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Tubular Structures

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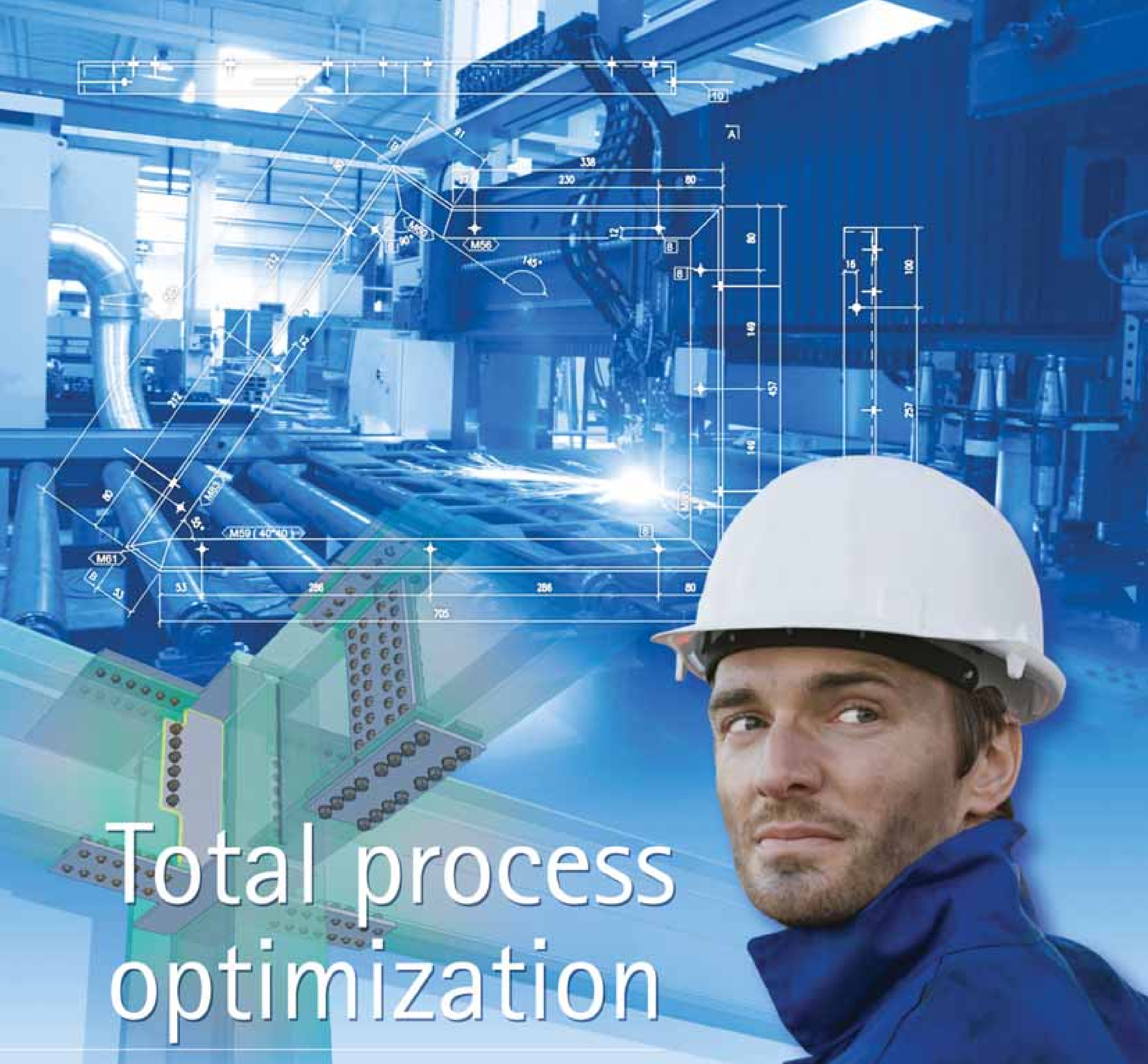
Total process
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EDITOR'S NOTE

What do people read in the 'too-much-information-age'? We (the writers of words) wish we really knew. So I wanted to do a Google search on the matter to see if there was any research done that I could tell you about in a few words. But it was Maurice Sendak's 85th birthday and he was featured on Google's home page 'doodle'. I had no idea who he was (he is a children's book illustrator) and the illustration and animation were done very well. Ten minutes after looking at his work, reading up on Wikipedia I realised I had digressed entirely from my mission and I realised why. I am drawn to art related topics or anything that is cleverly designed. Maybe we are becoming even more discerning in our topics of digression as more and more information floods into our lives. I never got to the research bit...

So our job here at Steel Construction is quite simple – to get you to pick up the magazine while you have other work to do and distract you so that you spend the next ten minutes reading that article on galvanized bolts (and hopefully learn something helpful in the process).

The Steel Awards entries are in and the judges are almost on their way out the door to visit as many shortlisted entries as we can squeeze in the next three weeks.

Steel Construction features three of the entries where tubular steel played a significant role. The Standard Bank office facility in Rosebank has some very impressive steelwork and I cannot wait to see the completed project when I will visit it with the judges. It is also a prime example of the way construction projects and sites will be managed in terms of sustainability and Green Star ratings. In both the other projects sustainability was a big consideration in the way things were ultimately done.

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SAISC COMMENT

By Dr Hennie de Clercq,
Chief Executive Officer, SAISC

In the steel industry Henry Bessemer's converter of 1860 stands out as the big macroinvention. It turned steel from a very expensive material best suited for making exquisite swords into a cheap product available in large quantities.

STEEL INVENTIONS

Rummaging through my bookshelf at home the other day I came upon a book I bought a long time ago but never got to read: The Lever of Riches – Technological Creativity and Economic Progress, by Joel Mokyr. I started reading and soon realised that it lived up to all the accolades listed on the back cover. What was also interesting was that the book was written in 1990 and consequently there is not a single word about the rise of China, even though the dynamic China of before 1400 is discussed at length, as well as why its remarkable technological progress and achievements came to a halt and subsequently went into decline.

Mokyr talks of two types of invention: macroinvention and microinvention. Macroinventions are those things where a "radically new idea, without clear precedent, emerges more or less ab nihilo". Often, the name of somebody who has since become famous can be attached to such an innovation. James Watt's steam engine is a good example, as is Edison's incandescent light bulb. Mokyr defines the term 'microinventions' as "the small, incremental steps that improve, adapt, and streamline existing techniques already in use, reducing costs, improving form and function, increasing durability, and reducing energy and raw material requirements".

Macroinventions count in the tens, microinventions in the millions, and few microinventors have become famous for their contributions. Nevertheless, microinventions are not unimportant; on the contrary, many of the great breakthroughs did not fair too well in the beginning, and only got off the ground when people started tinkering with them. Even Alexander Graham Bell's telephone only got to being a useful instrument once a switchboard was invented and Edison made improvements. As for that larger than life person, the famous inventor, he (they were almost all men) is largely a man of the past. There is still and may always be a role for the independent inventor, but most of the technological progress we see these days is the result of 'R&D' programmes, happening in research labs, conducted by groups of people and led by marketing types.

In the steel industry Henry Bessemer's converter of 1860 stands out as the big macroinvention. It turned steel from a very expensive material best suited for making exquisite swords into a cheap product available in large quantities. But there were many other important innovations, which make one wonder where to draw the line between macro and micro: the open hearth furnace, rolling steel into plates and profiles, using steel as reinforcing in concrete, painting and galvanising for corrosion protection, the electric arc furnace, steel rails, springs, rivets and later bolts, welding... My personal favourite is corrugated iron, dating from 1833 and today one of the 'greenest' products I can think of. (Yes, it was 'iron' then – wrought iron was the only material available.) Perhaps steel's most important contribution to mankind was as an enabling technology, making possible the manufacture of tools and equipment with which to make machines with sufficient accuracy and robustness to work properly.

Two steel products feature strongly in this issue of Steel Construction: hollow sections and light steel frame building. Hollow sections used for structural purposes constitute an obvious derivative of steel pipes used for conveying liquids. Water has been conducted in pipes made of bamboo, ceramics, wood or

lead since some 4 500 years ago. The steel pipe's pedigree goes back to that other hollow tube – the gun barrel – when in 1815 William Murdock used musket barrels discarded after the Napoleonic wars to make gas pipes for lighting the streets of London. Since then tubes have undergone significant development for the purpose of piping, and it was simply obvious that they could be employed as struts and thus as structural elements. The round tube is the ultimate shape for compressive elements, having its material as far away from its centroid as one can have. Over the years tubular construction has been the subject of many microinventions, including the introduction of computerised equipment to facilitate the interconnection of elements at joints. Structural tubes' greatest contribution to innovation may well be that they are another enabling technology: they allow huge scope for creativity in architecture and structural engineering.

Light steel frame building (LSFB) has, like steel pipes, also a post war origin. After the Second World War Japan's housing stock was decimated and they simply did not have enough trees to rebuild using the traditional timber construction. So they happened on the idea of using steel as a framing material. Amazingly, it took a good half century for the rest of the world to discover this form of construction, and even then it was fairly slow to catch on, but in the past 20 years it started moving in the USA, Australia and some European countries. A lot of development work has been done, mostly with respect to the strength of elements, the manufacture of elements and frame assemblies, and computer software to facilitate the process.

But LSFB has proved to be a disruptive technology, which is any technology that leads to the, typically unanticipated, destruction of older technologies. The motor car was, for example, a disruptive technology – it led to the destruction of all the technologies associated with horses and carriages. Light steel framing is busy replacing timber trusses and brick walls, basically because it is better and greener. There is every reason to expect that LSFB will see continued development for many years; it is simply a technology that makes you feel that there's still lots of room for new ideas – the microinventor's paradise.

INDUSTRY NEWS IN BRIEF

GRADE Q345 IMPORTED TUBE DOES NOT CONFORM TO GRADE S355

It has come to the attention of the ASTPM that Grade Q345 is being sold into the local market as equivalent to S355. An investigation into Q345, including a number of tests, has resulted in the following conclusions.

The imported product is a carbon–manganese steel while locally produced tube is typically produced with low carbon micro-alloyed steel. Thus the Q345 has a much higher 'carbon equivalent' content close to the maximum recommended maximum value of 0.45. Tests done on some of this material yielded the following chemistry as shown in *Table 1*. The table also shows typical values for locally manufactured S355.

