NICKEL

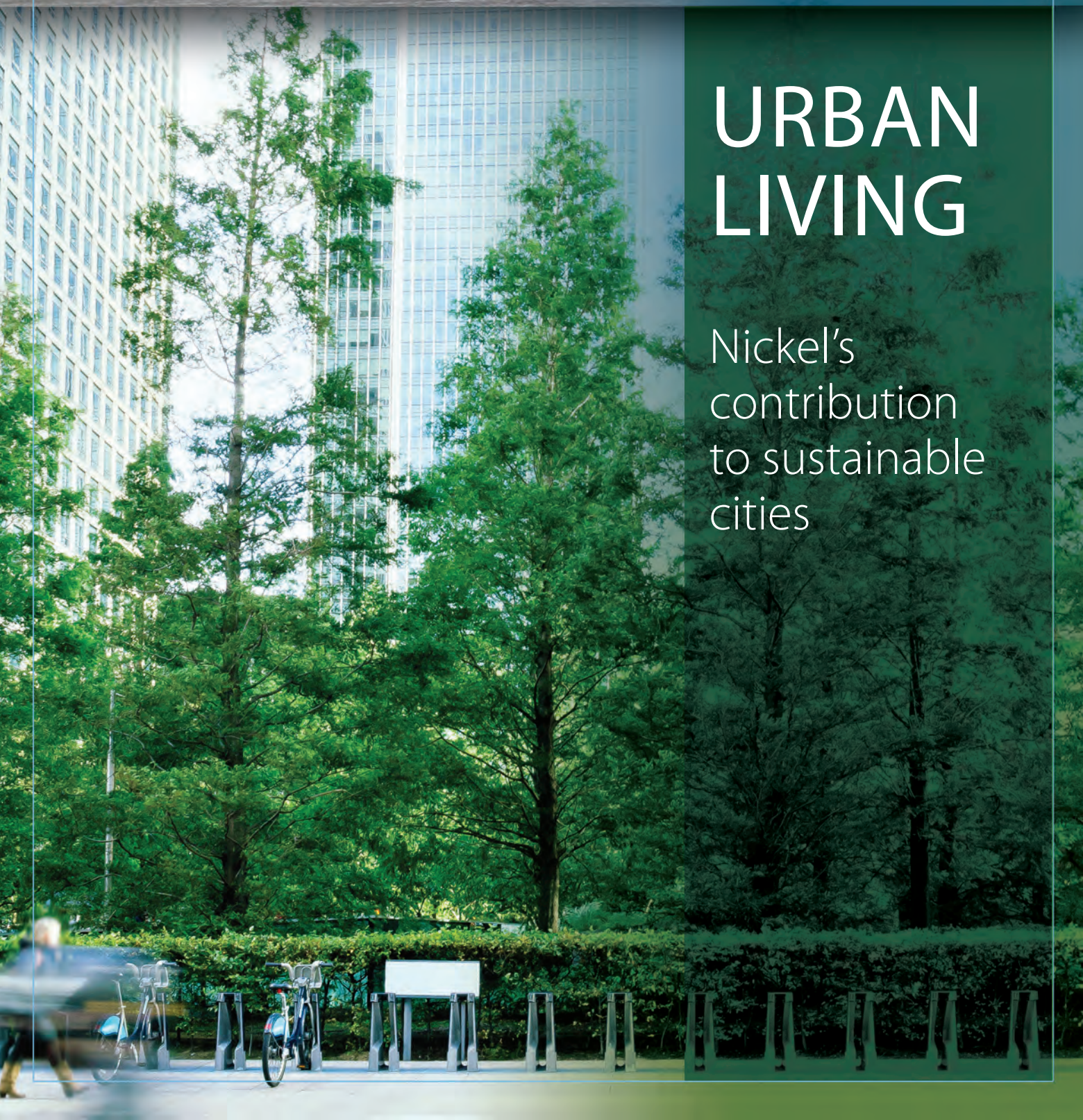
THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

Eco-buildings make sustainable cities

Improving the urban mass transit experience

Transforming urban garden waste locally

December 2014, Vol. 29, N° 3



URBAN LIVING

Nickel's contribution to sustainable cities

△ *Completed lamella steelwork* △ *Desalination plant*
▷ *Lamella clarification filter*

PHOTO: INTERSERVE

CASE STUDY 03
THAMES GATEWAY WATER TREATMENT WORKS

London is classed by the United Kingdom's Environment Agency as 'seriously water stressed'. It receives less rainfall per person than Rome, Istanbul, Dallas or Sydney and pressure on water resources will continue to grow in the future. Another 700,000 people are forecast to be living in London by 2021 and climate change will increase the likelihood of longer, hotter summers.

To help tackle water shortages, the UK's first water desalination plant, the Thames Gateway Water Treatment Works, opened in 2010.

The plant treats brackish water from the River Thames, and can produce up to 150 million litres of drinking water daily—enough to supply one million people. Within the plant, saline river water passes through lamella clarifiers to remove solid particles. The clarifiers are large, open tanks containing a coarse filter supported by a grillage of 78 I-beams made of Type 2205 (UNS S32205) nickel-containing duplex stainless steel.

Salt is removed from the water by a reverse osmosis process where water is forced at high pressure through very fine membranes. The treated water is re-mineralised so that it has similar properties to other local potable water supplies and then disinfected.

The lamella clarifiers are divided into three cells, which are split in two. Each half is supported by 13 stainless steel beams of 17.5m span, with supporting steel bracing at approximately 3m intervals. The grid of beams carries a load of 2.5 kN/m^2 during full working conditions. The most common profile for the stainless steel I beams was 512mm x 132mm. All the steelwork supporting the main beams was also fabricated in Type 2205 duplex stainless steel, to avoid bimetallic corrosion. Ni

DRINKING RIVER WATER IN LONDON

Drinking Water Inspectorate (DWI) approval is needed for all materials that come into contact with drinking water. The main beams for the Thames Gateway Water Treatment Works were initially specified to be carbon steel with an epoxy coating. However, there was a high risk of damage to the epoxy coating by follow-on operations and maintenance, which would have resulted in rusting and subsequent damage to the £7 million (US $11 million) desalination membranes.

