Stainless steel in construction: Developing the European market

SCI
Steel Knowledge

10 June 2015

Nancy Baddoo



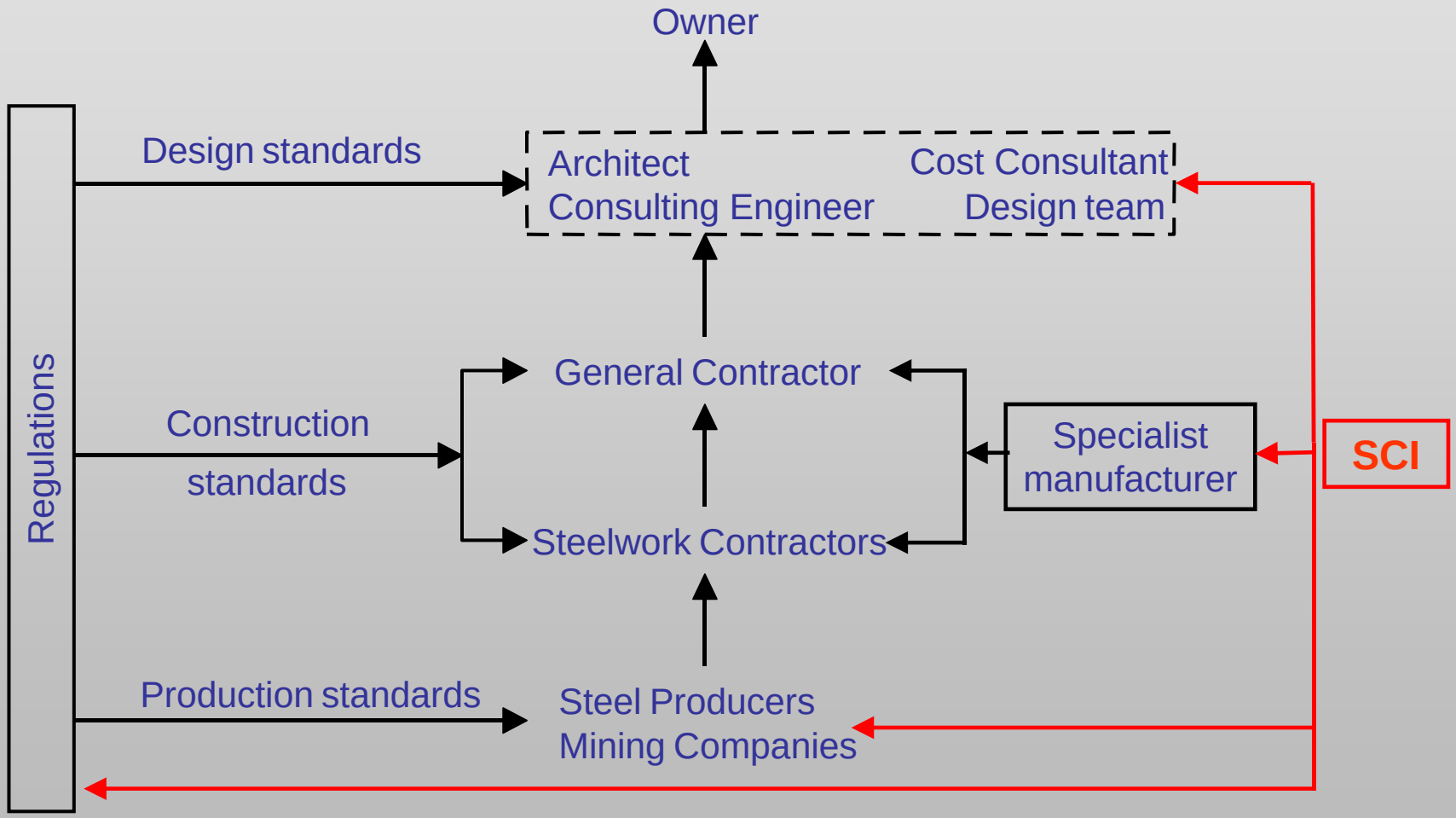

The Steel Construction Institute SCI

- Established in 1986 to develop and promote the effective use of steel in construction
- Independent member-based organisation
- Staff of 28

R&D, Publications, Standards development, Product Assessment, Engineering software, Courses, Industry Focus Groups…..

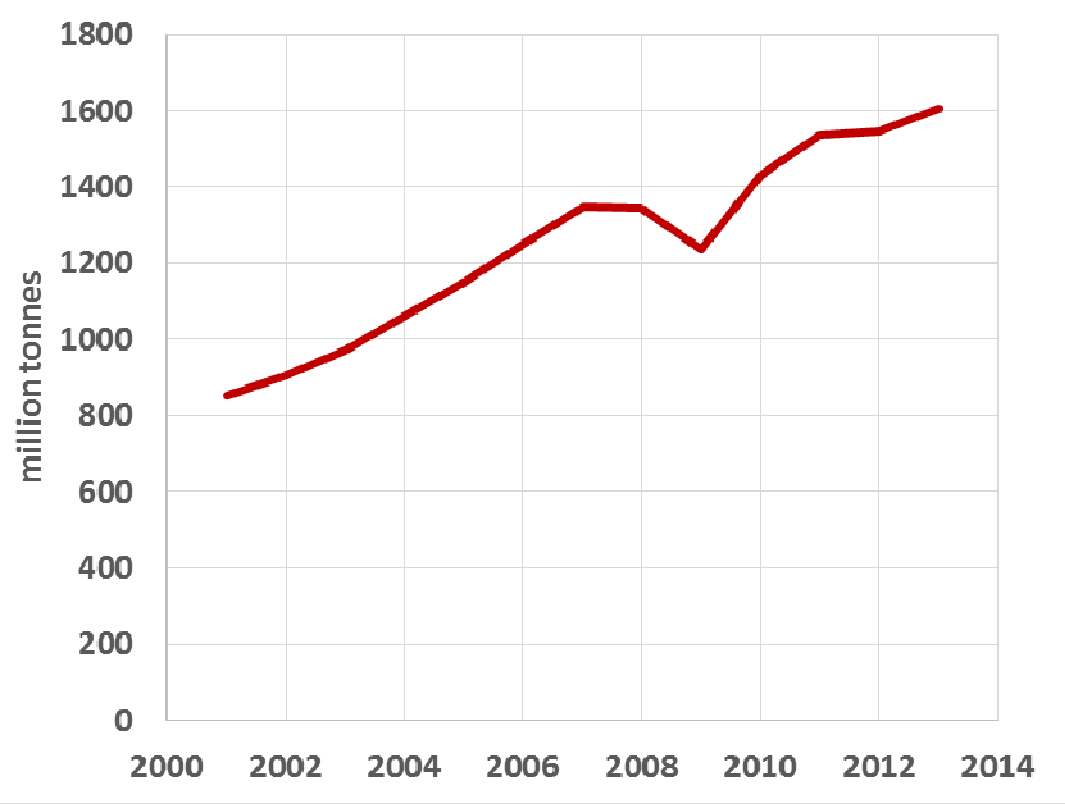
Composite construction, Connections, Fire engineering, Sustainability, Bridges, Light steel construction, Stainless steel, High strength steel….