Grade	Carbon	Manganese	Copper	Molybdenum	Nickel	Carbon equivalent
Q345	0.20	1.24	0.03	0.02	0.02	0.42
S355 (local manufactured)	0.09	0.97	0.015	0.001	0.012	0.24

Table 1.

When using the Q345 tube the fabricator may therefore need to take into consideration these characteristics when setting up weld procedures in order to mitigate the formation of brittle welds.

Hardness before forming Q345 was 80 Rockwell B, similar to the locally supplied tube, but when drawn down, it increased to 97 while the locally supplied steel increased to only 90. This indicates that the Q345 becomes a much harder material when manipulated if compared to locally manufactured tube.

Carbon–manganese steels also affect the elongation characteristics of the steel. The higher the content the less formable it is. Hence these steels should not be used when manipulated as cracking and collapsing of the material does occur. Elongation for Q345 is at the bottom end of the specification which is 22% while the local manufactured tube has an average of 37%.

Lastly but importantly the minimum yield of Q345 is 345MPa which is not the same as the minimum yield of grade S355 which is 355MPa. (For thicknesses less than 16mm).

The members of the ASTPM would therefore like to raise its concerns to engineers and fabricators regarding the use of Grade Q345 in the structural market. In our view and based on the above investigation, Grade Q345 is not equivalent to S355 in terms of mechanical properties in both yield and manipulation characteristics; and that the chemistry is on the top end of the S355 specification which will affect welding characteristics.

For further information please contact the ASTPM at +27 (0)11 823-2377 or send us an email at astpm@astpm.com.

INDUSTRIAL MAINTENANCE IS MADE EASY WITH THE RIGHT EQUIPMENT FROM EAZI

Steel Awards 2013 Partner Sponsor

As the sole distributor of JLG mobile elevated work platforms (MEWPs) in Sub-Sahara Africa, Eazi Sales & Service not only provides access platforms that get the job done quicker, safer and more cost-effectively. The company delivers site-specific solutions that consider unique requirements, as JJF Construction a local steel company can attest to after the successful completion of their maintenance projects.

When JJF Construction contracted Eazi to supply an aerial work platform to complete maintenance and cleaning at Kellogg's plant in Springs, the access specialist advised that this particular application required a more specialised access platform, which could work in a confined space work envelope. Eazi set about sourcing the ideal solution for the application and imported the first JLG Toucan 1310 to South Africa.

"The Toucan was ideal for this application because it works exceptionally well in confined spaces and at heights of up to 13 metres. It also offers good up-and-over reach of 8 meters with a reach of over 5 metres," says Larry Smith, Managing Director at Eazi Sales & Service.

One of Eazi's large steel fabrication clients was losing millions each time it had to halt production to complete maintenance tasks using a scaffolding solution. Apart from being time consuming, having to source scaffolding from suppliers whenever maintenance tasks had to be done and waiting for it to be rigged and then taken down after completion of the work, it was also posing safety risks.

"The client would lose between three and four days of production each time it had to do maintenance and urgently needed a safer and quicker solution.

After an assessment of the terrain and the requirements, we recommended the versatile JLG E300AJP electric boom as the most cost-effective solution. It is suitable for complicated as well as simple tasks and will serve the client's working at height purposes best."

The 1,2 metre wide JLG E300AJP has a reach of over 11 metres and a lifting capacity of 230kg. As it is electric, it emits no fumes. The client has also taken up a maintenance agreement as per JLG-prescribed standards to help ensure maximum uptime and predictable maintenance expenses.

"With these types of contracts, we typically provide user training to ensure that the client can realise the full potential of the JLG aerial work platform. Eazi's JLG representative in Midrand also stocks a full range of spare machine parts, and a dedicated team provides maintenance around the clock, 24/7," says Smith.

The JLG Toucan 1310, sourced specifically By Eazi Sales for maintenance and cleaning at Kellogg's plant, works exceptionally well in confined spaces, reaching heights of up to 13 metres and offering an up-and-over reach of 8 meters.

ROBOR IS THE LEADING LOCAL STEEL SOLUTIONS PROVIDER FOR SOLAR PROJECTS
SAISC Member Company

Robor will supply all steel required to construct the steel mounting structures of two large 64MW solar photovoltaic (PV) projects, allocated in the first round of bids under the South Africa Renewable Energy Independent Power Producer Procurement Program (REIPPPP).

The Letsatsi and Lesedi Projects are located in the Bloemfontein and Postmasburg areas. The combined cost of the two solar PV developments is approximately ZAR 5.15bn (US$586mn) - making these two of the largest PV renewable energy projects in Africa. The projects were two of 18 PV solar projects selected by the South African Department of Energy (DOE) and construction will be undertaken by a consortium led by one of the largest international contractors, ACS Cobra, along with Madrid-based Gransolar and South Africa's Kensani Energy EPC.

The REIPPP programme aims to reduce the impact of electricity generation on the environment and diversify the country's energy mix by encouraging

Robor will supply all steel required to construct the steel mounting structures of two large 64MW solar photovoltaic (PV) projects.

independent power producers to develop the country's abundant renewable-energy resources. "Robor had the strategic foresight to set-up a renewable energy department more than a year ago" says Indiran Gounden, Managing Director of Robor's Structural Solutions Division. Senior Robor executives including the CEO and Chairman visited solar farms and steel component manufacturers in Spain and Germany to understand how the Robor Group could position itself to effectively support the solar industry. "This enabled us to establish relationships with foreign and local bidders for the supply of steel components, galvanizing, tubing and piping for photovoltaic and concentrated solar power systems" Gounden continued.

As an integrated steel solutions supplier, the ability to provide various guarantees and ensure relatively short delivery lead times, positioned Robor as a front runner for steel supply. "It's vital for the success of our projects in phase 1 to partner with a local company that has an excellent track record and financial stability" a representative of Cobra Gransolar said. "When the tenders were allotted the South African government placed emphasis on localisation, BBBEE, community upliftment and job creation. We believe the Robor Group to be our perfect partner to complete these two projects within 18 months" he ended.

Further bidding rounds are expected to take place roughly six months apart from 2013 onwards to allocate the total 3725MW. In line with the country's long-term power plan, South Africa aims to secure a total of 17 800 megawatts of renewable energy or 42% of South Africa's new generation capacity by 2030.

Dodds Pringle, Managing Director of Vital Engineering and Angus McLeod.

INDUSTRY GALVANIZED BY VITAGRID FULLY SERRATED GRATING

Steel Awards 2013 Partner Sponsor

Industrial and mining environments are often harsh on products. Designing and engineering products with this in mind is a key factor in the longevity and reliability of a product.

Vital Engineering uses 350WA mill drawn material in the production of its Vitagrid products. "This ensures a sound, economical and definable design base for all our clients' loading requirements. It also guarantees a high galvanizing quality with a lower maintenance cycle than commercial-quality mild steels," says Dodds Pringle, Managing Director of Vital Engineering and Angus McLeod.

Pringle points out that all Vitagrid and Maclock products are suited to hot dip galvanizing. "An advantage with Vitagrid products is that all the material used is mill dressed, giving a rounded edge on the bearer bars. This allows hot dip galvanized coating to adhere without chipping or corner damage. Slit material that is not properly de-burred or dressed will result in chipping at the sharp edges and have less coating adherence in these areas. This causes transportation and erection damage in addition to earlier corrosion and wear. The net result is high-maintenance cost.

Vitagrid's specialised Maclock handrail tubular system design allows full hot dip galvanizing both on the inside and outside of the stanchions and their accessories, giving the client peace of mind that no uncoated areas will be exposed to corrosion.

Pringle explains that the high level of welding employed to AWS D1.1 standards ensures that porosity is kept to the minimum on fully banded products. "This ensures that critical items, such as stanchions, are welded to provide conformance to safety regulations."

As an alternative to tubular handrails, Vital Engineering developed the Maclock solid forged stanchions in 1940 in South Africa. These high-quality ball-type stanchion units are a single forged unit and are not welded together at the ball joints.

"The copyrighted slotted base plate makes fitment and replacement of any existing type of stanchion holing simple when clients wish to change existing, non-conforming products for either the tubular or solid forged systems," says Pringle.

"The patented Maclock angle section ball stanchion now allows clients to replace all their current site-fabricated angle stanchions with a new, safer alternative that allows a free hand passage along the handrail." says Pringle.

The Maclock angle ball stanchion can now be installed and erected without welding on site and it will maintain its corrosion integrity. This saves end-users considerable production shutdown and maintenance costs, and allows them to maintain a high level of safety in these replacement plant areas.

HOW WELL INTENDED PEOPLE, AND CAREFULLY MAINTAINED SYSTEMS, HAVE ACHIEVED NOTHING IN THREE YEARS

THE TRAGIC STORY OF JOB LOSSES IN THE POWER PYLON INDUSTRY

By Kobus de Beer,
Industry Development Executive, SAISC

While all of this was in progress the total imports during this critical three year period was 31 920 tons! Nothing visible was achieved as three companies closed down or had to change their activities resulting in at least 650 decent permanent jobs being lost for the period.

The futile efforts over the past three years to protect 650 jobs in SA's power pylon manufacturing industry is, indeed, a tragic one which could have been averted.

Eskom requirements for manufacture and construction of new power lines, as well as upgrades and maintenance of existing lines, were, for many years, supplied by local manufacturers, albeit at relatively low levels of activity.

The new power stations being constructed by Eskom, as well as the many renewable energy projects, require substantial investment in a network of new power lines. Eskom set out these requirements systematically and they pro-actively convene regular meetings with industry to outline details of their future power line requirements. As expected these plans show considerable growth and sustained increased requirements over a period of up to ten years. In practice, Eskom has had to revise these plans downward every year since the build programme achieved did not match expectations. The future requirements remain at high levels.

During 2008 imports of fabricated power pylon steelwork rose to 12 425 tons from 1 041 tons the previous year, mostly supplied from India at extremely low prices (this later proved to constitute 'dumping'). Local industry found itself in the frustrating position of not participating in the growth of their own market. The crisis did not improve in 2009 as overall activity levels were down.