Duplex for desalination

Duplex stainless steel grade Type 2205 was specified instead. This grade is DWI approved, requires little maintenance and is durable in brackish water without any applied coating. The 2205 alloy is considerably stronger than the standard stainless steels such as 304L and 316L—close to the strength level of the carbon steel beams. The higher material cost of stainless steel is offset by the low maintenance requirements and higher plant availability, as well as greater assurance of water quality throughout the plant's design life of at least 60 years. The stainless steel will retain its value and be recovered and recycled when the plant is eventually replaced.

This article has been adapted from a series of Structural Stainless Steel case studies produced on behalf of Team Stainless by SCI and available for download from:
www.nickelinstitute.org

NICKEL, VOL. 29, NO. 3, DECEMBER 2014

NICKEL

The Magazine Devoted to Nickel and its Applications

Nickel magazine is published by Nickel Institute
www.nickelinstitute.org

Tim Aiken, President
Clare Richardson, Editor
crichardson@nickelinstitute.org

Contributors: Angela Bywater, John Chapman, Gary Coates, David Hayes, Catherine Houska, Bruce McKean, Frank Smith

Design: Constructive Communications

Nickel Institute can be contacted at:
Eighth Floor
Avenue des Arts 13-14
Brussels 1210, Belgium
Tel. +32 2 290 3200
communications@nickelinstitute.org

ISSN 0829-8351

Printed on recycled paper in Canada.

Cover: Constructive Communications
Cover Photo: Canary Wharf ©ISTOCK.COM/ ROBEDERO

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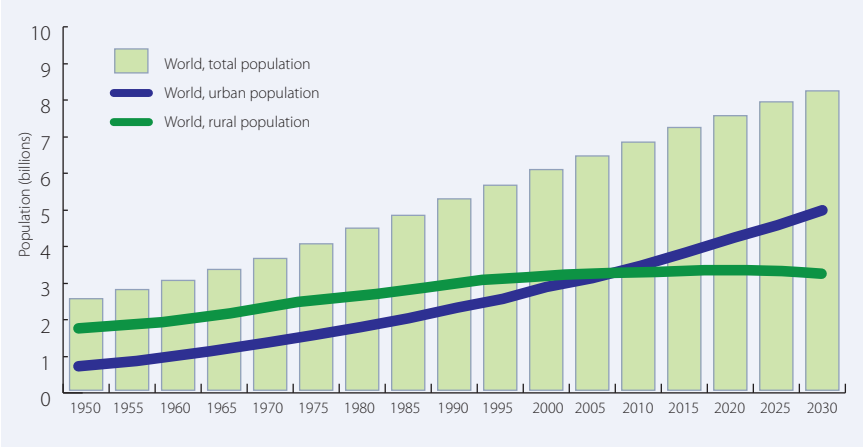
PHOTO: DAVID HAYES

URBAN LIVING

In 2008 the rural/urban balance tilted: for the first time half the global population was living in urban areas and the tide of people leaving the countryside (see graph below) continues strongly. Currently 3.5 billion people make their homes in cities and many more commute from rural areas to work there. By 2030, according to the United Nations, 4.9 billion people—or 60% of the projected world population—will be urban dwellers.

The urban and rural population of the world, 1950–2030



SOURCE: UNITED NATIONS

Coping with these massive shifts of population and increases in density poses enormous social, economic and environmental challenges.

Every issue of this magazine has examples of nickel's relevance to urban life and this time the focus is sharper than ever on one of the most time-consuming and often stressful aspects of city life: getting around. It isn't just the ability to move from home to work and back but also the quality and reliability of the experience that many of us question every day.

But the world increasingly looks to cities for a combination of shelter, employment and the social, community and cultural elements that collectively constitute our quality of life. Drawing on examples from Australia, Europe, Japan and North America this issue of *Nickel* gives large and small examples of how nickel is contributing to making a healthy and sustainable life possible in an ever-increasingly urbanised world.

Clare Richardson
Editor, *Nickel* magazine

Nickel INSTITUTE
knowledge for a brighter future

PHOTO: JERSEY PRECAST

△ *Pulaski Skyway: About 2,200 tonnes of stainless steel rebar will be used in this project*

△ *Gardiner Expressway: Corrosion of the carbon steel rebar causes the concrete to crack and spall off*

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Reliable Routes:

nickel protects investments in infrastructure

Traffic congestion make cities less livable. And when one or more lanes of a bridge, overpass or elevated roadway are shut down for repairs that can take months to complete, the chaos is compounded. This is where the specification of nickel-containing stainless steels for critical infrastructure will be the cost-effective choice that carries added benefits for both citizens and the environment.

Stainless versus carbon steel rebar

In demanding environments, the use of "inexpensive" carbon steel reinforcing bar (rebar) may offer an initial service life of 25 years or less before the expensive cycles of repair and refurbishment begin. If nickel-containing stainless steel rebar is selected, a service life of at least 75 years and usually over 100 years can be expected.

In North America, the first use of stainless steel rebar in highway bridges was 30 years ago, and usage has been steadily increasing. Here are three examples from Winnipeg, New Jersey and Toronto.

Bridges and overpasses

To increase safety, road salt is used to keep roads, and especially overpasses which tend to ice up more quickly, free of ice. The city of Winnipeg in Manitoba, Canada is familiar with the havoc caused by the corrosion of carbon steel rebar, and stainless steel is used extensively in its major roadwork. A principal route in south-west Winnipeg, the Kenaston Overpass is a two lane structure in each direction with two spans, and one example where the Public Works Department specified stainless steel rebar for the road deck, barrier walls, approach slabs and abutments. Salit Steel supplied nearly 200 tonnes of Type 2304 (UNS S32304) with about 4% nickel for this one overpass project.