Construction supply chain

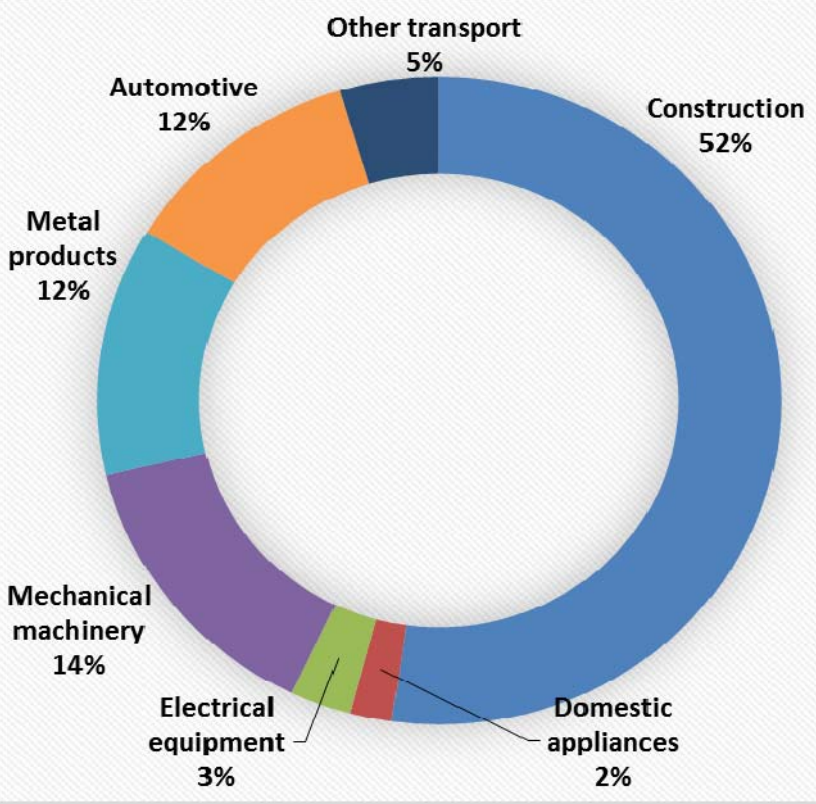


Steel

Crude Production



Consumption



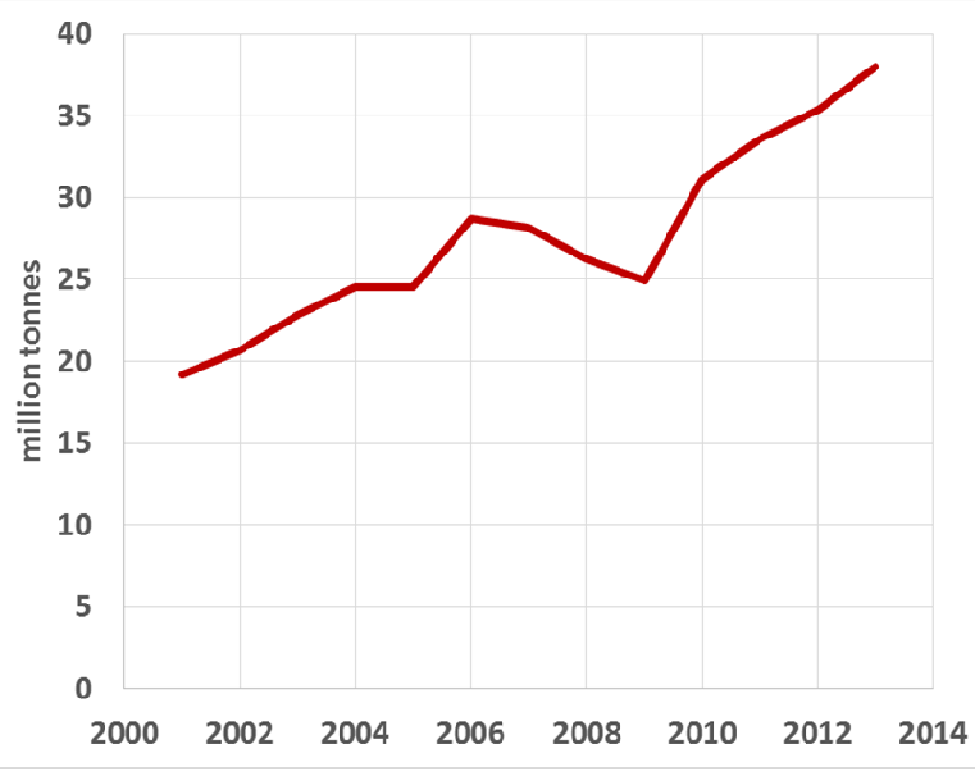
Source: World Steel 2014

2013 crude steel 1600 mt

Construction 830 mt

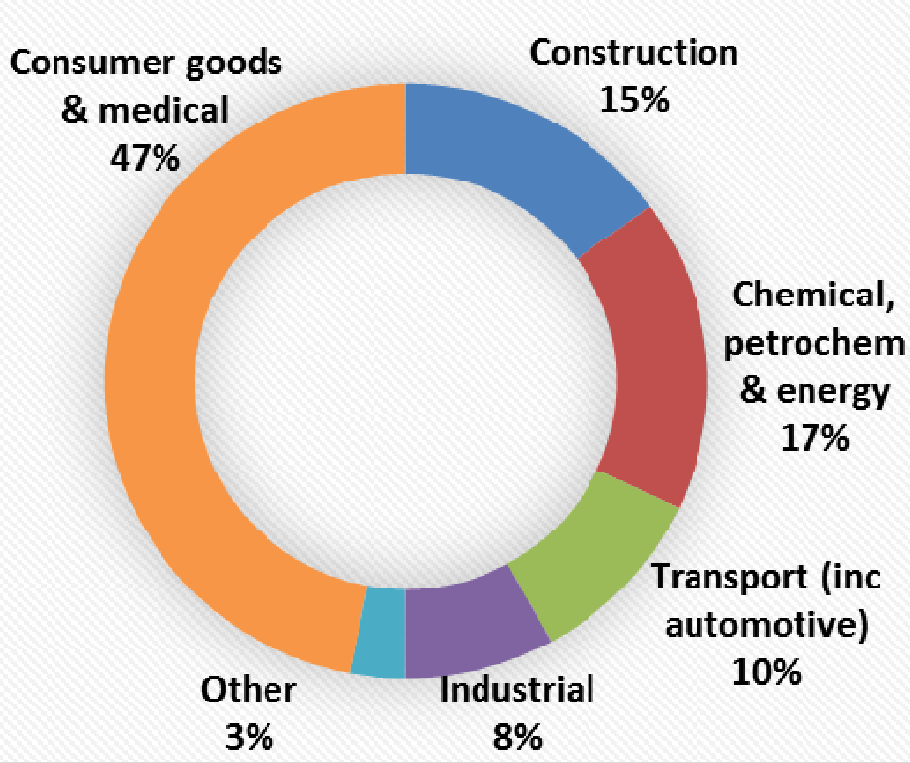
Stainless Steel

Crude Production



Source: ISSF 2014

Consumption



Source: SMR 2014

2013 crude stainless steel 38 mt

Construction 5.2 mt

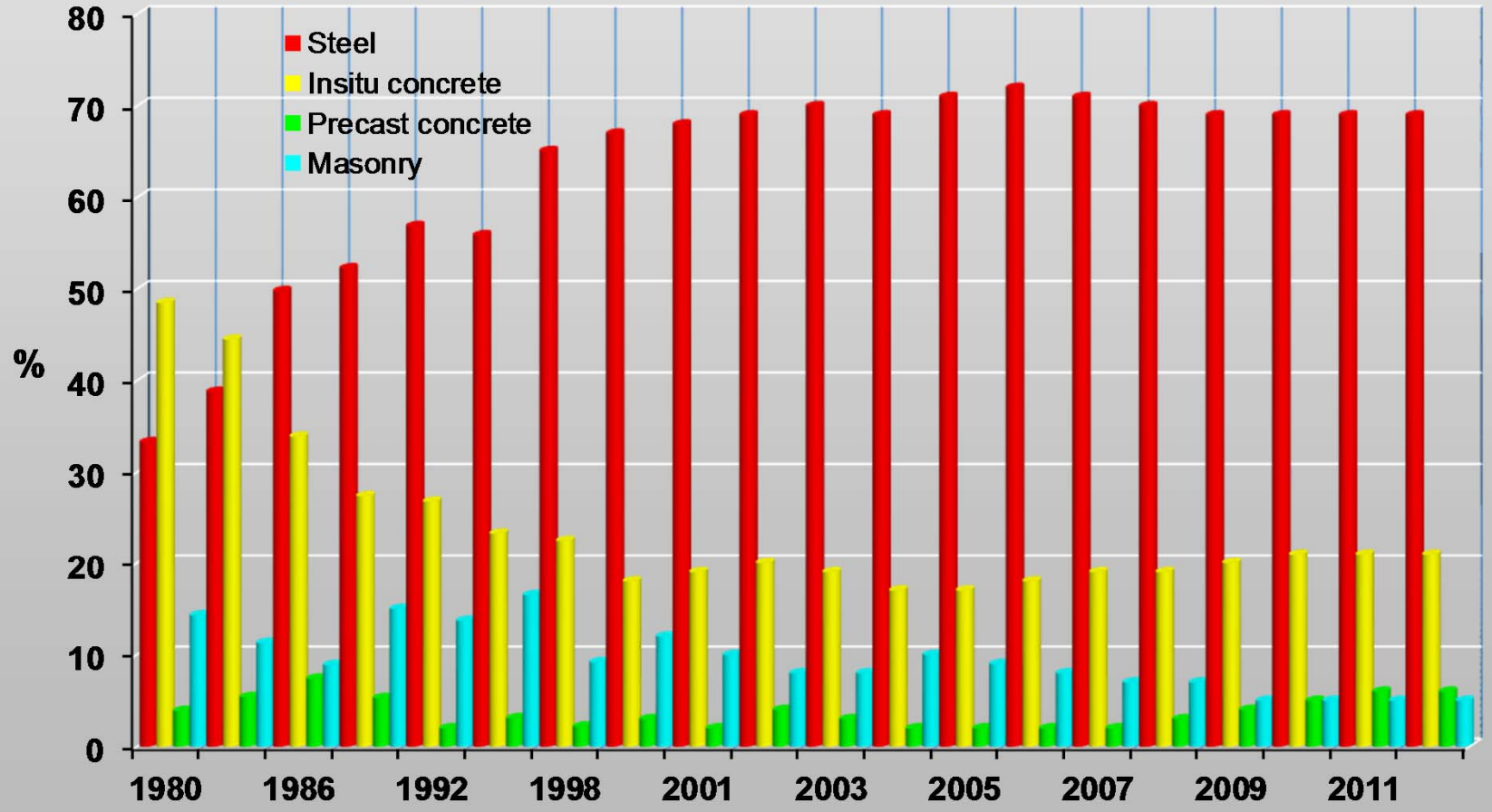
Market development strategy

For carbon steel:

- Influence specifiers in favour of steel
- Support the supply chain

  - Make design in steel easier than in other materials
  - Remove barriers (fire, corrosion, acoustics, vibrations)
  - Continuous improvement & innovation (new products, lower cost)
  - Communications publications/seminars/websites
  - Technical support

Success with Steel Construction
Multi-storey buildings in the UK



Market development strategy

For stainless steel:

- Influence specifiers in favour of stainless
- Support the supply chain

  - Make design in steel easier than in other materials
  - Remove barriers
  - Continuous improvement & innovation (new products, lower cost)
  - Communications (publications/seminars/websites)
  - Technical support

Cost considerations

- Initial cost of stainless steel is high
- Dependent on the cost of alloying elements
- Whole life cost should be considered

Life cycle cost analyses show that stainless steel can be the cheapest option compared to materials requiring more maintenance

