Steel an upright world

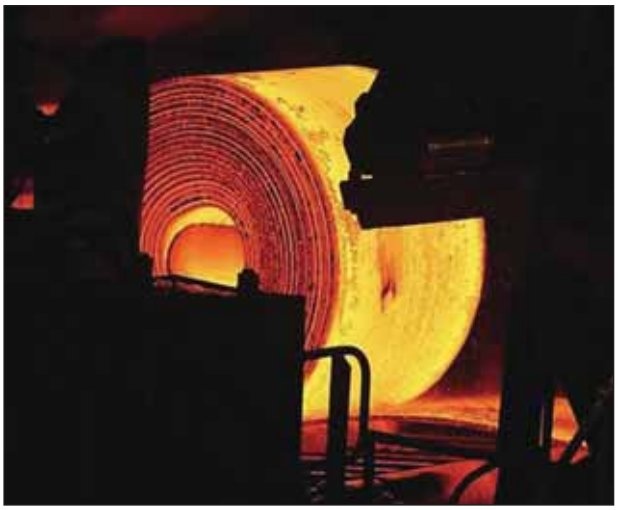
Steel as a building material is traditionally associated with high-rise buildings. Used routinely in the low-rise market for building envelopes, it is now becoming more widely used for structural applications. In view of the spotlight on sustainable building, what are steel's credentials, how smart is the resulting structure and how does steel as a building material impact on a structure's operational energy requirements? Jenny Baker reports.

Steel is as in demand today as in the 1880s, when it first took centre stage as a building material — but much water has gone under this bridge in the intervening years.

New Zealand Steel (NZS) market manager Chris Kay says steel's strength and durability remain its trump card, but the focus on sustainable building puts these characteristics in an interesting new light.

"Steel is a keeper — and there are good reasons," he says.

Situated 60km south of Auckland, NZS is the country's biggest steel manufacturer. It is unique in its use of locally mined ironsand rather than iron ore.



Steel has the highest strength to weight ratio of any building material.

Incorporated in 1965, it produces 600,000 tonnes of steel a year and contributes around 1% of New Zealand's GDP. It is a subsidiary of Bluescope Steel, which has 91 manufacturing sites in 17 countries.

According to the International Iron and Steel Institute (IISI), in 2006 global steel production reached 1.24 billion tonnes, an incredible 50% growth from 2000, the fastest growth rate in history. However, Mr Kay says, steel is a building material with a past, too.

Steel became economically viable for large-scale use only in 1855, when British inventor Henry Bessemer patented his Bessemer Converter. The machine could "mass-produce" an unprecedented 30 tons of high-grade steel in half an hour from molten pig iron — and builders saw the opportunity.

In 1889 the French erected the 300m-high Eiffel Tower. The United States followed with the 319m-high Chrysler building in 1929, making a quantum leap to the 442m-high Sears Tower in 1974. The highest building in the world today, at 448m, is the Taipei 101 in Taiwan, completed in 2004.

Steel was integral to the development of industrialised nations and high-rise construction. The resulting connotations left it in danger of becoming a victim of its own success, in particular since the 1980s, when sustainability credentials started to become a global public conscience issue.

In fact, Mr Kay says, NZS has actively managed sustainability since the 1970s.

"When comparing building materials, I encourage a close look at the credentials of the material's sector and manufacturer, as well as the credentials of the building material itself, in terms of a building's embodied energy content and operational energy requirements.

"Then it becomes clear that steel is a competitive sustainable building material," he says.

Steel's application possibilities in buildings go much further than its traditional role as the structural element in high-rise buildings and the building envelope in low-rise buildings, he says.

Builders today use it for many applications in high and low-rise buildings, including fastenings, foundations, framing, cladding, roofing, flooring, down pipes and decorating.

He says steel offers builders many intrinsic advantages. A good example is to consider a steel framing system for a low-rise building such as a residential home. In this context, its advantages are it does not absorb moisture and will not twist, rot, grow moulds nor emit gases. Vermin or insects cannot infest it.

Lightweight and strong, yet not rigid, it resists the impact of earthquakes. It conducts energy straight to the ground, providing a building with extra lightning protection. In a house fire it may deform but will not burn. Its maintenance requirements are low, and it can be designed to be thermally efficient.