In November 2009 BUSA (Business Unity South Africa) met with the Minister of Trade and Industry, Mr Rob Davies and tabled a list of 22 products or industries in crisis. This was the result of extensive consultations with industry to select worthy 'problem cases'. The Minister studied these crisis cases and then advised the industries to follow the formal system of making applications through ITAC (International Trade Agreements Council), a department working under the dti (Dept. of Trade and Industry) administrating trade agreements and applying Ad Valorem Duties on imports.

During April 2010 a formal ITAC application was submitted. The wisdom of having to do this was clear as the application demanded full information on the industry, a detailed listing with addresses etc. of the participants, breakdowns of people employed, past, current and future production volumes as well as cost and pricing structures. This required considerable effort and investment on behalf of the industries, with care needed to stay within the constraints demanded by the Competitions Commission.

During August 2010 the application had finally been processed (the 'normal' processing period is three to four months) and it was gazetted for comment. Again the system could only be admired since adequate opportunity was given for objections and further clarification – a process that closed in December 2010. Imports of power pylon steelwork was at 6 052 tons in 2010.

In March 2011 the imposition of a 15% Ad Valorem Import Duty was gazetted, bringing these products in line with all other types of fabricated structural steel products. Eskom promptly applied for and received exemption of these duties on existing contracts, thereby limiting the effect of the increased cost of duties on electricity prices.

In October 2011 an application was prepared by the dti working with industry for power line steelwork to be 'designated' in terms of Section 9 of the revised regulations to the PPPFA which empower the dti to designate certain industries that are of 'critical importance' for local manufacture by organs of state and public entities.

In December 2011 Minister Rob Davies announced the designation of a number of products which included power pylons. A specific local content target is set for different products and in the case of power pylons it is 100%. A further notice from the dti allowed the import of the raw steel requirements as these would be deemed local content – this has not yet been used by any fabricator. During 2011 imports of power pylon steelwork was at 15 857 tons.

During the first 11 months of 2012 a further 10 011 tons of imported power pylon steelwork arrived. Eskom was very fairly exempted from the designation ruling on existing contracts and at one of the industry information sessions formally advised all its suppliers of the future designation requirements.

While all of this was in progress the total imports during this critical three year period was 31 920 tons! Nothing visible was achieved as three companies closed down or had to change their activities resulting in at least 650 decent permanent jobs being lost for the period.

At the beginning of 2013 Eskom had placed only 540 tons of new power pylon work in South African industry in terms of the designation directive. Expectations are that little new work will be placed before mid-year, but that after that – now almost four years later – things will improve. We live in hope!

So, Eskom tries to work as cost effectively as possible, the Minister and dti takes appropriate action insisting industries prove their cases, ITAC acts within the disciplined structures and prescribed timelines and the industry does whatever is required to survive, including importing from competitors. This system has many redeeming characteristics, BUT IT TAKES FAR TOO LONG TO BE USEFUL. How do we explain what happened to the 650 breadwinners and their 2 000+ dependents?

A major part of the answer lies in the recent introduction of the 'designation' concept and applying it quickly. The Minister and dti are commended for this initiative and for extending it to other products and industries. Work is needed to add responsibly to the list and to extend similar local content specifications to all major buyers and investors in South Africa.

THE LSFB INDUSTRY TAKES ON THE CHALLENGE OF BUILDING IN FRONT OF TV CAMERAS!

By John Barnard, SASFA director

The earliest we could start on site was 7 May, and the footage for the final episode would have to be taken in the week starting 17 June, which gave us five and a half weeks or 39 days to complete the second storey… That was a tight programme, even for LSFB!

During March 2013, SASFA was approached by the producer of a TV programme asking whether the light steel frame building industry would be interested to add a 140m² double storey section to a masonry built house that will be renovated. The focus of the 13 part TV series was on 'eco-friendly building', and the producer felt that LSF would be the ideal solution to extend the house upwards.

All the material and component suppliers to this industry were keen to get involved, and detailed planning was carried out *(see the list of sponsors at the end of the article)*. During my first visit to the site in Parktown on 22 April, some walls of the existing masonry building were still being broken down to accommodate the changes in the house plans. By that time the series of TV programmes had already started, with the final programme scheduled for 25 June, only two months away!

SASFA appointed a builder who had completed some large LSF houses in the past, and drew up a day-by-day building schedule. The earliest we could start on site was 7 May, and the footage for the final episode would have to be taken in the week starting 17 June, which gave us five and a half weeks or 39 days to complete the second storey… That was a tight programme, even for LSFB!

As a first step, our builder visited the site, and took accurate measurements of the existing walls. Due to the accuracy of LSFB and the time wasted when having to adjust frames on site, these dimensions were to be used for the manufacturing of the floor joists and wall frames.

Things started off well – the first batch of floor beams were delivered, as well as fasteners, the shutterply and Nutec floor boards, and the rubber underlay. Deliveries were made difficult due to poor and limited access to the site. On 7 May it became clear that there were two places where our structure was not supported by masonry walls, and we had to install some hot-rolled steel beams for support.

These beams were ordered as a matter of urgency, and the supplier promised delivery on Friday 10 May. When it was not on site by the Saturday morning,

22 April – the second storey in LSF had to be built on top of the masonry walls.

Light weight floor construction: 18mm shutterply (plywood), followed by a 3mm thick layer of closed cell foam rubber (sponsored by Global Innovative Building Systems) and finished off with 15mm high density fibre cement board (Nutec, sponsored by Everite). The spade was not used to mix anything, merely to space the floorboards 2mm apart.

I spent four hours on my phone to get someone to deliver the load. Some of the directors of this large concern were also roped in during the course of events. Regretfully, "all the King's horses and all the King's men, could not..." arrange the deliveries on the Saturday. We had to wait until after the weekend.

Our builder (as opposed to the masonry builder) started installing the floor joists and the shutterply (plywood) floorboards, and by 11 May some of the joists were up.

Watch this space for the completion of the project in the next issue of Steel Construction!

MAJOR SPONSORS

ArcelorMittal SA
Galvanized steel for frame, Chromadek for roof cladding

Saint-Gobain SA
Gypsum board (lining and ceilings) and insulation

Everite Fibre-cement
External cladding, floor boards

Lafarge Gypsum
Gypsum board (lining and ceilings)

Trumod
Steel frame design and manufacture

OTHER SPONSORS

Mike Hull
Consulting engineer

Global Innovative Building Systems
Rubber mat and strips

Trowel-on-Textures
External render and paint

Kare
Fasteners, frame and roof

Speedfit Africa
Plumbing and installation (pipes)

Clotan Steel
Profiling of roofing, slitting of galvanized steel

Marshall Hinds
Vapour permeable membrane (Tyvek)

Simpson Strong-Tie
Fasteners, bracketry, tooling

Plascon / Terraco
Sealing of external joints between Nutec boards

LSF floor joists bearing on a hot rolled I beam.

After 17 days on site, the floor is installed and the first wall panels go up. Another advantage of LSF – it is photogenic!

SASFA TRAINING COURSE FOR BUILDING CONTRACTORS – MAY 2013

By John Barnard, SASFA director

This course is growing in popularity, as an increasing number of building contractors, developers, architects and engineers wish to become more knowledgeable on LSFB.

The student group in front of the structure they had erected.

SASFA has successfully presented its six-day training course for light steel frame building contractors during the week 20 to 25 May 2013 – for the 11th time! The course was presented at Saint-Gobain's facilities in Samrand, and was oversubscribed to such an extent that we will arrange another course in Gauteng later this year.

Two other courses are planned, one in Durban from 29 July to 3 August, and one in Cape Town from 22 to 27 October 2013.

This course is growing in popularity, as an increasing number of building contractors, developers, architects and engineers wish to become more knowledgeable on LSFB.

The course is split into two sections:

Steel frame components, and erection (4 days), covering introduction, the steel making process, properties of coated steel sheet, foundations, manufacturing of light steel frames and trusses, construction tools, wallframe set-out, handling, loads, floor framing, wall framing, roof structures, and the installation of services, and

Internal lining and insulation (1 day), covering the properties, manufacturing and benefits of glasswool insulation, acoustics, energy efficiency, environmental issues, storage and handling of glasswool, tools and installation methodology.

This is followed by the section on gypsum plasterboard covering properties, storage and handling, cutting, tools and application for walls, ceilings and finishing.

Finally fibre cement board for external cladding is addressed, including the installation of the vapour permeable membrane, sizes and availability of fibre cement – boards and planks, fixing accessories, installation guidelines, and door and window frame installation detail is presented.

To ensure that the theoretical concepts are well understood, the course includes a practical component, consisting of setting out of wall frames, squaring, levelling, and erection of walls, erection of roof trusses, installation of plumbing, external cladding (FC boards, OSB and FC planks), insulation and internal lining (gypsum board), and internal joint finishing. Finally, it is illustrated how difficult it is to make a hole in 15mm thick gypsum board, and how easy and quick it is to repair.

All the students rated the course highly, especially mentioning the value of the practical work. As part of the course, the students have to write two tests to confirm that the subject matter was understood. All of the students on this course passed, and received SASFA certificates of successful completion of the course. This brings the total number of students who completed this course since its inception in 2009 to 156.

The SASFA members who supplied support for the course and made it possible were Saint-Gobain, MonI Frames, Everite, Kare, Simpson Strong-Tie and Speedfit Africa. Bosch Tools also illustrated their wide range of equipment suitable for use in the LSFB industry.

Peter de Bruyn from Bosch Power Tools, illustrating the use of their laser level. He is well known for his role in 'Get it done!', a DIY program on the Home Channel.

Peddinghaus

BETTERECT - JOHANNESBURG, SOUTH AFRICA

BETTER THAN EVER

The Betterect Management Team:
Martin Zechner/Nicolette Skjoldhammer/David Jordan

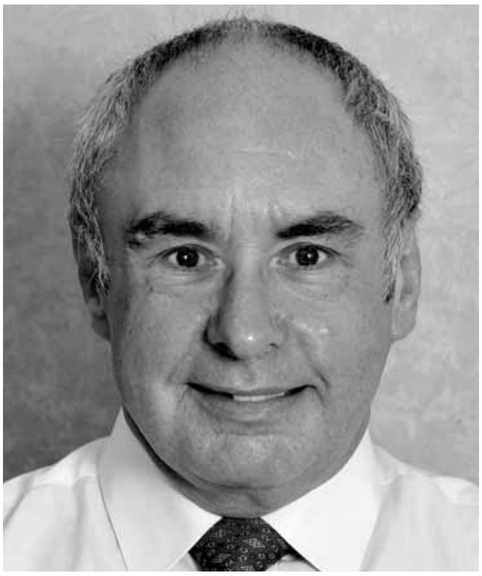
Facing the very same challenges as many other fabricators, Betterect found themselves searching for ways to enhance quality, reduce process time, and minimize their reliance on difficult to locate skilled labor. This required a leap of faith from traditional manual methods to automated processes.

