0.0236 | 0.0233 | 0.031 |
| **PR Connections** | | | | | | | | |
| Shear connection with slab | 0.029 - 0.0002dbg | 0.15 - 0.0036dbg | 0.4 | 0.0073 - 0.0001dbg | --- | --- | 0.1125 - 0.0027dbg | 0.15 - 0.0036dbg |
| Shear connection without slab | 0.15 - 0.0036dbg | 0.15 - 0.0036dbg | 0.4 | 0.0375 - 0.0009dbg | --- | --- | 0.1125 - 0.0027dbg | 0.15 - 0.0036dbg |

d is the depth of the beam.

$d_{bg}$ is the depth of the bolt group.

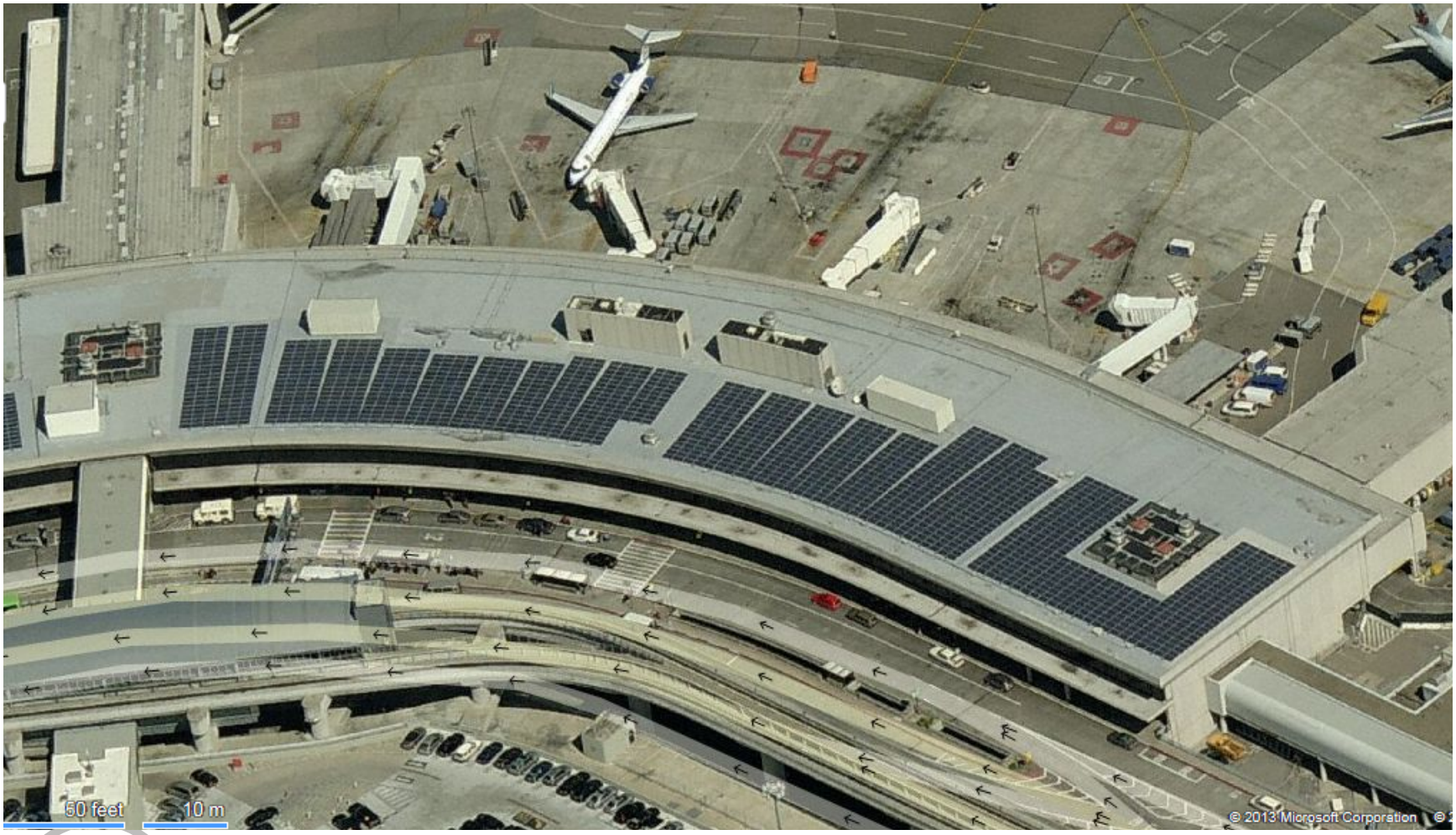
Tabulated values shall be modified as indicated in Sec. 5.5.2.4.3, item 4.