What comes around, goes around

"When sustainability is factored in, many of these advantages achieve a multiplier effect. Add to this technological advances that enhance its appearance, and steel comes out a logical preferred material in various applications," Mr Kay says.

He argues that construction using any building material, including steel, impacts on the environment. Effects can occur through obtaining or extracting the raw materials, processing the raw materials and manufacturing the building material, issues such as waste and disposal thereof via landfill, transport and distribution of the product, the building process, and how smart the resulting building is and will remain in the future.

The life cycle, or "cradle-to-cradle" approach for

citizen

Construction of a steel-framed barn.

measuring a building material's environmental impact takes into account the abovementioned modelling parameters.

"Industry role players must not be misled by isolated snippets of information given out of context. A number of agents around the world have performed life-cycle analyses on the environmental impacts of using steel. Based on the results, well-informed architects freely specify steel products in their various forms for projects of all sizes," he says.

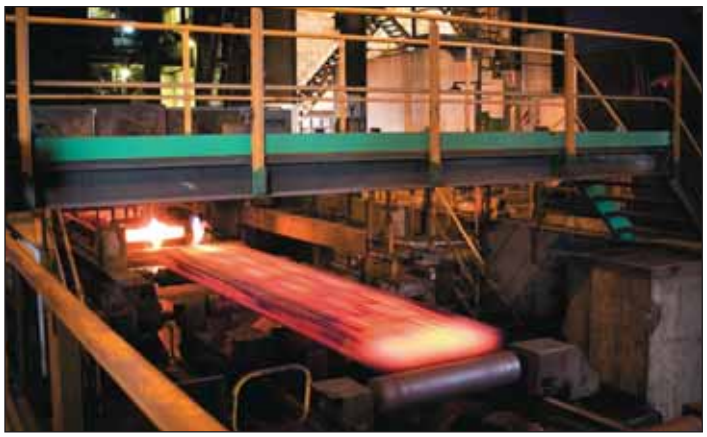
The global steel industry has actively improved its environmental record in mining, processing, dealing with waste products and recycling. It has never laid claim to a green image yet the issues of other sectors, such as destroying native habitats and environmental degradation so they can mine or grow, harvest, aggressively manage pests on the product, and dispose of toxic by-products and waste, are often conveniently ignored.

"Our issues and the way we deal with them are transparent and continuously improving. That's why it's important to compare building products with a cradle to cradle approach using the same modelling parameters for the analysis. Experts acknowledge the latter as the fairest way of assessing potential environmental impact," he says.

He explains New Zealand Steel's initiatives to remain in sustainable production. Even before achieving ISO14001 accreditation following the 1997 establishment of the ISO Standard, it already had environmental management systems in place. As a member of the IISI, NZS also actively participates in IISI policy commitments.

One such policy commitment is NZS's zero waste vision. Steel generates minimal production, manufacturing, construction site and demolition waste. "Steel can be engineered off site to precise specifications, requiring minimal on site cutting.

"And all steel waste has scrap value — steel's second most endearing feature is that it's 100% endlessly recyclable and suffers no product degradation in the process. More than 90% of commercial steel construction waste is recycled, and the average recycled content of the steel NZS produces is 10% to 15%," he says.



In the past five years NZS added co-products to its portfolio. "This resulted in markets for what was previously steel manufacture waste and by-products such as slag, vanadium and iron dust. We recycle, reuse or resell nearly 80% of the total waste from the ironsand to steel process, and actively pursue new ways to reduce waste.

"We've reduced the waste stream going into the on-site landfill by 60% in the past three years owing to targeted recycling and reduction programmes."

The company also tries to keep the utility bills down. By recycling hot gases from the manufacturing process, it generates 70% of its electricity needs. Only 1% of the water it uses is discharged each day after being treated, while the remaining water is recycled and recirculated.

Smarter for starters, smarter for longer

Home owners want low utility and maintenance bills, too. Mr Kay says the codes and standards that govern home building in New Zealand stipulate homes must be designed and constructed to last a minimum of 50 years.

"The frame's contribution to the durability and longevity of the home is immense. It provides the strength, stiffness, geometric stability and load bearing

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capacity of the building. It supports the cladding, lining materials and most fixtures. Failure of the frame to fulfil this function may have grave consequences.

"Steel framing is dimensionally stable and will not settle over time, which is vital to prevent superficial nuisance defects in everything attached to it, such as sticking windows and sagging roof lines.