Before

After

Thames Gateway Water Treatment Works

- The UK’s first desalination plant (2010)
- Stainless steel grillage supports filtering tanks

Interserve

Thames Gateway Water Treatment Works

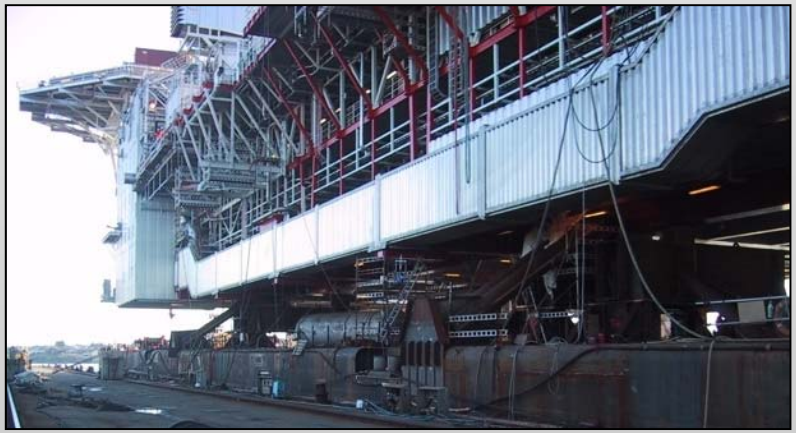
78 stainless steel I beams in duplex 2205, 20 m long

low maintenance and durable in brackish water

Increased material cost of stainless steel offset by:

- Reduced risk of damage to equipment (£7m/$11m desalination membranes)
- Low maintenance requirements
- No applied coating
- Greater assurance of water quality throughout the plant's design life

Structures for water, wastewater, petrochem, food & drink, nuclear industries



Tanks for water, wastewater, chemical, pharmaceutical, food & drink, biogas…

Building structures

Building envelope and sculpture

Bridges and tunnels

What do specifiers need?

- Design standards & supporting guidance
- Design examples & software
- Information on product availability
- Fabrication and erection specifications
- Case studies

Eurocode 3: Part 1-4 (EN 1993-1-4)

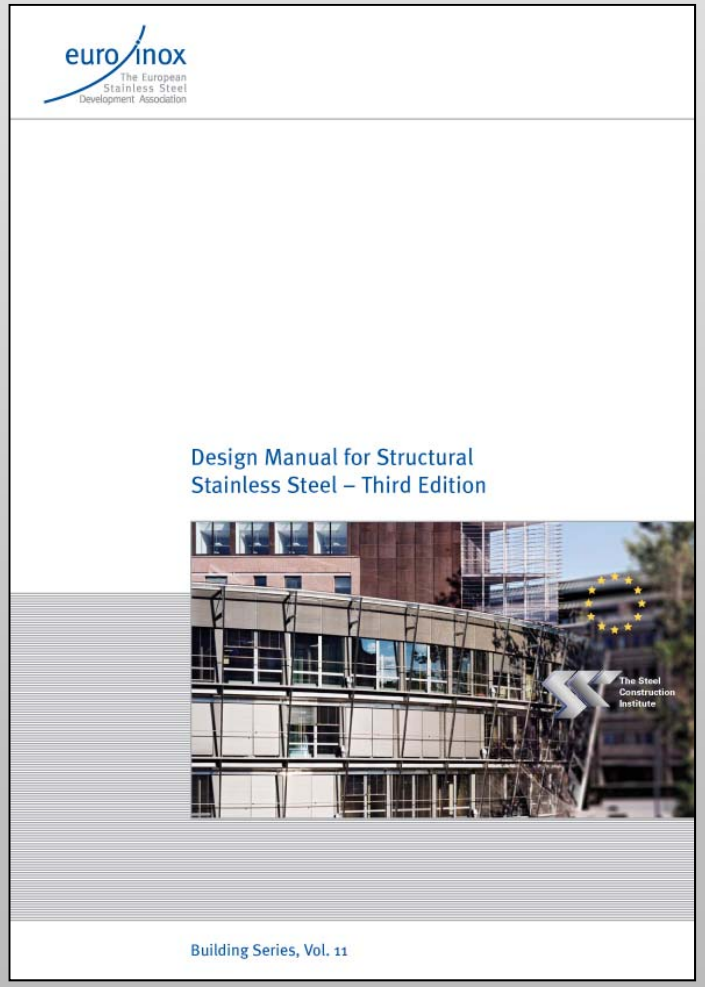
Design of steel structures.

Supplementary rules for stainless steels (2006)

- Modifies and supplements rules for carbon steel given in other parts of Eurocode 3
- Applies to buildings, bridges, tanks etc
- Austenitics, duplexes & ferritics

BREAKING NEWS: New amendment just published!

Design Guidance to Eurocodes



www.steel-stainless.org/designmanual

- Guidance
- Commentary
- Design examples

1st Edition 1993
2nd Edition 2002
3rd Edition 2006
4th Edition 2016?

EXECUTION OF STAINLESS STEEL STRUCTURES

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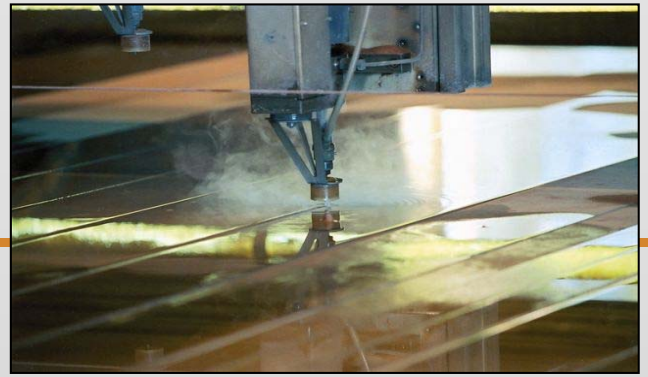
Technical Report: ED018



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Structural Case studies
www.steel-stainless.org/CaseStudies

- 12 published in English
- IMINOX have translated the first 8 into Spanish
- NI have translated all of them into Chinese


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Structural Stainless Steel Case Study 09

New Beijing Poly Plaza Cable-Net Wall

Beijing's Poly Plaza is the new headquarters for China Poly, a state-owned organisation with diverse responsibilities in the defence trade, real estate, cultural industries and mineral exploration. In addition to the company's headquarters, the 100,000 m² building comprises office space, shops and restaurants. The structure is triangular in plan, with an L-shaped office block forming two sides and the third side formed by one of the world's largest cable-net glass curtain walls. This creates a large atrium inside the structure, within which the 8 storey Poly Museum—'The lantern'—is suspended. Stainless steel cables and castings support the cable-net wall. The support fittings were cast from high strength duplex stainless steel.