# ASCE 41—Not Just for Existing Buildings




- Primary focus is existing buildings
- Used for new building designs as well

# SFO T3 East Expansion



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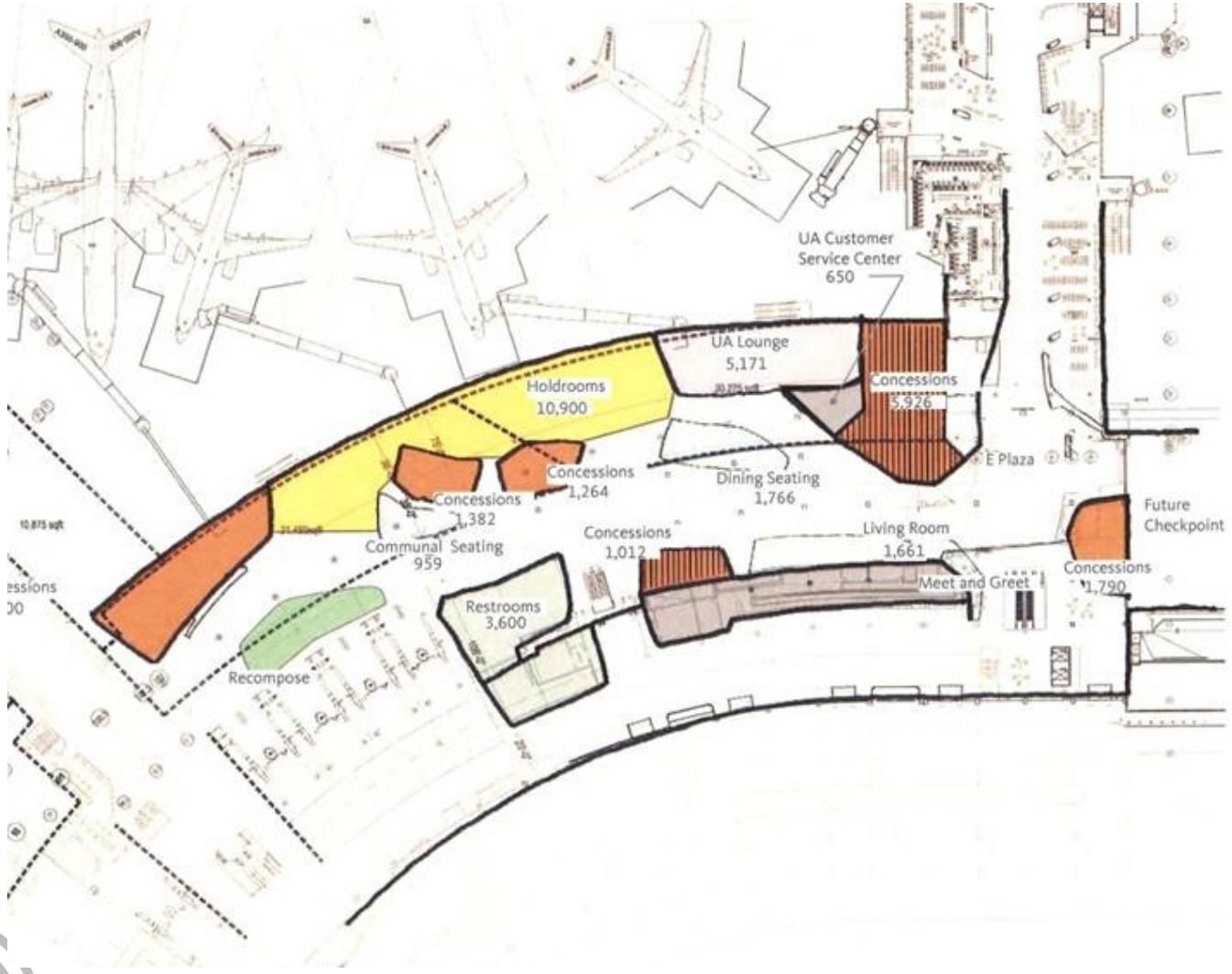

