STAINLESS STEEL IN STRUCTURES

DESIGN RULES IN AISC DESIGN GUIDE FOR STRUCTURAL STAINLESS STEEL

ORGANISED BY:

SCI Steel Knowledge

SPONSORED BY:

Nickel INSTITUTE

euro inox The European Stainless Steel Development Association

IMOA INTERNATIONAL MOLYBDENUM ASSOCIATION THE VOICE OF THE MOLYBDENUM INDUSTRY

icda

OUTO KUMPU

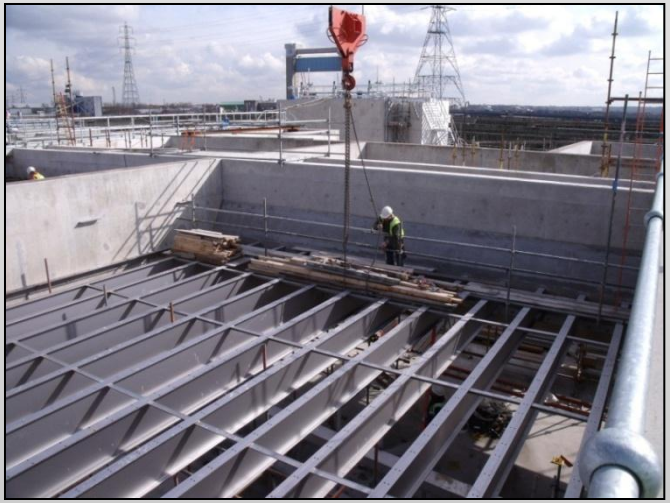
ISSF

Before

After

Photos: Stainless Structurals

Industrial structures



Building & architectural structures

Bridges

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 > 3mm
- 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

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

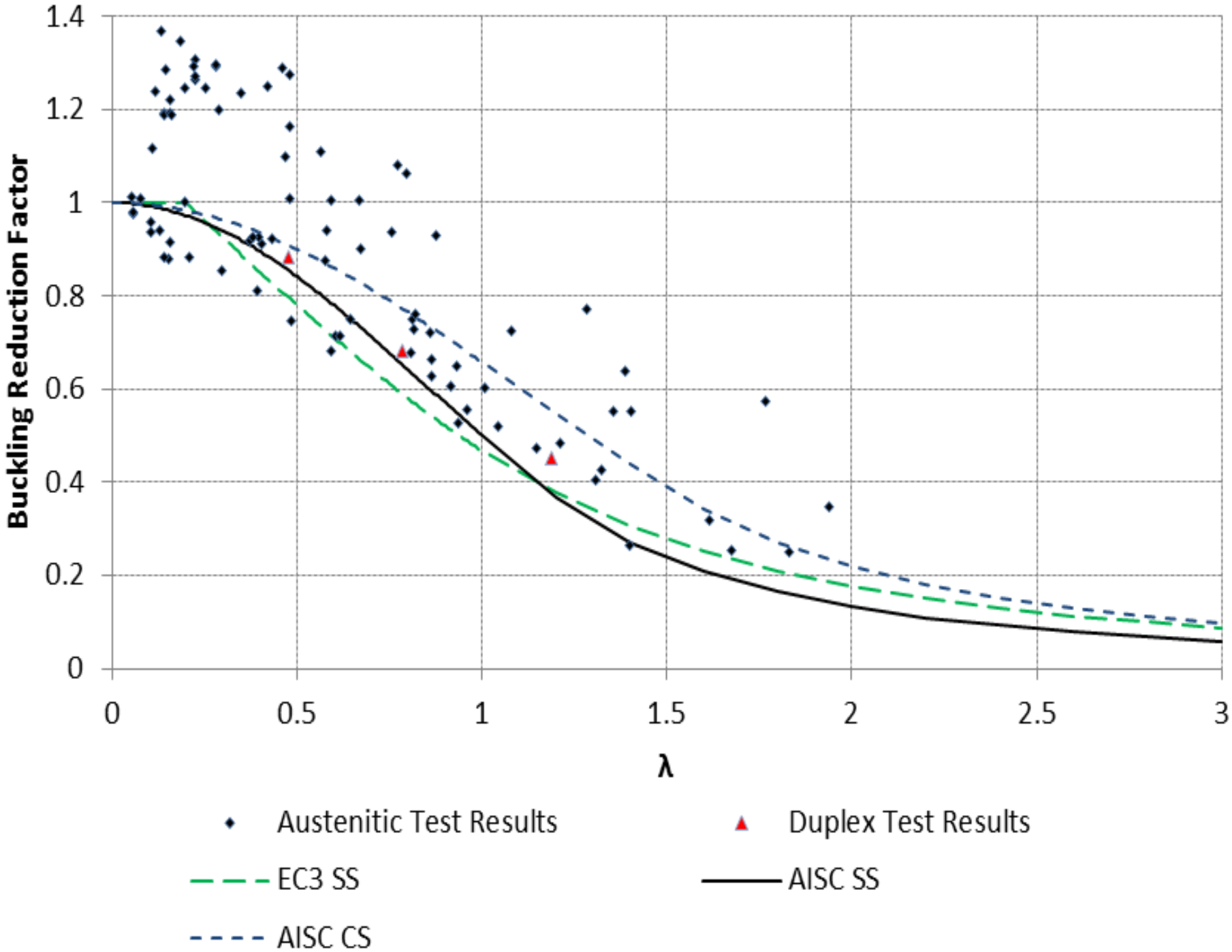
- Comprehensive reliability analysis
- Followed protocol adopted for AISC 360

