MAY 2005 VOL 13 NO 5

NSC

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NEW STEEL CONSTRUCTION NSC

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Structural Engineer: Burks Green
Steelwork Contractor: Atlas Ward Structures Ltd

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Developers are supersizing sheds

Nick Barrett - Editor

The market for sheds has been buoyant in recent years and is the lifeblood for more than a few steelwork specialists. Demand in this sector is driven primarily by the changing needs of distributors and logistics companies and has offset the long, slow fall in demand for production facilities as UK manufacturing declines.

The market is growing and the sheds themselves are getting bigger. Five years ago 100,000 sq ft was regarded as large. Today, Sainsbury's plans a group of 700,000 sq ft sheds around the M25; Debenhams and B&Q have 750,000 sq ft projects on the go; in North America 1,000,000 sq ft distribution facilities are not uncommon and that size of shed is said to be coming to the UK.

Clients for sheds are getting bigger as well. Last year Gazeley developed some 10 million sq ft of warehouses. The biggest user of steel in Europe, after three major car manufacturers, is ProLogis, some of whose projects are mentioned in our sheds feature in this issue. Clients like ProLogis owe their growth to the fact that the supply chains of global companies are undergoing fundamental structural change and outsourcing of warehousing and distribution is a strategic business decision for many.

Although sheds in the past may not have been regarded as the most sophisticated structures to design or build, their complexity grows with size. Among the benefits of mega-sized facilities is that they can incorporate the latest innovations in warehouse design, layout, and management systems that reduce the need for costly automated materials handling systems. This means steelwork specialists have to keep abreast of the latest client needs.

Up to 75% of the sheds market is calculated to be speculative, so the construction team has to be able to build fast to allow developers to capture the opportunities they have spotted. Steel has this market virtually to itself and as the pressures grow from demanding clients it is hard to see things changing anytime soon.

Housebuilders must discover steel

At a BCSA-Corus residential seminar in London (see Analysis) in April Bourne Steel Chairman David Sands confidently told the specially invited audience of some 100 developers: "Steel is the best discovery that could be made by the residential sector." The use of steel in the low rise sector could become as popular as it is with the high rise developers if only the message about steel's benefits was more widely understood, he argued.

Let's hope the government is listening. Exactly how the government will deliver on its ambitious plans for housebuilding, or how the construction industry will respond to its demands for a £60,000 house, are not fully clear. What is already obvious is that traditional wet trade approaches are not going to be up to the task and that steel will have to play a far greater role in providing housing than in the past.

There is a role for both hot and cold rolled steel in this and the steel sector has proven in recent years that it is more than ready to meet the challenge. Developers of prestige projects up and down the UK have acknowledged the advantages of building high rise in steel. The advance in market share has been dramatic, as the recent market shares survey from Construction Markets showed. As we saw in NSC in March, major investments are being made in off-site techniques and there is now a Steel Homes Group under the umbrella of the Steel Construction Institute. The steel sector is ready to meet the challenge for both high rise and low rise housing; the next step is to be sure that the housebuilding sector gets the message.

New industry force

Atlas Ward operates mainly in the warehouse market, typified by this 158,000 sq ft project for Europackaging in Yardley

Severfield-Rowen has created a new force in the constructional steelwork sector with the acquisition of Atlas Ward.

Severfield-Rowen has agreed with Atlas Ward major shareholder the Bank of Scotland to buy the entire issued share capital of the company for £1.21M cash and the deal went through on 22 March, with completion to take place within four weeks.

Atlas, based at Sherburn near Scarborough in Yorkshire, designs, fabricates and erects structural steelwork principally for the distribution warehouse market. Severfield-Rowen says its new acquisition has a business, skill base and client profile which is complementary to its own.

Atlas is a major player in the UK market and is a well known brand name within the industry. In the year ended 31 December 2004 Atlas had an unaudited turnover of approximately £35M with an estimated pre-tax profit for that year of £250,000 resulting in unaudited net assets of £1M.

Severfield-Rowen Chairman Peter Levine said: "With a good name in the industry and with a complementary market place, client base, skill base and location, as well as potentially significant synergies, this is a very positive acquisition for Severfield-Rowen.

"Atlas, a well respected name in our industry, operates primarily in the distribution warehouse market. It complements the Group's sectors of interest and has an extensive client base and a very experienced and skilled workforce.

"Atlas will benefit from our Group's commercial and financial strength and, as we integrate it with the Group in due course, we expect to make focused capital investment to upgrade technology and improve productivity and efficiency which are the hallmarks of Severfield-Rowen.

"Initial client reaction has been extremely favourable to the acquisition and to the anticipated investment in the Atlas business."

After the acquisition the Severfield-Rowen Group comprises four major brands — Severfield-Reeve Structures, Watson Structures, Rowen Structures, and Atlas Ward Structures.

Ultimate in luxury apartments takes shape

What is claimed will be the highest quality residential development ever built in the UK is under construction in Chelsea.

The toppping-out ceremony for the 21 Manresa Road development, which will provide its residents with an unprecedented level of opulence and luxury, is scheduled to take place on 12 May. Bourne Steel won the £2.72M contract to supply and install 1,400 tonnes of structural steelwork and metal decking. Multiplex is the main contractor.

The contract comprises 15 two and three-level apartments over four floors on the site of a 19th Century Kings College research and training facility. The new apartments are being built behind the retained façade of the Kings College building.

The basic structure consists of columns supporting cellular beams, supplied by Fabsec, on each side running from front to back of the building. These support blockwork dividing walls between the apartments. Beam-column connections and all other horizontal connections incorporate sound attenuation pads, so that each apartment is completely isolated from the others acoustically. The arrangement of the dividing walls creates a void of around 700mm between each apartment which provides space for services.

Floors are of steel/concrete composite construction, except for the mezzanine between the first and second floors, where timber construction on Metsec cold-rolled sections are used. This is to allow each apartment owner to remove the entire floor and create a double storey height space if they wish.

The apartments will be finished to the standard of a luxury hotel. Two thirds of the site is being given over to one of the largest landscaped garden square to be created in London for over a century.

Steelwork erection began last December and is due to be complete in June. Developer is Manresa Developments, and the structural engineer is Michael Barclay Partnership.

Albion's arena

Structural steel provides the striking structure of Burton Albion's new 6,000 capacity £6.5M Pirelli Stadium, which has been built as part of the club's bid for promotion from the Nationwide Conference.

Conder Structures designed and manufactured 585t of steelwork for the four perimeter stands which each incorporate a cantilevered roof formed with elegant tapered cellular beams.

The Nigel Clough-managed Brewers won their final home game at old ground Eton Park on 19 April, and when they move into the new stadium on 1 July will be able to claim to have the most impressive ground outside the Football League.

Unique roof for Windsor visitor centre

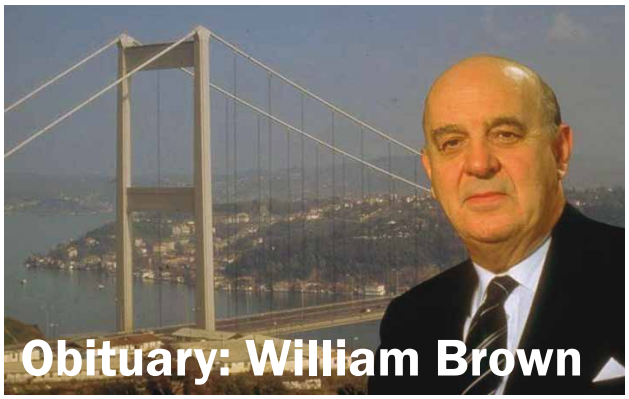
The complexity of a steel roof for the Savill Gardens visitor centre in Windsor Great Park belies its cost and the tonnage of material used. SH Structures' £220,000 contract used only 50 tonnes of steel, but the completed structure will be far more dramatic than these figures might suggest.

The roof structure consists of a circular hollow section ring beam supported on trestle columns in pairs, pinned at both ends. The ring beam is curved both in plan and elevation. "Angle Ring supplied the sections bent in a single plane, which we built up in our works to create the 3D effect," says SH Structures Estimating Manager Peter Redfern. In addition a series of plates at close centres around the inside of the perimeter act as brackets for the timber roof. There is virtually no repetition in the plates, said Mr Redfern, because of the changing angle of the ring beam and the fact that the timber rafters come in at different angles too.

The roof timbers will be erected on scaffolding within the ring beam. SH Structures fabricated elaborately shaped plates which are attached to the ends of the rafters and bolted to the brackets on the ring beam. When all the timber is in place the scaffolding is removed and the timber structure locks together.

Construction of the ring beam is virtually complete, and the centre is due to be completed in March 2006.

The main contractor is William Verry, Buro Happold is the structural engineer and the architect is Glenn Howells Architects. Contract value is £5.5M.



Obituary: William Brown

William Brown, one of the leading figures in long span bridge design, has died. Mr Brown, 76, was best known for his contribution in the pioneering team at Freeman Fox & Partners which developed aerodynamically advanced decks for suspension bridges first seen on the first Severn crossing and later on the Humber and Bosporus bridges.

Mr Brown played a significant role in many long span bridge designs, including the Forth Road Bridge, the Severn and Wye crossings, Auckland Harbour Bridge, The Erskine Bridge over the Clyde, and the two Bosporus bridges. For many years he had been promoting the concept of bridging the Messina Straits and was engaged on design work for it up until his death in London on 16 March.

Mr Brown graduated in engineering from University College, Southampton, and also studied at London University's Imperial College which made him a fellow in 1987. He was a partner at the world famous long bridge design specialists Freeman Fox & Partners for 15 years from 1970.

As an independent consultant — Brown Beech & Associates — he worked for a large number of clients worldwide, including directly for the Turkish client for the second Bosporus bridge whose construction he oversaw. This role brought him to the attention of the world press in a way few bridge designers ever achieve.

His early career was marred by the collapse of the Milford Haven box girder bridge during construction, which killed several workers. This was followed by another Freeman Fox box girder collapse at the River Yarra in Australia. Brown overcame these setbacks and became one of the world's leading designers of bridges in steel.

He also developed the system for spinning cables used on the Storebaelt crossing in Denmark. His controlled tension spinning method was used to spin 20,000 tonnes of steel wire in only three months. Brown's awards included an OBE,and the first McRobert Award. He was Master of the Royal Society of Arts' Royal Designers for Industry between 1983 and 1985, and was awarded the John A Roebling Medal for lifetime achievement in bridge engineering in 2004.

Free Corus seminars around the UK

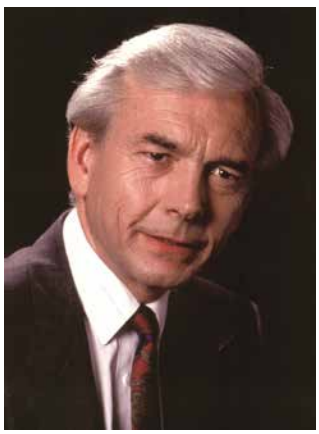
Corus has announced a new programme of free seminars covering the latest developments on a range of steel construction issues. A team of experts will be travelling the country to discuss a wide range of topics including health and safety, shallow floors, multi-storey residential, sustainability, car parks, fire, bearing piles and quality selection.

They will be visiting Worcester (18 May), London (16 June), Glasgow (28), Manchester (30), Southampton (13 July), Dublin (22 September), Durham (12 October), Scunthorpe (19 October).

For more details contact: www.corusevents.com

A further series of seminars on sustainability and fire are planned for the autumn.

BBC *Today* presenter to chair the Steel Construction Conference



TV and radio presenter John Humphrys of Radio 4's Today programme and BBC TV's Mastermind will be introducing and chairing an expert Panel discussion session on the future trends for the UK construction market at the 2005 Steel Construction Conference and Exhibition.

The programme for the event, to be held at The Brewery in London on Tuesday 15 November 2005, includes:

- The Client's View of Sustainable Steel Construction
- Launch of the Steel Construction Sustainability Charter
- Future Construction Trends
- Project Case Studies: Bridge, Hospital, School, Multi-storey residential
- Eurocodes for Buildings
- Eurocodes for Bridges

There will be 30 exhibitor stands.

A copy of a new book on Steel Construction Details, which will be launched at the Conference, is included in the attendance fee of £160+VAT.

AROUND THE PRESS

Construction News
31 March 2005
Reinforced concrete industry representatives claimed the fire that destroyed Windsor Tower in Madrid last month showed the weakness of structural steel under fire conditions and that this poor performance had caused the structure's partial collapse. But Roger Steeper, product development manager at steel producer Corus, called the claims "tenuous". He said: "The fact is that no-one is entirely sure what happened and the results from the inquiry will probably not be ready for another 12 months. What is inescapable is that the Windsor Tower is a concrete frame building and it partially collapsed."