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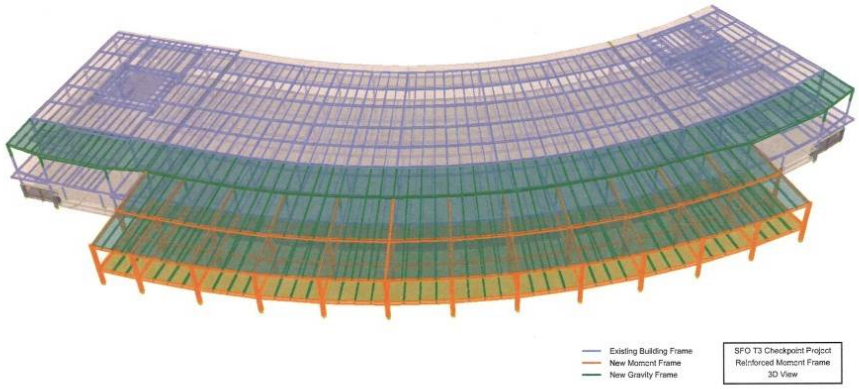
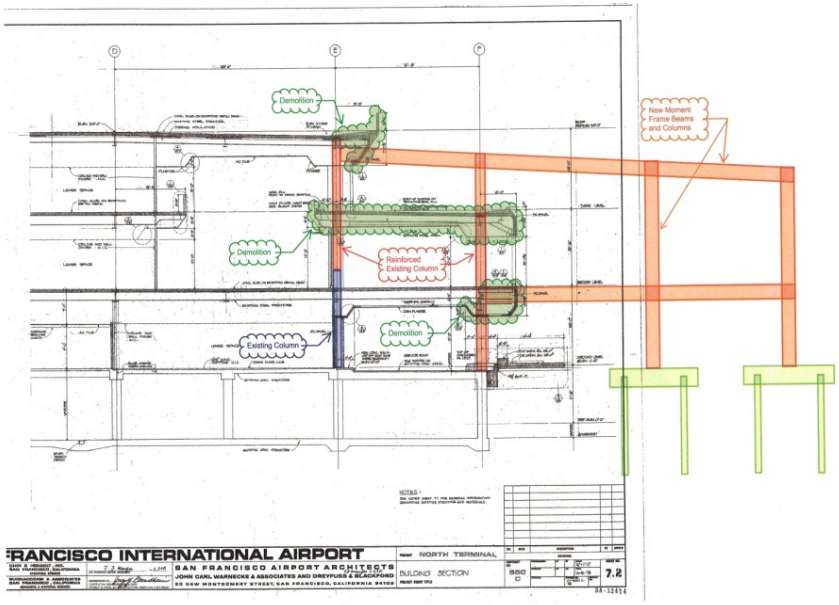
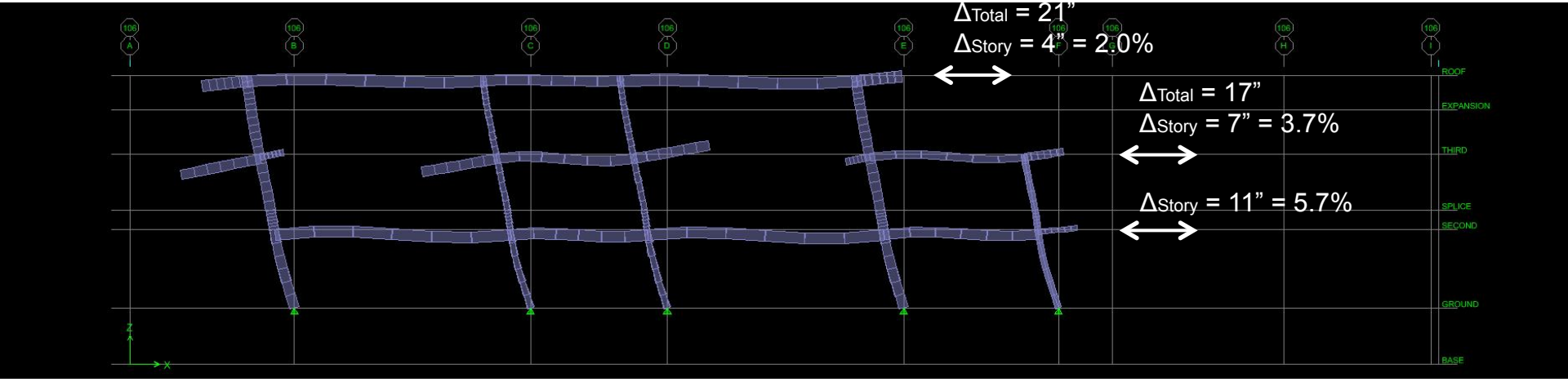
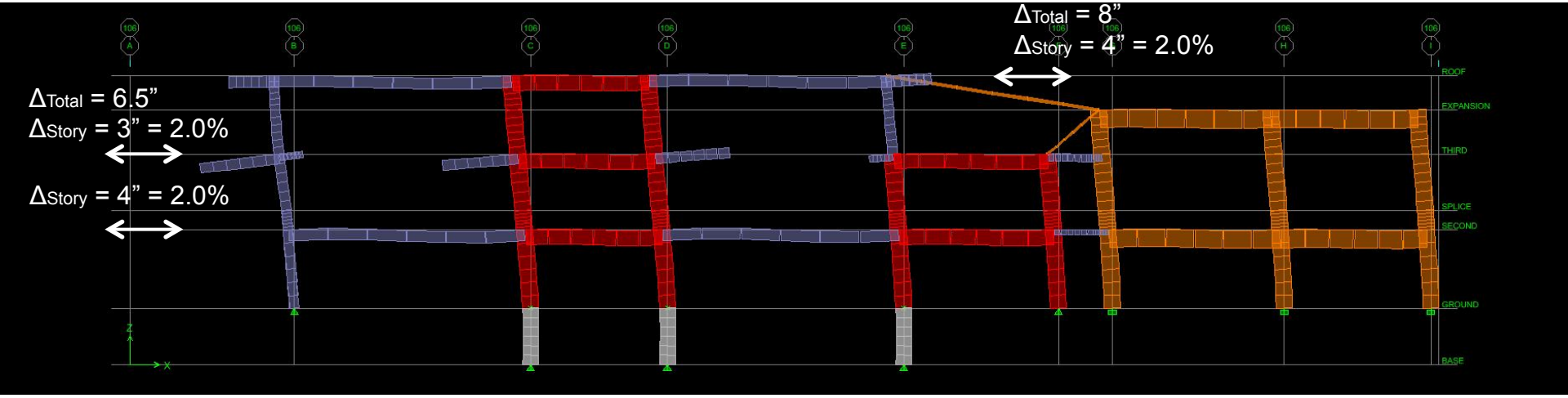