Material Selection

The cable-net wall in the Poly Plaza comprises many stainless steel elements including cables, clamp fittings, connecting rods as well as the support fittings. The grades of stainless steel chosen were component-dependant, taking consideration of its function within the cable-net assembly. Accordingly, austenitic grade 1.4401 (S31600) is used for the horizontal and vertical cables whilst the cable-net intersection points are connected with high strength clamp fittings of duplex grade 1.4462 (S32205). The rods between the primary support cables and the cable-net are also austenitic grade 1.4401 (S31600) stainless steel. The support armature is cast from the high strength duplex alloy CD3MN (J92205), which is the cast version of duplex grade 1.4462.

Stainless steel was selected primarily because of its high strength and corrosion resistance. In addition, its pleasing appearance and low maintenance needs were further advantages. Beijing has a corrosive environment with high levels of industrial pollution and there has been a significant rise in the use of de-icing salt in the winter. Specification of corrosion resistant stainless steels made it possible to avoid high maintenance coatings. Additionally, the bare stainless steel is a sculptural, structural design element. Low corrosion rates of stainless steels contribute to the efficiency of the design. Furthermore, the high scrap value of stainless steel makes the building sustainable even beyond its useful life.

The material specifications included a requirement that the surface of each cable was free of defects such as soot, cracks, notches, etc. A light shot blast finish was specified for the elements made from grades 1.4401 and 1.4462.

Figure 1: Beijing Poly Plaza (Photo: Tim Griffiths, Skidmore, Owings & Merrill LLP)

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Structural Stainless Steel Case Study 10

Schubert Club Band Shell

The Schubert Club Band Shell is an outdoor venue for performing arts on Raspberry Island, in the middle of the Mississippi River in St Paul, Minnesota. It was commissioned by the Schubert Club and completed in 2002. The island had been neglected for many years before the Band Shell was built but now offers generous pedestrian walkways, unique and scenic vistas as well as a central location. The structure itself is saddle-shaped (anticlastic) and brings together concrete, wood, stainless steel and laminated glass to create a functional space. The design team developed a 7.6 m wide stainless steel lattice grid that spans 15.2 m between precast concrete abutments and covers a wood-framed stage. Acid-etched glass is offset from and supported by the lattice.

Material Selection

Figure 1: General view of Schubert Club Band Shell

The overall design was influenced by the surrounding area which is subject to flooding as well as deicing salts. This precluded the use of closed shapes and also meant that the structure needed to be corrosion resistant. Furthermore, it needed to have a robust base in order to resist impact from flood-borne debris. These factors, coupled with the desire to create a low-maintenance but architecturally significant structure, led the designers to choose stainless steel for the lattice. The Schubert Club hoped for a unique structure that would draw people to the island and establish the area as an important public venue.

All lattice components as well as the interface plates are made from austenitic grades 1.4404 (S31603) and 1.4301 (S30400). Stiffening beams, also made from grade 1.4404, are used at the edges of the lattice. These grades were selected due to concerns about the material coming into contact with airborne deicing salts from adjacent overhead roadways. De-icing salts contain chlorides that may cause lower alloyed grades of stainless steel to corrode.

Figure 2: View of the stainless steel members and node point in the band shell (Photo: James Carpenter Design Associates and Shane McCormick)

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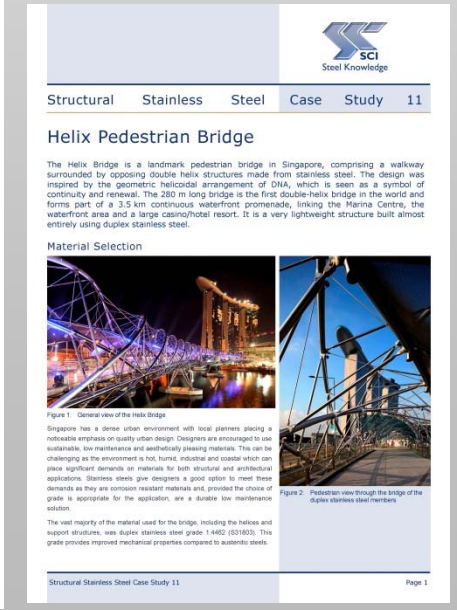
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Helix Pedestrian Bridge

The Helix Bridge is a landmark pedestrian bridge in Singapore, comprising a walkway surrounded by opposing double helix structures made from stainless steel. The design was inspired by the geometric helicoidal arrangement of DNA, which is seen as a symbol of continuity and renewal. The 280 m long bridge is the first double-helix bridge in the world and forms part of a 3.5 km continuous waterfront promenade, linking the Marina Centre, the waterfront area and a large casino/hotel resort. It is a very lightweight structure built almost entirely using duplex stainless steel.

Material Selection

Figure 1: General view of the Helix Bridge

Singapore has a dense urban environment with local planners placing a noticeable emphasis on quality urban design. Designers are encouraged to use sustainable, low maintenance and aesthetically pleasing materials. This can be challenging as the environment is hot, humid, industrial and coastal which can place significant demands on materials for both structural and architectural applications. Stainless steels give designers a good option to meet these demands as they are corrosion resistant materials and, provided the choice of grade is appropriate for the application, are a durable low maintenance solution.

The vast majority of the material used for the bridge, including the helices and support structures, was duplex stainless steel grade 1.4462 (S31803). This grade provides improved mechanical properties compared to austenitic steels.