"To date our Peddinghaus machines have significantly reduced production turnaround times and have enabled us to fabricate larger tonnages than before. The equipment has definitely given us a competitive edge in the structural steel arena and has allowed us to take on more jobs in this line of work."

-Martin Zechner
Founder/Managing Director

OLD WAY

NEW WAY



Carl Davies.

WORLD FIRST FOR LIGHT STEEL FRAMING

By Carl Davies, General Manager, The National Association of Steel Framed Housing Inc. New Zealand

Carl Davies presented a talk – Seismic testing – A world first for light steel framing at the Institute's SteelFuture Conference in March 2013. Here is an article to summarise the findings.

Historically, the seismic performance of wall ties that attach the brick veneer to a load bearing frame have been established from small-scale tests conducted according to the requirements of AS/NZS 2699.1. The test procedure consists of subjecting the specimen to prescribed levels of displacement in both the in-plane and out-of-plane direction such that the performance of the wall ties can be evaluated; the seismic veneer tie is classified through minimum characteristic axial strength and stiffness values given in this Standard as: light duty (EL); medium duty (EM); or heavy duty (EH). The levels of displacement given in AS/NZS 2699.1 have also been used by the Building Research Association of New Zealand (BRANZ) to pre-rack test specimen's in-plane, before subjecting them to out-of-plane sinusoidal loading at various frequencies to establish the seismic performance of brick veneer attached to timber load-bearing frames.

Light steel framing has gained a high market share internationally, with New Zealand companies being a leading international supplier of roll forming technology. The high strength, thin-walled steel used in Australasian light steel frame construction is unique, which means that none of the seismic testing undertaken in Northern Hemisphere countries on frames using thicker, lower strength steels is directly applicable to New Zealand practice. Following concerns raised over the seismic performance of brick veneer attached to light steel framing, through elemental tests conducted according to AS/NZS 2699.1, an obvious question is how realistic is this form of test compared to the performance that would be exhibited by this type of construction when subjected to real earthquake records. To investigate this question in detail, full-scale shaking table tests have recently been undertaken by the National Association of Steel Framed Housing (NASH) at the University of Melbourne.

The objective of the test programme was to assess the performance of light steel framing with brick veneer walls when subjected to out-of-plane earthquake loading, having been previously subjected to in-plane loading (which had the potential to weaken the veneer/tie/stud system). The

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Given that the test house was designed using conventional methods, constructed from typical components and built using professional NZ trades people, it would be considered to be representative of brick veneer steel-framed construction in New Zealand.

magnitude of the earthquake loading was determined in accordance with defined performance levels under the New Zealand Earthquake Loadings Standard, NZS 1170.5, so that the performance achieved in the test could be directly related back to expected limit state conditions for New Zealand. The test house measured approximately 2.6m x 2.8m in plan and 2.4m in height. It comprised a light steel frame with brick veneer exterior cladding and plasterboard interior lining. The steel frame was manufactured from 0.75mm thick G550 lipped C-sections. The bricks were standard 70 Series, and Type B brick ties.

The brick ties were screwed to the flanges of the studs through a standard 40mm x 10mm thick thermal break. The front and side walls were separated at the corners, in order to simulate the critical case of long brick veneer walls. A roof slab weighing 1 500kg was placed at the top of the test house and was supported by the frame to simulate the equivalent mass from a house roof; this roof mass combined with the designed frame wall bracing resulted in the test house exhibiting the same dynamic characteristics as those of a typical full-scale single-storey brick veneer house. The test house had a fundamental natural frequency prior to earthquake shaking of approximately 6 Hz.

The test house was subjected to earthquake motions based on the El Centro 1940 North-South record, scaled to generate levels of earthquake loading ranging from serviceability (SLS) to maximum considered (MCE). To ensure that the appropriate levels of loading were applied to the test house, the target shaking levels were verified by measured table accelerations. The test house performed extremely well, with MCE levels of shaking only causing minor cracking to the plasterboard and brick veneer walls (even though at this level of loading, major loss of the veneer walls would be considered acceptable). Owing to the exceptional level of performance up to MCE earthquakes, the test house was subjected to even more severe shaking. The test house did not suffer serious damage up to, and including 2.6 times, El-Centro (which is approximately 1.51 MCE; equivalent to magnitude 9 on the Richter scale), with no bricks being lost from the out-of-plane walls. This is extremely good performance given the fact that the test house had already been subjected to 7 high level earthquakes prior to the 2.6 El-Centro shaking. The testing was terminated after a final shake equivalent to 2.7 El-Centro (1.57 MCE) due to the capacity of the shaking table having been reached.

Given that the test house was designed using conventional methods, constructed from typical components and built using professional NZ trades people, it would be considered to be representative of brick veneer steel-framed construction in New Zealand. With its excellent performance under an extremely onerous earthquake testing programme, it can be concluded that this form of construction would be expected to exhibit performance considerably better than the most demanding design seismic conditions in New Zealand. Moreover, it would appear that the small-scale tests given in AS/NZS 2699.1 are not entirely appropriate for this form of construction.

ACKNOWLEDGEMENTS

This project was fully funded by the light steel framing industry and administered through NASH. The testing was undertaken in April 2009 at the University of Melbourne, under the direction of Prof. Emad Gad, with technical support being provided by Prof. Charles Clifton of the University of Auckland, BRANZ and NASH (Australia). The design of the test house was conducted by Graham Rundle of Redco (NZ) Ltd. The tests were witnessed in person by Dr Stuart Thurston of BRANZ, who was impressed with results and the professionalism of the work undertaken.

Feedback at all stages of the loadings selection and performance requirements were generously provided by the New Zealand Department of Building and Housing (DBH).

MAGNIFICENT WATERFALL COUNTRY ESTATE HOME BUILT WITH LIGHT STEEL FRAME BUILDING

The initial idea to use LSFB came from the architect. "This is a new methodology that has really stuck its head out in South Africa, and when I became aware in early discussions that time was of the essence, I insisted that we investigate LSFB as an option," said Kevin Els, of the innovative Fourways-based Els & Associates Architectural Studio.

If there were any doubts that the light steel frame building (LSFB) method is appropriate for upmarket housing in South Africa, then the magnificent new Kevin Els-designed home, built by Ivecon Projects in the new Waterfall Country Estate development north of Johannesburg, will certainly help to finally put those doubts to rest.

The spacious double-storey, which has 680m² under roof and a host of impressive design features – including breathtaking cantilevers, a home theatre, and a glass-walled wine cellar within the hypermodern kitchen – is a testament to the possibilities offered by LSFB.

The initial idea to use LSFB came from Els, of the innovative Fourways-based Els & Associates Architectural Studio. "This is a new methodology that has really stuck its head out in South Africa, and when I became aware in early discussions that time was of the essence, I insisted that we investigate LSFB as an option," he says.

Construction is significantly faster with LSFB because the lightweight steel frame is manufactured to specification in the factory and then assembled and erected very quickly on site. Once it is in place, the building can be enclosed and internal finishes, such as tiling and painting, can start much sooner than in a bricks and mortar structure. The method also saves time because it allows different disciplines to work concurrently. It is not necessary, for example, to wait for a completed facade before finalising accurate measurements for windows. LSFB can also be used in conjunction with heavy structural steel, which may be required for long spans or cantilevers, or to expose as part of the architectural expression.

But time-saving efficiency is only one of the many advantages of the LSFB method – others include environmental sustainability and long-term cost-saving.

LSFB is significantly more energy efficient than more traditional construction methods – both with regard to 'embodied energy' of the materials and components, as well as 'operational energy' relating to heating and cooling of the building over its design life. A recent research project carried out by the CSIR indicated that a LSF building will require less than half of the energy needed to heat and cool an equivalent masonry residential building to comfortable internal temperatures. This means significant cost-saving on heating and air-conditioning in the long term.

Steel is also a reusable and recyclable material, which means that it reduces the overall carbon footprint of the project and assists in compliance with the SANS 10400-XA:2011 national building regulations.

Sven Iversen, founder and director of Ivecon Projects, the construction and project management team involved with the project, has travelled extensively worldwide and says that in Europe, New Zealand and Australia, LSFB is the growing trend. "In South Africa, people are simply used to brick and mortar building, but it is only a matter of time before the mainstream South African building market catches on to the advantages of the LSFB method."

project team

Developer/Owner:
Dr Predeep Mistry

Architect:
Els and Associates Architectural Studio

Project Manager:
Ivecon Projects

Main Contractor:
Ivecon Projects

LSFB Fabricator
Innosteel (Pty) Ltd

Iversen says the building industry is continually evolving and that technology is the driving force. "Traditional building methods are no longer the only answer. Ivecon Projects embraces new technologies and is moving toward innovative, energy-efficient methods of construction, fast-tracking construction time which translates into cost savings for our clients," he says.

Ivecon Projects recently won the Best Built Home and the Green Design awards at the prestigious Century Properties Home Show.

From a construction point of view, there are numerous advantages to LSFB. Steel is unequalled in meeting tight construction schedules in any weather conditions, a smaller construction team is required, and because a limited amount of masonry work, if any, is required on site, LSFB ensures a cleaner and safer construction site.

"From an architectural perspective," says Els, "there are many reasons for the architect to feel comfortable and confident when designing with light steel framing. It is flexible enough to handle complex design elements, giving you freedom of expression in your design methodology. Also, steel has slenderness and grace when required to span distances and cantilevers."

Els added that allowance must also be made in the design to cater for technical issues such as truss depth – as opposed to concrete slab thickness – as well as bracing methods, external or internal treatments and finishes and cladding, for example.