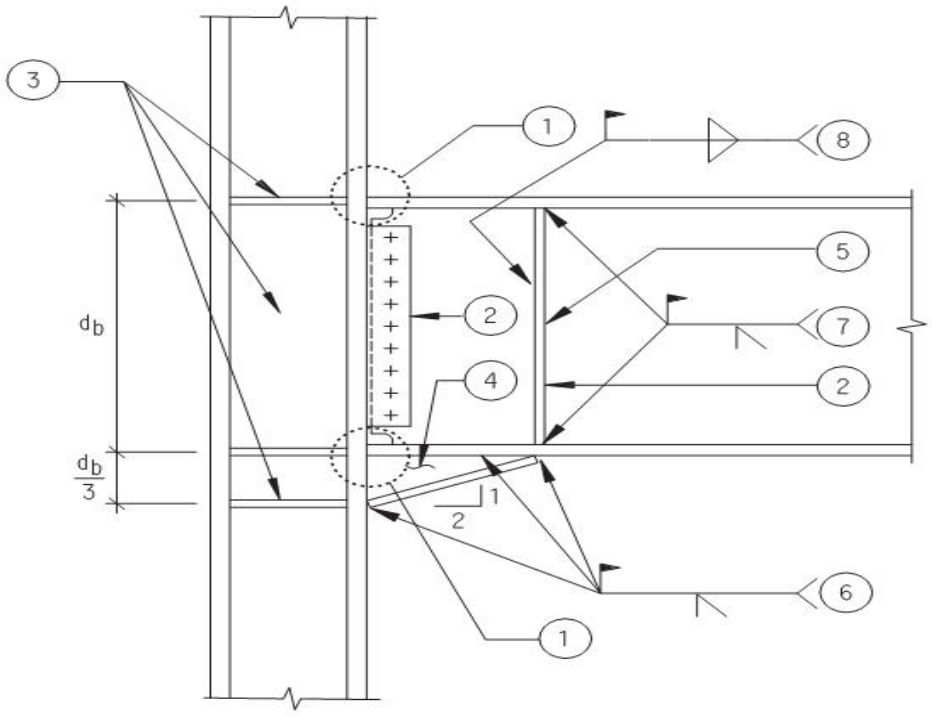



**Existing Condition**




**Retrofitted Condition**

# SFO T3 East Expansion




**Notes**

1. For OMF connection, existing weld can remain. For SMF connection, see Figure 6-11.
2. Existing bolted shear tab.
3. Existing continuity plates and web doubler plate. See Figure 6-9.
4. WT haunch.
5. New ½"-minimum stiffener plates each side.
6. Haunch welds, see Sections 6.4.2.3 and 6.4.2.4, QC/QA category AH/T.
7. Stiffener CJP welds; see Sections 6.4.2.3 and 6.4.2.4, QC/QA Category BM/T.
8. Stiffener fillet welds, 5/16" minimum. QC/QA Category CL/L.