"Such defects will push up the overall cost of ownership and may cause a loss of value," he explains.

In his opinion, adding the time, labour, the effect of availability on the price, and the long-term cost to operate a structure as a secure and comfortable home make steel framing economically viable.

Steel is a heat conductor but the informed application of insulation and thermal breaks in the house's design will address this concern.

"Steel frames are flexible and enable the design, orientation and construction of thermally-efficient buildings to provide healthy, comfortable indoor environments and minimise total energy consumed in heating and cooling over their lifetime.

"The versatility of steel permits the integration of active and passive energy saving measures. All these save the householder money, and just as important, lessen the impact on the environment.

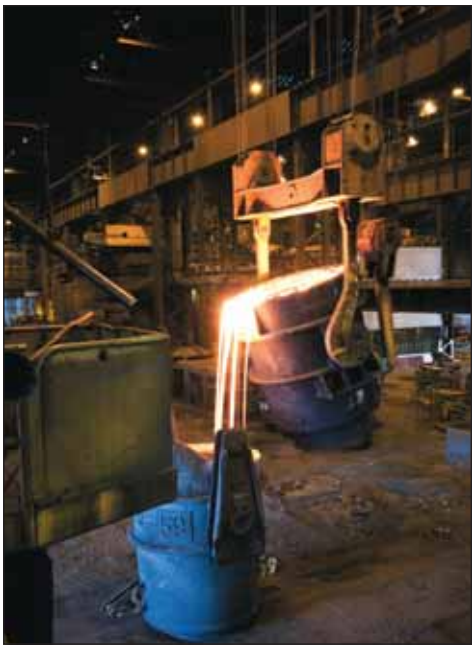
"Designing for efficiency may be more costly than using a lower priced building material, but from a life cycle perspective the total costs will usually be lower because the long-term benefits will continue over the life of the home."

Mr Kay says what is true for steel framing is true for other steel building products. But direct comparisons between building materials remain difficult.

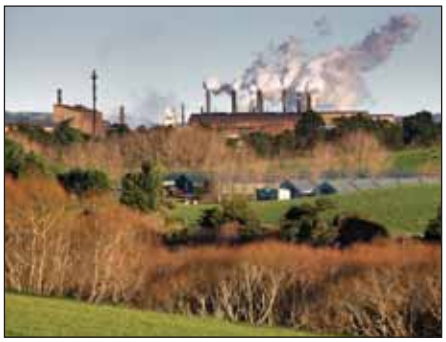
However, he says if all else fails, one argument stands persuasively above all others: "Lightweight steel frames mean less strain on installers, and provide safer work sites."

• For more information on steel framing visit www.nashnz.org.nz.

International expert Dr Michael Sansom, Sustainability Manager with the Steel Construction Institute in the UK, will be the guest speaker at three one-day seminars to be held in Auckland, Christchurch and Wellington on April 1 to 3. More information is available at www.scnz.org.



The New Zealand Green Building Council's Green Star NZ rating tool requires steel to have a 60% recycled content to gain points, but due to its durability, steel demand is far greater than the availability of scrap steel.



New Zealand Steel has invested considerable capital in its environmental management systems, in particular emission control, at the Glenbrook site.