Building
8 April 2005
Multiplex is set to sign two framework-style deals with concrete firms in an attempt to solve a capacity crisis in the sector. Building understands that Multiplex hopes to reach long-term agreements with one major concrete supplier and another, smaller firm.

There are now only three subcontractors large enough to provide concrete for major projects.

Building
8 April 2005
Bridges are no longer the sole preserve of engineers: architects, landscape architects and even artists are all energetically jumping on the bandwagon. The latest bridge design to be unveiled, a collaboration between structural engineer Buro Happold and architect Hakes Associates that won an open international competition in Liverpool, exemplifies this inter-disciplinary trend.

Construction News
21 April 2005
"Steel frames are an emerging method of construction in the residential sector and the industry didn't have a focus for it. The government likes to have an industry body to talk to rather than going to companies directly, which was a pretty substantial motivation. We launched a month ago and we've already got 13 members."– Steel Homes Group coordinator Graham Raven on why the group was formed.

First test for online training site

A new website to train specialist steelwork designers in the use of Eurocode 3 and its differences from the British Standards will be tested this month.

ESCDOT (Eurocodes for Steelwork Contractors: Designers Online Training) will be unveiled on 10 May at a British Constructional Steelwork Association workshop.

The DTI Training and Skills programme funded a £60M two-month pilot which began in February. Because time and funding were limited, the pilot was tightly focused on portal frame design and stability, the effects of wind, and portal frame connections. Other subject areas will be covered later.

BCSA Director of Engineering Dr. David Moore said the website was aimed at specialists and assumes familiarity with the design approach of British Standards and the BCSA's Green Book for the design of connections.

A working group comprising representatives from the BCSA, the Steel Construction Institute, steelwork contractors and software suppliers developed the site. Barrett Steel Buildings and purlin specialist Metsec Building Products were also represented because of their interest in portal frame design and wind loads on purlins respectively.

The 10 May workshop will be attended by members of the BCSA Process and Technical committee and used to seek feedback on how the site could be improved.

Dr Moore said the association will be submitting proposals for further DTI funding in the coming financial year to extend the website's coverage. He added that input from members and the SCI was also being sought: "As information emerges from other projects, it should be possible with a relatively small amount of effort to adapt it for ESCDOT."

As part of the project, the SCI is to set up an ESCDOT area on the SEFIE website to host an online forum where steelwork specialists can ask questions and exchange information. Software providers Acecad and ROM are supporting the project while CSC and Tekla have produced prototype versions of their CAD programs with links to ESCDOT from the software's built-in help systems.

Dr Moore said: "The aim is to produce an integrated set of help systems. If a designer needs help that isn't supplied by the software there will be a link to training material on ESCDOT, and if this doesn't answer everything you can go the SEFIE site and post a question there."

Sculptural Vauxhall Cross reinvents the bus station

Arguably the most striking building on London's bus network, Arup Associates' Vauxhall Cross transport interchange, entered service without fanfare last month.

Described as a 12m-wide, 200m-long stainless steel "ribbon", the bus station dips and rises as it stretches away from Vauxhall's Tube and mainline stations.

Arup Associates won the commission in a competition organised by Transport for London, the Cross River Partnership and London Buses.

The £4M development, which can handle 45,000 people per hour at peak times, removes bus traffic from the cluttered road system south of Vauxhall Bridge and integrates the new station with both bus and rail services.

Its structural form is meant to echo the lines of the Tube and bus route maps. Most visible is the dramatic 18m long end canopy that rises up at 20 degrees.

Arup says the entire scheme is designed to perform as a seamless sculptural artefact and "every effort has been made to integrate the paraphernalia of a public transport node into the architectural work, avoiding the clutter that scars many developments".

Robert Pugh, lead structural engineer with Arup Associates, says the structure was conceived as a 200m modular construction, made up five essentially similar modules while the sixth cantilevers skywards.

These create, says Pugh, "a relatively simple principal structure: a pair of parallel portal frames spaced at 3m centres, defining a central corridor zone and supporting the 12m wide roof."

Each module is 36m long and contains two repetitions in the roof line undulations, supported by prominent raking columns. Legs are square hollow sections while longitudinal members are rolled I-sections.

The frame changes form portal to cantilever for the sixth module, which provides an 18m clear cantilever, stretching a full 25m from the fulcrum of the raking strut.

The whole structure is clad in stainless steel, whose advantage is that aggressive cleaning agents can be used to remove graffiti without damaging its surface.

Norwest Holst was main contractor.

New safety rules broaden scope of design responsibility

Definition of a designer will be dramatically widened when the revised Construction (Design and Management) Regulations come into force early next year.

Advice given by telephone will come within the scope of the rules as well as designs produced on paper or on a computer.

The new regulations were issued for a 12-week public consultation period on 31 March in one of the final stages before they come into force. They were drawn up by a working party under the auspices of the Health & Safety Executive including representatives from the construction industry and trade unions.

"The HSE felt that the existing regulations didn't define the designer's responsibilities clearly enough," said British Constructional Steel Association Health and Safety Manager Peter Walker.

Designers are accountable for the health and safety implications of their design decisions on others. They are defined in the new regulations as those who have a trade or business which involves them in preparing designs for construction work, including variations, or anyone who specifies or alters a design.

This includes preparing drawings, design details, specifications and bills of quantities as well as analysis and calculations. The definition also applies to someone whose employees prepare designs.

The regulations would apply to steelwork contractors if, as often happens, they are consulted informally by structural engineers in the early stages of a project.

They would also apply to temproary works engineers, or to a purchaser who buys materials where the choice has been left open.

Designers' duties extend to modifications to designs: hurriedly produced solutions to problems or other last minute changes need to be properly thought through.

Mr Walker said: "The new regulations will cover an awful lot of people who might not normally think of themselves as designers." He added: "Regulations very rarely change significantly at this stage of the process."

Argos chooses Multibeam

Kingspan Metl-Con has supplied over 300 tonnes of Multibeam purlin and rail products for a regional distribution centre for retail giant Argos.

The 72,800m² centre will serve Argos's entire store network and direct sales operations across northern England, Scotland and Northern Ireland.

Multibeam's high strength to weight ratio and long spanning capabilities contributed to a construction time for the structural frame of only eight weeks, said Kingspan Metl-Con Marketing Manager John Williams. Steelwork contractor for the project is Atlas Ward Structures and main contractor is Bowmer & Kirkland.

Presenter Dara O'Briain (left) and the BCSA's Gillian Mitchell present the award to Billington MD Steve Fareham

Billington scoops award

Billington Structures scooped the steelwork category in the inaugural Construction News Specialists in Construction Awards at a ceremony at Grosvenor House in London last month.

The awards, established with the National Specialist Contractors' Council and the Specialist Engineering Contractors' Group, recognise the "critical role played by specialist contractors of all sizes and types on this country's construction projects, raising the profile of companies that are often the unsung heroes of the industry."

Finalists were shortlisted on the basis of a written submission, and the winner selected following a rigourous panel interview. Companies had to demonstrate their credentials in areas such as technical expertise, business management, and health and safety.

Billington Structures received the award from Gillian Mitchell, deputy director general of the British Constructional Steelwork Association, which supported the steelwork category along with the Steel Construction Institute and Corus.

The high-profile panel of judges, chaired by Sir Michael Latham, described Billington Structures "as simply a superb company — its exceptionally high standards across the board tipped the balance in its favour".

Fairfield-Mabey was highly commended. The judges described it as "a long-established company that has undergone a culture of change in order to face new challenges" and praised it "for having got to grips with key issues".

Rowecord Engineering and Waagner Biro were also shortlisted.

NEWS IN BRIEF

English Heritage has just bought what is said to be the world's first metal-framed building and "father of the skyscraper", Ditherington Flax Mill in Shrewsbury. The grade 1 listed mill was designed by Charles Bage and built in 1796–97, upstream of Ironbridge on the Shrewsbury Canal. It has been empty since 1987 and is in a poor state of repair.

The government is to publish its **report on modern methods of construction** a year early as part of an effort to increase the rate of housebuilding. It hopes that the increased use of offsite construction or factory built units will help it reach its target of 200,000 additional units by 2016.

The stainless steel industry needs to sustain its effort to develop target markets, said Director Nigel Ward in his address to the annual luncheon of the **British Stainless Steel Association**. Much development effort continues to be directed towards the architecture, building and construction but the association will also explore sectors such as the water industry and infrastructure including road and rail bridges.

Severfield Rowen has announced record profits of £12.2M pre tax with turnover up 20% at £204.3M for 2004. The forward order book stood at £165M. The company expects to see its exports, currently some 10% of turnover, increase. Severfield Rowen employees' productivity has increased due to investment in upgrading plant and machinery.

A new model specification for off site applied intumescent coatings has been launched by the Steel Construction Institute. The new guide - **Structural Fire Design: Off-site Applied Thin Film Intumescent Coatings** (Second Edition) - is a new edition of SCI P160 which was published in 1996. The guide was launched at a well attended London seminar on 21 April and can be downloaded at www.steelbiz.org.

Letters

NSC welcomes letters from readers on steel construction related issues. Please keep your letters brief — the Editor reserves the right to condense. Address your letters to: The Editor, NSC, BBA Linden House, Linden Close, Tunbridge Wells, Kent TN4 8HH. Fax: 01892 524456. e: info@new-steel-construction.com

Steelwork contractors' wide capability

I enjoyed the article on Admiral's Quay in February's NSC. It was reassuring to see a steel framed solution exceed, with a very comfortable margin, the new part E acoustic requirements, and in what appeared to be a relatively shallow floor zone. One thing did puzzle me however – why did the contractor, Wilson Bowden, choose four seperate steelwork contractors? Was it to spread the risk, the scale of the contract or some other reason?

David Hill, Associate Director, WSP Buildings

The Editor replies: I cannot give a categoric answer to your query, but the project clearly demonstrates the depth of capability and competition in the steelwork supply chain. A quick look at the Register of Qualified Steelwork Contractors (see p38, NSC April 2005) shows a list of over fifty companies that are fully certified to carry out works of various sizes and type. The concrete industry runs a similar scheme with only a handful of registered companies.

Concrete structures more prone to collapse

I have been reading with interest articles in the UK specialist engineering and construction press about the Windsor Building fire in Madrid, Spain, in March. Similar misinformation about fire resistance sometimes circulates here in the United States, although to a lesser extent than it seems occurs in the UK, and I have felt obliged to write to several UK editors to complain.

I have to say that I have been appalled at what seem like deliberate attempts by some representatives of the concrete industry to distract attention from and disguise the fire-induced collapse of this reinforced concrete building. I trust that your magazine will do its utmost to ensure that this shameful and reprehensible behaviour is exposed.

The Madrid building was entirely a reinforced concrete structure with a central reinforced concrete core and a surrounding system of interior reinforced concrete columns supporting waffle slab floors. The floor slab was cantilevered at the perimeter of the building, where it picked up the metal curtain wall system.

In the investigation of the World Trade Center disaster it was reported to the US National Institute of Standards and Technology that very few buildings around the world of any type of construction, whether steel, concrete, masonry or wood, have ever suffered collapse from fire. Yet it was also reported that more reinforced concrete buildings have collapsed in fires worldwide than those of any other type of construction.

The public interest would be better served if the representatives of the concrete industry took more interest in addressing the fire safety issues that their own construction material faces.

Charles J Carter, Chief Structural Engineer American Institute of Steel Construction Chicago, USA

Tate not so modern

I was very interested to read your article regarding the recent sculpture in Tate Britain.

I thought you might be interested to know that a very similar exercise was undertaken in 1982 by our practice Richter Associates in conjunction with Asteel Engineering. The artist was Richard Serra, and at that time this had never been done before in the Tate.

The pieces were essentially rectangular in shape and weighed up to 40 tonnes individually. This created a very high concentration of load over a very small area and not surprisingly floor strengthening was required. This was done using mini piles in the basement areas, with supporting steel frames up to the underside of the floor structure.

The clever part of this exercise was the way in which the blocks were slid from the main entrance portico down the full length of the main gallery using large universal beams as runway beams which spanned between known load-bearing walls below.

Once directly above their final resting position, a system of jacking and packing was used to lower the 40 tonne pieces from a height of approx. 1.0m above the floor, down to approx. 5mm above floor level to give the impression that the piece was actually sitting on the floor. In the final position the blocks were supported using steel cylinders passing through cored holes in the floor, down onto the steel frame below.