# San Francisco MOMA

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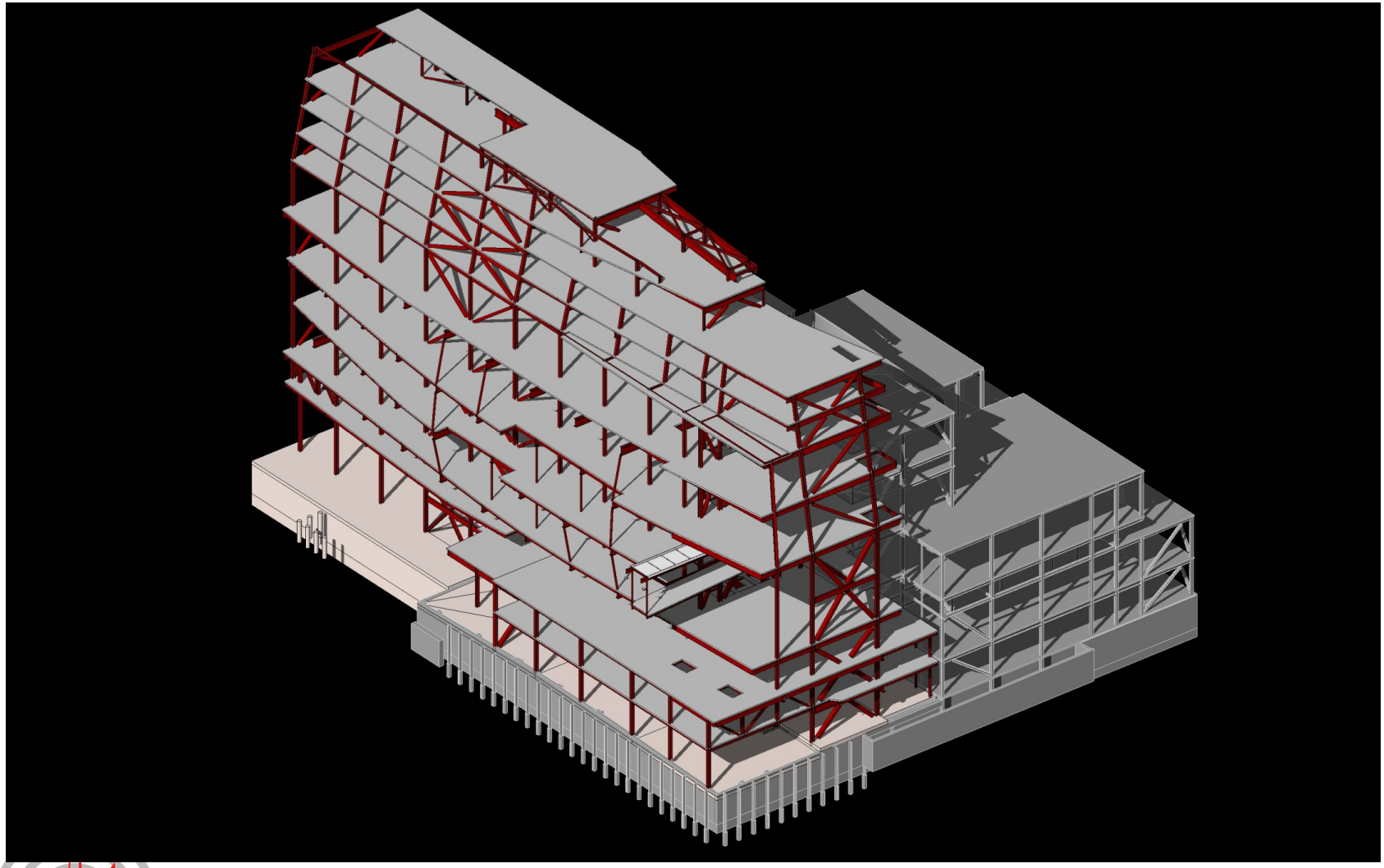