"Although the majority of the bracing elements are handled by the steel frame supplier and engineer, a close relationship between the architect and steel engineer / steel frame supplier should be maintained to enable a range of elements in the design such as ducting, electrical points, plumbing recesses, fixtures and finishes to be incorporated successfully," he said.

The silky deep-grey exterior of the house was achieved using 60mm thick EPS (expanded polystyrene) light-weight cladding, fixed to a light steel framework. The expanded polystyrene is plastered with a special, colour-impregnated polymer plaster rendering. Because no expansion joints need to be cut, a smooth, waterproof exterior surface is achieved.

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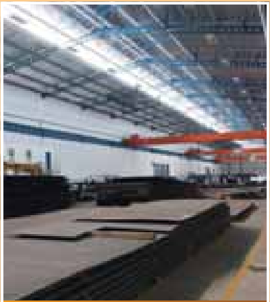

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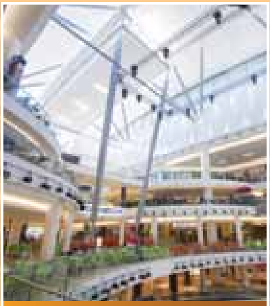
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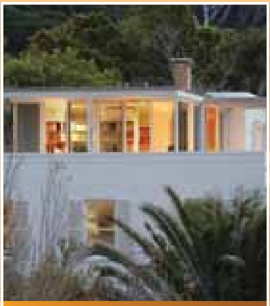
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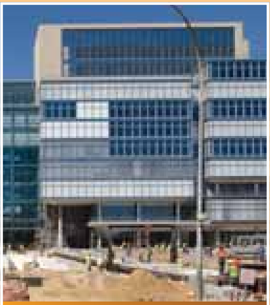

16. Standard Bank of South Africa – New Office Facility, Rosebank

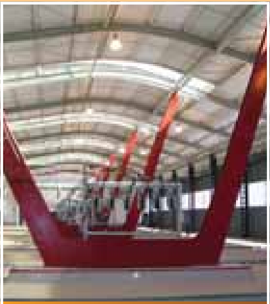

17. Elution Plant Gold Room


18. New Sports Facility for Afrikaanse Hoër Meisieskool Pretoria


19. House Jones


20. SBS 3.3ML Sheet Steel Water Tank


26. Mall of Rosebank – Link Bridge


27. BRT Dobsonville – Head Office and Workshops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STANDARD BANK OFFICE COMPLEX, ROSEBANK

By Spencer Erling,
Education Director, SAISC

Standard Bank has subsequently been awarded a five-star Design rating by the Green Building Council of South Africa and is still on track to achieve the four-star rating targeted in terms of the final As-Built certification.

In what must be just about the most choice position in suburban commercial areas of Johannesburg, Standard Bank is developing a new office block for their own use in Rosebank, filling the whole block bounded by Oxford, Bolton, Baker and Craddock streets.

To further add to (what do the estate agents say? "Position, position, position!") the great location, is that the Gautrain's Rosebank Station is indirectly opposite the site and Rosebank shopping areas a mere five minute walk away.

But apart from it being a great looking building (with lots of exposed steelwork) on a prime property site, it will also be one of the few 4 Star Green Star awarded buildings in South Africa.

APPLYING THE GREEN STAR RATING CRITERIA DURING THE CONSTRUCTION PHASE

Firstly the Green Building Council of South Africa's star rating system is extensive and includes many categories. Standard Bank opted to target 4 Stars in both the 'Design' submission as well as the 'As Built' submission.

Standard Bank has subsequently been awarded a five-star Design rating by the Green Building Council of South Africa and is still on track to achieve the four-star rating targeted in terms of the final As-Built certification.

The As Built submission is used as the mechanism to judge the implementation of the design in the final building product in respect to the sustainable building features. The whole building process, materials, waste, noise, air pollution, hygiene etc are taken into account. Each contractor on site has to abide by the Environmental Management Plan or face heavy fines.

Caylene Pienaar, WBHO's Green Star SA Accredited Professional, is responsible for their Green Star rating reporting and the 'green' buck literally stops at her desk in terms of the construction and building site. Each and every material used on the site has to comply with the various credits as specified by the Green

Building Council of SA in the Office v1 Technical Manual (example: low VOC (Volatile Organic Compound) paints/adhesives/insulation used, sustainable timber, recycled steel etc).

Recycling the waste on the building site is a story on its own. There are eight workers tasked with collecting, sorting and cleaning all waste material every day. This is not your usual glass, cans and paper system. Almost everything conceivable can be recycled today and reprocessed to either become something totally different or used to produce the exact same product as it was before. For example rubble is turned into low MPa bricks, wood crates are chopped and sold to nurseries for mulch, and gypsum board is pulverized and used as fertilizer.

The recycling process has to be followed from sorting the waste to delivering the waste to a waste specialist company then receiving proof from that company that it reached the source that turn waste into new products. Waste that cannot be recycled is kept separate and disposed of with minimal harm to the planet. What ends up in the landfill is very little.

WBHO is responsible for each contractor's environmental management in the end. Should a contractor not want to be part of the WBHO system they are still responsible for assessing if that contractor's system is according to the rules. The contractor must then have its own environmental plan, waste separation system and train their staff accordingly.

Each contractor has to submit a quality file and a green star file for their involvement in the project. Things that were hardly thought of, like what do you do with the leftover paint on brushes etc, have to be documented on how you ensure that the environment is not harmed by your actions.

Tass Engineering, the steelwork specialist sub-contractor, took a lot of trouble to submit a fully conforming bid paying attention to how they could contribute to the green building assessment and play their role as a 'green contractor'. For example water based Dulux 'Eco System' paints have been specified for the painting of the steelwork.

They had one advantage over some other contractors – their material, steel, is 100% recyclable.

THE STEEL IN THE STANDARD BANK BUILDING

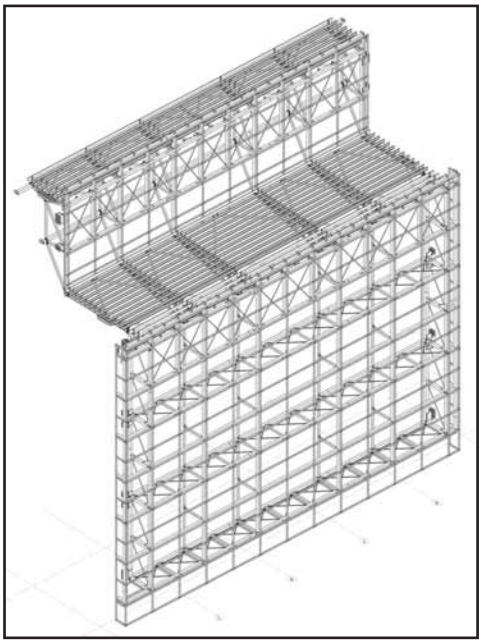
The major steelwork consists of three atrium facades and roofs. All three roofs are identical except for the manner in which the facades connect to the roofs.

The Standard Bank Rosebank site is an example for other building sites in terms of health and safety and environmental responsibility.
Photography: Jamie Thom/WBHO

Being glass clad on elevation (yes, double glazing to reduce energy consumption) the steelwork is largely exposed. The most difficult and so most interesting section of work for both engineers and contractors is the north facing atrium.

THE NORTH FACING FACADE AND GIRDER

This 36m (approx) wide facade hangs off a 4m deep main girder up at the lower roof level. What makes this girder exciting is the construction. It is made from 260 x 260 square hollow section (SHS) verticals and top and bottom chords, with the lacings consisting of 50mm diameter solid round bar crosses. The diagonal members are designed not to connect to each other where they pass at their midpoints. Perhaps the biggest challenge for the team was how to connect the solid round bars to the vertical / chord intersections with three main aims in mind:



The 36m wide facade hangs off a 4m deep main girder up at the lower roof level.

1. The forces are quite large and therefore sufficient welding must be laid down to ensure that the forces are shared by the two flange faces of the verticals and chord members.
2. The intersection points of the centres of gravity lines must meet in a common centroid.
3. The end finish is exposed so must be architecturally finished to the highest standards.

To achieve these requirements the gusset plates have been let into the chord SHS sections through a slot in the inner face through which to pass the gusset and a slot in the outer face which is used to 'slot weld' the gusset plate to the outer face. In addition fillet welds have been installed on the inner face of the SHS to connect it to the gusset. To keep the rectangular lines of the verticals and chord members (an architectural requirement), the connecting gussets were kept slightly inside of the radiused corners of the SHS sections and packs were inserted between the gusset plate and SHS wall where bolted connections were being made through the side wall of the SHS member.

Now the real issue: How does a fabricator do this productively and structurally effectively?

With careful planning, the required slots were cut into the chords as part of the material preparation process. Separate detailed drawings were produced of the nodal gusseted assemblies to maximise productivity. In addition to the diagonal / chord intersections, at each node, connections were required either below the bottom chord to accommodate the hanging columns of the facade or above to receive short vertical frames. A method for achieving these connections had to be devised.

The chosen method entailed making up separate pre-assemblies of the combined gusset plates for the diagonal connections together with the connection plates that extend through in a 'U' shape to pick up the extensions above or the hangars below. To simplify and standardise these connections, all nodes were made the same despite the bigger forces involved with the hangars below the girder when compared to extensions above the girder. This 'plated node assembly' was fully welded before offering it to the chord members.

It sounds so simple, but hats off to the professional (Pure Consulting) and fabrication teams for arriving at a 'buildable solution' that satisfied all the structural and aesthetic requirements.

Once the nodes were fitted and welded to the chords, the round bars diagonals still had to be connected to the gussets. This was done by means of 50mm thick end plates through which the round bar diagonals passed and were welded on both sides of the end plates. The diagonals with end plates were then fitted into the girder with the end plates between the gussets mentioned above and welded on the outer exposed faces to the gussets.

The erection of the components needed the services of a 220 ton capacity mobile crane.
Photography: Jamie Thom/WBHO

PRE-CAMBERING THE GIRDER

And in case you think that the above had its complications, now understand that the engineer needed a pre-camber to be built into the girder. Not just any old rule of the thumb pre-camber either. As glass was to be attached, it is important that when fully loaded with the glass, the girder should be true and horizontal. Once again congratulations to the team for devising the method.