Of course the entire operation had to be repeated to remove the 'art' when the exhibition was finished.

I attach two photos to show the loading of the blocks outside the main entrance and the 'runway' beams. I hope you will be able to make reference to this in your next issue, to show that nothing is ever entirely original!

Peter Wright, Director Richter Associates Marlow, Bucks

Diary

4-5 May **Steel bridges designed to BS5400** Inchyra Grange Hotel, Falkirk
Corus course covering common steel bridge forms, the code basis for loading, design of key elements, fatigue design and connection detailing.
Jane.parkins@corusgroup.com

23 June **Structural Steel Design Awards Luncheon** Savoy Hotel, London.
Winners of the 2005 awards, sponsored by Corus, the BCSA and the SCI, will be announced. Contact: Gillian.Mitchell@steelconstruction.org

20-21 September **Architecture and Steel International Symposium**, Palace de la Méditerranée, Nice (part of the ECCS 50th anniversary event).
Presentations will be given in English. Further details available at www.scmf.com.fr

15 November **Steel Construction Conference**
The Brewery, Chiswell Street, London EC1.
Organised by BCSA.
See story on page 7. Contact: Gillian.mitchell@steelconstruction.org

Dennis Lennard

Steel key to meeting housing plans

Constructional steelwork will play a vital role in meeting government objectives of investing £38,000M in housing, a government minister told delegates at a London seminar. Nick Barrett reports.

Trade and Industry Minister Jacqui Smith told over 100 developer delegates at the BCSA/Corus residential seminar — The benefits of steel in residential construction — that delivering the ambitious £38,000M 'Sustainable Communities' plan would require vital input from the constructional steelwork industry. The latest phase of the plan, 'Homes For All', was launched in January, involving creating 1.1 million new homes in the South East by 2016. Modern methods of construction would be essential for creating the sustainable communities which government wants.

Ms Smith said that a fresh look had to be taken at the construction process and step change improvements in quality, productivity and performance in the construction and operation of buildings would be demanded. Standardisation and repeatability, allowing flexibility in design of structures and external appearance, is an important benefit of Modern Methods of Construction and also a key in driving waste out of the system.

Ms Smith said the quality of design and living space that has already been achieved by using modular housing techniques is truly impressive, adding: "These projects surely lay to rest the myth that a modern approach to construction lacks design quality or rigour."

She paid tribute to the efforts being made by BCSA members to innovate: "BCSA members are those whose technical knowledge and capabilities are regarded as amongst the best in the world," she said. "They use advanced production technology — for example CAD programmes and computer-controlled cutting, punching and welding — and have an excellent understanding of how to produce detailed designs, using steel as a structural material, for any given project."

After hearing case studies from some of the other speakers seminar Chairman Dennis Lennard, Chief Executive of Constructing Excellence, said that the housebuilding industry had a new ratio to learn. The zero : zero : zero ratio refers to the ability of steel to be used with zero temporary works or falseworks; zero wet works; and zero waste.

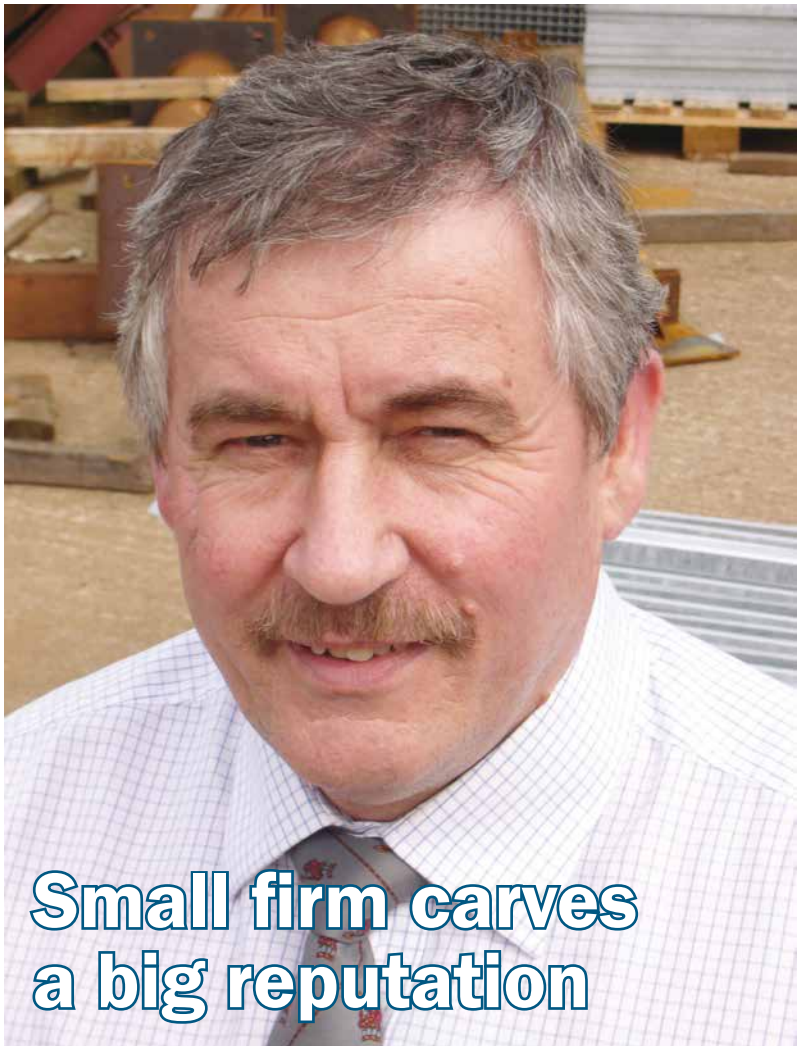
Nick Whitehouse, Managing Director of Terrapin, said so-called modern methods of construction had been around for 56 years. The material of choice originally was aluminium and then timber. But now, he said, "it is steel and more steel". There was a need for both hot and cold rolled steel to meet the demands. We need not be precious in how we use steel, as hot and cold rolled went together well.

Alan Shingler of architect Sheppard Robson described the work being undertaken for Kingspan to advance off-site methods. BCSA Technical Consultant Dr Roger Pope outlined the sustainability case for the use of steel.

Bourne Steel Chief executive David Sands outlined the advantages of steel in housebuilding, pointing out the recent major inroads made in the multi-storey sector. Steel could become even more popular, in low rise housebuilding as well, if the understanding of its benefits were more widespread, he said. He concluded: "Steel is the best discovery that can be made by the residential sector."

Mr Sands also mentioned the experience of an overseas based company which was convinced that concrete would be cheaper than steel, but changed its mind after the not untypical experience of only two tenders being returned. "The concrete supply chain is very short, whereas the structural steel sector remains very competitive," he said.

BCSA President Tom Goldberg presented a wide range of successful residential project, which had been executed in steel, ranging from student accommodation and sheltered housing to prestige multi-storey blocks with apartments costing up to £4M each. "Whether it is a landmark building or an infill site, steel has the answer," he said. "The more current of the projects prove that steel is still recognised as the cheaper option."



Small firm carves a big reputation

Successful small firms in the UK steel industry are invariably driven by a single character, often the founder of the company. Ty Byrd talks to one such founder, Jack Robertson, who describes what it takes to succeed as a small steelwork contractor

Jack Robertson has built up a considerable reputation as a secondary steelwork specialist over 30 years

To be small as a company in the UK steel industry offers the possibility of not just being beautiful but also manoeuvrable, flexible and highly responsive to clients' needs. So says Jack Robertson who started his company – J Robertson & Co Ltd of Walton on Naze, Essex – 30 years ago and continues to pull in the work. What he does not say is that to exploit the benefits of small size you have to be an early riser, thoroughly commited, thoroughly competent and clever at business. Trustworthy and trusting too. Jack is all of these things and widely regarded as a player, never mind that he only employs 10 people.

"See this pile of documents, it's a contract, for a large quantity of metalwork," he says. "I've only just got it. Done some of the work already so it's nice to see the paperwork." Jack Robertson does not have shareholders to answer to, who might for instance want signatures on dotted lines before committing company resources. He goes on his own judgement and instincts, and is careful. His client in this case is absolutely blue chip, has been an employer of J Robertson for many years and its principals are known personally to him. "Us responding rapidly helped them out and ourselves, to win the job."

Not that J Robertson has to go searching for work. The company is well known as a secondary steelwork specialist operating in certain niche markets and tender documents generally arrive as a matter of course rather than having been specifically sought. Sometimes a bid is not even asked for, the new work being offered on a cost plus basis. Trust is a two-way street, it seems.

"Riser floors are a speciality of ours, open mesh flooring, staircasing, balustrades, architectural metalwork, anything with a bespoke nature," Robertson says. The company also does "loads of structural steelwork", although the impression he gives is that this kind of activity is not necessarily his favourite. "We do actually like the specialty stuff best, the metalwork that requires doing by hand, we're good at it and not everyone else is." And it is not just fabrication that J Robertson does but erection as well. Oh yes, and putting handles on saucepans and bottoms in coal scuttles occasionally, although such activity can bring problems, see below.

The company operates in the east of England although it has carried out contracts as far north as Hull and as far west as Swindon in Wiltshire. It is London, though, which has provided much of the prestige work done throughout J Roberston's existence, and Jack is able to reel off a list of high profile projects that have involved his firm: "Palestra in Blackfriars Road, Moorhouse where we did the risers and ancilaries, 90 High Holborn, Atlantic House, St Catherine's House on Aldwych, Regis House by the Monument, Euston's Triton Square and the Diamond Centre in Farringdon road, to name a few."

Most of the activity in London is for Skanska whose City credentials are impeccable. (Skanska acquired the mantle of 'London builder' indirectly from Trollop & Colls, following T&C's takeover by

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Trafalgar House, TH's acquisition by Kvaerner and then Kvaerner assets going to Skanska.) "Skanska is a very good company to work for and the London emphasis for us with them is beginning to broaden. We are now working on schools outside town for the company following its PFI (private finance initiative) move into educational areas."

In the east of England, J Robertson is currently working for big builders such as Higgins Homes and the Cadmun Group as well as a number of other companies. It has competitors — "new names are always appearing," according to Jack — and not just its own size. The big boys sometimes go after quite small items of secondary work, when they have spare capacity. So how does J Robertson win? "On service, because we are an honest company and we can do what we say we can, on quality of work, on reliability." He owns his own yard and overheads are not sky high.

This staircase at St Paul's Girl's School, Hammersmith is a typical Robertson project

Jack Robertson obviously gets a big buzz out of satisfied customers: "We've never had to go back to make good a job," he says. "Our advice is often sought prior to a project which can give us a flying start in obtaining the work."

Jack Robertson moved to Walton on Naze as a young newly married man in the late 1960s, attracted by the coastline and the inexpensive housing. He got employment with the local firm of Alderton & Sams which he describes now as "a glorified blacksmith", learning all about metal from a clever craftsman called Dennis Polhill. There was a corporate lack of ambition at A&S that he found frustrating and after five years he started his own company, its first contract servicing a Trollop & Colls job in Colchester.

"There were only three of us and we've grown a

bit since then," he says. His two sons Tony and Colin work with him, both directors of the company and both extremely handy in workshop and on site. Will they take over from him? "I don't know. I love the job, it's my hobby, I'm often here at 6am and work until the sun is well down. I am not sure whether they would want that level of commitment."

As this might suggest, Jack Robertson does not see himself retiring. "I've still got ambition and will probably die in my office," he says.

One regret he will never have is moving to Walton on Naze. "It is a truly wonderful part of the world, with the most friendly people. I love it here." A believer in giving something back, Jack is a local councillor and before that a retained fireman, sometimes rushing out from his yard in response to his bleeper to fight a blaze, leaving the works unattended and unlocked. "Nothing has ever been stolen," he says.

'Giving something back' means being attentive to the locals, up to a point. "As a favour, we put a new bottom in this old lady's coal scuttle and she asked what she owed. Well, it was two hours' work but what could we charge her? I said 20p. In no time, three of her friends were around, all with worn out coal scuttles. I had to draw the line — you can't run a business making consistent losses!"

Work is also Mr Robertson's hobby, he says: "I'm often here from 6 am until the sun is well down."

Bauhaus chooses steel

The development features offices at the front and apartments at the back

Steel replaced concrete as the framing material on a combined office and residential development in Manchester on which designers had to contend with differing floor levels at the front and back of the building

FACT FILE
Rosetti Place, Phase two
Developer: *ASK, Crosby Homes*
Architect: *Aedas*
Structural engineer: *Ove Arup*
Main contractor *Shepherd Construction Ltd*
Steelwork contractor: *Conder Structures Ltd*
Steelwork tonnage: *885tonnes*
Decking: *11,226m²*
Contract value: *£16.7M*

Artist's impression of the finished building

Developers switched to steel for phase two of the prestige Rossetti Place development in Quay Street, Manchester, to gain cost and programme benefits, after phase one had been built in insitu concrete.