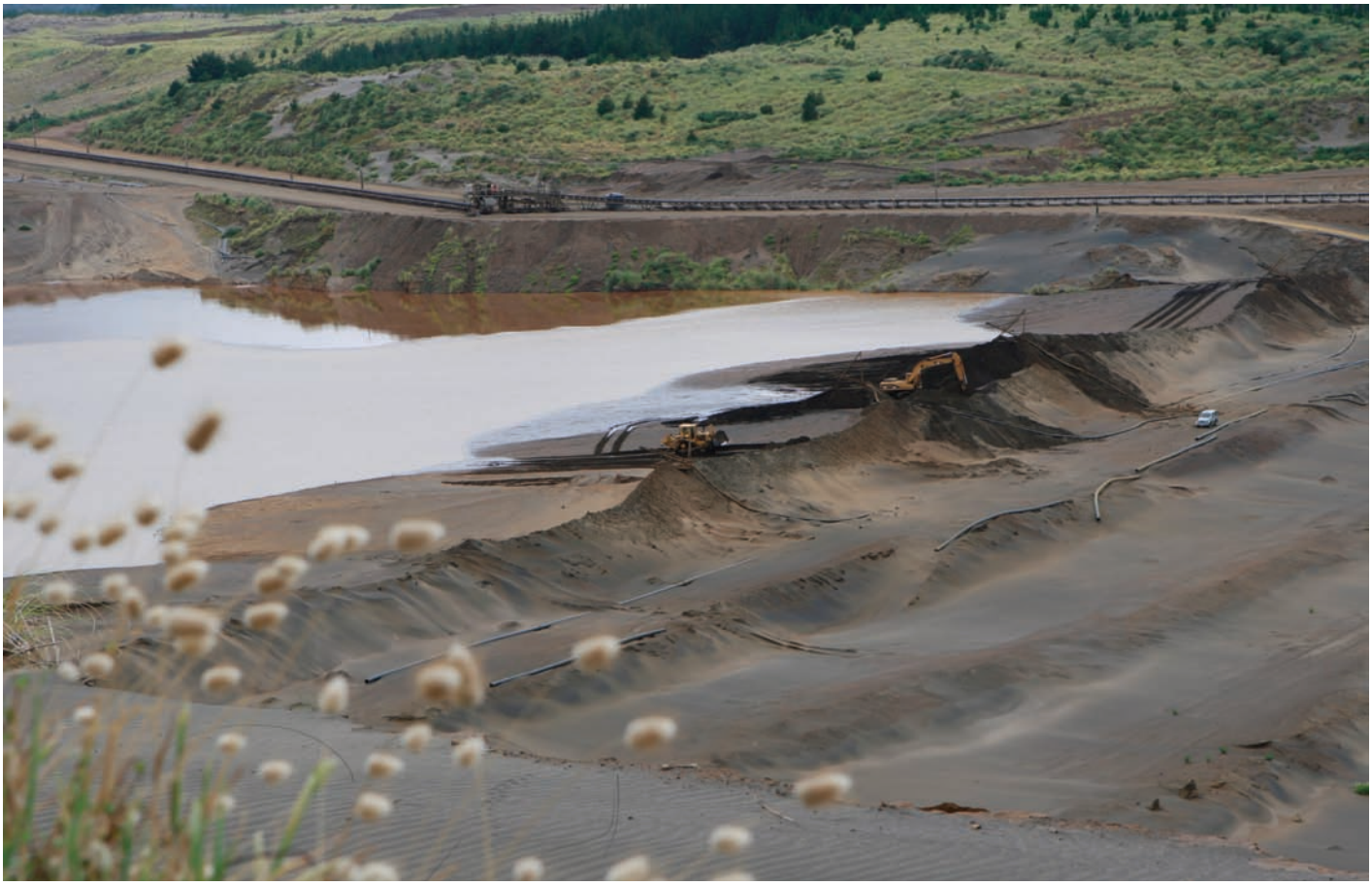
Beacon Pathway's NOW Home in Rotorua. New Zealand Steel is a shareholder of Beacon Pathway. The company also sponsored the Sustainable Build '07 conference.

Image courtesy of Craig Robertson Photography for Beacon Pathway Ltd

Replanting Marram grass on mined-out sand dunes at New Zealand Steel's Taharoa mine site, part of the rehabilitation programme. New Zealand Steel is unique among world steel producers in its use of local ironsand to make iron and steel. After extracting the titan-magnetite concentrate, unwanted material is returned to the areas that have been mined, to begin the process of returning the land to its original form.

Sustainability

New Zealand Steel has been working on it for years



New Zealand Steel uses its own iron sands as a key ingredient in steel production.

Climate change and rising energy costs have seen sustainability and environmental management gain momentum all around the world. In New Zealand the Government has outlined some initiatives as part of a broader programme to improve energy efficiency and sustainability and the building environment will be a focus for much of this activity, with sustainable building materials being a significant part of that process.

In changes outlined in the review of the New Zealand Building Code, building designers will be required to demonstrate the "intended life" for a building and demonstrate that "sustainable" factors have been given full consideration in material selection.

As one of the country's major companies, **New Zealand Steel** (NZS) began its journey with sustainable business practices 40 years ago, though much of what it has embraced is little known or recognised. NZS – RANZ Gold sponsor – has long been striving to minimise waste and reduce the environmental impact of its mining and manufacturing operation while still delivering innovative sustainable steel products and co-products. It is actively involved in the sustainable building movement and is a shareholder in BEACON, which is running the NOW homes project, a research programme creating affordable homes that are warmer, healthier, cheaper to run and reducing the impact on the environment.