The Pulaski Skyway is over 5.6km long and spans the Hackensack and Pulaski Rivers between Newark and Jersey City, New Jersey, USA. The original bridge is over 80 years old. In this new project, there will be four lanes of traffic, two in each direction with shoulders, separated by a concrete median barrier. To speed up the project, precast concrete decks will be used—1,142 of them. About 2,200 tonnes of Alloy 32 (S24100) stainless steel with about 1% nickel will be used for the new bridge.

Elevated highways

In Toronto, Canada, the Gardiner Expressway is the major highway access to the downtown core, handling about 150,000 vehicles per day in each direction. Because of initial inappropriate material specifications, the six-lane thoroughfare has been deteriorating for years, with a number of temporary measures being taken to stop the dangerous cracking of the concrete structure caused by corrosion of the carbon steel rebar. Pieces of concrete as much as 5kg in weight have fallen on the busy street below.

As a result, city engineers realised they needed a long-lasting solution, a solution that required stainless steel rebar. The two alloys specified are Type 2205 (S32205) with 5.5% nickel and Type 316LN (S31653) with 10.5% nickel. The work on the expressway is anticipated to require 1700 tonnes of nickel-containing stainless steel for road decks, barrier walls, support structures and piers.

For new construction or refurbishment of existing infrastructure in demanding environments the lesson is clear: the specification and use of nickel-containing grades benefits motorists, taxpayers and the environment. Ni

Consequences of corrosion

Often the cause of repair is cracking of the concrete because of corrosion of the carbon steel reinforcing bar (rebar), whether epoxy-coated or not. Salt, either used for keeping roads free of ice in winter, or coming via the atmosphere from marine environments, penetrates the concrete and causes corrosion. The product of corrosion (rust) has a larger volume than the steel. This causes the concrete to crack which, in turn, allows more salt-laden water to penetrate faster and deeper into the concrete structure.

To avoid eventual catastrophic failure of the structure, expensive and intensive refurbishment becomes vital, a process that is very disruptive to the life of a city.

Often there are few alternative routes, and during rush hour, those alternatives also get clogged. As well as frustration for drivers there are shipping delays, loss of productivity, wasted fuel from idling engines, increased air pollution and increased traffic in otherwise non-commercial streets as traffic seeks ways around the blockages. More concrete, more rebar and more landfill are also needed to accommodate the rubble from the infrastructure being refurbished.

PHOTO: SALIT STEEL

▽ *Kenaston Overpass in Winnipeg: The Public Works Department regularly specifies the use of stainless steel rebar*

TRANSFORMING URBAN WASTE **IN A SMALL SPACE**

In urban environments small scale anaerobic digesters are providing an innovative solution to recycling food and garden waste—with the added benefit of generating energy and producing fertiliser.

Most people are familiar with composting where aerobic bacteria in the heap produce heat, turning organic materials such as manure, sewage, food and garden waste into fertiliser in the form of compost, and carbon dioxide. To go a step further, however, and produce usable biogas, requires the strength and corrosion resistance of nickel-containing stainless steels.

If organic materials are put into an airless tank (instead, for instance, into a garden compost pile exposed to the air), anaerobic bacteria will create fertiliser (technically called 'digestate') and combustible biogas, a mixture of carbon dioxide and methane, with trace impurities of other-gases such as hydrogen sulphide. The tank and all the equipment needed to feed, mix and heat the material is known as an anaerobic digester and the process is known as anaerobic digestion or AD. AD happens naturally in many places, including the bottoms of ponds and the stomachs of cows—which is why cows belch and pass methane.

> My digester designs incorporate both fibreglass and stainless steel, two materials I use extensively in order to create robust and long-lived systems.

Land and energy productivity

The modern, and ultimately unsustainable, 'linear' method of food production is underpinned by fossil fuel energy. Food is grown using fossil fertilisers, then processed, transported and, if unused, disposed of to landfill. This results in a flow of fertiliser (nutrients) from rural areas to cities and landfill sites. The challenge for a more sustainable 'circular' economy is how to effectively return nutrients to the land in order to grow more food and thus break, or at least minimise, the extraction-to-landfill process. Anaerobic digestion can help do this by effectively recycling the nutrients back to land and reducing fossil fertiliser use, as well as producing renewable biogas for heating, electricity creation and vehicle fuel.

For a number of reasons, including space constraints, it may not be practical to build large anaerobic digesters within many cities. However small on-site AD units can be used to recycle food and non-woody garden waste produced by families, communities, schools, hotels, hospitals, restaurants, food manufacturers and a wide variety of other businesses. The digestate can be used in areas such as allotments, parks, roof gardens, 'living walls', office plants, hydroponics and aquaponics—for urban greening and local food production. It also avoids the financial and environmental costs of trucking organic material from urban to rural areas.

METHANOGEN UK LTD

△ *Small on-site anaerobic digesters can be used to recycle food and non-woody garden waste*

Urban applications

A revolutionary project at London's Camley Street Natural Park near King's Cross in Central London is doing just that with a 2m^3 'Biogastronome' micro-digester. Food waste from local cafes, hotels and food manufacturers is collected using cargo bikes and put into the digester. The biogas is used for heating using a micro-biogas boiler and to make tea with a biogas tea urn. There are plans to convert a natural gas combined heat and power (CHP) engine to run off biogas and heat the buildings.

The fertiliser produced is used in various places on the site, including for vegetables grown on raised beds, shrubs and bushes in the garden and even a 'floating orchard'—a barge filled with fruit trees and soft fruit bushes, anchored on the canal which runs alongside the park.

Why nickel stainless steel

James Murcott of Methanogen UK Ltd has been designing successful farm, sewage and abattoir digesters for more than 40 years and is responsible for the 'Biogastronomy' range of digesters. He engineers for longevity and low operation and maintenance costs.