Figure 2: Pedestrian view through the bridge of the duplex stainless steel members

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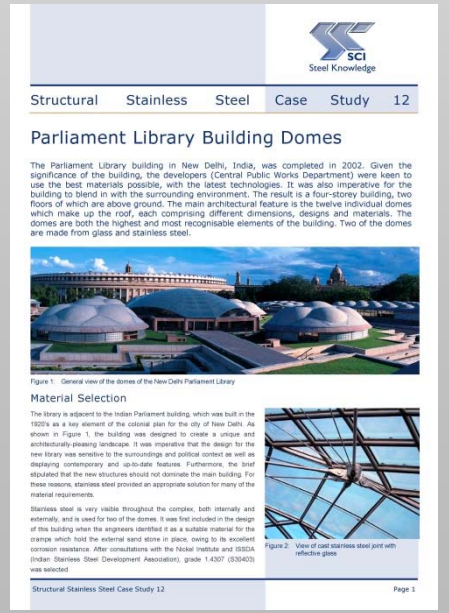
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Parliament Library Building Domes

The Parliament Library building in New Delhi, India, was completed in 2002. Given the significance of the building, the developers (Central Public Works Department) were keen to use the best materials possible, with the latest technologies. It was also imperative for the building to blend in with the surrounding environment. The result is a four-storey building, two floors of which are above ground. The main architectural feature is the twelve individual domes which make up the roof, each comprising different dimensions, designs and materials. The domes are both the highest and most recognisable elements of the building. Two of the domes are made from glass and stainless steel.

Figure 1: General view of the domes of the New Delhi Parliament Library

Material Selection

The library is adjacent to the Indian Parliament building, which was built in the 1920's as a key element of the colonial plan for the city of New Delhi. As shown in Figure 1, the building was designed to create a unique and architecturally-pleasing landscape. It was imperative that the design for the new library was sensitive to the surroundings and political context as well as displaying contemporary and up-to-date features. Furthermore, the brief stipulated that the new structures should not dominate the main building. For these reasons, stainless steel provided an appropriate solution for many of the material requirements.

Stainless steel is very visible throughout the complex, both internally and externally, and is used for two of the domes. It was first included in the design of this building when the engineers identified it as a suitable material for the cramps which hold the external sand stone in place, owing to its excellent corrosion resistance. After consultations with the Nickel Institute and ISSDA (Indian Stainless Steel Development Association), grade 1.4307 (S30403) was selected.

Figure 2: View of cast stainless steel joint with reflective glass

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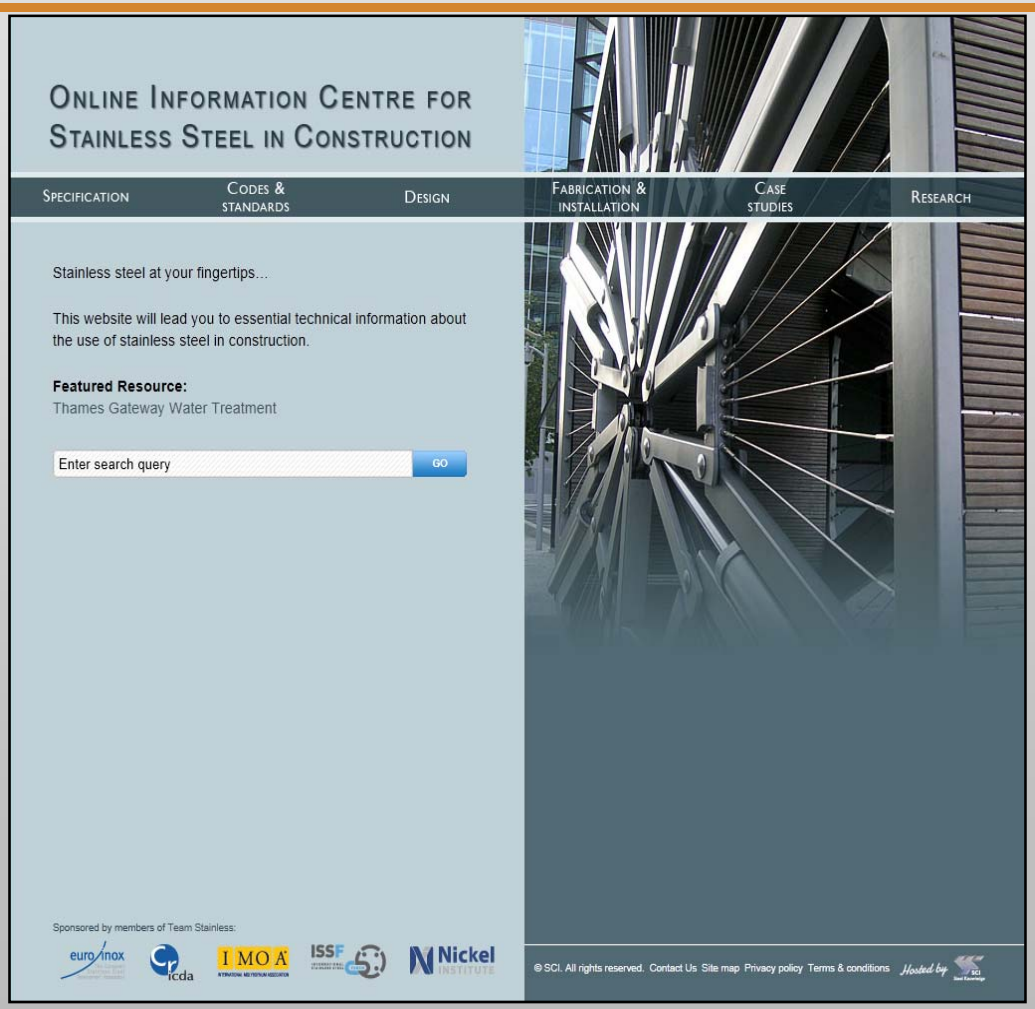
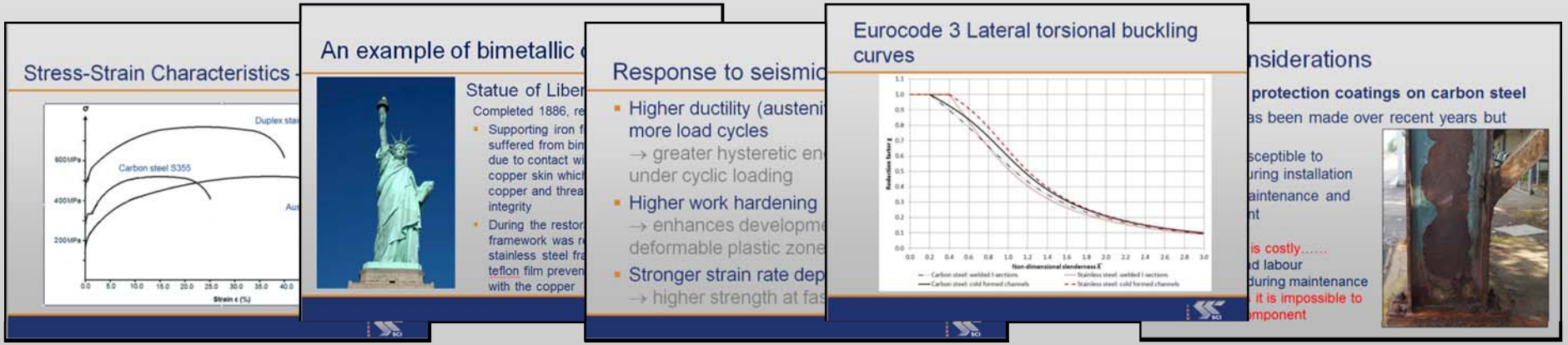
Stainless in Construction Information Centre