The restricted nature of the site meant there was limited space to accommodate concrete equipment, giving steel another advantage.

The site's mixed commercial and residential use accounts for an unusual feature of the development, with floor levels in the front, commercial part, of the building not coinciding with the rear, residential part.

Phase two, known as Bauhaus, will provide 50,900sq ft of office space plus 65 luxury apartments. The commercial/residential combination came about because outline planning permission for the site stipulated mixed use. Commercial developer ASK and residential specialist Crosby Homes came together to develop the site. Shepherd Construction was awarded the £16.7M construction contract. The decision to adopt a vertical split between the two uses was made because the site has a substantial frontage on to Quay Street, in Manchester's business district, making this the obvious place for the offices.

The Quay Street elevation will be clad in curtain walling to provide an imposing frontage to the office development. The residential elevations will use metal and timber panels with rainscreens, and brickwork.

Ove Arup & Partners was responsible for the scheme design both for the original project and the change to steel. Conder successfully bid for the detailed design and construction of the steel frame.

Conder was appointed in a two-stage tendering process. At an early stage after the decision to go for steel in phase two, Conder produced a tender design to establish the cost of the project before going on to win the job proper in the second stage.

"From a design point of view one of the interesting things was the fact that the residential part had different floor-to-floor heights to the offices," says Conder Managing Director Gordon Ridley.

The storey heights are 3m floor-to-floor in the residential area, and 3.6m in the more heavily serviced offices. Ground and first floor levels are the same throughout the building; residential level seven is close to office level six, but none of the other floors coincide. In total there are 11 residential floors and 8 office floors, with two levels of car parking at lower ground and basement. Mr Ridley says the whole building was modelled as one frame. "On the grid line common to both, quite large columns were needed to help restrain the floors. A combination of steel grades and column orientations were investigated to minimise the impact on the internal layouts."

The differing floor levels also made design of the structural bracing in the main dividing wall more complex, adds Mark Elsegood, Associate Structural Engineer at Ove Arup. "Crossed flats are used, except in cases where the beams were so close in level that diagonals were impractical." In these cases the beams and columns were welded together to form a moment frame.

Generally, the main beams are 533mm deep in the commercial area and 305mm in the residential. A number of holes ranging from 150mm to 350mm were cut by Conder through the beams for service runs in the offices.

Despite steel's advantages for construction of the frame, the lower ground and ground floors, above the two car park levels, are in insitu concrete. The project services engineer insisted on a completely flat soffit to the parking levels to allow extract fans for removing fumes to operate effectively. The columns, however, remain in steel down to the foundations.

Having to cast two insitu floors before the rest of the steel frame could go up would have had severe disadvantages for the programme, giving the construction team some of the usual headaches associated with concrete frames. Instead, the lowest columns span from the basement to the first floor and can carry the loads imposed on them during construction without restraint against buckling from the insitu floors. The columns are between 9m and 11m long with the heaviest section, a 355 x 406 x 467 UC, weighing 5 tonnes.

"We checked the higher slenderness ratio and found that in some cases a small increase in the column weight was enough to carry the loads in the temporary condition," says Mr Ridley. "In other cases we were able to brace the columns temporarily."

As a result the insitu concrete can be cast at any time until the frame is nearly complete.

For the floors Conder installed decking three levels at a time. Typically, with the frame up to level four, decking was put in place at that level, so it could then be used as a working platform for erecting upwards, as well as providing the necessary crash deck and diaphragm to the structure.

A Conder innovation with beam ends has made the erection process faster. "To speed erection, Conder introduced the use of beam end plates with two extra bolt holes — 10 instead of eight — where two beams are to be bolted together through the web of a column," says Mr Ridley.

"This allows one of the beams to be erected first, and work to continue on installing decking on that side of the column. When the time comes to erect the second beam on the other side of the column, the two extra bolts hold the first beam in place while the other eight are removed and reconnected through both beams."

The building is designed to achieve a two-hour fire rating, using intumescent paint to protect the steel beams, while the columns are enclosed in plasterboard. Internal walls are constructed in a metal stud partitioning system to avoid wet trades.

Total weight of steelwork in the main steel frame is 885 tonnes. Conder is also supplying 11,226m^2 of decking.

Conder is currently midway through the 26-week construction programme and had reached the fourth floor of the offices and seventh floor of the residential structure by the end of April. The structure is scheduled for completion in September, with overall completion of the building in June 2006.

Above: Different floor levels complicated the design of columns and bracing

Below: Apartments, seen here to the left. have a lower floor to floor height than the offices

On an upward curve

Fifty years' experience and an approach based on engineering principles has given Angle Ring unsurpassed versatility in the growing market for curved steel. David Fowler reports

Top: The James Joyce bridge in Dublin is one of the prestigious structures for which the company has bent steel.

Above: Bespoke polygonal sections are a new development.

Angle Ring is one of the biggest curved steel specialists in Europe and is proud to boast that in just over half a century of existence it has been consistently responsible for its fair share of market innovations.

Angle Ring Marketing Manager Paul Middleton puts this down to the fact that the company is engineering-led. The company undertakes both cold bending and induction bending, but in both areas, he says: "We design and build many of our own machines. We can make them do exactly what we want them to do."

That gives the company an extremely wide range of jobs it can tackle. "We can bend anything up to the largest sections Corus makes," says Managing Director David Springthorpe. "People are often surprised at our capabilities."

Started in 1951 and named after its main product, angle section bent into rings as stiffeners for West Midlands manufacturers, Angle Ring now finds most of its £8M turnover comes from the construction market. Middleton points out that in the Victorian age, when cast and wrought iron were the key construction materials, buildings with curves were common, because cast iron could easily be cast into curved shapes. From around the turn of the century, as steel became more widely available, buildings became essentially linear, rectangular boxes. Since the 1970s, the aesthetic appeal of curves has led to a resurgence in demand for curved sections.

Angle Ring has supplied curved steelwork for prestigious projects from Wembley Stadium to Manchester's B of the Bang sculpture, and the James Joyce bridge in Dublin. Other jobs are less well-known. "We do some fantastic projects that are never really publicised, such as some company HQs," says Mr Springthorpe.

Angle Ring started designing its own machines because nothing available on the market would satisfy its customers' demands. "You can't buy a machine today to match ours," says Mr Springthorpe. "You can get one to do boxes, tubes and flats but not universal beams, and vice-versa. Ours do everything."

Angle Ring got into induction bending in an effort to keep the company moving forward. Again, it found the range of machines limited. They were generally designed for bending tubes for the petrochemical and offshore industries. "In those markets you usually want a 90° bend in the smallest space. If the radius is 1m, 1050mm or 950mm it doesn't matter," says Mr Springthorpe. "In the structural market they specify a definite radius." Again the solution was to design a bespoke machine. "At the same time we removed a lot of limitations that normally applied, such as a maximum radius. We developed mechanisms for getting an accurate radius, and we have additional machines to adjust the bend afterwards if needed."

The majority of the company's work continues to be cold-bending, for which it has far more capacity. "Induction bending is fantastic but does involve a higher production cost than simple cold rolling. The machines are more complicated and need a lot of maintenance," says Mr Middleton. He adds, however, that although induction bending machines need more attention, "because we designed and built them and have our own maintenance department, most problems can be fixed relatively quickly."

There is no clear dividing line to define whether cold bending or induction bending is preferable for a given project. Generally induction bending is

Induction bending (left) tends to be used for bigger hollow sections which might otherwise distort. Cold bending (right) still accounts for the bulk of the company's work.

favoured for large sections, especially hollow ones, because the risk of the section distorting or collapsing is greater. "We try to find the most economic solution," says Mr Springthorpe. "For example, with a 300mm square section it may be more economic to increase the wall thickness from 10mm to 12mm and bend it cold rather than keeping the thinner wall and having to hot bend it. There's a large grey area where we offer advice."

As a rule of thumb, hollow sections above about 600mm are more likely to need induction bending.

The decision also depends on whether slight distortion or rippling is acceptable, which in turn depends on how visible the section will be. Mr Springtorpe gives the example of a curved tube used as a guide for the cable of a cable-stayed bridge. Slight internal rippling will not be visible, so provided the cable will go through the tube freely the rippling will not be critical.

Induction bending, in which about 25mm of the section is heated electromagnetically as it passes through the machine, allowing it to be bent at the heated point, tends to be a slower process. Cold bending is a cyclic process in which the component is repeatedly bent by a small amount, but it still takes a relatively short time. Induction bending is a single pass process but slower because it requires more setting up, and also because it takes a certain amount of time for the section to heat up. So it may only progress at a rate of 25mm/minute if the section has a thick wall, although most sections are curved at faster speeds.

Engineers generally have little training in how to design curved steel members. Design is complicated by a number of factors. First, the steel has been strained, which will increase its yield point and means that some of its reserves of strain have been used. Residual stresses can also be significant. Material properties can be restored by heat treatment if necessary.

The fact that members are curved means loads become eccentric and torsion can be introduced, leading to warping on I-beams. Stability against buckling and the appropriate effective length to be used in calculations are affected. And there are difficulties in modelling all these effects in CAD programs designed for straight members.

For a number of years, Angle Ring with the Steel Construction Institute has run seminars dealing with these issues, and with the SCI and Barnshaws Steel Bending, produced the SCI specialist guide, *The Design of Curved Steel*.

Though most of its work is now in structures, Angle Ring continues to supply the mechanical engineering and process markets. A recent job was for Airbus, making highly accurate steel frames for moulds used in vacuum-forming carbon fibre airframe components. Another project involved bending an 800mm sheet of 180mm thick plate to form the motor casing for an electric generator.

Driving the structures market, says Mr Middleton, is the fact that architects and the public want buildings that look more interesting, and that generally involves curved sections. Demand for prestige structures such as stadiums is expected to continue. For different reasons, County Councils are becoming big customers. With the focus on inner city regeneration, more thought is going into building design. A percentage of funding on highway schemes to be spent on works of art has meant an upsurge in "island art" — sculptures to decorate traffic islands.

For the future Angle Ring is continuing to develop the range of three dimensional bending. Another new service is making bespoke polygonal box sections by bending them from plate and then welding them together. The finished section may subsequently be bent. This technique is likely to have applications where standard sections are not suitable because of restricted space or high loading, and a wall thickness greater than 20mm is needed. "We have a job coming up shortly where we're making some 500 x 500 x 25mm and 500 x 300 x 25mm sections for a bridge," says Mr Springthope.

"As far as developing the market goes, being engineering-led gives us an advantage," he adds. The overall philosophy, he says, is this: "We're trying to push the market towards new things. Unless we make people aware of what we can do they won't design that way."

Angle Ring was founded in 1951 to supply local mechanical engineering firms in the West Midlands. 54 years later the firm is still expanding on the same site in Tipton near Wolverhampton.

