Pre-Northridge Partial Joint Penetration Column Splices
Hazard and Retrofit

By Michael Chisholm, James Malley and Robert Pekelnicky
Welded Connection Failures

- 1995 Kobe
- Nearly unseated column splices
PJP Splice Deficiency

1. Non-notch tough weld metal

2. Insufficient weld size to flange thickness ratio

\[ \frac{t_f}{2} + \frac{1}{8} \text{"} \quad \text{Or } \approx 60\% \]
Capacity Formulation

\[
\sigma_{cr} \leq \sigma_{ue} \leq \sigma_{ye}
\]

\[
\frac{K_{IC}}{F \left( \frac{a_0}{t_{f,u}} \right) \sqrt{\pi a_0}} \leq F_{u,exp} \left( 1 - \frac{a_0}{t_{f,u}} \right) \leq F_{y,exp}
\]

where \( F \left( \frac{a_0}{t_{f,u}} \right) = \left( 2.3 - 1.6 \frac{a_0}{t_{f,u}} \right) \times \left( 4.6 \frac{a_0}{t_{f,u}} \right) \)
Critical Weld Stress vs. Notch Ratio

- **σ_{we} (MED)**
- **σ_{we} (LB)**
- **σ_{ye}**

- **Rupture Stress**: \( t_f / 2 + 1/8 \) " Range
- **Fracture Stress**: \( t_f - 1/8 \) " Range
- **Yield Stress**: 75 ksi vs. 15 ksi

Critical Stress (ksi) vs. Notch Ratio -- \( a_0/t_f \) (in./in.)
Demand Calculation

- Tension vs. Gravity
- Time-Step P-Mx-My
- Amount of weld area under critical stress
  - Mx & My
- Wobble of inflection point
The Hotel Nikko Retrofit
Repair Constraints

Inside face of precast facade

Column Flange
Creating Access

- Reinforce Flanges
- Cut web window
Gouge, Grind and Re-Weld
Stability During Construction

Reinforce flanges with fin plates
Patch Plate and Next Splice