STAINLESS STEEL AND SUSTAINABLE CONSTRUCTION

Special BSSA Report - February 2004

BSSA

Introduction

Sustainability is no longer the preserve of a small group of environmental lobbyists. It has moved into the social and political mainstream, influencing government policy and legislation, investment decision-making and consumer choice. The subject is complex and the issues challenging, but there is no doubt that 'business as usual' without reference to sustainability is no longer a viable option.

This Special Report seeks to provide architects and other construction specifiers with an overview of stainless steel and sustainable construction. It sets the context for sustainable development and describes how stainless steel is being used to help deliver sustainable building solutions. It also seeks to assist companies in the stainless steel supply chain to identify and respond to the new challenges and opportunities presented by the sustainability agenda.

What is sustainable development?

One of the easiest ways to understand sustainable development is to consider the legacy that we leave to those who follow us. Whether through environmental pollution, depletion of non-renewable resources or social inequity, we need to understand the impacts that our actions today will have on the opportunities for future generations to develop and live healthy, happy and full lives.

Few now doubt the need for more sustainable development; in fact *The World Wildlife Fund* estimates that three Planet Earths would be required to support the current world population, at a standard of living which matches that enjoyed in the UK.

Why is construction important?

Construction is an important industry for achieving sustainable development, both because of its contribution to the UK economy, around 8% of GDP, and because of the significant environmental and social impacts that the built environment has on everyone's quality of life.

We spend around 90% of our lives in buildings and whether we are at home, at work, in education or at leisure, we all use and rely on the outputs from the construction industry. Furthermore our quality of life and even our productivity can actually be improved by enhancing the quality of the buildings in which we live and work.

The challenge is for the construction industry to move towards socially and environmentally responsible policies whilst, at the same time, maintaining economic viability. Many leading companies are doing just this and in doing so are creating new markets and opportunities to meet the needs of a rapidly changing world.

Delivering sustainable construction using stainless steel

Stainless steels are high-tech materials (alloys) developed for a range of demanding, modern applications and environments.

The greater awareness and growing appreciation of the long-term benefits of stainless steel is reflected in the sustained growth in the global production of stainless steel from 1 million tonnes in 1950 to more than 20 million tonnes today. An estimated 16% of the UK market for primary stainless steel products (plate, sheet, bars, tubes etc) is used in the construction sector (2002).

The versatility of stainless steel is reflected in the wide range of products used in the built environment that includes:

Building Exteriors: Façades; roofing, balustrades; street furniture; sculptures; lighting columns; guttering & drainage; walkways

Building Interiors: Window & door fittings; lift panels; architectural metalwork; swimming pool fixtures & linings

Structural Applications: columns & column cladding; brickwork support; lintels, wall ties; fire protection

Services: lifts, escalators, heating & ventilation systems; hot and cold water pipes; solar panels; water storage tanks; work surfaces; kitchen equipment

Civil engineering: bridge parapets; concrete reinforcement, tunnel linings; anchorages and fixings

In 1999 the 70-year old entrance canopy at London's Savoy Hotel was cleaned, repaired and re-installed after the fire at the Savoy Theatre alongside (Courtesy of Outokumpu Stainless)

The most common stainless steels used in construction are the austenitic grades 1.4301 (304) and 1.4401 (316). The ferritic grade 1.4016 (430) is also sometimes used for interior applications, and more specialised grades, such as the duplex steel 1.4462 (2205) for applications where a combination of higher strength and resistance to corrosion is required.

Stainless steels offer architects, designers, engineers, contractors and clients a unique combination of material and aesthetic qualities that are routinely used to deliver sustainable construction solutions.

Excellent corrosion resistance

The one key characteristic that all stainless steels share is that they contain at least 10.5% chromium. Oxygen in the atmosphere reacts with the chromium to produce a very thin, inert, self-healing layer of chromium oxide that protects the steel from corrosion.

Stainless steel's corrosion resistance is utilised in numerous offshore, chemical processing and other aggressive industrial applications, where less resilient materials would not survive or would require onerous maintenance programmes.