www.stainlessconstruction.com



Supporting students and researchers



University lecture materials for structural stainless steel design

International Experts Seminar
1998, 2003, 2008, 2012

29 May 2015

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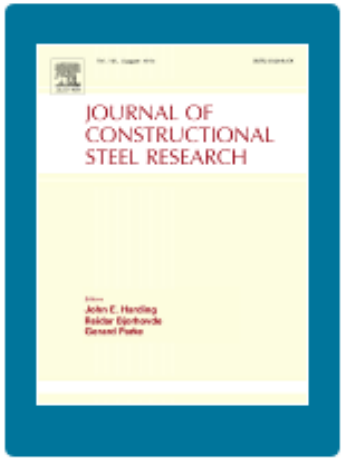

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November 2012

J.G. Teng | T. Yu | D. Fernando

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Share Article

2. Stainless steel in construction: A review of research, applications, challenges and opportunities

November 2008

N.R. Baddoo

Stainless steel has unique properties which can be taken advantage of in a wide variety of applications in the construction industry. This paper reviews how research activities over the last 20 years...

Dissemination

Continuing research

Recent & current EU collaborative research:

- Structural ferritic stainless steels
- Stainless biogas tanks
- Stainless bolted connections

Design brochures

Structural design of ferritic stainless steels


Stainless Steel

Technical information sheet ED023

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Structural Design of Ferritic Stainless Steels

This information sheet is written for engineers and architects and gives guidance on the structural design of ferritic stainless steels. Much of the information was developed as part of the EU's Research Fund for Coal and Steel project *Structural Applications of Ferritic Stainless Steels (SAFSS)*. This was a three year research project which was completed in 2013. The project partners included stainless steel producers, research institutes, universities and design consultants. Through experimental tests, field trials and numerical analysis, the project developed design guidance for a group of ferritic stainless steels which are suitable for structural applications.

Key advantages of ferritic stainless steels

- Good atmospheric corrosion resistance.
- High yield strength relative to carbon steel S275 and austenitic stainless steels.
- Less non-linear yielding behaviour compared with the austenitic grades.
- Lower cost than other grades of stainless steel of equivalent corrosion resistance.
- Easier to roll form and achieve tighter bends, and less weld distortion, compared to austenitic stainless steels.

Summary

Ferritics are a family of stainless steels which are low cost, price-stable and versatile. They display considerably better atmospheric corrosion resistance than carbon steels, as well as having good ductility and formability. Their structural performance in terms of strength and stiffness lies between that of carbon steel and the more highly alloyed stainless steel austenitics and duplexes. These factors combine to make ferritic stainless steel a cost effective and versatile material to many light gauge galvanized steel applications such as purlins, cladding rails, service support systems, and composite floor decking. The Summary Final Report and detailed reports for each work package of the SAFSS project, from which this technical information is derived, can be downloaded from www.steelstainless.org/ferritics.

SAFSS Project Partners

The Steel Construction Institute (SCI) www.steel-sci.com United Kingdom

VTT Technical Research Centre of Finland www.vtt.fi Finland

Aperam Stainless France www.aperam.com France

IMI www.imi.si Slovenia

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1

Stainless steel tanks for biogas production


Stainless Steel

Technical information sheet ED023

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Stainless steel tanks for biogas production

Key advantages of ferritic stainless steels

Summary

Coming soon!

1

Sponsors

European stainless steel producers	outokumpu, aperam, Industeel, ACERINOX
Euro Inox	euro inox – The European Stainless Steel Development Association
Nickel Institute	Nickel INSTITUTE
International Molybdenum Association	IMOA – INTERNATIONAL MOLYBDENUM ASSOCIATION
International Stainless Steel Forum	ISSF – INTERNATIONAL STAINLESS STEEL FORUM
International Chromium Development Association	icda
National stainless steel development associations	SSN – STOWARZYSZENIE STAL NIERDZEWNA; BSSA