$$\beta = \frac{\ln\left(R_m / Q_m\right)}{\sqrt{V_R^2 + V_Q^2}} \longrightarrow \phi = \frac{1.481 M_m F_m P_m}{\exp\left(\beta\sqrt{V_R^2 + V_Q^2}\right)}$$

Target Reliability:
β=2.6 for Members, β=3.5 for connections

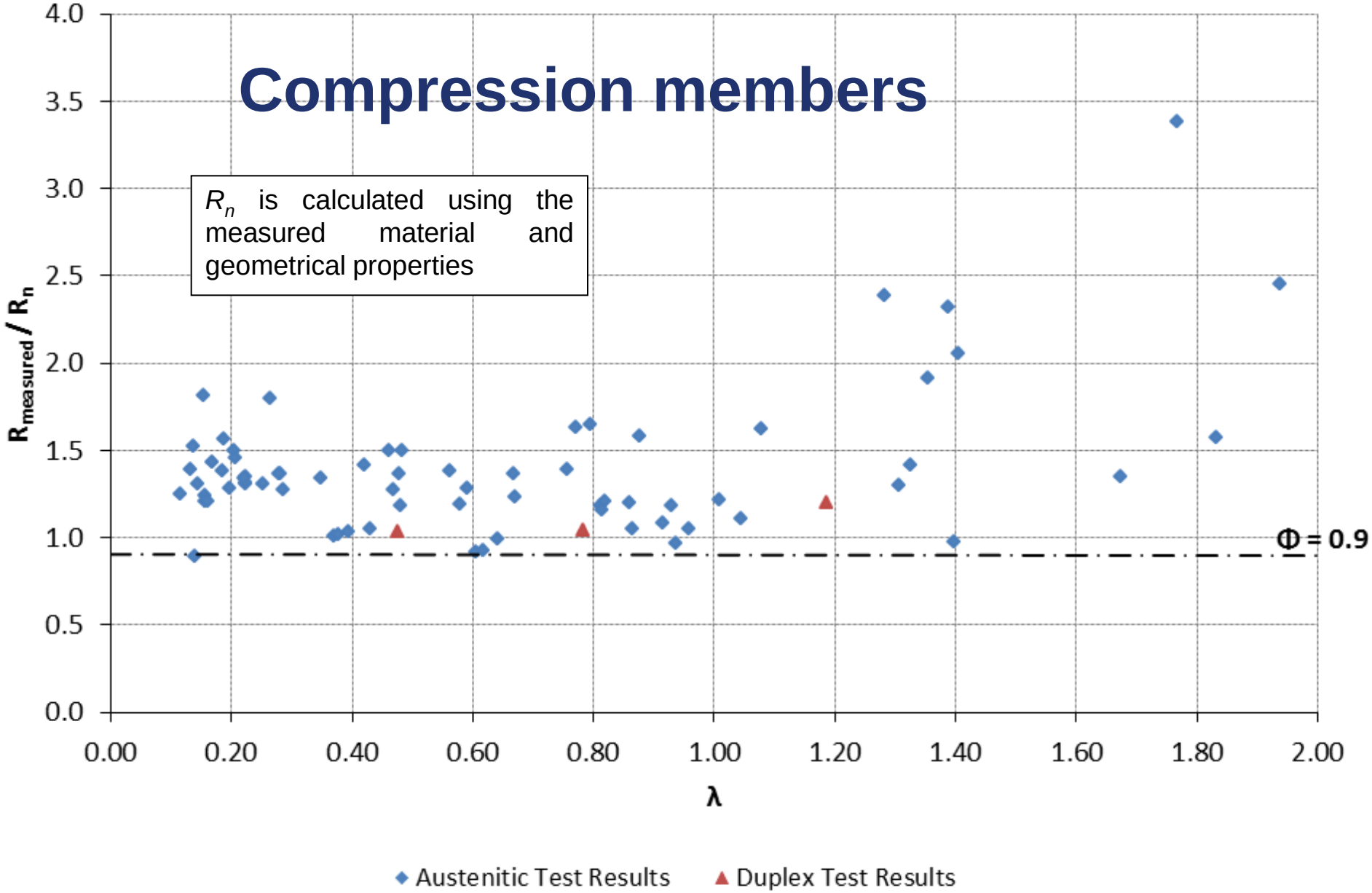
Resistance/safety factors

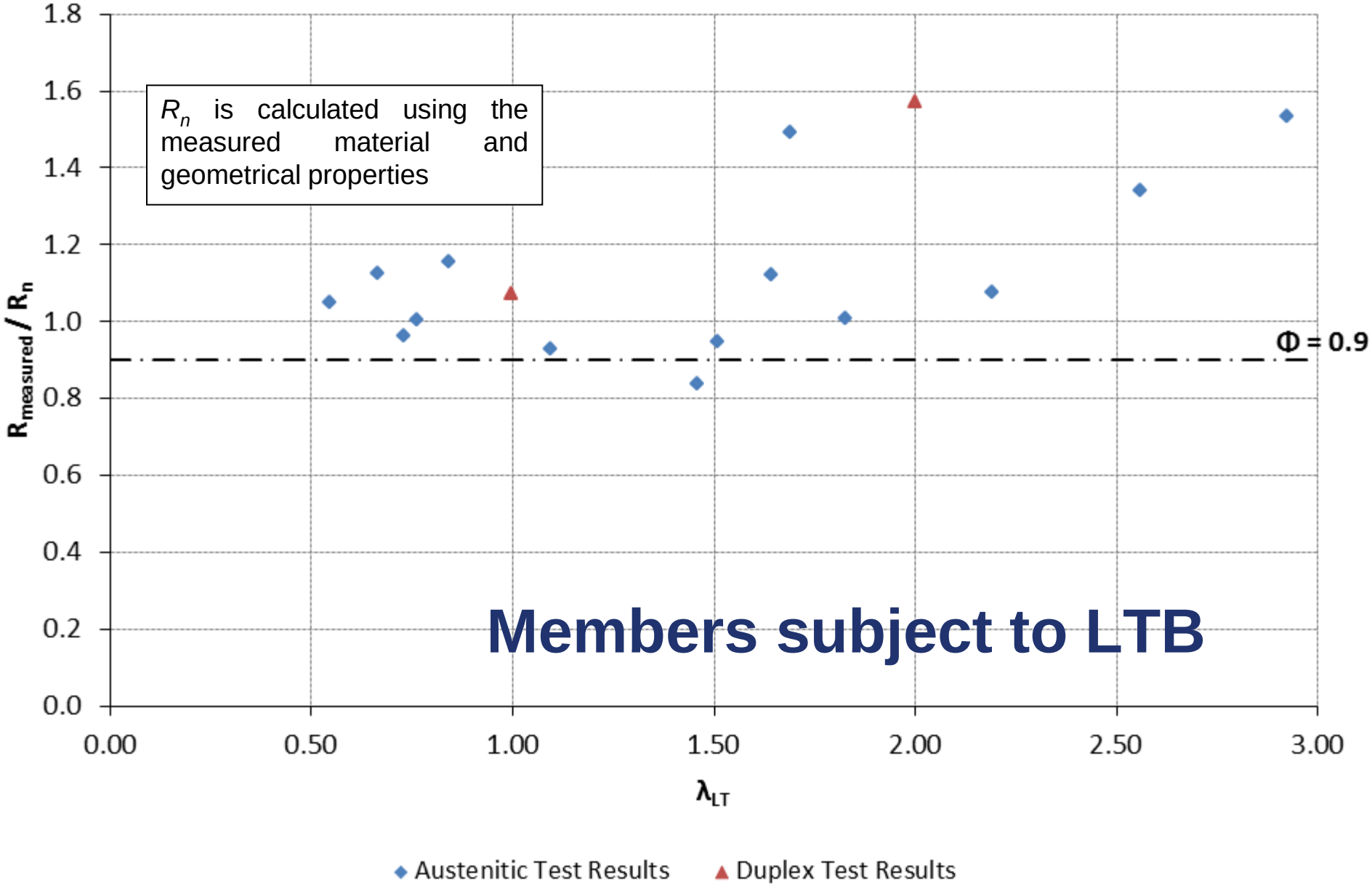
- Statistics on material data and geometrical variations of sections
  Mean and **Scatter** both impact the resistance factor
- Database of all (known) test results worldwide on stainless structural sections
- Analysed different failure modes
- App B of Design Guide gives results in full


1.4
1.2
1
0.8
0.6
0.4
0.2
0
Buckling Reduction Factor
0
0.5
1
1.5
2
2.5
3
λ
Austenitic Test Results
Duplex Test Results
EC3 SS
AISC SS
AISC CS

Compression members

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