This excellent corrosion resistance avoids the need for metallic and organic coatings such as zinc and PVC coatings or paints, which can leach into the environment with potentially harmful impacts.

Structural efficiency

Stainless steels also offer high strength and good strength-to-weight ratios. These mechanical properties are exploited in applications such as roofing and cladding, where thinner cross-sections enable stainless steel to compete with 'lightweight' materials, such as aluminium.

Where strength and corrosion resistance need to be combined, stainless steel is also used in applications which are hidden from the eye, such as the brickwork support systems used in the upper levels of multi-storey buildings.

Long-term durability

Stainless steel's mechanical properties, coupled with its corrosion resistance, yield a material that is highly durable and therefore extremely long-lived. Early applications of stainless steel cladding such as the Chrysler Building in New York (1930) and London's Savoy Theatre (1929) demonstrate that externally exposed stainless steel can retain both its functional performance and beauty after more than 80 years in use, with little or no maintenance.

In sustainability terms, durable, long-lived buildings and structures can represent substantial savings in both cost and resources, by avoiding the need for maintenance and the replacement of building components. In short, greater value is extracted from the resources invested in the building.

North Greenwich Underground Station: stainless steel combines modern design and durability in areas of high density use (Courtesy of Euro Inox)

Low maintenance

Stainless steel's excellent corrosion resistance offers opportunities to reduce the cost of maintenance and repair over the life-cycle of building components. It can for example eliminate the need for repainting or recoating at regular intervals.

By reducing the amount of maintenance required, stainless steel construction products can lessen disruption to users as well as save the client money over the project life. The selective use of stainless steel reinforcement in concrete structures, such as motorway bridges, for example, can avoid the costly disruption and delays occasioned by repairs to areas damaged by road salts.

The surface properties of stainless steel also make it the ideal material in public areas with high intensity use, such as airports and underground stations.

100% recyclable

Recycling contributes to sustainability for three important reasons:

1. By substituting primary production, recycling avoids the depletion of non-renewable resources.
2. Producing from scrap has significantly less environmental impact than the sole use of primary resources.

3. Recycling avoids end-of-life waste disposal impacts.

Scrap at the Outokumpu Stainless melting shop in Sheffield ready for recycling into 'new' stainless steel

The positive economic value of scrap steel and the extensive, international scrap recovery and processing infrastructure, ensures that virtually all construction steel is recycled or reused when buildings are demolished. The recovery rate of steel construction products from UK demolition sites is currently 94% with 10% being reused and 84% recycled.

Stainless steel is 100% recyclable – this is important for the future because we know that we already have the technology to recycle stainless steel back into new products - indefinitely. Equally importantly the stainless steel produced today already has an average recycled content of 70%. Unlike most other common construction materials, stainless steel can also be recycled again and again without any degradation in terms of its properties or performance.

Reusability

Reuse of stainless steel offers further environmental advantage by avoiding the impacts of remelting the steel. Although not widespread, there are examples of where stainless steel street furniture and lighting columns have been dismantled and reused in new locations. The proportion of recovered products that are reused will increase as design for decon-

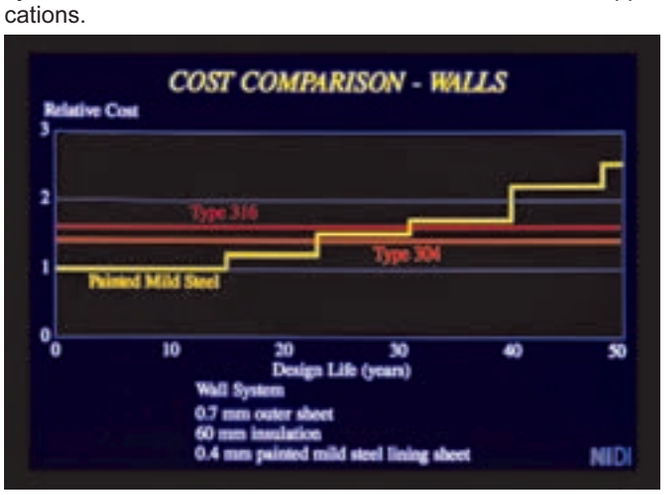
struction is better understood and a stronger market for reusable steel construction products is stimulated, alongside increasing standardisation as the market for stainless steel components grows.