"My digester designs incorporate both fibreglass (GRP) and stainless steel, two materials I use extensively in order to create robust and long-lived systems. We have even managed to relocate and reuse digester equipment after operating for 20 years and more—both materials withstand the harsh outdoor 24/7 operating conditions extremely well," he says. Nickel-containing stainless steel is used in a number of places on the Biogastronomes, much of it Type 316 (UNS S31600): on the manual feed handle, the feed auger ends, heat exchangers and on the 12V heater. Stainless steel bolts (generally A2-70, which is the name given to a Type 304 (S30400) bolt with 700 MPa tensile strength) are exclusively used for bolting the two halves of the insulated fibreglass tank together,

METHANOGEN UK LTD

△*Nickel-containing stainless steel is used in the Biogastronome's manual feed handle, the feed auger ends, heat exchangers, 12V heater and bolts*

mounting the motor/gearbox assembly and fixing items such as the viewing port window and micro-switches.

James adds that he "banned any non-stainless bolts from our workshops, as it just wasn't worth using anything else." He has also used nickel-containing stainless steel in his micro-biogas boiler design, as the biogas can contain hydrogen sulphide which quickly destroys a lesser alloy.

The Camley Street system was used as a test bed for a very successful micro-hammer mill, designed by the Alvan Blanch Group, Wiltshire, UK, which uses Type 304L (S30403) stainless for both the hammer mill body and hopper. This mill macerates the food waste down to 12mm, which helps to maximise the surface area that the bacteria can work on, as well as allowing easy pumping for regular automatic digester feeding.

Boilers as well as digesters

Methanogen UK's Angela Bywater has been trialling the new automated micro-boiler system on her four year old micro-digester system. The boiler is fabricated from Type 316 stainless and she has found it to be very effective. "I normally cook on the biogas, but am now able to use excess gas through the micro-boiler in order to thermosiphon hot water into a storage tank which raises the temperature of the greenhouse, allowing me to grow winter crops such as lettuces."

She believes that such local or on-site AD systems have wide applicability, "What we are doing here is taking the concept of many millions of simple digesters which exist in India, China, Nepal, Africa and elsewhere in the world, and engineering it for a colder climate and our own strict regulatory regimes." And nickel-containing stainless steel has a vital role to play in that engineering. Ni

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BUILDING SUSTAINABLE CITIES

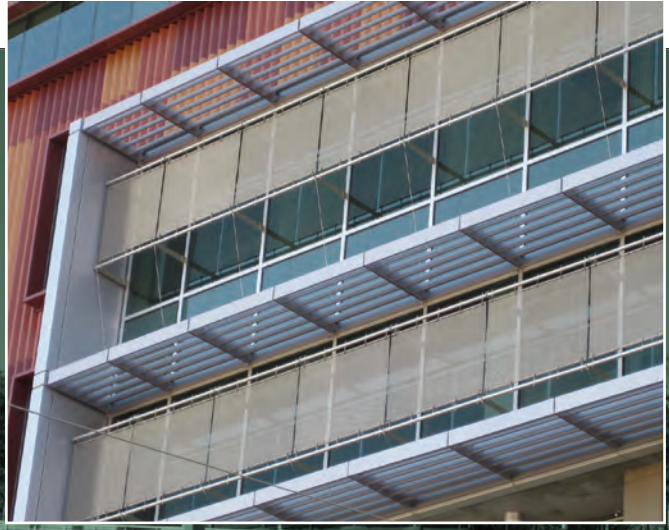

PHOTO: GKD

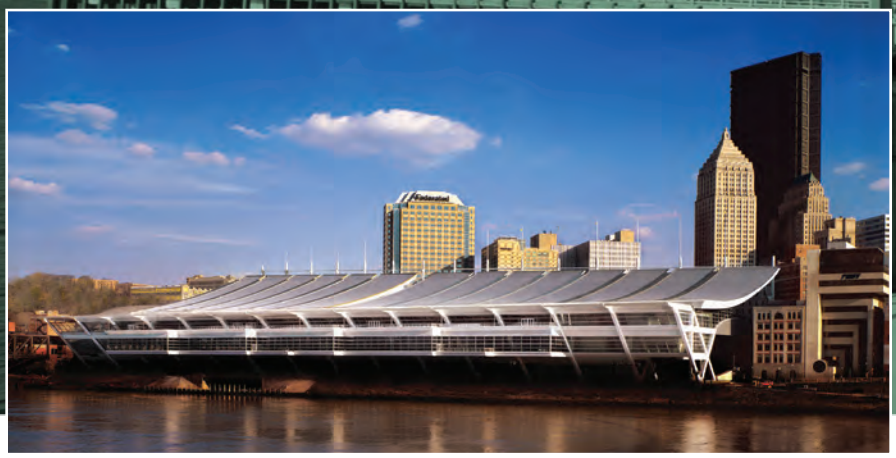

PHOTO CREDIT ATI ALLEGHENY LUDLUM

PHOTO: C. HOUSKA

△ *Top: Sunscreens at Arizona State University*

△ *Above Left: The Pittsburgh Convention Centre with its stainless steel roof has had higher than expected energy savings*

△ *Above: Type 316 stainless steel is used extensively for durability at the Britomart train station, Auckland*

With over half the world's population now living in urban areas, the concept of sustainable or eco-cities has become increasingly attractive. Sustainability is however a complex topic, which makes applying the concept to a subject as broad as urban development quite challenging. For that reason there is no agreement on a detailed definition of what a sustainable city should encompass.

This ambiguity has lead to a variety of approaches, but all share a commitment to minimizing environmental impact - energy, water, food, waste output, and pollution.

The overall goal is an urban area that can at least partially feed and power itself, thus minimizing its reliance on the surrounding countryside while reducing its ecological footprint and contribution to climate change. With planning, the increased economies of scale of urban environments can make them more environmentally sustainable than rural or suburban living.