In addition to the pre-camber, pre-tensioning of the round bar lacings was used to limit the amount of camber coming out when loading took place. To achieve this, the following steps were planned:

1. When the diagonals with end plates were fitted into the girder the one end plate was initially welded to its node gussets and then the diagonal was heated to a measured extension before immediately welding the loose end plate to its node gussets.
2. This procedure is also applied to the members involved in the site welded splices.
3. Once all the pre-tensioning and welding of the diagonals are complete, cover plates are inserted to hide the actual connection from view.
4. The pre-camber was built into the girder in the workshop and checked during site splicing.
5. The facade, despite being designed as a hanging facade, was built in the normal upward direction on temporary supports - all the vertical members being SHS profiles. The main support girder was then erected onto its two supporting 'vertical latticed side girders' which carry the main girder loads back to the supporting concrete work.
6. The shape and style of these vertical lattice side girders are in keeping with that of the main support girder. The vertical side girders carry the full vertical load of the facade and are connected to the supporting concrete work via a load carrying connection at the top and three sets of vertically slotted connections lower down which resist horizontal wind loading. This assists with accommodating expansion and contraction of the facade.
7. All wind forces from the glazing are carried across the facade span by horizontal wind girders (once again style in keeping with the main girder) which are connected directly to the vertical side girders.
8. Once all the steelwork to the facade had been erected, the pre-camber of the girder was pulled out by pulling down on the hanging columns, clamped to temporary supports and kept horizontal until all the glazing and finishes were attached. Only then were the clamps released leaving a truly horizontal facade.

SOME MORE ABOUT THE CONSTRUCTION

As with all their complicated jobs, Tass Engineering does a considerable amount of trial assembly as part of their process allowing for critical holes to be drilled when the steelwork is in the trial assembly stage to ensure accurate fit up on site.

As mentioned the vertical 'glass supporting members' are square hollow sections. To ensure a high architectural finish a combination of hand holes to permit tightening from the inside and countersunk bolts are used. The bolts will be hidden from view by closing up with body filler on final completion. All hand holes will be closed after use; those that need to be 'structural' will be fully welded up. Fortunately the bulk of the hand holes need to be closed for architectural appearance only.

SOMETHING ABOUT THE ERECTION

The girder was delivered to site in three pieces and welded together. To achieve the complete joint penetration welds, as suggested in the American Welding Society's specifications, a close fitting sleeve is inserted inside one end of the tubes. All important site welds were ND tested.

The girder was delivered to site in three pieces and welded together.

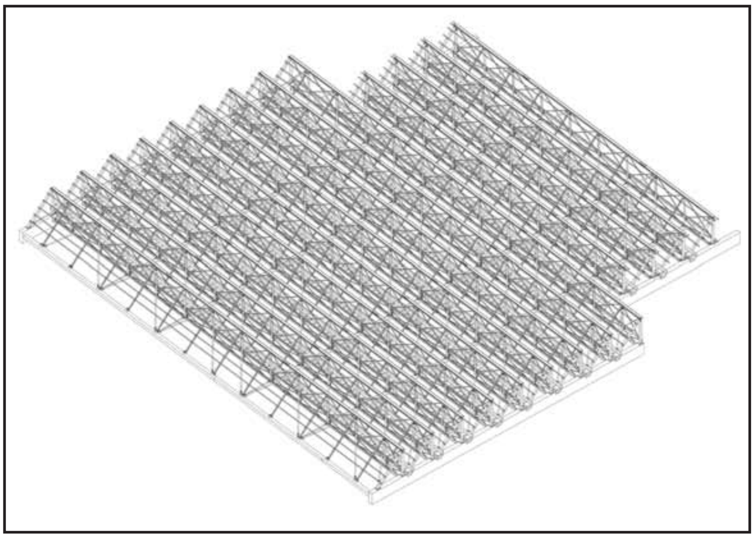
The roofs to the three atriums are basically identical. Normally one thinks of saw tooth construction as being 'old fashioned' and pretty industrial in their nature. This does not apply to these roofs.

The erection of the components needed the services of a 220 ton capacity mobile crane. This necessitated ensuring that the permanent concrete structure could withstand the crane loads. A back-propped roadway to reach the position from where the crane was positioned as well as under the outriggers and wheels has been designed and installed through four levels of concrete.

Since this requirement was qualified in Tass' bid, WBHO, the main contractors, and professionals were able to take advantage of this early warning both from a budget point of view and to do all the necessary planning and installation of the back-propping timeously.

THE SAW TOOTH ROOFS TO THE ATRIUMS

The roofs to the three atriums are basically identical. Normally one thinks of saw tooth construction as being 'old fashioned' and pretty industrial in their nature. This does not apply to these roofs. The vertical portions are cladded in glass to permit lots of light. So this steelwork is once again exposed square tubing construction. The sloping portions are hidden behind ceilings.



Detailed drawing of the main roof.

The smaller atriums do not have hanging columns as does the north facing atrium. The construction is thus relatively simpler than that described above. There is structural concrete work at each end to carry the girder for the two smaller atriums.

It will truly be an accomplishment for the whole project team once the building has been completed and awarded its Green Star rating. It will be one of the few 4 Star Green Star buildings in South Africa and it has paved the way for future construction. The entire construction team has also been made aware of and trained in how a building site should be managed so that its impact on the environment is minimised.

project team

Developer/Owner:
Standard Bank

Architect:
GLH Architects

Structural Engineer:
Pure Consulting (Pty) Ltd

Facade Engineer:
Pure Consulting (Pty) Ltd

Quantity Surveyor:
Norval Wentzel Steinberg (Pty) Ltd

Project Manager:
Standard Bank Properties

Time Manager:
Orion Project Management

Contract Coordinator:
mstudio (Pty) Ltd

Main Contractor:
Wilson Bayly Holmes - Ovcon (WBHO)

Steelwork Contractor:
Tass Engineering (Pty) Ltd

Detailers/Detailing Company:
Precise Structural Modelling (Pty) Ltd

Erector:
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ROOIELS BEACH HOUSE

Text and photography by George Elphick, Elphick Proome Architects Inc.

The use of a steel frame to construct a building set in an extremely hostile climate in a coastal environment seems like an unsuitable choice! However, the visual lightness envisaged for the pavilion and particularly the long spans and cantilevers demanded the use of steel as the primary structure.

The brief from the client, a maverick businessman from Johannesburg, was a single space leisure house capitalising on the site's remarkable environment in the small village of Rooiels. The genesis of the building was a sketch on a paper napkin over a calamari lunch in Hermanus some five years ago. A torturous journey ensued with the creation of a landmark beach house set amongst the fynbos on an exposed rocky peninsula.

Designed as a glazed pavilion with sub-divisible internal spaces foiled with mechanically operable timber solar screens, the house is raised on a semi-submerged concrete podium. Counterpointed by a freestanding pool and subterranean entry court and garage, the elongated pavilion with a floating curvilinear roof displays a sophisticated, minimal architectural language which hovers gently in its unique setting.

STEELWORK INNOVATION

The use of a steel frame to construct a building set in an extremely hostile climate in a coastal environment seems like an unsuitable choice! However, the visual lightness envisaged for the pavilion and particularly the long spans and cantilevers

The elongated pavilion with a floating curvilinear roof displays a sophisticated, minimal architectural language which hovers gently in its unique setting.

demanded the use of steel as the primary structure. Architecturally, a sense of unlimited connection to the panoramic views, a quality of lightness and desire to open up the internal space entirely to decks on all sides of the house, corroborated the deployment of steel. The structure is a composite of tubular and universal sections which have been crafted to produce a skeletal frame wholly integrated into the fabric of the building and able to withstand wind speeds of up to 250km/h.

Lightweight tubular trusses and shaped universal sections serve to span a maximum opening span of 13.5m and cantilever some 4.5m for the principal pool deck. The galvanizing process, transport, on situ assembly connection systems and coating application were meticulously considered and impeccably executed by a contractor whose background is Formula 1 motor cars and mechanical stage set design and construction! The result is an extraordinary, innovative house which has taken more than four years to complete.

CHALLENGES AND SOLUTIONS

Perhaps the overriding aspect of this building is that nearly every single component is purpose designed and specially made, down to the stainless steel hide-away sliding wall handles. Challenge is the word which has driven this project. From transporting 13.5m long trusses along a torturous coastal road into the village's dirt lanes to dealing with a continuous onslaught of corrosion and untenable windy conditions, the execution of the work at the quality level achieved is nothing less than a miracle. The following outlines some of the significant challenges and solutions:

- This project was the biggest galvanizing undertaking in South Africa at the time in terms of member size with the biggest members sized to fit into the largest galvanizing bath available.
- All cantilevered sections were double dipped in the galvanizing process.
- There are no visible bolt joints in the expressed steelwork structure as all junctions were welded on site and zinc sprayed to accept a Sigma duplex paint coating.
- The transportation of the largest sections in the assembly of 4.5m width from Cape Town to Rooiels demanded special permits – the route had to be fully plotted and approved, the process taking a month to facilitate.

The perimeter channel emits a regular skirt sequence of propped and cantilevered tubular fames that support the perimeter timber slatted veranda.

- A 90T mobile crane was deployed in the assembly of the steelwork, its position being very restricted in terms of location to the house due to dune stability and environmental restrictions.
- The final steelwork assembly was executed within a 4mm accuracy specifically because of the tolerance demanded by the mechanical shutters.

CORROSION PROTECTION

The challenge behind constructing at the point of Rooiels in the Western Cape was not just the barrier to entry on the environmental responsibility front. It was also a question of the barrier to the environment: how do you adequately protect an open steel structure in such a proximity to some of the worst corrosive conditions in the Cape?

Environmentally, Brandbild (the main contractor) have made huge strides in protecting and rehabilitating dune vegetation outside of the site boundaries. Using non–woven fabric constructed with coconut husk, pinned to the constantly shifting

Huge efforts were made in protecting and rehabilitating dune vegetation outside of the site boundaries.


The seamless aesthetic of the architecture is replicated in the interior of the house.

sands, they have squeezed into onto a site literally no bigger than the footprint of the overhanging floor perimeters. In tribute fynbos grows liberally on the site establishment fences.