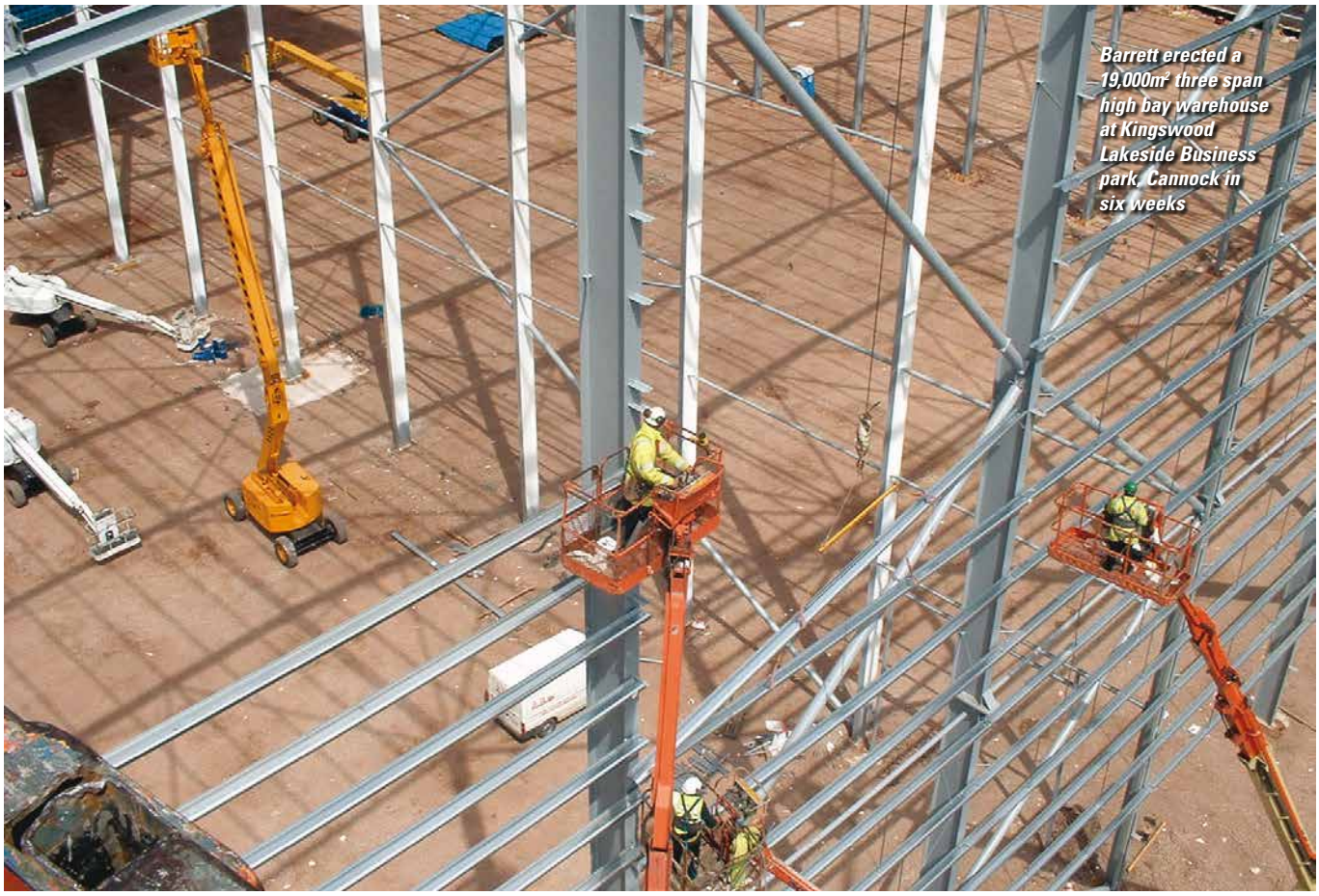
As time progressed the company developed the capacity to bend larger and larger sections and the market changed to become primarily structural, though the company still works for the manufacturing and process industries.

The founder had two sons, one of whom still owns the company; the other left in 1969 to set up Angle Ring's biggest competitor, Barnshaws Steel Bending, based a few miles away.

Between them these two command between two-thirds and three-quarters of the UK market for steel bending.

While Barnshaws has also diversified into areas such as profiling, Angle Ring has concentrated on developing its original speciality, bending, and is able to tackle an extremely wide range of projects. "By the early 1980s we could bend everything Corus made," says Angle Ring's David Springthorpe.

In 1992 it designed its first induction bending machine and has been active in both the cold and hot bending markets ever since.



Barrett erected a 19,000m² three span high bay warehouse at Kingswood Lakeside Business park, Cannock in six weeks

Logistics drive shed expansion

Healthy demand for industrial portal frames, and especially large distribution warehouses, looks set to keep steelwork contractors busy for some time to come.

Ikea's new Doncaster distribution centre, being built by Billington Structures, will have nine bays. The three central bays are 37m high.

Demand for large portal frame sheds is buoyant in the UK. The typical project is increasing in size and steelwork contractors have plenty of work. The market shows no sign of peaking, particularly as far as large distribution warehouses are concerned, with developers increasingly working with the construction industry to find ways of erecting the buildings in ever-shorter timescales.

"The market for industrial sheds is operating with a very high level of demand," says Bob King, business development manager of Billington Steel Structures. "Some major contractors are pre-booking work with us down the line. They're aware the market is warming up and making sure they can get their projects built."

Steel frames already account for over 96% of the market for single storey industrial buildings, according to figures for 2004.

Mr King says the biggest area of work at the moment is large distribution sheds, though there are also a lot of retail projects on brownfield sites which tend to be smaller because the sites themselves are more compact. "They're typically 20,000sq ft rather than 200,000," he says.

Richard Fitzpatrick, commercial director of Gazeley, one of Europe's biggest developers of distribution warehouses, says that the size of the typical project is on a rising trend. "Ten to 12 years ago around 100,000sq ft was typical. The trend now is to a standard size of 220,000 to 400,000sq ft or bigger."

Andrew Marston, commercial manager of Barrett Steel buildings, goes even further. "A few years ago half a million sq ft for a big retailer was unusual. Now a million sq ft is not unheard of." A recent Barrett project for Debenhams in Peterborough was 762,000sq ft.

It might be thought that demand for regional distribution warehouses would be limited on the grounds that the number of supermarket, retail and DIY chains that need developments of this size is relatively small, but this is not the case, says Mr Fitzpatrick.

"Retailers and other businesses are outsourcing their distribution to third party logisticians or strategic partners such as Exel and TNT. In a number of cases these partners are then requiring units either for specific contracts or sites for multiple customers where there are economies of scale from running more than one contract from one unit." He

ProShed made to measure for Wetherspoon

The made-to-order distribution centre was completed in just 10 weels.

When pub chain JD Wetherspoon wanted a regional distribution centre to handle bottled beers, wines, spirits and food for its pub chain nationwide, ProLogis initially offered a 150,000sq ft speculative unit on its site at Daventry, Northamptonshire.

But the client required a considerable area of cold storage and it became clear that fit-out would take some time because part of the interior would have to be excavated, Instead it proved quicker to build a new shed from scratch, using the modular ProShed system.

ProShed had been devised over a 12-month period by a team brought together by ProLogis, including Barrett Steel Buildings and Burks Green as architect and engineer.

The team brainstormed all aspects of shed design and construction and in particular looked at causes of delay. They engineered a modular system for both the warehouse and office elements, allowing a bespoke building to be put together from pre-designed standard elements. Construction is speeded up dramatically by virtually removing design and lead-in times and drawing costs.

ProShed is based on a matrix grid, and can be of any size. The steel grid is designed to cater for all wide and narrow aisle racking layouts. Offices too are modular, using a steel and precast panel design.

A new safety handrail solution, which slots into brackets on the structural steelwork, allows vertical and roof cladding to start simultaneously. Conventionally, the handrail is fixed to the side rail system, meaning that vertical cladding cannot begin until the roof is completed.

Steel instead of concrete ground beams are used for economy, speed and easier integration of other trades.

Standard off-the-shelf components are used wherever possible, including Corus HPS200 panels for roof cladding.

The 175,000sq ft, £3.8M distribution centre took only 50 working days or 10 weeks to construct, tailored to Wetherspoon's specific needs, at no extra cost compared with a conventional shed.

adds that contracting-out of logistics is a continuing trend in the UK, which already has the highest level of outsourcing in Europe.

This trend is fuelling the growth of a market for speculatively-built sheds.

Barrett's Andrew Marston says: "Two years ago there was very little spec-building. Now there are several big developers who are speculatively building units of up to half a million sq ft. The demand is definitely there."

Along with Gazeley, the biggest developers in this field are Astral, ProLogis and Rosemound. In a typical year Gazeley undertakes eight or nine major projects in the UK and in 2004 constructed 10M sq ft of warehouses.

Mr Fitzpatrick estimates that between two-thirds and three-quarters of new space transactions in 2004 were speculative premises. It reflects the fact that a logistics firm will want premises quickly when it wins a new contract, and that planning consent in the UK is taking longer than it used to. "Logisticians prefer units that are complete or coming out of the ground," he says.

In turn this has led to developers devising systems to compress the building process. Gazeley has G-Track, first used on a TNT site in Lutterworth and its Magna Park in Arras, France, where it built a 22,000m^2 unit in 14 weeks.

G-Track involves assembling a construction team consisting of suppliers — engineer, architect, steelwork contractor — with whom the company has worked in the past so that there is a good working relationship between all the parties. "We rely on their input to each stage of the process to get better co-ordination between the activities and trades," says Mr Fitzpatrick.

As far as possible elements are prefabricated off-site. Typically dock units and firewalls will be precast. Even office walls may be precast instead of using blockwork.

As far as the steel frame is concerned site work is eliminated as far as possible with any fixings fitted as far as possible in the factory. The co-ordinating role is nominally taken by the main contractor, but the steelwork contractor inevitably has a large role to play. In general it is up to the steelwork contractor to work out where purlins can be omitted to leave room to crane materials into place and programme the job so that these areas can be finished later.

ProLogis's ProShed system is a different approach. G-Track allows a one-off building to be constructed more quickly, but still relies on an essentially traditional system of construction, though with more effective co-ordination between the trades.

ProShed is designed as a modular system from which pre-designed elements can be chosen and fitted together as needed for a given design.

"ProShed is engineered to be quick," says Barrett's Mr Marston, who worked on the first ProShed development in Daventry, Northamptonshire. "It slashes the development time, and you can build it even in bad weather or when daylight is short."

Meanwhile, Billington's Mr King says another

source of work for the company is for retailers who want mezzanine floors adding to existing sheds. "Companies such as Asda, Tesco and Sainsbury are typically putting restaurants, clothes and other non-foods upstairs," he says.

The most dramatic example was the short-lived Marks & Spencer Life store in Gateshead. This had a mezzanine with an elliptical space in the centre, which allowed a full-size house to be built to showcase the products on sale. Billington has a number of other mezzanine projects under way at present.

The next development on the horizon could be the true multi-storey shed, in which lorries can drive directly up to the upper storeys to make deliveries, like a multi-storey car park. The idea originates from Asia and has been enthusiastically espoused by Tim Wheeler, chief executive of the UK's biggest industrial landlord, Brixton. Brixton recently took a group of architects and engineers out to Singapore to see some real examples. The developer may experiment with a two-storey shed initially. BAA is understood to be interested but does not want to pioneer the idea.

A major furniture retailer is known to be seeking planning permission in the UK for a store with lorry ramps to the first floor, but it is not yet clear whether other developers are enthusiastic.

"It's a very interesting idea but we haven't researched it in detail," says Mr Fitzpatrick. "It will come down to the cost of construction versus the additional space. Most of our jobs are on the edge of town, where space is not tight."

Barrett's Mr Marston adds: "We've been talking to a developer, but the numbers don't stack up yet. They will only work in specific areas, such as the south east near Heathrow. The steel content and development costs are higher so they will only be economic where rent and land costs are very high."

For the time being it is likely that the current trend towards bigger distribution centres and shorter construction times will continue. And that will give steel contractors plenty to do for some time to come.

New direction at The Junction

Caunton Engineering is steelwork contractor on The Junction Retail Park project in Hull, being developed by Simons Estates.

The area is being developed into a large retail site on what was originally a leisure-based complex centred on a Mega Bowl bowling alley.

The structure is a 51m span portal frame 230m long, providing 10,990m^2 of floor space, and comprising 700t of steelwork. The project's first phase was completed earlier this year. Caunton is responsible for steelwork design and supply, with Simons Construction, a sister company of the developer, leading the design and build contract. Prospective tenants include Currys and PC World.

Ardra is easier for Atlas Ward

Atlas Ward played a coordinating role in the construction of the two multi-bay structures.

The fact that the Ardra Road project in Edmonton, Hertfordshire, consists of two distribution sheds made co-ordinating work with other trades simpler for Atlas Ward Structures. Typically the steelwork contractor will erect the main frame, fit purlins and side rails as far as possible, and then leave the cladding contractors to get on with their part of the job. Usually the side rails can only be fitted above 8m if precast ground beams are used, to allow them to be craned in. On multispan sheds, an area of roof purlin may have to be omitted to allow the crane used by the cladding contractor to reach through the roof to deliver materials.

All this means a return trip by the steelwork contractor to complete these areas, and possibly another to finish details such as the gatehouse and any external canopies and sun-breaks which have to wait till all the cladding is complete.

Atlas Ward project manager Andrew Bramley says of Ardra Road: "Because there were two units on the job we only had to come back once. It was like two contracts with a slight lag. We were able to move to the second building while the cladder was working on the first, then go back to unit one after the precast ground beams were placed."

Unit one is a small twin span structure with two 34m bays, 105m in length with an in-built office. Unit two is larger with three 32m bays, 173m long, and offices at one corner, partly inside and partly outside the main shed. Atlas Ward played a key role in drawing up a programme to co-ordinate work by the different trades within an overall programme of 11 weeks. "We developed a programme to show where the cladder could go in — it's something we're used to doing — and then thrashed out the details with everyone around a table. You have to have a flow between different subcontractors working in the same areas."