Various concepts can be used to create more sustainable cities, such as:

- Include agricultural plots within the city and suburbs;
- Encourage zero-energy buildings and installation of renewable energy sources, such as wind turbines, solar panels and waste-to-energy technologies;
- Minimise the heat island effect, and therefore air conditioning requirements of cities (typically as much as 6°C warmer than surrounding areas), by using, for example, green or high solar reflectance roofs, natural ventilation and cooling, weather screens and green spaces;
- Reduce vehicle emissions. Integrate efficient public transport and bicycle and pedestrian friendly cities with optimized business, industrial, and residential zone density;
- Minimise potable water use in buildings through use of grey water;
- Reduce waste through the selection of materials that are capable of lasting the life of the project; and
- Increase green spaces and design them to improve air quality, cool the environment and be water friendly.

Nickel-containing stainless steels such as Types 304 (UNS S30400), 316 (S31600) and 316L (S31603) contribute to many aspects of sustainable city design.

Building construction and operation is responsible for a large percentage of raw material, energy and water use and the amount of waste generated. Exterior material choice can affect both building energy requirements and a project's contribution to the heat island effect of cities. Stainless steel roofs not only meet solar reflective index (SRI) requirements, which reduce heat gain, they also retain those values over time with minimal maintenance.

The convention center in Pittsburgh USA was the first LEED rated project of its type

PHOTO: CAMBRIDGE

PHOTO: C. HOUSKA

△ *Top: Architectural mesh in Type 304 stainless steel protects and beautifies this car park in Las Vegas*

△ *Background: Hudson River Park*

and received a gold rating upon completion. Its large sloping stainless steel Type 304 roof has had no SRI value deterioration. The building has much higher than expected energy savings and was upgraded to a Platinum rating after its 10-year evaluation. Stainless steel is also the ideal material for supporting vegetated roofs since it provides excellent corrosion resistance in soil environments.

Stainless steel sunscreens can dramatically reduce energy requirements, even in cooler climates. By sheltering building exteriors from sun and reducing energy requirements with minimal maintenance, they provide long term solutions. Type 316 was chosen for the sunscreens on the Arizona State University Walter Cronkite School of Journalism and Communication.

Stainless steel trains and buses have long been a mainstay of reliable long lasting public transit but the stations and bus stops must also be durable like Britomart train station in Auckland, New Zealand. And bicycle-friendly cities require not only safe lanes but also long-lasting bike racks for security.

PHOTO: C. HOUSKA

PHOTO: C. RONSTAN TENSILE ARCHITECTURE

△ *Top: The Highline, New York City. Type 316 stainless steel was combined with wood for benches, railings and other elements*

△ *Type 316 stainless steel is used to create the living sunscreen in the South Bank Arbour, Brisbane*

Green spaces

New York City has two creative green space examples. Hudson River Park converted deteriorating waterfront into a 2.2km^2 naturally landscaped park with athletic facilities, bike and walking paths and abandoned piers converted into green space. Over 11km of Type 316L stainless steel railings provide a safe long lasting barrier along its length. The Highline is a raised abandoned railroad track converted into a 2.3km linear park filled with vegetation and again, the durable Type 316L stainless steel was combined with wood for benches, railings, and other elements.

Sheltering systems within green spaces provide more comfortable outdoor areas like the sunscreen in the Las Vegas City Center

PHOTO: C. HOUSKA

PHOTO: C. HOUSKA

△ *The Empire State Building is an example of how stainless steel contributes to longevity*

△ *The 9/11 museum is clad in Type 316 stainless steel sunscreens*

project and the South Bank Arbour in Brisbane Australia.

A frequently less-visible aspect of sustainable city operations is water reclamation and reuse. Often this is accomplished by capturing and reusing grey water and rain water for use in flushing toilets, landscaping and even cooling. In-building water purification systems are also used to minimise water loss. And stainless steel is a primary construction material within these systems.

Whether it's an older building that has already stood the test of time such as the Empire State building (completed in 1931 and recently awarded a Gold LEED rating for performance), or a high profile building like the 9/11 museum in New York, clad with stainless steel Type 316 sunscreens, there are many examples of how specifying nickel-containing stainless steel for longevity minimises the need for resources by avoiding replacement and makes a significant contribution to the sustainability of our cities. Ni

GETTING AROUND:

moderizing urban mass transit travel

Movement in, out and through urban areas is essential. How this is accomplished has enormous impacts on the quality of life of citizens and their environment. Success requires that there be sufficient peak capacity and clean, safe and welcoming infrastructure. In all of these the use of nickel-containing stainless steels are making valuable contributions and, in addition, doing so in durable, cost-effective ways.

In a tale of two cities we see how more commuters are moving more efficiently in Toronto and how the iconic Paddington Station in London has been refurbished for another even busier century of service to travellers.

△ *A new trainset in the Toronto Transit Commission livery showing its nickel-containing stainless steel shell*

△ *The open interior runs from car to car the length of the train. Stainless steel is used where strength, durability and cleanability are needed*

PHOTOS: WIKIMEDIA COMMONS

Rejuvenating the Yonge Street line

cost-effective increases in capacity, safety, acceptability

Toronto is a newcomer (opening in 1954) compared to the London Underground (first line opening in 1863) but the demands on the Toronto subway system are the same: ever increasing passenger journeys and an understanding by the citizens that their quality of life is directly affected by the quality of public transit.

As of October 2014, the Yonge/University line has been completely re-equipped with new trains that, in addition to increasing capacity by 8%, provide a travel experience far superior to the trains they replaced. The new cars have shells of 201LN (UNS S20153) stainless steel rather than the aluminum which was used on the older cars.

Why stainless steel?

When transit systems consider new rolling stock, manufacturers offer choices of carshell materials of which stainless steel is one. In the Toronto case both technical (structural integrity and weight) and commercial (cost) considerations were considered seriously.

