Before

After

Photos: Stainless Structurals
Industrial structures
Building & architectural structures
Introduction to AISC Design Guide: Structural Stainless Steel

- No US design spec. for hot rolled & welded stainless steel
- SEI/ASCE Spec. for cold-formed stainless steel has been available for many years

? How are heavier-walled stainless structures being designed in the US?
The objective

AISC Design Guide: Structural stainless steel

- Hot rolled or welded open structural sections, e.g. I-shaped, channels, equal angles
- Round and rectangular HSS
- Austenitic and duplex stainless $t > 3$mm
- Precipitation hardening stainless bar & fasteners
Keeping it simple…………..but

- Align to AISC 360 (carbon steel building spec)
- Adopt carbon steel rules where possible
- Where special rules stainless steel are necessary, they take same form as carbon steel expressions
- Use carbon steel resistance factors, wherever possible
- Design examples
Keeping it simple……………but

- Appendix A gives a less conservative method leading to up to 20% higher strengths (Continuous Strength Method)
- Appendix B gives comprehensive basis for design rules, so refinements easily made in the future
The sponsors
The contributors

- Catherine Houska (Outokumpu)
  - materials issues, US market
- Phil Francis (SCI)
  - reliability/ determination of resistance factors
- Katherine Cashell (formerly SCI)
  - fire and precipitation hardening grades
- Team Imperial College
  - LTB

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AISC DG: Structural Stainless Steel

**Materials issues (30 pages)**
- Material properties, selection & durability
- Fabrication and erection

**Design rules (40 pages)**
- Member and connection design rules
- Fire resistance

**Commentary (60 pages)**

**Design Examples**
Tension members, columns & beams

- **Tension members & restrained beams:** use same rules as for carbon steel

- **Local buckling, column buckling, lateral torsional buckling of unrestrained beams:** use lower buckling curves than carbon steel
Resistance/safety factors

- Comprehensive reliability analysis
- Followed protocol adopted for AISC 360

\[
\beta = \frac{\ln\left(\frac{R_m}{Q_m}\right)}{\sqrt{V_R^2 + V_Q^2}} \quad \Rightarrow \quad \phi = \frac{1.481 M_m F_m P_m}{\exp\left(\beta \sqrt{V_R^2 + V_Q^2}\right)}
\]

Target Reliability:
\(\beta=2.6\) for Members, \(\beta=3.5\) for connections
Resistance/safety factors

- Statistics on material data and geometrical variations of sections
  - Mean and Scatter both impact the resistance factor
- Database of all (known) test results worldwide on stainless structural sections
- Analysed different failure modes
- App B of Design Guide gives results in full
Compression members

\( R_n \) is calculated using the measured material and geometrical properties

\[ R_{\text{measured}} / R_n \]

\( \lambda \)

\( \Phi = 0.9 \)

- \( \text{Austenitic Test Results} \)
- \( \text{Duplex Test Results} \)
$R_n$ is calculated using the measured material and geometrical properties.

Members subject to LTB
Resistance/safety factors

Use carbon steel resistance factors

except

Round HSS in compression  \( \phi_{ss} = 0.85, \phi_{cs} = 0.90 \)

Fillet Welds  \( \phi_{ss} = 0.60, \phi_{cs} = 0.75 \)
Summary

- AISC Design Guide: Structural Stainless Steel….*to be published early 2013*

- In the future…….
  - As research becomes available, extend scope (shear buckling, HSS connections, angles, slip critical connections, composite members….)
  - Refine rules to be less conservative