The Ardra Road site is situated off the A10, two miles from the M25 and also close to the A406 North Circular Road. Developer is Prologis (though not using the ProShed system) with Fitzpatrick as main contractor. The larger, speculatively built unit covers 16,750m^2. The first is to be occupied by a leading furniture retailer. Overall value of the project, which should be fully operational by the end of May, is £1.2M.

Designing portal frames

Portal Frames account for some 40% of structural steelwork used in the UK, but they are far from simple structures. David Brown and Martin Heywood of the Steel Construction Institute highlight some of the key design issues.

Portal frames are familiar to us all. Large spans, low pitches, and used throughout the UK. Portal frames account for around 40% of structural steelwork used in the UK, and are common enough to have their own special rules in BS 5950. Often, portal frames are designed using software specially written for that form of construction. Tempting, then, to assume that the design of portal frames is simple. On the contrary, portal frames involve most types of structural phenomena that designers might meet, all in the one structure. This article highlights some of the more important design issues that should not be overlooked. Familiarity should not lead to inattention!

Restraint at the column top

It is essential that the inside flange of the column be restrained where the column meets the underside of the haunch, as shown in Figure 1. This requirement is simply to prevent that point buckling out of plane under the massive compression forces present. Often the column will be at or very near its full moment capacity, with a keen desire to buckle. Regrettably, it is not uncommon to see frames without a restraint at this point. If the restraint is to be provided by knee (or 'fly') bracing, then a side rail must be provided at this level. This can seem uneconomic, as the sheeting can often span to a side rail located at a much lower level, but the importance of a restraint at that level cannot be over-emphasised. The original research and the code clauses expect a restraint at that point. If restraints are provided at a lower level in the column, and at some point along the haunch, it may appear that the region is restrained. There is no clause in the Standard that describes how members under a large bending moment and incorporating a massive change in direction are to be designed, however.

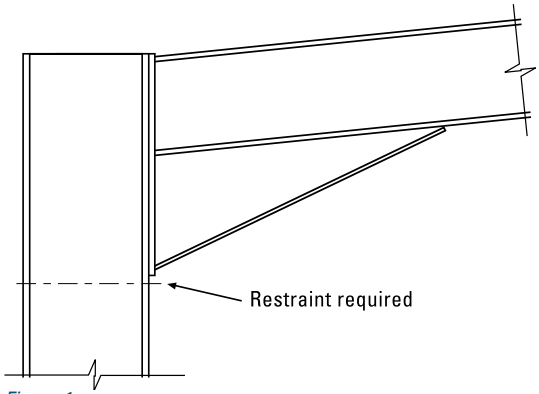


Figure 1.
Restraint to the inside of the eaves joint

Restraints around the frame

In completed structures, the system of restraints to the inside flange is often interesting, and is a good indicator of how well the structural mechanics has been understood. In the gravity load case, the inside of the frame in the eaves region is in compression, and the inside flange of the column, haunch and rafter will need restraining – often by fly bracing. The moments in this region are high, and several restraints are likely. Toward the apex, the outside of the frame is in compression, but here the purlins automatically restrain the compression flange.

In the wind uplift cases, the region near the apex has compression on the inside flange, and often restraints are needed. Compared to the eaves region in the gravity load case, the moments are lower, and fewer, more widely spaced restraints are usually sufficient. A typical layout of restraints is shown in Figure 2. If restraints seem to be provided every second purlin as if by default, one might question the reason.

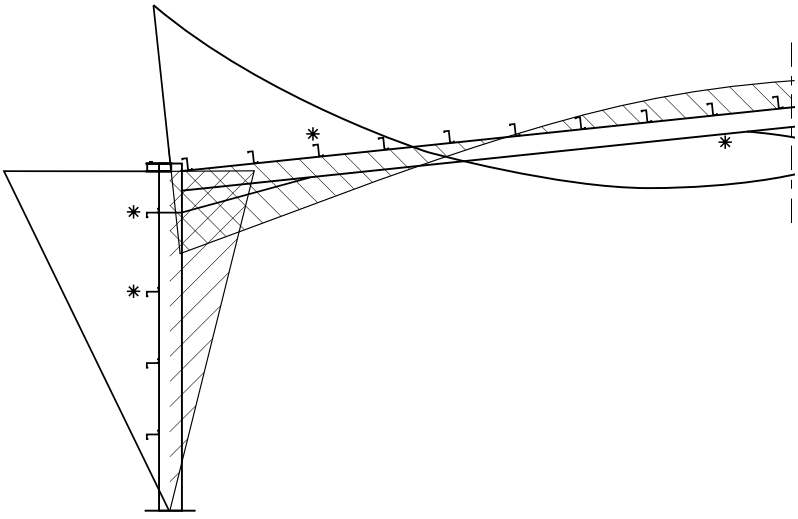


Figure 2
Typical restraint layout

In Figure 2, a restraint is provided at an intermediate side rail. The rail does need to be continuous – if the elevation is perforated by roller shutter doors and the side rails are in short lengths between the door posts, it is unlikely that fly braces to the column are effective. At the design stage, it is likely that the section size of the column must be increased, until it has sufficient resistance without intermediate restraints. In look-up tables, this condition is sometimes described as 'unrestrained'.

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Relative size of rails and purlins

Years of experience have demonstrated that at reasonable spans, the combination of UB members and light gauge rails and purlins perform entirely satisfactorily. Designers should be alert to longer spans, where the same proportions of members may not be maintained. Long spans produce large moments, which demand large members. The compression force in the flange which must be restrained is large. However, if the frames are still provided at 'normal' bay spacing, the purlins and rails will not have grown in size from more modest spans. It is easy to envisage a situation where the stiffness of the secondary member is insufficient to provide the necessary 'U-frame' action, even though locally the fly bracing has a firm grip on the flange. The potential buckled form is shown in Figure 3. This is only a risk at large spans – and need not be considered for normal construction

In-plane stability

All steel-framed buildings need to be checked to ensure that they have adequate in-plane stability and single storey portal frames are no exception. BS 5950-1:2000 contains specific recommendations for portal frame stability, which can be found in Clause 5.5.4. The rules for multi-storey frames given in Clause 2.4.2 should not be used for portal frames.

Three alternative methods are presented:

- The Sway Check Method
- The Amplified Moments Method
- Second Order Analysis

Of the three methods, the Sway Check Method is the simplest and will normally be the designer's first choice. In essence, the method involves little more than applying Notional Horizontal Forces at the top of each column and calculating the corresponding deflections. However, there are a number of pitfalls that are worthy of comment in this article.

a) Geometrical limitations – BS 5950-1:2000 places limitations on the use of the Sway Check Method relating to the geometry of the frame. It is essential that these limitations are observed, as trial calculations carried out at the SCI have demonstrated that the Sway Check Method is unreliable outside these limits.

b) Calculation of Notional Horizontal forces – The Notional Horizontal Forces (NHF) should be calculated as 0.5% of the vertical reaction at the base of each column. This is subtly different to the NHF used in checking the stability of multi-storey frames. The NHF used for portal frames should be applied as separate horizontal point loads at the top of each column and should include the vertical component of the wind loading where appropriate.

c) Load cases – Since the 2000 revision of BS 5950-1, there has been a requirement to perform the Sway Check in all load cases (previously it was only used in the gravity load case). Whereas it is possible that the required load factor λ_r for the gravity load case will be 1 (if the height/1000 check is passed), λ_r for load cases including wind will always be greater than 1. In practice however, the wind load cases rarely govern the design of the frame, so it is unlikely that heavier members will be needed as a result of λ_r.

d) Use of formulae – As an alternative to applying the NHF and calculating the horizontal eaves deflection, BS 5950-1:2000 presents formulae that may be used to determine λ_r. Designers should note that these formulae are no more accurate than the use of the NHF; i.e. frames that fail the height/1000 check will not pass the corresponding formula check.

Whichever method is used, designers are advised to take advantage of the column base stiffness, as this will increase the in-plane stability of the frame (reducing the deflection in the Sway Check Method or increasing λ_{cr} in the Amplified Moments Method). For nominally pinned bases, BS 5950-1:2000 permits the use of a base stiffness of 10% of the column stiffness when checking frame stability. Furthermore, there is no need to design the foundation for the base moment arising from this stiffness, provided that the base is assumed to be a true pin (i.e. zero stiffness) for all other ULS checks. Designers will also find it useful to allow for the base stiffness when carrying out the SLS deflection checks. In this case, a base stiffness of 20% of the column stiffness should be used.

Purlin and cladding considerations

The changes to the requirements of Part L of the Building Regulations over recent years have resulted in building designers paying more attention to the cladding than ever before. In the past, these changes have involved increasing the insulation thickness, resulting in the weather sheet

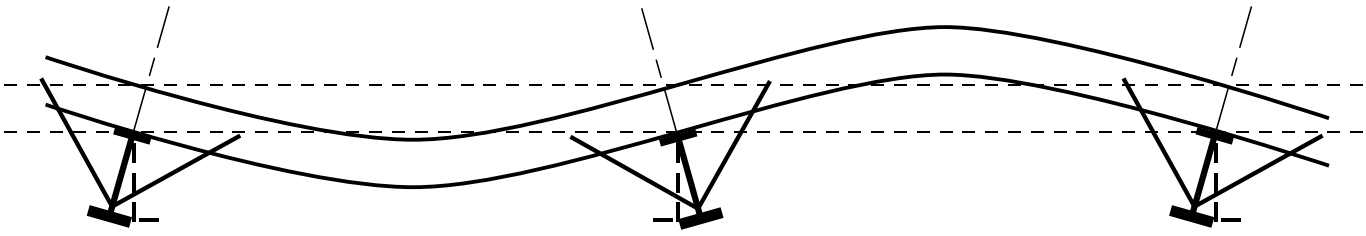

Figure 3
Possible buckling mode at large spans

and liner of built-up systems becoming further apart and all forms of roof cladding becoming heavier. With the insulation thickness now reaching a point where further increases will result in diminishing improvements in performance, greater emphasis is now being placed on air tightness with the promise of strict enforcement of the regulations through on-site testing. There are two issues that designers should be aware of:

a) Purlin restraint – It is common practice in the United Kingdom for designers to select the required purlin size from the manufacturer's load/span tables. The capacities presented in these tables are usually based on the assumption that the purlins will be fully restrained in the gravity load case and partially restrained against wind uplift. The load capacities have in the past been determined by full-scale tests. However, the increase in insulation thickness in recent years has reduced the level of restraint offered to the purlins by the cladding system and designers should check with purlin suppliers that their test results and calculations remain applicable for the proposed cladding system and insulation thickness.

b) Position of purlin flange – With the air leakage requirements becoming ever tighter, accurate installation of the cladding is essential. The quality of the installation will naturally depend in part on the care with which the contractors carry out their work, but it can also be influenced by the condition of the supporting steelwork. In particular, excessive sag of the purlins in the plane of the roof slope can present difficulties when it comes to fixing the cladding. To avoid any such problems, it is important that consideration is given at the design stage to the method of working on the roof and that the assumptions made at this time are realised on site. For example, operatives should not walk on unrestrained purlins unless they have been specifically designed for this loading.

The SCI is currently engaged on research in this area and further guidance on the specification and installation of purlins and cladding will be published later this year.

New and Revised Codes and Standards

(from BSI Update March 2004)

BS EN PUBLICATIONS

The following are British Standard implementations of the English language versions of European Standards (ENs). BSI has an obligation to publish all ENs and to withdraw any conflicting British Standards or parts of British Standard. This has led to a series of standards, BS ENs using the EN number.

BS 4:-
Structural steel sections
BS 4-1 (Revision)
Specification for hot-rolled sections
Will supersede BS 4-1:1993

BS EN 1991:-
Accidental actions
BS EN 1991-1:-
Eurocode 1. Actions on structures
NA to BS EN 1991-1-2:2002
Actions on structures exposed to fire
BS EN 1991-1-7
Accidental actions

CEN EUROPEAN STANDARDS

EN 1994:-
Eurocode 4. Design of composite steel and concrete structures
EN 1994-1-1:2004
General rules and rules for buildings

EN 10292:-
Continuously hot-dip coated strip and sheet of steels with higher yield strength for cold forming. Technical delivery conditions.

AMENDMENT 2: December 2004 to EN 10292:2000

Payment provisions still disappoint

The long awaited consultation paper from the Department of Trade and Industry (DTI) on reform of the Construction Act has now been published. BCSA Legal Director Marion Rich analyses what it means for specialist contractors.