New Zealand Steel advocates the use of Life Cycle Assessment (LCA) as a measurement tool for quantifying the impact on the environment of a product or service throughout its lifespan. This is seen as the fairest way of assessing potential environmental impact and extends from the extraction and processing of raw materials through to the manufacturing process, distribution, end-use and then waste management and/or recycling including all the intervening transportation steps.

Of significance is the fact that embodied energy in building materials is significantly less than the energy consumed by the occupants of the building. In the UK a study by the Steel Construction Institute showed that the energy embodied in the structural system is about 2% of the total energy consumption of the building over an expected life of 60 years.

Research by the Steel Construction Institute found that for an air-conditioned office building over a 60 year design life, the ratio of embodied to operational energy is around 1:10.

Unique local resource

NZS is unique in the world of steel making. This is because it uses its own iron sands resource as a key ingredient in the production of high quality steel and is the only company in the world making steel in this way.

In recent times technology and product development have been at the heart of changes in the steel industry, with increasing importance placed on product lifecycle and a manufacturing process that delivers sustainable products.

NZS was one of the first companies in New Zealand to set up a laboratory to measure the environmental impact of its manufacturing site with air and water quality being constantly monitored and information presented to the Auckland Regional Council and a local environment committee.

The company's objectives of managing its environment and minimising harmful affects from its Glenbrook site was recognised by achievement of ISO 140001, one of only a few major New Zealand companies to achieve this internationally recognised standard. The company had already developed its Environmental Management Systems prior to the establishment of the ISO standard in 1997 and by far the biggest percentage of capital investment in environmental control has been in the improvement of the quality of emissions into the atmosphere.

It is the increasing importance of product lifecycle and a manufacturing process supporting sustainable products that is shaping the future for NZS and its primary manufacturers. It is no longer merely a steel business but one that is producing a number of innovative co-products from what previously were 'waste streams'. For example a co-product from the smelting process is used for road surfacing, soil conditioning, sports field drainage and filtering in waste water treatment by both Auckland City and Franklin District Councils.

Iron sand is concentrated using double drum magnetic separators and further cleaned before stock piling.

New Zealand Steel is the single largest employment site in the country and is the country's largest steel producer (620,000 tonnes of steel per year). New Zealand Steel (NZS) contributes 1% of New Zealand's GDP and over $2 billion into the economy. One half of all steel produced is exported.

Extraction of iron sand

The iron sand extraction process at NZS's Waikato North Head mine site and concentration plant is itself an exercise in improved environmental efficiency. When the iron sand is concentrated using double drum magnetic separators and further cleaned before stock piling, the iron sand is transported in the form of slurry through an underground pipeline over a distance of 18k to the Glenbrook mill. No trucks required. Strenuous efforts have been made to reduce the levels of clay in the slurry and as part of a study into utilising this "waste" material the company is awaiting resource consent to develop a worm farm from the clay material carried in the slurry pipe. The sand that is left over from the extraction process – called "tailings" – is returned to the site where the iron sand was removed and these areas are being progressively planted with Marram grass and pine trees. It is almost impossible in parts of the sand dunes to tell that the area was once mined.

Recycling

The steel industry in New Zealand has a good record of recycling. Scrap steel comes from a variety of sources including the scrap generated in steel plants and the off-cuts generated by manufacturers. There is also steel that has been used to manufacture items that have become obsolete. Steel can be endlessly recycled and does not suffer any product degradation, which makes its life cycle potentially continuous. Steel scrap is a necessary and integral part of the steel manufacturing process and the average recycled content of steel produced by NZS is approximately 12%. The recovery rate of steel from buildings is 85% and a recent report on commercial

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construction waste found that more than 90% of steel was recycled.