The technical considerations favoured stainless steel. In extreme events, the strength and "crumple versus fracture" benefits can be critically important to the survival of passengers and crew. To compensate for the weight advantage (and thus operating cost benefits) of aluminium, the contract with Bombardier Transportation of Thunder Bay, Ontario, called for very stringent weight management through the supply chain (not just the carshells) to ensure that the overall weight of the stainless steel trainsets were similar to aluminium ones.

The cost differential represented by the selection of stainless steel was overcome with strict production discipline, including lean manufacturing techniques, and the selection of a low carbon alloy that did not compromise the desired strength and corrosion resistance. In addition, the stainless steel and its 2B mill finish, according to Kam Kwok, P.Eng., Chief Vehicle Engineer–Rail, "showed significantly lower maintenance costs according to the Life Cycle Costing Analysis that was a key part of our procurement analysis".

More capacity, safer, cost-effective, attractive…and achieved with the help of nickel-containing stainless steel.

PHOTOS: WHEELABRATOR GROUP

Bright new look for Paddington

stainless steels add light and quality to an urban landmark

In 2013, 34 million people passed through Paddington Station in London. This is an extraordinary achievement—and challenge—for a railway station first established in 1838. Its area is constrained, the through traffic is dense, and the overall impression was of a dark, dirty and stressed infrastructure. That has changed, however, thanks to the extensive use of the right grade, Type 304, (UNS S30400) and the right finish of nickel-containing stainless steel.

Crossrail catalyst

The need was clear but became urgent when plans for the new Crossrail line were finalized. When completed in 2018 Crossrail will add 30 new stations integrated into the London Underground system and Paddington is one of its main stops. With an expected carriage of 200 million passengers per year, Crossrail is causing major changes to a number of existing stations, starting with Paddington.

The Paddington redesign and refurbishment faced all the usual challenges: the finished station had to survive the annual passage of millions of people for many decades without significant deterioration or need for maintenance beyond cleaning. This includes consideration of scratched or vandalised surfaces.

Shot-peening

Shot-peening is not new. What has evolved, however, are new shot materials and new ways of using them to achieve performance and/or aesthetic properties. Those have been applied at Paddington to good effect.

One of the essentials beyond the common objectives of durability and resistance to vandalism was the reduction of glare. The bright, shiny and reflective surfaces so easily achieved with stainless steel needed to be dampened in this case as engine drivers could be dazzled with reflections from surfaces that while tough and easy to clean could impair speed and breaking decisions.

According to Chris Pallot, Business Development Manager for Wheelabrator Impact Finishers, the company that prepared the stainless steel surfaces for the Paddington refurbishment, "A surface that has been work-hardened through shot-peening is extremely durable and tougher to scratch—an important attribute in Paddington's busy thoroughfares and heavy-traffic pedestrian areas. We can also fine-tune the reflectivity of the surface within a spectrum from low to medium—striking a balance between getting light into the station and protecting drivers against glare."

Ceramic beads used for the peening avoided possible iron contamination of the surface that could lead to unsightly signs of rust on the surfaces.

The refreshed Paddington

The extensive use of Type 304 nickel-containing stainless steel at Paddington does not reduce the pressure of traffic. It does, however, make the passage of humans and trains through this landmark station as pleasant, cost-effective and safe as possible. Ni

△ *Stainless steel was used for wall-cladding, skirting, balustrades and station furniture*

Carrying Japan's value-added future

stainless steel tanks for transport and storage

Japan competes on the value it adds to raw and intermediate materials. The volumes of imported chemicals are increasing and the need for their safe transport and storage has never been greater. Tank containers made of nickel-containing stainless steel in a range of sizes are providing solutions for a growing number of Japanese chemical companies.

A chemical industry in transition

The cost of labour and overall rising production costs in many countries have made it unprofitable to produce basic commodity chemicals. For those reasons, Japan's chemical industry is entering a long term transition and a new era as production of basic commodity chemicals is moving offshore to lower cost countries. On the other hand, imports from Asian and Middle Eastern producers of commodity chemicals are growing to feed the Japanese production of high value-added chemicals.

Moving chemicals safely

Tank containers made of stainless steel, available in various sizes, are facilitating the safe movement of chemicals. In addition to so-called ISO tanks which are common the world over, smaller Intermediate Bulk Carrier (IBC) tanks are used for carrying low hazard cargos. The trade association @tco estimates that there are between 376,000 and 416,000 tanks of various sizes in service worldwide.

And these containers are ideally suited to serving the particular needs of the Japanese market. "It's very costly to produce chemicals in Japan, so domestic chemical manufacturers are going abroad to produce commodity chemicals elsewhere in Asia to reduce costs," explained Taiji Tano, Director and General Manager of Japan Dangerous Goods Container Association. It develops the tank container market and industry in Japan and represents the industry in consultations with the government over dangerous goods transport, storage regulations and other issues.

Restricted access

Although ISO-tanks are becoming more common for transporting chemicals in Japan, route planning is important as not all customers' premises can receive ISO-tank deliveries. Often factories in Japan using chemicals in their manufacturing processes are located in areas where access is restricted by narrow streets, tight road bends and other hazards which limit the size of vehicles that can deliver to these premises.

"Many delivery yards are not big enough for ISO-tank trucks to enter or the customer's storage tanks are not large enough to receive ISO-tank deliveries," explained

PHOTOS: NRS CORPORATION JAPAN

△ *NRS has been Japan's leading ISO-tank leasing company since buying Interflow Ltd of the UK in 1990. Interflow leases ISO-tanks to chemical company customers worldwide and currently operates 5,300 ISO-tanks globally*

a Tokyo-based logistics manager of one leading American company that regularly ships chemicals to clients in Japan.

"In some areas the roads are not wide enough for ISO-tanks to pass. Also, for safe movement we need to fill up the ISO-tank to reduce air contact: partial loads are less safe or could degrade the quality of the material being transported. In addition, it may be that some roads cannot support the ISO-tank weight or there is an obstacle with the ISO-tank height." For these reasons some companies use smaller portable tanks.