Whole life cycle value

Decision-making in the construction and property industries has historically been governed by initial costs. However, life cycle assessment and the use of life cycle costing tools are increasingly being adopted by the construction industry, in order to measure environmental impacts and to inform decision-making.

When stainless steel construction products are considered in 'whole life' terms, by taking account of their longevity and low maintenance and the avoidance of product replacement, their true value becomes more apparent and, in many applications, stainless steel becomes the preferred, most sustainable material choice.

The global stainless steel industry, through the International Stainless Steel Forum (ISSF), is taking a lead in gathering high quality life cycle assessment data for stainless steel products. This data can be used to evaluate the whole life cycle benefits of stainless steel in different construction applications.



Cost comparison of stainless steel wall cladding and painted mild steel over 50 year design life (Courtesy of NiDI)

Other environmental benefits

Increasingly tight restrictions on leaching of hazardous materials into the environment, both through air and water pollution, present new challenges to all construction materials to demonstrate their environmental safety.

Stainless steel's metallurgical and surface properties make it the material of choice for a range of applications where hygienic and sterile conditions are required, such as in food processing and medical facilities. Leaching tests carried out on three representative stainless steel grades (1.4307, 1.4404 and 1.4462) confirmed that leaching of nickel, chromium and iron falls well within limits set by the UK Drinking Water Inspectorate for products in contact with drinking water.

Construction can also give rise to significant other adverse social and environmental impacts when carried out on site. Stainless steel construction products can be fabricated off-site and delivered pre-engineered to site to the correct dimensions. This provides a safer working environment than the construction site. Factory working also facilitates more accurate workmanship, leading to fewer defects and less waste.

Beauty

A central component of sustainable development is the enhancement of quality of life - we are all influenced by the architecture of the built environment in which we live, work and take our leisure. Building performance is very important and we all need safe, secure and comfortable buildings, but aesthetics are also important as we strive to become more sustainable.

Stainless steel is used to create beautiful buildings by taking advantage of its metallurgical properties and modern, hi-tech rolling techniques to produce a wide range of attractive surface finishes, ranging from bright reflective to brushed, matt or textured. All finishes are designed for ease of maintenance.

This aesthetic appeal is combined with physical and mechanical properties, which make stainless steel ideal for construction use, in particular its corrosion resistance and high strength.

Stainless steel design

Like all materials, the optimum performance of stainless steel in the built environment can only be achieved by following some basic principles.

It is important that the **appropriate grade** of stainless steel is selected to match its environment conditions, e.g. the optimal grade for an aggressive coastal or industrial environment will be different from an internal application.

The choice of **surface finish** will affect the 'self cleaning' performance of stainless steel in external applications. It is recommended that advice is sought to determine the most appropriate finish for a particular location and application.

External envelope applications should be **designed to promote natural washing** of stainless steel with rainwater. Overhangs and other areas where dirt can accumulate should be avoided and, where possible, joints designed to eliminate crevices in which chlorides and other airborne contaminants can accumulate. Galvanic corrosion can be avoided by using stainless steel fasteners and/or non-metallic washers and seals.

The technique for welding stainless steel is different from mild steels; it is therefore **recommended that a contractor experienced in fabricating stainless steels is used**. Advice should be sought on component design, surface finishes, product handling and installation.

Following the above principles will go a long way to reducing the maintenance requirements of stainless steels. However it is recommended that natural washing is supplemented by a **regular programme of washing** with warm water and a mild solution of non-abrasive cleaner, rinsed with clean water.