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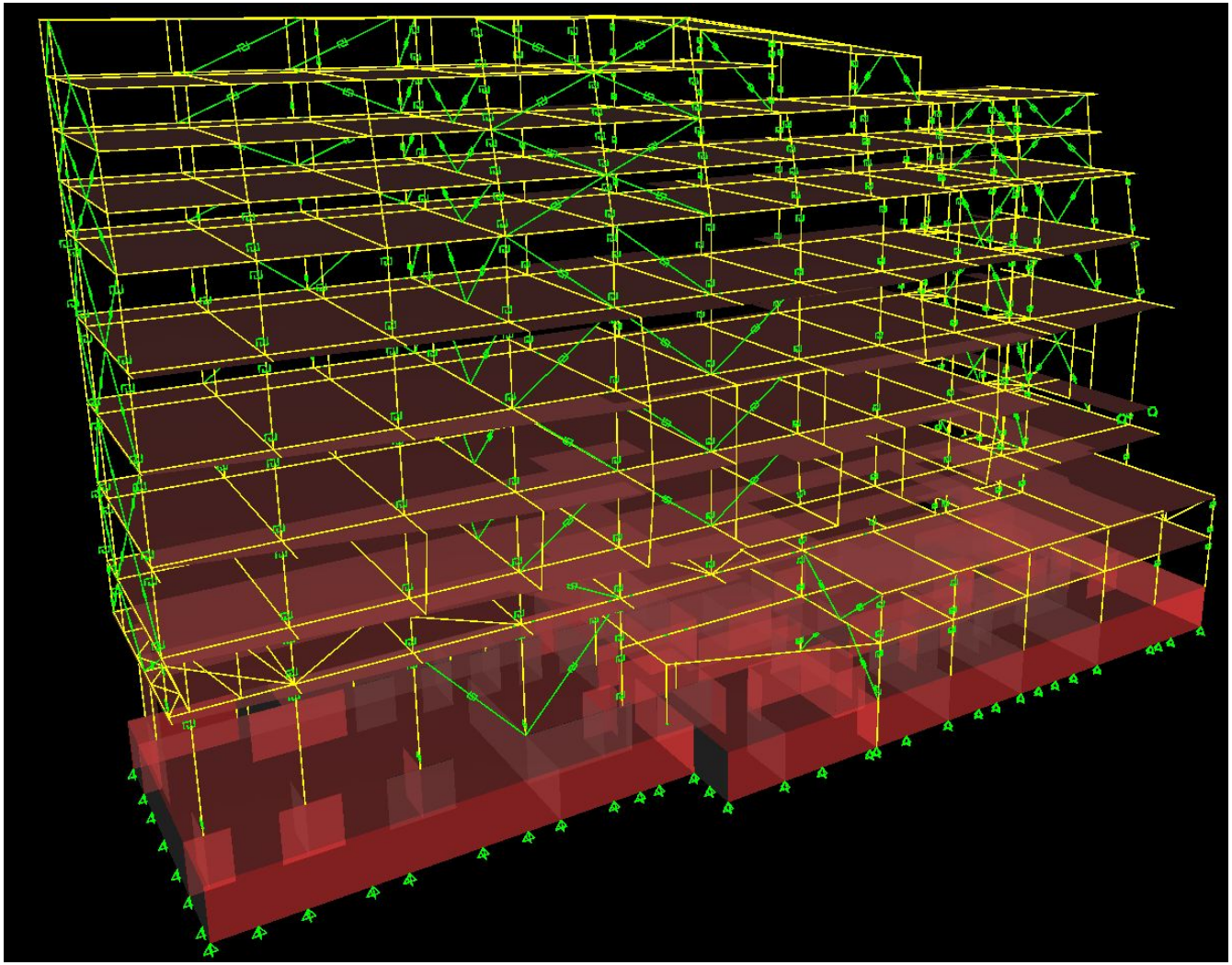

