Potential new directions in research on stainless steel structures

Stainless Steel in Structures - 5th International Experts Seminar

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Materials

Analysis

Design provisions

Applications

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Materials

Alloys

- Duplex grades
- Increasingly recognised and accepted structurally
  - Strength
  - Fatigue
  - Corrosion
- High/ultra-high strength stainless steel alloys for structural applications

Added manufacturing

- High value add
- Complicated geometries
- Optimisation
- Composite solutions

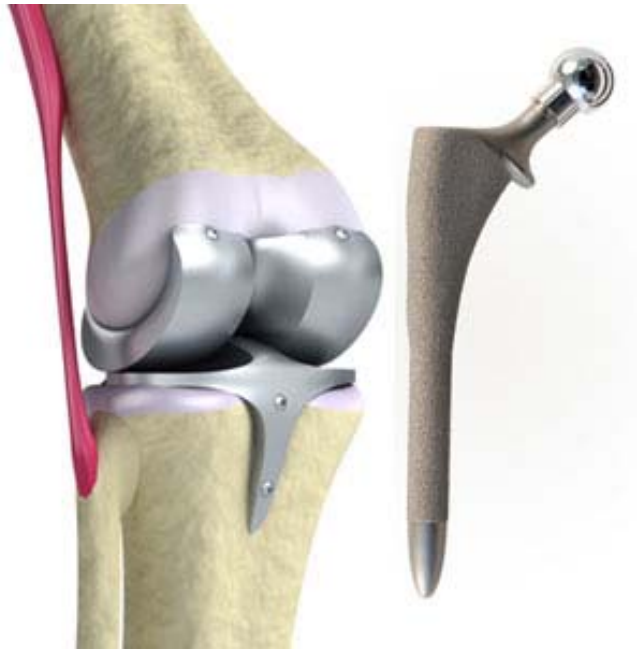
Materials

Extreme events

- Seismic – China and New Zealand
- Blast – ductility and strain hardening
- Low/high temperature properties

Biomedical?

- Joints
- Stents



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Analysis

Direct Design Method (DDM)

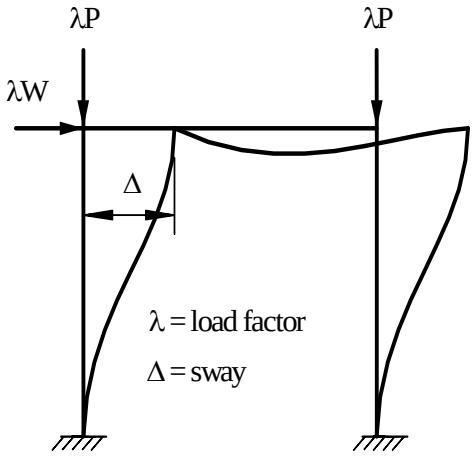
- Design stainless steel structures by advanced (GMNIA) analysis

$$\phi_s R_n \geq \sum \gamma_i Q_{ni} \qquad \frac{R_n}{\gamma_{Ms}} \geq \sum \gamma_i Q_{ni}$$

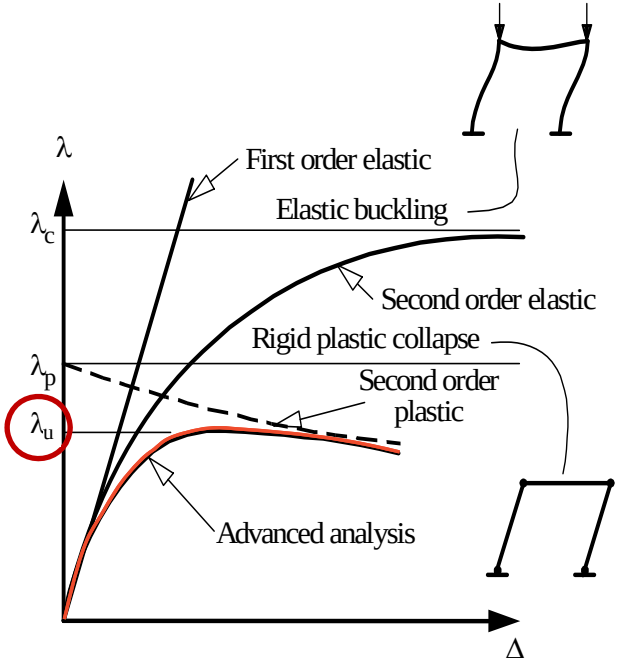
- Design check: $\phi_s \lambda_u \geq 1 \rightarrow \lambda_u \geq 1/\phi_s$ or $\lambda_u/\gamma_{Ms} \geq 1 \rightarrow \lambda_u \geq \gamma_{Ms}$
- What is ϕ_s , or γ_{Ms}?