Storage solution

Meanwhile, ISO-tanks are providing a new chemical storage solution for a growing number of companies.

Rented or leased chemical terminal storage capacity is limited in many parts of Japan due to a shortage of suitable land for new tank storage facilities to be built. For companies without sufficient space to build their own permanent storage tank or who have been refused planning permission, leasing ISO-tanks or smaller tank containers to store chemicals in their factory yard is proving to be a popular practical choice for many. These companies may have been supplied with chemicals in for example 200 litre metal drums, but recently have started to import their chemical needs in bulk.

> ISO-tanks are providing a new chemical storage solution

"For the next few years demand for storage will be growing as chemical imports grow, but no new storage capacity is planned, so more ISO-tanks will be used for chemical storage," said Taiji Tano.

For both transport and storage, nickel-containing stainless steels will be helping the Japanese chemicals industry to flourish as it supplies the world with complex value-added chemicals for modern society. Ni

STAINLESS STEEL FOR HAZARDOUS LIQUIDS

A tank container to ISO (International Organization for Standardization) standards is a vessel of stainless steel surrounded by insulation or protective layer usually of polyurethane or aluminum. The two most commonly used stainless steel grades for tank containers that carry hazardous liquids, such as chemicals, are nickel-containing Types 304L (S30403) and 316L (S31603). A few ISO tank containers are made in duplex or higher alloyed stainless steels for special chemical end users. Other ISO tanks are made with linings.

The usual stainless steel grade used for food- and beverage-related liquids such as beer, is Type 304L, while Type 316L is also used for other food-related products such as edible oils.

The thickness of the stainless steel sheets used to make tank containers can vary, but a typical tank container used to carry hazardous liquids, such as chemicals, is made of 4.0 to 4.5mm thick sheets, while stainless steel plates up to 15.0mm thick are used to make gas-carrying tanks.

STATELY SLIDE

△ *The slide is made of nickel-containing Type 304 (UNS S30400) stainless steel in order to resist the weather and to always retain a clean, shiny appearance*

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Formerly owned by the Anglo-American Astor family, Cliveden House is located about 40 kilometers to the west of London. Situated high above the River Thames and surrounded by wooded countryside, this stately home has a colourful history dating back to the 1600s. Today, the house and grounds are a major tourist venue—attracting visitors from all around the world. The estate now belongs to the National Trust and the house has been a luxury hotel since 1985.

To help fund restoration work to the large terrace which runs the length of the south side of the house, a temporary pay-to-ride slide was installed in 2013. From August 2013 until November 2014 the slide took youngsters, and the young at heart, from the terrace at the back of Cliveden House down to the huge lawns and formal flower gardens.

The slide is made of nickel-containing Type 304 (UNS S30400) stainless steel in order to resist the weather and to always retain a clean, shiny appearance. The "wavy" slide is 7.5m high, 22m long and weighs about 3900kg. It is wide enough to accommodate four side-by-side tracks. The 2mm thick stainless steel was cut, formed and welded by Steel Line, U.K. with great care and attention to detail in order to minimize joints, eliminate rough edges and sharp corners and ensure a smooth, oxidation-free appearance.

Due to the restoration work on the terrace, the slide had to be moved. It easily endured this re-location.

Type 304 is a good material choice for playground equipment and outdoor furniture in most settings, as illustrated by this beautiful slide at Cliveden House. Seaside locations, or urban locations where road salt is used, would require more corrosion-resistant alloys such as nickel-containing Type 316 (UNS S31600) or Type 2205 (UNS S32205). Ni

UNS details

Chemical compositions (in percent by weight) of the alloys and stainless steels mentioned in this issue of *Nickel*.

UNS No.	C	Co	Cr	Cu	Fe	Mn	Mo	N	Nb	Ni	P	S	Si
S20153 p. 10	0.03 max.	-	16.0-18.0	-	bal.	6.4-7.5	-	0.10-0.25	-	4.0-5.0	0.045 max.	0.015 max.	0.75 max.
S24100 p. 4	0.15 max.	-	16.50-18.50	-	bal.	11.00-14.00	-	0.20-0.45	-	0.50-2.50	0.060 max.	0.030 max.	1.00 max.
S30400 p. 6, 8, 9, 11, 14	0.08 max.	-	18.00-20.00	-	bal.	2.00 max.	-	-	-	8.00-10.50	0.045 max.	0.030 max.	1.00 max.
S30403 p. 2, 7, 13	0.03 max.	-	18.00-20.00	-	bal.	2.00 max.	-	-	-	8.00-12.00	0.045 max.	0.030 max.	1.00 max.
S31600 p. 6, 7, 8, 9, 14, 16	0.08 max.	-	16.00-18.00	-	bal.	2.00 max.	2.00-3.00	-	-	10.00-14.00	0.045 max.	0.030 max.	1.00 max.
S31603 p. 2, 6, 8, 9, 13	0.030 max	-	16.00-18.00	-	bal.	2.00 max.	2.00-3.00	-	-	10.00-14.00	0.045 max.	0.030 max.	1.00 max.
S31653 p. 4	0.030 max.	-	16.00-18.00	-	bal.	2.00 max.	2.00-3.00	0.10-0.16	-	10.00-14.00	0.045 max.	0.030 max.	1.00 max.
S32205 p. 2, 4, 14, 16	0.030 max.	-	22.0-23.0	-	bal.	2.00 max.	3.00-3.50	0.14-0.20	-	4.50-6.50	0.030 max.	0.020 max.	1.00 max.
S32304 p. 4	0.030 max.	-	21.5-24.5	0.05-0.60	bal.	2.50 max.	0.05-0.60	0.05-0.20	-	3.0-5.5	0.040 max.	0.040 max.	1.00 max.