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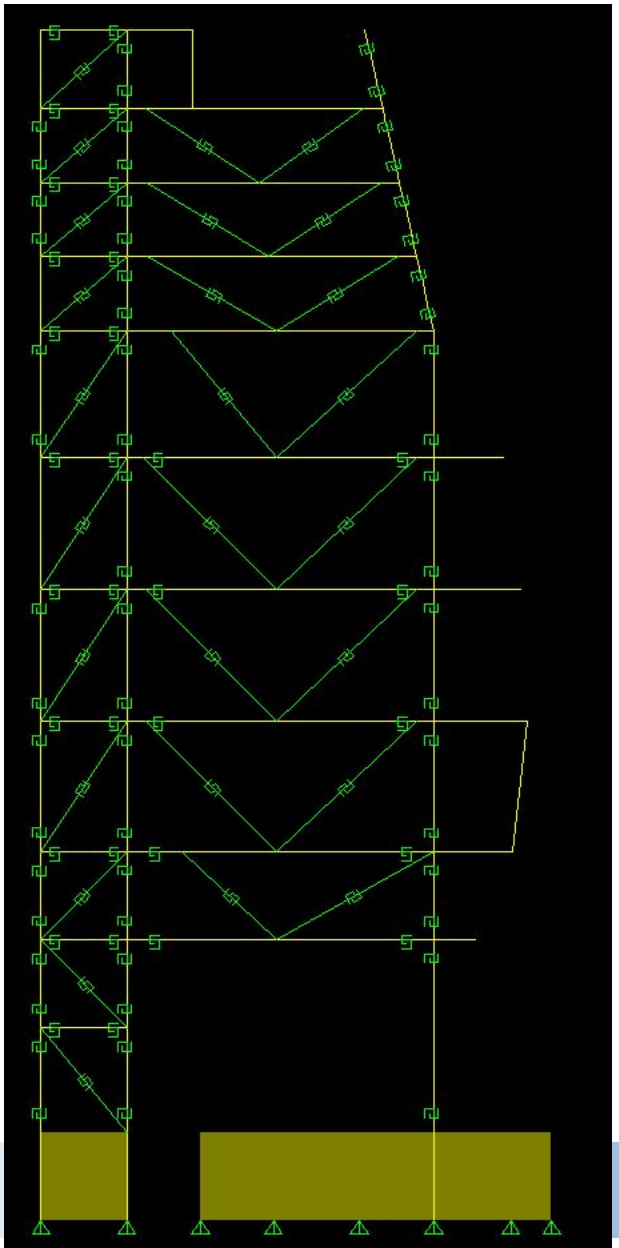