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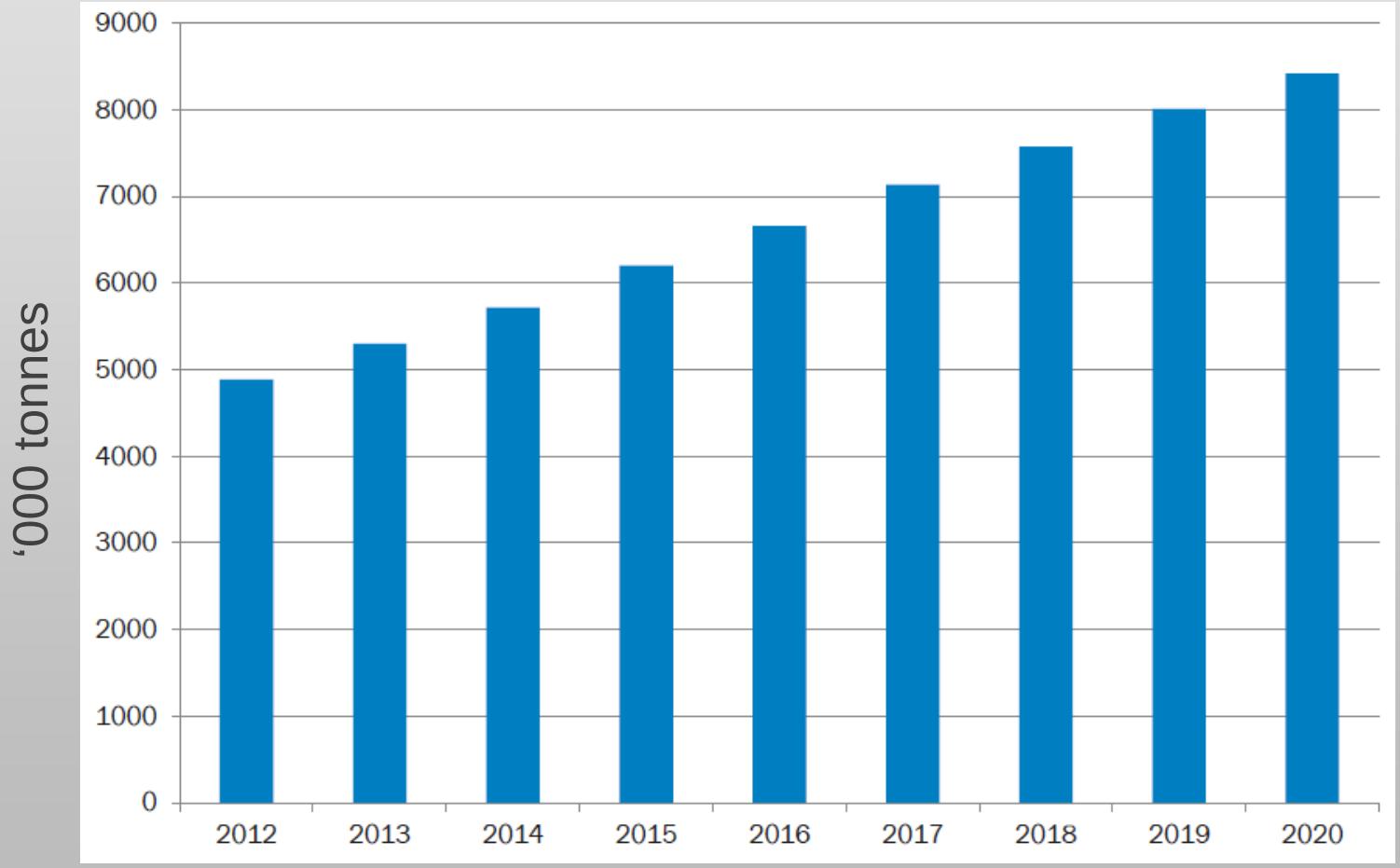
What are the prospects for stainless steel in construction?

How do we realise them?

Stainless Steel in Construction



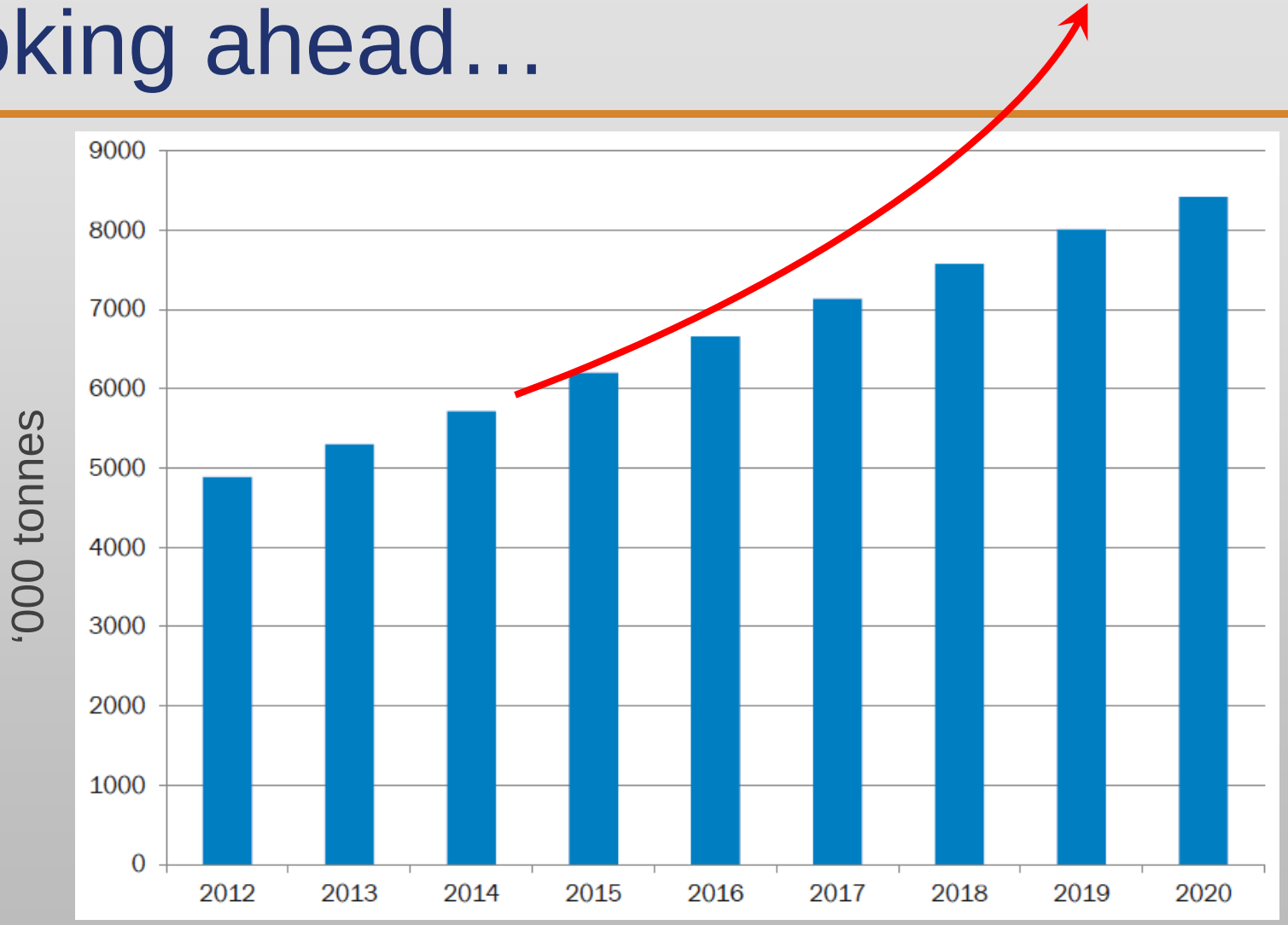
Source: SMR 2014

Prospects for Stainless Steel in Construction
Looking ahead…

- Innovative new products; e.g.
  - Structures in nuclear power plant
  - Exploit durability, ductility, aesthetics
- Sustainability and life cycle cost
- Research to improve design standards
- Reach the right audience

Prospects for Stainless Steel in Construction

Looking ahead…



Source: SMR 2014


Thank you…