Safe passages

Nickel-zinc batteries keep the traffic flowing

The reliability of signalized intersections is a crucial component of urban infrastructures. When electrical power to an intersection fails, often due to bad weather or traffic accidents, it can cause major gridlock and safety concerns as responses to fire, police and health emergencies are delayed or prevented.

While some city agencies and departments of transportation do not carry any form of Uninterruptible Power Supply (UPS) or Battery Backup System (BBS), those that do often rely on lead-acid systems to ensure traffic intersections are able to function 24/7. However the cost of installing a UPS/BBS at all traffic intersections is prohibitive for many cities.

A new solution, developed and manufactured by Blue Earth Energy Power Solutions (Blue Earth EPS), based in Wilsonville, Oregon, USA, brings the twin advantages of being extremely flexible in terms of installation and maintenance while avoiding the use of lead-acid batteries that are disliked because of the care required in their handling, maintenance and end-of-life management.

Blue Earth EPS' intelligent UltraPower-Stealth Battery Backup System (UPStealth™) is accompanied by PowerGenix' high-powered and energy efficient nickel-zinc (Ni-Zn) chemistry, which solves the problem of utility power failure at traffic intersections.

PHOTO:BLUE EARTH ENERGY POWER SOLUTIONS

△ *The nickel-zinc battery panels are flat (half of the exterior removed to show individual cells) and hinged to allow them to flex and bend to take advantage of variable space geometries in existing equipment racks*

The UPStealth can be installed in various configurations. The intelligent battery can bend around corners and fit into spaces that cannot be accessed by traditional battery backup systems and eliminates the need for additional piggyback cabinets.

Compared to lead-acid batteries that the UPStealth replaces, cost of ownership is lower, less maintenance is required ('plug and play') and the nickel-zinc batteries have a longer life.

In the US alone, the market potential is estimated at approximately $453 million excluding applications such as railroad crossings, school warning signals and other intelligent transport applications. And globally, the potential seems unbounded for nickel-zinc batteries to help keep the traffic flowing. Ni

Going the distance

Electric cars and hybrids may go further with nickel foam

FLICKR @ GLEN WALLACE

Lithium-oxygen (Li-air) battery technology has the theoretical capacity to offer up to 15 times more energy density than current lithium batteries. This translates to lighter but more powerful batteries for applications such as automobiles. But technological barriers have so far prevented commercialisation. To overcome this, scientists in Singapore and China have turned to nickel foam, an inexpensive substance with a porous three-dimensional structure that makes it both rigid and lightweight.

Lithium-oxygen batteries generate power from atmospheric oxygen trapped inside porous, carbon-based electrodes. However, a build-up of insoluble lithium peroxide by-products in the carbon electrode can cause the battery to stop working after just a few charge cycles.

Zhaolin Liu from the A*STAR Institute of Materials Research and Engineering in Singapore, in collaboration with co-workers from Fudan University in China has developed a carbon nanotube electrode that can reduce these recharging problems in lithium-oxygen batteries, thanks to a support made from nickel foam.

Using chemical vapour deposition, the researchers were able to cover the nickel foam with layers of carbon nanotubes which they doped with small amounts of nitrogen. These nanotubes were loosely packed and contributed to a network of large, interconnected tunnels throughout the foam. According to Liu, these tunnels facilitate oxygen diffusion and provide critical voids where lithium peroxide can be deposited without limiting battery performance.

The team found that the "nickel foam" electrode could deliver twice the electrical capacity of a pure-nitrogen-doped carbon-nanotube electrode. "The next step will be to apply these electrodes in real lithium-oxygen batteries," he says. In the future, more capacity means a greater range for electric cars and hybrids… and nickel will be part of the solution. Ni

VENUS RISING

The Fibonacci spiral and the intersecting spines of a nautilus shell have inspired an impressive 23m high stainless steel sculpture at Kangaroo Point Park overlooking the Brisbane River, Brisbane, Australia.

Designed by UK public space artist Wolfgang Buttress, Venus Rising features 10,790 individual welds and over 7km of nickel-containing grades Type 316 (UNS S31600) and duplex Type 2205 (UNS S32205) stainless steel tube, pipe and round bar.

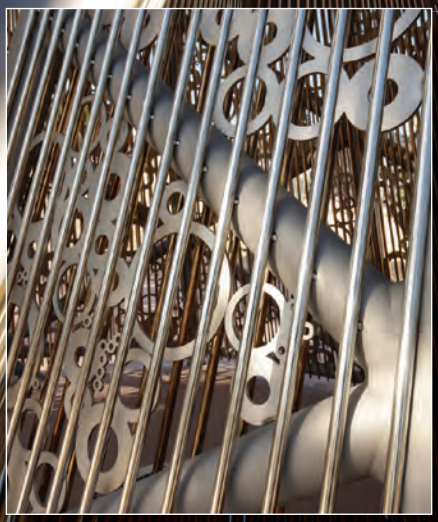
Having worked with stainless steel for over 25 years, Buttress said that the material's strength, ability to look good over time with minimal maintenance, and the flexibility of finishes works well both practically and aesthetically. "The material needs to be strong, resilient and look as good in 50 years as it does on installation."

The central design of the sculpture was to create a piece of artwork that was visibly prominent and exemplified strength, elegance and weightlessness. The sculpture features a criss-cross ladder-type construction with heavy wall pipes that gently twist to create a hollow spiral. Visitors can enter the sculpture at the base level and gaze up at the sky through an opening at the top.

"I wanted to make connections between the Brisbane River and the sky above. It was important to me that the sculpture works on an intimate scale as well as being seen from afar," Buttress said.

Commissioned by the Queensland Government, Venus Rising was selected in a public vote as the winning design from over 60 submissions and was unveiled in late January 2012.

Abridged from an article which originally appeared in Australian Stainless magazine, issue 51.



△ *Venus Rising features 10,790 individual welds and over 7km of nickel-containing Types 316 and 2205 duplex stainless steel tube, pipe and round bar*

PHOTOS COURTESY OF DAVID SANDISON