Structural Steel

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Impacts – Structural Steel

- Unexpected Problems in Steel Seismic Systems
  - Fractures in steel moment frame beam-to-column connections
  - Fractured steel braces in braced frames
Impacts – Moment Frames

- Primary problem: brittle fractures of the weld between beam flange and column flange
Impacts – Moment Frames

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[Diagram of moment frame]

[Image of weld crack]

Business card in weld crack
Impacts – Moment Frames

- Causes of Problems in Steel Moment Frames
  - Design Problems
    - Use of less reliable version of tested moment frame connection
    - Use of deep steel beam sections

All-welded: better performer
Bolted web: not so much
Impacts – Moment Frames

■ Causes of Problems in Steel Moment Frames
  ■ Construction Problems
    Weld metal with low resistance to brittle fracture
    Welders did not follow required welding procedures
Impacts – Moment Frames

- Causes of Problems in Steel Moment Frames
  - Inspection Problems
    Over-reliance on after-the-fact inspection methods
    Lack of diligence on the part of some inspectors
Impacts – Moment Frames

- Solutions to Problems in Steel Moment Frames
  - Development of moment frame connection designs based on thorough research
  - FEMA-sponsored SAC Joint Venture
  - AISC Connection Pre-Qualification Panel
Impacts – Moment Frames

- Solutions to Problems in Steel Moment Frames
  - Use of steel and welding materials with improved seismic characteristics
Impacts – Moment Frames

- Solutions to Problems in Steel Moment Frames
  - Improved Inspection Practices
    - Increased reliance on visual inspection
    - Availability of standardized inspection requirements in building codes
    - Improved certification programs (e.g., ICC-ES, AISC)
Impacts – Braced Frames

- Primary problem: fractured braces
Impacts – Braced Frames

- Causes of Problems in Steel Braced Frames
  - Use of braces with excessively thin walls
Impacts – Braced Frames

- Causes of Problems in Steel Braced Frames
  - Overcutting slots in braces required for fit-up
Impacts – Braced Frames

- Solutions to Problems in Steel Braced Frames
  - Specification of minimum ratio for wall thickness to brace width
  - Explicit consideration of impact of slots in braces
Impacts – Braced Frames

- Solutions to Problems in Steel Braced Frames
  - Requirement that connections develop strength of brace
  - Revised analytical methods to account for brace buckling
Recommendation - Practice

Recommendations - Research

- Improve understanding of seismic behavior correlation between individual components and actual structures
- Improve understanding of tall steel buildings and steel buildings with heavily loaded columns during earthquakes
- Improve understanding of multi-tier braced frame behavior
- Develop reliable seismic performance standards for steel structures