At last we have the consultation paper from the Department of Trade and Industry (DTI) on the Construction Act.

You will remember, I am sure – see my article in New Steel Construction volume 12 number 5 of September/October 2004 – that a Review of the Construction Act was announced by the Chancellor of the Exchequer in the Budget papers last year and was carried out by a Review Group headed by Sir Michael Latham under the auspices of Nigel Griffiths MP, Construction Minister at DTI. Task groups looked at payment and adjudication and reported to the Review Group in September 2004. Sir Michael in turn reported to the minister. The awaited DTI consultation paper was finally published just before Easter this year. It relates to England and Wales only at the moment.

So how does the consultation paper match up to the Review? The main thrust of the Review is to do with improving payment in the construction industry, so payment is the place to start.

PAYMENT

Proposals on payment

The Specialist Engineering Contractors' Group (SECG), of which BCSA is a member, believes that the most important thing that this Review should achieve is to ensure that a debt crystallises by the final date for each payment. This is what the Act originally set out to achieve by introducing in s.110 of the Act the concept of 'adequate mechanism' and the requirement for a payment notice. However, it is now clear that, even when a s.110 notice is served, a debt is not necessarily established. The right of suspension in s.112 and withholding under s.111 (insofar as it relates to set off) are both predicated upon there being a debt.

The consultation paper proposes dropping the need for a s.110 notice and setting out the elements of an adequate mechanism for payment. It also proposes giving the payee a statutory right to make an application. The trouble is that it is not possible to see how these proposals would ensure debt crystallisation: DTI's 'default' option is to adjudicate. Adjudication should not be part of the normal payment process.

During the Review, SECG proposed the following simple procedure:

- The payee to have a statutory right to apply for payment in respect of the work and services to be provided under the contract;
- The payer to have a right to challenge the amount applied for by the issue of a withholding notice before final date for payment;
- The amount in the payee's application or the difference between that amount and any lesser amount withheld shall constitute a debt at the final date for payment.

This seems to be clear, simple and fair to both payer and payee.

It was also proposed during the Review that withholding notices should contain detail of the reasons and calculations behind the withholding; DTI does not agree to this but has proposed that the amount remaining to be paid after withholding should be notified. This is useful as far as it goes but it does not go far enough.

Conditional Payment Provisions

BCSA members have been saying for some years now that 'pay when certified' clauses are more and more frequently being used to mitigate the effect of the outlawing of general pay when paid clauses. SECG proposed that all conditional payment clauses should be banned – including both pay when certified clauses and clauses providing for pay when paid in the event of third party insolvency, currently allowed under the Act.

The consultation paper rightly sets out the arguments against pay when certified clauses. However, it lacks the courage of its convictions and proposes that 'pay when certified' clauses should fulfill the criteria of an adequate mechanism under certain conditions that do not seem to address the main problem with pay when certified – that a subcontractor has no remedy where the certification procedure breaks down.

As an alternative, DTI put forward the possibility of guidance to subcontractors so that parties can then negotiate. I find it touching the faith that politicians and civil servants always seem to put in the power of guidance to change behaviour.

As far as pay when paid in the event of third party payer insolvency is concerned, DTI proposes to maintain the status quo in the absence of what it calls 'clear evidence that the removal the current exception would [deliver a fairer outcome than the current legislation]'.

Reimbursement for the costs of suspension and additional time for remobilisation

DTI has agreed that these should be a statutory right when s.112 is exercised. This is good. It carries on to suggest that the Scheme should contain a

fall-back position where the contract does not set out rights – and proposes a maximum of 5% of the value of payment outstanding and a maximum of 7 days for remobilisation. However, an artificial maximum is not very helpful.

Making contractual provisions on cross contract set-off inefective

The consultation paper proposes making provisions on cross contract set-off ineffective whilst retaining equitable set-off. This would be a good move.

Allowing stage payments under the Scheme for Construction Contracts to be made for materials in advance of their arrival on site

Subject to safeguards, for instance, ensuring that title passes, the consultation paper proposes to amend the Scheme to allow stage payments. No doubt this is good as far as it goes but the Scheme can easily be ignored or amended. Thus the proposal will do little to address the situation in which many BCSA members find themselves, that they have expended 80 or 90% of their costs before thay arrive on site. What is required is an amendment to s.109 to give a start date for instalments.

Payment proposals upon which DTI has declined to consult

For one of these issues, costs, DTI has already agreed to legislative change. The basic position will be that parties should bear their own costs. Any agreement in the contract to any other effect will be ineffective. However, adjudicators will be obliged to deal with costs where both parties ask for costs after the reference has been made.

There are two further payment issues, both of great importance for specialist contractors upon which DTI has not consulted: proposals for insolvency protection and limit on length of payment periods. This appears to be because construction is not allowed to be a special case. This is strange as it already is a special case - it has its own dedicated legislation in the shape of the Act. In many other jurisdictions – in Europe, North America and Australia – construction is treated as a special case with protection against the risk of insolvency. As far as a limit on the length of payment periods is concerned, it seems clear that payment periods are being extended in order to limit the effectiveness of the Act. That is a good reason for having a 'long stop' period.

ADJUDICATION

Trustee stakeholder accounts

It is not infrequent to see contractual provisions requiring adjudicators to order payement of sums the subject of an adjudication decision into a trustee stakeholder account, often until the end of the project. DTI has agreed that such provisions should be ineffective, with an exception under the scheme in circumstances where the receiving party is involved in insolvency proceedings that will require the adjudicator to act as trustee, perhaps for a long time. Will adjudicators want this role? Who will pay?

Adjudicator's power to rule on own jurisdiction and right to payment when adjudicator stands down for lack of jurisdiction'

DTI agrees that adjudicators should be given power to rule on their own jurisdiction in certain matters. This will certainly save costs and time in challenges to jurisdiction. The matters over DTI proposes to give adjudicators such power are largely sensible but with some odd exceptions:

- whether there is a contract
- whether a contract is in writing for the purposes of s.107
- whether the contract is with a residential occupier or is of another excluded description (s.106 is specifically excluded from the adjudicator's remit).

DTI proposes that there should be a clear right for adjudicators to be paid if they stand down for lack of jurisdiction although it is arguable that such a right already exists.

Providing the adjudicator with the power to re-open 'final and conclusive' decisions

The exclusion from the adjudicator's jurisdiction under the Scheme of certificates and decisions stated to be 'final and conclusive' (paragraph 20(a)) was inserted to deal with Final Certificates under JCT contracts. The trouble is that over the years, all sorts of things appear in contracts under the banner of being 'final and conclusive': interim valuations, extensions of time, health and safety issues. DTI proposes to amend the Act (not merely the Scheme) to allow adjudicators to 'open up, review and revise' any decision or certificate, subject to the exception currently in the Scheme. This exception would be subject to a new qualification that the decision or certificate is 'of substance to a non-interim payment' (this would be for the adjudicator to decide). This helps to some extent but does not seem to deal with non-payment decisions.

Adjudication and other matters upon which DTI has declined to consult

Some of these are among the most important for contractors:

- **Single adjudication procedure** There was a large degree of consensus among the industry, both at the first review of adjudication and during this Review, that there should be only one adjudication procedure, as is the case in other jurisdictions that have similar legislation (New Zealand, Singapore, some Australian states). One procedure makes life simpler for all parties and avoids unnecessary arguments with their concomitant cost.
- **Mitigation of the effects of the decision in RJT *Consulting Engineers v DM Engineering*** This is the case that radically altered our understanding of s.107 of the Act. S.107 provides that a construction contract has to be in writing for the Act to apply and goes on to define what 'in writing' means. The Court of Appeal decided that all the terms of the contract (or at least all relevant terms) must be in writing. In the construction industry, contracts often do not have everything set out neatly in writing and it is naïve to think that this is suddenly going to happen. This interpretation of s.107 could mean that large numbers of contractors find themselves with no right to adjudicate their disputes. DTI however regards the interpretation of the Court of Appeal as 'appropriate in the context of adjudication', despite the fact that a large majority of the representatives of the construction industry appear to disagree.
- **Amendments to the scope of the legislation** This covers three issues, exclusion of head contracts under PFI, exclusion of contracts with residential occupiers and revision to the exclusion of process plant. On PFI, DTI's view appears to be that these contracts are far removed from traditional construction contracts and that there are no major problems. With regard to residential occupiers, the reasoning is that adjudication would represent an unwanted shift in balance away from the customer and towards the industry. This is debatable!

The most important item in this category is the refusal even to consult on bringing the process plant industry into the scope of the Act. There has been considerable litigation to try and decide exactly what is within scope and what is not. This is a major difficulty for thousands of small companies for which litigation is an expensive burden.

OTHER ISSUES

The consultation paper also deals with a number of other matters relating to adjudication generally and to the Scheme in particular that are probably of more immediate relevance to adjudicators than they are to BCSA members.

CONCLUSION

The consultation paper, while certainly comprehensive, is disappointing in many respects. The Act has never worked quite as intended from the start. We have been – thanks in part to a great deal of work on the part of BCSA and its SECG colleagues – given an opportunity to put things right. The Review will shape how the Act works for the next 10 or 20 years. It would be a great shame not to make the Act as perfect as possible while we have that chance. I hope that as many interested parties as possible will help DTI to achieve this by responding to the consultation paper.

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BUILDING WITH STEEL

New Water Chute at Southend's Kursaal

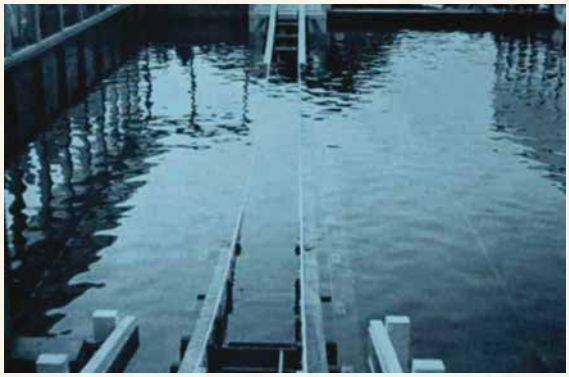
A landmark familiar to several generations of visitors seeking pleasure at the famous Kursaal Amusement Park, Southend-on-Sea, was the huge water chute which dominated the surrounding buldings and stall. This structure has now beeen replaced by a new water chute of equally preposessing dimensions and which comes into service when the Kursaal re-opens for the 1965 season.

The previous water chute – of steel construction – was originally erected at the White City Exhibition at Shepherds Bush around 1905. In 1922 it was re-erected at the Kursaal and was in continuous operation until 1963. The lasting qualities of steelwork, even in a corrosive marine atmosphere, are well demonstrated by the fact that the structure was still in first class condition even after 60 years service. But the design had become obslete and uneconomical – the time taken by the cars to reach the top was unduly long, the turnaround procedures and the top at bottom were cumbersome and it required 20 attendants to ensure smooth operation.

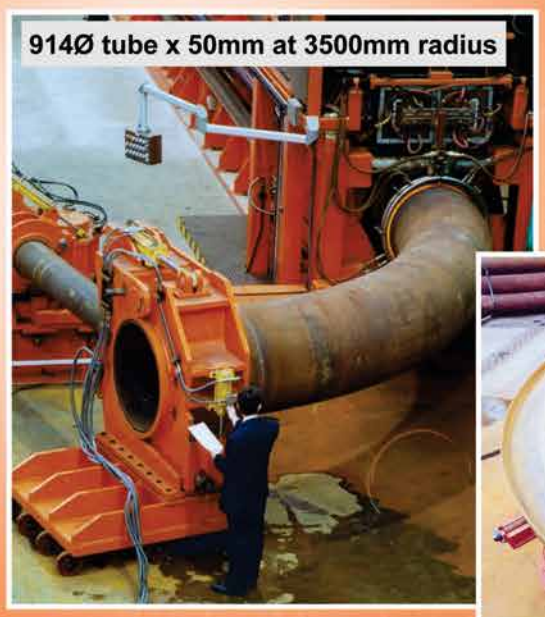
Other recent water chutes of this type have been erected in wood and the Kursaal authorities had to decide whether to build in this or another material. After careful research it was found that steel work would not only be more economical and easier and quicker to erect but, being galvanised, easier to maintain. Timber construction would have required expensive impregnated Canadian Pitch Pine to be imported because of the considerable lengths required. Also, because of the need for periodic repainting, maintenance would have been quite expensive.

The new water chute has six boats, each carrying six passengers and is operated by just five attendants. Each boat is pulled up the incline by a motor driven endless chain, and released at the top. Gravity does the rest – the boats travel around a slight incline on the banked top half circle, then plunge down a steep slope into the water 50 feet below with a tremendous splash. They then complete their journey around the lower half circle, coming to rest at the station under the control of a braking system comprising squeeze type angles.