The business case for sustainable development

A sustainable business is a well run, efficient and profitable enterprise; its long-term viability relies upon its relationships with its stakeholders. Whether investors, owners, suppliers, employees or customers, the aspirations of all stakeholder groups need to be understood and balanced to ensure the long-term success of an organisation.

Financial markets throughout the world now monitor the sustainability performance of companies and evidence is mounting that sustainability pays. The London Stock Exchange tracks the sustainability performance of UK's largest companies in its FTSE4Good Index. Over the past 5 years, the top 50, 'most sustainable' companies have outperformed the conventional FTSE 100 Index by 15%.

Construction companies not convinced by the business bene-

fits of sustainability are being forced to change the way they operate by a raft of legislation at both the national and European levels.

At the national level:	At the European level:
• The Building Regulations	• Directive on the energy performance of buildings
• The Landfill tax	• Regulation on substances that deplete the ozone layer
• The Primary Aggregates tax	• Landfill directive
• The Climate Change levy	• Directive on packaging and packaging waste
• Environmental Protection Act	• Construction Products directive • The Water Framework directive

Companies in the construction sector supply chain that do not comply with relevant legislation or change their business practices to minimise the impact of fiscal measures will find it increasingly difficult to survive, let alone prosper.

Building a better future

The steel construction sector formally launched its sustainability strategy in December 2002. Development of the strategy has been led by the Steel Construction Sector Sustainability Committee, in consultation with the sector, and with the support of the DTI/DEFRA Pioneers Group.

The strategy document reports on a review of how the sustainable development agenda is being addressed by the UK steel construction sector, and reviews progress achieved in terms of the four principle sustainable development objectives defined by UK Government:

- Social progress which meets the needs of everyone
- Effective protection of the environment
- Prudent use of natural resources
- Maintenance of high and stable levels of economic growth and employment

The steel construction sector is committed to further advances and the strategy outlines 25 initiatives to support the delivery of more sustainable construction. It also outlines the sector's long-term commitment to sustainability by outlining programmes of work to:

- Extend the acquisition and dissemination of information required by the industry to enable informed decision-making.
- Provide guidance on design for flexibility, adaptability, recyclability and reuse.
- Improve supply chain engagement and reporting.
- Support the selection of responsible contractors.
- Encourage the adoption of environmental reporting.
- Fund the development of credible, robust whole life assessment tools.
- Evaluate progress and awareness, and develop measurable targets.

The full version of the strategy can be downloaded from the websites hosted by Corus, SCI and BCSA.

Future challenges for stainless steel

Despite stainless steel's many sustainability benefits in construction applications, there are potentially significant impacts that arise from the production of stainless steel, particularly from the winning and refining of the ferro-alloys chromium, nickel and molybdenum that are used in stainless steels.

Stainless steel producers have made significant progress in reducing their environmental impacts. For example, the Sheffield works of Outokumpu Stainless has achieved a 70% reduction in energy consumption over the last 20 years by introducing new technologies and is a partner in an innovative project to recycle waste packaging into reusable materials.

The challenge for the sector is to sustain the growth rates that stainless steel has enjoyed in recent years while continuing to reduce the environmental impacts of production. In particular there is a need to address the requirement for more primary resources as the stainless steel scrap deficit grows.

It is important that the global stainless steel industry builds on the life cycle assessment work done by the ISSF to deliver credible whole life cycle assessment tools and information that will enable designers to make robust, more sustainable material choices for their buildings.

Conclusions

Stainless steel offers many positive sustainability benefits to the construction sector. Its durability, longevity and superior corrosion resistance makes it the material of choice for many specialist, modern applications and harsh, corrosive environments.

Architects and engineers are learning to use stainless steel's versatile material properties to innovate and produce high performance, attractive products and buildings that deliver excellent functional performance without compromising beauty.

Decision support tools, such as life cycle costing and life cycle environmental assessment, are increasingly being used to quantify the whole life sustainability benefits of using stainless steel in the built environment.

Tools are also available from the BSSA for the initial costing of bridges where stainless steel reinforcement is placed in the high corrosion risk parts of the structure.