The location of the structure quickly focused the design team on smoothing the corrosion resistance ride for the steelwork. With a back–to–back corrosion protection guarantee for the client in mind, a team was brought together around the design table. Terry Smith from the Hot Dip Galvanizers Association of Southern Africa, Cape Galvanising Consolidated (Pty) Ltd, PPG Coatings Europe (Sigma Coatings) and fabricator Apocalypse have presented a 15 year guarantee for the duplex system as installed.

This has undoubtedly created a continued awareness for the quality issues surrounding the preparation and implementation of the system at every stage, without the traditional concerns at the interface between one trade and the next. The unusual guarantee satisfied a somewhat perturbed NHBRC, who referenced that 316 stainless steel was perhaps the only metal suitable for the site.

project team

Developer/Owner:
Upbeat Properties 167 (Pty) Ltd

Architect:
Elphick Proome Architects Inc.

Structural Engineer:
Linda Ness Associates

Project Manager:
Elphick Proome Architects Inc.

Main Contractor:
Brandbild (Pty) Ltd

Steelwork Contractor:
Apocalypse Mechanical Monsters

Detailers/Detailing Company:
Apocalypse Mechanical Monsters, Precise Structural Modelling

Corrosion Protection Consultants:
Hot Dip Galvanizers Association of Southern Africa

Corrosion Protection:
Cape Galvanising Consolidated (Pty) Ltd

DESIGN, FABRICATION AND ERECTION

With the corrosion protection system defined and the team on board, attention was diverted to devising a suitable family of joints, splices and connections within the frame. The architectural aesthetic for the steel skeleton is 'seamless', so maximising the shop fabricated 'chunks' of frame was paramount to minimise site bolting and welding. This was limited to the size of the galvanizing baths at Cape Galvanising, and transport facilities to the point of Rooiels.

The structural design was challenging in the large clear span leaps and cantilevered overhangs demanded by the architecture. Careful attention was paid to the deflection criteria over and around glazed sliding–folding perimeter walls, under particularly onerous wind loading conditions.

The structural detailing was taken to a stage just short of intricate completion using 3D environment modeling, Xsteel, in close collaboration with LNA. After further collaboration with the fabricator, structural details were refined in design, revised on the 3D model and bled into a visual approval process by Elphick Proome Architects who were aware of the structural development at all stages, so to retain the original philosophies of the design.

The balance of the intricate detailing was carried out by Apocalypse fabricators who infused the inevitable complexity of minimalist architecture, open honest steel structure, and all the services in–between. Not least of these complexities was the development of a unique mechanical shutter system that necessitates a series of complex fabrications to accommodate the moving parts.

The Apocalypse factory floor, an area smaller than the footprint of the final skeleton, in Gordons Bay, became a full scale prefabrication facility.

Sequential lengths of the structure, both floor perimeter and roof, were fabricated and pre-assembled in the factory before being carved off into the carefully pre-planned chunks to be masked, galvanized, primed and coated at the premises of Cape Galvanising. Steel was bulk delivered on to the site for erection in two separate phases: floor perimeter and roof.

All site welding was carried out on section ends masked prior to galvanizing, and zinc metal sprayed on site prior to full paint system application.

The floor structure is a composite of a reinforced concrete flat slab, framed by a steel channel, and supported on a regular grillage of steel columns bolted to reinforced stub columns using isolated 316 stainless steel HD bolts (the only stainless steel used on the primary structures). The perimeter channel emits a regular skirt sequence of propped and cantilevered tubular fames that support the perimeter timber slatted veranda. Tubes were used specifically in the outdoor environment to minimise the corners and heels associated with accelerated corrosion of angular hot rolled sections. Tubular sections also maximise natural wash–down during rains.

The steel columns extend uninterrupted up to the ceiling plane where they are framed by a toblerone vierendeel truss that rings the house and ultimately forms a glazed clerestory. Off this truss ring, springs another series of cantilevered frames which emulate the veranda below and form a framework for the mechanical shutters, and a narrow skirt of cladded roof in which all of the services are hidden. The fabricated curved rafters and cold rolled lipped channel purlins form the ribs and grillage for a slim–line biscuit of smooth timber roof cladding, and timber ceiling.

SUSTAINABILITY

Apart from the inherent sustainability of the use of steel as the primary structure, a number of passive sustainability aspects are embodied in the house:

- All four facades open out fully, connecting with site and affording 100% natural cross ventilation in all directions, as the house is 'a one room deep space' in its purest form.
- The house has a simple rectangular footprint with the short ends oriented east/west and is effectively a large umbrella.
- Decks wrap around the entire house and the glazing enclosure is filtered with hinged screens, creating verandas when open horizontally. In summer these screens control solar exposure to the house and in winter allow solar penetration.

GREEN POINT ATHLETICS STADIUM

NEW ROOF STRUCTURE

Circular hollow sections were the natural choice for the majority of members in the frame to maximise unrestrained lengths under compression thereby achieving a relatively 'clean' aesthetic.

As part of the wider redevelopment of the Green Point Common Area surrounding the completed 2010 Cape Town Stadium, the decision was made to refurbish the original Green Point Stadium for use as an athletics track.

Originally completely enclosed by covered seating, three sides of the relayed track were to be opened up to the surrounding revitalised landscaped areas. The western seating segment was re-used to refurbish the original reinforced concrete raking seating.

The original (rational but rather tired and 'workaday') roof had already been removed and was to be replaced with a sweeping cantilevering roof plane shading and protecting the remaining seating below and allowing unobstructed views of the track for the spectators.

STRUCTURAL CONCEPT

The structural concept can easily be understood in section. New steel towers stand behind the existing raking reinforced concrete seating structures and are partly

The project enabled the re-use of a large existing reinforced concrete seating structure and steel provided an economic and lightweight solution to re-roofing it.

braced by it. Raking struts from the tops of these columns form a large scale triangulated cantilever frame that supports the raking main rafters with purlins underslung.

The roof is lightweight in nature thus wind forces are the dominant load on the structure and result in significant push-pull action on the tower structures. Uplift on the rear columns is resisted by large reinforced concrete footings.

The existing seating structure stands approximately 9m tall and consists of 9m seating bays supported on paired raking beams and columns 1.8m apart. The 15m-wide new roof spans 14 seating bays and at its highest point is 18 metres above the level of the athletics track below.

The roof is braced in cross-section by its connection to the existing reinforced concrete structure which was assessed and investigated as fit for this purpose. Along its 140m length, the roof is eccentrically braced by a large reinforced concrete portal frame that frames the main entrance to the track.

Circular hollow sections were the natural choice for the majority of members in the frame to maximise unrestrained lengths under compression thereby achieving a relatively 'clean' aesthetic. A maximum tube section of 219 x 6 was used with an unrestrained length of over 7 metres.

DESIGN DEVELOPMENT

The initial 2D analysis of the frame was carried through to a 3D model of a single frame in Strand7 and finally to a more complex 3D model to investigate the bracing forces transferred to the central concrete portal structure.

Initial concepts for the structural connections were developed in 3D in SketchUp and this model was used as the basis for discussions with the architect and fabricator. The final connection arrangements were developed by close liaison between the design engineer's hand-sketches and the fabricator's proficient Tekla detailing.

Three architectural concepts were carried through the design development of the connections:

- The architectural desire to achieve a smooth visual plane with minimal articulation resulted in a unique feature of the underside of the roof. Standard roof sheeting, using special fixings, was attached to the underside of the parallel flange channel purlins which themselves sit in a plane below the main 'rafters' of the support truss. The project teams named it "upside-down construction".

- Since the roof was to be 'underslung' from these purlins, connections above this plane would not be visible at close quarters and would primarily be dictated by structural requirements though considerable care was still taken.
- The first connection, visible below the plane of the roof, is the primary 'knuckle' connection and brings eight individual tubular members together. This connection is at eye-level of the spectators at the top of the stand so this was an opportunity to drop the solid wall and replace it with an opening allowing the connection to be viewed at close-quarters. Typically shaped plates were notched into the ends of the tubular connections to allow bolting between the members.

project team

Developer/Owner:
City of Cape Town

Architect:
Stadium Architects & Urban Designers

Structural Engineer:
Structures JV Members:
ILISO Consulting (Pty) Ltd
Goba Consulting (Pty) Ltd
Henry Fagan and Partners
KFD Wilkinson (Pty) Ltd
Arcus Gibb (Pty) Ltd

Quantity Surveyor:
Aecom/Mahlathi Liebetrau

Project Manager:
Ariya Projects

Main Contractor:
Filcon Projects Cape

Steelwork Contractor:
Triomf Staalwerke

The new steel towers stand behind the existing raking reinforced concrete seating structures and are partly braced by it.

CONSTRUCTION

Due to the complexity of a number of the connections trial assemblies of the modules were made in the steel fabricator's yard in Paarl before disassembling and transporting to Green Point.

Construction of the large reinforced concrete footings took careful excavation and sequencing to avoid undermining the existing column footings and steel more than proved its worth in accommodating the tolerances of the existing (and some of the new!) reinforced concrete work.

The project enabled the re-use of a large existing reinforced concrete seating structure and steel provided an economic and lightweight solution to re-roofing it. The carefully detailed external structure is articulated and brought alive by the shadows created in the late afternoon sun while the trackside face of the structure, by its nature, generally sits in the shade and allows the athletics to take the main stage.

The original roof was already removed and was replaced with a sweeping cantilevering roof plane.

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GALVANIZED BOLTS – AN UPDATE

PART 1

By Spencer Erling,
Education Director, SAISC

The writer wishes to thank both Bob Wilmot, director of the Hot Dip Galvanizers Association of Southern Africa and Rob Pietersma, Director of CBC bolt manufacturers and the Association of Bolt Manufacturers for the valuable editing, comments and input into this article.

BACKGROUND AND HISTORY

South Africa has a long tradition of specifying and using hot dipped galvanized bolts for steel structures with generally great success.

The SAISC has recommended for a long time that bolts to class grade 4.8 bolts and class 4 nuts (in general because of our relatively small market class 8 nuts are made for use both with grade 4.8 and 8.8 bolts) should be used for minor applications only (e.g. purlin connections, hand rails treads etc). For this reason and to ensure that steel erectors did not erect grade 4.8 bolts in a connection that required grade 8.8 bolts we recommend that the maximum diameter of 4.8 bolts should be limited to 16mm.