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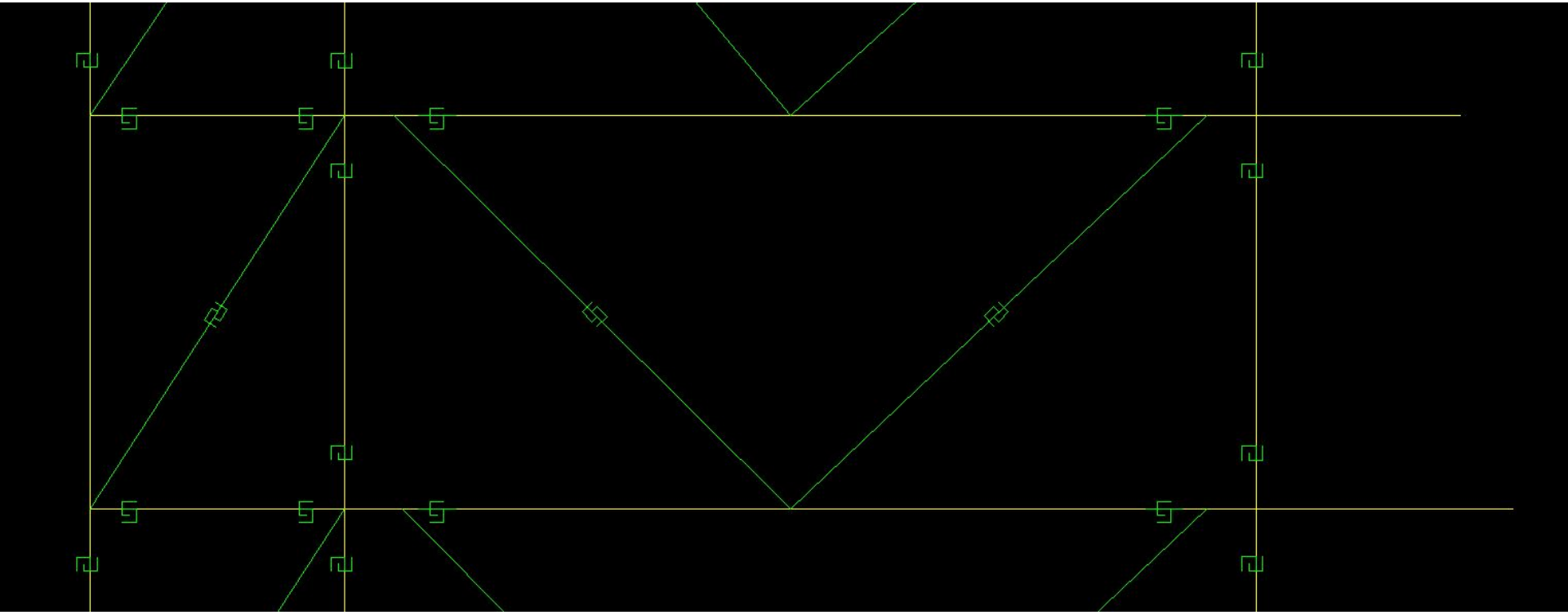

# Thank You!

# Task 1

Review Chapter 5 of the Prestandard for general agreement with approaches developed for acceptance criteria by the FEMA/SAC Steel Project

# Task 2

Review particular values for acceptance criteria for moment frames for agreement with those contained in the FEMA/SAC recommendations

# Task 3

Review SAC testing and investigations for input to acceptance criteria for other steel systems, connections or joints (e.g., gravity connections, welds, bolted connections)

# Task 4

Review the FEMA/SAC reliability framework to assess its future application to the Prestandard