Research questions:

- Categorise typical stainless steel structural systems
- Determine ϕ_s / γ_{Ms} by system reliability analysis
- Define nominal model
- Include semi-rigid joints



(a) Rigid jointed sway frame



(b) Load deflection responces

Analysis

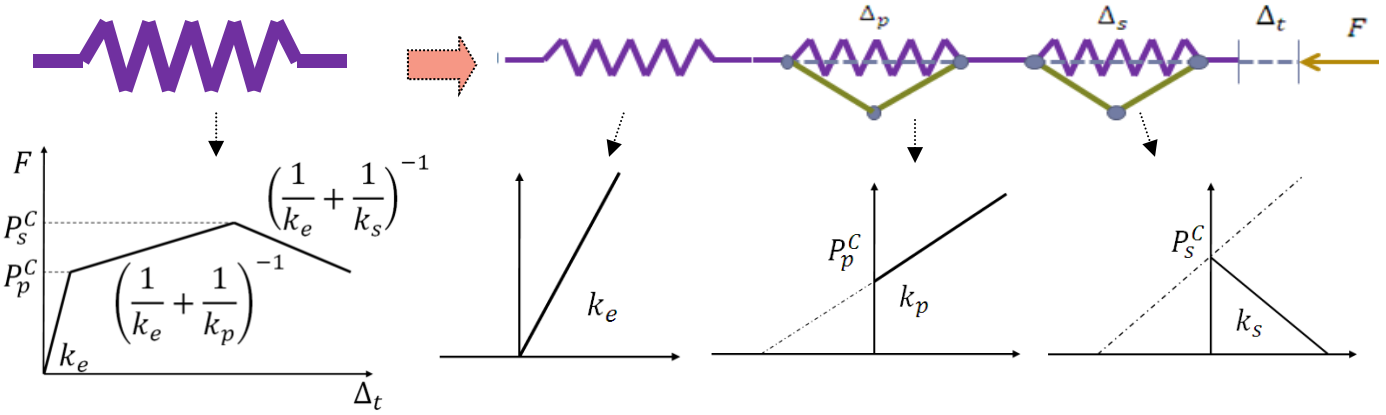
Connections – FE analysis

- Fracture of stainless steel alloys
- Constitutive models
- Implementation of constitutive models in FE software like Abaqus

Elflah, Theofanous & Dirar
Stainless Steel in Structures
London 2017

Component Method

- Inelastic component model
- Strain hardening
- Ductility



Materials

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Design provisions

Cross-sections

- Built-up sections
- Sections with holes
- Open sections:
  - Web crippling using DSM

Members

- Open sections:
  - Beams
  - Beam-columns
  - Shear
- Welded sections:
  - Identify appropriate strength curves for columns and beams as per level of residual stress and strength grade

Design provisions

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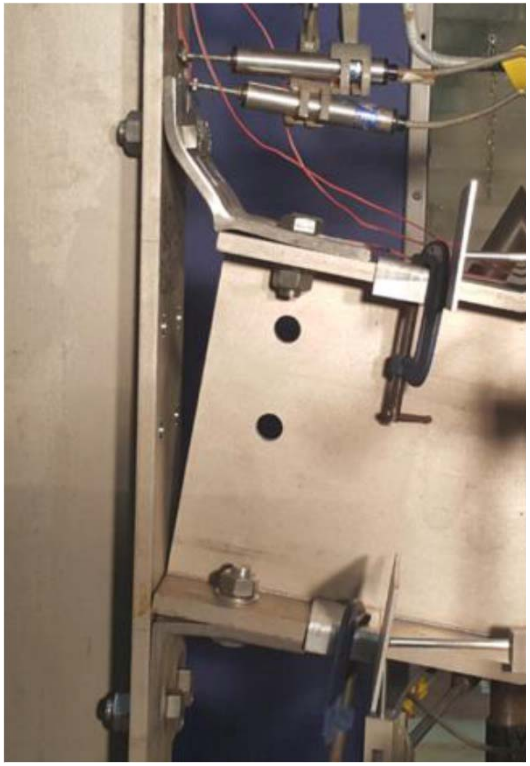

Members con't

- Concrete-filled stainless steel tubes:
  - High strength concretes
  - Seismic performance

Connections

- Hot-rolled and cold-formed steels.
  Consistent framework for component limit states for:
  - Bolted connections
  - Welded connections
- Design methods and M-theta relations for complete connections, e.g.
  - Bolted moment end-plate connections
  - Top and seat angle connections
  - Web cleat angle connections
  - Tubular connections

Materials

Analysis

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Applications

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Applications

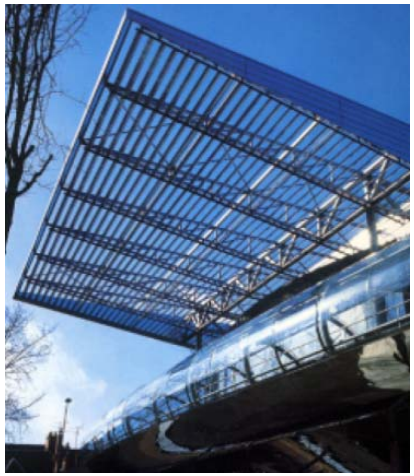
Complete systems – design guidelines

- Tubular truss and framing systems, including connections
- Portal frames
- Roofing and façade systems, (purlin and sheeting systems)
- Bridges

Sub-structural applications

- Large bridges
- Off-shore building components

Dismantlement and re-use



Thank-you

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Thank you

Nancy Baddoo and SCI

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- 2003
- 2007
- 2012
- 2017

Imperial College

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