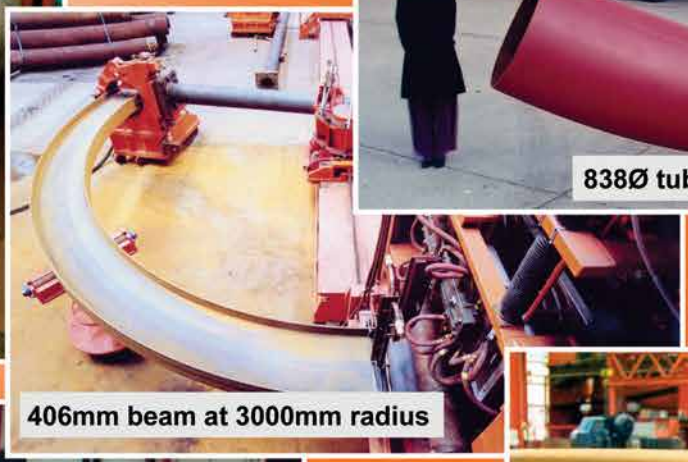
As the boats travel around the circuit the structure is subjected to very severe shock loads and thus maximum strength and rigidity are essential requirements. The elevated portion comprises a series of braced towers of varying heights designed as cantilevers from the ground level bases to resist wind pressure: a system of inter-connecting cross braces ensures neccessary rigidity.



Too tight to curve?... think again!


914Ø tube x 50mm at 3500mm radius

838Ø tube x 20mm spiralled tube


406mm beam at 3000mm radius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AD 286
Preloaded Bolts: The Net Effect of Applied Tension and Preload

Although the fundamental issues relating to the effect of applied tension and preload on bolts were covered in AD 184, which deals with preload due to tightening on ordinary (non-preloaded) bolts, we continue to receive many questions concerning this effect for preloaded bolts. This Advisory Desk Note explains why the bolt load in preloaded bolted steelwork connections, when subjected to applied tension, is **not** the sum of the preload *(P)* and the applied tension *(T)*.

When preloaded bolts are tightened or torqued, considerable tension is induced into the shank of the bolt. This tension in the bolt is called the preload, *P*, and clamps the plies together in compression as shown in Figure 1.

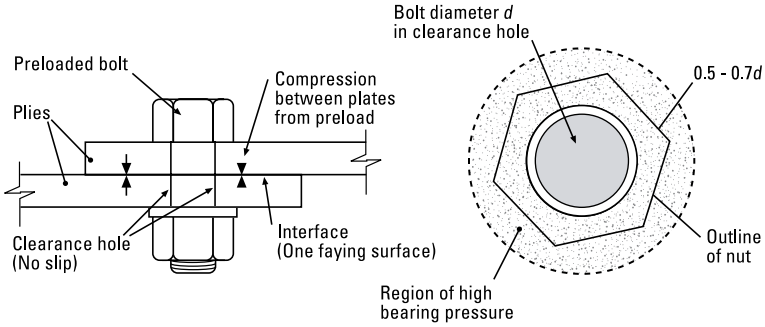

Figure 1 – Preloaded bolt arrangement

In preloaded bolts the preload in the shank is balanced by compression under the head and nut of the bolt, which induces the required compression or pressure on the faying surfaces for non-slip joints. The equilibrium of the components (separated for clarity) before the application of the applied tension *T* is shown in Figure 2. Each component has a force *P* and an equal and opposite reaction *P*. Therefore, everything is in equilibrium.

When tension is applied to a connection component as a result of axial load or moment, designers often refer to the calculated 'bolt load' or 'bolt tension'. However, in steelwork connections the applied tension does not act directly on the bolt but instead acts on the plies or plates in the joint. In non-preloaded bolted joints the tension is then transferred to the bolt from the plies. In preloaded bolted joints the load path is different.

All the components are in equilibrium and the load in the bolt is still *P*. The applied tension only reduces the intensity of pressure on the faying surface from *P* to *(P-T)* and the equilibrium of the ply is *T + (P-T) = P*. The bolt load remains *P* and is not the sum of *P+T*.

From the equation of equilibrium for the ply, if the applied tension equals the preload, *P-T* is zero and the plies are on the point of separation but the bolt load is still equal to *P*.

If *T* is greater than *P* the bolt will have stretched and the plates have separated; the bolt load is then equal to *T*. At this stage the connection is behaving as a non-preloaded bolted joint. The bolt load cannot increase above the preload *P* unless the bolt stretches and the bolt cannot stretch until the plies separate. In general, there is no increase in the bolt load unless the applied tension exceeds the preload.

A similar analysis can be carried out assuming the applied tension acts at the external face of the plies and that the plies are not rigid. In this case the plies and the bolt stretch slightly, due to the load applied at the outer face, but because the stiffness of the plies is much greater than that of the bolt, the strain and the increase in the bolt load above the value of the preload *P* will be very small. However, again, the main point to note is that the bolt load is **not** simply the sum of *P+T*.

Note that the value of *T* applied at the bolt position must include any value for prying action, where it occurs. Prying is a complex subject and depends on many variables including the bolt and ply dimensions as well as the layout of the joint.

If a designer engineer requires greater understanding of these issues they are referred in the first instance to the article by P. J. Gill – Notes on the Load Carrying Characteristics of Pre-Tensioned Bolts: Tensioned Joints – that appeared in the Proceedings of the Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, 1959. This Advisory Desk Note has drawn heavily from this article.

Contact: Thomas Cosgrove
Email: t.cosgrove@steel-sci.com
Telephone: 01344 623345

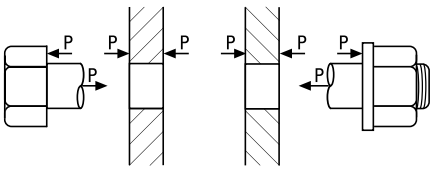

Figure 2 - Equilibrium of components before application of applied tension, T

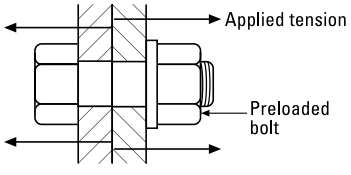

Figure 3 – Applied tension acting at the faying surface of a preloaded joint

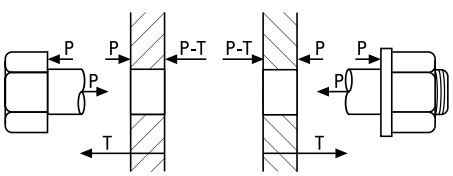

Figure 4 - Equilibrium of components after application of applied tension, T

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You can find out email and website addresses for all these companies at www.steelconstruction.org

BCSA is the national organisation for the construction industry; its member companies undertake the design, fabrication and erection for all forms of construction in building and civil engineering. Associate Members are those principal companies involved in the purchase, design or supply of components, materials, services etc, related to the industry. Corporate Members are clients, professional offices, educational establishments etc, which support the development of national specifications, health and safety, quality, fabrication and erection techniques, overall industry efficiency and good practice. The principal objectives of the association are to promote the use of structural steelwork; to assist specifiers and clients; to ensure that the capabilities and activities of the industry are widely understood; and to provide members with professional services in technical, commercial and quality assurance matters.

Details of BCSA Membership and services are available from: Gillian Mitchell MBE, Deputy Director General, British Constructural Steelwork Association Ltd, 4 Whitehall Court, Westminster, London SW1A 2ES. **Tel** 020 7839 8566 **Fax** 020 7976 1634

KEY

Categories

- **A** All forms of building steelwork
- **B*** Bridgework
- **C** Heavy industrial plant structures
- **D** High rise buildings
- **E** Large span portals
- **F** Medium/small span portals and medium rise buildings
- **H** Large span trusswork
- **J** Major tubular steelwork
- **K** Towers
- **L** Architectural metalwork
- **M** Frames for machinery, supports for conveyors, ladders and catwalks
- **N** Grandstands and stadia
- **S** Small fabrications

Quality Assurance Certification

- **Q1** Steel Construction Certification Scheme Ltd
- **Q2** BSI
- **Q3** Lloyd's
- **Q4** Other

Classification Contract Value

- **10** Up to £40,000
- **9** Up to £100,000
- **8** Up to £200,000
- **7** Up to £400,000
- **6** Up to £800,000
- **5** Up to £1,400,000
- **4** Up to £2,000,000
- **3** Up to £3,000,000
- **2** Up to £4,000,000
- **1** Up to £6,000,000
- **0** Above £6,000,000

Notes

1. Applicants may be registered in one or more categories to undertake the fabrication and the responsibility for any design and erection of the above.
2. Where an asterisk (*) appears against any company's classification number, this indicates that the assets required for this classification are those of the parent company.

* For details of bridgework sub-categories contact Gillian Mitchell at the BCSA.

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Bocad Service International S A
International Iron & Steel Institute (IISI)
Staalinfocentrum - Centre Information Acier

Brazil
Brazilian Centre of Steel Construction (CBCA)
CODEME Engenharia S.A.
Gerdau Acominas S.A.
Universidade Federal da Ouro Preto
USIMINAS

Canada
Canadian Institute of Steel Construction

Chile
Construcciones Y Montajes S.A (COYMSA)

Croatia
Institut Gradevinarstva Hrvatske

Finland
Finnish Constructional Steelwork Association
Rautaruukki Oyj
Seinajoki Polytechnic
VTT Building and Transport

France
CTICM
Terrell International

Germany
Bauen mit Stahl e.V.
POSCO Research Centre Europe

Greece
Democritus University of Thrace
K.Liaromatis SA
Maraveas & Associates SA
Metallostegastiki SA
Technical Chamber of Greece (TEE)

Hong Kong
Arup Group
Corus Asia Ltd
The Hong Kong Polytechnic University
WSP Asia

India
Bechtel Overseas Corporation
Institute for Steel Development & Growth

Ireland
Barrett Mahony Consulting Engineers
Barry Kelleher & Associates
C S Pringle Consulting Engineers
Corus Ireland
Coyle Kennedy Ltd
Downes Associates
Dryform Limited
ESB International Ltd
Frank Fox & Associates
Fusion Building Solutions
Hanley Pepper Consulting Engineers
Hayes Higgins Partnership*
J B Barry & Partners Limited*
Joda Engineering Consultants
John Doyle & Associates
Kigallen & Partners Consulting Engineers Ltd
McCabe Delaney*
The McKenna Pearce Practice
Michael Punch & Partners
National University of Ireland, Galway
Nestor Kelly
Nordman Profile Ltd
O'Connor Sutton Cronin
Oliver Russell & Associates Ltd
Pat O'Gorman & Associates *
Project Management Ltd
RPS-MCOS Ltd
SIAC Butlers Steel Ltd
Stanta Limited
University College Dublin
Walsh Draughting Services Ltd

Italy
FICEP S.p.A.
Politecnico Di Milano
Universita Degli Studi Di Trento

Kenya
David Engineering Ltd
H P Gauff Consulting Engineers
Steel Structures Ltd*

Korea
INI Steel Company
Korea University

Lithuania
Vilnius Technical University

Malaysia
Corus Asia Ltd
Malaysian Structural Steel Association
Universiti Teknologi Malaysia

The Netherlands
Bouwen met Staal
Delft University of Technology

New Zealand
Heavy Engineering Research Associates

Norway
Tee Consult Holding AS

Portugal
GEG - Gabinete de Estruturas e Geotecnia Ltda
Universidade de Aveiro
Universidade de Coimbra

Principality of Liechtenstein
HILTI AG

Qatar
Metalex Trading & Contracting Co. W.L.L

Republic of Singapore
Corus South East Asia Pte Ltd
Jurong Engineering Ltd
LSW Consulting Engineers
Ngee Ann Polytechnic
Singapore Structural Steel Society

Slovenia
University of Ljubljana

South Africa
Southern African Institute of Steel Construction

Spain
In Hoc Signo Vinces
ITEA
University of Navarra

Sweden
Luleå University of Technology
Outokumpu AB
Swedish Institute of Steel Construction

Turkey
CIMTAS Celik Imalat Montaj Ve Tesisat A.S.
UMO Architecture Engineering and Consulting Ltd Co

United Arab Emirates
Corus Middle East
GINCO Steel L.L.C.
The PHB Group
Techno Steel Construction Co

USA
American Institute of Steel Construction Inc
American Iron & Steel Institute (AISI)
Corus America Inc
Epic Metals Corporation
Steel Recycling Institute

**New corporate members since last long list in March 2005 issue*

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