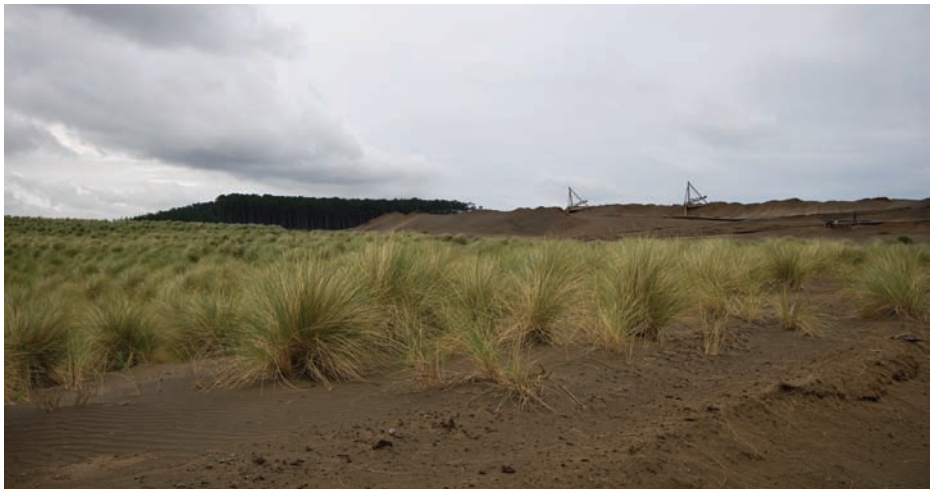
Other waste reduction initiatives include.-

- Nearly 82% of the total waste from New Zealand Steel's sand to steel process is recycled, reused or resold and the company continues to actively pursue new ways to reduce waste.
- Hot gases are recycled to generate 70% of its electricity needs; the waste stream going into the onsite landfill has been reduced 60% in the past three years owing to targeted recycling and reduction programmes.
- 15 tonnes of plastic and 25 cubic metres of polystyrene have been diverted from landfill in the last year; all old machinery and scrap metal on the site has been recycled through the steel making process and the use of chemicals has been reduced.
- One million tonnes of water is circulated through the steel making and finishing operations daily with 2% of the total added each day to replenish discharge water. Maximum conservation is achieved by water being cleaned, cooled and re-circulated many times. A large volume of storm water is collected on site but NZS also takes water from the Waikato River, with an innovative system in place to ensure that fish stocks and recreational users of the river are not affected.

Capital investment

The greatest amount of capital investment at the 190 acre Glenbrook site has been directed into issues concerning the environment, specifically improving the quality of emissions into the atmosphere. NZS is a member of the International Iron and Steel Institute (IISI) which in its first sustainability report for the world steel industry commits to seven key actions including.-

- Expanding the use of efficient technology
- Research into new low carbon steelmaking methods



Marram grass is helping the regeneration of the sand dunes.

- Maximising the recycling of steel and by-products
- Developing new generation steels that improve energy efficiency of the products in which they are used.

Steel cannot be produced without the production and emission of carbon dioxide. However NZS has committed to reduce CO2 emissions to the minimum and has consistently met government targets for reducing these emissions. It is currently involved in a joint venture with a Japanese steel company researching new technology for reducing coal use in the steel making process.

A big factor in consideration of steel for sustainable building is the distance required to transport it through the supply chain and the level of recycling that is possible at the end of its life. As our environmental consciousness is being constantly aroused, the 80% of RANZ primary members involved in metal roofing plus associates in the manufacturing and supply sector should note the following advantages of steel for today's building applications.-

- Steel can be engineered to precise specifications which means minimum waste on site
- It is non-toxic and is available coated to give greater corrosion resistance and durability
- Steel products can be used to reduce the cooling and heating of buildings, leading to reduced energy use
- Steel products are light and easily transported
- Steel products have been in use in New Zealand for over 100 years for the catchment and storage of drinking water
- Steel is the most recycled material in the world and does not suffer any degradation through repeated recycling.
- Steel requires minimum maintenance and has a long life.
- Steel is non-combustible
- Steel has a high strength-weight ratio which means buildings can be extended without the need to alter foundations

NZS's journey for sustainability is a challenging one but has led to exciting product improvements, new products and the development of many co-products from waste such as materials for pigments, material for magnets and even waste material that can be used to manufacture house bricks.

Going forward the company is supporting the development of a standard New Zealand methodology for LCA and is actively participating in this work with a group of organisations with a vested interest in resolving the issues.

Sustainability has become a hot topic of debate and many companies and organisations may just be starting to consider it. NZS had the foresight to predict the impact of its steel making operation on the environment and has been actively managing sustainability since the 1970s. It's almost as if the rest of New Zealand has just caught up.