We further recommended that for all bearing/shear structural connections that grade 8.8 bolts and class 8 nuts 20mm diameter and bigger be used. All of the above bolts were made in South Africa to the appropriate DIN or ISO specification (which really only differed marginally on the across the flats dimensions, the thickness of bolt heads and nuts and the length of the thread on the bolts). These grades of bolts and nuts all hot dip galvanize well with very few, if any, problems. The small differences in dimensions (between the ISO and DIN specifications) have no impact on the structural strength of the bolts as far as designers are concerned.

When it comes to dynamically loaded connections our recommendation was to use grade 10.9 bolts with class 10 nuts. The most readily available 10.9 bolts were those made for HSFG applications (10.9S). We recommended these bolts be used not only for friction grip connections but also for any application where a pre-tensioned bolt would be required, such as for fluctuating dynamically loaded structures and non-slip applications.

From a bolt manufacturer's point of view, un-worked steel having the mechanical properties required for 10.9 grade bolts and nuts is available. The process would be based on using a wire with a suitable chemical composition (often called a Boron steel) that could be heat treated up to the hardness and ultimate strengths required to satisfy the 10.9 grade requirements (as specified in ISO 898 parts 1 and 2, recently reviewed in 2009).

It is common knowledge that when it comes to the heat treatment and hot dip galvanizing of grade 10.9 material it is very important to adhere to good practice recommendations such as not pickling grade 10.9 in acid to remove rust before galvanizing. It was found that excess pickling could lead to hydrogen embrittlement. It was thus recommended to blast clean the bolts before dipping in the zinc. Current European developments do permit acid dipping with a suitable hydrogen inhibitor (technology that has not yet been fully developed in SA). Two types of failures (occasionally) occurred.

The broad term hydrogen embrittlement, and also hydrogen induced delayed stress corrosion cracking (the finding of an extensive research programme) are often mentioned to be the cause of failure of these bolts. What is not mentioned is the impact of site procedures and abuse of the bolts (see part 2 of this article in the next issue of Steel Construction).

Bolt failures associated with incorrect hardness (i.e. too brittle or too soft) have also occurred. The latest version of the ISO 898-1 specification very clearly defines hardness ranges to ensure that this problem does not occur. A further recommendation (not in the code) is that ultimate tensile strength should be in the range 1040 to 1170 MPa (and should not exceed this number). It should be noted that

there is a close relationship between hardness and ultimate tensile strength so the latter instruction may not necessarily be of value to bolt manufacturers. Such failures were few and far between and to the best of the writer's knowledge were all picked up before completion of the project and did not result in any collapses.

Most failure cases, usually caused by the heat treatment or galvanizing process failing to adhere to good practice, could most often be traced back to a request by a (steelwork) contractor to his favourite bolt supplier to do him a special favour and to deliver the bolts in a hot dipped galvanized finish by the following morning. This resulted in rushing the process and failing to adhere to good practice recommendations ending up with bolt failures.

Generically one could say that as a result of the split responsibility between bolt manufacturer, heat treater (if applicable) and the galvanizer, no one party took overall responsibility for the quality of the product delivered. SANS EN 14399 suite of documents addresses this issue.

SANS EN 14399 PARTS 1 - 10 HIGH STRENGTH BOLTING ASSEMBLIES FOR PRE-LOADING

In 2011 SANS adopted the EN 14399 suite of documents covering high strength bolting assemblies for pre-loading.

Pre-loading in this instance has the same meaning as the term previously used in South Africa viz. pre-tensioning. Clearly this set of documents therefore replaces the 10.9S bolts as described above.

The great emphasis is now on the word 'assemblies' in the title. The term 'bolt assembly' in this context means the combination of bolt, nut and washer(s).

The bolt manufacturer takes responsibility for and certifies the adequacy of an assembly to be suitable for pre-loading (all as defined in the various parts of the code). Irrespective of whether the responsible bolt manufacturer buys in from others items such as the hardened washers (there is no washer manufacturer in South Africa) or subcontracts out hot dip galvanizing and/or heat treatment, the bolt manufacturer takes total responsibility for the whole assembly and coating and certifies it to be suitable for use as a pre-loaded bolt assembly. This in itself should go a long way to eliminating hardness and/or embrittlement issues of the past.

It should be noted that there are a series of very stringent tests to prove both the mechanical properties required by ISO898 and suitability of the assembly as required by SANS EN 14399. Only once the manufacturer conforms totally to these requirements can he certify the assemblies suitable for pre-loading.

There are some requirements in the documents relating to the shape of the bolt head and the radius between the bolt shank and the bolt head that are specifically intended to lower the possibility of hydrogen embrittlement (during hot dip galvanizing). One of the EN 14399 requirements is that nuts be tapped only after the galvanizing process (i.e. no re-tapping of nuts after galvanizing is permitted).

Clearly the technical issues to achieving the requirements of ISO898 and EN 14399 have not been without their difficulties.

Further requirements are that all bolts be traceable back to source material, that they be supplied in sealed containers as delivered by the responsible bolt manufacturer. This means that small quantities will not easily be available 'off the shelf', but not impossible, from bolt stockists. It also means that adequate lead times will be necessary to allow the bolt manufacturer to manufacture, test, and coat in a controlled manner to achieve a good and suitable end product.

The bolt manufacturer can also be requested to supply (galvanized) bolts for pre-loading in a lubricated form, where the friction coefficient of the lubrication is known.

Part 2 of this article will be published in the next issue of Steel Construction which will look at the possible impact of chemical composition of the steel on hydrogen embrittlement, how bad site practise and bolt tightening procedures could be the cause of some of the failures as well as some thoughts and recommendations for HD bolts.

SOCIAL SNIPPETS

By Marlé Lötter, Events Manager, SAISC

SAISC GOLF DAY 2013: GAUTENG

LEFT: The winning team of the SAISC Golf Day 2013, 8 May, Houghton Golf Club: Tudor Engineering – Tobie Oosthuizen, Shaun Diggeden, Braam Beukes (Host) and Johan du Plessis (Score: 98)

Braam Beukes really had a field day and also ended play with the highest individual score of 64!

BELOW RIGHT: Freddie Herselman of the dti (and team SAISC) was awarded for nearest-to-pin on the 7th.

BELOW LEFT: Tony Sheasby (left) of the AGLTA-DSE Fabrication team received the prize sponsored by Macsteel for nearest-to-pin on the 9th from Spencer Erling.

GAUTENG GOLF DAY RESULTS:

8 May 2013 - Houghton Golf Club

Winning team: Tudor Engineering – Braam Beukes (Host), Shaun Diggeden, Johan du Plessis and Tobie Oosthuizen (Score: 98)

2nd place: Vital Engineering – Braam van der Heever, Johan van Wyk, Martin Nel, Fred Smith (Score: 89)

3rd place: Robor Baldwins – Andre Winter (Host), Vicus Meyburgh, Rob Wilmot, Pieter Blignaut (Score: 88)

4th place: Macsteel VRN – Uys Loubser (Host), Mark Segers, Craig Davidovics, Brendon Davies (Score: 87)

5th place: Macsteel Trading Wadeville – Wayne Allcock (hosting for Macsteel), Stan Tokarsky, Ernest Webber, Christo Claassens (Score: 86)

Best individual player: Braam Beukes (Score: 64)

Nearest-to-pin on 7th: Freddie Herselman, SAISC Invitational team

Nearest-to-pin on 9th: Jason Williams, First Tech Construction team

Nearest-to-pin on 14th: Tony Sheasby, AGLTA-DSE Fabrication team

Longest drive on 5th: Manie Fourie, Louwill Engineering team

Longest drive on 15th: Stuart Morgan, Bigen Africa Services team

SPONSORS:

The SAISC proudly acknowledges all the event sponsors:

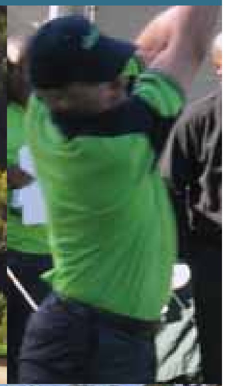
Absolute Gifts, ArcelorMittal, AVENG Trident Steel, Genrec, Internet Solutions, Louwill Engineering, Macsteel, Robor, SA Roofing and Vital Engineering.

THE dti GETTING OH-SO-CLOSE TO TARGET!

Freddie Herselman of the dti played in the SAISC invitational team. The following is based on the 'Ooh-Aah' account of team host Gary Jones about his incredible shot on the 7th:

The 7th hole is a long par 3, slightly uphill and over water. Freddie had not been playing too well all day. He hit a tee shot with great force, but extremely low. The ball flew towards the water... but then due to the low angle it bounced three times right across the water and out the other side... heading straight for the right hand bunker... it stopped on the bunker... then gently started running back down the contour of the slope... onto the green... towards the pin... stopping a miraculous 300mm behind the pin! Needless to say, both Freddie and the team were very pleased with this stellar performance. *Keep it up, Freddie!*

MORE MOMENTS AT THE SAISC GOLF DAY (JHB)



SAISC GOLF DAY 2013: KZN

KZN GOLF DAY:

24 May 2013 – Royal Durban Golf Club

TOP LEFT: The KZN champions – BSI STEEL was awarded 1st place for their top score of 103. From left: Tony Antonic and Wayne Marcus with Sunthosh Balchund, Chairman of the SAISC KZN Committee, assisted by Alet Momberg of BNC Projects.

(Team players not in the picture: Morne Van Vuuren and Lee Daff)

LEFT: SAISC KZN Golf Day 2013, 2nd Place: The team of AVELLINI BROS with a score of 99. From left: Hugh Bowman, Ricardo Avellini, Renzo Avellini, Sandro Avellini.

BELOW: SAISC KZN Golf Day 2013, 3rd Place: The team of FREYSSINET MNDENI with a score of 97. From left: Robert Yuille; Grant Watson; Ivan Dunlop with Alet Momberg of BNC Projects.

(Team player not in the picture: Ed Van Os)

The ‘Pink Ball’ competition of the SAISC KZN Golf Day 2013 was won by the team of SIVEST with a score of 33 points.

Team players: Peter Garett, Des Lavender, Ant Jackson and Leon Hellburg

SAISC MEMBERSHIP

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LSFB systems & trusses
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